Notices

OF THE AMERICAN MATHEMATICAL SOCIETY

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THE CALENDAR BELOW lists all of the meetings which have been approved by the Council up to the date this issue of the *Notices* was sent to press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change; this is particularly true of meetings to which no numbers have yet been assigned.

ABSTRACTS SHOULD BE SUBMITTED ON SPECIAL FORMS which are available in most departments of mathematics; forms can also be obtained by writing to the headquarters of the Society. Abstracts to be presented at the meeting in person must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline for the meeting.

CALENDAR OF MEETINGS

MEETING NUMBER	DATE	PLACE	DEADLINE for ABSTRACTS * and NEWS ITEMS
---		No June meeting	April 15 (News Items only)
747	August 14-18, 1977 (81st Summer Meeting)	Seattle, Washington	June 7
	October 29, 1977	West Lafayette, Indiana	
	November 11-12, 1977	Memphis, Tennessee	
	November 11-12, 1977	San Luis Obispo, California	
	January 4-8, 1978 (84th Annual Meeting)	Atlanta, Georgia	
	March 18-23, 1978	Columbus, Ohio	
	April 7-8, 1978	Houston, Texas	
	April 14-15, 1978	San Francisco, California	
	August 8-12, 1978 (82nd Summer Meeting)	Providence, Rhode Island	
	January 11-15, 1979 (85th Annual Meeting)	Milwaukee, Wisconsin	
	April 6-8, 1979	Honolulu, Hawaii	
	August 21-25, 1979 (83rd Summer Meeting)	Blacksburg, Virginia	
	January 3-7, 1980 (86th Annual Meeting)	San Antonio, Texas	
	January 8-12, 1981 (87th Annual Meeting)	San Francisco, California	

*Deadline for abstracts NOT presented at a meeting (by title)

June 1977 issue:	APRIL 12
August 1977 issue:	MAY 31

OTHER EVENTS

July 11-August 5, 1977	Summer Research Institute on Automorphic Forms, Representations, and L-Functions, Oregon State University, Corvallis, Oregon
August 12-13, 1977	Fundamentals of Applied Combinatorics (AMS Short Course) University of Washington, Seattle, Washington
August 15-23, 1978	International Congress of Mathematicians, Helsinki, Finland

PLEASE AFFIX THE PEEL-OFF LABEL on these *Notices* to correspondence with the Society concerning fiscal matters, changes of address, promotions, or when placing orders for books and journals.

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Notices

OF THE AMERICAN MATHEMATICAL SOCIETY

CONTENTS

April, 1977

744TH MEETING

Biltmore Hotel
New York, New York
April 14–17, 1977

The seven hundred forty-fourth meeting of the American Mathematical Society will be held at the Biltmore Hotel, Madison Avenue at 43rd Street, New York City, on Thursday and Friday, April 14 and 15.

By invitation of the Committee to Select Hour Speakers for Eastern Sectional Meetings, there will be two one-hour addresses on Thursday, April 14. D. KAZHDAN of Harvard University will speak at 11:00 a.m. on "Representations of semisimple groups over finite fields". At 2:00 p.m. LARRY PAYNE of Cornell University will present a lecture entitled "On improperly posed Cauchy problems for partial differential equations".

There will be two special sessions of selected twenty-minute papers. The titles of these special sessions and the names of the mathematicians arranging them will be found in the section which follows titled SPECIAL SESSIONS.

A special symposium has been arranged to commemorate the 200th anniversary of the birth of C. F. Gauss, who was born April 30, 1777. By invitation of the above committee, there will be three addresses on Friday, April 15. JUN-ICHI IGUSA of Johns Hopkins University will speak on "Gauss' contributions to algebra and number theory" at 10:00 a.m.; D. J. STRUIK of Massachusetts Institute of Technology will speak at 11:00 a.m. on "Gauss' contributions to geometry"; and at 1:30 p.m. MARC KAC of Rockefeller University will lecture on "Gauss' contribution to analysis". Harold M. Edwards, Jr., of the Courant Institute of Mathematical Sciences, New York University, is chairman of this symposium.

Sessions for contributed ten-minute papers are scheduled on both days. No provision has been made for late papers.

The Council of the Society will meet at 2:00 p.m. on Saturday, April 16, in the French Suite (L&M) at the Biltmore Hotel.

SPECIAL SESSIONS

The subjects of the special sessions and the names of the mathematicians participating are as follows: DONALD C. RUNG of Pennsylvania State University has organized a special session on Boundary behavior of meromorphic functions; the speakers will be Karl F. Barth, Boris Korenblum, and George Piranian. MARSHALL SLEMROD of Rensselaer Polytechnic Institute has organized a special session on Control theory; the speakers will be H. Thomas Banks, David L. Elliott, V. Jurdjevic, Andrzej Z. Manitius, and Hector J. Sussmann.

SYMPOSIUM ON COMPUTATIONAL FLUID DYNAMICS

With the support of the Energy Research and Development Administration and the National Science Foundation, a symposium on Computational Fluid Dynamics will be held on Saturday and Sunday, April 16 and 17. This topic was selected by the AMS-SIAM Committee on Applied Mathematics, whose members were Donald S. Cohen (chairman), Richard C. DiPrima, Edward L. Reiss, David Siegmund, and W. Gilbert Strang.

The symposium will attempt to cover a broad spectrum of the areas in which computational fluid dynamics is important, and will seek to uncover the current "best" methods used. In addition, a variety of new types of problems will be presented, as well as numerical methods used to solve them. The role of current advances in numerical analysis (i.e., fast algorithms, adaptive methods and extrapolation techniques) will be explored either directly or in a special discussion session. The Organizing Committee includes Alexandre Chorin, University of California, Berkeley; Herbert B. Keller, Firestone Laboratory, California Institute of Technology (chairman); Peter D. Lax, Courant Institute of Mathematical Sciences, New York University; and R. W. MacCormack, NASA-Ames Research Center.

The list of speakers includes: ALEXANDRE CHORIN; S. C. R. DENNIS (The University of Western Ontario, Canada); BENGT FORNBERG (California Institute of Technology); A. JAMESON (Courant Institute of Mathematical Sciences, New York University); CARL W. KREITZBERG (Drexel University); R. W. MacCORMACK (NASA-Ames Research Center); JAMES J. O'BRIEN (Florida State University); HAROLD D. ORVILLE (South Dakota School of Mines and Technology); and ROBERT F. WARMING (NASA-Ames Research Center).

MATHEMATICIANS ACTION GROUP

There will be a panel discussion on "Budget crisis at CUNY; its effect on standards, curriculum, faculty-student morale, and work load" at 3:00 p.m. on Thursday in the Key Room. Frank R. Buianouckas will serve as moderator. Panelists include Erwin Just, Bronx Community College; Edwin Moise, Queens College; and Harold Shane, Baruch College.

REGISTRATION

The registration desk will be located in the Vanderbilt Suite (N, O, P) on the first floor of the Biltmore Hotel. The desk will be open from 8:00 a.m. to 4:30 p.m. on Thursday and Friday, April 14-15; from 8:30 a.m. to 4:30 p.m. on Saturday, April 16; and from 8:30 a.m. to noon on Sunday, April 17.

The registration fees for the meeting are as follows:

Nonmember	$5
Member	3
Student or unemployed	1

ACCOMMODATIONS

Persons planning to stay at the Biltmore Hotel should make their own reservations directly with the hotel. A reservation form listing the room rates will be found on page A-285 in the February issue of these *Notices*. However, since the deadline for receipt of reservations is March 25, those persons who have not already obtained room reservations should telephone the Biltmore reservation office (212-687-7000) and be sure to mention that they are attending the AMS meeting, in order to obtain these special rates.

TRAVEL

The Biltmore Hotel is located on Madison Avenue at 43rd Street on the east side of New York City. Walkways from Grand Central Station are located under the hotel, and signs are posted directing persons to the hotel lobby.

Those arriving by bus may take the Independent Subway System from the Port Authority Bus Terminal. There is shuttle bus service from LaGuardia and Kennedy Airports directly to Grand Central Station. Starters can direct passengers to the correct bus. Travelers arriving at Newark Airport can take a shuttle bus to the Port Authority Bus Terminal and take the subway, taxi, or bus to the hotel.

Persons arriving by car will find several parking garages in the area, in addition to the garage at the hotel. Parking service can be arranged through the hotel doorman; the present rate is $9.50 for each 24-hour period; however, the rate may increase by the time the meeting takes place. There will be an additional charge for extra pickup and delivery service if it is required. The parking fee is subject to New York City taxes.

MAIL ADDRESS

Registrants at the meeting may receive mail addressed to them in care of the American Mathematical Society, Biltmore Hotel, Madison Avenue at 43rd Street, New York, New York 10017.

PROGRAM OF SESSIONS

The time limit for each contributed paper in the general sessions is ten minutes and in the special sessions is twenty minutes. To maintain this schedule, the time limits will be strictly enforced.

THURSDAY, 8:30 A.M.

Session on Analysis and Applied Mathematics, Park Lounge, Eighteenth Floor

8:30- 8:40 (1) Stability and growth estimates for electric fields in non-conducting material dielectrics. Professor FREDERICK BLOOM, University of South Carolina (744-B2)

8:45- 8:55 (2) Sub- and super-solutions of quasilinear elliptic boundary value problems. Dr. RICHARD J. KRAMER, Pennsylvania State University (744-B13)

9:00- 9:10 (3) The vector of maximum harmonic content with elliptical locus in Chebychev approximations. CHARLES R. GIARDINA, Fairleigh Dickinson University and Singer Aerospace and Marine Systems, Wayne, New Jersey and FRANK P. KUHL*, Singer Aerospace and Marine Systems, Wayne, New Jersey (744-C1)

9:15- 9:25 (4) Well posed problems concerning nonlinear integro-differential systems with hyperbolic operators and self-controlled limits of integration. Professors L. K. KRIVOSHEIN, Kirgizian State University, USSR, K. V. LEUNG, Concordia University, D. J. MANGERON*, Polytechnic Institute of Jassy, Romania, and University of Alberta, and M. N. OGUZTORELI, University of Alberta (744-C2)

9:30- 9:40 (5) An application of functional integration to the Coulomb gas. Debye screening. Preliminary report. Dr. DAVID BRYDGES, Rockefeller University (744-C3)

9:45- 9:55 (6) On infinite dimensional cores. Preliminary report. Dr. RONALD J. STERN, Concordia University (744-C4) (Introduced by Professor Marshall Slemrod)

10:00-10:10 (7) Convergence of states on quantum logics. Preliminary report. Mr. THURLOW A. COOK, University of Massachusetts (744-C5)

10:15-10:25 (8) Why are computerised simulations not mathematical models? Preliminary report. Dr. G. ARTHUR MIHRAM, Haverford, Pennsylvania (744-C8)

10:30-10:40 (9) The higher regularity of liquid edges in aggregates of minimal surfaces. Professor JOHANNES C. C. NITSCHE, University of Minnesota (744-B27)

*For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.

THURSDAY, 9:00 A. M.

Session on Algebra, Rooms L & M, First Floor

9:00- 9:10 (10) Ext in L. Preliminary report. Mr. HOWARD L. HILLER*, Massachusetts Institute of Technology and Professor SAHARON SHELAH, Hebrew University of Jerusalem (744-E2)

9:15- 9:25 (11) Inverse eigenvalue problem for random matrices. Professor F. ALBERTO GRUNBAUM, University of California, Berkeley (744-A6) (Introduced by Professor Jacob Feldman)

9:30- 9:40 (12) Complemented congruences on complemented lattices. Mr. M. F. JANOWITZ, University of Massachusetts, Amherst (744-A1)

9:45- 9:55 (13) On faithful irreducible projective representations. Preliminary report. Professor K. BOLLING FARMER, University of Florida (744-A2)

10:00-10:10 (14) A note on graphical reconstruction. Professor HERBERT S. WILF, University of Pennsylvania (744-A3)

10:15-10:25 (15) Pointwise products of incidence matrices of subgraphs. Preliminary report. Dr. CARL BUMILLER, St.John's University (744-A4)

10:30-10:40 (16) Crossed extensions. Mr. JOHN G. RATCLIFFE, University of Michigan (744-A5)

THURSDAY, 9:30 A. M.

Special Session on Boundary Behavior of Meromorphic Functions, Windsor Room, Eighteenth Floor

9:30- 9:50 (17) Nonrectifiable level sets. Preliminary report. Professor GEORGE PIRANIAN*, University of Michigan and Professor ALLEN WEITSMAN, Mittag-Leffler Institute, Djursholm, Sweden (744-B4)

9:55-10:15 (18) Generalizations of Iversen's Theorem. Professor KARL F. BARTH, Syracuse University (744-B5)

10:20-10:40 (19) A Beurling-type theorem. Dr. BORIS KORENBLUM, Tel-Aviv University, Israel and the Institute for Advanced Study (744-B6)

THURSDAY, 11:00 A. M.

Invited Address, Bowman Room, Lobby Level

(20) Representations of semisimple groups over finite fields. Professor DAVID KAZHDAN, Harvard University (744-A7)

THURSDAY, 2:00 P. M.

Invited Address, Bowman Room, Lobby Level

(21) On improperly posed Cauchy problems for partial differential equations. Professor L. E. PAYNE, Cornell University (744-B21)

THURSDAY, 3:15 P. M.

Special Session on Control Theory, Windsor Room, Eighteenth Floor

3:15- 3:35 (22) Controllability of bilinear systems. VELIMIR JURDJEVIC, University of Toronto (744-C9) (Introduced by Professor Marshall Slemrod)

3:40- 4:00 (23) Controllability and observability of retarded functional differential equations—a C_0-semigroup approach. Dr. A. MANITIUS, University of Montréal (744-B26) (Introduced by Professor Marshall Slemrod)

4:05- 4:25 (24) Approximation methods for control of hereditary systems. Professor H. T. BANKS, Brown University (744-B11)

4:30- 4:50 (25) Stability theory of nonlinear control systems. Dr. N. KALOUPTIDIS and Professor D. L. ELLIOTT*, Washington University (744-C6)

4:55- 5:15 (26) Subanalytic sets and feedback control. Preliminary report. Professor HECTOR J. SUSSMAN, Rutgers University (744-C7)

THURSDAY, 3:15 P. M.

Session on Analysis I, Rooms L & M, First Floor

3:15- 3:25 (27) Interpolating sequences with applications to σ-porous exceptional sets. Preliminary report. Professor D. C. RUNG* and Mr. S. A. OBAID, Pennsylvania State University (744-B14)

3:30- 3:40 (28) The curvatures of the analytic capacity. Dr. JACOB BURBEA, University of Pittsburgh (744-B9)

3:45- 3:55 (29) On vanishing Eichler periods and Carleson sets. Preliminary report. THOMAS A. METZGER, University of Pittsburgh (744-B12)

4:00- 4:10 (30) Interpolation and approximation of generalized axisymmetric potentials. ALLAN J. FRYANT, U. S. Naval Academy (744-B17)

4:15- 4:25 (31) Generalizations of the Robertson functions. Preliminary report. Professor EDWARD J. MOULIS, Jr., United States Naval Academy (744-B25)

4:30- 4:40 (32) Identities involving Fourier coefficients of non-analytic automorphic forms. Professor V. V. RAO, University of Regina (744-B15)

4:45- 4:55 (33) Abstract Wiener spaces for non-Gaussian measures. Dr. STANLEY L. BOYLAN, Touro College (744-B23)

THURSDAY, 3:15 P. M.

Session on Topology, Geometry and Foundations, Park Lounge, Eighteenth Floor

3:15- 3:25 (34) Bounds on simplicial volumes. Preliminary report. Professor FRANCINE F. ABELES, Kean College of New Jersey and Courant Institute of Mathematical Sciences, New York University (744-D1)

3:30- 3:40 (35) Some ultrafilter constructions using Martin's axiom. Preliminary report. Dr. STEVEN GLAZER, Floral Park, New York (744-E1)

3:45- 3:55 (36) A note on the Fréchet topology. Dr. DAVID A. SCHEDLER, Virginia Commonwealth University (744-G1)

4:00- 4:10 (37) Decomposed partial peeling. Dr. OKAN GUREL, IBM Corporation, White Plains, New York (744-G2)

4:15- 4:25 (38) Self equivalence of rational homotopy types. Preliminary report. Dr. JOSEPH NEISENDORFER, Syracuse University (744-G4)

4:30- 4:40 (39) Statically tame periodic homeomorphisms of 3-manifolds. Professor EDWIN E. MOISE, Queens College, CUNY (744-G5)

FRIDAY, 8:00 A. M.

Session on Analysis II, Rooms L & M, First Floor

8:00- 8:10 (40) On local normal forms for diffeomorphisms and flows. Preliminary report. Professor DENIS BLACKMORE, New Jersey Institute of Technology (744-B29)

8:15- 8:25 (41) The classification of C^*-algebra bundles. Professor MAURICE J. DUPRÉ, Tulane University (744-B24)

8:30- 8:40 (42) Solvable extensions of operators of monotone type. Preliminary report. Dr. EDWARD J. CONJURA, Trenton State College (744-B8)

8:45- 8:55 (43) On the sampling rate for cardinal series representations. CHARLES R. GIARDINA, Fairleigh Dickinson University and Singer Company-Kearfott Division, Wayne, New Jersey (744-B20)

9:00- 9:10 (44) A complete normed space $C^n_{[a,b]}$. Preliminary report. Dr. YEN TZU FU, Indiana State University, Evansville (744-B18)

9:15- 9:25 (45) Approximation by discrete Jackson-type operators. Preliminary report. Professor S. EISENBERG, University of Hartford (744-B3)

FRIDAY, 8:00 A. M.

Session on Differential Equations, Room H, First Floor

8:00- 8:10 (46) Asymptotic solutions of a certain differential equation. Professor T. K. PUTTASWAMY, Ball State University (744-B19)

8:15- 8:25 (47) Design of Bi-focal lenses. Preliminary report. Dr. WILLIAM R. MELVIN, University of Rhode Island (744-B22)

8:30- 8:40 (48) On the Whittaker differential equation and Laplace transforms. Dr. JAMES D'ARCHANGELO, U. S. Naval Academy (744-B10)

8:45- 8:55 (49) A generalized Laplacian operator. Dr. JOHN F. SCHMEELK, Virginia Commonwealth University (744-B1)

9:00- 9:10 (50) On the instability of nonlinear vibrations of beams with various boundary conditions. Professor R. B. RAM*, State University of New York at Oneonta and Professor G. R. VERMA, University of Rhode Island (744-B28)

9:15- 9:25 (51) Saddle points and instability of solutions of nonlinear partial differential equations: Some examples. Professor HOWARD A. LEVINE, University of Rhode Island (744-B7)

FRIDAY, 8:30 A. M.

General Session, Room T, First Floor

8:30- 8:40 (52) Infinite variate wide-sense stationary Markov processes. Dr. MILTON ROSENBERG, Rockaway Beach, New York (744-F1)

8:45- 8:55 (53) Multiple scales analysis of a randomly-perturbed one-dimensional wave equation. Preliminary report. WERNER KOHLER, Virginia Polytechnic Institute and State University (744-F2)

9:00- 9:10 (54) Entropy of a random field. Professor MILLU ROSENBLATT-ROTH, State University of New York at Buffalo (744-F3)

9:15- 9:25 (55) Metric topological division algebras. Dr. GERHARD F. KOHLMAYR, Mathmodel Consulting Bureau, Glastonbury, Connecticut (744-B16)

FRIDAY 9:45 A. M.

Gauss Symposium, Bowman Room, Lobby Level

Chairman: Robert M. Edwards, Courant Institute of Mathematical Sciences, New York University

9:45-10:00 Introduction

10:00-10:50 Gauss' contributions to algebra and number theory. JUN-ICHI IGUSA, Johns Hopkins University

11:00-11:50 Gauss' contributions to geometry. D. J. STRUIK, Massachusetts Institute of Technology

1:30- 2:20 Gauss' contribution to analysis. MARC KAC, Rockefeller University

2:20- 2:40 Discussion

PROGRAM FOR THE SYMPOSIUM ON COMPUTATIONAL FLUID DYNAMICS

All sessions will be held in the Bowman Room, Lobby Level

SATURDAY, APRIL 16

First Session - Chairman: Herbert B. Keller, California Institute of Technology

9:00 a. m. Transonic flow calculations for airplane wings. A. JAMESON, Courant Institute of Mathematical Sciences, New York University

10:15 a. m. Pseudospectral calculations on two-dimensional turbulence and nonlinear waves. BENGT FORNBERG, California Institute of Technology

11:30 a. m. On the construction and application of implicit factored schemes for conservation laws. ROBERT F. WARMING, NASA-Ames Research Center

Second Session - Chairman: Eugene Isaacson, Courant Institute of Mathematical Sciences, New York University

2:00 p. m. How numerical analysts can aid oceanographers. JAMES J. O'BRIEN, Florida State University

3:15 p. m. The numerical simulation of convective clouds. HAROLD D. ORVILLE, South Dakota School of Mines and Technology

4:30 p. m. Progress and problems in small scale (regional) numerical weather prediction. CARL W. KREITZBERG, Drexel University

SUNDAY, APRIL 17

Third Session - Chairman: Heinz-Otto Kreiss, Uppsala University, Sweden, and Courant Institute of Mathematical Sciences, New York University

9:30 a. m. The computation of two-dimensional asymmetrical flows past bodies. S. C. R. DENNIS, The University of Western Ontario, Canada

10:45 a. m. Approximation of boundary layers by random vortex sheets. ALEXANDRE J. CHORIN, University of California, Berkeley

noon An efficient explicit-implicit scheme for solving the compressible Navier-Stokes equations. R. W. MacCORMACK, NASA-Ames Research Center

University Park, Pennsylvania

Raymond J. Ayoub
Associate Secretary

PRESENTORS OF PAPERS

Following each name is the number corresponding to the speaker's position on the program

● Invited one-hour lecturers *Special session speakers

745TH MEETING

Northwestern University
Evanston, Illinois
April 15–16, 1977

The seven hundred forty-fifth meeting of the American Mathematical Society will be held at Northwestern University, Evanston, Illinois, on April 15 and 16, 1977. Northwestern University is located near Lake Michigan, about twelve miles north of downtown Chicago. All sessions will be held in Norris Center, the campus center of Northwestern University.

By invitation of the Committee to Select Hour Speakers for Western Sectional Meetings, there will be four invited one-hour addresses: MICHAEL R. STEIN of Northwestern University will speak on Friday, April 15, at 11:00 a.m.; his topic is "Whitehead groups of finite groups". CARL-WILHELM R. DE BOOR of the University of Wisconsin will address the Society on Friday, April 15, at 1:45 p.m.; his subject is "Splines as linear combinations of B-splines". RICHARD A. HUNT of Purdue University will speak on Saturday, April 16, at 11:00 a.m.; the title of his talk is "Harmonic measure and estimates of Green's function." ARUNAS L. LIULEVICIUS of the University of Chicago will address the Society on Saturday, April 16, at 1:45 p.m.; his topic is "Characters tell all." All four addresses will be given in the auditorium of the Norris University Center.

By invitation of the same committee there will be seven special sessions of selected twenty-minute papers. RICHARD A. ASKEY of the University of Wisconsin has arranged a special session on Inequalities, to be held Saturday; the speakers will be William Beckner, Ralph P. Boas, Burgess J. Davis, George F. D. Duff, I. I. Hirschman, Jr., B. F. Logan, Hugh L. Montgomery, Benjamin Muckenhoupt, Harry Pollard, Isaac J. Schoenberg, and Peter A. Tomas. GEORGE K. FRANCIS of the University of Illinois at Urbana-Champaign has arranged a special session on Graphic techniques in geometry and topology, to be held Friday afternoon and Saturday morning and afternoon; the speakers will be Ralph H. Abraham, Thomas F. Banchoff, James J. Callahan, George K. Francis, Nelson Lee Max, Anthony V. Phillips, Tim Poston, Raymond M. Redheffer, Alyn P. Rockwood and Marvin D. Tretkoff. DANIEL H. GOTTLIEB of Purdue University has arranged a special session on Homotopy theory, to be held Saturday; the speakers will be Mark F. Feshbach, Jay E. Goldfeather, Christopher H. Hanks, Mark Mahowald, Howard A. Osborn, Jerrold N. Siegel, Victor P. Snaith, and Lawrence R. Taylor. SIMON HELLERSTEIN of the University of Wisconsin has arranged a special session on Entire functions and related parts of analysis, to be held Friday; the speakers will be James D. Buckholtz, Albert Edrei, Wolfgang H. J. Fuchs, Joseph B. Miles, N. V. Rao, Lee A. Rubel, Swarupchang M. Shah, Daniel F. Shea, Linda R. Sons, and Jack Williamson. MICHAEL B. MARCUS of Northwestern University has arranged a special session on Random variables with values in a normed linear space, to be held Friday afternoon and Saturday morning; the speakers will be Anatole Beck, Gerald A. Edgar, Heinz W. Engl, D. J. H. Garling, Victor Goodman, Marjorie G. Hahn, James D. Kuelbs, Wojbor A. Woyczynski, and Joel Zinn. PETER P. ORLIK of the University of Wisconsin and PHILIP D. WAGREICH of the University of Illinois at Chicago Circle, have arranged a special session on Transformation groups and singularities, to be held Friday and Saturday, with sessions in the morning and afternoon; the speakers will be Richard J. Allen, Robert M. Ephraim, Ulrich Karras, Louis H. Kauffman, Henry B. Laufer, Walter D. Neumann, Ted E. Petrie, Richard C. Randell, Louis Solomon, and Stephen Shing-Toung Yau. JUDITH D. SALLY of Northwestern University has arranged a special session on Commutative algebra, to be held Saturday morning and afternoon; the speakers will be Edward D. Davis, E. Graham Evans, Jr., Eloise Ann Hamann, William J. Heinzer, Melvin Hochster, Eben Matlis, David L. Shannon, Wolmer V. Vasconcelos, and David Wright.

There will be three sessions for contributed ten-minute papers on Friday. On Friday evening at 8:00 p.m. in the auditorium of the Norris Center there will be a public showing of films presented at the special session on Graphic techniques in geometry and topology.

Those attending the meeting are invited to attend a dinner in honor of Professor Ralph P. Boas at 7:00 p.m. on Saturday, April 16, in the Orrington Hotel. This dinner has been arranged by the Department of Mathematics of Northwestern University. To obtain further information and to purchase tickets for the dinner, please write by April 1 to Department Secretary, Department of Mathematics, Northwestern University, Evanston, Illinois 60201. The price of the tickets is $10.50 per person.

REGISTRATION

The registration desk will be located at the entrance to the Auditorium on the first floor of the Norris Center. The desk will be open from 8:30 a.m. to 4:00 p.m. on Friday, and from 8:00 a.m. to 3:00 p.m. on Saturday.

ACCOMMODATIONS

The following two hotels are holding blocks of rooms until April 1.

HOLIDAY INN EVANSTON (312) 491-6400
1501 Sherman Avenue, Evanston 60201
(Six blocks from the Norris Center)

Single	$27
Double or Twin	32
Extra person in double room	3

ORRINGTON HOTEL (312) 864-8700
1710 Orrington Avenue, Evanston 60201
(Four blocks from the Norris Center)

Single	$15-$30
Double	18- 33

In order to obtain the rates listed, participants should mention the American Mathematical Society meeting when sending in their reservations.

FOOD SERVICE

The Norris Center has a large cafeteria on the ground floor. The cafeteria serves at all times between 7:30 a.m. and 9:00 p.m. Friday, and between 9:00 a.m. and 9:00 p.m. Saturday.

TRAVEL AND LOCAL INFORMATION

The Continental Air Transport Company provides bus service to Evanston, leaving Chicago's O'Hare Airport at thirty minutes after the hour, from 7:30 a.m. until 8:30 p.m. weekdays. The trip to Evanston's Orrington Hotel and Holiday Inn takes approximately one hour and ten minutes; one way fare is $3.50. Since schedules are subject to change, it would be best to check with your local travel agent, the hostesses at the Ground Transportation Centers in O'Hare Airport, or call (312) 454-7800 to be sure this schedule is still in effect. Return bus service from Evanston to O'Hare is also available; however, participants are advised to obtain a schedule for the trip back to the airport, since there is limited service on Saturday and Sunday.

Amtrak offers direct service from many points to Union Station in Chicago. Two blocks north of Union Station is the Chicago and Northwestern Station, from which there is direct commuter train service to Davis Street Station in Evanston. The Davis Street Station is two long blocks from each of the above hotels and is about six blocks from the Norris Center.

For those coming by car the following three options afford easy access to the campus. (1) Follow Illinois Route 42 (Sheridan Road), a generally north-south route within a few blocks of Lake Michigan, which skirts the Northwestern campus on the west. The parking entrance to Northwestern at the south end of the campus (the point at which northbound traffic on Sheridan Road makes a sharp left turn) leads directly to the parking lot adjacent to the Norris Center. (2) Follow the Edens Expressway (Interstate 94) and leave it at the eastbound Skokie-Evanston exit, which leads into Dempster Street. Continue east on Dempster Street (Illinois Route 58) until it intersects Sheridan Road. Turn left on Sheridan Road and proceed as in (1). (3) Follow the Tri-State Tollway (Interstate 294) and leave it at the eastbound Dempster Street exit. Continue east on Dempster Street, turn left on Sheridan Road, and proceed as in (1).

PARKING

The University Bureau of Parking has agreed not to ticket cars without parking stickers on Friday and Saturday. Those attending the meeting may, therefore, park in any of the university parking lots. The most convenient one is the large lot adjacent to the Norris Center.

PROGRAM OF THE SESSIONS

The time limit for each contributed paper in the general sessions is ten minutes. In the special sessions the time varies from session to session and within sessions. To maintain the schedule, the time limits will be strictly enforced.

FRIDAY, 8:15 A. M.

Session on Analysis, Room 2A, Norris Center

8:15- 8:25 (1) Area theorems for nonanalytic univalent functions. Professor MARIO O. GONZALEZ, University of Alabama (745-B30)

8:30- 8:40 (2) Zeros of polynomials. Professor EVELYN FRANK, University of Illinois at Chicato Circle (745-C1)

8:45- 8:55 (3) A generalization of $(\Sigma a_i^2)^{1/2} \leq \Sigma |a_i|$. R. VENCIL SKARDA, Brigham Young University (745-B6)

9:00- 9:10 (4) Stability conditions for Banach-space-valued random variables. Professor ARUNOD KUMAR, Northeastern Illinois University and Professor BERTRAM M. SCHREIBER*, Wayne State University (745-F2)

9:15- 9:25 (5) Operators with the Banach-Saks property. J. DIESTEL* and C. SEIFERT, Kent State University (745-B1)

9:30- 9:40 (6) A new set of basic hypergeometric orthogonal polynomials. Preliminary report. Professor RICHARD ASKEY* and Mr. JAMES A. WILSON, University of Wisconsin (745-B12)

9:45- 9:55 (7) Some new orthogonal polynomials. Preliminary report. Mr. JAMES A. WILSON, University of Wisconsin (745-B13)

*For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.

10:00-10:10 (8) Convolution structures for polynomials orthogonal with respect to the weight function $(1-x^2)^{\alpha}|x|^{2\beta+1}$. Preliminary report. Mr. THOMAS P. LAINE, Northwestern University (745-B17)

10:15-10:25 (9) WITHDRAWN.

FRIDAY, 8:30 A. M.

Special Session on Entire Functions and Related Parts of Analysis I, Room 2G, Norris Center

8:30- 8:50 (10) Another growth indicator for the study of value distribution. Preliminary report. Professor L. R. SONS, Northern Illinois University (745-B25)

9:00- 9:20 (11) A theorem on entire functions of infinite order. Professor JOSEPH MILES, University of Illinois (745-B18)

9:30- 9:50 (12) An inequality involving the absolute value of an entire function and the counting function of its zeros. Professor WOLFGANG H. J. FUCHS, Cornell University (745-B7)

10:00-10:20 (13) Growth and Riesz mass of subharmonic functions of finite order. Preliminary report. Professor N. V. RAO, University of Toledo and Professor DANIEL F. SHEA*, University of Wisconsin (745-B19)

10:30-10:50 (14) Distribution of the zeros of Padé polynomials of an entire function. Professor ALBERT EDREI, Syracuse University (745-B23)

FRIDAY, 8:45 A. M.

Session on Algebra, Room 2B, Norris Center

8:45- 8:55 (15) Obstructions in associative algebra. Professor Y. C. WU, Oakland University (745-A19) (Introduced by Professor C. Cheng)

9:00- 9:10 (16) On groups with specified lower central series quotients. Professor JERROLD W. GROSSMAN, Oakland University (745-A12)

9:15- 9:25 (17) Bounds for perturbations of eigenvalues of relative hermitian matrix problems. Dr. DAVID W. FOX, The Johns Hopkins University (745-A18)

9:30- 9:40 (18) A class of surfaces introduced by O. Zariski. Preliminary report. Mr. PIOTR BLASS, University of Michigan (745-A17)

9:45- 9:55 (19) Generators for the group of rational solutions of $y^2 = x(x-1)(x-t^2-c)$. Preliminary report. Mr. CHARLES F. SCHWARTZ, Rutgers University (745-A15)

10:00-10:10 (20) Commutative rings all of whose finitely generated modules are direct sums of cyclics. Professor ROGER WIEGAND* and Professor SYLVIA WIEGAND, University of Nebraska (745-A4)

10:15-10:25 (21) Modules injective with respect to primes. Preliminary report. Professor JON L. JOHNSON, The Citadel (745-A3)

10:30-10:40 (22) A mathematical system with applications. Preliminary report. Mr. MICHAEL D. KONRAD, Ohio University (745-A16)

FRIDAY, 9:00 A. M.

Special Session on Transformation Groups and Singularities I, Room 2C, Norris Center

9:00- 9:20 (23) Equivariant embeddings of finite abelian group actions. Preliminary report. Professor RICHARD J. ALLEN, St. Olaf College (745-G4)

9:40-10:00 (24) Iso-singular loci and the Cartesian product structure of complex analytic singularities. Professor ROBERT EPHRAIM, Herbert H. Lehman College (745-B16)

10:20-10:40 (25) On pencils of curves and surface singularities. Preliminary report. Dr. ULRICH KARRAS, Purdue University (745-B29) (Introduced by Professor Henry B. Laufer)

FRIDAY, 11:00 A. M.

Invited Address, Auditorium, Norris Center

(26) Whitehead groups of finite groups. Professor MICHAEL R. STEIN, Northwestern University (745-A8)

FRIDAY, 1:45 P. M.

Invited Address, Auditorium, Norris Center

(27) Splines as linear combinations of B-splines. Professor CARL-WILHELM R. de BOOR, University of Wisconsin, Madison (745-B31)

FRIDAY, 3:00 P.M.

Special Session on Entire Functions and Related Parts of Analysis II, Room 2G, Norris Center

3:00- 3:20 (28) Derivatives of entire functions and a conjecture of Pólya and Wiman. Professor SIMON HELLERSTEIN, University of Wisconsin and Professor JACK WILLIAMSON*, University of Hawaii (745-B21)

3:30- 3:50 (29) Approximation to meromorphic functions on the positive real axis. II. Professor S. M. SHAH, University of Kentucky (745-B24)

4:00- 4:20 (30) Irreducibility of certain entire functions. Preliminary report. Dr. J. M. ANDERSON, University College, London, England; Professor L. A. RUBEL*, University of Illinois; Mr. W. A. SQUIRES and Professor B. A. TAYLOR, University of Michigan (745-B2)

4:30- 4:50 (31) Carlson's theorem for harmonic functions in $\mathbb{R}^n$. Professor N. V. RAO, University of Toledo (745-B22) (Introduced by Professor Simon Hellerstein)

5:00- 5:20 (32) Uniqueness theorems for entire functions. Professor J. D. BUCKHOLTZ, University of Kentucky (745-B20)

FRIDAY, 3:00 P. M.

Special Session on Transformation Groups and Singularities II, Room 2C, Norris Center

3:00- 3:20 (33) The behavior of the exceptional set under ambient deformations. Preliminary report. Professor HENRY B. LAUFER, Purdue University (745-B5)

3:40- 4:00 (34) Complete intersections with $\mathbb{C}^*$-action. Dr. RICHARD RANDELL, Institute for Advanced Study (745-B3)

4:20- 4:30 (35) On strongly elliptic singularities. Professor STEPHEN S.-T. YAU, Institute for Advanced Study (745-B32)

FRIDAY, 3:00 P. M.

Special Session on Graphic Techniques in Geometry and Topology I, Auditorium, Norris Center

3:00- 3:20 (36) An illustration for Robert Wells' cobordism of immersions: 8 times Boy's surface ($\mathbb{P}^2 \alpha \mathbb{R}^3$) is null-cobordant. Professor A. V. PHILLIPS, State University of New York at Stony Brook (745-D7)

3:30- 3:50 (37) Visualizing relativistic gravitation. Preliminary report. Dr. TIM POSTON, Battelle Advanced Studies Center, Geneva, Switzerland (745-D8) (Introduced by Professor George K. Francis)

4:00- 4:20 (38) Road maps for Riemann surfaces and the Jacobian variety of the Klein-Hurwitz surface. Preliminary report. Professor MARVIN TRETKOFF, Stevens Institute of Technology (745-A14)

4:30- 4:50 (39) From Riemann surfaces to catastrophe machines. Preliminary report. Professor GEORGE K. FRANCIS, University of Illinois (745-D6)

5:00- 5:20 (40) Informal session chaired by Louis H. Kauffman

FRIDAY, 3:00 P. M.

Special Session on Random Variables with Values in a Normed Linear Space I, Room 2A, Norris Center

3:00- 3:20 (41) A characterization of the Kolmogorov difference property and its relationship to the central limiting behavior of square-integrable stochastic processes. Dr. MARJORIE G. HAHN, University of California, Berkeley (745-F8)

3:30- 3:50 (42) Conditional independence. ANATOLE BECK, University of Wisconsin (745-F5)

4:00- 4:20 (43) Domains of attraction of stable measures on Banach spaces. Preliminary report. Professor WOJBOR A. WOYCZYNSKI, Northwestern University and Wroclaw University, Poland (745-F7)

4:30- 4:50 (44) Convexity, smoothness and martingale inequalities. Dr. D.J.H. GARLING, Ohio State University (745-B9) (Introduced by Dr. M. B. Marcus)

5:00- 5:20 (45) A random fixed point theorem for nonexpansive mappings with stochastic domain. HEINZ W. ENGL, Kepler-Universitaet, Linz, Austria and Georgia Institute of Technology (745-F1)

FRIDAY, 3:00 P. M.

Session on Geometry and Topology, Room 2B, Norris Center

3:00- 3:10 (46) A characterization of inversive groups of spheres. JOEL C. GIBBONS*, Illinois Institute of Technology and CARY WEBB, Chicago State University (745-D1)

3:15- 3:25 (47) The inversive group of S^n. Professor CARY WEBB*, Chicago State University and Professor JOEL GIBBONS, Illinois Institute of Technology (745-D10)

3:30- 3:40 (48) An alternate method of finding certain link groups. Mr. STEVE DIBNER, Washington University (745-G1)

3:45- 3:55 (49) Restricting Lie group actions to lattice subgroups. Professor ROBERT J. ZIMMER, U. S. Naval Academy (745-G6)

FRIDAY, 8:00 P. M.

Friday Night at the Movies, Auditorium, Norris Center
Public showing of films presented at the Special Session on Graphic Techniques in Geometry and Topology

SATURDAY, 8:30 A. M.

Special Session on Inequalities I, Room 2G, Norris Center

8:30- 8:50 (50) Enflo's theorem on norms of products of polynomials in many variables. Preliminary report. Professor HUGH L. MONTGOMERY, University of Michigan (745-B28)

9:00- 9:20 (51) The Jensen-Steffensen inequality. Professor R. P. BOAS, Northwestern University (745-B8)

9:30- 9:50 (52) A new class of variational problems. Professor HARRY POLLARD, Purdue University (745-B26)

10:00-10:20 (53) Variation of a maximal function. Professor G. F. D. DUFF, University of Toronto (745-D2)

10:30-10:50 (54) On Landau's problem on bounds for derivatives. Professor I. J. SCHOENBERG, University of Wisconsin (745-B33)

SATURDAY, 8:30 A. M.

Special Session on Random Variables with Values in a Normed Linear Space II, Room 2B, Norris Center

8:30- 8:50 (55) Vector-valued amarts. Professor G. A. EDGAR, Ohio State University (745-B4)

9:00- 9:20 (56) The central limit theorem in $\ell^p (p > 2)$ and the log log law in Hilbert space. Professor G. PISIER, Ecole Polytechnique, France and University of Massachusetts, and Professor J. ZINN*, University of Massachusetts (745-F9) (Introduced by Professor Richard Ellis)

9:30- 9:50 (57) Some exponential moments with applications to density estimation and the empirical distribution function. Professor J. D. KUELBS, University of Wisconsin (745-F6)

10:00-10:20 (58) Asymptotic behavior of certain exit probabilities for vector-valued symmetric random walk and Brownian motion. VICTOR GOODMAN, Indiana University (745-F4)

10:30-10:50 (59) Problem session

SATURDAY, 9:00 A. M.

Special Session on Commutative Algebra I, Room 2A, Norris Center

9:00- 9:20 (60) The Syzygy problem. Professor E. GRAHAM EVANS, Jr.* and Professor PHILIP A. GRIFFITH, University of Illinois, Urbana (745-A10)

9:30- 9:50 (61) Invariants of inertial K-automorphisms of K[X,Y] and K[[X,Y]]. Preliminary report. Professor DAVID L. SHANNON, University of Kentucky (745-A5)

10:00-10:20 (62) Ideal transforms of Noetherian integral domains. Preliminary report. PAUL EAKIN, DAVID SHANNON, University of Kentucky and WILLIAM HEINZER*, Purdue University (745-A11)

10:30-10:50 (63) Higher properties of R-sequences. Professor EBEN MATLIS, Northwestern University (745-A13) (Introduced by Professor Judith D. Sally)

SATURDAY, 9:00 A. M.

Special Session on Transformation Groups and Singularities III, Room 2C, Norris Center

9:00- 9:20 (64) Signature of branched fibrations. Preliminary report. Professor LOUIS H. KAUFFMAN, University of Michigan (745-G14)

9:40-10:00 (65) Proper equivariant maps between representations of Lie groups. Preliminary report. Professor TED PETRIE, Rutgers University (745-G9) (Introduced by Professor Peter Orlik)

10:20-10:40 (66) Weighted homogeneous surfaces. Preliminary report. Professor WALTER D. NEUMANN, University of Maryland (745-B15)

SATURDAY, 9:00 A. M.

Special Session on Graphic Techniques in Geometry and Topology II, Auditorium, Norris Center

9:00- 9:20 (67) Sketching umbilics. Preliminary report. JAMES CALLAHAN, Smith College (745-D3)

9:30- 9:50 (68) Turning a sphere inside out with computer graphics. Dr. NELSON L. MAX, Case Western Reserve University (745-D5)

10:00-10:20 (69) A reinvestigation of the centro-surface of the ellipsoid. Professor THOMAS F. BANCHOFF* and Dr. CHARLES M. STRAUSS, Brown University (745-D9)

10:30-10:50 (70) Electro-optical exploration of forced Navier-Stokes bifurcations. RALPH H. ABRAHAM, University of California, Santa Cruz (745-C2)(Introduced by Professor G. K. Francis)

SATURDAY, 9:00 A. M.

Special Session on Homotopy Theory I, Room 2E, Norris Center

9:00- 9:20 (71) On the structure of Thom spaces. Preliminary report. Professor MICHAEL BARRATT, Northwestern University and Professor CHRISTOPHER HANKS*, Millikin University (745-G7)

9:30- 9:50 (72) New infinite families in the stable 2-stem of the homotopy of spheres. Professor MARK MAHOWALD, Northwestern University (745-G11)

10:00-10:20 (73) Incompressible maps. Dr. JAY E. GOLDFEATHER, University of Wisconsin-Milwaukee (745-G8)

10:30-10:50 (74) The transfer and characteristic classes. Preliminary report. Professor MARK FESHBACH, Northwestern University (745-G5)

SATURDAY, 11:00 A. M.

Invited Address, Auditorium, Norris Center

(75) Harmonic measure and estimates of Green's function. Professor RICHARD A. HUNT, Purdue University (745-B36)

SATURDAY, 1:45 P. M.

Invited Address, Auditorium, Norris Center

(76) Characters tell all. Professor ARUNAS LIULEVICIUS, University of Chicago (745-G13)

SATURDAY, 3:00 P. M.

Special Session on Commutative Algebra II, Room 2A, Norris Center

3:00- 3:20 (77) Canonical elements in local cohomology modules. Preliminary report. Professor MELVIN HOCHSTER, University of Michigan (745-A6)

3:30- 3:50 (78) Prime divisors and saturated chains. Professor E. D. DAVIS*, State University of New York at Albany and Professor S. McADAM, University of Texas (745-A2)

4:00- 4:20 (79) On cancellation. Preliminary report. Dr. ELOISE A. HAMANN, North Central College (745-A9)

4:30- 4:50 (80) Cancellation of certain variables. Preliminary report. DAVID WRIGHT, Washington University (745-A7)

5:00- 5:20 (81) Generating modules extravagantly. Preliminary report. Professor W. V. VASCONCELOS, Rutgers University (745-A1)

SATURDAY, 3:00 P. M.

Special Session on Inequalities II, Room 2G, Norris Center

3:00- 3:20 (82) Weighted norm inequalities relating the Hilbert transform to the Hardy-Littlewood maximal function. Professor BENJAMIN MUCKENHOUPT, Rutgers University (745-B10)

3:30- 3:50 (83) Szegö's theorem on SU(3). Preliminary report. Professor I. I. HIRSCHMAN, Jr.*, Washington University and Dr. DAVID S. LIANG, Chicago, Illinois (745-B27)

4:00- 4:20 (84) On stopping times for n dimensional Brownian motion. Dr. BURGESS DAVIS, Purdue University (745-F3)

4:30- 4:50 (85) Bandlimited functions bounded below over an interval. Dr. B. F. LOGAN, Jr., Bell Laboratories, Murray Hill, New Jersey (745-B35)(Introduced by Professor Richard A. Askey)

5:00- 5:20 (86) A restriction theorem for the Fourier transform. PETER A. TOMAS, University of Chicago (745-B14) (Introduced by Professor Richard A. Askey)

5:30- 5:50 (87) Convolution inequalities and Fourier analysis. Professor WILLIAM BECKNER, University of Chicago (745-B34)

SATURDAY, 3:00 P. M.

Special Session on Transformation Groups and Singularities IV, Room 2C, Norris Center

3:00- 3:20 (88) Automorphism groups of forms. Professor LOUIS SOLOMON*, and Professor PETER ORLIK, University of Wisconsin (745-G15)

3:40- 5:00 (89) Informal problem session

SATURDAY 3:00 P. M.

Special Session on Graphic Techniques in Geometry and Topology III, Auditorium, Norris Center

3:00- 3:20 (90) An inexpensive technique for displaying algebraically defined surfaces. Professor ALYN P. ROCKWOOD* and Professor ROBERT P. BURTON, Brigham Young University (745-D4) (Introduced by Professor George K. Francis)

3:30- 3:50 (91) Informal session

4:00- 4:20 (92) Mathematics with and without words. Professor RAY REDHEFFER, University of California, Los Angeles (745-H1)

4:30- 4:50 (93) Informal session chaired by Tim Poston

5:00- 5:20 (94) Informal session chaired by Nelson Lee Max

SATURDAY, 3:00 P. M.

Special Session on Homotopy Theory II, Room 2E, Norris Center

3:00- 3:20 (95) Some new elements in the stable homotopy of BO. Professor VICTOR P. SNAITH University of Western Ontario (745-G2)

3:30- 3:50 (96) β-representable homotopy functors. Professor JERROLD SIEGEL, University of Missouri-St. Louis (745-G10)

4:00- 4:20 (97) The Hopf ring. Professor HOWARD OSBORN, University of Illinois (745-G3)

4:30- 4:50 (98) A bordism spectral sequence. Preliminary report. Professor LAURENCE R. TAYLOR, University of Notre Dame (745-G12)

Paul T. Bateman
Associate Secretary

Urbana, Illinois

PRESENTORS OF PAPERS

Following each name is the number corresponding to the speaker's position on the program

● Invited one-hour lecturers * Special session speakers

*Abraham, R. H. #70
*Allen, R. J. #23
Askey, R. #6
*Banchoff, T. F. #69
*Beck, A. #42
*Beckner, W. #87
Blass, P. #18
*Boas, R. P. #51
*Buckholtz, J. D. #32
*Callahan, J. #67
*Davis, B. #84
*Davis, E. D. #78
●de Boor, C. W. R. #27
Dibner, S. #48
Diestel, J. #5
*Duff, G. F. D. #53
*Edgar, G. A. #55
*Edrei, A. #14
*Engl, H. W. #45
*Ephraim, R. #24
*Evans, Jr., E. G. #60
*Feshbach, M. #74
Fox, D. W. #17
*Francis, G. K. #39
Frank, E. #2
*Fuchs, W. H. J. #12
*Garling, D. J. H. #44
Gibbons, J. C. #46
*Goldfeather, J. E. #73
Gonzalez, M. O. #1
*Goodman, V. #58
Grossman, J. W. #16
*Hahn, M. G. #41
*Hamann, E. A. #79
*Hanks, C. #71
*Heinzer, W. #62
*Hirschman, Jr., I. I. #83
*Hochster, M. #77
●Hunt, R. A. #75
Johnson, J. L. #21
*Karras, U. #25
*Kauffman, L. H. #64
Konrad, M. D. #22
*Kuelbs, J. D. #57
Laine, T. P. #8
*Laufer, H. B. #33
●Liulevicius, A. #76
*Logan, Jr., B. F. #85
*Mahowald, M. #72
*Matlis, E. #63
*Max, N. L. #68
*Miles, J. #11
*Montgomery, H. L. #50
*Muckenhoupt, B. #82
*Neumann, W. D. #66
*Osborn, H. #97
*Petrie, T. #65
*Phillips, A. V. #36
*Pollard, H. #52
*Poston, T. #37
*Randell, R. #34
*Rao, N. V. #31
*Redheffer, R. #92
*Rockwood, A. P. #90
*Rubel, L. A. #30
*Schoenberg, I. J. #54
Schreiber, B. M. #4
Schwartz, C. F. #19
*Shah, S. M. #29
*Shannon, D. L. #61
*Shea, D. F. #13
*Siegel, J. #96
Skarda, R. V. #3
*Snaith, V. P. #95
*Solomon, L. #88
*Sons, L. R. #10
●Stein, M. R. #26
*Taylor, L. R. #98
*Tomas, P. A. #86
*Tretkoff, M. #38
*Vasconcelos, W. V. #81
Webb, C. #47
Wiegand, R. #20
*Williamson, J. #28
Wilson, J. A. #7
*Woyczynski, W. A. #43
*Wright, D. #80
Wu, Y. C. #15
*Yau, S. S.-T. #35
Zimmer, R. J. #49
*Zinn, J. #56

746TH MEETING

California State University Hayward, California April 22–23, 1977

The seven hundred forty-sixth meeting of the American Mathematical Society will be held at California State University, Hayward, on Saturday, April 23, 1977. A special session on Algebraic and geometric topology will also be scheduled on Friday afternoon, April 22. This meeting will be held in conjunction with a meeting of the Northern California Section of the Society for Industrial and Applied Mathematics.

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be two invited hour addresses. PAUL C. FIFE of the University of Arizona will lecture on Saturday at 9:45 a.m. The title of his talk is "The equations of reaction and diffusion." MICHAEL J. SHARPE of the University of California at San Diego will lecture on "Some applications of Markov additive functionals" at 8:30 a.m. Both lectures will be given in Room 2032 of Meiklejohn Hall.

There will be sessions for contributed ten-minute papers on Saturday. Late papers will be accepted for presentation at the meeting, but will not be listed in the printed program of the meeting.

SPECIAL SESSIONS

There will be six special sessions, the last four of which are jointly sponsored by the AMS and SIAM. RUSSELL L. MERRIS of California State University, Hayward, has organized a special session on Combinatorial matrix theory. The speakers include Allan B. Cruse, John de Pillis, Moshe Goldberg, Robert Grone, Derrick H. Lehmer, Marvin Marcus, Russell L. Merris, Morris Newman, Herbert J. Ryser, Olga Taussky Todd, Robert C. Thompson, and Eric P. Verheiden. LOUISE E. MOSER and RICHARD GOODRICK of California State University, Hayward, have organized a special session on Algebraic and geometric topology, which will take place on Friday afternoon. The speakers include Michael H. Freedman, David S. Gillman, Robion C. Kirby, Joseph M. Martin, Edward J. Mayland, Jr., Paul M. Melvin, Kenneth C. Millet, Martin G. Scharlemann, John R. Stallings, and James M. Van Buskirk. GORDON BRADLEY of the Naval Postgraduate School, Monterey, has organized a special session on Large scale mathematical programming; the speakers will be Glenn W. Graves and Janusz S. Kowalik. CRAIG COMSTOCK of the Naval Postgraduate School, Monterey, has organized a special session on Numerical methods in meteorology. The scheduled speakers are Frank D. Faulkner, Robert W. MacCormack, Joseph E. Oliger, Thomas E. Rosmond, and R. Terry Williams. IRA BERT RUSSAK of the Naval Postgraduate School, Monterey, has organized a special session on Optimization. This session will include a forty-minute lecture by Magnus R. Hestenes and twenty-minute talks by Hubert Halkin, G. Leitmann, R. Tyrrell Rockafellar, Junior Stein, Ian G. Walton, and Salah M. Yousif. SUSANN J. N. SHAW of San Francisco State University has organized a special session on Mathematical methods in biology. This session will include two one-hour talks; these will be given by Hans J. Bremermann and Joseph B. Keller. There will also be three twenty-minute talks by Herbert D. Landahl, Richard E. Plant, and David A. Sánchez.

REGISTRATION

The registration area will be in the main entrance to Meiklejohn Hall (north side of building), and will be open on Saturday from 8:00 a.m. to noon and from 1:00 p.m. to 3:00 p.m.

ACCOMMODATIONS

The following are among the many hotels and motels in Hayward and Oakland. Reservations should be made directly with the hotel or motel.

PLAZA INTERNATIONAL INN OF HAYWARD
(415) 785-0260
410 West A Street, Hayward 94541

Single	$16.90 up
Double or Twin	19.90 up

TRAVEL LODGE (415) 538-4380
21598 Foothill Boulevard, Hayward 94541

Single	$14 up
Double	16 up
Twin	18 up

VAGABOND MOTOR HOTEL (415) 785-5480
20455 Hesperian Boulevard, Hayward 94541

Single	$19 up
Double	21 up
Twin	23 up

HOLIDAY INN OF OAKLAND (415) 562-5311
500 Hegenberger Road, Oakland 94621

Single	$23 up
Double	27 up

OAKLAND HYATT HOUSE HOTEL
(415) 562-6100
455 Hegenberger Road, Oakland 94621

Single	$21 up
Double	27 up

FOOD SERVICE

Noon meals are available in Carlos Bee Residence Hall, which is within walking distance just off campus. On Friday lunch is served from 11:15 a.m. to 1:00 p.m. and costs $2.10. On Saturday brunch is served from 11:00 a.m. to noon and costs $1.70. A selected list of restaurants in the Hayward area will be available at the registration desk.

TRAVEL

Persons driving to the meeting should use the Nimitz Freeway (Route 17) and take the Jackson Street exit east (in Hayward, not Oakland!). At the first traffic light turn right onto Santa Clara Street. Santa Clara bends to the left, becoming Harder Road. Harder Road goes up the hill to the university. Near the top it curves to the left. Take the first left turn after the curve. You will see the road go under a multistory building, but you should park in the first parking lot to the left before you go under the building. This is Parking Lot B; special arrangements have been made so that you may park there without a permit on Friday from 11:00 a.m. One can park anywhere on Saturday (except for blue, yellow and red zones). As you come out of Parking Lot B, Meiklejohn Hall is the red brick building across the street and to the right.

Hayward is served by two commerical airports; San Francisco Airport and Oakland Airport. The best way to get to Hayward from these airports is by car. Moreover, once in Hayward, it is very difficult to travel between motels, restaurants, and the university without a car.

San Francisco Airport is south of San Francisco and on the opposite side of San Francisco Bay from Hayward. This airport is served by all major airlines. To drive from the airport to Hayward, drive south on the Bayshore Freeway (Route 101) to the exit for Route 92 (Hayward-San Mateo Bridge). Take Route 92 east across the bridge into Hayward. The freeway ends and becomes Jackson Street. Then follow the directions above for those driving to Hayward on the Nimitz Freeway (Route 17).

The Oakland Airport is served by Air California, Airwest, American, Delta, Eureka Aero, PSA, TWA, United and Western Airlines. To drive to Hayward from Oakland Airport, go east on Hegenberger Road from the airport. Take the Nimitz Freeway (Route 17) south to the Jackson Street exit east and follow the directions above for those driving to Hayward on the Nimitz Freeway.

Public bus lines and BART can be used to reach Hayward from these airports, though BART does not yet run on Saturday. Greyhound Bus Lines serves Hayward; the station is in downtown Hayward across from the BART station.

PROGRAM OF THE SESSIONS

The time limit for each contributed paper in the general sessions is ten minutes. In the special sessions the time varies from session to session and within sessions. To maintain the schedule, the time limits will be strictly enforced.

FRIDAY, 1:30 P. M.

Special Session on Algebraic and Geometric Topology I, Room 2032, Meiklejohn Hall

1:30- 1:50 (1) Fibred Links. Professor JOHN R. STALLINGS, University of California, Berkeley (746-H1)

2:00- 2:20 (2) Examples of non-fibred knots with Π_c knot group. Preliminary report. Professor E. J. MAYLAND, Jr., Rice University (746-G4)

2:30- 2:50 (3) Surgery on solid tori. Preliminary report. Professor JOSEPH MARTIN, University of Wyoming (746-G10)

3:00- 3:20 (4) Approximating CAT CE maps. Preliminary report. MARTIN SCHARLEMANN, University of California, Santa Barbara (746-G8)

3:30- 3:50 (5) Embeddings of D^n in $D^m \times S^n$. KENNETH C. MILLET, University of California, Santa Barbara (746-G6)

SATURDAY, 8:30 A. M.

Invited Address, Room 2032, Meiklejohn Hall

(6) Some applications of Markov additive functionals. Professor MICHAEL J. SHARPE, University of California, San Diego (746-F1)

SATURDAY, 9:45 A. M.

Invited Address, Room 2032, Meiklejohn Hall

(7) The equations of reaction and diffusion. Professor PAUL C. FIFE, University of Arizona (746-B10)

SATURDAY, 10:55 A. M.

Special Session on Combinatorial Matrix Theory I, Room 3111, Meiklejohn Hall

10:55-11:15 (8) Some analogues of the assignment polytope. Preliminary report. Dr. ALLAN B. CRUSE, University of San Francisco (746-A17)

11:20-11:40 (9) Permanent problems concerning combinatorial matrices. Professor D. H. LEHMER, University of California, Berkeley (746-A16)

11:45-12:05 (10) Integral group matrices. Professor OLGA TAUSSKY TODD, California Institute of Technology (746-A15)

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*For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.

12:10-12:30 (11) Completions of integral matrices. Preliminary report. Mr. ERIC VERHEIDEN, California Institute of Technology (746-A2)

SATURDAY, 11:00 A. M.

Special Session on Optimization I, Room 2032, Meiklejohn Hall

11:00-11:40 (12) A role for augmentability in optimization theory. Preliminary report. Professor MAGNUS HESTENES, University of California, Los Angeles (746-B8)

SATURDAY, 11:00 A. M.

Special Session on Mathematical Methods in Biology I, Room 2078, Meiklejohn Hall

11:00-12:00 (13) Algorithms and optimization in biology. Survey. Professor HANS J. BREMERMANN, University of California, Berkeley (746-C9)

SATURDAY, 11:15 A. M.

Joint Session with SIAM on Analysis, Room 2038, Meiklejohn Hall

11:15-11:25 (14) A unified treatment of some means of classical analysis. Preliminary report. J. L. BRENNER, Palo Alto, California (746-B1)

11:30-11:40 (15) An analogue of the Hausdorff-Young theorem for integral operators. Professor JAMES A. COCHRAN*, Washington State University and Professor CHARLES OEHRING, Virginia Polytechnic Institute and State University (746-B7)

11:45-11:55 (16) Global optimization using interval analysis. Preliminary report. Dr. ELDON HANSEN, Lockheed Palo Alto Research Laboratory, Palo Alto, California (746-B5) (Introduced by Peter A. Szego)

12:00-12:10 (17) Campylotropic coordinates. Dr. C. M. ABLOW* and Dr. S. SCHECHTER, Stanford Research Institute, Menlo Park, California (746-C3)

SATURDAY, 1:45 P. M.

Session on Algebra and Topology, Room 2008, Meiklejohn Hall

1:45- 1:55 (18) A codimension-two version of Novikov's theorem on foliations without limit cycles. KENNETH M. deCESARE, DeAnza College (746-G3)

2:00- 2:10 (19) A property related to ordered group algebras. Preliminary report. Professor RALPH DEMARR, University of New Mexico (746-B6)

2:15- 2:25 (20) Linear operators preserving the decomposable numerical range. Professor MARVIN MARCUS and Mr. IVAN FILIPPENKO*, University of California, Santa Barbara (746-A8)

2:30- 2:40 (21) Bounds on the number of Hamiltonian circuits in the n-cube. Professor ROBERT J. DOUGLAS, San Francisco State University (746-A18)

2:45- 2:55 (22) Pure diagrams of Abelian groups. Preliminary report. Professor JAMES A. ANDERSON, Northern Arizona University and Professor TOM HEAD*, University of Alaska (746-A14)

3:00- 3:10 (23) Linear relations with small support for group representations. Professor CHRISTOPHER L. MORGAN, California State University, Hayward (746-A12)

3:15- 3:25 (24) On a rotation of Pascal's triangle giving the number of terms in a multinomial expansion. Preliminary report. Professor S. VERMA, University of Nevada (746-A13) (Introduced by Professor L. J. Simonoff)

3:30- 3:40 (25) The probability that k polynomials are relatively r-prime. Preliminary report. Dr. STANLEY J. BENKOSKI, Tetra Tech Inc., ARPA Research Center, Moffett Field, California (746-A4)

SATURDAY, 2:00 P. M.

Special Session on Large Scale Mathematical Programming, Room 3075, Meiklejohn Hall

2:00- 2:30 (26) Use of simple algebraic structures for implementing algorithms in large scale mathematical programming. Preliminary report. Professor GERALD G. BROWN, Naval Postgraduate School and Professor GLENN W. GRAVES*, University of California, Los Angeles (746-C12) (Introduced by Ira Bert Russak)

2:40- 3:10 (27) Hydroelectric power system optimization is a large scale mathematical programming problem. JANUSZ S. KOWALIK, Washington State University (746-C8) (Introduced by Ira Bert Russak)

SATURDAY, 2:00 P. M.

Special Session on Numerical Methods in Meteorology, Room 3079, Meiklejohn Hall

2:00- 2:20 (28) Statistical corrections to improve weather prediction. Professor FRANK D. FAULKNER* and Professor CRAIG COMSTOCK, Naval Postgraduate School, Monterey, California (746-C10)

2:30- 2:50 (29) Variable scale finite element models. Preliminary report. Professor R. T. WILLIAMS* and Lieutenant R. G. KELLEY, Jr., Naval Postgraduate School, Monterey, California (746-C11) (Introduced by Professor Craig Comstock)

3:00- 3:20 (30) Global atmospheric modeling with spherical harmonics. THOMAS E. ROSMOND, Naval Environmental Prediction Research Facility, Monterey, California (746-C13) (Introduced by Professor Craig Comstock)

3:30- 3:50 (31) An efficient numerical method for solving the Navier-Stokes equation. Dr. ROBERT MacCORMACK, Ames Research Center, Moffett Field, California

SATURDAY, 2:00 P. M.

Special Session on Algebraic and Geometric Topology II, Room 2038, Meiklejohn Hall

2:00- 2:20 (32) An exotic involution on S^4. Professor SELMAN AKBULUT, University of Wisconsin and Professor ROBION KIRBY*, University of California, Berkeley (746-G5)

2:30- 2:50 (33) On localizing Dehn's lemma. Preliminary report. Professor DAVID GILLMAN, University of California, Los Angeles (746-G1)

3:00- 3:20 (34) Kawauchi's conjecture for strongly amphicheiral knots. Professor JAMES M. VAN BUSKIRK, University of Oregon (746-G9)

3:30- 3:50 (35) Slice knots and property R. ROBION KIRBY and PAUL MELVIN*, University of California, Berkeley (746-G2)

4:00- 4:20 (36) Multiple points of an immersion. Preliminary report. Professor MICHAEL H. FREEDMAN, University of California, San Diego (746-G7)

SATURDAY, 2:00 P. M.

Special Session on Combinatorial Matrix Theory II, Room 3111, Meiklejohn Hall

2:00- 2:20 (37) Positive definite matrices and Catalan numbers. Dr. MORRIS NEWMAN, University of California, Santa Barbara (746-A10)

2:25- 2:45 (38) Indeterminates and incidence matrices. Preliminary report. Dr. H. J. RYSER, California Institute of Technology (746-A9)

2:50- 3:10 (39) Similarity invariants for principal submatrices. Professor R. C. THOMPSON, University of California, Santa Barbara (746-A7)

3:15- 3:35 (40) An inequality on ranks in sums of decomposable tensors. Professor JOHN de PILLIS, University of California, Santa Cruz (746-A11)

3:50- 4:10 (41) Decomposable tensors as a quadratic variety. Dr. ROBERT GRONE, Institute for Algebra and Combinatorics, University of California, Santa Barbara (746-A5) (Introduced by Dr. M. Marcus)

4:15- 4:35 (42) Some inclusion relations for c-numerical ranges. Professor MOSHE GOLDBERG, University of California, Los Angeles (746-A6)

4:40- 5:00 (43) Some convexity properties of the higher numerical range. Professor MARVIN MARCUS*, University of California, Santa Barbara, Professor B. N. MOYLS, University of British Columbia, and Mr. I. FILIPPENKO, University of California, Santa Barbara (746-A3)

5:05- 5:25 (44) Generalized matrix functions. Dr. RUSSELL MERRIS, California State University, Hayward (746-A1)

SATURDAY, 2:00 P. M.

Special Session on Optimization II, Room 2090, Meiklejohn Hall

2:00- 2:20 (45) Set-valued differentials and optimization theory. Professor HUBERT HALKIN, University of California, San Diego (746-B3)

2:30- 2:50 (46) Avoidance control. Professor GEORGE LEITMANN, University of California, Berkeley (746-C1) (Introduced by Ira Bert Russak)

3:00- 3:20 (47) A generic characterization of optimality in nonconvex programming. Preliminary report. Professor R. TYRRELL ROCKAFELLAR, University of Washington (746-C4) (Introduced by Ira Bert Russak)

3:30- 3:50 (48) A generalized saddle point characterization for solutions of singular problems in differential equations. Preliminary report. Dr. E. M. LANDESMAN and Mr. IAN WALTON*, University of California, Santa Cruz (746-B4)

4:00- 4:20 (49) Optimal control in Hilbert space. Preliminary report. Dr. SALAH M. YOUSIF, California State University, Sacramento (746-B9) (Introduced by Ira Bert Russak)

4:30- 4:50 (50) Conjugate gradient algorithms in non-Hilbertizable Banach spaces. Professor JUNION STEIN, University of Toledo (746-B2)

SATURDAY, 2:00 P. M.

Special Session on Mathematical Methods in Biology II, Room 2078, Meiklejohn Hall

2:00- 3:00 (51) Population genetics and diffusion equations. Professor JOSEPH B. KELLER, Stanford University (746-C5)

3:10- 3:30 (52) Simulation of transient and steady state transport in the kidney. Professor HERBERT D. LANDAHL, University of California, San Francisco (746-C6) (Introduced by Professor Susann Shaw)

3:40- 4:00 (53) Lotka's demographic equation—some asymptotic results and a new numerical approach. Professor WALTER T. KYNER, University of New Mexico and Professor DAVID A. SÁNCHEZ*, University of California, Los Angeles (746-C2)

4:10- 4:30 (54) Constrained differential equations for the crustacean cardiac pacemaker. Professor RICHARD E. PLANT, University of California, Davis (746-C7) (Introduced by Professor Susann Shaw)

Eugene, Oregon

Kenneth A. Ross
Associate Secretary

PRESENTORS OF PAPERS

Following each name is the number corresponding to the speaker's position on the program

● Invited one-hour lecturers   * Special session speakers

Ablow, C.M. #17
*Benkoski, S.J. #25
*Bremermann, H.J. #13
Brenner, J.L. #14
Cochran, J.A. #15
*Cruse, A.B. #8
*deCesare, K.M. #18
*DeMarr, Ralph #19
*dePillis, J. #40
*Douglas, R.J. #21
*Faulkner, F.D. #28
●Fife, P.C. #7
*Filippenko, I. #20
*Freedman, M.H. #36
*Gillman, D. #33
*Goldberg, M. #42
*Graves, G.W. #26
*Grone, R. #41
*Halkin, H. #45
Hansen, E. #16
*Head, T. #22
*Hestenes, M. #12
*Keller, J.B. #51
*Kirby, R. #32
*Kowalik, J.S. #27
*Landahl, H.D. #52
*Lehmer, D.H. #9
*Leitmann, G. #46
*MacCormack, R. #31
*Marcus, M. #43
*Martin, J. #3
*Mayland, Jr., E.J. #2
*Melvin, P. #35
*Merris, R. #44
*Millet, K.C. #5
*Morgan, C.L. #23
*Newman, M. #37
*Plant, R.E. #54
*Rockafellar, R.T. #47
*Rosmond, T.E. #30
*Ryser, H.J. #38
*Sánchez, D.A. #53
*Scharlemann, M. #4
●Sharpe, M.J. #6
*Stallings, J.R. #1
*Stein, J. #50
*Thompson, R.C. #39
*Todd, O.T. #10
*Van Buskirk, J.M. #34
*Verheiden, E. #11
*Verma, S. #24
*Walton, I. #48
*Williams, R.T. #29
*Yousif, S.M. #49

PRELIMINARY ANNOUNCEMENTS OF MEETINGS

81ST SUMMER MEETING | *University of Washington* *Seattle, Washington* *August 14–18, 1977*

The eighty-first summer meeting of the American Mathematical Society will be held at the University of Washington, Seattle, Washington, from Sunday, August 14, through Thursday, August 18. All sessions of the meeting will take place on the campus of the university.

A set of Colloquium Lectures, consisting of four one-hour talks, will be presented by HERBERT FEDERER of Brown University in Meany Hall. The title of the series is "Geometric measure theory". The first lecture will be given at 1:00 p.m. on Monday; the second lecture will be given at 11:00 a.m. on Tuesday; the third and fourth lectures will be given at 1:00 p.m. on Wednesday and Thursday.

By invitation of the Society's Program Committee, there will be five or six invited one-hour addresses, including JAMES W. CANNON of the University of Wisconsin; JAMES M. GREENBERG of the State University of New York at Buffalo; WILLIAM B. JOHNSON of Hebrew University, Jerusalem and Ohio State University at Columbus; and KENNETH A. RIBET of Princeton University. The names of the speakers and the titles of the addresses will appear in the June issue of these *Notices*

There will be sessions for contributed ten-minute papers on Monday afternoon, Wednesday afternoon, and Thursday afternoon. If necessary, sessions will also be scheduled Tuesday morning, Wednesday morning, and Thursday morning. If there is a demand, a late-paper session will be scheduled on Thursday afternoon. Overhead projectors and screens will be provided; each room will also contain a blackboard. Abstracts should be prepared on the standard AMS form available in most departments of mathematics and from the AMS office in Providence, and should be sent to the American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940, so as to arrive prior to the deadline of June 7. (Recall that a typing charge of $7 is imposed on abstracts that are not in camera-ready form.)

This meeting of the Society will be held in conjunction with the annual summer meetings of the Mathematical Association of America (August 14–16), the Institute of Mathematical Statistics (August 15–18), and Pi Mu Epsilon.

The twenty-fifth series of Earle Raymond Hedrick Lectures, sponsored by the Association, will be given by JOSEPH B. KELLER. The title of his lecture series will be announced in a future issue of these *Notices*. The Carl B. Allendorfer, Lester R. Ford, and George Pólya Awards will be presented at the Business Meeting of the Association at 10:00 a.m. on Monday, and the receipt of a bequest to the Association will be announced.

Program information on the Institute of Mathematical Statistics will appear in the June issue of these *Notices*.

The J. Sutherland Frame Lecture will be delivered to Pi Mu Epsilon on Monday at 7:30 p.m. The name of the speaker and title of the address will be announced in a later issue of these *Notices*.

The Association for Women in Mathematics will hold a panel discussion on "Alternatives to academic employment for mathematicians" at 7:30 p.m. on Monday. Lenore Blum will serve as moderator. There will be an open meeting of the AWM Executive Committee at 4:00 p.m. the same day.

The Council of the Conference Board of the Mathematical Sciences will meet on Wednesday at 3:15 p.m.

The Mathematician's Action Group will hold an open meeting of its Steering Committee at 7:30 p.m. on Sunday, its Business Meeting at 3:15 p.m. on Monday, and a panel discussion at 9:30 a.m. on Tuesday.

There will be a conference on Discrete Optimization just prior to the mathematics meetings, from August 8–12, at the University of British Columbia in Vancouver, Canada (145 miles north of Seattle). The program will consist of survey lectures on the state of the art of integer programming. Information about the program is available from the directors: P. L. Hammer (University of Waterloo), E. L. Johnson (IBM-Yorktown Heights, NJ), and B. Korte (University of Bonn).

A preliminary list of speakers includes E. Balas, E. M. L. Beale, C. Berge, R. Burkard, J. Edmonds, R. Graham, P. L. Hammer, A. Hoffman, R. Jeroslow, E. Johnson, V. Klee, B. Korte, J. Krarup, A. Land, G. Lawler, J. K. Lenstra and A. Rinnooy Kan, L. Lovász, M. Padberg, J. Shapiro, K. Spielberg, and J. Tind. Participation in this conference is open to mathematicians and practitioners of operations research interested in this area. Full texts of surveys will be distributed to all participants in advance of the meeting. The final form of these texts, including discussions and comments by participants, will be published. For further information, including information about accommodations and registration fees, contact Brian Alspach, DO77, Department of Mathematics, Simon Fraser University, Burnaby, B.C., Canada (V5A 1S6).

SPECIAL SESSIONS

MIROSLAV BENDA and ANNE C. MOREL

American Mathematical Society Short Course Series
FUNDAMENTALS OF APPLIED COMBINATORICS
August 12 and 13, 1977

The American Mathematical Society will present a one and one-half day course on Fundamentals of Applied Combinatorics on Friday and Saturday, August 12 and 13, in Room 120 in Kane Hall on the campus of the University of Washington, Seattle.

The course is designed to provide substantial introductions to three important areas of application of combinatorial mathematics for mathematicians whose specializations are in other areas. It is intended to illustrate both the variety of mathematically challenging questions which can arise in connection with problems encountered in modern applications as well as some of the new approaches now being taken for treating those problems which are inherently too difficult to solve. Although some mathematical maturity will be assumed on the part of the participant, no prior specialized knowledge of combinatorics, graph theory or coding theory will be required.

The program is under the direction of Ronald L. Graham of Bell Laboratories, Murray Hill, New Jersey. The course was recommended by the Society's Committee on Employment and Educational Policy (CEEP), whose members are Lida K. Barrett, David Blackwell, Wendell H. Fleming (chairman), Hugo Rossi, Martha K. Smith, and Robert J. Thompson.

There will be three lecturers, each of whom will give two seventy-five minute lectures. RONALD L. GRAHAM will speak on combinatorial scheduling theory; DANIEL J. KLEITMAN of Massachusetts Institute of Technology will speak on graphs and algorithms; and ROBERT J. McELIECE of California Institute of Technology, Jet Propulsion Laboratory will speak on coding theory.

Summaries of these talks and accompanying lists appear on pages A-355 and A-356 of these *Notices*.

This course is open to all who wish to participate upon payment of the registration fee. This fee is reduced for students and unemployed individuals. Please refer to the section entitled MEETING PREREGISTRATION AND REGISTRATION for details.

of the University of Washington are organizing a special session on Boolean algebras. AFTON H. CAYFORD of the University of British Columbia is organizing a special session on Banach spaces of analytic functions. COLIN W. CLARK of the University of British Columbia will organize a special session on Mathematical models in natural resource management. MICHEAL N. DYER and ALLAN J. SIERADSKI of the University of Oregon are organizing a special session on Algebraic topology; the list of speakers includes M. Bendersky Roy R. Douglas, Ross Geoghegan, Alex Heller, Peter J. Hilton, Cheong Seng Hoo, G. Kozlowski, George E. Lang, Jr., Douglas C. Ravenal, Jack Segal, Denis Sjerve, and Kalathoor Varadarajan. BRANKO GRÜNBAUM of the University of Washington is organizing a special session on Tilings, patterns and symmetries. DOUGLAS A. LIND of the University of Washington is organizing a special session on Ergodic theory and dynamical systems. HENRY L. LOEB of the University of Oregon is organizing a special session on Approximation theory; the tentative list of participants includes Richard B. Barrar, David L. Barrow, R. Creighton Buck, Hermann G. Burchard, Bruce L. Chalmers, Joel Davis, Gary A. Gislason, Allen A. Goldstein, Seymour Haber, Karl Heinz Hoffmann, John M. Karon, John W. Lee, Lois E. Mansfield, Larry Lee Schumaker, Ambikeshwar Sharma, David A. Sprecher, Frank Stenger, Jerry Wolfe, and Daniel Wulbert. CALVIN T. LONG of Washington State University will organize a special session on Combinatorial number theory. EDGAR LEE STOUT of the University of Washington is organizing a special session on Several complex variables; a tentative list of speakers includes Herbert J. Alexander, James R. King, James A. Morrow, Alexander J. Nagel, Hugo Rossi, and Wilhelm F. Stoll.

Most of the papers to be presented at these special sessions will be by invitation. However anyone contributing an abstract for the meeting who feels the paper is particularly appropriate for one of these special sessions should indicate this clearly on the abstract and submit it by May 24 (two weeks prior to the normal deadline for contributed papers), in order that it may be considered for inclusion.

COUNCIL AND BUSINESS MEETING

The Council of the Society will meet at 5:00 p.m. on Monday, August 15, in the Condon Room of the University Tower Hotel. The Business Meeting of the Society will be held in Meany Hall at 11:00 a.m. on Wednesday, August 17. The secretary notes the following resolution of the Council: "Each person who attends a Business Meeting of the Society shall be willing and able to identify himself as a member of the Society." In further explanation, it is noted that "each person who is to vote at a meeting is thereby identifying himself as and claiming to be a member of the American Mathematical Society."

MEETING PREREGISTRATION AND REGISTRATION

Participants who wish to preregister for the meetings should complete the Meeting Preregistration Form on the last page of these *Notices*. Please note that one may preregister for the meetings until July 27, although the deadline for confirmed residence hall reservations through the Housing Bureau is July 10. Those who preregister will pay lower registration fees than those who register at the meeting, as indicated in the schedule below. Preregistrants will be able to pick up their badges and programs when they arrive at the meeting after 2:00 p.m. on Saturday, August 13, at the Joint Mathematics Meetings registration desk. Complete instructions on procedures for making hotel or residence hall reservations are given in the sections entitled RESIDENCE HALL HOUSING and HOTELS.

Meeting preregistration and registration fees partially cover expenses of holding the meetings. The preregistration fee does not represent an advance deposit for lodgings.

Please note that separate registration fees are required for the short course and the Joint Meetings. These fees are as follows:

Fundamentals of Applied Combinatorics

Short Course

	Preregistration	At Meeting
Student or unemployed	$ 3	$ 5
All other participants	18	20
One day fee for second day	-	10

Joint Mathematics Meetings

	Preregistration	At Meeting
Members of AMS, MAA, or IIME, who are not members of IMS	$15	$20
Members of IMS	18	23
Nonmember	25	30
Student or unemployed	2	3

An extra $3 is being charged IMS members, to be assigned to IMS, to cover some of that organization's expenses beyond those required for the Joint Mathematics Meetings.

There will be no extra charge for members of the families of registered participants, except that all professional mathematicians who wish to attend sessions must register independently.

The unemployed status refers to any participants currently unemployed and actively seeking employment. It is not intended to include participants who have voluntarily resigned or retired from their latest position. Students are considered to be only those currently working toward a degree who do not receive an annual compensation totaling more than $7,000 from employment, fellowships, and scholarships.

> Checks for the preregistration fee(s) should be mailed to arrive in Providence not later than July 27. Participants should make their own reservations directly with hotels in the area (cf. section titled HOTELS). It is essential, however, to submit the Meeting Preregistration Form on the last page of these *Notices* by July 10 to obtain confirmed residence hall accommodations.

A fifty percent refund of preregistration fees will be made for all cancellations received in Providence prior to August 10. There will be no refunds granted for cancellations received after that date, or to persons who do not attend the meetings.

Registration for the short course only will begin on Thursday, August 11, in the first floor foyer of Kane Hall. Lecture notes and other short course material will be distributed before the first session at the short course registration desk. Those individuals who do not preregister for the short course are strongly urged to register and pick up their material on Thursday evening so as not to miss the start of the lecture on Friday morning.

Joint Meeting registration will commence on Saturday, August 13, at 2:00 p.m. in the basement of the Odegaard Undergraduate Library. Participants who are not attending the short course are advised that no general meeting information material will be available prior to the opening of Joint Meeting registration on Saturday. Upon arrival at the University of Washington campus, participants should proceed directly to the check-in desk in Haggett Hall in order to check into their accommocations before registering for the meetings. The hours the registration desks will be open are as follows:

Fundamentals of Applied Combinatorics
Short Course Registration
Location: First Floor Foyer, Kane Hall

Date and Time

Thursday, August 11	4:30 p. m. - 7:30 p. m.
Friday, August 12	8:00 a. m. - 5:00 p. m.
Saturday, August 13	noon - 2:00 p. m.

Joint Mathematics Meetings Registration
Location: Basement Registration Area
Odegaard Undergraduate Library

Date and Time

Saturday, August 13	2:00 p. m. - 8:00 p. m.
Sunday, August 14	8:00 a. m. - 5:00 p. m.
Monday, August 15 through Wednesday, August 17	8:30 a. m. - 4:30 p. m.
Thursday, August 18	8:30 a. m. - 1:30 p. m.

MATHEMATICAL SCIENCES
EMPLOYMENT REGISTER

It is planned to operate an informal Employment Register at Seattle. No interviews will be scheduled by the staff. Instead, facilities will be provided for applicants and employers to display resumes and job listings. Message boxes will be set up for individuals to leave messages for one another requesting interviews. Tables and chairs will be provided in the room for interviews.

Employers are encouraged to attend the meetings and participate, if possible. Applicants should recognize that the Mathematical Sciences Employment Register (MSER) cannot guarantee that any employers will, in fact, attend the meeting or participate in the Employment Register. The AMS-MAA-SIAM Committee on Employment Opportunities will, however, request employers listing in the July and August 1977 issues of Employment Information for Mathematicians to signify in their listing their intention to participate in the Employment Register at the summer meeting.

Employers and applicants are referred to the news item on page 184 of this issue of these

Notices which announces the new list of applicants to be published by the MSER in August of this year.

EXHIBITS

The book and educational media exhibits will be displayed in the Basement Registration Area of the Odegaard Undergraduate Library at the following times: Sunday, August 14, 1:00 p.m. to 5:00 p.m.; Monday and Tuesday, August 15–16, 8:30 a.m. to 4:30 p.m.; and Wednesday, August 17, 8:30 a.m. to noon. All participants are encouraged to visit the exhibits some time during the meeting.

RESIDENCE HALL HOUSING

Participants desiring to obtain confirmed reservations for residence hall accommodations must preregister prior to the deadline of July 10. Residence hall reservations will not require a deposit in advance. Full payment for rooms at the residence halls must be made at check-in time. Requests for residence hall housing will be acknowledged. Participants who fail to preregister before July 10 may still be able to obtain residence hall accommodations by writing or calling the University of Washington Housing and Food Services Conference Office, Lander Hall, 1201 N.E. Campus Parkway, University of Washington, Seattle, Washington 98195 (telephone 206-543-7634) in order to determine whether residence hall space is still available; however, the Mathematics Meetings Housing Bureau cannot guarantee that space will be available or that it will be possible to obtain confirmed reservations. No requests for rooms will be honored after July 29. Please use the preregistration and housing request form provided on the last page of these *Notices* and return it to the Housing Bureau, being as explicit as possible in order that your residence hall assignment can be made correctly.

Three residence halls have been reserved for the use of participants in the Joint Mathematics Meetings and the Fundamentals of Applied Combinatorics Short Course: Haggett Hall, Hansee Hall, and McCarty Hall (see map on page 171). The residence halls are not air conditioned, but it is seldom uncomfortably warm in Seattle in August. All of these residence halls are within a five minute walk of the HUB (Student Union Building), and the central square on campus where Meany and Kane Halls are located, as well as the Odegaard Undergraduate Library. Participants must go to the check-in desk at Haggett Hall in order to determine their residence hall assignment, and to obtain keys to the room and mail/message box. Payment in full for lodgings will be required at that time. The desk in Haggett Hall will be open during the following hours:

Thursday, August 11 and Friday, August 12	7:30 a.m. to 10:00 p.m.
Saturday, August 13 and Sunday, August 14	7:30 a.m. to midnight
Monday, August 15 through Thursday, August 18	7:30 a.m. to 10:00 p.m.

Those participants arriving after the check-in desk in Haggett Hall is closed will be assisted by the night watch personnel. Signs will be posted near the telephones in Haggett Hall lobby giving instructions on how to locate the watchman by telephone. It will not be possible for participants to occupy residence hall rooms before Thursday, August 11, or after the night of Thursday, August 18. All participants must be checked out of their rooms no later than 10:00 a.m. on Friday, August 19. If housing requests are received for dates before August 11 or after August 18, they will be honored for the period August 11–18 only.

The rates quoted below include the maximum per night cost of the room, plus breakfast which will be served at Haggett Hall August 14 through August 18. Those short course participants staying in a residence hall room on campus the nights of Thursday, August 11, and Friday, August 12 should refer to the chart of available meal facilities included in the section titled FOOD SERVICES.

Single Room	\$10/night
Double Room	\$ 8/night per person

Rooms occupied nights prior to August 13 will be charged at a slightly lower rate.

There will be no room charge for children under nine years of age occupying a sleeping bag, air mattress, or crib provided by the parents, but breakfast will be charged, except for infants. Children nine years of age or over are required to occupy a bed, and will be charged the same rate as an adult. Any child under nine years of age occupying a bed will, of course, be charged the same rate as an adult. Information on crib rental will appear in the June issue of these *Notices*. Participants accompanied by small children should be aware that some hazards to them exist in the residence halls which are highrise structures designed for adult use. There are automatic elevators and open railings in the stairwells and on balconies, and in some lounge areas there are portions of the windows at floor level which may be open and without screens.

Most rooms contain two single beds (double beds are not available), and there are community bathroom facilities on each floor. Because each bathroom will be used by only one sex, in a few instances a participant may have to use a bathroom on another floor or on the same floor but in the opposite wing from where he or she is housed. There are several large and comfortable public lounges in each residence hall. Coin-metered automatic washers are available (20¢); use of automatic dryers is free. Participants are required to supply their own detergent and laundry materials. There are several ironing boards in each hall, and irons may be checked out at the desk on the main floor.

Beds will be made up with linen and blankets when participants arrive. Two bath towels will be provided each guest and replaced every third day. Wastebaskets will be emptied every third day; otherwise, no further daily maid service will be provided. Soap and plastic cups will be in each room; toilet paper will be supplied in the bathrooms.

Light kitchen facilities are available on some floors; participants are advised to bring their own cooking utensils. Vending machines dispensing soft drinks and snacks are also located in convenient areas in each building. Comsumption of alcoholic beverages in one's room is permitted, but is not allowed in public areas such as hallways or lounges. No pets are alowed in the residence halls.

There is a telephone in each room which is restricted to local use; however, there are pay phones located on some floors.

HOTELS

Blocks of rooms have been set aside for use by participants at the University Tower Hotel (F on the map on page 171), and the Sherwood Inn (G on the map on page 171). Participants should make their own reservations early directly with these hotels, and should identify themselves as participants in either the Fundamentals of Applied Combinatorics Short Course or the Joint Mathematics Meetings.

The following codes apply: FP-Free Parking; SP-Swimming Pool; AC-Air Conditioned; TV-Television; CL-Cocktail Lounge; RT-Restaurant. In all cases "single" refers to one person in one bed; "double" refers to two persons in one bed; and "twin" refers to two persons in two beds. A rollaway cot for an extra person can be added to double or twin rooms only. Participants will be advised of deposit requirements at time of confirmation by hotels.

UNIVERSITY TOWER HOTEL
4507 Brooklyn Avenue N.E.
Single $24; Double $26; Twin $30
Extra person in room $4
Code: FP, TV, CL, RT
Telephone: 800-547-4262 or 206-634-2000
(Within Oregon, call collect 503-221-1611)
(The tenth floor is reserved for nonsmokers. There is direct courtesy car service for registered guests to and from the downtown airport terminal daily between 6:00 a.m. and 10:00 p.m.)

SHERWOOD INN
400 N.E. 45th Street
Single $20; Double $25; Twin $25
Extra person in room $4.
Code: FP, SP, AC, TV, CL, RT
Telephone: 206-634-0100

Information on other hotels within walking distance of the campus will be available in the June issue of these *Notices*.

FOOD SERVICES

The following food service facilities will be available on campus to participants in the Applied Combinatorics Short Course and/or Joint Mathematics Meetings:

Evergreen in HUB

Saturday, August 13 — 10:30 a.m. to 2:30 p.m.

Husky Den in HUB

Thursday and Friday (August 11–12) — 7:00 a.m. to 4:00 p.m.

Monday through Friday (August 15–19) — 7:00 a.m. to 4:00 p.m.

Haggett Hall Cafeteria

Sunday through Thursday (August 14–18) — (Breakfast only) 7:00 a.m. to 9:00 a.m.

Odegaard Undergraduate Library Cafeteria

Thursday and Friday (August 11–12) — Lunch only

Monday through Friday (August 15–19) — Lunch only

There are many good restaurants in the "University District" bordering the campus which are within walking distance. A list of these will be supplied to participants in their registration packets at the meeting.

MEDICAL SERVICES

Around the clock emergency service is available at the University Hospital and many other area hospitals. The King County Medical Society can make referrals Monday through Friday, from 9:00 a.m. to 5:00 p.m. (telephone 285-0221). Referrals to dentists can be obtained by calling 624-4912 at any time. For temporary emergency service (to take care of pain, etc.) call for an appointment at 543-5850.

The Hall Health Center on campus provides one-time emergency service only.

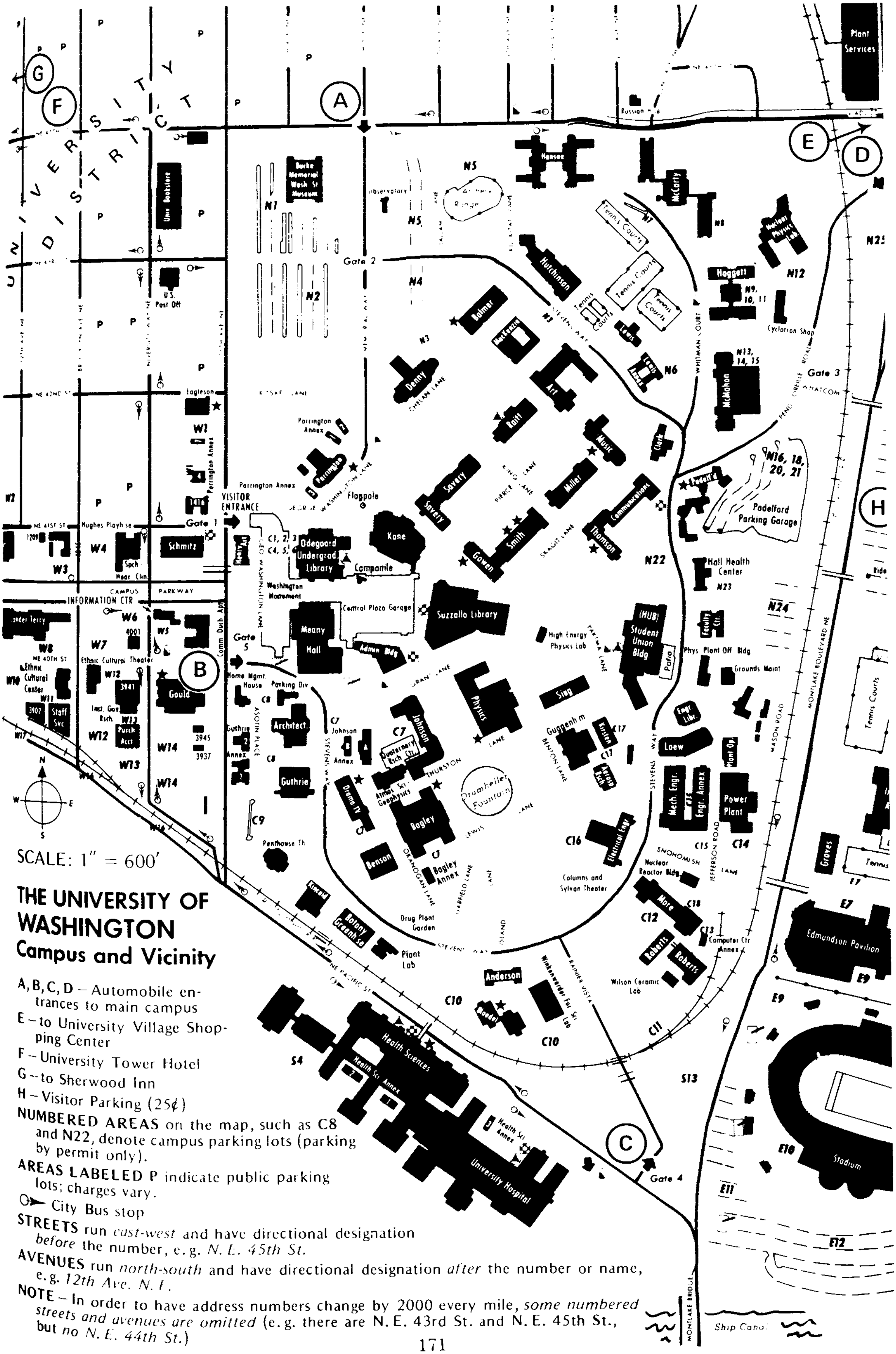
ENTERTAINMENT

At 6:00 p.m. on Tuesday, August 16, an Indian-style salmon barbecue will be served on the campus. Fresh Pacific Ocean King salmon will be prepared in the ancient Makah manner on cedar stakes over an open alderwood fire and, in addition to the salmon, dinner will include tossed green salad with choice of dressings, potato, vegetable, dessert, and beverage. The cost per person, including tax, will be $8.75 for adults and $5 for children aged 12 and under. Tickets may be purchased at the meeting; however, to be assured of a reservation, participants are urged to use the section of the preregistration form on page A-365 of these *Notices* to reserve and pay for their tickets in advance; these would be picked up at the Joint Meetings registration desk. A beer party will follow the barbecue, and additional details regarding this event will be included in a subsequent announcement.

TRAVEL AND LOCAL INFORMATION

Seattle operates on Pacific daylight time during the summer. Airlines offering regular service to the Seattle-Tacoma International Airport are Alaska, Air Canada, Braniff, Continental, Eastern, Hughes Airwest, Northwest Orient, Pacific Western, United, and Western. The airport bus to downtown Seattle costs $3 and takes about twenty minutes. Taxi fare from downtown to the University runs about $4 and the fare from the airport to the University is approximately $14. There are a number of car rental agencies at the airport, including Airway, Avis, Budget, Hertz, and National. If you plan to drive from the airport to the University, follow the signs to northbound I-5, and then the following directions.

The main highways into Seattle are I-90 from the east and I-5 from the north and south. To reach the University from I-90, follow the signs from I-90 to northbound I-5. When approaching Seattle on I-5 (from north or south),



THE UNIVERSITY OF WASHINGTON
Campus and Vicinity

A, B, C, D – Automobile entrances to main campus

E – to University Village Shopping Center

F – University Tower Hotel

G – to Sherwood Inn

H – Visitor Parking (25¢)

NUMBERED AREAS on the map, such as C8 and N22, denote campus parking lots (parking by permit only).

AREAS LABELED P indicate public parking lots; charges vary.

City Bus stop

STREETS run *east-west* and have directional designation *before* the number, e.g. *N. E. 45th St.*

AVENUES run *north-south* and have directional designation *after* the number or name, e.g. *12th Ave. N. E.*

NOTE – In order to have address numbers change by 2000 every mile, *some numbered streets and avenues are omitted* (e.g. there are N. E. 43rd St. and N. E. 45th St., but *no N. E. 44th St.*)

exit at N.E. 45th Street and proceed approximately ten blocks east to the main entrance of the University at the corner of N.E. 45th Street and 17th Avenue N.E. Campus directions will be available at the gate.

Two Amtrak trains arrive daily in Seattle from the east and midwest; one from California and one from Vancouver, Canada. The railroad station is in downtown Seattle, approximately a $4 cab ride from the University.

PARKING

Parking permits will be required for parking in all areas of the campus, with the exception of a metered lot (Montlake lot, 25¢ out). Parking fees are $1.25 per day, $1.50 per week on campus; $2.25 per week in a garage. For persons residing in the dormitories, permits are issued at check-in time when housing arrangements are paid for. Others may obtain their permits at the Parking Division Building, Monday through Friday, from 8:00 a.m. to 5:00 p.m.

WEATHER

The normal daytime high is 23°C. Normal nightime low is 12°C. Rainfall in August averages only 2.74 cm (although the last two summers have considerably exceeded this with 11.7 cm in 1975). Humidity ranges from an early morning high of 90% to an evening low below 50%. The record high and low temperatures for August are 37°C and 7°C, respectively. Light sweaters and jackets are advisable for evening wear.

MAIL AND TELEPHONE MESSAGES

All mail and telegrams for persons attending the meetings should be addressed to the participant in care of Joint Mathematics Meetings, Department of Mathematics (GN-50), University of Washington, Seattle, Washington 98195. Mail and telegrams so addressed may be picked up at the Joint Meetings Registration Desk located in the basement registration area of the Odegaard Undergraduate Library.

A telephone message center will be located in the same area to receive incoming calls for registrants during the hours the desk is open, cf. section titled MEETING PREREGISTRATION AND REGISTRATION, on a previous page. Messages will be written down, and the name of any participant for whom a message has been received will be posted until the message is picked up at the message center. The telephone number of the center will be published in a later issue of these *Notices*.

LOCAL ARRANGEMENTS COMMITTEE

Kathleen Baxter, Ross A. Beaumont, Roy Dubisch (chairman), Samuel L. Dunn, Thomas W. Hungerford, J. Maurice Kingston, Lloyd J. Montzingo, Jr., Norman G. Myer, Jr., David P. Roselle (ex officio), Kenneth A. Ross (ex officio), Friedrich W. Scholz, and Gordon L. Walker (ex officio).

SUMMARY OF ACTIVITIES

The purpose of this summary is to provide assistance to registrants in the selection of arrival and departure dates. The program, as outlined below, is based on information available at press time.

	AMERICAN MATHEMATICAL SOCIETY SHORT COURSE SERIES
THURSDAY, August 11	FUNDAMENTALS OF APPLIED COMBINATORICS
4:30 p.m. - 7:30 p.m.	REGISTRATION (Short Course Only)
FRIDAY, August 12	
8:00 a.m. - 5:00 p.m.	REGISTRATION (Short Course Only)
9:00 a.m. - 10:15 a.m.	Introductory remarks Combinatorial scheduling theory I Ronald L. Graham
10:45 a.m. - noon	Combinatorial analysis of convolutional codes I Robert J. McEliece
2:00 p.m. - 3:15 p.m.	Fast but imperfect algorithms I Daniel J. Kleitman
3:45 p.m. - 5:00 p.m.	Combinatorial scheduling theory II Ronald L. Graham
SATURDAY, August 13	
noon - 2:00 p.m.	REGISTRATION (Short Course Only)
2:00 p.m. - 3:15 p.m.	Combinatorial analysis of convolutional codes II Robert J. McEliece
3:45 p.m. - 5:00 p.m.	Fast but imperfect algorithms II Daniel J. Kleitman

	AMS - MAA SUMMER MEETINGS	
SATURDAY, August 13	American Mathematical Society	Mathematical Association of America
9:00 a.m. - 4:00 p.m.		Board of Governors Meeting
2:00 p.m. - 8:00 p.m.	REGISTRATION	
SUNDAY, August 14	AMS	Other Organizations
8:00 a.m. - 5:00 p.m.	REGISTRATION	
9:00 a.m. - 9:10 a.m.		Welcome Address John Hogness, President University of Washington
9:10 a.m. - 10:00 a.m.		MAA - Hedrick Lecture I Joseph B. Keller
10:00 a.m. - 11:00 a.m.		MAA - Session: How to teach mathematics What not to do (a demonstration) Peter J. Hilton What to do (some rules of thumb) George Polya
1:00 p.m. - 5:00 p.m.	EXHIBITS	
1:30 p.m. - 2:30 p.m.		MAA - Hedrick Lecture II Joseph B. Keller
2:30 p.m. - 3:20 p.m.		MAA - Session: The WAM program: women in mathematics Jean J. Pedersen Eileen L. Poiani
3:30 p.m. - 4:20 p.m.		MAA - Invited Address Mathematics and mathematicians in industry Brockway McMillan
7:00 p.m. - 9:00 p.m.		MAA - Film Program
7:00 p.m. - 10:00 p.m.		MAA - Section Officers Meeting
7:30 p.m. - 10:30 p.m.		Mathematicians Action Group Steering Committee - Open Meeting

MONDAY, August 15	American Mathematical Society	Other Organizations
8:30 a.m. - 4:30 p.m.	REGISTRATION	
8:30 a.m. - 4:30 p.m.	EXHIBITS	
8:30 a.m. - 4:30 p.m.	EMPLOYMENT REGISTER	
9:00 a.m. - 9:50 a.m.		MAA - Hedrick Lecture III Joseph B. Keller
10:00 a.m. - 10:50 a.m.		MAA - Business Meeting
11:00 a.m. - 11:50 a.m.		MAA - Invited Address On the Landau problem of bounds for derivatives Isaac J. Schoenberg
noon - 1:00 p.m.		Pi Mu Epsilon - Council Luncheon
1:00 p.m. - 2:00 p.m.	COLLOQUIUM LECTURE I Geometric measure theory Herbert Federer	
afternoon	Sessions for Contributed Papers Special Sessions	
3:00 p.m. - 5:30 p.m.		ΠME - Contributed Papers
3:15 p.m. - 5:00 p.m.		MAG - Business Meeting
3:30 p.m. - 4:30 p.m.	Committee on Employment and Educational Policy Panel Discussion	
4:00 p.m. - 5:00 p.m.		Association for Women in Mathematics Open Executive Committee Meeting
5:00 p.m.	Council Meeting	
5:30 p.m. - 7:30 p.m.		MAA Pacific Northwest Section - Social
6:00 p.m. - 7:00 p.m.		ΠME - Banquet
6:15 p.m.		Institute of Mathematical Statistics Council Meeting
7:00 p.m. - 9:00 p.m.		MAA - Film Program
7:30 p.m. - 8:30 p.m.		ΠME - J. Sutherland Frame Lecture
7:30 p.m. - 9:30 p.m.		AWM - Panel Discussion

TUESDAY, August 16	AMS	Other Organizations
8:00 a.m. - 9:00 a.m.		ΠME - Breakfast
8:30 a.m. - 4:30 p.m.	REGISTRATION	
8:30 a.m. - 4:30 p.m.	EXHIBITS	
8:30 a.m. - 4:30 p.m.	EMPLOYMENT REGISTER	
8:30 a.m. - 9:30 a.m.	INVITED ADDRESS	
9:30 a.m. - 11:00 a.m.		MAG - Panel Discussion
9:45 a.m. - 10:45 a.m.	INVITED ADDRESS	
11:00 a.m. - noon	COLLOQUIUM LECTURE II Geometric measure theory Herbert Federer	
1:30 p.m. - 2:20 p.m.		MAA - Invited Address Measure algebras and their uses Dorothy Maharam Stone
2:30 p.m. - 3:20 p.m.		MAA - Invited Address Some recent results on the geometry of N-space David G. Larman
3:00 p.m. - 5:30 p.m.		ΠME - Contributed Papers
3:30 p.m. - 4:20 p.m.		MAA - Invited Address A lost notebook of Ramanujan George E. Andrews
4:30 p.m. - 5:30 p.m.		MAA Pacific Northwest Section Business Meeting
6:00 p.m.	SALMON BARBECUE BEER PARTY	

WEDNESDAY, August 17	American Mathematical Society	Other Organizations
8:30 a.m. - noon	EXHIBITS	
8:30 a.m. - 4:30 p.m.	REGISTRATION	
8:30 a.m. - 4:30 p.m.	EMPLOYMENT REGISTER	
10:00 a.m. - 11:00 a.m.	Prize Session	
11:00 a.m. - noon	Business Meeting	
1:00 p.m. - 2:00 p.m.	COLLOQUIUM LECTURE III Geometric measure theory Herbert Federer	
afternoon	Sessions for Contributed Papers Special Sessions	
3:15 p.m. - 6:15 p.m.		Conference Board of the Mathematical Sciences - Council Meeting
6:15 p.m.		IMS - Council Meeting
7:30 p.m. - 10:30 p.m.		CBMS - Council Meeting
THURSDAY, August 18	**AMS**	
8:30 a.m. - 9:30 a.m.	INVITED ADDRESS	
8:30 a.m. - 1:30 p.m.	REGISTRATION	
9:45 a.m. - 10:45 a.m.	INVITED ADDRESS	
11:00 a.m. - noon	INVITED ADDRESS	
1:00 p.m. - 2:00 p.m.	COLLOQUIUM LECTURE IV Geometric measure theory Herbert Federer	
afternoon	Sessions for Contributed Papers Special Sessions	

Kenneth A. Ross
Associate Secretary

Eugene, Oregon

ORGANIZERS AND TOPICS OF SPECIAL SESSIONS

Abstracts of contributed papers to be considered for possible inclusion in special sessions should be submitted to the Providence office by the deadlines given below. The latest abstract form has a section for indicating special sessions. Lacking this, be sure your abstract form is clearly marked "For consideration for special session (title of special session)." Those papers not selected for special sessions will automatically be considered for regular sessions unless the author gives specific instructions to the contrary.

	Deadline
Seattle, Washington, August 1977	May 24

Miroslav Benda and Anne C. Morel, Boolean algebras
Afton H. Cayford, Banach spaces of analytic functions
Colin W. Clark, Mathematical models in natural resource management
Micheal N. Dyer and Allan J. Sieradski, Algebraic topology
Branko Grünbaum, Tilings, patterns and symmetries
Douglas A. Lind, Ergodic theory and dynamical systems
Henry L. Loeb, Approximation theory
Calvin T. Long, Combinatorial number theory
Edgar Lee Stout, Several complex variables

INVITED SPEAKERS AT AMS MEETINGS

This section of these *Notices* lists regularly the individuals who have agreed to address the Society at the times and places listed below. For some future meetings, the lists of speakers are incomplete.

Seattle, Washington, August 1977

James W. Cannon — William B. Johnson
James M. Greenberg — Kenneth A. Ribet

WASHINGTON REPORT: SCIENCE AND THE NEW CONGRESS

By Truman Botts
Conference Board of the Mathematical Sciences

As of the present writing at the end of February, more than a month after the installation of the new Carter Administration, that Administration has left a number of uncertainties regarding the outlook for Federal science policy, organization, and budget. A new Presidential Science Adviser has yet to be appointed (though the leading candidate now appears to be distinguished Massachusetts Institute of Technology geophysicist Frank Press—see the 25 February issue of Science, pages 763-766). A new Director for the National Science Foundation is also as yet unchosen; former Deputy Director Richard C. Atkinson, a psychologist from Stanford, continues at present to serve as Acting Director. In addition, any Carter changes in the budget request for scientific and technological research and development for fiscal year 1978 (which begins on 1 October 1977) presented to Congress by the Ford Administration on January 17 remain to be spelled out. Organizational and other changes in the new Congress that might affect Federal science policy and budget are, however, now largely settled.

In the House of Representatives, the Committee on Science and Technology received added jurisdiction in the domain of nuclear research and development, including fusion research and high energy physics when, in a House action early in January, the Joint Committee on Atomic Energy was stripped of its legislative powers. As shown in the tabulation below, there have also been a number of changes in the membership of the Committee on Science and Technology. Notable among the friends of science that the Committee has lost are the former chairman of its Subcommittee on Science, Research and Technology, James W. Symington, who resigned to run, unsuccessfully, for the Senate seat formerly held by his father, and the ranking Republican member of the Committee, Charles A. Mosher, who retired. The ranking Republican is now John W. Wydler.

House Committee on Science and Technology

(Starred names are those of new members)

Olin E. Teague (D-TX), Chairman

Jerome Ambro, Jr. (D-NY)	Marilyn Lloyd (D-TN)
*Anthony C. Beilenson (D-CA)	*Manuel Lujan, Jr. (R-NM)
James J. Blanchard (D-MI)	Mike McCormack (D-WA)
George E. Brown, Jr. (D-CA)	Dale Milford (D-TX)
*Robert K. Dornan (R-CA)	Gary A. Myres (R-PA)
*Thomas J. Downey (D-NY)	*Stephen L. Neal (D-NC)
*Hamilton Fish, Jr. (R-NY)	Richard L. Ottinger (D-NY)
*Ronnie G. Flippo (D-AL)	*Carl Pursell (R-MI)
Walter Flowers (D-AL)	Robert A. Roe (D-NJ)
Louis Frey, Jr. (R-FL)	*Eldon Rudd (R-AZ)
Don Fuqua (D-FL)	James H. Scheuer (D-NY)
*Bob Gammage (D-TX)	Ray Thornton (D-AR)
*Dan Glickman (D-KS)	*Richard A. Tonry (D-LA)
Barry M. Goldwater, Jr. (R-CA)	*Doug Walgren (D-PA)
*Albert Gore, Jr. (D-TN)	*Robert S. Walker (R-PA)
Tom Harkin (D-IA)	*Wes Watkins (D-OK)
*Harold Hollenbeck (R-NJ)	Larry Winn (R-KS)
Robert Kreuger (D-TX)	Timothy E. Wirth (D-CO)
Jim Lloyd (D-CA)	John W. Wydler (R-NY)

In a January 25 caucus of the Democratic members (who now outnumber the Republicans 27 to 12) the Committee's subcommittee structure was reviewed and slightly revised and the chairmanships of the seven subcommittees were assigned. Relinquishing to Scheuer his former chairmanship of the Subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation, Thornton replaces Symington as chairman of the Subcommittee on Science, Research and Technology, which has oversight over the National Science Foundation. Flowers becomes the chairman of the major energy subcommittee, the Subcommittee on Fossil and Nuclear Energy Research, Development and Demonstration, while McCormack retains the chairmanship of a second energy subcommittee, the Subcommittee on Advanced Energy Technologies and Energy Conservation Research, Development, and Demonstration. The other three subcommittee chairmanships remain unchanged: Milford for the Subcommittee on Transportation, Aviation and Weather; Brown for the Subcommittee on Environment and the Atmosphere; and Fuqua for the Subcommittee on Space Science and Applications.

For the mathematical sciences, the most important of these subcommittees is the one on Science, Research and Technology, because especially of its jurisdiction over the National Science Foundation (NSF). This Subcommittee consists (in addition to the chairman and ranking Republican member of the full Committee, who are ex officio members of all subcommittees) of the following nine: Brown, Dorman, Flippo, Fuqua, Harkin, Hollenbeck, Kreuger, McCormack, and Thornton (chairman). Throughout February this Subcommittee has been primarily occupied with sessions and hearings on an authorization bill for the NSF for fiscal year 1978. Its mark-up (i.e., finalization) session on this bill was scheduled for March 2, with consideration of the resulting bill by the full Committee on Science and Technology set for March 9. Action on the bill by the entire House of Representatives could come as early as late March, but is more likely to take place in early April. An area in which this House bill might authorize a higher NSF budgetary allocation than the Administration has requested is the area of Science Education, for which the Administration request is just \$75.7 million, representing an increase of less than 2% over the 1977 estimated expenditure level and hence a real decrease when projected inflation is taken into account.

In the Senate the Committee on Rules and Administration held hearings in January on a proposal for a considerably reduced number of standing committees that was drawn up last fall by a Temporary Select Committee to Study the Senate Committee Structure, and on February 4 the Senate voted to consolidate its standing committees into the following fourteen: Agriculture, Nutrition, and Forestry; Appropriations; Armed Services; Banking, Housing, and Urban Affairs; Budget; Commerce, Science, and Transportation; Energy and Natural Resources; Environment and Public Works; Finance; Foreign Relations; Governmental Affairs; Human Resources; Judiciary; and Rules and Administration. Jurisdiction over the NSF remains with the Committee on Human Resources (formerly the Committee on Labor and Public Welfare) rather than being transferred to the Committee on Commerce, Science and Transportation, as the Temporary Select Committee had intended. Within the Committee on Human Resources, immediate jurisdiction over both NSF and the National Institutes of Health (NIH) now resides in a new Subcommittee on Health and Scientific Research, which roughly combines the old Subcommittee on Health with the old Special Subcommittee on the NSF. Senator Edward M. Kennedy (D-MA) chairs this new subcommittee as he did both of the old ones. Initial Senate authorization hearings on the 1978 NSF budget were scheduled to be held in this subcommittee on March 1 and 3, but it is not anticipated that a resulting subcommittee mark-up session will be held until after an NSF authorization bill passes the House of Representatives.

Apart from activities of NSF and NIH and the energy Research and Development (R&D) activities noted below, Senate jurisdiction over science, engineering and technology research and development and policy now resides in the new Committee on Commerce, Science and Transportation, as does jurisdiction over nonmilitary aeronautical and space science and activities pertaining to oceans, weather and the atmosphere. This Committee is chaired by Senator Warren G. Magnuson (D-WA), and it is anticipated that its subcommittee on science, engineering and technology R&D and policy will likely be chaired by Senator Adlai E. Stevenson, III (D-IL). The Committee on Energy and Natural Resources, chaired by Senator Henry M. Jackson (D-WA), includes in its jurisdiction legislation on energy policy, regulation, conservation and research and development, including nonmilitary development of nuclear energy.

SUMMER GRADUATE COURSES—*Supplementary List*

The following graduate courses are being offered in the mathematical sciences during the summer of 1977. These are in addition to the courses listed in the February issue of these *Notices*.

ALABAMA

UNIVERSITY OF ALABAMA IN BIRMINGHAM
University Station, Birmingham, AL 35294
Application deadline: May 1
Information: Dr. Loy O. Vaughan, Director of the Graduate Program in Mathematics

June 13 - August 24
Set Theory
Ordinary Differential Equations
Topics in Geometry and Related Areas II

FLORIDA

FLORIDA INSTITUTE OF TECHNOLOGY
Melbourne, FL 32901
Information: Department of Mathematical Sciences

June 20 - September 3
Computer Data Base Design
Microprocessors and Microcomputing
Theory of Coding
Numerical Linear Algebra
Mathematical Programming
Systems Programming II

ILLINOIS

CHICAGO STATE UNIVERSITY
95th and King Drive, Chicago, IL 60628
Application deadline: June 1
Information: Michael Sullivan, Graduate Advisor, Department of Mathematics

June 28 - August 18
Review of Mathematics Topics
Matrices and Linear Transformations
Introduction to Real Variables
Mathematical Logic
Projective Geometry

INDIANA

BALL STATE UNIVERSITY
Muncie, IN 47306
Application deadline: Open
Information: Duane E. Deal, Chairman, Department of Mathematical Sciences

June 6 - July 8
Foundations of Mathematics
Abstract Algebra
Theory of Numbers 1
Topics in Statistics 1
Non-Euclidean Geometry
History of Mathematics 1
Numerical Analysis 1
Advanced Calculus 1
Scientific Computer Programming
Machine Language and Systems Programming 1
Advanced Programming Techniques
Information Structures
Data Processing Techniques

July 11 - August 12
Advanced Linear Algebra
Topics in Statistics 2
Topics in Number Theory
Geometry for Teachers
History of Mathematics 2
Numerical Analysis 2
Advanced Calculus 2
Advanced Differential Equations
Scientific Computer Programming
Machine Language and Systems Programming 2

KANSAS

KANSAS STATE COLLEGE OF PITTSBURG
Pittsburg, KS 66762
Information: Helen Kriegsman, Department of Mathematics

June 6 - July 29
Transformation Geometries
Functions of a Complex Variable

June 13 - June 24
Topics in Mathematics (Finance)

July 11 - July 22
Topics in Mathematics (Construction)

KENTUCKY

UNIVERSITY OF LOUISVILLE
Belknap Campus, Louisville, KY 40208
Application deadline: June 1
Information: Roger H. Geeslin, Department of Mathematics

June 13 - July 15
Computer in Mathematics Teaching
Overview of Mathematics

June 13 - July 29
Fields, Rings, and Ideals

July 18 - August 18
Seminar in Mathematics Teaching

NEW JERSEY

MONTCLAIR STATE COLLEGE
Upper Montclair, NJ 07043
Application deadline: May 1
Information: Graduate Office

June 13 - August 5
Foundations of Modern Algebra
Number Theory

June 27 - August 5
Statistics: Theory and Applications
Complex Variables I
Selected Topics in Mathematics
Advanced Programming

PENNSYLVANIA

CLARION STATE COLLEGE
Clarion, PA 16214
Information: Department of Mathematics

June 13 - July 15
Special Topics
Complex Variables

July 18 - August 19
Algebraic Numbers
Abstract Algebra II

COMBINED MEMBERSHIP LIST 1977–1978

CHANGE OF ADDRESS OR STATUS

The AMS computer file of the members of the Society contains several items of information in addition to mailing addresses, information on subscriptions and types of membership. Date of birth and date of election to membership, as well as name of employer and title of position are also included. The last items of information are of considerable interest to AMS committees concerned with the state of the profession, especially the employment patterns of mathematicians. Members who move or change jobs would provide valuable assistance for such studies by making certain that their entries are accurate and current. Postal Service change of address forms are inadequate, unless they are supplemented by the information requested below.

If there have been any changes in address, institution, or position, and the Society has not been notified, please fill in the appropriate portions of the form below and return it to the American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940, no later than July 8, 1977. Since the CML appears in the fall, changes should reflect the location or position you anticipate will be in effect beginning in September.

Address changes submitted by members throughout the course of the year result in the automatic deletion of existing CML information unless the Society is instructed otherwise. Thus, if no institution is provided either as part of the mailing address, or as additional information, a name will appear in the geographic section under city and state only, and not institution. If an address change is not accompanied by information concerning position, no position will appear in the CML entry. Members are also reminded that names are entered in the CML in the form in which they are provided to the Society.

Members who have not submitted address changes since the appearance of the 1976–1977 CML should consult that edition to check the accuracy of our data. Those who have submitted address changes, but who did not provide new information concerning position, or the name of an institution either as part of the mailing address or as additional information, should fill in the pertinent portions of the form below.

Peel off the (*Notices*) mailing label and place in the space provided. The mailing label contains the member code, and with this information clerks are able to process address or other changes more efficiently. If your mailing label is lost, damaged, or is being used for other purposes, please print your complete name, address, and member code in the space provided.

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Temporary position____________________

Temporary institution or business____________________

Address for mail____________________

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Date the above change in address for mail becomes effective____________________

LETTERS TO THE EDITOR

Editor, the *Notices*

Keeping in touch with our Soviet colleagues. This letter is addressed to all scientists interested in maintaining and improving contact with Russian colleagues, and represents the fruit of a fair amount of consideration and enquiry during the academic year 1975-76, which I spent in Minsk and Moscow universities. The first section contains points which I would like to draw to the attention of those organising international meetings, or otherwise having the possibility of inviting Soviet scientists to Western universities.

Perhaps the most important single point I would like to make is that in my opinion Western scientists do not make full use of the existing channels of communication, perhaps because of traditional Western misinformation as to what is or is not feasible.

The growth of international scientific and cultural ties is potentially of enormous value in developing the spirit of cooperation and friendship between nations; and I am proud to believe that we scientists can make a contribution towards making this world a safer and a more decent place.

(i) Invitations to the West. The majority of Western scientists are probably familiar with the frustrating fact that senior (non-party) Soviet scientists invited to Western conferences find it impossible to take up the invitation.

The first step for any Soviet citizen in obtaining a visa to travel abroad is to get a reference from the Party Committee of his place of work recommending the visit; there are several steps subsequent to this at which hitches may occur, but I believe the first step to be the essential obstacle, since if the Partkom is prepared to give its backing the remaining problems may turn out to be soluble.

Now there is some reason to believe that this obstacle may be less serious for younger scientists. This optimistic view is suggested partly by analogy with the case of visits from the USSR to the countries of eastern Europe (a closer analogy than most people in the West will be aware of); and partly by speculation as to the nature of the decision-making procedure within the Partkom of universities and institutes.

I would thus like to urge that every possible opportunity be taken to invite the younger generation of Soviet scientists to meetings in the West or to Western universities. In my field of mathematics (algebraic geometry) there is certainly no shortage of excellent young scientists, and visits to the West by such people, even for short periods, should provide for an extremely stimulating flow of ideas and information in both directions.

I would like to suggest that as a matter of form every invitation to a senior scientist should contain a clause to the effect that if the person invited feels unable to take up the invitation that he suggest the name of a junior colleague or research pupil who could be interested in coming in his stead. Of course, one does not necessarily expect that a research student of a particular scientist would be able to do more than give a token representation, but his presence will allow a flow of ideas, and will do something towards correcting the balance in the make-up of Soviet delegations.

As far as I am aware almost any young Soviet scientist would jump at the opportunity of travelling to the West, and be extremely keen to attempt the considerable task of applying for permission. There's probably a practical upper bound of about two months on the length of time a Russian scientist would be allowed out, and one should allow for some uncertainty in the time of arrival.

Contrary to what is commonly supposed in the West, there is no reason of principle why a Soviet citizen having obtained permission to travel abroad should not support himself on the issue of dollars he is entitled to under the currency regulations, although I am informed that University authorities may be very much more impressed by an invitation promising support and even a contribution towards travel expenses.

Even for a (non-party) scientist with an impeccable student and Komsomol background the probability of being allowed out is probably no greater than one-tenth, and it seems to be the case that Western organisers who have had repeated failures in attempts to invite Soviet colleagues sometimes get discouraged and give up trying. This is obviously wrong on probabilistic grounds, since if the probability of success is small one should clearly make more attempts rather than fewer. And if one draws a blank after taking reasonable measures over a period of several years (such as writing periodic supporting letters to individual members of the University or Institute management urging the advantages to both Western and Soviet science to be gained by some particular visit) then one is in a stronger position to complain that the Soviet side is being uncooperative.

There is certainly no way in which invitations addressed to an individual scientist, or letters enquiring as to the best way of inviting either him or one of his students could compromise him or lead to retaliation from the authorities.

I regard suggestions sometimes made that we take a hardline attitude and boycott delegates we regard as too "official" as potentially extremely harmful and counterproductive.

To sum up this section, it is my firm conviction that success in this matter will be directly proportional to the amount of patient effort which we are willing to exert.

(ii) The copyright convention. In 1973 the

Soviet Union signed the Geneva copyright convention, thus bringing to an end the tradition of publishing pirate translations of Western books and journals. The potentially damaging effect of this on Soviet mathematics doesn't seem to have been generally realised. Before the copyright convention any important textbook was published in an edition of 10,000 (say), ensuring that every college, university or technical school was able to obtain a copy for its library. Similarly important Western articles found their way into libraries across the country in the form of translations in Matematika. Since the convention, the number of textbooks translated has dwindled to an insignificant trickle, and Matematika has ceased publication.

Important university or institute libraries get an issue of foreign currency with which they can buy a selection of the essential literature; but this may have the effect of reducing contact with Western scientific ideas down to the scientists at a few major centers.

An important additional source of foreign journals costing nothing in dollars is the exchange of publications, and every attempt should be made to extend the existing exchanges.

The use of the photocopying machines at the major Soviet libraries remains at present expensive and inconvenient.

(iii) Contact by mail. A visitor at a Russian scientific center is constantly embarassed by being pumped for information about what's going on in the West; and the plea for preprints, lecture notes and copies of letters is invariably repeated in any discussion. I am not necessarily implying that the Western scientific community has been mean in this respect in the past, but I'd like to emphasize the desirability of sending as much information as possible.

Although it's true that every item of news received from the West is circulated and discussed with great interest, it's also true that even within Moscow there are many different institutes at which scientists are employed, and there may not be very close contact between them; *a fortiori* this applies to provincial universities. Western scientists need only consider how frequently they make photocopies of preprints or letters for their own use or for passing on to a colleague or student to realise the inconvenience of being deprived of this facility; so that it doesn't seem unreasonable to suggest sending a larger number of preprints to a Russian university than one would to the corresponding Western university.

It's perhaps quite striking the extent to which the average scientist depends for his general outlook on informal contact—thus one might discuss in conversation the work in progress of some colleague and gain thereby an overall impression of some new field of research without having to wait for the precise results to appear as preprints or articles. For a while now I have been trying to apply this principle in written form to try to bridge the gap between Soviet mathematicians in my field and the West, writing with occasional news of new developments (sometimes of which I have only the sketchiest knowledge myself). A slight difficulty is that there are in principle and in practise restrictions on one's correspondents' replies (see below), and one sometimes has to content oneself with the abstract knowledge that the communication is well received, and somehow get over the psychological difficulty of corresponding with someone whose replies are infrequent.

This idea has a potentially invaluable application to an international gathering at which no Soviet delegate is present, and I would like to suggest that if maybe two or three of the participants write their impressions of a few of the most exciting new results, and send three or four copies to interested colleagues in the Soviet Union, then this will do something towards correcting the isolation of Soviet science.

This problem has a converse: Russian scientists also complain that it is very difficult for them to send round copies of their recent work; some of the controversy about Russians not getting fair recognition for their original work perhaps stems from this difficulty.

An article prepared for publication in a Soviet journal will be typed, with 3 or 4 carbon copies made, of which several have to be submitted. It would be useful to have some system whereby a Soviet author who so desires could send out a carbon copy of his typescript to be copied and distributed in the West. This could perhaps be done officially, for example in connection with the translation schemes, or unofficially by private arrangement; those of us who are in correspondence with Soviet scientists should at any rate offer to perform this function.

There are in principle two legal restrictions on what can be sent out of the Soviet Union; firstly, the State holds the copyright on anything written by one of its citizens. And secondly, an archaic clause of the State Secrets Act requires that before sending abroad any written item containing mathematical formulae, the sender must obtain the explicit permission of a scientific establishment—which involves the completion of exhaustive formalities, and is usually only possible if the item is already cleared for publication. However, in practise scientific manuscripts and short items containing formulae are sent abroad rather frequently, as shown for example by the fact that Soviet scientists review regularly for Western journals and translate for the AMS. In general I am impressed by the amount of material that has been permitted in recent years to pass through the mail in both directions, and I would like to interpret this as an indication of the genuine application of one of the clauses of the Helsinki agreement.

It could be argued that the postal regulations, which make it impracticable for papers submitted to Soviet journals to be sent to a reviewer outside the USSR, are partly responsible for the uneven quality of some of the papers appearing in the Soviet scientific press.

(iv) Visits to the Soviet Union. The possibilities are as follows: a) as a tourist; b) by formal invitation; c) under the international Cultural Exchanges.

a) It's perfectly feasible to visit say Moscow or Leningrad as a tourist, and nowadays the tourist gets a very reasonable deal (travelling with a group may be very much cheaper, and the group activities are not compulsory). When applying for a visa one is required to name the Soviet citizens one intends to meet, but there can be no objection to a scientist who intends to get in touch with colleagues declaring only one name.

It's perhaps worth pointing out in connection with the forthcoming International Congress of Mathematicians that Leningrad is just one night on the train away from Helsinki, and is a town that has considerable attraction to the tourist; for details consult Intourist.

b) Soviet scientists may be very willing to attempt to get an invitation made out to a Western colleague to visit them for periods of up to two months. However, it's fair to say that this is not necessarily straightforward. Certainly any Western scientist interested in this possibility should in the first instance write well in advance to a Soviet colleague with whom he has good scientific relations to discuss tactics.

c) There are Cultural Exchanges in operation between the Soviet Union and every Western country. They take place both at the level of visiting fellowships (organised through the Academy of Sciences) and visiting studentships (through the Ministry of Higher Education), and represent almost the only practical possibility for a Western scientist to spend a long period (six months or a year) in contact with a Soviet scientific center. I would strongly recommend the latter to any Western research student of recent Ph.D. who is interested in some aspect of Soviet science, is willing to learn Russian, and is prepared to face the difficulties as well as the varied delights of Soviet life. Copies of my report to the British Council containing some of the fruits of my two years' experience in the USSR will be available on request.

The very least that Western universities can do to encourage the use of these exchanges is to display the advertising matter relating to them; the relevant addresses are as below:

USA
International Research and Exchanges Board (IREX)
110 East 59 Street
New York, New York 10022

CANADA
Canada Council
Conseil des Arts du Canada
C. P. 1047
Ottawa, Ontario KIP 5V8, Canada

ENGLAND
British Council
10 Spring Gardens
London SW1A 2BN, England

Royal Society
6 Carlton House Terrace
London SW1Y 5AG, England

FRANCE
Centre national de la recherche scientifique
27, avenue du Maréchal-Lyautey
75016 Paris, France
M. Eugène Zaleski, Directeur de Recherche

JAPAN
Science and Technology Agency
2-2-1 Casumigaseki
Chiyodo-ku, Tokyo, Japan

In conclusion I would remark that there are many countries in the world where the working conditions of scientists, and the ways in which contacts with the world scientific community can be improved is a subject which certainly deserves further study; but it seems fair to say that the Soviet Union, the People's Republic of China, and Czechoslovakia stand out as the three major countries of the world whose minimal cooperation in maintaining scientific contact amounts to a deliberate affront to the world academic community on the part of their governments.

Miles Reid

Editor, the *Notices*

An Irish Mathematical Society was recently formed and its first annual general meeting was held in Trinity College, Dublin (T.C.D.) on December 20, 1976. The following officers were elected: President: Dr. F. Holland (University College, Cork); Vice-President: Professor M. Hayes (University College, Dublin (U.C.D.)); Secretary: Dr. T. Hurley (U.C.D.); Treasurer: Senator T. T. West (T.C.D.). The other members of the committee are: Dr. R. Flood (Kevin Street College of Technology, Dublin), Dr. T. Laffey (U.C.D.), Professor J. Lewis (Dublin Institute for Advanced Studies), Dr. P. McGill (New University of Ulster, Coleraine), Professor M. Newell (University College, Galway), Dr. R. Smyth (Queens University, Belfast).

The aim of the society is to foster the development of Mathematics in Ireland. In addition to arranging lectures and conferences, the society intends to produce a newsletter which will be circulated to members, and which will contain material relevant to mathematicians in Ireland. In particular, it will include information on mathematical conferences and meetings abroad. Persons organising such conferences are requested to forward information on them to the Secretary for inclusion in the newsletter. The mailing address of the society is: Dept. of Mathematics, University College, Dublin 4, Ireland.

Thomas J. Laffey

Editor, the *Notices*

Readers of the latest Employment Information for Mathematicians will note that something new has been added: several of the ads ask for new Ph.D.'s of "any age." Unkind souls might infer that some people actually believe that academic institutions might discriminate against new Ph.D.'s who are over forty, say.

To such people my own experience is not reassuring. This is now my third year of looking for a job, and after two hundred letters I have yet to obtain an interview, let alone a job. This year's rejections are particularly galling in view of the fact that I now have my Ph.D. Could my age (43) have something to do with my difficulty?

Perhaps not. At any rate, the final returns for this year are not all in. But if I receive a request for an interview, the shock will undoubtedly age me another ten years.

Of course, it is ridiculous to conclude on the basis of my experience alone that mathematicians discriminate on the basis of age. Perhaps the standards of the Mathematics Department of Columbia University, which has given me my doctorate, have sunk to an abysmal low.

In any event, I am curious to hear from your readers whether any of them have had similar experiences.

Gerald Goldstein

Editor, the *Notices*

Barbara Osofsky's fascinating little article on Small Calculators for the Mathematician prompted me to buy one. I chose one of the least expensive ($120 at discount) programmable models with the idea of using it for calculation that I could do very tediously by hand (using log tables) in addition to balancing my checkbook and having a delightful toy.

To my surprise I found that I had a minicomputer contrary to what I expected from Professor Osofsky's remarks. If one works very hard at designing programs, one can do some serious problems in spite of very limited programming and storage space.

The capabilities of the machine are really limited to analysis in $\mathbb{R}^1$. A single 2×2 matrix would use half my storage registers, and it seems a waste of time to try to program matrix calculations for the trivial problems the machine could handle.

One can do differential equations, however. After strenuous effort I managed to do the initial value problem for

$$dy/dx = y', \quad dy'/dx = f(x, y, y')$$

by the predictor-corrector method with the machine programmed to stop at a given value of x so that one could read y and y' and then continue to a new value of x which one punched in; the procedure can continue for as long as one wants. With a small calculator there are two principal difficulties. One is the amount of programming space available for computing $f(x, y, y')$ assuming that the arguments are stored in the memories. The best I could do was get 17 steps and one memory available, for the program used 32 steps and all but one of the storage registers. This is not so bad. For example

$$d^2y/dx^2 = [e^{2y} + (dy/dx)^2 + x^{-2}]/3$$

uses 12 steps for f.

The second difficulty is the amount of time the machine uses. Professor Osofsky emphasized this, and I ran the above program for the initial conditions $x_0 = 1$, $y_0 = 0$, $y'_0 = -1$, so $y = -\log x$, while writing this letter. The number of iterations depends on the grid size h while the accuracy is $O(h^2)$ once h is small enough. I used $h = .01$. Since the predictor-corrector method requires some recycling, each iteration involved 67 operations. I stopped the machine at $x = 2$, 3, 5, 10 to read and record the values of y and y'. The time required to get to $x = 10$, over 60,000 steps, was about 75 minutes with the final reading $x = 10$, $y = -2.30254\ldots$, $y' = -0.10000\ldots$ as against the true values $y = -2.302585\ldots$, $y' = -.1$.

Indeed the machine is slow, about 800 steps per minute or 100 iterations of a second-order differential equations program in 8-9 minutes depending on complexity. Nevertheless, these times seem acceptable. For qualitative information about the behavior of equations encountered to illustrate theories one can very often use a smaller grid size. Also, one can do something else while the machine is chugging along.

I should like to be able to have students use small programmable calculators the next time I teach a course in ordinary differential equations. If the students have some experience with calculators then questions of grid size, etc. provide excellent motivation for the study of existence and uniqueness of solutions. Moreover, one can see what is going on in the nonlinear theory,—it is practical to run a number of calculations for van der Pol's equation $y'' = -y + y^3$ with varying initial conditions.

Analysis is, after all, mainly a matter of making majorations. There is no question that numerical examples are instructive, and when these become more like playing pinball than doing tedious arithmetic the pedagogical advantages are obvious. Thus I think small programmable calculators definitely have a role in the classroom if one can surmount two obstacles, and I should like to say something about these.

It would certainly be harmful to waste time in the classroom doing a lot of trivialities designed to accommodate the real and apparent limitations of small calculators. The non-programmable calculators are slide-rules with buttons and flashing lights. Slide rules never had much use in mathematics courses, and I don't see that the modern gadget does either. With some programming the question becomes what one can do with it. The manual of sample programs that came with my machine was very poor. For example, it gave a tedious and stupid routine for Simpson's Rule. This is a good illustration. Simpson's rule is

$$F(x) = \int_{x_0}^{x} f(t)dt \approx \frac{1}{3} h \sum_{n=0}^{N} C_n f(x_n)$$

where $x_n = x_0 + nh$; $x = x_N$, N an even integer; and $C_n = 1, 2$, or 4. The program should be an iterative process which stops at N and chooses $C_n = 4$ if n is odd, $C_n = 2$ if n is even and $n \neq 0, N$, while $C_n = 1$ for $n = 0, N$; one should be able to continue to a new x without reprogramming. The routine is complicated; there have to be four branches corresponding to $n = 0$, n odd, n even $(n \neq 0, N)$, and $n = N$. This takes space while at the same time one has to compute $f(x_n)$ in the program. It is possible to program Simpson's Rule on my calculator with 19 programming steps and 3 memories available for $f(x)$, but this requires the branching signals to carry other information and not merely be "flags". If you, as I, lack programming experience, you have to spend a lot of time devising schemes to fit the limits of your calculator.

Counter-balancing the capabilities of the calculator is the price. With more programming space and more memories one can either spend less time making up clever programs or do more complicated routines. The calculator I have can be bought for $120 in New York City while its popular competitor sells for about $80. Perhaps in the future these models will be improved slightly. I hope so, but I don't see the price going down much further. The more advanced models are unlikely to be at a price which will tempt many individuals who don't have a pressing need for them, although departments could easily purchase some for general use.

Can students afford machines which can do serious problems? $120 is 2% of Princeton tuition or 4-6 mathematics texts. That would seem a reasonable outlay. Were I not near a large city with discount outlets, the price would be significantly higher, and at institutions with modest tuition the relative expense is considerable. In Canada the price is probably prohibitive. I'm sure that there are lots of classroom uses which I don't even imagine*, but I'm ready to advance two conclusions.

1. Small calculators have a worthwhile place in the classroom provided their programming capability enables them to handle at least some specimen nontrivial problems.

2. Whether one's students can afford a machine meeting these minimal standards is a vexed question; at many institutions the answer will probably be "no" for the next few years unless special purchasing arrangements can be made.

Carl Herz

*Analysis offers obvious examples of potential applications and challenges for small calculators. The same is true of number theory (here an "integer portion" function is essential). In some other areas where numerical examples are useful the cost in money and classroom distraction of a sophisticated calculator may not be justified.

NEWS ITEMS AND ANNOUNCEMENTS

COLLOQUIUM LECTURES

A set of Colloquium Lectures was presented at the annual meeting in St. Louis, Missouri, in January 1977. A limited number of copies of the lecture notes (70 pages) prepared by Professor William Browder, "Differential topology of higher dimensional manifolds", is still available.

Requests for copies should be accompanied by a check for one dollar per copy to cover the cost of handling; requests should be mailed to the Society, P. O. Box 1571, Annex Station, Providence, Rhode Island 02940. Please note that informally distributed manuscripts and articles should be treated as a personal communication and are not for library use. Reference to the contents in any informal publication should have the prior approval of the author.

SEMI-ANNUAL LISTS OF APPLICANTS

The AMS-MAA-SIAM Committee on Employment Opportunities, which is charged with operation of the Employment Registers at Annual and Summer Meetings, and which oversees publication of EMPLOYMENT INFORMATION FOR MATHEMATICIANS, plans to prepare semi-annual lists of job applicants on an experimental basis. The first such list will be distributed (for a nominal fee) at the Seattle meeting in August 1977. Copies are expected to be available following the meeting for distribution to employers with last-minute openings, upon payment of the costs for reproduction and distribution.

Full details, including instructions and copies of the form required for those who wish to be listed, will be published in the June issue of these *Notices*.

NEW RULES ANNOUNCED FOR AAAS-NEWCOMB CLEVELAND PRIZE

The Newcomb Cleveland Prize awarded each year by the American Association for the Advancement of Science (AAAS) previously honored research papers presented at AAAS Annual Meetings. Beginning with the 1978 award, the prize will be awarded in recognition of the author of an outstanding paper published in the Reports section of Science magazine, with the competition year extending from the first issue in September to the final issue in August. The value of the prize has been increased to $5,000, in addition to a bronze medal.

Throughout the year readers are invited to nominate papers appearing in the Reports section. Nominations must include the following information: the title of the paper, issue in which it was published, author's name, and a brief statement of justification for the nomination. To be eligible, a paper must be a first-time presentation (other than to a departmental seminar or colloquium) of previously unpublished results of the author's own research. Reference to pertinent earlier work by the author may be included to give prespective. Nominations should be submitted to the AAAS-Newcomb Cleveland Prize, AAAS, 1515 Massachusetts Avenue, N.W., Washington, D.C. 20005.

The award will be presented at a session of the Annual Meeting at which the winner will be invited to present a scientific paper reviewing the field related to the prize-winning research. The review paper will subsequently be published in Science, the official journal of the AAAS.

NEW AMS PUBLICATIONS

PROCEEDINGS OF SYMPOSIA IN PURE MATHEMATICS

SEVERAL COMPLEX VARIABLES edited by R. O. Wells

Volume 30, Parts 1, 2
390/332 pages; list price $24.40 each/$44.40 set; member price $18.30 each/$33.30 set
ISBN 0-8218-0249-6/0-8218-0250-X; LC 77-23168
Publication date: 3/31/77
To order, please specify PSPUM/30.1 and PSPUM/30.2

The American Mathematical Society held its twenty-third Summer Research Institute at Williams College, Williamstown, Massachusetts, from July 28 to August 15, 1975. Several Complex Variables was selected as the topic for the institute. Members of the Committee on Summer Institutes at the time were Louis Auslander (chairman), Richard E. Bellman, S. S. Chern, Richard K. Lashof, Walter Rudin, and John T. Tate. The institute was supported by a grant from the National Science Foundation.

The Organizing Committee for the institute consisted of Ian Craw, Hans Grauert, Robert C. Gunning (cochairman), David Lieberman, James Morrow, R. Narasimhan, Hugo Rossi (cochairman), Yum-Tong Siu, and R. O. Wells, Jr. (Editor of these Proceedings).

The topic of the 1975 summer institute was the theory of functions of several complex variables. The emphasis in arranging the program was on the more analytical aspects of that subject, with particular attention to the relations between complex analysis and partial differential equations, to the properties of pseudoconvexity and of Stein manifolds, and the relations between currents and analytic varieties. However, there were also lectures and seminars on other aspects of that broad and active field of investigation, such as deformation theory, singularities of analytic spaces, value distribution theory, compact complex manifolds, and approximation theory.

There were six series of invited expository lectures, as well as twenty-two hour lectures of a general or survey nature; there were also eight series of seminars on current developments in the subject, six of which were planned and partially arranged in advance.

The proceedings of the 1975 summer institute are published in two volumes. The hour lectures and seminar papers accepted for publication appear in the seminar series most appropriate to the subject matter of the given paper. These are principally research reports describing current research of the authors, while some are of a general expository nature in a given area. The principal lecture series are represented by six survey articles which have been interlaced in these volumes with the seminar series, with an attempt being made for some relationship between the seminar series and the survey articles they juxtapose.

The Seminar Series and Principal Lectures in volume 1 are Seminar Series: Singularities of Analytic Spaces, Principal Lecture 1: M. Kuranishi; Seminar Series: Function Theory and Real Analysis, Principal Lecture 2: J. J. Kohn; Seminar Series: Compact Complex Manifolds, Principal Lecture 3: Reese Harvey.

The Seminar Series and Principal Lectures in volume 2 are Seminar Series: Noncompact Complex Manifolds, Principal Lecture 4: R. Greene and H. Wu; Seminar Series: Differential Geometry and Complex Analysis, Principal Lecture 5: D. Burns, Jr., and S. Shnider; Seminar Series: Problems in Approximation, Principal Lecture 6: O. Forster; Seminar Series: Value Distribution Theory; Seminar Series: Group Representation and Harmonic Analysis. The detailed list of authors and titles of papers is given in the table of contents for each volume. At the conclusion of each volume is an author index for authors of articles, as well as authors of papers cited in the bibliographies for each particular part.

TRANSLATIONS OF MATHEMATICAL MONOGRAPHS

UNIVALENT FUNCTIONS AND ORTHONORMAL SYSTEMS by I. M. Milin

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Publication date: 5/31/77
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In the present book orthonormal functions are applied to the study of univalent functions, according to the following scheme. In Part I, which contains three chapters, the author considers univalent functions in a simply connected domain. Attention is centered here primarily on the behavior of the Taylor coefficients of univalent functions; in the first chapter the author studies the properties of a special system of functions for the coefficients, while in the second he finds sharp bounds and asymptotic equalities for the coefficients of a composite exponential function. The heightened interest in this question is undoubtedly due to the coefficient problem. Part II is devoted to univalent functions in a finitely connected domain containing the point at infinity. In Chapter 4 he constructs the so-called Laurent system of functions, which plays the same role for an arbitrary finitely connected domain as the system $\{z^n\}$ for a circular ring domain. The fifth chapter is analogous to the first, and the last is devoted to applications, principal attention being paid to determination of the ranges of various functionals. Since the exposition in the second part of the book is independent of the first, the reader may proceed to Chapter 4 immediately after the Introduction.

The book was translated from the Russian by the Israel Program for Scientific Translations; the translation was edited by P. L. Duren.

SPECIAL MEETINGS INFORMATION CENTER

THIS CENTER maintains a file on prospective symposia, colloquia, institutes, seminars, special years, and meetings of other associations, helping the organizers become aware of possible conflicts in subject matter, dates, or geographical area.

AN ANNOUNCEMENT will be published in these *Notices* if it contains a call for papers, place, date, subject (when applicable), and speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the volume and page of the issue in which the complete information appeared.

IN GENERAL, SMIC announcements of meetings held in the United States and Canada carry only date, title of meeting, place of meeting, speakers (or sometimes general statement on the program), deadline dates for abstracts or contributed papers, and name of person to write for further information. Meetings held outside the North American area may carry slightly more detailed information. Information on the pre-preliminary planning will be stored in the files, and will be available to anyone desiring information on prospective conferences. All communications on special meetings should be sent to the Special Meetings Information Center of the American Mathematical Society.

DEADLINES are the same as the deadlines for abstracts. They appear on the inside front cover of each issue.

1977-1978. The Mittag-Leffler Institute, Sweden (24, p. 70)

January 2-December 17, 1977. Mathematisches Forschungs Institut Oberwolfach (Weekly Conferences), Federal Republic of Germany (23, p. 275; 24, p. 70)

Spring 1977. NSF Chautauqua-type Short Courses for College Teachers, U.S.A. (23, p. 274)

March 21-November 24. European Mechanics Colloquia 1977 (24, p. 130)

APRIL

20-22. CONFERENCE ON SCIENTIFIC COMPUTING, Courant Institute of Mathematical Sciences, New York University, New York, New York (24, p. 71)
Purpose: To inaugurate the Courant Professorship of Mathematical Sciences, sponsored by the Stifterverband für die Deutsche Wissenschaft. The first appointment to the professorship will be Fritz John.
Topics: Numerical fluid mechanics (in aerodynamics, physiology, plasticity, and viscous flow); minimal surfaces; economic equilibria; and magnetohydrodynamics.
Speakers: Reimar Lüst, Björn Engquist, Paul R. Garabedian, Stefan Hildebrandt, Malvin H. Kalos, Herbert B. Keller, Egon Krause, Robert MacCormack, Charles S. Peskin, Stephen Smale, and W. Gilbert Strang.
Organizing Committee: Peter D. Lax (Chairman), Alexandre J. Chorin, and Heinz-Otto Kreiss.
Information: Conference on Scientific Computing, Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, New York 10012.

MAY

2-4. Ninth Annual ACM Symposium on Theory of Computing, Colorado (23, p. 344)

2-14. Regional Workshop in Numerical Analysis and Computer Science, Malaysia (24, p. 71)

5-6. Optimization Days 1977, Canada (24, p. 71)

5-7. THIRTEENTH DENISON CONFERENCE, Fellows Hall Auditorium, University of Denison, Granville, Ohio.
Topics: Hopf algebras, quadratic forms, group theory, number theory, ring theory.
Information: Surinder Sehgal or Hans Zassenhaus, Department of Mathematics, The Ohio State University, Columbus, Ohio 43210.

9-12. Twelfth New Zealand Mathematics Colloquium, New Zealand (24, p. 131)

12-15. The John H. Barrett Memorial Lectures, Tennessee (24, p. 131)

16-20. Twenty-First Annual Meeting of the Australian Mathematical Society, Australia (24, p. 71)

30-June 3. GAMM-Jahrestagung 1977, Denmark (24, p. 132)

30-June 5. International Conference on Constructive Function Theory, Bulgaria (24, p. 132)

31-June 5. The Iowa Symposium and Workshop on A. Robinson's Theory of Infinitesimals, Iowa (24, p. 71)

JUNE

3-4. Gauss Bicentennial Symposium, Canada (23, p. 222)

3-9. THE SIXTH BALKAN MATHEMATICAL CONGRESS, Drubja, Varna, Bulgaria.
Sponsors: The Balkan Mathematical Union; Bulgarian National Committee for Mathematics
Programme: The Scientific Program of the Congress will be divided into the following sections: A. Universal Structures, including logic and foundations, algebra, topology, analysis, differential equations, and geometry; B. Informatics, including theoretical cybernetics, software, and numerical methods; C. Mathematical Modelling, including stochastics, operational research, mathematical models in the sciences, and mathematical models in the social sciences and the arts; D. History and Education, including history of mathematics and mathematical education. The scientific program will include also some symposia and panel discussions.
Information: L. Iliev, P.O. Box 373, 1000 Sofia, Bulgaria.

5-10. Symposium on Functional Analysis and its Applications, Federal Republic of Germany (24, p. 132)

6-8. Joint Workshop on the New Computer Science and Engineering Model Curricula, Virginia (24, p. 131)

6-July 2. Conference on Vector Space Measures and Applications, Ireland (23, p. 408)

8-10. SYMPOSIUM ON NONLINEAR EQUATIONS IN ABSTRACT SPACES, University of Texas at Arlington, Arlington, Texas.
Purpose: To discuss current trends in the theory and applications of nonlinear equations.
Program: In addition to invited addresses and contributed papers, there will be an informal panel discussion on the future of nonlinear equations in abstract spaces.
Information: V. Lakshmikantham, A. R. Mitchell, or Stephen Bernfeld, Department of Mathematics, University of Texas at Arlington, Arlington, Texas 76019.

9-11. SYMPOSIUM ON BOUNDARY BEHAVIOR OF FUNCTIONS-THEORY OF CLUSTER SETS, Wayne State University, Detroit, Michigan.
Program: There will be lectures on the boundary behavior of analytic, harmonic and subharmonic functions. Invited lectures will be given by J. L. Doob (University of Illinois), P. Gauthier (University of Montreal), M. Heins (University of Maryland), R. Hunt (Purdue University), P. Lappan (Michigan State University), and A. J. Lohwater (Case Western Reserve University). The symposium will honor Wladimir Seidel on the occasion of his retirement.
Contributed Papers: There will be fifteen-minute sessions for contributed papers throughout the conference. Title

and abstract of papers must be submitted by May 10, 1977.
Information: Leon Brown or Lowell Hansen, Department of Mathematics, Wayne State University, Detroit, Michigan 48202.

13-15. SIAM National Meeting, Pennsylvania (23, p. 408)

13-August 26. GORDON RESEARCH CONFERENCES, New Hampshire and California.
Purpose: The Conferences were established to stimulate research in universities, research foundations, and industrial laboratories. This purpose is achieved by an informal type of meeting consisting of scheduled speakers and discussion groups. Sufficient time is available to stimulate informal discussion among the members of each Conference.
Location: The Conferences will be held at various locations in New Hampshire and at the Miramar Hotel in Santa Barbara, California.
13-17. Theoretical Biology and Biomathematics, Tilton School, Tilton, New Hampshire.
Program: Includes "Mathematical models of immunological surveillance against cancer" by R. Lefever; "Stochastic Models of Metastases" by C. DeLisi; Respiratory rhythmogenesis: mathematical modeling vs. the real world" by J. Feldman; "Mathematical models of cancer progression" by G. Bell; "Limit cycle oscillations in mathematical models of biological control systems" by L. Glass; and "Asymptotic behavior of solutions to systems of reaction-diffusion equations" by J. Smoller. The complete program for the Conferences is published in Science, March 11, 1977.
Application: Applications must be submitted on the standard form which may be obtained from the office of the Director. Attendance at each conference is limited to about 100.
Information: Further information on all the Conferences as well as a schedule may be obtained from Alexander M. Cruickshank, Director, Gordon Research Conferences, Pastore Chemical Laboratory, University of Rhode Island, Kingston, Rhode Island 02881.

14-18. Summer Short Course on Mathematical Modeling, Ohio (24, p. 132)

19-22. Eighth Conference on Computers in the Undergraduate Curricula, Michigan (24, p. 72)

20-21. Conference on Numerical and Statistical Computing, California (24, p. 132)

20-24. Conference on the Structure of Attractors in Dynamical Systems, North Dakota (24, p. 132)
Principal Lecturer: Rufus Bowen.

20-24. Seminar on Applications of Mathematics in Modeling Theory, Minnesota (24, p. 72)

20-July 8. Sixteenth Seminar of the Canadian Mathematical Congress on Lie Theories and Applications, Canada (24, p. 132)

20-July 15. SIXTEENTH SESSION OF THE SÉMINAIRE DE MATHÉMATIQUES SUPÉRIEURES, Université de Montréal, Montréal, Québec, Canada.
Program: Analysis and probability theory.
Invited Speakers: S. Dubuc, Université de Montréal: Problèmes d'optimisation en calcul des probabilités; C. Herz, McGill University: Intégrales stochastiques générales; S. Karlin, Stanford University: Majorization and related convexity inequalities with applications in probability and statistics; G. Letac, Université Paul Sabatier, Toulouse: Résultats récents sur les chaînes discrètes de Markov; P. Malliavin, Université Paris VI: Géométrie différentielle stochastique; G.C. Papanicolaou, Courant Institute, New York University: Comportement asymptotique des équations différentielles stochastiques.
Sponsors: The Ministry of Education of Québec, the National Research Council of Canada and the Université de Montréal.
Information: Aubert Daigneault, Département de Mathématiques, Université de Montréal, C.P. 6128, Montréal, Québec, Canada H3C 3J7.

25-July 2. INTERNATIONAL SYMPOSIUM ON FUNCTIONAL ANALYSIS AND ITS APPLICATIONS, University of Ibadan, Ibadan, Nigeria.
Purpose: To bring together research workers in the West African countries working in the field of Functional Analysis and its applications in order to identify areas of application of Functional Analysis and encourage co-operation among research workers in this field.
Program: The scientific sessions are expected to consist of a number of instructional lectures, invited one-hour lectures and short communications designed for individuals to announce their recent results. The Symposium will provide an opportunity for participants to learn something of recent developments in Functional Analysis and its applications. The topics to be covered will include operator theory, topological vector spaces, differential equations (ordinary and partial), functional equations, quantum field theory, integral equations, Von Neumann algebras, and nonlinear functional analysis.
Registration deadline: April 30, 1977.
Abstracts: Participants intending to contribute papers should send two copies each of an extensive summary (approximately 400 words) and a brief abstract (100–150 words) not later than April 30, 1977.
Information: V. A. Babalola, Department of Mathematics, University of Ibadan, Ibadan, Nigeria.

26-July 2. Conference on Vector Space Measure and Applications, Ireland (24, p. 132)

27-July 1. Universal Algebra, Hungary (23, p. 344)

27-July 2. Second Vilnius Conference on Probability Theory and Mathematical Statistics, USSR (24, p. 133)

28-July 15. Symposium on Representation Theory of Lie Groups, England (24, p. 133)

JULY

5-9. Conference on Graph Theory and Related Topics, Canada (24, p. 72)

9-21. LMS Durham Symposium on Applications of Sheaf Theory to Logic, Algebra and Analysis, England (23, p. 344)

11-13. Third Nonlinear Programming Symposium, Wisconsin (24, p. 133)

11-15. Sixth British Combinatorial Conference, England (24, p. 72)

11-16. First World Conference on Mathematics at the Service of Man, Spain (23, p. 277; 344)

18-20. SUMMER COMPUTER SIMULATION CONFERENCE, Hyatt Regency O'Hare, Chicago, Illinois.
Program: The program will deal with the application of simulation to solving problems in the fields of chemistry, electrical engineering, aerospace engineering, marine engineering, environmental sciences, life sciences, social sciences, and management. There will also be presentations on topics of vital interest such as econometric and energy systems.
Information: W. O. Grierson, Publicity Chairman, Summer Computer Simulation Conference, Bendix Research Laboratories, 20800 Civic Center Drive, Southfield, Michigan 48076.

18-30. ÉCOLE INTERNATIONALE D'ÉTÉ D'INFORMATIQUE, Université de Montréal, Montréal, Québec, Canada.
Application deadline: April 1, 1977, if possible.
Information: Lucille Roy, Département d'informatique, Université de Montréal, Case postale 6128, succ. A. Montréal, Québec, Canada H3C 3J7.

21-30. DURHAM SYMPOSIUM ON MULTIVARIATE APPROXIMATION, University of Durham, England.
Support: London Mathematical Society.
Topics: Theoretical and practical topics in the area of multivariate approximation.
Speakers: R. E. Barnhill; B. Brosowski; C. W. Clenshaw, L. Collatz; J. W. Jerome; G. G. Lorentz, G. Meinardus; J. R. Rice; T. J. Rivlin; H. S. Shapiro; and I. Singer.
Membership: To be limited to about fifty.
Information: D. C. Handscomb, Oxford University Computing Laboratory, 19 Parks Road, Oxford OX1 3PL, England.

25-29. CONFERENCE ON AFFINE SPACES AND POLYNOMIAL RINGS, Northern Illinois University, DeKalb, Illinois.
Program: As part of NSF/CBMS Regional Conference Series in Mathematical Sciences, this conference features Professor Masayoshi Nagato of Kyoto University as principal lecturer. He will deliver ten lectures on topics of current interest centered on affine spaces and polynomial rings.
Support: Limited amount of travel and subsistence support funds are expected to be made available by the National Science Foundation to qualified participants in need.
Information: T. Kambayashi or W. D. Blair, Mathematics, Northern University, DeKalb, Illinois 60115.

AUGUST

1-5. Summer Institute of Applied Statistics, Utah (24, p. 133).

1-5. International Symposium on Continuum Mechanics and Partial Differential Equations, Brasil (23, p. 344; 24, p. 72)

1-6. International Symposium on Approximation Theory, Brasil (23, p. 277)

1-12. The 1977 European Summer Meeting of the Association for Symbolic Logic. Poland (24, p.72)

1-13. International Advanced Study Institute on Nonlinear Equations in Physics and Mathematics, Turkey (24, p.133)

4-6. ACM Symposium on Complexity Issues in Symbolic Computation, Canada (24, p. 72)

7-13. Eighth International Conference on General Relativity and Gravitation, Canada (23, p. 85)

8-12. International Conference on Discrete Optimization, Canada (24, p. 133)

8-20. Advanced Study Institute on Statistical Modeling and Sampling for Ecological Abundance and Diversity with Applications, Pennsylvania (23, p. 409)

15-17. Conference on Theoretical Computer Science, Canada (23, p. 409)

15-19. SEVENTH CONFERENCE ON STOCHASTIC PROCESSES AND THEIR APPLICATIONS. Twente University of Technology, Enschede, The Netherlands.
Sponsors: Dutch Ministry of Education, Dutch Mathematical Society, Netherlands Society for Statistics, European Research Office, Twente University Foundation.
Organizers: The Committee for Conferences on Stochastic Processes of the Bernoulli Society for Mathematical Statistics and Probability.
Program: There will be fifteen invited speakers presenting survey papers or research papers on topics of special interest. Moreover there will be a number of sessions for short contributed papers. These sessions will be devoted to special topics such as biological and medical applications, computer modelling, numerical methods, statistical inference and control problems. On Thursday, August 18, there will be a workshop on computer system modelling. Some of the relevant topics are queueing and flow in networks, operating systems, network optimization (e.g. optimal network topology) and network simulation techniques. Two invited lectures will be given in the morning, and one of the afternoon sessions of contributed papers will be devoted to this subject.
Invited Speakers: The list tentatively includes R. E. Barlow (Berkeley), E. Cinlar (Evanston), J. Gani (Canberra), E. Gelenbe (Paris), H. Kesten (Ithaca), N. Keiding (Copenhagen), K. Kirckeberg (Paris), P. A. Meyer (Strasbourg), H. J. Rossberg (Leipzig), Yu. A. Rozanov (Moscow), M. Rubinovitch (Haifa), A. J. Stam (Groningen), and M. Westcott (Canberra).
Call for Papers: Those wishing to contribute a paper should submit an abstract not later than June 1, 1977. The abstracts of contributed papers will be published in Advances in Applied Probability and should therefore not exceed one half to one page and contain complete references. The time available for a contributed paper will be twenty-five minutes including discussion. There will be sessions on Markov processes, limit theorems, stochastic control, queues and inventories, reliability, biological applications and other subjects.
Information: J. H. A. de Smit, Department of Mathematics, T. H. Twente, P. O. Box 217, Enschede, The Netherlands.

15-19. A Program of Instructional Lectures on Applied Matrix Computations, Maryland (24, p. 133)

15-19. International Conference on Applied General Systems Research: Recent Developments and Trends, New York (23, p. 409)

16-27. International Conference on Combinatorial Theory, Australia (23, p. 85)

17-19. Second International Symposium on the Operator Theory of Networks and Systems, Texas (24, p.73)

22-26. TENTH EUROPEAN MEETING OF STATISTICIANS, Katholieke Universiteit te Leuven, Leuven, Belgium (23, p. 345)
Organizer: European Regional Committee on the Bernoulli Society for Mathematical Statistics and Probability.
Programme: The Meeting, which immediately follows the Seventh Conference on Stochastic Processes and their Applications (to be held August 15-19, 1977, in Enschede, The Netherlands), will feature both invited and contributed papers.
Topics: Limit theorems, nonparametric statistics, stochastic geometry, spatial analysis, multivariate analysis, information theory, risk theory, Bayesian methods, environmental statistics, statistics and cancer research, and teaching of statistics.
Call for Papers: Authors of contributed papers will be offered two formats of presentation. The first will be the standard fifteen-minute lecture followed by five minutes of discussion. The second will be that of an informal poster session.
Instructions for Authors: Persons interested in submitting a contributed paper should indicate this to the Program Committee at the address below. They will be sent an abstract on which a summary of the paper is to be typed. Acceptance of papers will be on the basis of the abstract.
Information: Organizing and Program Committee, EMS 1977, Department of Mathematics, Katholieke Universiteit te Leuven, Celestijnenlaan 200 B, 3030 Heverlee, Belgium.

29-September 1. International Conference on Mathematical Modeling, Missouri (24, p. 73)

29-September 2. International Symposium on the Theory of Sets, Foundations of Mathematics, Yugoslavia (24, p. 73)

29-September 2. Third International Symposium on Topology and its Applications, Yugoslavia (24, p. 73)

SEPTEMBER

5-10. Eighth IFIP Conference on Optimization Techniques, Federal Republic of Germany (23, p. 345)

5-17. NATO Advanced Study Institute on Representations of Lie Groups and Harmonic Analysis, Belgium (23, p. 345)

6-9. COMPCON 77–FIFTEENTH IEEE COMPUTER SOCIETY INTERNATIONAL CONFERENCE, Mayflower Hotel, Washington, D.C.
Program: Components, hardware, software, systems design; applications of micro, mini, and maxi computers.
Information: Paul Skartvedt, Program Chaiman, TRW Energy Systems Planning Division, Building W1, Room 3426, 7600 Colshire Drive, McLean, Virginia 22101.

6-16. LMS Durham Symposium on Homological and Combinatorial Techniques in Group Theory, England (23, p. 345)

19-22. US-JAPAN SEMINAR ON MINIMAL SUBMANIFOLDS, INCLUDING GEODESICS, Tokyo, Japan.
Sponsors: The United States-Japan Cooperative Science Program.
Information: T. Otsuki, Tokyo Institute of Technology, Tokyo, Japan, and S. S. Chern, University of California, Berkeley, California.

19-23. International Conference on Fundamentals of Computation Theory, Poland (24, p. 73)

26-28. Conference on Distributed Computer Control

Systems, England (24, p. 134)

26-28. SYMPOSIUM-WORKSHOP ON MOVING BOUNDARY PROBLEMS, Riverside Motor Lodge, Gatlinburg, Tennessee.
Cosponsors: Army Research Office–Durham and the Mathematics and Statistics Research Department of the Computer Sciences Division, Union Carbide Corporation, Nuclear Division (prime contractor for the U.S. Energy Research and Development Administration).
Program: The purpose of the Symposium-Workshop is to bring together the expertise of both mathematicians and engineers working in the field of moving boundary problems. The emphasis will be on generalized Stefan problems in heat and mass transfer. To maximize interaction and information exchange, attendance will be limited to approximately 100 participants. Invited talks will be given in three areas: theory, methods, and applications. In each case a survey talk will be followed by presentations of current research work. In addition, there will be a contributed paper session, a problem session, and a panel discussion. The problem session is expected to furnish topics for further methods development and research.
Call for Papers: The contributed paper session will consist of fifteen-minute presentations of appropriate papers for which abstracts are received. To contribute a paper, send title, author, affiliation, and abstract not exceeding 300 words by June 15, 1977 to R. C. Ward at the address below. Authors will be notified of decisions regarding their papers by August 1, 1977.
Invited Speakers: Some of the invited speakers are Bruno Boley (Northwestern University), John Cannon (University of Texas-Austin), Colin Cryer (Mathematics Research Center at University of Wisconsin), Robert W. Dutton (Stanford University), George J. Fix (Carnegie-Mellon University), Bernard A. Fleishman (Rensselaer Polytechnic Institute), Avner Friedman (Northwestern University), Gabriel Horvay (University of Massachusetts), Gunter Meyer (Georgia Institute of Technology), J. R. Ockendon (Oxford University), J. T. Oden (University of Texas-Austin), Alan D. Solomon (Union Carbide Corporation, Nuclear Division on leave from the University of the Negev, Israel), E. M. Sparrow (University of Minnesota), John Wheeler (Exxon Production Research Company), and D. G. Wilson (Union Carbide Corporation, Nuclear Division).
Information: Robert C. Ward, Mathematics and Statistics Research Department, Union Carbide Corporation, Nuclear Division, P. O. Box Y, Building 9704-1, Oak Ridge, Tennessee 37830.

26-30. Ninth Congress of Austrian Mathematicians, Austria (24, p. 73)

30-October 1. Fifth Annual Mathematics and Statistics Conference, Ohio (24, p. 134)

OCTOBER

5-7. TENTH ANNUAL WORKSHOP ON MICROPROGRAMMING, Ramada Inn, Niagara Falls, New York.
Sponsors: IEEE Computer Society's Technical Committee on Microprogramming and ACM SIGMICRO.
Program: This workshop will bring together practitioners and theoreticians from industry, government, and academia who are interested in problems relating to the underlying concepts and use of microprogramming. Most of the time will be dedicated to short informal presentations and discussion groups in order to assist in the exchange of ideas and the sharing of experiences. These sessions will be organized around papers accepted for publication in the proceedings; however, all attendees will be encouraged to contribute to the discussions.
Information: T. G. Rauscher, Amdahl Corporation, 1250 East Arques Avenue, Sunnyvale, California 94086.

17-19. International Symposium on Nonlinear Evolution Equations, Wisconsin (24, p. 134)

31-November 2. Eighteenth Annual Symposium on Foundations of Computer Science, Rhode Island (24, p. 134)

NOVEMBER

7-9. Joint National ORSA/TIMS Meeting, Georgia (24, p. 134)

* * * 1978 * * *

June 25-July 2. Eighth International Congress on the Application of Mathematics in Engineering, German Democratic Republic (24, p. 134)

August 15-23. The 1978 International Congress of Mathematicians, Finland (24, p. 135)

NEWS ITEMS AND ANNOUNCEMENTS

1978–1979 FULBRIGHT-HAYS AWARDS

The deadline for applications for Fulbright-Hays Awards for the American Republics, Australia, and New Zealand, is June 1, 1977, while the deadline for Africa, Asia, and Europe, is July 1, 1977. Some of the openings available in mathematics and statistics in 1978–1979 are:

Colombia: applied mathematics; functional analysis (Spanish required); Denmark: probability theory; algebraic topology and number theory; functional analysis; Ethiopia: statistics and survey research; India: social science research; Ireland: mathematics; Jordan: mathematical statistics; Liberia: mathematics or chemistry; Malawi: head department and teach; Nigeria: statistics; Peru: mathematical logic (Spanish required); Thailand: application of statistics to business and industry; U.S.S.R.: theoretical statistics; harmonic analysis and theory of trigonometric series; theoretical mathematics; mathematical modeling of ocean dynamics.

Those desiring a copy of the 1978–1979 announcement of Fulbright-Hays award opportunities for university teaching and advanced research abroad should immediately send name, address, highest degree, specialization and country interest to the Council for International Exchange of Scholars, Eleven Dupont Circle, Washington, D.C. 20036.

CIES will also assist in the administration of about 500 awards in 1978–1979 for Fulbright scholars visiting the U.S. for lecturing and research. In many cases host institutions are expected to assist the scholar with full or partial maintenance. A directory of scholars currently in the U.S. is available on request and inquiries are welcome at any time regarding scholars from abroad for 1978–1979.

QUERIES

Edited by Hans Samelson

QUESTIONS WELCOMED from AMS members regarding mathematical matters such as details of, or references to, vaguely remembered theorems, sources of exposition of folk theorems, or the state of current knowledge concerning published or unpublished conjectures.

REPLIES from readers will be edited, when appropriate, into a composite answer and published in a subsequent column. All answers received will ultimately be forwarded to the questioner.

QUERIES AND RESPONSES should be typewritten if at all possible and sent to Professor Hans Samelson, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

QUERIES

119. Bruce C. Berndt (Department of Mathematics, University of Illinois at Urbana–Champaign, Urbana, Illinois 61801). I have been collecting materials and references on $\zeta(2n+1)$. To date, I have collected about 100 references, including papers of Grosswald, Guinand, Katayama, Mikolás Ramanujan, Sandham, Stieltjes, and others. No doubt, I am still unaware of many papers, probably a majority of them. In particular, I have very few references predating 1900. I also have little knowledge of numerical calculations. There are undoubtedly many papers in which isolated formulas for special cases of $\zeta(2n+1)$ appear. I would be very grateful for any references on $\zeta(2n+1)$, or special cases thereof.

RESPONSES

The reply below has been received to a query published in a recent issue of these *Notices*. The editor would like to thank all who have replied.

111. (vol. 24, p. 82, Jan. 1977, Parker). Let X be an uncountable set, and let S be the set of all infinite subsets of X. Consider the following relation R on S: if $a, b \in S$ then aRb if and only if there exist a positive integer n (depending on sets a and b), such that the cartesian product a^n of n copies of a is equinumerous with b (i.e. there is a bijection $a^n \to b$). The reflexivity of R is obvious, and the proof of transitivity of R is elementary. It is however quite difficult to prove that R is symmetric. The proof depends strongly on Axiom of Choice. (Indeed, the statement that a^2 is equinumerous with a, for each infinite set a, is equivalent with Axiom of Choice.) (Contributed by Edward Howorka)

PROBLEM LISTS

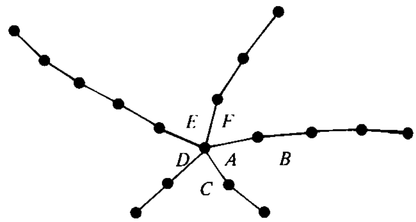
THEORY OF COMBINATORIAL GAMES

The following research problems were presented at the Special Session on the Theory of Combinatorial Games at the 83rd Annual Meeting of the Society at St. Louis, January, 1977. (This list was presented by the organizer of the special session, Aviezri S. Fraenkel, Department of Applied Mathematics, The Weizmann Institute of Science, Rehovot, Israel.)

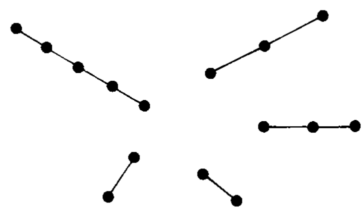
1. Problem Concerning a Game on Graphs. We give the name ARC KAYLES to the following two-person game which can be played on an arbitrary (finite) graph. A move consists of choosing an arc of the graph which has not yet been chosen and is not adjacent to any arc which has been chosen. The first player who cannot move loses.

Call a graph *starlike* if it is connected and acyclic and has at most one node of degree greater than two. We pose the problem: find a method to determine, for an arbitrary starlike graph, whether the first player can win ARC KAYLES.

Example. In the pictured graph, the first player can win by choosing arc A. (This move makes B, C, D, E and F unplayable; what remains then is 5 strings, as shown at right–a lost position for the player to move.)



A starlike graph



"Residual" graph after playing arc A.

Note. For graphs in which every node is of degree 2 or less, the winner can easily be determined (cf. R. K. Guy and C. A. B. Smith, *The G-values of various games*, Proc. Cambridge Philos. Soc. 52 (1956), 514–526). Thus starlike graphs are the "simplest" unsolved case. (Contributed by T. Schaefer)

2. Theory of Cannibal Games. Cannibal Games are two-person games played on an arbitrary finite digraph. Place any number of "cannibals" on any vertices. A move consists of selecting a cannibal and moving it to a neighboring vertex u along a directed edge. If u was occupied, the incoming cannibal eats up u's entire population (in the game "greedy cannibals") or only one cannibal (in "polite cannibals"). The player first unable to move is the loser, the other the winner. If there is no last move, the outcome is defined to be a tie.

Find a method to determine, for an arbitrary digraph and an arbitrary position thereon, whether the first player can win or at least force a tie.

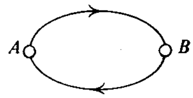
Note. A particular case is a linear board. Even there no general theory was found, though many particular cases were solved (mentioned briefly in R. B. Eggleton and A. S. Fraenkel, *Cannibals: a game with captures*, Abstracts of Communications, ICM, p. 186, Vancouver, 1974). (Contributed by R. B. Eggleton and A. S. Fraenkel)

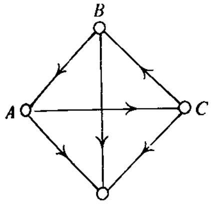
3. Reducible and Prime Vertices. Let $R = (V(R), E(R))$ be an arbitrary finite digraph. Let $(z_1, \ldots, z_n)$ be an arbitrary ordering of the vertices. Define the induced *contrajunctive com-*

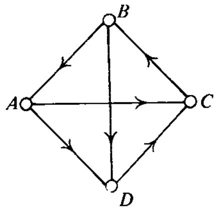
pound graph $\bar{R}$ of R by $V(\bar{R}) = \{(u^1, \ldots, u^n): u^i = 0$ or 1 $(1 \leqslant i \leqslant n)\}$, which thus contains 2^n vertices. If $\bar{u}, \bar{v} \in V(\bar{R})$, then $(\bar{u}, \bar{v}) \in E(\bar{R})$ if and only if for some k, ℓ, $(z_k, z_\ell) \in E(R)$, $u^k = 1, \bar{v} = \bar{u} \oplus \gamma_{k\ell}$, where $\gamma_{k\ell}$ is an n-tuple satisfying $\gamma_{k\ell}^k = \gamma_{k\ell}^\ell = 1$, $\gamma_{k\ell}^j = 0$ $(k \neq j \neq \ell)$ and $0 \oplus 0 = 1 \oplus 1 = 0$, $0 \oplus 1 = 1 \oplus 0 = 1$.

Let $\bar{u} \in V(\bar{R})$. We write $\bar{v} \subset \bar{u}$ if $v^i = 1 \Rightarrow u^i = 1$ $(1 \leqslant i \leqslant n)$. Let G be the generalized Sprague-Grundy function on $\bar{R}$. Then $\bar{u}$ is called *reducible* if there exists $\bar{v} \subset \bar{u}$, $\bar{v} \neq (0, \ldots, 0)$, such that $G(\bar{v}) < \infty$. Otherwise $\bar{u}$ is *irreducible*. An irreducible vertex $\bar{u}$ satisfying $G(\bar{u}) < \infty$ is called *prime*. Let $p(R) = \max \Sigma_{i=1}^n u^i$, where the max is taken over all primes $\bar{u} = (u^1, \ldots, u^n) \in V(\bar{R})$.

Digraphs R with $p(R) = 2, 3, 4$ are given in the figures:







Are there digraphs R with $p(R) > 4$? The answer may yield a different strategy for *annihilation games* than the $O(n^6)$ algorithm mentioned in A. S. Fraenkel and Y. Yesha, *Theory of annihilation games* , Bull. Amer. Math. Soc. **82** (1976), 775–777. (Contributed by A. S. Fraenkel and Y. Yesha)

4. Pattern-Games. In combinatorial games, the player first unable to move is usually defined as the loser; sometimes as the winner (misère play).

In many interesting games, the loser or winner is defined as the player who first attains a certain *pattern*, as in "Connect Four" or "Three in a Row", where the pattern is not, in general, an end position. Develop a theory for such informally defined pattern games (p-games), or interesting subsets thereof.

Notes. (i) A theory of the type sought is not required for proving a family of p-games to be *NP*-complete or *NP*-hard.

(ii) Chess is a p-game: The winner is the first player attaining a pattern without the opponent's king.

(iii) It would be of interest to imbed checkers, chess and similar games which are intuitively difficult--and hence interesting--in various families of games on graphs, and prove each family *NP*-complete or *NP*-hard. (Contributed by A.S. Frankel)

PERSONAL ITEMS

EUGEN B. DYNKIN of the Central Economics-Mathematical Institute, Academy of Sciences, Moscow, USSR, has been appointed to a professorship at Cornell University.

GERALD HAJIAN of the American Cyanamid Company has been appointed to section head, Preclinical Statistics, Burroughs Wellcome Co., Research Triangle Park, North Carolina.

JACK SONN of the Technion-Israel Institute of Technology has been named this year's recipient of the Mahler Prize for research in Pure Mathematics.

MICHAEL D. WEISS of Alexandria, Virginia, has been appointed mathematical statistician with the Economic Research Service of the U.S. Department of Agriculture, Washington, D.C.

J. ERNEST WILKINS, JR., of Howard University has been appointed associate general manager for Science and Engineering at EG&G Idaho, Inc.

G. MILTON WING of the Los Alamos Scientific Laboratory has been appointed to the chairmanship of the Department of Mathematics and to a professorship at Southern Methodist University.

DEATHS

Professor PAUL BROCK of the University of Vermont died on February 2, 1977, at the age of 53. He was a member of the Society for 34 years.

Dr. JOSEPH HOBART BUSHEY of Fayetteville, Arkansas, died on November 25, 1976, at the age of 80. He was a member of the Society for 47 years.

Professor Emeritus HERMAN H. FERNS of the University of Saskatchewan died on December 19, 1976, at the age of 81. He was a member of the Society for 29 years.

Professor WALTER H. LESER of Franklin and Marshall College died on January 27, 1977, at the age of 51. He was a member of the Society for 25 years.

Mr. MICHAEL P. O'DONNELL of the University of Queensland died on October 11, 1976, at the age of 48. He was a member of the Society for 8 years.

American Mathematical Society

REPORTS AND COMMUNICATIONS

REPORTS OF MEETINGS

THE OCTOBER MEETING IN STORRS

The seven hundred thirty-eighth meeting of the American Mathematical Society was held at the University of Connecticut, Storrs, Connecticut, on Saturday, October 30, 1976. There were 101 registrants including 89 members of the Society.

By invitation of the Committee to Select Hour Speakers for Eastern Sectional Meetings, there were two one-hour addresses. Leonard Gross of Cornell University spoke on Logarithmic Sobolev inequalitics. Walter A. Strauss of Brown University spoke on Nonlinear scattering theory. The speakers were introduced by John V. Ryff.

Jerome H. Neuwirth of the University of Connecticut arranged a special session on Ergodic Theory; speakers were Nathaniel A. Friedman, Brian Marcus, N. F. G. Martin, Alan Saleski, Paul C. Shields, and Dorothy Stone. Eugene Spiegel of the University of Connecticut arranged a special session on Group Rings; speakers were Donna L. Beers, Richard Brauer, R. Keith Dennis, Jacques Lewin, Michael Rosen, and Allan Trojan.

There were two sessions for contributed ten-minute papers, chaired by Kinetsu Abe and Manuel Lerman.

There was a concurrent meeting of the Association for Women in Mathematics which was organized by Stephanie F. Troyer.

John V. Ryff was in charge of local arrangements.

Walter H. Gottschalk
Associate Secretary

Middletown, Connecticut

THE NOVEMBER MEETING IN ANN ARBOR

The seven hundred thirty-ninth meeting of the American Mathematical Society was held at the University of Michigan, Ann Arbor, Michigan, on Saturday, November 6, 1976. There were 134 registrants, including 115 members of the Society.

By invitation of the Committee to Select Hour Speakers for Western Sectional Meetings, there were two one-hour addresses. Professor Philippe M. Tondeur of the University of Illinois at Urbana-Champaign addressed the Society on the subject G-foliations and their characteristic classes; he was introduced by Professor Carl P. Simon. Professor M. Pavaman Murthy of the University of Chicago spoke on the topic, Serre's problem and complete intersections; Professor Melvin Hochster presided.

By invitation of the same committee there were three special sessions of selected twenty-minute papers. Professor Herbert J. Alexander of the University of Illinois at Chicago Circle organized a special session on Several Complex Variables; the participants were Eric D. Bedford, Daniel M. Burns, Jr., Frank Forelli, John Erik Fornaess, Paul M. Gauthier, R. Michael Range, Walter Rudin, and B. A. Taylor. Professor Noel J. Hicks of the University of Michigan organized a special session on Differential Geometry and Global Analysis; the participants were Richard L. Bishop, Harold G. Donnelly, Daniel S. Drucker, James L. Heitsch, Richard S. Millman, Mark A. Pinsky, Jack R. Quine, Anthony J. Tromba, and Karen K. Uhlenbeck. Professor Joseph Lipman of Purdue University organized a special session on Stratification of Algebraic and Analytic Varieties; the participants were James N. Damon, Robert M. Hardt, Heisuke Hironaka, Henry B. Laufer, Kenneth R. Mount, Augusto Nobile, Joel L. Roberts, and Jonathan M. Wahl.

There was also one session of six contributed ten-minute papers, for which Professor Robert G. Bartle served as presiding officer.

Paul T. Bateman
Associate Secretary

Urbana, Illinois

THE NOVEMBER MEETING IN COLUMBIA, SOUTH CAROLINA

The seven hundred fortieth meeting of the American Mathematical Society was held at the University of South Carolina, Columbia, South Carolina on November 19-20, 1976. There were 274 registrants including 233 members of the Society.

By invitation of the Committee to Select Hour Speakers, hour addresses were given by Professor Frank T. Birtel of Tulane University, Professor T. A. Chapman of the University of Kentucky, and Professor Thomas G. Hallam of the University of Georgia and Florida State University. The speakers were introduced, respectively, by O. G. Harrold, R. D. Anderson, and Charles W. McArthur.

There were also five special sessions organized by Professors Douglas N. Clark, Louis F. McAuley, Carl D. Meyer, Jr., William T. Trotter, Jr., and Eutiquio C. Young. In addition there were six sessions for contributed papers. These were chaired by Professors Frederick Bloom, Thomas Nordahl, Robert C. Sharpley, P. L. Sperry, R. M. Stephenson, Jr., and Manfred Stoll.

Tallahassee, Florida

O. G. Harrold, Jr.
Associate Secretary

THE NOVEMBER MEETING IN ALBUQUERQUE

The seven hundred forty-first meeting of the American Mathematical Society was held at the University of New Mexico, Albuquerque, New Mexico, on Friday and Saturday, November 19 and 20, 1976. There were 116 registrants including 37 members of the Society.

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there were two invited hour addresses. Professor Gerald B. Folland of the University of Washington lectured on Applications of analysis on nilpotent groups to partial differential equations. He was introduced by Professor Reuben Hersh. Professor Gary M. Seitz of the University of Oregon gave a lecture entitled A survey of recent work on finite simple groups; he was introduced by Professor Alexander P. Stone.

There were three special sessions of selected twenty-minute papers. David W. Fox of the Applied Physics Laboratory at Johns Hopkins University organized a special session on The Estimation of Eigenvalues. The speakers were Robert Dillon Brown, Joaquin B. Diaz, George Fix, Sydney H. Gould, Wilfred M. Greenlee, Karl E. Gustafson, Robert Nyden Hill, Harry Hochstadt, Cornelius O. Horgan, Bruce Kellogg, Jerry F. Kuzanek, Henry J. Landau, E. F. Masur, Joyce R. McLaughlin, Coreen L. Mett, John E. Osborn, Lawrence E. Payne, G. Philippin, Carl H. Popelar, Murray H. Protter, Steven A. Pruess, Benjamin Rulf, Howard L. Schreyer, Melvin R. Scott, Vincent G. Sigillito, G. W. Stewart, and B. Andreas Troesch. P. K. Pathak of the University of New Mexico organized a special session on Probability and Statistics. The participants were William A. Beyer, Patrick Lee Brockett, Bernard Epstein, Richard J. Griego, Barthel W. Huff, Gustavus J. Simmons, Vijendra P. Singh, J. N. Srivastava, William C. Torrez, Howard G. Tucker, Venkata R. R. Uppuluri, and Raymond E. Williams. In conjunction with this session, an hour lecture was given by Robert A. Wijsman. A special session on Partial Differential Equations was organized by Stanly Lee Steinberg of the University of New Mexico. The list of speakers was: George W. Bluman, George H. Pimbley, Jr., Paul H. Rabinowitz, Steven I. Rosencrans, Joel A. Smoller, Monty J. Strauss, James K. Thurber, Burton Wendroff, and Kjell-Ove H. Widman.

There were two scheduled sessions of contributed ten-minute papers and a late session of ten-minute papers. These sessions were chaired by Professors Ralph E. DeMarr, Richard Grassl, and Ray Mines.

Local arrangements were handled by Professor Alexander P. Stone.

Eugene, Oregon

Kenneth A. Ross
Associate Secretary

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**Elected member of Executive Committee with term extended to four years.

ABSTRACTS

The abstracts are grouped according to subjects chosen by the author from categories listed on the abstract form and are based on the AMS (MOS) Subject Classification Scheme (1970). Abstracts for which the author did not indicate a category are listed under miscellaneous.

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Abstracts Presented to the Society

The abstracts printed in this section were accepted by the American Mathematical Society for written presentation. An individual may present only one abstract by title in any one issue of the *Notices*, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for the same issue.

Algebra and Theory of Numbers (05, 06, 08, 10, 12–18, 20)

77T-A86 G. GRÄTZER and D. KELLY, University of Manitoba, Winnipeg, Manitoba R3T 2N2. Free m-products of lattices. III. Applications.

For m-lattices and $n \leq m$, we define two properties: (W_m) if $\bigwedge S \leq \bigvee T$ and $0 < |S|, |T| < m$, then $[\bigwedge S, \bigvee T] \cap (S \cup T) \neq \phi$. $(SD_\vee^n)$ if $a = x \vee s$ for all $s \in S$ and $0 < |S| < n$, then $a = x \vee \bigwedge S$. Let L be the free m-product of the m-lattices $L_i (i \in I)$ and let $X = \dot{\bigcup}(L_i \mid i \in I)$. We use the Structure Theorem of Part II to prove Theorem 1. If each L_i satisfies (W_m) for $i \in I$, then so does L. Theorem 2. If each L_i satisfies $(SD_\vee^n)$ for $i \in I$, then so does L.— In Theorem 2, we also apply the following consequence of our abstract: A normal form theorem. Theorem 3. If $a \in L - X$ is m-join-reducible, then there is $T \subseteq L$ with $0 < |T| < m$ such that $a = \bigvee T$; $\rho(t) < \rho(a)$ for all $t \in T$; and if $t \in T - X$, then (i) t is m-meet-reducible (and therefore, m-join irreducible), (ii) $t^{(i)} \nleq a_{(i)}$ for all $i \in I$, and (iii) if $t = \bigwedge S$ for $t \in T$, $S \subseteq L$ with $0 < |S| < m$ such that $\rho(s) < \rho(t)$ whenever $s \in S$, then $s \nleq a$ for all $a \in S$. Similarly to the finitary case, the theory of C-reduced free m-products is developed. Applications are: Theorem 4. Let L be a bounded m-lattice in which every element has at most one complement. Then L has a $\{0,1\}$- preserving m-embedding into a uniquely complemented m-lattice. Theorem 5. Every monoid can be represented as the $\{0,1\}$-preserving m-endmorphism semigroup of a bounded m-lattice. (Received August 10, 1976.)

77T-A87 RONSON J. WARNE, University of Alabama, Birmingham, Alabama 35294. Natural $\mathcal{L}$-unipotent semigroups.

Let S be a regular semigroup and let T denote the union of the maximal subgroups of S. If T is a semilattice of right groups (groups) (right zero semigroups), we term S a natural $\mathcal{L}$-unipotent (natural inverse) (discrete $\mathcal{L}$-unipotent) semigroup. Let Y be a semilattice. Let V be an inverse semigroup in which each subgroup consists of a single element and with semilattice Y. Let (J,*) be a semilattice Y of right groups $(J_\alpha : \alpha \in Y)$. Let $\alpha \to \varphi_\alpha$ be a mapping of V into End (J, *), the semigroup of endomorphisms of (J, *), and let $(\alpha, \beta) \to \alpha^\beta$ be a mapping of $V \times V$ into J such that: 1(a) $J_\alpha \varphi_\beta \subseteq J_{\beta^{-1}\alpha\beta}$; 1(b) $\alpha^\beta \in J_{(\alpha\beta)^{-1}\alpha\beta}$; 1(c) α^α is an idempotent of J_α for $\alpha \in Y$. 2(a) $\alpha^\beta * j\varphi_\alpha\varphi_\beta = j\varphi_{\alpha\beta} * \alpha^\beta$ for $j \in J$. 2(b) $\alpha^{\beta\gamma} * \beta^\gamma = (\alpha\beta)^\gamma * \alpha^\beta\varphi_\gamma$. Let $(Y, J, V, \varphi, \alpha^\beta)$ denote $\{(\alpha, a) : \alpha \in V, a \in J_{\alpha^{-1}\alpha}\}$ under the multiplication $(\alpha, a)(\beta, b) = (\alpha\beta, \alpha^\beta * a\varphi_\beta * b)$. Theorem 1.

$(Y, J, V, \varphi, \alpha^{\beta})$ is a natural $\mathcal{L}$-unipotent semigroup, and conversely every natural $\mathcal{L}$-unipotent semigroup is isomorphic to some $(Y, J, V, \varphi, \alpha^{\beta})$. In the statement of Theorem 1, let each J_α be a group (right zero semigroup) and assume φ_α is the identity map of H_α for $\alpha \in Y$ (omit 1(c)). Then Theorem 1 is valid with "natural $\mathcal{L}$-unipotent" replaced by "natural inverse" (discrete $\mathcal{L}$-unipotent). (Received November 1, 1976.)

*77T-A88 Justin R. Smith, Rice University, Houston, Texas 77001. Homology Surgery Theory and Perfect Groups.

This paper gives an algebraic proof of the following theorem:

Let $f: G \to H$ be a surjective homomorphism of groups with a kernel that is the normal closure (in G) of a finitely generated perfect group. Then the homomorphisms j_N: $\Gamma_N^S(ZG \to ZH) \to L_N^S(ZH)$ defined in Chapter I of "The codimension-two placement problem and homology-equivalent manifolds," by Cappell and Shaneson in the Annals of Math., Vol. 99, No. 2, 227-348, are isomorphisms for all N. This theorem was originally proved by Hausmann (not, as yet, published) for N even and by Cappell and Shaneson for N odd. Their proofs used geometric methods involving performing surgery on imbedded integral homology spheres. (Received December 17, 1976.)

77T-A89 G. Grätzer and C. R. Platt, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2. Two embedding theorems for lattices.

Theorem 1. Every lattice can be embedded in the ideal lattice of a lattice satisfying $(SD_\wedge)$.
Theorem 2. Every lattice can be embedded in the ideal lattice of a lattice satisfying $(SD_\vee)$.
Corollary. Every transferable lattice satisfies $(SD_\wedge)$ and $(SD_\vee)$. — All the statements remain valid if we take infinitary versions $(SD_\wedge^\infty)$, $(SD_\vee^\infty)$ of $(SD_\wedge)$, $(SD_\vee)$, respectively. $(SD_\wedge^\infty)$ is the condition that $a \wedge b_i = c$ for all $i \in I$ and the existence of $\bigvee(b_i \mid i \in I)$ imply that $a \wedge \bigvee(b_i \mid i \in I) = c$; $(SD_\vee^\infty)$ is the dual of $(SD_\wedge^\infty)$. (Received December 21, 1976.)

*77T-A90 M. Fiedler and V. Pták, CSAV, Prague, Czechoslovakia. The rank of extreme positive operators on polyhedral cones. Preliminary report.

A cone in an n-dimensional vector space with $n + 1$ extreme rays which satisfy exactly one linear dependence relation (with all coefficients different from zero) is called minimal. If C_1 and C_2 are two minimal cones in the finite-dimensional spaces E_1 and E_2, consider the cone $P(C_1, C_2)$ of all linear operators which map C_1 into C_2. A complete characterization of $P(C_1, C_2)$ is given. A corollary: the rank of an extreme linear operator of $P(C_1, C_2)$ may assume any of the possible values within the natural boundaries with exception of rank two. (Received January 14, 1977.)
(Authors introduced by Professor Emilie Haynsworth).

*77T-A91 Kenneth K. Hickin, Michigan State University, East Lansing, MI 48824. Complete universal homogeneous groups. Preliminary report.

$HU_\varkappa^\lambda$ is the class of all groups of power λ which are $\varkappa$-universal and homogeneous. ($\varkappa \geq \aleph_1$ is regular, $\lambda \geq \varkappa$, and the G.C.H. is assumed). Thus $HU_\varkappa^\varkappa$ has exactly one member up to $\cong$. Theorem 1. There is a set $\mathcal{K} < HU_\varkappa^{\varkappa^+}$ of power $2^{\varkappa^+}$ of non-isomorphic groups such that every automorphism of every $H \in \mathcal{K}$ is inner. Further, every $H \in \mathcal{K}$ is the union of a chain $\mathcal{C} = \{H_\mu \mid \mu < \varkappa^+\}$ where $H_\mu \in HU_\varkappa^\varkappa$ for all non-limit μ, and, for every proper subgroup $A < H$ such that

$H_\mu < A$ for some μ, we have $A \in \mathcal{C}$. Theorem 2. A result identical to Theorem 1 holds if $HU_\kappa^{\kappa^+}$ is replaced by the class of universal locally finite groups of power $\aleph_1$ ($\kappa = \aleph_0$). (Received January 17, 1977.) (Author introduced by Professor R. E. Phillips).

77T-A92 Williams K. Forrest, University of Manitoba, Winnipeg, Manitoba, Canada. R3T 2N2. Mappings and Correspondences of Open Formulas over Integral Domains.

Let R be an integral domain and ψ_1, ψ_2 open R-formulas with points in a universal domain. Theorem 1(a) If ψ_1 and ψ_2 are regularly isomorphic then the dimensions, degree and splitting extensions of ψ_1 and ψ_2 are equal. (b) If R is a field and $\varphi : \psi_1 \to \psi_2$ a regular isomorphism where ψ_2 is an irreducible variety then φ maps the Zariski closure of ψ_1 onto ψ_2. (c) If R is algebraically closed then regular maps over R lift to open continuous unique maps of the spaces $S_A^n(R)$. Definition If ψ_1, ψ_2 have degree 1 then a finite disjoint correspondence of ψ_1 and ψ_2 is an open R-formula $\pi \Rightarrow \psi_1 \times \psi_2$ such that points of ψ_1 and ψ_2 have finite nonempty images and preimages and independent points have disjoint images and preimages. The correspondence π is complete over $R_1 \supseteq R$ if images and preimages of points from R_1 have coordinates in R_1. Theorem 2 (a) Finite disjoint correspondence defines an equivalence relation on the degree 1 open R-formulas. (b) If a finite disjoint correspondence of ψ_1 and ψ_2 is complete over $R_1 \geq R$ then the maximal cardinality of an independent subset of $\psi_1(R_1^n)$ equals the maximal cardinality of an independent subset of $\psi_2(R_1^m)$. (Received January 24, 1977.)

*77T-A93 S. Fajtlowicz, University of Houston, Houston, Texas 77004. Independence ratio for cubic graphs.

Albertson, Bollobas and Tucker proved recently that if G is a connected regular graph of degree r containing no complete subgraphs on r vectices, then the independence ratio for G is, with two exceptions strictly greater than $\frac{1}{r}$, and they conjectured that if G is a planar cubic graph, containing no triangles then there is $S > \frac{1}{3}$ such that the independence ratio of G is bigger than S. The purpose of this paper is to prove the above conjecture even without the assumption that G is planar. Our $S = \frac{12}{35}$. We have also an example of a graph in which the independence ratio is $\frac{5}{14}$. William Staton conjecture s and has some evidence that $\frac{5}{14}$ is the best possible. (Received January 26, 1977.)

*77T-A94 Wesley J. Browning, Cornell University, Ithaca, New York 14853. A relative Neilsen theorem, preliminary report.

Given a group G and a free group F of finite rank. A relative Neilsen transformation is an automorphism of G*F of one of two types: (i) a Neilsen transformation of F extended by the identity over G, (ii) an automorphism obtained by requiring it to be the identity on G and on all generators of a given basis for F but one, say x, and sending x to some conjugate of x by an element of G. Theorem: An automorphism of G*F which leaves G pointwise fixed and carries the normal closure of F onto itself is a composition of relative Neilsen transformations. The proof is modeled on one of Magnus-Karrass-Solitar for the case G=(1). (Received January 26, 1977.)

77T-A95 WITHDRAWN

*77T-A96 BRIAN J. DAY, Department of Pure Mathematics, University of Sydney, Sydney, N.S.W. 2006. Note on linear monads.

Theorem. If $N: A \to C$ is a fully faithful dense functor and $\mathbb{T} = (T, \mu, \eta)$ is a monad on C such that $\int^A C(NA, C) \cdot TNA \to TC$ is an epimorphism then the full image of A under the free-algebra functor to Eilenberg-Moore category $C^{\mathbb{T}}$ is dense in $C^{\mathbb{T}}$ if A is small and $C^{\mathbb{T}}$ is cocomplete. A comparison is made of $C^{\mathbb{T}}$ with the algebras for the corresponding algebraic N-theory (in the sense of Y. Diers "J-adjonction, lim J-absolue et J-théorie algébrique", C.R. Acad. Sc. Paris, t. 278, série A, 1974, pp.1009-1012). (Received January 31, 1977.)

*77T-A97 J.A. GERHARD, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.
Free products of idempotent semigroups.

In this paper the free product (coproduct) of (any number of) idempotent semigroups (bands) is described. The method is an inductive one with similarities to the solution of the word problem for free idempotent semigroups. We construct a suitable free semigroup and then define inductively a congruence on part of this semigroup so that the quotient is the free product. In the case of two rectangular bands this (necessarily) gives the result of H.E. Scheiblich (Notices 742-20-39, Jan 1977). (Received February 7, 1977.)

*77T-A98 T. W. CUSICK, State University of New York at Buffalo, Amherst, New York 14226. Integer multiples of periodic continued fractions, Preliminary report.

Some results of H. Cohen (Acta Arith. 26 (1974-75), 129-148) are obtained much more simply by using an algorithm of A. Châtelet (Bull. Soc. Math. France 40 (1912), 1-25). (Received February 10, 1977.)

*77T-A99 Albert Nijenhuis, University of Pennsylvania, Philadelphia, Pa., 19174
Note on the unique determination of graphs by proper subgraphs.

Let G be an (unlabeled) n-graph, and D(G) (the deck of G) the multiset of its n vertex-deleted (n-1)-subgraphs. The conjecture that G is uniquely determined by D(G) is called the Kelly conjecture, or the Ulam conjecture for graphs. It has been known to be true for $3 \le n \le 6$; in the summer of 1976 P. Stockmeyer has roved the modified, stronger conjecture for 2-vertex deleted subgraphs, for $6 \le n \le 8$. The author has just verified the original conjecture, for $3 \le n \le 9$, by computer. This gives an independent confirmation of a recently announced result of B.D. McKay and C. Godsil, also obtained by computer.

The author has obtained, for each n-graph G $(3 \le n \le 9)$ a list of the isomorphism classes of each member of D(G) . The author thanks H.S. Wilf for numerous helpful thoughts. General reference: Bibliography on the reconstruction conjecture for graphs, compiled by B. Manvel and B. Hemminger. Research supported by an N.S.F. Grant. (3 Feb. 1977). (Received February 10, 1977.)

77T-A100 JAMES T. LOATS, University of Colorado, Boulder, Colorado 80309
Some Results on Boolean Algebras. Preliminary Report

Recall that an algebra is hopfian if every onto endomorphism is one-to-one. Theorem. There are no countable hopfian Boolean Algebras (BA's). Theorem (MA). There are no hopfian BA's of power $< 2^{\aleph_0}$ with infinitely many atoms. Theorem. There exist an atomic hopfian BA of power $2^{\aleph_0}$. Definition. For ultrafilters $\mathfrak{U}, \mathfrak{V} \in X_{\mathfrak{A}}$, the Stone space of $\mathfrak{A}$, and for a subalgebra $\mathfrak{B}$ of $\mathfrak{A}$, define $\mathfrak{U} \doteq_{\mathfrak{B}} \mathfrak{V}$ iff $\mathfrak{U} \cap \mathfrak{B} = \mathfrak{V} \cap \mathfrak{B}$. Theorem. For any set S carrying equivalence-relation E , there are BA's $\mathfrak{A}, \mathfrak{B}$ with $\mathfrak{B} < \mathfrak{A}$ and a function $f : X_{\mathfrak{A}} \twoheadrightarrow S$ such that $\mathfrak{U} \doteq_{\mathfrak{B}} \mathfrak{V}$ iff $f(\mathfrak{U}) E f(\mathfrak{V})$. (For S/E finite, proof due to Professor J.D. Monk.) Theorem. For any BA, $\mathfrak{A}$ we have $|\text{Ideals of } \mathfrak{A}| \le |\text{Subalgebras of } \mathfrak{A}|$. (Received February 10, 1977.)

77T-A101 WITHDRAWN

*77T-A102 TIM TILLSON, The Ohio State University, Columbus, Ohio 43210. A Hamiltonian Decomposition of K^*_{2m}, $2m \geq 8$, Preliminary report.

A constructive proof utilizing difference methods is given in this paper of E. G. Straus' conjecture:

> For $2m \geq 8$, the arcs of the complete directed graph on 2m-1 vertices K^*_{2m-1} can be partitioned into 2m-1 directed Hamiltonian paths.

This is equivalent to:

> For $2m \geq 8$, the arcs of the complete directed graph on 2m vertices K^*_{2m} can be partitioned into 2m-1 directed Hamiltonian cycles.

Previously obtained results that I am aware of are computer verification for $8 \leq 2m \leq 18$, and solutions for 2m = 22, 28, 40, 56 and 58 given by the existence of sequenceable groups of orders 21, 27, 39, 55 and 57. (Received February 11, 1977.)

*77T-A103 Katherine Johnston, Vanderbilt University, Nashville, Tennessee 37235. Congruence Lattices of Rees Matrix Semigroups.

For any set A, let $\Pi(A)$ denote the partition lattice of A. Let $N(G)$ denote the normal subgroup lattice of a group. Theorem: A modular lattice L is the lattice of proper congruences of a Rees matrix semigroup iff L is isomorphic to a complete sublattice of $\Pi(I) \times N(G) \times \Pi(M)$ for some sets I and M and a group G, satisfying (1) if $(r,N,\pi) \in L$, and $s \leq r$, $K \geq N$, $\rho \leq \pi$, then $(s,K,\rho) \in L$; and (2) $(\varepsilon,\{e\},\varepsilon) \in L$. The proof uses a characterization due to Lallement of congruences on a Rees matrix semigroup.

We also give an example showing that the conditions in the above theorem are not sufficient if L is non-modular. (Received February 14, 1977.)

*77T-A104 EDWARD HOWORKA, University of Florida, Gainesville, Florida 32611. On metric properties of certain clique graphs.

The present paper brings together the results of [1]: D. C. Kay and G. Chartrand, "A characterization of certain ptolemaic graphs", Canad. J. Math. 17(1965), 342-346, and of [2]: P. Buneman, "A note on the metric properties of trees", J. Combinatorial Theory (B) 17(1974), 48-50. The theorem established in [1] is slightly extended: A graph G is a Husimi tree iff G is ptolemaic and if each two distinct cliques of G have at most one vertex in common. It is found on the other hand that the class of Husimi trees is itself characterized by a metric condition in some respects much resembling the ptolemaic inequality: A connected graph G is a Husimi tree iff $d_G(u,v) + d_G(x,y) \leq \max\{d_G(u,x) + d_G(v,y),\ d_G(u,y) + d_G(v,x)\}$ holds for each four vertices u, v, x, y of G (this strengthens [2, Theorem 1]). (Received February 14, 1977.)

Analysis (26, 28, 30–35, 39–47, 49)

*77T-B72 Albert A. Mullin, 6840 Todd Street, Patton Park, Ft. Hood, TX 76544. On common fixed extreme points for families of mappings.

This note is a synthesis of several results by M. G. Kreĭn and D. P. Mil'man on extreme points and by A. A. Markov, S. Kakutani, and F. E. Browder on the existence of common fixed points for commuting families of mappings. Lemma 1. Let S be a compact convex subset of a locally convex LTS. Let C be a non-empty commuting family of affine continuous mappings of S into S. Let F be the (non-empty) set of all common fixed points over C. Then F contains all extreme points of S iff

$C \equiv \{I_S\}$ where I_S is the identity map on S. Lemma 2. Let B be a bounded closed convex subset of a Hilbert space. Let C be a non-empty commuting family of non-expansive mappings of B into B. Let F be the (non-empty) set of all common fixed points over C. Then F contains all extreme points of B iff $C \equiv \{I_b\}$. Problems. Determine N & S conditions on C so that F contains at least one extreme point of S (or B). Applications to potential theory and barycentric measure-theory are discussed informally. Scholium. Lemma 2 is nearly trivial when "bounded-closed" is replaced with "compact". (Received October 20, 1976.)

*77T-B73 GARY WEISS, University of Cincinnati, Cincinnati, Ohio 45221. The Fuglede Commutativity Theorem modulo the Hilbert-Schmidt class and generating functions for matrix operators.

Relative to separable, complex Hilbert space, let L(H), N, $\mathcal{D}$, C_2, C_1 denote, respectively, the class of bounded linear operators, normal operators, diagonalizable operators, Hilbert-Schmidt operators ($||\cdot||_{C_2}$ denotes the respective norm), and trace class operators. We prove the following. Theorem 1. $||NX-XD||_{C_2} = ||N^*X-XD^*||_{C_2}$ whenever $N \in N$, $D \in \mathcal{D}$, $X \in L(H)$. Corollary 2. If $N \in N$, $D \in \mathcal{D}$, then $N = D+K$ for some $K \in C_2$ if and only if N is similar to $D+K'$ for some $K' \in C_2$. Corollary 3. The proposition $[NX-XN \in C_2 \Rightarrow N^*X-XN^* \in C_2$ whenever $N \in N$, $X \in L(H)]$ is equivalent to $[M_\phi X-XM_\phi \in C_2 \Rightarrow M_\phi^* X-XM_\phi^* \in C_2$, whenever $\phi \in L^\infty(T)$ and $X \in L(L^2(T^2))]$. Theorem 4. If $N \in N$, $X \in L(H)$, $NX-XN \in C_2$ and $N^*X-XN^* \in C_2$, then $||NX-XN||_{C_2} = ||N^*X-XN^*||_{C_2}$. Corollary 5. If $N \in N$, $N=D+K$ for some $D \in \mathcal{D}$, $K \in C_2$, then $||NX-XN||_{C_2} = ||N^*X-XN^*||_{C_2}$ for every $X \in L(H)$. Theorem 6. If $N \in N$, $X \in C_2$, $NX-XN \in C_1$, then trace $(NX-XN) = 0$.

The main technique employs a new concept which we call "generating functions for matrix operators". (Received November 18, 1976.)

*77T-B74 JOSE BARRIA and DOMINGO A. HERRERO, Instituto Venezolano de Investigaciones Científicas, Matemáticas, A.P.1827, Caracas 101, Venezuela, The similarity orbit of a bi-quasitriangular operator.

The norm-closure $\mathcal{S}(T)^-$ of the "similarity orbit" $\mathcal{S}(T)=\{WTW^{-1}$: W is invertible$\}$ of a (bounded linear) operator T acting on a complex separable Hilbert space is completely determined for the case when T is a bi-quasitriangular operator whose spectrum and essential spectrum coincide, provided T behaves "nicely" on every spectral subspace associated with an isolated point of the spectrum (This class includes every normal operator without normal eigenvalues). It is also shown that $S \oplus S^*$ (S=the unilateral shift) belongs to $\mathcal{S}(T)^-$, provided the essential spectrum of T is an infinite subset of the unit circle, the spectrum of T is a proper subset of the closed unit disc and the restriction of T to every spectral subspace associated with an isolated eigenvalue in the open disc is cyclic. (Received January 14, 1977.)

77T-B75 PEI YUAN WU, National Chiao Tung University, Hsinchu, Taiwan, China. Jordan model for weak contractions. Preliminary report.

Let T be a c.n.u. weak contraction with finite defect indices. We obtain a Jordan model for such contractions, which generalizes the Jordan model for $C_0(N)$ contractions as developed by Sz.-Nagy and Foiaş. More specifically, we have Theorem. Let T be as above. Then T is quasi-similar to a uniquely determined operator of the form $M_1 \oplus M_2 \oplus \ldots \oplus M_m \oplus S(\varphi_1) \oplus \ldots \oplus S(\varphi_n)$, where M_j, $j = 1, \ldots, m$, denotes the multiplication by e^{it} on the space $L^2(E_j)$ with E_j measurable subset of the unit circle satisfying $E_1 \supseteq E_2 \supseteq \ldots \supseteq E_m$ and $S(\varphi_k)$, $k = 1, \ldots, n$, denotes the compression of the shift on the space $H^2 \ominus \varphi_k H^2$ with $\varphi_k | \varphi_{k-1}$. As corollaries, we show that μ_T, the multiplicity of T (in the sense of Sz.-Nagy and Foiaş), is equal to $\mu_{T^*} = \max\{m, n\}$ and we can also define "multiplicity-free" weak contractions parallel to the notion of multiplicity-free $C_0(N)$ contractions. (Received January 20, 1977.)

77T-B76 Simeon Reich, University of Chicago, Chicago, Illinois 60637. Almost convergence and nonlinear ergodic theorems.

Let H be a Hilbert space, C a closed convex subset of H, $T : C \to C$ a nonexpansive (odd) mapping with a fixed point, and $x \in C$. G. G. Lorentz's concept of almost convergence [Acta Math. 80 (1948), 167-190] can be used to show that the sequence $\{T^n x\}$ is weakly (strongly) summed by every strongly regular matrix (to its asymptotic center). This improves upon recent results of H. Brézis and F. E. Browder [Bull. Amer. Math. Soc. 82 (1976), 959-961]. In particular (as has also been shown by R. E. Bruck who employed a different argument), Theorem 2 there remains true even if the matrix is not assumed to be "proper". An analogous result holds for semigroups of nonexpansive mappings. (Received January 27, 1977.)

77T-B77 M. RAPHAEL and J.J. SEMBER, Mathematics Department, Simon Fraser University, Burnaby, B.C. V5A 1S6. SOME FURTHER RESULTS ON UNCONDITIONAL SECTION BOUNDEDNESS

A sequence x has UAB in a K-space E in case $\{\sum_{k\in F} x_k \delta^k : F \in \Phi\}$ is a bounded subset of E, where Φ denotes the collection of all finite subsets of the natural numbers (see these notices, §171, Aug. 1976, 737-40-1). Let $E_{UAB} = \{x \in \omega : x$ has UAB in $E\}$. The first two parts of Proposition 1 are known [GOES, TÔHOKU MATH. J. 26, No. 4, 1974, (487-504); BUNTINAS, PROC. CAMB. PHIL. SOC. 78, 1975 (451-460)].

PROPOSITION 1. Let E be a barrelled K-space. Then (i) $E \subseteq E_{AB}$ iff $E_{AB} = E^{\gamma\gamma}$ (ii) $E \subseteq E_{FAK}$ iff $E_{FAK} = E^{\beta\beta}$ (iii) $E \subseteq E_{UAB}$ iff $E_{UAB} = E^{\alpha\alpha}$.

PROPOSITION 2. Let E be an FK-space with $E \subseteq E_{UAB}$. Then $\Sigma x_k \delta^k$ is weakly convergent iff it is subseries convergent.

PROPOSITION 3. Let E be any FK-space. Then

$$\{x \in E : \Sigma x_k \delta^k \text{ is subseries convergent}\} = c_o \cdot E_{UAB}.$$

PROPOSITION 4. Let E be any FK-space. Then $\Sigma \delta^k$ is weakly unconditionally convergent in E iff E is conservative and conull.

PROPOSITION 5. For any matrix $A = (a_{nk})$, $(c_A)_{UAB} = \{x : \sup_{n=1,2,\ldots;\, F\in\Phi} |\sum_{k\in F} a_{nk} x_k| < \infty\}$.

(Received January 31, 1977.)

77T-B78 Gonzalo G. Riera, Columbia University, New York, N.Y. 10027. Algebraic quotients of Bergman domains. Preliminary report.

A Bergman domain in $\mathbb{C}^n$ is a set $D = \{(z_1,\ldots,z_n)/z_1 \in U, z_{j+1} \in D_{j+1}(z_1,\ldots z_j)\ j=1,\ldots,n-1\}$ where D_{j+1} is a Jordan domain in whose boundary admits a parametric representation $z_{j+1} = W(z_1,\ldots, z_j; x)$; $x \in \mathbb{R}$, W being for fixed x a holomorphic function in D_j. We consider group G of analytic automorphisms of D obtained as follows: There is a sequence of subgroups $\{1\} = G_o \triangleleft G_1 \ldots \triangleleft G_n = G$ such that G_i/G_{i-1} is isomorphic to a Fuchsian group H_i of type (p_i,k_i) and G_i is a split extension of G_{i-1} by H_i $(1 \le i \le n)$ (Explicit formulae for the action are obtained in my thesis: Columbia University, October 1976.) Theorem: If $k_i = 0$ for $1 \le i \le n-1$ then D/G is a quasi-projective variety. (Received February 8, 1977.)

*77T-B79 REKHA PANDA, University of Victoria, Victoria, British Columbia, Canada V8W 2Y2 and Ravenshaw College, Cuttack-753003, Orissa, India. *The reducible cases of certain hypergeometric functions of several variables.* Preliminary report.

Recently, the author [Indag. Math. 38 (1976), 41-45; see also these *NOTICES* 22 (1975), pp. A456-A457, Abstract # 75T-B104] gave a number of generalizations of certain reduction formulas for the generalized hypergeometric ${}_pF_q(z)$ function and for its basic analogue ${}_r\Phi_s[z]$, which were considered earlier by P. W. Karlsson [J. Mathematical Phys. 12 (1971), 270-271; Indag. Math. 36 (1974), 195-198], H. M. Srivastava [Indag. Math. 35 (1973), 38-40], and M. Chakrabarty

[Indag. Math. 36 (1974), 199-202]. The present paper considers the corresponding problem for certain multiple hypergeometric functions and provides generalizations of the earlier results to hold for multiple series with arbitrary terms. Finally, as an application of one of the results presented in this paper, it is shown how readily one can derive a multiple-series analogue of a known summation theorem for a generalized hypergeometric series of type ${}_pF_q(1)$ under certain parametric restrictions. The paper concludes by observing an interesting connection of this multiple summation theorem with a known reduction formula given elsewhere by the author [Jñānabha Sect. A 4 (1974), 165-168, especially p. 168, Equation (12)].
(Received February 8, 1977.)

77T-B80 P.N.NATARAJAN, The Ramanujan Institute, University of Madras, Madras-600 005 and M.S.RANGACHARI, The Ramanujan Institute, University of Madras, Madras-600 005 (India). Matrix transformations between sequence spaces over non-archimedean fields. Preliminary report.

K is a complete, non-trivially valued non-archimedean field. $l(p)$ denotes the space of sequences $\{x_k\}$, $x_k \in K$ with $\sum_{k=1}^{\infty} |x_k|^{p_k} < \infty$, where $p = \{p_k\}$ is a sequence of real numbers such that $0 < p_k \leq \sup_{k\geq 1} p_k < \infty$. $l_\infty(p)$ denotes the space of sequences $\{x_k\}$, $x_k \in K$ with $\sup_{k\geq 1} |x_k|^{p_k} < \infty$. The following theorem is proved in the paper. Theorem: If [illegible], n, [illegible] ,2,... , $a_{nk} \in K$ is an infinite matrix, A transforms any sequence $x \in l(p)$ to the sequence $Ax \in l_\infty$ if and only if $\sup_{n,k} |a_{nk}|^{t_k} < \infty$. It is noteworthy that [illegible] the condition $\sup_{k\geq 1} p_k < \infty$ [illegible] linear space. This is in variance with the case of K being the field of real or the field of complex numbers.
(Received February 7, 1977.) (Authors introudced by Dr.T.V. Lakshminarasimhan).

*77T-B81 Robert Carroll, University of Illinois, Champaign-Urbana, Illinois 61801 Uniqueness theorems for abstract differential equations.

Let F be a suitable locally convex space and consider $\vec{u}'(t) = P(A,t)u(t)$, $\vec{u}(0) = \vec{u}_0$, where $\vec{u}(t)$ has entries $u_i(t) \in F$ $(0 \leq i \leq m-1)$ and $P(A,t)$ is an $m \times m$ matrix with suitable polynomial entries; A generates a suitable group $T(x)$ in $L(F)$. As in Donaldson (Bull. AMS, 81 (1975), 576-578) a solution is $\vec{u}(t) = \int W(t,x)T(-x)\vec{u}\, dx$ where $D_t\hat{W}(t,s) = P(-is,t)\hat{W}(t,s)$ and $\hat{W}(0,s) = I$. Here for t fixed $U(t,x) = T(x)\vec{u}(t)$ is an F^m valued distribution over a suitable space Φ and $\mathcal{F}W(t,x) = \hat{W}(t,s)$ where $\hat{U}(t,s) = \hat{W}(t,s)\hat{U}(0,s)$ is an F^m valued distribution over $\Psi = \mathcal{F}\Phi$ (the elements of $\hat{W}(t,s)$ are assumed to be suitable multipliers in $\hat{\Psi}$). We prove a uniqueness theorem for this problem based on techniques of Carroll (cf. Carroll-Showalter, Singular and degenerate Cauchy problems, Acad. Press, N.Y., 1976). Everything makes sense for the standard parabolic, hyperbolic, correct, etc. problems of Gelfand-Šilov. (Received February 14,1977.)

77T-B82 CHIEN WENJEN, California State University, Long Beach, California 90840. A new proof of a theorem for changing variables in multiple integrals.

The new proof is elementary and rigorous; the Jacobian in the formula emerges naturally; and the proof can be extended to Euclidean n-space for $n > 3$ without difficulty. [Cf. J. Schwartz, "The formula for change in variables in a multiple integral", Amer. Math. Monthly 61(1954), no. 2 and T. Rado and P. V. Reichederfer, "Continuous transformations in analysis", Springer-Verlag, 1955.] (Received February 7, 1977.)

77T-B83 R.BHASKARAN, The Ramanujan Institute, University of Madras, Madras-600 005 (India) and U.NAIK-NIMBALKAR, Michigan State University, East Lansing, Michigan 48104. Banach Algebras of Lipschitz Functions over Valued Fields. Preliminary report.

If (X,d) is an ultrametric space and F denotes a non-archimedean non-trivially valued complete field $\mathrm{Lip}(X,d) = \{f : X \to F,\ \|f\|_\infty \equiv \sup\{|f(x)| : x \in X\} < \infty,\ \|f\|_L \equiv \sup\{|f(x) - f(y)|/d(x,y)$

$x,y \in X,\ x \neq y\} < \infty\}$ is a non-archimedean Banach Algebra with the norm $\|f\| = \mathrm{Max}(\|f\|_\infty, \|f\|_d)$, $f \in \mathrm{Lip}(X,d)$. The object of the paper is to study this Banach algebra particularly with reference to its Gelfand ideal space. The main result is that when F is locally compact, X is a dense subset of the Gelfand ideal space and Lip(X,d) is a weakly regular non-archimedean Banach algebra. Among other results are an isomorphism theorem for Lipschitz algebras and a characterization theorem for the automorphism of such algebras. (Received February 14, 1977.) (Author introduced by Dr. T. V. Lakshminarasimhan).

*77T-B84 **FRANK N. HUGGINS, University of Texas at Arlington, Arlington, Texas 76019.** **Generalized Lipschitz Conditions II.**

This paper presents further results concerning functions which satisfy a uniform Lipschitz condition of order p with respect to an increasing function m on [a,b]. (See Abstract 73T-B191, these Notices, 20 (1973), p. A-438.) Some representative results are: THEOREM. A function f satisfies a uniform Lipschitz condition of order 1 with respect to an increasing function m on [a,b] if and only if f is the Lebesgue-Stieltjes integral on [a,b] of a bounded function g with respect to m. THEOREM. If m is an increasing function on [a,b], f is a function such that the Hellinger integral $\int_a^b (df)^2/dm$ exists, and $h_f(x) = \int_a^x (df)^2/dm$ for each x in [a,b], then f satisfies a uniform Lipschitz condition of order 1 with respect to m on [a,b] if and only if h_f satisfies a uniform Lipschitz condition of order 1 with respect to m on [a,b]. (Received February 15,1977.)

Applied Mathematics
(65, 68, 70, 73, 76, 78, 80–83, 85, 86, 90, 92–94)

77T-C24 D. V. CHOODNOVSKY and G. V. CHOODNOVSKY, Tarasovskaya 10a, Ap. 17, 252033, Kiev, USSR. The law of addition for elliptic curve and Korteweg-de Vries equation.

We investigate the connection between solutions of KdV equation and particle problems with elliptic potential of interaction $\wp^2(x)$ first found by Kruskal. Proposition 1. If $u(x,t) = \sum_{i \in I} \wp(x-x_i)$, $x_i = x_i(t)$, then $u(x,t)$ satisfy $u_t = 12cuu_x - cu_{xxx}$ iff simultaneously $\dot{x}_i = 12c \sum_{j \neq i} \wp(x_i - x_j)$; $\sum_{j \neq i} \wp'(x_i - x_j) = 0 : i \in I$. Proposition 2. Any solution $x_i = x_i(t)$ of the following system of equations $\dot{x}_i = k \sum_{j \neq i} \wp(x_i - x_j)$, $\sum_{j \neq i} \wp'(x_i - x_j) = 0$ is a trajectory of the Hamiltonian $H = \frac{1}{2}\{\sum_{i \in I} \dot{x}_i^2 + k^2 \sum_{i \neq j} \wp^2(x_i - x_j)\}$. Here and supra $\wp(x)$ is any Weierstrass elliptic function, in particular, $\wp(x) = x^{-2}$. The system of equations in Proposition 2 has Lax representation $\dot{L} = [L, A]$, following from the law of addition for $\wp(x)$. Here matrices L and A have the form $L_{ij} = 2\delta_{ij} \sum_{k \neq i} \wp(x_i - x_k) + (1-\delta_{ij}) \wp(x_i - x_j)$; $A_{ij} = (1-\delta_{ij}) k \wp'(x_i - x_j)$. So Lax pair for KdV is equivalent to the law of addition for $\wp(x)$.

(Received December 16, 1976.)

77T-C25 Alexander G. Ramm, Inst. Fine Mech. & Optics, Leningrad 197101. Stable solution of an integral equation arising in applications.

Consider eq. (1) $\int_{-1}^{1} \varphi(t)(x-t)^{-1} dt = f(x)$, $x > 1$. Let $x = N+y$; $N > 2$ will be chosen so that (4) holds (see below), $f(N+y) \equiv g(y)$. Eq. (1) takes the form (2) $A\varphi \equiv \int_{-1}^{1} \varphi(t)(N+y-t)^{-1} dt = g(y)$, $y > -1$. Function $g(y)$ is known for $-1 \leq y \leq 1$. If eq. (2) is sol–

vable, then it is equivalent to eq.(3) $A^*A\varphi = A^*g$, where $A^*A = K$, the kernel of K is $K(z,t)=(t-z)^{-1}\ln\left\{\frac{N+1-t}{N+1-z}\cdot\frac{N-1-z}{N-1-t}\right\}$, $K(z,t) \sim 2(N^2-1)^{-1}$ as $N \to +\infty$.

Operator $K>0$ is compact in $H=L_2[-1, 1]$. For sufficiently large N the inequality $\|K\| < 1$ holds. So the operator (4) $B \equiv I-K>0$, and $\|I-K\|=1$ as K is compact. The iterative process (5) $\varphi_{n+1} = B\varphi_n + \psi$, $\varphi_0=\psi$; $\psi \equiv A^*g$ converges in H to the unique solution of eq.(1). Process (5) supplies a stable method for solving eq.(1) because knowing $\delta>0$, $\|f-f_\delta\|_{L_2(1,\infty)}<\delta$ one can chose $n=n(\delta)$ such one that $\|\varphi-\varphi_{n(\delta),\delta}\|_H \to 0$ as $\delta \to 0$. Here $\varphi_{n,\delta}$ is the sequence, generated by (5) with $\psi=\psi_\delta=A^*f_\delta(N+y)$. Every iterative process of solving the solvable equation of the first kind supplies a stable method of solving this equation. The given method can be used for solving the inverse problem in potential theory: $\int_{\mathcal{D}}\varphi(t)r_{xt}^{-1}dt = f(x)$, $x\in\Delta$, $\mathcal{D}\cap\Delta=\emptyset$, $r_{xt}=|x-t|$. (Received December 20, 1976.)

*77T-C26 STEPHEN GROSSBERG, Boston University, Boston, Massachusetts 02215.
Competition, Decision, and Consensus, Preliminary report.

This paper proves that given any number of competing populations, any mean competition function, and any interpopulation signal functions constrained by weak smoothness conditions, then global pattern formation occurs. Theorem (Global Consensus): Given any $n \geq 2$, let $\dot{x}_i = A_i(x)[B_i(x_i) - C(x)]$ where $x = (x_1,x_2,\ldots,x_n)$ and $i = 1,2,\ldots,n$. Also suppose: 1. Smoothness: (a) $A_i(x)$ is nonnegative and continuous for $x \geq 0$; (b) $B_i(x_i)$ is either continuous with piecewise derivatives for $x_i \geq 0$, or is continuous with piecewise derivatives for $x_i > 0$ and $B_i(0) = \pm\infty$; (c) $C(x)$ is continuous with bounded piecewise derivatives for $x \geq 0$. 2. Nonnegativity: $A_i(x) > 0$ if $x_i > 0$ and $x_j \geq 0$, $j \neq i$; $A_i(x) = 0$ if $x_i = 0$ and $x_j \geq 0$, $j \neq i$. 3. Boundedness: $\limsup_{w\to\infty} B_i(w) \leq \min\{C_k: k = 1,2,\ldots,n\}$ where $C_k = C(0,0,\ldots,\infty,\ldots,0,0)$ with "∞" in the k^{th} entry. 4. Competition: $\frac{\partial C}{\partial x_k} \geq 0$, $k = 1,2,\ldots,n$. Then given any nonnegative initial data $x(0)$, bounded nonnegative limits $x(\infty)$ exist. (Received January 5, 1977.)

77T-C27 E.A. Galperin, NP Research, P.O.Box 24, Station 'CDN', Montréal, Qué., Canada. Non-asymptotically stable observers for linear time-invariant systems. Preliminary report.

Theorem. Given the plant $dx/dt=Ax+Du$, (1), $t\geq 0$, $x(0)$ unknown, with the output $y(t)=H'x$, $\dim y<\dim x$, assume that such a matrix Q can be chosen that the matrix $B=A-QH'$ have k zero eigenvalues with k corresponding linearly independent eigenvectors and all other roots in the left half plane. Denote by g_i k eigenvectors of the transpose B', satisfying $B'g_i=0$, $i=1,\ldots,k$. Then for any $\varepsilon>0$ there can be chosen such $\delta>0$ that for any data $z_0, x(0)$ satisfying the conditions $g_i'[z_0-x(0)]<\delta$ (2), $i=1,\ldots,k$, the model $dz/dt=Bz+Qy+Du$, (3), $t\geq 0$, $z(0)=z_0$ in some time t^* (depending on the negative real parts of the eigenvalues) reaches and stays in ε-neighborhood of the motion of the original system (1): $\|z(t)-x(t)\|<\varepsilon$ for $t\geq t^*>0$ (4).

For k=0 the model (3) represents conventional observers (see D.G. Luenberger, IEEE Trans., AC-11, 2, 1966) asymptotically stable in the large. Stable observers possess closed-loop stability properties as the conventional do and function robustly under small perturbations not affecting the stability of integrals corresponding to (2). (Received January 14, 1977.)

*77T-C28 ETHELBERT N. CHUKWU, Cleveland State University, Cleveland, Ohio 44115.
Absolute Controllability of Nonlinear Pursuit Games. Preliminary report.

In this paper we shall first reduce the absolute controllability (absolute null-controllability) of the game

$$\dot{x} = A(t)x-p+q,\ p(t)\in P,\ q(t)\in Q \qquad (1)$$

to the complete controllability (null-controllability) of the control system

$$\dot{x} = A(t)x-u,\ u(t)\in P \overset{*}{-} Q \qquad (2)$$

where $P \overset{*}{-} Q = \{u: u+Q\subseteq P\}$. Next we shall treat the nonlinear game

$$\dot{x} = A(t)x + k(t,p,q) \qquad (3)$$

and its perturbation

$$\dot{x} = A(t)x + k(t,p,q) + g(t,x,p,q) \qquad (4)$$

After characterizing the absolute controllability of (3) by a growth condition, we give a class of nonlinear systems (4) the absolute controllability of which can be determined by reducing the game to the simpler form (3).

Our results continue the developments in O. Hajek, Pursuit Games, Academic Press (1975), and generalize J. P. Dauer, Journal of Optimization Theory and Applications, Vol. 9, No. 2, (1972); Vol. 11, No. 2, (1973). (Received January 20, 1977.)

*77T-C29 G.V.Choodnovsky,Tarasovskaya 10a,Ap.17,252033,Kiev, USSR.
Many body problem with elliptic potentials and Burgers-Hopf equation

We consider solutions $u(x,t)$ of Burgers-Hopf (BH) equation with poles $x_i = x_i(t)$ of order one; formally we put $u(x,t) = \sum_{i\in I}(x-x_i)^{-1}$. Then $u(x,t)$ satisfy BH_c: $u_t = 2cuu_x + cu_{xx}$ iff $\dot{x}_i = 2c\sum_{j\neq i}(x_i-x_j)^{-1}$. Analogically for $u(x,t) = \sum_{i\in I} d\,ctg(d(x-x_i))$ the equation BH_c is satisfied, iff $\dot{x}_i = 2cd\sum_{j\neq i} ctg(d(x_i-x_j))$. Proposition. Any solution $x_i(t)$ of $\dot{x}_i = a\sum_{j\neq i}(x_i-x_j)^{-1}$ is a trajectory of Hamiltonian $\eta = \frac{1}{2}\sum_{i\in I}\dot{x}_i^2 - a^2\sum_{i\neq j}(x_i-x_j)^{-2}$. Moreover any trajectory of this Hamiltonian with vanishing first integrals is a solution of system in Proposition. Analogous of proposition are valid for $(x_i-x_j)^{-1}$ replaced by $ctg(x_i-x_j)$ or cth and $(x_i-x_j)^{-2}$ by $ctg^2(x_i-x_j)$ or cth^2. There are three ways for solving arising particle problems: by reducing BH to heat equation; using Lax's pair; considering moments $I_n = \sum_{i=1} x_i^n$ as polynomials in [illegible]. For complex a, c and x_i we have real systems of the form $\dot{x}_i = k\sum_{j\neq i}(y_i-y_j)r_{ij}^{-2}$; $\dot{y}_i = k\sum_{j\neq i}(x_i-x_j)r_{ij}^{-2}$.
(Received December [illegible], 1976.)

*77T-C30 S.T.CHIRIACESCU,University of Braşov,Romania;K.V.LEUNG,CONCORDIA University,Montreal H3G1M8 Canada;D.J.MANGERON,Polytechnic Institute of Jassy,Iaşi,Romania.At present:University of Alberta,Canada and M.N.OGUZTORELI,University of Alberta,Edmonton T6G 2G1,Canada.
Stability of nonlinear dynamic machining systems with time-lags.

The authors investigated in their papers presented to the 14th IUTAM Congress (Delft,Holland,1976) and to the IFToMM World Congress (Newcastle upon Tyne,England,1975) the "global"stability of certain cutting machine tool spindles,the global instability of dynamic working systems,the stability of certain nonlinear models of machine tools,and the experimental determination of the dynamic variations of the cutting forces.This paper discusses the stability of a time-lag nonlinear dynamic machining system DMS governed by the following dynamic matrix equations: $\nu(p) = G^{-1}(p)[\beta F(x,px,\theta,p\theta) - K\phi(\nu)]$, $\theta(p) = G_o^{-1}(p)[\gamma F(x,px,\theta,p\theta) - K_o\phi_o(\theta)]$, $x(p) = H(p)\alpha\nu(p)$, $F(x,px,\theta,p\theta) = F_o - \Delta F(x,px) - \Delta F^*(\theta,p\theta)$,where $p = d/dt$, t is the time variable, $G^{-1}(p)$ and $G_o^{-1}(p)$ are the transfer matrices of the linearized machine tool structure,$x(x_1,x_2,x_3)$ are the instantaneous coordinates of a generic point O_1 on the machined surface, while ΔF and ΔF^* are two experimentally determined parts of the dynamic cutting force F,α, β,γ matrices with constant elements.The established eqs.relate the flexional ν and torsional θ vibrations of the structure to the nonlinear characteristics K and the regenerative effects K_o of the structure and of the components of the cutting forces,while H(p) contains time-lags.The absolute stability analysis of the considered system is accomplished by the method of harmonic linearization of E.P.Popov.A good agreement with experimental results was also found and the DMS of a boring bar was finally discussed.
(Received February 15, 1977.)

Geometry (50, 52, 53)

77T-D4 MELVYN W. JETER, University of Southern Mississippi, Hattiesburg, Mississippi 39401. Some Extremal Elements of the Convex Cone of Monotone Processes of Concave Type. Preliminary report.

This note is concerned with the extremal elements of the convex cone of monotone processes of concave type from E_n^+ to E_m^+, (For background see R.T. Rockafellar, "Monotone Processes of Convex and Concave Type," Memoirs of the Amer. Math. Soc., 77 (1967)). Let $a \in E_n^+ \setminus \{0\}$ and $b \in E_m^+ \setminus \{0\}$. Define $T(x) = \{y \in E_m^+ : x \geq \lambda a$ and $y \leq \lambda b$ for some $\lambda \geq 0\}$. Theorem T is an extremal element of the convex cone of monotone processes of concave type from E_n^+ to E_m^+ iff b has only one positive component. (Received February 1, 1977.)

*77T-D5 GEORGE P. GRAHAM, JR. Indiana State University, Terre Haute, Indiana 47809
The incidence function in planes of prime power order.

Let P be a projective plane with points π, lines λ, and incidence relation I. Define the function $\delta: \pi \times \lambda \to \{0,1\}$ by $(P,\ell)\delta = 0$ if $PI\ell$ and $(P,\ell)\delta = 1$ otherwise. The function δ, containing as it does the incidence information for P, is related to the other forms for presenting that information: (1) If homogeneous coordinates are used for points and lines, then δ is similar to the matrix product of the point coordinates with the line coordinates. (2) The function δ is the characteristic function of the complement of $I \subseteq \pi \times \lambda$. (3) If the values of δ are arranged in an appropriate square, the result is the 1's complement of an incidence matrix for P. Let ℓ_0 be a line of P. An equation for ℓ_0 is $(X,\ell_0)\delta = 0$. Similarly an equation for point P_0 is $(P_0,x)\delta = 0$. Theorem: If P is a plane of prime power order p^n, then δ is induced by a polynomial function δ^* in two variables over the Galois field of order p^{3n}. Homogeneous coordinates in P(*A.M.S. Notices vol. 23, no. 4* #76T-D9) are used to determine the relationship between δ and δ^*. (Received February 10, 1977.)

*77T-D6 Paul Ehrlich, University of Missouri, Columbia, Mo. 65201. Stability subgroups for surfaces without conjugate points.

We note that the fact that all finite subgroups of SO(2) are cyclic implies

Theorem 1: Let M be a connected simply connected 2-manifold. Let G be a properly discontinuous group of isometries for M, i.e., for any two compact subsets of M, only finitely many G-translates of one set intersect the other. Then for any $p \in M$, the stability subgroup $G_p := \{g \in G;\ g(p) = p\}$ is trivial or finite cyclic,

Via Thm. 1, some results for Fuchsian groups generalize to properly discontinuous groups of isometries acting on Hadamard surfaces M. Call an isometry elliptic if it has a fixed point in M.

Cor. 2: Let M be a complete simply connected surface without conjugate points. If G is an abelian properly discontinuous group of orientation preserving elliptic isometries, then G is a finite cyclic group. (Received February 10, 1977.)

Logic and Foundations (02, 04)

77T-E24 ROGER MADDUX, University of California, Berkeley, California 94720
Relation algebras and neat embeddings of cylindric algebras. Prelim. report.

For notations see Henkin-Monk-Tarski, Cylindric Algebras Part I, North-Holland, 1971, and Chin-Tarski, Un. Calif. Publ. in Math. 1951, pp. 341ff. Theorem 4 below gives a negative solution to problem 2.12 of the first reference. Def: For $n < \omega$, $\mathfrak{A} \in W_n$ if $\mathfrak{A}$ is a subalgebra of a relation algebra $\mathfrak{B}$ and there is some $C \subseteq B$ such that $|C| = n$ and $1;x;1 = 1$, $x;1;x \leq 1'$, and $x;y \neq 0$ whenever $x \in C$ and $0 \neq y \in Sg^{(\mathfrak{B})}(A \cup (C \sim \{x\}))$. Th 1: For every n,

W_n is a variety, $W_{n+1} \subseteq W_n$ but $W_{n+1} \not\supseteq W_n$. Th 2: $\mathfrak{A} \in \bigcap_{n<\omega} W_n$ iff $\mathfrak{A}$ is representable (i.e. isomorphic to a proper relation algebra). Def: For every $\mathfrak{C} \in CA_3$, $\mathfrak{Ra}\,\mathfrak{C} = \langle Nr_2\mathfrak{C}, +, -, ;, ^{\smile}, d_{01}\rangle$ where $x;y = c_2(s_2^1 x \cdot s_2^0 y)$ and $x^{\smile} = s_1^2 s_0^1 s_2^0 x$ for all $x, y \in Nr_2\mathfrak{C}$. Th 3: For every $n < \omega$, $W_n = \mathfrak{Ra}^* SNr_3CA_{4+n}$. From theorems 1 and 2, plus the known fact that $CA_3 \not\subseteq SNr_3CA_4$, we derive Th 4: For all $n, k < \omega$ with $2 < n$, $SNr_nCA_{n+k} \not\subseteq SNr_nCA_{n+k+1}$. This theorem has the following implication for (non-monadic) first order predicate logic. Cor 5: For every n with $0 < n < \omega$, there is a sentence φ, formulated with at most 3 distinct variables, such that φ has some derivation from the usual axiom schemata of predicate logic which involves n distinct variables, and no such derivation involving fewer than n variables. It was previously known that corollary 5 holds for infinitely many numbers n (see Monk, J. Symb. Logic 34(1969), pp. 331-343 and Proc. A.M.S. 27(1971), pp. 353-358). (Received January 27, 1977.)

77T-E25 J. W. Berry, University of Manitoba, Winnipeg, Man. R3T 2N2, Canada, and University of Leicester, Leicester LE1 7RH, U.K. Representation of e-degrees. Preliminary report.

For A, B $\subseteq$ N we write A $\equiv_r$ B if A = B $\cap$ X for some recursive set X. We identify partial functions with their (one dimensional) graphs so that f = { j(x, y) : x $\in$ f & y = f(x) }.

Theorem: Let $\underline{d}$ be any e-degree of partial functions. Then $\exists g \in \underline{d}$ such that for every e-degree $\underline{d}_1 \le_e \underline{d}$ there is a partial function $f \in \underline{d}_1$ such that f $\le_r$ g.

Corollary: Let $\underline{d}_1 <_e \underline{d}_2$ be two e-degrees of partial functions. There exist partial functions $f \in \underline{d}_1$ and $g \in \underline{d}_2$ such that for any degree $\underline{d}$, $\underline{d}_1 \le_e \underline{d} \le_e \underline{d}_2 \Rightarrow$ there is a partial function $h \in \underline{d}$ such that f $\le_r$ h $\le_r$ g. [illegible] if we drop the restriction to single-valued sets. Thus all the e-degrees [illegible] formed by intersecting a [illegible].
(Received January 31, 1977.)

77T-E26 J. B. Remmel, University of California, San Diego, La Jolla, California 92093
On the lattice of r.e. superspaces of a r.e. space.

Let V_∞ be a recursively presented vector space over a recursive field F (see these Notices, April 1976, Abstract 723-E6). We let $\mathcal{L}(V_\infty)$ denote the lattice of r.e. subspaces of V_∞ under the operations of intersection and weak sum. If W is a subspace of V_∞, $\mathcal{L}(W,\uparrow)$ denotes the lattice of all r.e. subspaces of V_∞ such that $V \supseteq W$ under the operations of intersection and weak sum. We let $\mathcal{L}^*(V_\infty)$ and $\mathcal{L}^*(W,\uparrow)$ denote the lattices $\mathcal{L}(V_\infty)$ and $\mathcal{L}(W,\uparrow)$ mod finite dimensional subspaces respectively. The notion of an $\exists\forall\exists$-Boolean algebra is defined by Lachlan in Trans. Amer. Math. Soc., 130 (1968), pp. 1-37. Theorem. Let $\mathfrak{B}$ be an $\exists\forall\exists$-Boolean algebra, then there exists a r.e. subspace W of V_∞ such that $\mathcal{L}^*(W,\uparrow)$ is isomorphic to $\mathfrak{B}$. Corollary. There exists a r.e. presented space V over a recursive field F such that $\mathcal{L}^*(V)$ is isomorphic to $\mathfrak{B}$. The method of proof involves modifying the priority argument used by Lachlan to show that for any $\exists\forall\exists$-Boolean algebra $\mathfrak{B}$, there exists a hyper-hyper-simple set H such that the lattice of r.e. supersets of H mod finite sets is isomorphic to $\mathfrak{B}$.
(Received January 10, 1977.)

*77T-E27 PETR HÁJEK, Mathematical Institute, ČSAV, 115 67 Prague, Czechoslovakia. Another sequence of degrees of constructibility. Preliminary report.

If ω_1^L is countable then there is a sequence $\{d_n, n \in \omega\}$ of reals and a real d such that (i) the sequence of degrees of d_n is strictly increasing and the degree of d is its minimal upper bound, (ii) in L[d], each d_n is a Δ^1_3 real and the same holds for d. The proof is by iterating the forcing of Jensen and Johnsbraten. (Cf. Balcar and Hajek, A sequence of degrees of constructibility, these NOTICES, February 1977.)

In the preceding one may replace "ω_1^L is countable" by "$O^\#$ exists" and "in $L[d]$" by "in V". This is proved using a basis theorem which gives also the following: If $O^\#$ exists then there are Δ^1_3 Cohen, Solovay, Sacks reals; for each finite lattice L there is and initial segment of degrees isomorphic to L and consisting only of degrees of Δ^1_3 reals (Δ^1_3 Adamowicz reals); there are Δ^1_3 reals a, b whose degrees have no g. l. b.
(Received February 2, 1977.) (Author introduced by Dr. Petr Štěpánek).

77T-E28 Gerhard F. Kohlmayr, Mathmodel Consulting Bureau, Glastonbury, Connecticut 06033. Good news about topological fields.

Let R be the reals, C the complex number field, and Q the division ring of quaternions. A copy of Q is a bijective image of Q; copies of R and C are defined correspondingly. THEOREM I. A countably normed division algebra over C is a copy of C. This theorem strengthens Theorem 1 by R. Arens (Bull. Amer. Math. Soc. 52 (1947) 623-630) by eliminating the hypothesis of continuous inversion. A Frechet field over C is a field which is also a complete linear topological quasi-normed algebra over C. THEOREM II. A Frechet field over C is a copy of C. This theorem provides an affirmative answer to an open problem (7.9 Problem) stated by W. Zelazko (Rozprawy Matematycne, XLVII, Warzawa 1965, Metric generalizations of Banach algebras, p.26). THEOREM III. There exists a locally compact connected Hausdorff topological division ring which is not a copy of R, C, or Q. This theorem provides a counterexample to Satz I by L. Pontrjagin (Ann. of Math. II, 33 (1932) 163-174). THEOREM IV. There exists a Dedekind complete non-Archimedean ordered field which is not a copy of R. Therefore, the reals cannot be categorically defined in this manner.
(Received February 3, 1977.)

*77T-E29 Manuel Lerman and James Schmerl, University of Connecticut, Storrs, Connecticut 06268. Theories with Recursive Models. Preliminary report.

All theories considered here are consistent and deductively closed. For each $n < \omega$ let $\exists_n$ denote the class of first-order sentences in prenex normal form with $\leq n$ blocks of quantifiers and for which the first quantifier (if there is one) is existential. A structure $\mathfrak{R}$ is recursive if $Th((\mathfrak{R},a)_{a\in A}) \cap \exists_0$ is a recursive set of sentences. Theorem 1: Every $\Sigma^0_2(\Pi^0_2)$ extension of the theory of linear order has a recursive model. This result is best possible since Theorem 2: There is a Δ^0_3 extension of the theory of linear order which has no recursive model. These theorems replace Theorem 1 and Theorem 3 of abstract 76T-E10. Theorem 1 in that abstract is false. Similar theorems are obtained for the theory of trees at one level lower in the arithmetical hierarchy.
(Received February 8, 1977.)

*77T-E30 Dr. Zofia Adamowicz, Instytut Matematyczny P.A.N., Warsaw, Poland Constructible semilattices of degrees of constructibility.

Theorem. If M is a countable model of ZFC+V=L and $\mathcal{L}$ is an upper semilattice in M well-founded in M and every initial segment $[\eta]$ of $\mathcal{L}$ of the form

$$[\eta] = \{\xi \in |\mathcal{L}| : \xi \leq_{\mathcal{L}} \eta\}$$

is countable in M then there is a model N of ZF such that $M \subseteq N$ and the degrees of constructibility of sets of ordinals of N form an ordering isomorphic to $\mathcal{L}$ in N. Remark. The model N is obtained as a symmetric submodel of a generic extension of M. The construction is similar to that in Z. Adamowicz, "On finite lattices of degrees of constructibility", J. Symb. Logic, to appear. A new idea in the present paper is that of using symmetric forcing conditions. (Received February 15, 1977.) (Author introduced by Professor A. H. Lachlan).

Topology (22, 54, 55, 57, 58)

*77T-G46 Jonathan A. Hillman, Australian National University, Canberra. <u>High dimensional knot groups which are not 2-knot groups.</u>

Two arguments are given, one involving orientability and the other Milnor duality and free finite group actions on cohomology spheres, to show that there are high dimensional knot groups which are not the groups of knotted S^2's in S^4, thus answering a question of Fox (in "Some problems in knot theory", <u>Topology of 3-Manifolds</u>, Prentice-Hall, 1962). (Received November 22, 1976.) (Author introduced by Dr. N. F. Smythe).

77T-G47 C. E. Aull, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061. <u>Absolute C-embedding in P- and Z-spaces</u>.

The following are equivalent for a P-space (Tychonoff Z-space) X. (a) X is almost Lindelöf i.e. given 2 disjoint zero sets of X one is Lindelöf. (b) X is C-embedded in every P-space (Tychonoff Z-space) it is embedded in as a closed set. For the P-space case we have also (c) X is C-embedded in every P-space it is embedded in. In the above C-embedded may be replaced by C*-embedded or z-embedded the latter due to some results of Blair and Hager. P-spaces are defined in Gillman and Jerison. Z-spaces (first defined by Zenor) are spaces such that if F is closed and disjoint from a zero set Z then F and Z are completely separated. (Received January 28, 1977.)

77T-G48 MICHAEL P. FOURMAN, Clark University, Worcester, Massachusetts 01610 and Wolfson College, Oxford, G.B.
<u>A Representation for Internal Sober Spaces</u> (Preliminary report.)

We interpret in the topos Sh(X) of sheaves on a sober space X the <u>Definitions</u>. An <u>$\wedge\bigvee$ map</u> between cHa (complete, $\wedge$ over $\bigvee$-distributive lattices) preserves empty and pairwise $\wedge$ and all $\bigvee$. A cHa has <u>enough points</u> iff $\forall p, q \in H[\forall \wedge\bigvee\phi : H \to \Omega \quad \phi(p) = \phi(q) \to p=q]$. A <u>topological space</u> A (defined in terms of opens) is <u>sober</u> iff for every $\wedge\bigvee\phi:\mathcal{O}(A) \to \Omega$ there is a <u>unique</u> $a\varepsilon A$ such that $\forall U\varepsilon\mathcal{O}(A)\ (a\varepsilon U \leftrightarrow \phi(U) = \text{true})$.
<u>Theorem</u>. We have a commuting diagram of functors

$$\begin{array}{ccccc} \underline{Sob}(Sh(X)) & \asymp & \underline{Pts}(Sh(X)) \hookrightarrow & \underline{cHa}(Sh(X)) \simeq \Omega/\underline{cHa}(Sh(X)) \\ R \downarrow & & & \Gamma \downarrow \simeq \\ \underline{Sob}/X & \asymp & \mathcal{O}(X)/\underline{Pts} \hookrightarrow & \mathcal{O}(X)/\underline{cHa} \end{array}$$

Where $\asymp$ denotes a duality, Γ (induced by global sections) is an equivalence $\simeq$ and R (the representation) is full and faithful $\hookrightarrow$. If we write $\Pi_A : E_A \to X$ for R(A) then A is (naturally isomorphic to) the sheaf of sections of Π_A with the topology whose global opens correspond to V open in E_A as follows: $[a\varepsilon V^*] = a^{-1}(V)$.
<u>Example</u>. The Dedekind reals $\mathcal{R}$ in Sh(X) are represented by $\Pi : \mathbb{R}\times X \to X$.
<u>Corollary</u>. $\Gamma(U, \mathcal{C}(\mathcal{R}, \mathcal{R})) \cong \mathcal{C}(\mathbb{R}\times U, \mathbb{R})$
Further work relates properties of the representing map Π_A to internal properties of the space A, e.g. Π_A is separated iff A is "T_2": $\forall x,y,U[x\varepsilon U \to y\varepsilon U \vee \exists V,W(V\cap W=\phi \wedge x\varepsilon V \wedge y\varepsilon W)]$. (Received January 31, 1977.) (Author introudced by Professor J. F. Kennison).

77T-G49 Ludvik Janos, Mississippi State University, Mississippi State, Mississippi 39762. Fixed point property and even continuity.

If $f : X \to X$ is a map of a topological space X into itself we denote by A_f its core, i.e., $A_f = \cap\{f^n(X) : n \geq 1\}$ and we let F_f stand for the family of subsets of X containing A_f with the fixed point property, i.e., $F_f = \{Y : A_f \subset Y \subset X$ and Y has the fixed point property$\}$.
Theorem. Let $f : X \to X$ be a map of a compact Hausdorff space X into itself such that the family $\{f^n : n \geq 1\}$ is evenly continuous, and assume that the family F_f is nonempty. Then f has a fixed point. (Received January 31, 1977.)

*77T-G50 Bang-yen Chen, Michigan State University, East Lansing, Michigan 48824. Complex submanifolds in Hermitian symmetric spaces. Preliminary report.

Let M be a complete complex submanifold of a compact Hermitian symmetric space $\bar{M}$. Then the normal connection is flat if and only if $\bar{M} = M \times M'$ for some compact Hermitian symmetric space M'. (Received February 3, 1977.)

*77T-G51 William T. Eaton, Carl P. Pixley and Gerard A. Venema, The University of Texas at Austin, Austin, Texas 78712. A topological embedding which cannot be approximated by a piecewise linear embedding. Preliminary report.

There is a topological torus $T \approx S^1 \times S^1$ such that $T \subset S^4$ but for some $\varepsilon > 0$ there is no ε-small homeomorphism from T to a PL torus in S^4. Let M^4 denote the Matsumoto 4-manifold in S^4 which has no PL $S^1 \times S^1$-spine. [Bull. Amer. Math. Soc., 81(1975), 467-470.] The proof follows by observing that the C. Giffen construction [R.D. Edwards, these Notices, 24(1977), A-154] allows one to find a topological embedding of $S^1 \times S^1$ into M^4 which is a homotopy equivalence. (Received February 4, 1977.)

*77T-G52 Teodor C. Przymusiński, University of Pittsburgh, Pittsburgh, PA 15260 and Institute of Mathematics of the Polish Academy of Sciences, Warsaw, Poland. Products of perfectly normal spaces. Preliminary report.

The following theorem answers a problem raised by R. W. Heath whether there exists a space X such that X^2 is perfect but X^3 is not (Proc. Auburn Top. Conf. 1969).
THEOREM. (CH) For every $n = 1,2,\ldots$ there exists a first countable, separable, locally compact and locally countable space $X = X(n)$ such that:
(a) X^n is perfectly normal (and hereditarily separable)
(b) X^{n+1} is normal but X^{n+1} is not even hereditarily normal.
The space X^{n+1} can be made Lindelöf but then X can no longer be locally compact or locally countable. (Received February 11, 1977.)

77T-G53 Dix H. Pettey, University of Missouri, Columbia, Missouri 65201. Products of R-closed spaces. Preliminary report.

In [Trans. Amer. Math. Soc. 108 (1963), 97-105], M. P. Berri asked if the topological product of minimal regular spaces is necessarily minimal regular. In [Trans. Amer. Math. Soc. 124 (1966), 131-147], C. T. Scarborough and A. H. Stone asked an analogous question for R-closed spaces. In the present paper, an example is obtained which shows that both questions have negative answers (see Theorem 1, below). However, a reasonably mild additional condition is found to be sufficient to guarantee the product invariance of the R-closed and minimal regular properties (Theorems 2 and 3). THEOREM 1. There exists a countably compact, minimal regular space whose product with itself is not R-closed. A topological space X is said to be feebly sequentially compact iff every sequence of non-empty open sets in X has a subsequence with a nonempty limit inferior. (Most of the noncompact, R-closed spaces described in the literature are feebly sequentially compact.) THEOREM 2. If a space X is R-closed (minimal regular) and feebly sequentially compact, then for every R-closed (minimal regular) space Y, X × Y is R-closed (minimal regular). THEOREM 3. If $\{X_\alpha | \alpha \in A\}$ is a family of R-closed (minimal regular) spaces, each of which is feebly sequentially compact, then $\prod_{\alpha \in A} X_\alpha$ is R-closed (minimal regular). (Received February 14, 1977.)

*77T-G54 B. J. Pearson, University of Missouri-Kansas City, Kansas City, Mo. 64110. Composants of nonmetric solenoids.

Theorem. For each infinite cardinal λ there exists an indecomposable continuum X such that X is a topological group, X has λ composants, and each proper subcontinuum of X is a separable arc. The continuum X is obtained as an inverse limit space by extending the usual construction of the dyadic solenoid by inverse sequences to a construction by inverse systems. The inverse system is generated by a single space and a single bonding map. (Received February 14, 1977.)

77T-G55 Richard E. Heisey, Vanderbilt University, Nashville, Tennessee 37235. Factoring open subsets of R^∞ with control. Preliminary report.

Let R^∞ = dir lim R^n where R denotes the reals. Theorem. Let U be an open subset of R^∞ and let $\mathcal{U}$ be an open cover of U. Then there is a homeomorphism $h: U \times R^\infty \to U$ such that h is $\mathcal{U}$-close to the projection map. Combined with previous work of the author we obtain the following. Corollary. If U and V are open subsets of R^∞ then any homotopy equivalence $f: U \to V$ is homotopic to a homeomorphism $g: U \to V$. (Received February 14, 1977.)

*77T-G56 HUGH R. MORTON, University of Liverpool, L69 3BX, England. A criterion for a surface in $\mathbb{R}^3$ to be unknotted.

When a closed surface is embedded in $\mathbb{R}^3$ there is a close relation between height functions on it and its total curvature. In answer to a question raised by Langevin and Rosenberg [On curvature integrals and knots. Topology 15 (1976) pp.405-416] we have the following:

Theorem Let $M \subset \mathbb{R}^3$ be a closed surface of genus g, and suppose that some height function on M has $2g + 2$ or $2g + 4$ non-degenerate critical points. Then M is unknotted.

In fact M is unknotted if some height function on M has only one local maximum. The case of embeddings having two local maxima is discussed for a torus, where it can be knotted in at worst a 2-bridge knot, and for a double torus. (Received February 15, 1977.)

*77T-G57 D. R. READ, Lamar University, Beaumont, Texas 77710. Branchpoint covering theorems and n-pseudo-confluent mappings.

The class of n-pseudo-confluent mappings is introduced in this paper. These mappings fill a gap between weakly confluent and pseudo-confluent mappings of compacta. It is shown that for $n \geqq 3$ the following irreversible implications hold: every weakly confluent mapping is $(n+1)$-pseudo-confluent; every $(n+1)$-pseudo-confluent mapping is n-pseudo-confluent; and every n-pseudo-confluent mapping is pseudo-confluent. Weakly confluent mappings are then characterized as those mappings which are n-pseudo-confluent for each $n \geqq 2$. Eberhart, Fugate, and Gordh have shown that the weakly confluent image of a graph is a graph. In this paper the stronger result is shown that for $n \geqq 2$, the n-pseudo-confluent image of a graph is a graph. (Received February 15, 1977.)

742-02-10 REPRINTED KAN CHING NG, Mount Holyoke College, South Hadley, Mass. 01075. The Cantor-Bernstein theorem and related results in a relation-algebraic setting. Preliminary report.

See preceding abstract for notations. Following in part some suggestions of Tarski we show that various results of cardinal arithmetic can be extended, formulated and proved within the theory of RAT's. Let $\mathfrak{A}$ be a RAT with universe A, and let a, b $\in$ A. Call a and b strictly disjoint, [written a)(b], iff $Fd(a)\cdot Fd(b) = 0$, where $Fd(a)$, the field of a, is defined as $a;1 + a^{\smile};1$. We set $a \cong b$ iff there is $f \in A$, f bifunctional (i.e., $f;f^{\smile} + f^{\smile};f \leqslant 1'$), $f;b;f^{\smile} = a$ and $f^{\smile};1 = Fd(b)$. Such an f is called an isomorphism from a to b. We write $a \prec b$ iff $a \leqslant b$ and a)(b-a, and we write $a \ll b$ iff there is $a_1 \in A$ so that $a \cong a_1 \prec b$. Equivalence Theorem (Cantor-Bernstein): If $a \ll b$ and $b \ll a$, then $a \cong b$. In fact, an isomorphism h from a to b is determined by $h = f\cdot u + g^{\smile}\cdot(f;1 - u)$ where $u = (1' + (f;g)^{\smile\smile});(f;1 - g^{\smile};1)$, f is an isomorphism from a to a_1 and $a_1 \prec b$, and g is an isomorphism from b to b_1 and $b_1 \prec a$. Among the related results holding in all RAT's is the Mean-value Theorem: If $a \prec b \prec c$, $a' \prec c'$, $a \cong a'$, $c \cong c'$, then there is $b' \in A$ such that $a' \prec b' \prec c'$ and $b' \cong b$. Another related result true for all RAT's is the Interpolation Theorem: Let n, m be positive integers. If $a_i \ll b_j$, all $0 \leq i \leq n$, $0 \leq j \leq m$, then there is $c \in A$ such that $a_i \ll c \ll b_j$, all $0 \leq i \leq n$, $0 \leq j \leq m$.

(Received November 3, 1976.)

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Algebra and Theory of Numbers (05, 06, 08, 10, 12–18, 20)

*744-A1 M. F. Janowitz, University of Massachusetts, Amherst, MA 01002. Complemented congruences on complemented lattices.

Let Con(L) denote the lattice of congruence relations of the complemented lattice L. Theorem 1. A congruence relation θ has a complement in Con(L) iff there is a central element z of L such that θ is the minimal congruence generated by [0,z]. Theorem 2. A necessary and sufficient condition for Con(L) to be a Boolean algebra is that L be the direct product of a finite number of simple lattices. Theorem 3. Let L and its dual satisfy axioms (A) and (B) of Janowitz (On a paper by Iqbalunissa, Fund. Math. 78 (1973), 177-182). Then Con(L) is a Stone lattice iff the kernel of every congruence relation has a join in L. (Received January 13, 1977.)

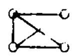
*744-A2 K. Bolling Farmer, University of Florida, Gainesville, Florida 32611. On faithful irreducible projective representations. Preliminary report.

A sufficient condition for a finite nilpotent group G to possess a faithful irreducible projective representation is that G have a central series such that each factor is of symmetric type (the direct sum of two isomorphic groups). An algorithm is given for constructing such a representation of degree $\sqrt{|G|}$. (Received February 10, 1977.)

*744-A3 Herbert S. Wilf, University of Pennsylvania, Philadelphia, PA 19174.
A note on graphical reconstruction.

If G and H are nonisomorphic graphs with the same deck of vertex-deleted subgraphs, then the cards in the deck are quite special: each such subgraph has either a triple eigenvalue, or a double eigenvalue whose space is orthogonal to (1,1,1,...,1). This follows from an application of classical perteubation theory to a result of Tutte. (Received February 11, 1977.)

744-A4 Carl Bumiller, St. John's University, Jamaica, New York 11439
Pointwise products of incidence matrices of subgraphs Preliminary report

It is well known that the spectrum of a subgraph is bounded by the spectrum of the larger graph. This condition can be improved by taking certain pointwise products of incidence matrices arising from the subgraph with matrices from the larger graph. The quality of the results is most transparent if the larger graph is rank 3. Some examples follow: Suppose the graph G is rank 3 with valence k, eigenvalues $-r < 0$ and $s > 0$. **Theorem** If G contains a clique with $1+k'$ points, then $k' \le k/r$. Theorem If G contains a regular subgraph with $1+k'+\ell'$ points and valence k', then $(k-rs)(\ell'+1+s) \ge r(s+1)(k'-s)$ and $(k-rs)(\ell'+1-r) \le s(r-1)(k'+r)$. Theorem If G contains a subgraph isomorphic to  , then $k^2(s+2) \ge 2krs+r^2(5s+1)$. (Received February 17, 1977.)

*744-A5 John G. Ratcliffe, University of Michigan, Ann Arbor, MI 48109. Crossed Extensions.

Let G be a group. A G-crossed module C with boundary ∂ gives rise to a central extension $0 \to A \to C \xrightarrow{\partial} N \to 1$ where $N \triangleleft G$ and A is a Q-module with $Q = G/N$. I have shown that these extensions, suitably classified by a congruence relation, are the elements of an abelian group $XEXT_G(N,A)$. Moreover, this group fits nicely into an exact sequence

$$H^2(Q,A) \to H^2(G,A) \to XEXT_G(N,A) \to H^3(Q,A) \to H^3(G,A) .$$

I have further shown that the XEXT term is involved in two other exact sequences. The first is a Universal Coefficient Theorem: $0 \to EXT_Q(H_1(N),A) \to XEXT_G(N,A) \to Hom_Q(H_2(N),A)$. The second is an exact sequence

$$0 \to H^1(Q,H^1(N,A)) \to XEXT_G(N,A) \to H^2(N,A)^Q \to H^2(Q,H^1(N,A)) ,$$

which involves the $E_2^{1,1}$, $E_2^{0,2}$, and $E_2^{2,1}$ terms of the Lyndon-Hochschild-Serre spectral sequence. (Received February 21, 1977.)

*744-A6 F. ALBERTO GRUNBAUM, Department of Mathematics, Univ. of California, Berkeley 94720. Inverse Eigenvalue Problem for Random Matrices.

For a discrete analog of the operator $-\nabla^2 + q$, q a random vector with mean vector $\bar{q}_i$, we show that the moments of the top eigenvalue suffice to determine the vector $\bar{q}_i$. This holds for a large class of distributions of $q - \bar{q}_i$ including Gaussian, discrete Bernoulli and uniform. (Received February 22, 1977.) (Author introduced by Professor Jacob Feldman).

744-A7 David Kazhdan, Harvard University, Cambridge, Massachusetts 02138
Representations of semisimple groups over finite fields.

The author describes representations of reductive groups over finite fields which are "in general positions", their characters and representations. (Received February 22, 1977.)

*744-B1 JOHN F. SCHMEELK, Virginia Commonwealth University, Richmond, Virginia 23284.
A Generalized Laplacian Operator.

The classical existence and uniqueness results for solution to differential equations in the milieu of generalized function theory are finite dimensional insofar as the solutions are continuous linear functionals on topological vector spaces of test functions that are C^∞ on the finite dimensional vector space R^n to R. (or C^n to C) Presented in this paper is one approach to the definition and application of a notion of an infinite dimensional test function i.e. test functions which are C^∞ on the space of tempered distributions to the field of real numbers. We then study a form of an infinite dimensional generalized Laplacian operator and a proof is given for the existence of solutions of initial value problems involving this generalized Laplacian Operator. (Received December 16, 1976.)

*744-B2 FREDERICK BLOOM, University of South Carolina, Columbia, South Carolina 29208. Stability and Growth Estimates for Electric Fields in Non-Conducting Material Dielectrics.

Employing results previously derived by the author for solutions of an abstract integro-differential equation in Hilbert space (Bull. A.M.S., Vol. 82, No. 4, July, 1976) we obtain stability and growth estimates for electric fields in non-conducting material dielectrics. It is assumed that a linear constitutive equation of Maxwell-Hopkinson type relates the electric field $\underset{\sim}{E}$ and the electric displacement field $\underset{\sim}{D}$ in the dielectric, viz,

$$\underset{\sim}{D}(t) = \epsilon \underset{\sim}{E}(t) + \int_0^t \phi(t-\tau)\underset{\sim}{E}(\tau)d\tau$$

where $\epsilon > 0$ and $\phi(t)$ is a nonnegative continuous monotonically decreasing function of t, $0 \le t < \infty$; specific results for a simple memory function ϕ of exponential type are given. (Received January 7, 1977.) (Author introduced by Dr. M. Slemrod).

744-B3 S. EISENBERG, University of Hartford, West Hartford, Connecticut, 06117.
Approximation by discrete Jackson-type operators. Preliminary report.

Jackson-type operators are defined by $L_{n,p}(f;x) = C(n,p)\int f(x+t)K(n,p,t)\,dt$ for $n,p = 1,2,\ldots,$ where $K(n,p,t) = \{\sin(nt/2)/\sin(t/2)\}^{2p}$, $C^{-1}(n,p) = \int K(n,p,t)\,dt$, and the integrals are evaluated on the interval $[-\pi,\pi]$. The approximation properties of these operators on the space of continuous 2π-periodic functions f were discussed by Schurer and Steutel (Mathematica, 9 (1967), 155-184). For $p=1$ the operators reduce to the Fejer operator and for $p=2$ they become the usual Jackson operators. The author discusses the discrete version of $L_{n,p}$ obtained by replacing the integral by a Riemann sum and shows that the easily calculable discrete version has essentially the same approximation properties as the integral version. (Received January 11, 1977.)

744-B4 George Piranian, University of Michigan, Ann Arbor, Michigan 48109, and Allen Weitsman, Mittag-Leffler Institute, Djursholm, Sweden. Nonrectifiable level sets. Preliminary report.

The question whether a bounded analytic function f in the unit disk can have a level set $S(K,f) = \{z: |f(z)| = K\}$ of infinite length has circulated for some years. We construct a bounded analytic function f such that $S(K,f)$ has infinite length for uncountably many values K. (Received January 27, 1977.)

744-B5 Karl F. Barth, Syracuse University, Syracuse, NY 13210. <u>Generalizations of Iversen's Theorem</u>.

Some generalizations of Iversen's Theorem will be discussed including an extension of a result of D. A. Brannan, W. K. Hayman, and the author. See these <u>Notices</u>, 24(1977), p. A-84.
(Received January 27, 1977.)

*744-B6 Boris Korenblum, Tel-Aviv University, Ramat-Aviv, Israel and The Institute for Advanced Study, Princeton, New Jersey 08540. <u>A Beurling-type theorem.</u>

A classical result of A. Beurling describing invariant subspaces of H^2 is extended to the topological algebra $A^{-\infty}$ of analytic functions in the unit disk U satisfying $|f(z)| \leq C_f(1 - |z|)^{-n_f}$. It is shown that every non-trivial closed ideal in $A^{-\infty}$ is uniquely determined by its zero set and by its so called κ-singular measure which is a Borel measure on a class of "thin" subsets of ∂U.
(Received January 20, 1977.)

744-B7 Howard A. Levine, University of Rhode Island, Kingston, Rhode Island 02881. Saddle points and instability of solutions of nonlinear partial differential equations: Some examples.

Consider the initial boundary value problem for the nonlinear parabolic equation $u_t = \Delta u+f(u)$ on $\Omega \times [0,T)$ with Dirichlet boundary conditions and given initial values $u(x,0) = u_0(x)$. If $f(u) = u^3$ then it is known that there are choices of u_0 for which the solution exists and is stable on $(0,\infty)$ and choices of u_0 for which the solution blows up in finite time, both cases occuring when the potential energy is less than the depth of the potential well. We give an example to show that the latter situation can occur for arbitrarily large values of the potential energy. A similar example can be found for $u_{tt} = \Delta u+f(u)$.

If $f(u) = -u^3$, then the solution exists globally for all (smooth) choices of u_0. We show that this is still the case if $f(u) = u^3 \sin u$ which oscillates between $\pm u^3$. This partially answers a conjecture of W. A. Strauss. (Received February 1, 1977.)

744-B8 Edward J. Conjura, Trenton State College, Trenton, New Jersey 08625. <u>Solvable extensions of operators of monotone type</u>. Preliminary report.

Let D be a dense linear subset of the reflexive Banach space X. If F is a not necessarily linear operator of D into Banach space Y, then various conditions are imposed on F in order to establish the existence of a solvable extension of F such that it is possible to describe the nature of the extended domain and the form of the extended operator. The results obtained subsume those of Browder and Petryshyn and are applied abstractly to potential operators along with concrete applications to ordinary and partial differential BVP's with both linear and nonlinear boundary conditions. (Received February 3, 1977.)

*744-B9 Jacob Burbea, University of Pittsburgh, Pittsburgh, Pa. 15260. <u>The Curvatures of the Analytic Capacity</u>.

Let $D \notin O_{AB}$ be a plane region and let c(z) be the analytic capacity of D at the point z. Suita (Kodai Math. Sem Rep. 25 (1973), 215-218) has shown that c(z) is real analytic and the curvature of the metric $c(z)|dz|$ is ≤ -4. Here we generalize the result of Suita in several directions. Specifically, we show that, for any point z in D, $c^{(n+1)^2} \leq (\prod_{k=1}^{n} k!)^{-2} \det||c_{j\bar{k}}||_{j,k=0}^{n}$, where $c = c(z)$ and $c_{j\bar{k}} = \frac{\partial^{j+k}}{\partial z^j \partial \bar{z}^k} c$. For n = 1, we obtain the result of Suita. Moreover, we show that the above inequality is strict if the Ahlfors function with respect to z has a zero in D other than z. (Received February 7, 1977.)

*744-B10 JAMES D'ARCHANGELO, U.S. Naval Academy, Annapolis, Md. 21402. On the Whittaker differential equation and Laplace transforms.

The author applies to Whittaker's equation, $W''_{km} + \{-1/4 + k/t - (m^2-1/4)/t^2\} W_{km} = 0$, recent results of Philip Hartman concerning the existence and uniqueness of solutions of ordinary differential equations with Laplace-Stieltjes transforms as coefficients. As a consequence, results of Meier and Erdelyi are obtained concerning integral representations for W_{km} and its product as Laplace-Stieltjes transforms of hypergeometric functions. Also a new result of W^2_{km} is derived. This work extends some previous results of the author. (Received February 10, 1977.)

*744-B11 H.T. BANKS, Division of Applied Mathematics, Brown University, Providence, Rhode Island 02912. Approximation methods for control of hereditary systems

We shall present results for the approximation of optimal controls for problems governed by systems of differential equations containing hereditary terms. Theoretical and numerical results for both linear and nonlinear systems will be discussed. The methods developed are based on the Trotter-Kato approximation ideas for semigroups which can be applied in the situations discussed to approximate infinite dimensional (hereditary system) optimal control problems by finite dimensional (ordinary differential equations) problems. (Received February 10, 1977.)

*744-B12 Thomas A. Metzger, University of Pittsburgh, Pittsburgh, Pennsylvania 15260. On vanishing Eichler periods and Carleson sets. Preliminary report.

Let Γ be a Fuchsian group acting on the unit disk D. Let $A_q^p(\Gamma)$ stand for the Bers' spaces of p integrable automorphic forms of weight q (q an integer, $q \geq 2$; $1 \leq p \leq \infty$). If h is the (2q-1) st integral of such an f, then h satisfies $(h\circ\gamma)(\gamma')^{1-q} = h + c(\gamma,f)$ for all γ in Γ and the polynomial $c(\gamma,f)$ of degree (2q-1) is called the Eichler period of f along γ. A Carleson set is a set of measure zero on D such that its complimentary intervals I_k satisfy $\sum_{n=1}^{\infty} \ell(I_n) \log 1/\ell(I_n) < \infty$. These sets are related to Fuchsians via

Theorem: Suppose f is in $A_q^p(\Gamma)$ and $c(\gamma,f) = 0$ for all γ in Γ. Then either $f \equiv 0$ or the limit set of Γ is a Carleson set. Also, a necessary and sufficient condition for the limit set of Γ to be a Carleson set is given which has

Corollary: If Γ is a finitely generated Fuchsian group of the second kind then its limit set is a Carleson set. (Received February 10, 1977.)

*744-B13 Richard J. Kramer, Pennsylvania State University, Media, Pennsylvania, 19063 Sub- and Super-Solutions of Quasilinear Elliptic Boundary Value Problems

Let Ω be a smooth bounded domain in $\mathbb{R}^n$. Consider the Dirichlet Problem div $A(x,u,Du) = a(x,u,Du)$ in Ω, $u = \phi$ on $\partial\Omega$. Assume $A(x,u,p)$, $a(x,u,p)$ satisfy Ladyzhenskaya-Uraltseva type growth conditions. Functions β,γ in $C^{2,\alpha}(\bar{\Omega})$ are respectively sub- and super-solutions of the BVP if div $A(x,\beta,D\beta) \geq a(x,\beta,D\beta)$ in Ω, $\phi(x) \geq \beta(x)$ on $\partial\Omega$ and div $A(x,\gamma,D\gamma) \leq a(x,\gamma,D\gamma)$ in Ω, $\phi(x) \leq \gamma(x)$ on $\partial\Omega$. We prove that if such β,γ exist with $\beta \leq \gamma$ on Ω then there exists a solution of the BVP.

This theorem uses and extends a related Theorem of Choquet-Bruhat and Leray (C.R. Acad. Sc. Paris, 274, Ser. A. (1972)). Our result promises to be easier to apply since the sub-

and super-solutions are required to satisfy weak inequalities rather than strict inequalities. This should be helpful since in most applications to BVP of the form $Lu = a(x,u)$ in Ω, $u = \phi$ on $\partial\Omega$ one can find sub- and super-solutions satisfying weak but not strict inequalities.
(Received February 14, 1977.)

744-B14 D.C. RUNG and S.A. OBAID, Pennsylvania State University, University Park, Pa. 16802 Interpolating sequences with applications to σ-porous exceptional sets. Preliminary report.

Theorem 1. Let $\{z_n\} = \{x_n + iy_n\}$ be a sequence in the upper-half plane H, where both $\{x_n\}$ and $\{y_n\}$ strictly decrease to zero, then $\{z_n\}$ is an interpolating sequence if and only if $\inf_n \rho(z_n, z_{n+1}) > 0$, where $\rho(z_n, z_{n+1})$ is the pseudo-hyperbolic distance on H.
Corollary. Let $\{w_n\} = \{x_n + iy_n\}$ be a sequence in the first quadrant of the unit disc Δ, where $\{x_n\}$ strictly increases to $\{1\}$ and $\{y_n\}$ strictly decreases to $\{1\}$, then $\{w_n\}$ is an interpolating sequence if and only if $\inf_n \lambda(w_n, w_{n+1}) > 0$, where $\lambda(w_n, w_{n+1})$ is the psuedo-hyperbolic distance on Δ.
Let $K = \{z: \mathrm{Im} z = 0\}$ and let $\xi \varepsilon K$. Let h be a real-valued continuous function on [-1,1], with (i) $h(0) = 0$, (ii) $h(x)=h(-x)$, (iii) $h(x_1) < h(x_2)$ whenever $0 \leq x_1 < x_2$. For $0<a<b$ define $RA(\xi,a,b,h) = \{z \varepsilon H: h(\frac{x-\xi}{b}) < \mathrm{Im} z < h(\frac{x-\xi}{a})\}$.

Theorem 2. For each σ-porous set $E \subset K$ and each function h there exists a bounded analytic function f on H with the property that for each $\xi \varepsilon E$ there exist $0<a<b$ and $0<a'<b'$ such that the cluster sets of f on $RA(\xi,a,b,h)$ and $RA(\xi,a',b',h)$ are not equal. (Received February 16, 1977.)

744-B15 V.V. RAO, University of Regina, Regina, Sask. S4S 0A2, Canada. Identities involving Fourier Coefficients of non-analytic automorphic forms.

In this paper we obtain some identities involving Fourier Coefficients of non-analytic automorphic forms of the type considered by H. Maass and occurring in the work of C.L. Siegel on indefinite quadratic forms with rational coefficients.
(Received February 16, 1977.)

744-B16 GERHARD F. KOHLMAYR, Mathmodel Consulting Bureau, Glastonbury, Connecticut 06033. Metric topological division algebras.
Let R be the reals, C the complex number field, and Q the division ring of quaternions. A copy of Q is a bijective image of Q; copies of R and C are defined correspondingly. A metric topological algebra is a Hausdorff topological algebra whose topology is determined by a metric; in such an algebra, subtraction, multiplication by scalars, and multiplication are continuous maps. A metric topological division algebra is a metric topological algebra which possesses a two-sided inverse x^{-1} for each nonzero element x in it. In a metric topological division algebra with continuous inversion, subtraction, multiplication by scalars, and division are continuous maps. THEOREM 1. A necessary and sufficient condition for a metric topological algebra X to be a metric topological division algebra with continuous inversion is that X be a division algebra. THEOREM 2. A metric topological division algebra over C is a copy of C. THEOREM 3. A metric topological division algebra over R is a copy of either R, C, or Q. (Received February 22, 1977.)

744-B17 Allan J. Fryant, U. S. Naval Academy, Annapolis, Maryland 21402. Interpolation and approximation of generalized axisymmetric potentials.

Using a function theoretic approach, we consider the uniform approximation of solutions of the generalized axisymmetric potential (GASP) equation

$$U_{xx} + U_{yy} + (\alpha/y)U_y = 0, \qquad \alpha > 0$$

by polynomial solutions of the equation. Results obtained include a Runge theorem in which it is shown that the GASPpolynomial approximants can be chosen so as to converge at a geometric rate, determination of the maximal degree of geometric convergence, construction of such approximants by GASP polynomial interpolation at the boundary, and introduction of GASP polynomials which enjoy the expansion properties associated with the classical Faber polynomials. The Dirichlet problem is also considered, and in the case of an ellipse a constructive solution is given by interpolation to the boundary values. (Received February 18, 1977.)

*744-B18 Yen Tzu Fu, Indiana State University-Evansville, Evansville, Indiana 47712. A complete normed space $C^n_{[a,b]}$. Preliminary report.

Let $C^n_{[a,b]}$ be the set of real functions on $[a,b]$ that are continuously differentiable up to nth order. Define $||f||_n = \sup_{1<k<n} \{ \sup_{x\varepsilon[a,b]} |f^{(k)}(x)| \}$ for each $f \varepsilon C^n_{[a,b]}$.

Theorem 1. $C^n_{[a,b]}$ with norm defined above is a complete normed space.

Theorem 2. Polynomials are dense in $C^n_{[a,b]}$.

Corollary 3. If f is a real function on $[a,b]$ with continuous derivatives $f^{(k)}$ $k=1,2,\cdots,n$; there exists a sequence of polynomials p_m such that

$$\lim_{m\to\infty} p_m(x) = f(x) \quad \text{and} \quad \lim_{m\to\infty} p_m^{(k)}(x) = f^{(k)}(x) \quad k=1,2,\cdots,n$$

uniformly on $[a,b]$. (Received February 18, 1977.)

*744-B19 T.K. PUTTASWAMY, Ball State University, Muncie, Indiana 47306
Asymptotic Solutions of a Certain Differential Equation.

This paper is devoted to the solution in the large of the differential equation

$$(1) \qquad \sum_{j=0}^{n} z^j (a_j + b_j z^m) \frac{d^j y}{dz^j} = 0 .$$

Here, m is a positive integer, the variable z is regarded as complex and the constants a_j, b_j (j= 0, 1, 2,...,n) are real or complex with $a_n \neq 0$, $b_n \neq 0$. If α_i(i= 1, 2,...,m) are the roots of $a_n + b_n z^m = 0$, then (1) will have regular singular points at $z = 0$, $z = \alpha_i$ (i= 1, 2,...,m) and $z = \infty$. The indicial equation about $z = 0$ is found to be

$$(2) \qquad a_o + \sum_{i=0}^{n-1} a_{n-1} \prod_{j=0}^{n-i-1} (h-j) = 0 .$$

It is also assumed that the roots h_i (i= 1, 2,...,n) of (2) are such that the difference of no two of them is congruent to zero module m. (Received February 18,1977.)

744-B20 CHARLES R. GIARDINA, Fairleigh Dickinson University, Teaneck, New Jersey Singer Company-Kearfott Division, Wayne, New Jersey 07470. On The Sampling Rate For Cardinal Series Representations.

Consider the class of functions S which are continuous and in L_1 with a derivative everywhere except at most a finite number of points such that the derivative is in L_1 and of bounded variation wherever defined. For any f in S values are obtained for the sampling rate w_c, $w_c > o$, bounding the "aliasing" error when using the Cardinal Series representation

$$g(t) = \sum_{n=-\infty}^{\infty} f\left(\frac{n\pi}{w_c}\right) \frac{\sin(w_c t - n\pi)}{w_c t - n\pi}$$

For any $\varepsilon > o$ if $w_c \geq \frac{2 \overset{\infty}{\underset{-\infty}{V}}(\dot f)}{\pi\varepsilon}$ then $||f-g||_\infty \leq \varepsilon$ where $\dot f$ is the derivative of f when this derivative exists and equals one half the "jump value" at those points where the derivative of f does not exist. Furthermore, the same result holds if

$$w_c \geq \frac{\overset{\infty}{\underset{-\infty}{V}}(\dot f)}{\pi\varepsilon} \text{ and } f\left(\frac{n\pi}{w_c}\right) \text{ is replaced by } h\left(\frac{n\pi}{w_c}\right) \text{ in the interpolation}$$

series where

$$h\left(\frac{n\pi}{w_c}\right) = \frac{1}{2\pi} \int_{-w_c}^{w_c} F(w)\, e^{\frac{jwn\pi}{w_c}} dw \text{ and F is the Fourier Transform of f.}$$

(Received February 18, 1977.)

744-B21 L. E. PAYNE, Cornell University, Ithaca, New York 14853. On improperly posed Cauchy problems for partial differential equations.

Let Ω be a bounded region in R_n whose boundary $\partial\Omega$ consists of two parts—an open $C^{2+\alpha}$ portion Σ and the complement $\partial\Omega - \Sigma$ which need not be smooth. We investigate the Cauchy problem for the quasilinear equation $Lu = F(x, u, Du)$ in Ω with Cauchy data prescribed in some approximate sense on Σ. Here Lu is in general a second order linear variable coefficient operator of arbitrary type and Du denotes an arbitrary first partial derivative of u. Our principle aim is the derivation of meaningful methods of stabilizing solutions of such improperly posed Cauchy problems under appropriate hypotheses on F. The problems and methods will be extended in various direction. (Received February 18, 1977.)

744-B22 William R. Melvin, University of Rhode Island, Kingston, Rhode Island 02881. Design of Bi-Focal Lenses. Preliminary report.

In the design of bi-focal lenses the following system of delay-differential equations arises (See R. L. Sternberg, "Successive Approximations...", Journal of Mathematics and Physics, Vol. 34 (1955) for a detailed discussion of the bi-focal lens problem)

$$(1)\quad \left.\begin{aligned} \frac{dy}{dx} &= C(x,x', y(x),z(x')) \\ \frac{dz}{dx} &= H(x,x'', y(x''),z(x)) \end{aligned}\right\} \; x > a \qquad \left.\begin{aligned} y(x) &= f(x) \\ z(x) &= g(x) \end{aligned}\right\} \; x \in [-a,a]$$

Where G and H are known functions and x' and x" can be determined by the known implicit relations $K(x,x', y(x),z(x')) = 0$ and $L(x,x'', y(x''),z(x)) = 0$. Existence and uniqueness of solutions to (1) are studied and some numerical approximations to solutions are presented. In addition the application of bi-focal lenses to solar collection devices is discussed. (Received February 21, 1977.)

*744-B23 Stanley L. Boylan, Touro College, 30 West 44th Street, New York, New York, 10036.-Abstract Wiener Spaces for non-Gaussian measures.

L. Gross has introduced the concept of an Abstract Wiener Space (B,H,i) where H is a Hilbert-Space, B the closure of H with respect to a measurable norm, and i the identity map on H, $i: H \to B$. The normal distribution on H induces a countably additive measure on B, which extends to a Borel measure which is called Abstract Wiener measure. We consider the question of whether continuous distributions on H other than the normal distribution similarly induce countably additive measures on B. We show that any measure on a Hilbert Space can be derived in such a manner and we derive necessary and sufficient conditions for the induced cylinder-set measure to be countably additive. (Received February 21, 1977.)

744-B24 MAURICE J. DUPRE, Tulane University, New Orleans, Louisiana 70118. The Classification of C-algebra bundles.

A C*-bundle (p,B,X) is a type of fibre space $p: B \to X$ such that each $p^{-1}(x)$ is a C*-algebra. However $p^{-1}(x)$ may vary in dimension as x varies in X, even when X is connected. We develop a "homotopy" type classification theory for C*-bundles having primarily finite dimensioal fibres. A C*(m,n)-bundle over the pair (X,A) is a C*-bundle (p,B,X) such that $p^{-1}(x) = L(\mathbb{C}^m)$ for $x \in A$ and $p^{-1}(x) \cong L(\mathbb{C}^n)$ otherwise. As a special case our theory shows that if X is a compact metric space, C*X the upper cone of the suspension SX, then the isomorphism classes of C*(m,n)-bundles over (SX,C*X) are one one-to-one correspondence with members of [X,C*U(m,n)], where C*U(m,n) is the compact manifold of injective *-homomorphisms $L(\mathbb{C}^m) \to L(\mathbb{C}^n)$. The lower homotopy of C*U(m,n) is calculated for illustration. The results are applicable to the classification of C*-algebras. (Received February 21, 1977.)

744-B25 Edward J. Moulis, Jr. United States Naval Academy, Annapolis, Maryland 21402. Generalizations of the Robertson functions. Preliminary report.

Let $P^k(\rho)$ denote the class of regular functions $p(z)$ in $E = \{z:|z|<1\}$ such that $p(0) = 1$ and $\int_0^{2\pi} \left|\frac{\mathrm{Re}\{e^{i\alpha}p(z)\} - \rho\cos\alpha}{1-\rho}\right| d\theta \leq k\pi\cos\alpha$, $k\geq 2$, $0\leq\rho<1$, α real, $|\alpha|<\pi/2$, $z = re^{i\theta}$, $0\leq r<1$. Let $V_\alpha^k(\rho)$ denote the class of functions $f(z)$ regular in E with $f(0) = f'(0) - 1 = 0$ and $1 + z f''(z)/f(z) \in P_\alpha^k(\rho)$, α, k and ρ as above. Functions in the class $V_\alpha^2(\rho)$ satisfy the inequality $\mathrm{Re}\{e^{i\alpha}[1+zf''(z)/f'(z)]\} > \rho\cos\alpha$, ρ, z and α as above. The subclasses $V_0^2(\rho)$ and $V_\alpha^2(0)$ were introduced by M. S. Robertson in 1936 and 1969, respectively, and the latter class, consisting of those functions $f(z)$ for which $z f'(z)$ is α- spirallike, has been called the class of Robertson functions. $V_0^k(0)$, $k\geq 2$, is the class of functions with bounded boundary rotation. We prove representation theorems for $V_\alpha^k(\rho)$ and use a criterion due to Ahlfors to show that $f(z)$ in $V_\alpha^k(\rho)$ is univalent whenever $0<(1-\rho)\,k\cos\alpha\leq 1$. This result improves ones previously published for the subclass $V_\alpha^k(0)$, $V_0^k(\rho)$ and $V_\alpha^2(\rho)$. (Received February 21, 1977.)

*744-B26 A. MANITIUS, Université de Montréal, Montreal, Canada. Controllability and observability of retarded functional differential equations - a C_0-semigroup approach.

Controllability and observability of linear retarded functional differential equations is investigated by using an abstract approach based on C_0-semigroup representation of retarded equations in the Hilbert space $R^n \times L^2$. Starting from the abstract equation $\dot{x} = Ax+Bu$, where A generates a C_0-semigroup in $R^n \times L^2$, it is shown that useful criteria for the approximate controllability in $R^n \times L^2$ expressed directly in terms of the original system matrices, can be obtained by this approach. The resolvent $R(\lambda,A)$ and certain results on entire functions play crucial role in this development. It is further shown that a certain bounded linear operator F defined on $R^n \times L^2$ and associated to the equation's right hand side plays a very important role in the relations between the semigroup generated by A and its adjoint. As a consequence, a property related to the operator F and called F-controllability, which is weaker than the approximate controllability in $R^n \times L^2$, guarantees a stabilizability with an arbitrary exponential decay rate; its dual concept of observability corresponds to the previously known concept of state trajectory observability. (Received February 22, 1977.) (Author introduced by Professor Marshall Slemrod).

*744-B27 Johannes C.C. Nitsche, University of Minnesota, Minneapolis, Minnesota 55455 The Higher Regularity of Liquid Edges in Aggregates of Minimal Surfaces.

Since the investigations of J.A.F. Plateau and E. Lamarle a century ago and clarifying work by J.E. Taylor (Ann. of Math. 103 (1976), 489-539) it is known that aggregates of surfaces of least total area can have two kinds of singularities: (i) Branch lines, or liquid edges, along which exactly three sheets meet under mutually equal angles of 120°. (ii) Vertices in which six surfaces and four liquid edges come together. Any pair of these edges includes the same angle $\alpha = 109{,}47^\circ$ ($\cos\alpha = -1/_3$). Taylor proved that the branch lines are regular curves of class $C^{1,\lambda}$ for some $\lambda \in (0,1)$. Here the following theorem is proved: "The branch lines are, with the possible exception of their endpoints (vertices and points on the boundary), regular curves of class C^∞. If one of the minimal surfaces meeting along the branch line is plane, then the branch line is analytic." The proof is based on a refinement of the methods developed by the author for the treatment of related problems (Inventiones math. 8 (1969), 313-333; 9 (1970), 270 and Ann. Scuola Norm. Sup. Pisa (4), 3 (1976), 139-155). (Received February 17, 1977.)

*744-B28 R.B. Ram, SUNY, Oneonta, N.Y. 13820 and R.A. Verma, University of Rhode Island, Kingston, R.I. 02881. On the instability of nonlinear vibrations of beams with various boundary conditions.

In this paper we consider the non-existence of global solutions of certain initial-boundary value problems involving a specific nonlinear partial differential equation governing the motion of a beam and various types of boundary conditions. (Received February 22,1977.)

744-B29 DENIS BLACKMORE, New Jersey Institute of Technology, Newark, N. J. 07102
On Local Normal Forms for Diffeomorphisms and Flows. Preliminary report.

Let $\dot{x} = F(x)$ be a C^r differential equation in R^n having $x = o$ as an isolated critical point, and let DF (0) be the derivative. If $r \geq 2$ Montgomery, using some ideas of Fenichel, proved that the system is (topologically) conjugate about the origin to the flow generated by a field $F_\# \times L$, where $F_\#$ is conjugate to F restricted to a center manifold and L is a linear map corresponding to the stable and unstable manifolds. We give a new proof of this result by first proving it for diffeomorphisms as in Hartman's proof for the nondegenerate case. This approach extends rather easily to the infinite dimensional case. A closer study of the method shows that the conjugacy can be selected so that it is C^r off the stable, unstable, and center manifolds. We then apply the results to find generalizations of theorems on normal forms obtained by Sternberg, Blackmore, and others. (Received February 22, 1977.)

Applied Mathematics
(65, 68, 70, 73, 76, 78, 80–83, 85, 86, 90, 92–94)

*744-C1 CHARLES R. GIARDINA, Fairleigh Dickinson University, Teaneck, New Jersey.
Singer Company, Kearfott Division, Wayne, New Jersey 07470.
FRANK P. KUHL, Singer Company, Kearfott Division, Wayne, New Jersey 07470.
The Vector of Maximum Harmonic Content With Elliptical Locus in Chebychev Approximations

Let D be the subset of n dimensional Euclidean Space with each tuple a real valued function periodic with period $T>o$, continuous everywhere and differentiable $[o,T]$ except possibly at a finite number of points with derivative of bounded variation where defined. For any x in D and $\varepsilon>o$ the vector of maximum harmonic content with elliptical locus is found. This vector when used in a linear combination with lower harmonically related vectors with elliptical loci affords a Chebychev approximation to x of degree ε. (Received February 9, 1977.)

*744-C2 L.E.KRIVOSHEIN,Kirgizian State University,Frunze,U.S.S.R.;K.V.LEUNG,CONCORDIA University, Montreal H3G 1M8,Canada;D.J.MANGERON,Polytechnic Institute of Jassy,Romania.At present:University of Alberta,Canada,and M.N.OGUZTORELI,University of Alberta,Edmonton T6G2G1,Canada.
Well posed problems concerning nonlinear integro-differential systems with hyperbolic operators and self-controlled limits of integration.

The authors prove the existence,unicity,stability,approximate solution determination,and the valuation of the committed errors theorems concerning the loaded nonlinear integro-differential system
(1) $M_2[u]=f[x,t,u(x,t),u(b,t),u(x,\gamma),\int_a^{r[x,u(x,\gamma)]} d\xi \int_\alpha^{s[t,u(b,t)]} K(x,t,\xi,\tau,u(\xi,\gamma),u(\xi,\tau),u(b,\tau))d\tau]$, where $M_2^{(n)}[u(x,t)] \equiv \partial^{2n} u(x,t)/\partial x^n \partial t^n$, $n=1,2,\ldots$, and $u(x,t)$ satisfies the following integro-differential boundary value conditions: $u(a,t)=\phi[t,\iint_D N(\xi,\tau,M_2^{\frac{1}{2}}[u])dD]$, $u(x,\alpha)=\psi[x,\iint_D P(\xi,\tau,M_2^{\frac{1}{2}}[u])dD]$ and $\phi[.]_{t=\alpha}=\psi[.]_{x=a}=q=\text{const}$. The lipschitzianity of the functions $f(x,t,\ell_1,\ell_2,\ell_3,\ell_4)$, $K(x,t,\xi,\tau,\ell_5,\ell_6,\ell_7)$, $N(\xi,\tau,\ell_9)$, $P(\xi,\tau,\ell_{11})$, $\phi(t,\ell_8)$, $\psi(x,\ell_{10})$, $r(x,\ell_3)$, $s(t,\ell_2)$ respect to ℓ_i, $i=\overline{1,11}$ with continuous and non negative L coefficients in their domain of definition and continuity $D_1=\{a\leq\xi,r(x,\ell_3),x\leq b,\alpha\leq\tau,s(t,\ell_2),t\leq\gamma,0\leq|\ell_i|\leq r_1=\text{const},i=\overline{1,11}\}$: $0<|\phi(t,\ell_8)|,|\psi(x,\ell_{10})|<r_1$, $\forall(x,t),\ell_8,\ell_{10}\in D_1$ is admitted,as well as continuous differentiability of these two last functions respect to t andx,respectively,with nonegative and continuous L coefficients of their derivatives.The authors'aim is achieved if $||\cdot||=\max_{D_1}|\cdot|$ and the nonlinear operators corresponding to the used integral eqs.method are supposed to satisfy certain constraints.Extensions are also discussed. (Received February 18, 1977.)

744-C3 David Brydges, Rockefeller University, New York, N.Y. 10021. An application of functional integration to the Coulomb gas. Debye screening. Preliminary report.

The Coulomb gas at equilibrium is described by a probability measure $d\mu_{\tau,\rho}$ on an infinite dimensional configuration space Ω. τ is the temperature, ρ is the density. The charge in a region $X \subset \mathbb{R}^3$ is a random variable ρ_X on Ω. A physical argument known as Debye screening suggests that the correlation $\int d\mu \rho_X \rho_Y$ has an exponential decay proportional to exp(-const. dist (X,Y)). Thus in contrast to the long range character of the Coulomb potential r^{-1}, Debye screening asserts that most of the mass of the measure is concentrated on a subset of Ω where the forces between distant particles are cancelled. This paper provides a rigorous proof that: Theorem. Debye screening in the above sense of exponential decay of $\int d\mu \rho_X \rho_Y$ holds for a restricted region of ρ, τ. (Received February 18, 1977.)

744-C4 RONALD J. STERN, Concordia University, Sir George Williams Campus, Montreal, Canada. On Infinite Dimensional Cores. Preliminary report.

We consider the control system $\dot{x} = Ax + Bu$ where the state and control spaces are Hilbert spaces. A and B are bounded Linear operators. An example is given which shows that in this setting, a closed linear space need not have a closed core. Necessary and sufficient conditions for a subspace to be a core are provided. The question of holdability in a subspace by means of linear feedback is discussed. (Received February 18, 1977.) (Author introduced by Professor Marshall Slemrod).

*744-C5 Thurlow A. Cook, University of Massachusetts, Amherst, Massachusetts 01003. Convergence of states on quantum logics. Preliminary report.

We prove the following generalization of the theorem of Nikodym, Hahn, Vitale and Saks: If (ω_k) is a sequence of countably additive probability states on a σ-ortho-complete, orthomodular poset L (a quantum logic) such that $\lim_k \omega_k(p) = \omega(p)$ for each $p \in L$, then ω is also a countably additive probability state on L and the sequence (ω_k) is uniformly countably additive. For the measure theoretic version of this theorem see Dunford and Schwartz, Part 1, p. 160. Our proof depends on a property of weakly convergent sequences in the Banach space ℓ_1 and does not use the Baire category theorem as in the previous reference. Finally, the classical result is a special case of this theorem. (Received February 18, 1977.)

*744-C6 N. KALOUPTSIDIS and D. L. ELLIOTT, Washington Univ., St. Louis, MO 63130 Stability Theory of Nonlinear Control Systems

We are given a collection D of dynamical systems on a metric space N. Each element $X \in D$ generates a group of homeomorphisms $G_X = \{X_t : t \in \mathbb{R}\}$. G is the smallest group containing all the G_X, $X \in D$. For each t, $G^t = \{X^1_{t_1}, \ldots, X^n_{t_n} : X^i \in D, \Sigma t_i = t\} \subset G$. A G^0-orbit $M = G^0(x)$ is N is, if G-invariant, the generalization of a controllability subspace for a linear system. Stability and asymptotic stability are defined for (closed) M in terms of the behavior of $G^t(y)$ for y near M, and for compact M give rise to Lyapunov functions constant on G^0-orbits, but not usually continuous. If M is replaced by $\{z \in N : zRx\}$ (R is the smallest closed equivalence relation containing G^0) continuous Lyapunov functions are obtained. (Received February 18, 1977.)

744-C7 HECTOR J. SUSSMANN, Rutgers University, New Brunswick, New Jersey 08903. Subanalytic sets and feedback controls. Preliminary report.

Consider a control system $\dot{x} = f(x,u)$, where the state x is a point in a connected real analytic manifold M, the control u belongs to a set S and, for each u, the vector field $x \longrightarrow f(x,u)$ is analytic. Assume that the system is completely controllable. Theorem: For every point x^0 in M there exists a piecewise analytic feedback control $x \longrightarrow u(x)$ that steers all of M to x^0. In the statement of the theorem, the expression "piecewise analytic" means that the control $x \longrightarrow u(x)$ is analytic on the open strata of a stratification A of M, and that the strata of positive codimension are partitioned into two kinds, as in Boltyanski's definition of regular synthesis. The proof of the theorem uses the theory of subanalytic sets. (Received February 21, 1977.)

744-C8 G. Arthur Mihram, Ph. D.; P. O. Box 234; Haverford, Pa. 19041. Why Are Computerised Simulations Not Mathematical Models? Preliminary report.

The distinction between mathematical models and computer-directed models, as introduced in SIMULATION: STATISTICAL FOUNDATIONS AND METHODOLOGY [1972 (1970)], is emphasised by noting that an explicit functional relationship between the computerised simulation's input and output variables is typically not available. A truly simular model consists of a set of algorithms, each of which describes an instantaneous decision, which in the real system being modelled would account for a change in one or more of its attributes. Thus the dynamics of socio-politico-economic and/or ecologico-environmental systems are capable of being more scientifically mimed by means of computerised simulations rather than computerised, truly mathematical models. The comments of John G. Kemeny [CYBERNETICS AND THE MANAGEMENT OF LARGE SYSTEMS] are thereby underscored in a discussion of both the operational description of the scientific method [cf. SYSTEMS THINKING AND THE QUALITY OF LIFE, 464-473 (1975)] and the contemporary concern that the pro-Zionist electrical engineer N. Wiener would claim to have coined "cybernetics" as "control and communication" and yet be unaware of the electrical scientist Ampère's (1834) proper coinage of "cybernétique" as "political science" (See Wiener's claim in a 1954 book of the particularly political title: HUMAN USE OF HUMAN BEINGS.). (Received February 22, 1977.)

*744-C9 VELIMIR JURDJEVIC, University of Toronto, Toronto, Canada, M5S 1A1. Controllability of Bilinear Systems. Abstract

In this report, I will study control systems of the form: (*) $\frac{dx}{dt} = (A + u(t)B)x$, where A and B are real $n \times n$ matrices, $x(t) \in \mathbb{R}^n/\{0\}$ and where the control $u(t)$ is a measurable function defined on $[0, \infty)$. I will show that for each $n > 1$, there is an open set of pairs of matrices (A, B) such that (*) is controllable. In addition, I will consider the case where A and B are both symmetric matrices. In such a case, there is evidence that (*) is never controllable. Finally, I will make a connection between stabilizability and controllability of bilinear systems. (Received February 22, 1977.)(Author introduced by Professor Marshall Slemrod).

Geometry (50, 52, 53)

*744-D1 Francine F. Abeles, Kean College of New Jersey, Union, New Jersey 07383, and Courant Institute of Mathematical Sciences, New York, New York 10012. Bounds on Simplicial Volumes. Preliminary report.

We show that if Q_n is a geometric n-simplex formed by passing a hyperplane through the barycenter of a geometric n-simplex V_n, dividing the edges of V_n in the ratio n, then the absolute volume ratio $|Q_n|/|V_n| = n^n/(n+1)^n$. Since $\lim_{n \to \infty} n^n/(n+1)^n = 1/e$, if $|S_n|$ is the volume of any n-simplex formed by passing a hyperplane through the barycenter of V_n, we have $1/e < |S_n| \leq \frac{1}{2}$.

We then extend this result to the more general notion of a centroid (the center of mass determined by the weights at the vertices of the simplex). If the edges of V_n are divided in the ratio k, k a positive real number, then $|Q_n|/|V_n| = k^n/(k+1)^n$ and $k^n/(k+1)^n \leq |S_n| \leq k/k+n$, for suitable simplices. (Received February 22, 1977.)

Logic and Foundations (02, 04)

744-E1 Steven Glazer, 263-08 79th Avenue, Floral Park, New York 11004. Some ultrafilter constructions using Martin's Axiom. Preliminary report.

We assume Martin's Axiom and ZFC throughout. Theorem 1 There exists an infinite retract of βN all of whose members are Q points and none of whose members are countable limits of P points. Theorem 2 Every ultrafilter over N has an immediate successor in the Rudin-Keisler order which is Rudin-Frolik minimal and is a Q point. Corollary 1 There are exp(exp(aleph null)) Q points over N that are not limits of countable families of P points. Corollary 2 There are exp(exp(aleph null)) Rudin-Frolik minimal Q points which are hereditary of Rudin-Keisler rank n for each natural number n. (Received February 22, 1977.)

744-E2 Howard L. Hiller, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 and Saharon Shelah, Hebrew University of Jerusalem, Jerusalem, Israel. Ext in L. Preliminary report.

We prove the following strengthening of Shelah's solution of Whitehead's problem in Gödel's constructible universe. Theorem 1: (V=L) If G is κ-free of size κ, but not free, then $\mathrm{Ext}(G,\mathbb{Z})$ contains an element of infinite order. Using an easy inductive technique, this yields: Theorem 2: (V=L) If $\mathrm{Ext}(G,\mathbb{Z})$ is torsion, divisible then G is free. (Indeed both statements in these theorems are actually independent of the usual axioms of set theory). As a topological consequence we obtain: Theorem 3: (V=L) There is no topological space X and integer $n \geq 2$ such that $H^n(X,\mathbb{Z})$ is a nontrivial torsion, divisible group. ($H^n(-,\mathbb{Z})$ denotes singular cohomology with integral coefficients). (Received February 22, 1977.)

Statistics and Probability (60, 62)

744-F1 Milton Rosenberg, 8400 Shore Front Parkway, Rockaway Beach, New York 11693. Infinite variate wide-sense stationary Markov processes.

In two papers, "Spectral Integrals, I, II" (J. Multivariate Anal. (1974) 4, 166-209; (1976) 6, [illegible]) the author developed properties of the spectral integral $\int_\Omega \Phi(\omega)E(d\omega)$ of a p×q operator-valued function Φ; $\int \Phi\, dE$ is a linear operator from $\mathcal{H}^q$ to $\mathcal{H}^p$ ($1 \leq p,q \leq \infty$) where $\mathcal{H}$ is a Hilbert space and $\mathcal{H}^q$ is the Hilbert space of square summable column vectors $f = (f^i)_{i=1}^q$, $f^i \in \mathcal{H}$. For $f \in \mathcal{H}^q$, $g \in \mathcal{H}^p$, we define the Gram matrix $\langle f,g\rangle = [(f^i,g^j)]$ (the matrix of scalar products of components). Our main theorem is: If $(f_t)_{t\geq 0} \subseteq \mathcal{H}^q$ is a continuous wide-sense stationary Markov Process, then the "correlation operators", $B_t = \Gamma_0^{1/2}\,{}^{\#}(\Gamma_0^{1/2}\,{}^{\#}\langle f_0,f_t\rangle)^*$ ($t \geq 0$) form a q×q strongly continuous contraction operator semigroup, i.e. $B_tB_s = B_{t+s}$ (where $\Gamma_0 = \langle f_0,f_0\rangle \equiv \langle f_t,f_t\rangle$ and $^\#$ denotes "generalized inverse"). □ A semigroup exponential formula holds for B_t. Moreover, (1) $\Gamma_t = \langle f_t,f_0\rangle = \Gamma_0^{1/2}B_t\Gamma_0^{1/2}$ for $t > 0$ and (2) on defining the "transition operators" $A_t = \Gamma_0^{1/2}B_t\Gamma_0^{1/2\,\#}$ ($t \geq 0$), the projection $(f_t|\mathcal{M}_s^q(f)) = A_{t-s}{}^{v}f_s$ for $t > s$.
(Received February 7, 1977.)

*744-F2 WERNER KOHLER, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061. Multiple Scales Analysis of a Randomly-Perturbed One-Dimensional Wave Equation. Preliminary report.

The following initial value problem is considered: $\partial_{xx}^2 u - c^{-2}\partial_t([1+\epsilon\kappa(x,t,\omega)]\partial_t u) = 0$, $-\infty < x < \infty$, $t > 0$ with u and $\partial_t u$ specified at $t = 0$ and κ a zero-mean, wide sense stationary random field. The stochastic perturbation theory of Papanicolaou and Keller (SIAM J. Appl. Math. 21 (1971), 287-305) is applied directly in the space-time regime to derive transport equations for the first moment and offset second moment (mutual coherence function) of the solution. These equations are solved in a special case. (Received February 16, 1977.)

*744-F3 Millu Rosenblatt-Roth, State University of New York at Buffalo, Amherst N.Y. 14226. Entropy of a random field.

The purpose of this paper is to introduce various basic information-theoretic concepts related to a random field (entropy, differential entropy, entropy stability, a.s.c.), and to give necessary and sufficient conditions for their existence.
Some properties are studied and particular cases presented. (Received February 21, 1977.)

Topology (22, 54, 55, 57, 58)

*744-G1 DAVID A. SCHEDLER, Virginia Commonwealth Univ., Richmond, Virginia 23284. A Note on the Fréchet Topology.

If (X,T) is a topological space, we say that T is a Fréchet topology iff T is such a topology that the set of limits of convergent sequences in A is closed whenever $A \subset X$. DEFINITION T is a subsequential topology iff T is such a topology that for every $p \in X$ and sequence x of points in X, if x clusters to p, then there is a subsequence of x which converges to p. We show that every Frechet topology is subsequential and use this fact to establish the equivalence of several classes of spaces among the class of Frechet spaces. (Received February 14, 1977.)

*744-G2 OKAN GUREL, IBM CORPORATION, 1133 Westchester Avenue, White Plains, New York 10604 Decomposed Partial Peeling

A dynamical system considered is (X_p, M^n) where X_p is a vector field of class C^k, $k \geq 3$, continuously depending on a set of parameters $p=(p_1,\ldots,p_m)$ and M^n is an n-dimensional Riemanian manifold of class C^∞. Based on the definitions given by Poincaré [O. Gurel, Notices Amer. Math. Soc. 23(1976)A387], p splits into parameters relevant to bifurcation (peeling) and those playing no role in this phenomenon. A new type of partial peeling [O. Gurel, In: Dynamical Systems, Vol.II (1976) p.255] is defined and observed as the decomposed partial peeling in which the generating singular point $M_0 \in M^n$ decomposes into multi singular points with partial stability alterations. An example in M^3 is given as illustration: $\dot{x}_1=-(x_2+x_3)$, $\dot{x}_2=x_1+p_1x_2$, $\dot{x}_3=p_2+x_3(x_1-p_3)$. It is shown that decomposed partial peeling may even lead to oscillating stable attractors of considerable practical interest. (Received February 16, 1977.)

*744-G3 Eric John Braude, Behrend College, The Pennsylvania State University, Erie, Pa., 16510. Rings of Cocontinuous Functions on a Lattice, Preliminary Report.

Let $R_1 = (\{(-\infty,b] : b \in R\} \cup \{[a,\infty) : a \in R\} \cup \{\{r\} : r \in R\}, \subseteq)$. Definitions. Let X be a complete lattice. 1. By C(X) we shall denote the set of all cocontinuous maps [These notices 23(1976),A-180] from R_1 to X satisfying (i) for every a in R, $F(-\infty,a] = \bigvee\{F(x) : x \leq a\}$ and $F[a,\infty) = \bigvee\{F(y) : y \geq a\}$, and (ii) $1_X = \bigvee\{F(\{z\})\ z \in R\}$. 2. For F, G : $R \to X$, we define F + G and $F \cdot G$: exp $R \to X$ by $(F+G)(T) = \bigvee\{F(u) \wedge G(v) : u+v \in T\}$, and $(F \cdot G)(T) = \bigvee\{F(u) \wedge G(v) : uv \in T\}$. 3. For F : $R_1 \to X$, let $B(F)=\{|r| : F(r) \neq 0\}$. Let $C^*(X) = \{F \in C(X) : B(F) \neq \emptyset\}$. For $F \in C^*(X)$, $\|F\|$ means sup B(F). 4. For $k \in R$, $\underset{\sim}{k} \in C^*(X)$ is defined by "$\underset{\sim}{k}(S) = 0_X$ for $k \notin S$; and $k(S) = 1_X$ for $k \in S$". 5. A subset P of X will be called saturated if, for every atom a with $a \leq P$, we have $a \leq p$ for some $p \in P$. 6. A T-distributive lattice is a complete lattice X in which every finite subset is saturated, and which satisfies $b \wedge (\bigvee P) = \bigvee\{b \wedge p : p \in P\}$ for every $b \in X$ and every saturated $P \subsetneq X$ (so X is distributive).
Proposition 2. For every T-distributive lattice X, (C(X), + , $\cdot$) is a commutative ring with identity when scalar multiplication is defined by $kF = \underset{\sim}{k}F$ for $k \in R$ and $F \in C(X)$. The function $\|\ \|$ is a norm on $C^*(X)$. If X is the lattice of closed sets of a T_1 topological space T_X, then X is T-distributive and the map $f \to f^{-1}$ is an isomorphism of $C(T_X)$ onto $C(X)$, and an isometric isomorphism of $C^*(T_X)$ onto $C^*(X)$. (A generalization for noncomplete nondistributive semilattices has actually been obtained.) (Received February 17, 1977.)

744-G4 Joseph Neisendorfer, Syracuse University, Syracuse, New York 13210. Self equivalences of rational homotopy types. Preliminary report.

If X is a nilpotent space with finite dimensional rational homology, let Aut(X) denote the group of homotopy classes of homotopy self equivalences of X. Let $Aut_0(X)$ be the kernel of the natural map from Aut(X) to Aut(H(X;Q)). Then Sullivan has shown that $Aut_0(X)$ is commensurable to an arithmetic subgroup of the unipotent algebraic group $Aut_0(X \otimes Q)$. If X is formal in Sullivan's sense, then there is a differential on the graded rational vector sapce V = Hom(H(X;Q), kernel $\pi(X;Q) \to H(X;Q)$) such that H_0V maps surjectively onto the underlying vector space of the Lie algebra of $Aut_0(X \otimes Q)$. This differential is often computable in terms of Whitehead products and cup products. Using these techniques, we can prove theorems like: If V is a projective algebraic variety which is a complete intersection of complex dimension ≥ 2, then $Aut_0(V)$ is finite. (Received February 18, 1977.)

*744-G5 EDWIN E. MOISE, Queens College (CUNY), Flushing, New York 11367. Statically tame periodic homeomorphisms of 3-manifolds.

Let M be a compact connected 3-manifold, and let f be a homeomorphism $M \to M$, of period n. For each i, let F_i be the fixed-point set of f^i. If each set F_i is tame, then f is statically tame. If f is simplicial, relative to some triangulation of M, then f is tame. Conjecture (C). If f is statically tame, then f is tame. Following are some partial results. Theorem 1. If n is odd, then (C) holds. Theorem 2. If M is orientable, and f preserves orientation, then (C) holds. Suppose that n is even. Let M' be the orbit space of f^2, and let Pr be the projection of M onto M'. Theorem 3. M' is locally Euclidean. Evidently f induces an involution f', of M' onto M', with $f'(\{P_i\}) = \{f(P_i)\}$. Theorem 4. If no fixed point of f' is isolated in the union of the sets PrF_i, then (C) holds. (Received February 22, 1977.)

745TH MEETING | Northwestern University, Evanston, Illinois, April 15–16, 1977

Algebra and Theory of Numbers (05, 06, 08, 10, 12–18, 20)

745-A1 W. V. Vasconcelos, Rutgers University, New Brunswick, New Jersey 08903. Generating modules extravagantly. Preliminary report.

Let A be a commutative ring of Krull dimension d and let E be a finitely generated module locally generated by n elements. Then E can be globally generated by n(n+1)(d+2)/2 elements. When the prime spectrum of A is Noetherian, Forster's bound, d + n, is much sharper; it is even valid for broader classes of low-dimensional rings. This is joint work with R. Wiegand.
(Received January 24, 1977.)

745-A2 E.D. DAVIS, SUNYA, Albany N.Y. 12222 and S.MCADAM, University of Texas, Austin, Texas 78712. Prime divisors and saturated chains.

We employ a generalization of the notion of "prime divisors in function fields" to investigate certain phenomena concerning saturated chains of primes in noetherian domains. The principal tool of this study is E.G. Evans' formulation of Zariski's Main Theorem on Birational Correspondences. Among the corollaries of these considerations we obtain a unified (and somewhat simplified) treatment of the equivalence of certain formulations, developed by L.J. Ratliff Jr., of "R satisfies the altitude formula." (Received January 31, 1977.)

745-A3 JON L. JOHNSON, The Citadel, Charleston, S.C. 29409. Modules Injective with respect to primes, Preliminary report.

Let R be a Noetherian Integral domain. Let $\mathcal{P} \subseteq \mathrm{Spec}(R)$ and $\mathcal{Y}$ be the ideals in R closed under multiplication which are generated by $\mathcal{P}$. We say that an R-module M is $\mathcal{P}$-injective if for each $P \in \mathcal{P}$ and R-homomorphism $f: P \to M$, there exists an R-homomorphism $\Theta: R \to M$ so that $\Theta|_P = f$. A $\mathcal{P}$-injective envelope is also defined with notation $E_{\mathcal{P}}(M)$. The following results are obtained:

(1) $E_{\mathcal{P}}(R)$ is the generalized transform of R at $\mathcal{Y}$. (written $R_{\mathcal{Y}}$)

(2) The smallest torsion theory $(\underline{A},\underline{B})$ with $R_{\mathcal{Y}}/R$ torsion must have q.f.(R)/ $R_{\mathcal{Y}}$ torsion free.

(3) If E is $\mathcal{P}$-injective then a sufficient condition for $0 \to N \to M$, $N \to E$ to have an extension $\Theta: M \to E$ is that M/N is torsion ($M/N \in \underline{A}$).

(4) If R is a Noetherian commutative ring, $\mathcal{P} = \mathrm{Spec}(R)$, and $M = E_{\mathcal{P}}(M)$, then M is injective. (Proof due to Enochs). (Received February 7, 1977.)

*745-A4 ROGER WIEGAND AND SYLVIA WIEGAND, University of Nebraska, Lincoln, Nebraska 68588. Commutative Rings all of whose finitely generated modules are direct sums of cyclics.

The rings of the title are characterized as finite direct products of rings R satisfying these conditions: (1) R has a unique minimal prime p; (2) Every finitely generated ideal of R is principal; (3) R_q is an almost maximal valuation ring for every prime ideal q; (4) Each non-minimal prime ideal is contained in a unique maximal ideal; (5) Every element outside p is in only finitely many maximal ideals; and (6) The ideals contained in p are totally ordered by inclusion. The proof depends heavily on earlier work by Brandal, Gill, Hindman, Kaplansky, Matlis, Pierce, W. Rudin, Vamos, and the authors. (Received February 9, 1977.)

745-A5 DAVID L. SHANNON, University of Kentucky, Lexington, Kentucky 40506. Invariants of inertial K-automorphisms of $K[X,Y]$ and $K[[X,Y]]$. Preliminary report.

Let K be an algebraically closed field of characteristic zero. A K-automorphism σ of $K[X,Y]$ is called inertial if $\sigma(x) - x, \sigma(y) - y \in (x,y)^2K[X,Y]$. We first characterize those inertial automorphisms of $K[X,Y]$ which have non-trivial invariants. THEOREM. Let σ be an inertial K-automorphism of $K[X,Y]$. Then $K[X,Y]^{\sigma} \neq K$ if and only if σ is conjugate to a K-automorphism τ of the type $\tau(x) = x$, $\tau(y) = y + g(x)$ where $g(x) \in K[X]$. In the context of this result we discuss an old result of G. Birkhoff which characterizes the inertial automorphisms of $K[[X,Y]]$ having non-trivial invariants. In particular, this result has as application that all inertial K-automorphisms of $K[X,Y]$, canonically considered as K-automorphisms of $K[[X,Y]]$, have non-trivial invariants in $K[[X,Y]]$. (Received February 8, 1977.)

745-A6 MELVIN HOCHSTER, University of Michigan, Ann Arbor, Michigan 48109. Canonical elements in local cohomology modules. Preliminary report.

Let (R,m,K) be a local ring, dim R = d, and let (#) $0 \to S \to F_{d-1} \to \dots \to F_0 \to K \to 0$ be an exact sequence such that F_i is free of finite rank, $0 \le i \le d-1$, i.e. S is a d^{th} module of syzygies of K. Then (#) represents an element of $\mathrm{Ext}_R^d(K,S)$ (Yoneda definition of Ext) and hence maps to an element $\eta \in H_m^d(S)$ (H_m^* denotes local cohomology). Conjecture: $\eta \neq 0$. The talk will deal with this conjecture, which is true if R has a big Cohen-Macaulay module (hence if

R_{red} contains a field or dim $R \leq 2$), and which seems to have "all" the same consequences as the existence of big Cohen-Macaulay modules (old and new intersection conjectures, regular rings are direct summands of module-finite extension algebras, etc.). The functorial behavior of η, which seems to be "canonical" (although S is not), will also be discussed. (Received February 8, 1977.)

*745-A7 DAVID WRIGHT, Washington University, St. Louis, Missouri 63130. Cancellation of certain variables. Preliminary report.

Whether or not the situation $A[T] \simeq_k k[X,Y,Z]$ implies $A \simeq_k k[U,V]$, for a k a field, is the simplest unknown case of the polynomial cancellation problem. Russell and Sathaye have answered the question affirmatively for the case $X = bT - a$, $a,b \in A$, and I have recently extended this to the case $X = bT^n - a$. The proof involves looking at the A-endomorphism of $B = A[T]/XA[T]$ sending t to $\sqrt[n]{1}\, t$, where t is the image of T in B. B is a polynomial ring in two variables, and A is birationally contained in the fixed ring of this automorphism. Russell and Sathaye have kindly pointed out that, in fact, one need only assume that $X \in A[T^n]$, $n > 1$. They also raised interesting questions about the fixed ring of a finite group G acting on $B = k[X,Y]$. If G is a cyclic group acting on $B = k[X,Y]$, with $B = B^G[t]$, then B^G is a polynomial ring in two variables over k. (Received February 9, 1977.)

745-A8 MICHAEL R. STEIN, Northwestern University, Evanston, Illinois 60201. Whitehead groups of finite groups.

• Let R be an associative ring with 1. Recall that $K_1(R)$ is the abelianization of the infinite general linear group $GL(R) = \cup_{n\geq 1} GL_n(R)$. The units, R^*, of R give rise to elements of $K_1(R)$ under the composite homomorphism $\phi : R^* \to GL_1(R) \to GL(R) \to K_1(R)$. If R is commutative, the usual determinant $GL_n(R) \to R^*$ induces a similarly named epimorphism $\det : K_1(R) \to R^*$ which is split by ϕ. We write $SK_1(R) = \ker(\det)$; $SK_1(R)$ is the abelianization of $\cup_{n\geq 1} SL_n(R)$. If $R = \mathbb{Z}G$, the integral group ring of a not necessarily abelian group G, we may extend the definition of SK_1 by setting $SK_1(\mathbb{Z}G) = \ker(K_1(\mathbb{Z}G) \to K_1(\mathbb{Q}G))$. The Whitehead group, Wh(G), of a group G is $K_1(\mathbb{Z}G)/H$, where H is generated by the images of all $\pm h$, $h \in G$. It is a theorem of C.T.C. Wall that when G is finite, $SK_1(\mathbb{Z}G)$ is precisely the torsion subgroup of Wh(G). The study of Wh(G) arose in topology from the work of J.H.C. Whitehead, who defined the torsion of a homotopy equivalence between finite CW-complexes X and Y as a certain element of $Wh(\pi_1 Y)$. Whitehead torsion has proved to be a key tool in the study of manifolds with nontrivial fundamental groups. One of the signal successes of algebraic K-theory has been in the computation of the previously intractable Whitehead groups of finite groups. This talk will survey the main techniques and results of these computations, with particular focus on finite abelian groups. (Received February 14, 1977.)

745-A9 ELOISE A. HAMANN, North Central College, Naperville, Illinois 60540. On Cancellation. Preliminary Report.

The talk will discuss counterexamples and other matters related to the following question. Let R and S be commutative rings with identity, X and Y indeterminates over R and S respectively, then if $R[X] = S[Y]$ or if $R[[X]] = S[[Y]]$ when can one say that $R \cong S$? (Received February 14, 1977.)

745-A10 E. Graham Evans, Jr. and Philip A. Griffith, University of Illinois, Urbana, Illinois 61801. The Syzygy Problem.

Let R be a regular local ring. The syzygy problem is to determine if every nonfree i-th syzygy has rank at least i. A recent theorem of Bruns (J. of Alg. 1976) shows that if M is an i-th syzygy of rank greater than i then there exists a free submodule $F \subset M$ with M/F an i-th syzygy of rank equal to i. On the other hand a module of rank one can only be a first syzygy, and an i-th syzygy of projective dimension one must have rank at least i. The syzygy problem also has connections with questions about vector bundles, cohen-macaulay rings, and three gererator ideals. (Received February 14, 1977.)

745-A11 PAUL EAKIN and DAVID SHANNON, University of Kentucky, Lexington, Kentucky, 40506 and WILLIAM HEINZER, Purdue University W. Lafayette, Indiana 47907. Ideal transforms of Noetherian integral domains. Preliminary report.

Let R be an integral domain with quotient field K. For an ideal I of R the set $T = \{x \in K \mid xI^n \subseteq R$ for some positive integer $n\}$ is a subring of K called the I-transform of R. For R a Noetherian domain we consider the following questions:

1. When is T finitely generated as a ring extension of R?
2. When is T Noetherian?

It was shown by Nagata that question (1) has relevance to the 14th problem of Hilbert. Of course, (1) implies (2). It is not always true that (2) implies (1) even for R a two-dimensional Noetherian domain. We consider some additional conditions that are sufficient in order that (2) implies (1). (Received February 15, 1977.)

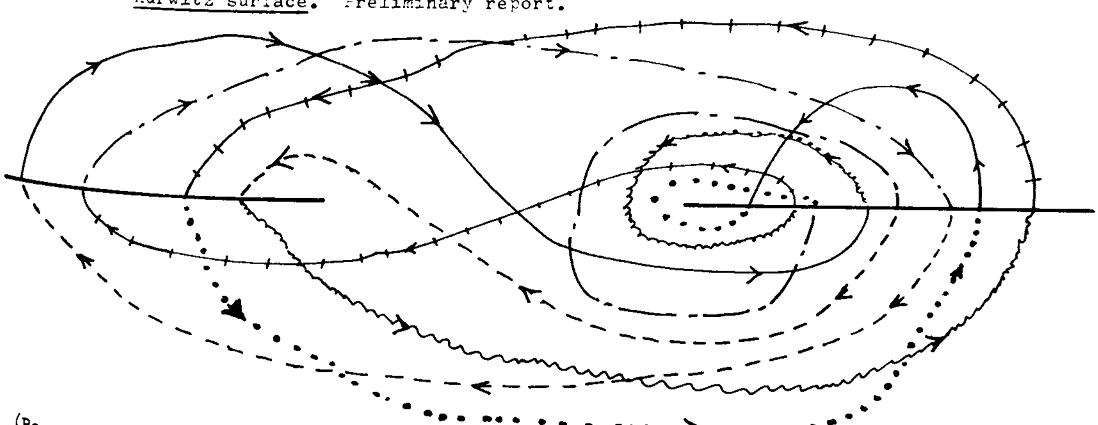
*745-A12 Jerrold W. Grossman, Oakland University, Rochester, Michigan 48063. On Groups with Specified Lower Central Series Quotients.

Let $\Gamma_s G$ denote the normal subgroup of a group G generated by all s-fold commutators, $s \geq 1$. The tower $\cdots \to G/\Gamma_{s+1}G \to G/\Gamma_s G \to \cdots \to G/\Gamma_2 G \to 1$, the "nilpotent completion of G", has the property that $1 \to \Gamma_s(G/\Gamma_{s+1}G) \to G/\Gamma_{s+1}G \to G/\Gamma_s G \to 1$ is exact for each s. CONJECTURE: A tower of groups $\cdots \to G_{s+1} \to G_s \to \cdots \to G_2 \to 1$ such that $1 \to \Gamma_s G_{s+1} \to G_{s+1} \to G_s \to 1$ is exact for each s is the nilpotent completion of some group (called a "decompletion" of the tower). We prove the conjecture in the case in which G_2 is finitely generated and (using homological methods) in the case in which G_2 is free abelian. In these cases, unless the tower stabilizes, there are always many residually nilpotent decompletions; for example, it is consistent with set theory to assume the existence of an arbitrarily large cardinality of parafree groups (residually nilpotent decompletions of the completion of a free group). We also formulate these results in terms of pro-groups. (Received February 16, 1977.)

745-A13 EBEN MATLIS, Northwestern University, Evanston, Illinois 60201. Higher Properties of R-sequences.

Let $x_1,\dots,x_n$ be an R-sequence over a commutative ring R, $I_t = (x_1^t, \dots, x_n^t)$, where $I_1 = I$; and let $K = \varinjlim R/I_t$. A module C is defined to be K torsion-free if $\mathrm{Tor}_i^R(K,C) = 0$ for $i > 0$ and K-divisible if $\mathrm{Ext}_R^i(K,C) = 0$ for $i > 0$. We prove that if C is I-complete (i.e. $C \cong \Lambda(C)$), then C is K-torsion-free if and only if $x_1,\dots,x_n$ is a C-sequence; and if A is I-torsion (i.e., $A = \Gamma(A)$), then A is K-divisible if and only if $x_1, \dots, x_n$ is an A-cosequence. In these cases we retain the duality isomorphisms $C \cong \mathrm{Hom}_R(K, K \otimes_R C)$ and $A \cong K \otimes_R \mathrm{Hom}_R(K,A)$. Among the many applications is the theorem that if $\tilde{R} = \Lambda(R)$ is the I-completion of R, then every permutation of $x_1,\dots,x_n$ is an $\tilde{R}$-sequence. (Received February 17, 1977.) (Author introduced by Professor Judith D. Sally).

745-A14 MARVIN TRETKOFF, Stevens Institute of Technology, Hoboken, New Jersey 07030. Road Maps for Riemann Surfaces and the Jacobian Variety of the Klein-Hurwitz surface. Preliminary report.



(Received February 21, 1977.)

*745-A15 Charles F. Schwartz, Rutgers University, New Brunswick, New Jersey 08903. Generators for the group of rational solutions of $y^2 = x(x-1)(x-t^2-c)$. Preliminary report.

For the Weierstrass equation $y^2 = x(x-1)(x-t^2-c)$, $c \neq 0, 1$, there is a $C(t)$-rational solution $x = mt + b$, $y = im(x - t^2 - c)$, where $b = c + \sqrt{c^2 - c}$ and $m = \sqrt{1 - 2c - 2\sqrt{c^2 - c}}$. I prove that this solution is not torsion, and together with the solutions of order 2 ($(0,0)$, $(1,0)$, and $(t^2 + c, 0)$), it generates the group of $C(t)$-rational solutions. I prove this by showing that, to every solution, there is associated an automorphic form of weight 3; that there is a bilinear form, (,), on the space of automorphic forms of weight 3; that 4 times this bilinear form is integer valued, when applied to automorphic forms arising from solutions; and that, if f comes from the above solution, then $4(f,f) = 1$.
(Received February 21, 1977.)

745-A16 Michael D. Konrad, Ohio University, Athens, Ohio 45701. A Mathematical System with Applications. Preliminary report.

If B is a well ordered set and ν is an ordinal-valued function whose domain is well ordered, a mathematical system (F,W) is inductively constructed, where F is termed the ν-forest with B leaves and W well orders F. Explicit conditions are derived which characterize the system (F,W) in terms of B and ν in a noniterative fashion. As a first application, let C be any function whose domain is the inverse of 0 under ν. It is shown that there is a unique V which is a ν-forest with $B \cup$(range of C) leaves and a function G such that (V,G) is a universal algebra of type ν. Then for every universal algebra (A,H) of type ν satisfying $A \supseteq B$ and $H \supseteq C$, the algebra generated by (A,H) over B is isomorphic to a quotient algebra of (V,G) and can be fingered in (V,G). Under the assumption that given any ordinal there exists a higher regular cardinal, the above results can be derived without the Axiom of Choice. (Received February 22, 1977.)

*745-A17 [illegible] A class of [illegible] Preliminary report.

[illegible] be a surface in [illegible] be a non-[illegible] (or [illegible]).

(1) [illegible] example is constructed in characteristic [illegible] (unpublished).

(2) In each characteristic [illegible] with arbitrarily high genus p_g. Corollary: [illegible] fields (over k) between $K(x,y)$ and [illegible].

(3) The following [illegible] in the class of [illegible]'s : K3, enriques, rational, [illegible]. (Received February 22, 1977.)

*745-A18 DAVID W. FOX, The Johns Hopkins University, Baltimore, Maryland 21218
Bounds for perturbations of eigenvalues of relative hermitian matrix problems

This article gives new bounds for perturbations of the eigenvalues of a class of relative Hermitian eigenvalue problems in finite-dimensional spaces. The bounds are "best possible" and improve those given recently by G. W. Stewart. The formulation is mainly in terms of quadratic forms. (Received February 22, 1977.)

*745-A19 Y.C. WU, Oakland University, Rochester, Michigan 48063. Obstructions in associative algebra.

Let A be an algebra and M an A-module. We define a special two-fold extension of M by A to be an exact sequence of algebras $0 \to M \to E_1 \to E_2 \to A \to 0$ in which E_2

operates on M, E_1, E_2, A compatibly and M is contained in the annihilator ideal of E_1. We show that the set of equivalence classes of these extensions, denoted by $\mathrm{Sext}^2_A(A,M)$, is in a 1-1 correspondence with the third Hochschild cohomology group $H^3(A,M)$, when the ground ring is a field. Moreover, such correspondence is natural in M and all results analogous to those in the interpretation of the third Eilenberg-MacLane cohomology group of a group hold. (Received February 22, 1977.)(Author introduced by Professor C. Cheng).

Analysis (26, 28, 30–35, 39–47, 49)

*745-B1 J. DIESTEL AND C. SEIFERT, Kent State University, Kent, Ohio 44242
Operators with the Banach-Saks Property.

Theorem 1. If Ω is a compact Hausdorff space and $T: C(\Omega) \to X$ is a weakly compact linear operator then (Tf_n) has a subsequence whose arithmetic means are norm convergent for each bounded sequence $(f_n) \subseteq C(\Omega)$. Theorem 2. If G is a Grothendieck space and $T: G \to X$ is not weakly compact then T fixes a copy of ℓ_1. Theorem 3. If Ω is a compact Hausdorff space such that $C(\Omega)$ is a Grothendieck space and $T: C(\Omega) \to X$ is not weakly compact then T fixes a copy of $C[0, 1]$. Corollary 4. If $C(\Omega)$ is a Grothendieck space and $T: C(\Omega) \to X$ is a bounded linear operator that takes weakly null sequences to sequences having subsequences whose arithmetic means are norm convergent then T is weakly compact. (Received December 23, 1976.)

745-B2 J. M. Anderson, University College, London; L. A. Rubel, University of Illinois, Urbana, Illinois 61801; W. A. Squires and B. A. Taylor, University of Michigan, Ann Arbor, Michigan, 48109. Irreducibility of certain entire functions. Preliminary report.

Theorem. Let $f_1, f_2, \ldots, f_n$ be non-constant entire functions of one complex variable. Then $f_1(z_1)+f_2(z_2)+\ldots+f_n(z_n)$ is an irreducible entire function of n complex variables, provided $n \geq 3$.

The special case when $f_1, f_2, \ldots, f_n$ are polynomials was proved by Ehrenfeucht and Pełczyński. For applications to convolution theory in $\mathcal{E}' = C_0^\infty(R^n)$, a similar irreducibility result is proved for functions of the form

$$\sum_{j=1}^{n} (g_j(z_j) \prod_{k \neq j} h_k(z_k)),$$

where the g_j and h_j have no common zeros, their ratio is not constant, and each h_j has at least one simple zero. The proof uses deep results from the theory of functions of one complex variable. (Received September 30, 1977.)

*745-B3 Richard Randell, Institute for Advanced Study, Princeton, New Jersey 08540. Complete Intersections with $\mathbb{C}^*$-action.

We will present a formula for the Milnor number of a complete intersection with isolated singularity and $\mathbb{C}^*$-action. This formula is given in terms of numerical invariants of the action, and generalizes a result of J. Milnor and P. Orlik for hypersurfaces. An explicit description of the characteristic polynomial of a certain monodromy will be presented also, and it will be shown to what extent this describes the link of the singularity. Various geometric and homological properties of the orbit spaces under such actions will be discussed as well. (Received January 31, 1977.)

745-B4 G. A. EDGAR, The Ohio State University, Columbus, Ohio 43210. Vector-valued amarts.

This survey of recent results on amarts (also called "asymptotic martingales") with values in a Banach space includes convergence theorems and Riesz-type decomposition theorems, as well as the connection between amart convergence and properties of the Banach space: reflexivity, Radon-Nikodym property, separability of the dual, containment of ℓ^1 , finite dimension. Some open questions will also be mentioned. (Received February 7, 1977.)

*745-B5 Henry B. Laufer, Purdue University, West Lafayette, Indiana 47907. The behavior of the exceptional set under ambient deformations. Preliminary report.

Let M be a two-dimensional strictly pseudoconvex manifold with exceptional set A. Let $\pi: \mathcal{M} \to T$ be a deformation of M. Let $\mathcal{A}$, a subvariety of $\mathcal{M}$, be the union of the exceptional sets. Then, after a base change and over a subspace of T, each irreducible component of $\mathcal{A}$ represents a flat deformation of a cycle on A. The generic fiber is reduced and irreducible. Additional information about $\mathcal{A}$ is obtained via a generalization of Kodaira's obstruction theory.

One application is in the computation of degeneracies of simple, unimodal and bimodal singularities. In particular, some new degeneracies are found for the bimodal singularities. (Received February 7, 1977.)

*745-B6 R. VENCIL SKARDA, Brigham Young University, Provo, UT 84602, A Generalization of $(\Sigma a_i^{\,2})^{\frac{1}{2}} \le \Sigma |a_i|$.

Let Σa_i and Σb_i be absolutely convergent real series. Under the conditions that $\Sigma |a_i| = A > 0$, $\Sigma |b_i| = B > 0$ and $\Sigma |a_i - b_i| = C$, we have

$$\tfrac{1}{4}(A-B-C)(A-B+C) < \Sigma a_i b_i \le \tfrac{1}{2}(A+B-C)\max(A,B).$$

Under the conditions that $\Sigma |a_i| = A > 0$, $\Sigma |b_i| = B > 0$ and $\Sigma |a_i + b_i| = D$, we have

$$\tfrac{1}{2}(D-A-B)\max(A,B) \le \Sigma a_i b_i < \tfrac{1}{4}(D-A+B)(D+A-B).$$

If either A or B equals zero, these are trivial equalities. These bounds are best possible. (Received February 9, 1977.)

*745-B7 WOLFGANG H. J. FUCHS, Cornell University, Ithaca, New York 14853. An inequality involving the absolute value of an entire function and the counting function of its zeros.

Theorem. If $f(z)$ is an entire function of finite non-integral order λ and if $\max(\frac{1}{2}, \lambda) < \gamma < [\lambda] + 1$, $\beta = 2\pi/\gamma$, then, as $z \to \infty$

$$\liminf (\log|f(ze^{i\beta})| + \log|f(ze^{-i\beta})|)/N(|z|, f) \le 2\pi\lambda \cos(\pi\lambda - \beta\lambda)/\sin\pi\lambda .$$

(Received February 8, 1977.)

745-B8 R. P. Boas, Northwestern University, Evanston, Illinois 60201. The Jensen-Steffensen inequality.

Jensen's inequality states that if ϕ is a continuous convex function, λ is nondecreasing, and f is continuous, then $\phi\{\int f(x)d\lambda(x)/\int d\lambda(x)\} \le \int \phi(f(x))d\lambda(x)/\int d\lambda(x)$. The Jensen-Steffensen inequality has the same conclusion but assumes more (monotonicity) about f and less about λ, in fact only that (if the integration is over $[a,b]$) $\lambda(a) \le \lambda(x) \le \lambda(b)$ for $a < x < b$, and $\lambda(b) > \lambda(a)$. Several variations and applications of the Jensen-Steffensen inequality will be discussed. (Received February 9, 1977.)

*745-B9 D. J. H. Garling, Ohio State University, Columbus, Ohio 43210. Convexity, smoothness and martingale inequalities.

First we determine the uniform smoothness and convexity of $L^p(X)$, where $1 < p < \infty$ and X is a Banach space. The results extend the familiar scalar L^p results, but the proofs, based on an idea of Figiel and Pisier, are, even in the scalar case, simpler than previous ones.
Secondly these results are used to give necessary and sufficient conditions, in terms of the behaviour of martingales, for a Banach space to be given an equivalent norm under which it is δ-uniformly convex or ρ-uniformly smooth, where δ and ρ are suitable Orlicz M-functions. The results extend and generalize results of Pisier. (Received February 9, 1977.) (Author introudced by Dr. M. B. Marcus).

*745-B10 BENJAMIN MUCKENHOUPT, Rutgers University, New Brunswick, New Jersey 08903. Weighted norm inequalities relating the Hilbert Transform to the Hardy-Littlewood maximal function.

The problem considered is the determination, given p satisfying $1<p<\infty$, of all non-negative functions $W(x)$ such that (1) $\int_{-\infty}^{\infty} |\tilde{f}(x)|^p W(x)dx \le C \int_{-\infty}^{\infty} [f^*(x)]^p W(x)dx$, where $\tilde{f}(x)$ denotes the Hilbert transform of f, $f^*(x)$ is the Hardy-Littlewood maximal function of f and C is a constant independent of f. Coifman and Fefferman [Studia Math. 51 (1974), pp. 241-250] showed that a condition on W known as the A_∞ condition is sufficient to make (1) valid. The A_∞ condition is not a necessary condition, however; the characteristic function of $[0,\infty)$, for example, satisfies (1) but not the A_∞ condition. It is shown that if W satisfies (1), then it satisfies the following statement known as the C_p condition: there exist positive constants K and ε such that $\int_E W(x)dx \le K\left(\frac{|E|}{|I|}\right)^\varepsilon \int_{-\infty}^{\infty} \frac{|I|^p\, W(x)\, dx}{|I|^p+|x-x_I|^p}$ for every interval I and every subset E of I, where x_I denotes the center of I. It is conjectured that C_p is also a sufficient condition for (1). (Received February 16, 1977.)

745-B11 WITHDRAWN

745-B12 RICHARD ASKEY and JAMES A. WILSON, University of Wisconsin, Madison, Wisconsin 53706. A new set of basic hypergeometric orthogonal polynomials. Preliminary report.

The function ${}_4\varphi_3\left(\begin{matrix} q^{-n},\ q^{n-1}abcd,\ ax,\ ax^{-1} \\ ab,\ ac,\ ad \end{matrix}\ q, q\right) = p_n(t)$ is a polynomial of degree n in the variable $t = x + x^{-1}$. These polynomials are orthogonal with respect to a positive measure for many choices of a, b, c, d, and they include as limiting cases all of the classical orthogonal polynomials. The weight functions have been found in some cases. The three term recurrence formula has been found, and it can be used to prove the nonnegativity of the linearization coefficients in the expansion $p_n(t)\, p_m(t) = \sum a_k\, p_k(t)$ in some cases. (Received February 17, 1977.)

745-B13 JAMES A. WILSON, University of Wisconsin, Madison, Wisconsin 53706. Some New Orthogonal Polynomials. Preliminary report.

$$p_n(t^2) = {}_4F_3\left(\begin{matrix}-n,\ n+a+b+c+d-1,\ a-t,\ a+t;\\ a+b,\ a+c,\ a+d\end{matrix}\ 1\right)$$

defines a new set of orthogonal polynomials which includes as limiting cases the classical polynomials with continuous or discrete orthogonalities. For special values of a, b, c, d, these polynomials, disguised as 6-j symbols, already play an important role in physics. Results for the classical polynomials, including Rodrigues formulas, have been generalized to p_n. (Received February 17, 1977.)

*745-B14 Peter A. Tomas, University of Chicago, Chicago, Illinois 60637. A restriction theorem for the Fourier transform.

E.M. Stein has shown how a priori inequalities may be used to define the Fourier transform of L^p functions, on sets of measure zero. The author discusses some new results related to Stein's work. (Received February 17, 1977.)(Author introduced by Professor Richard Askey).

745-B15 WALTER D. NEUMANN, University of Maryland, College Park, Maryland 20742. Weighted homogeneous surfaces. Preliminary report.

If $f(z_1,z_2,z_3,z_4)$ is a weighted homogeneous polynomial, then the algebraic surface $V = (f^{-1}(0) - \{0\})/\mathbb{C}^*$ can be desingularized and then classified in many cases. For example, if $f = z_1^{a_1} + z_2^{a_2} + z_3^{a_3} + z_4^{a_4}$, so V is the orbit space $\Sigma(a_1,a_2,a_3,a_4)/S^1$ of the usual S^1-action on a Brieskorn manifold, and if V is non-singular, then there are (up to biholomorphic equivalence) 5 cases when V is rational, 2 where V is K3, and in all other cases V has general type. The polynomial $z_1^2 + z_2^6 + z_3^6 + z_4^6$ gives the "unusual" model of the K3 surface. (Received February 17, 1977.)

*745-B16 Robert Ephraim, Herbert H. Lehman College, Bronx, New York 10468. Iso-Singular Loci and the Cartesian Product Structure of Complex Analytic Singularities.

Let X be a complex analytic space (not necessarily reduced), and let V be a germ of a complex analytic space. The set of points of X at which the germ of X is isomorphic to V is studied. When it is non-empty it is shown to be a locally closed submanifold of X. Moreover, locally along this submanifold, X is isomorphic to the cartesian product of this submanifold and a transversal section.

This is used to prove a uniqueness theorem for the decomposition of reduced singularities into cartesian products of simpler singularities. (Received February 18, 1977.)

745-B17 Thomas P. Laine, Northwestern University, Evanston, Illinois 60201. Convolution Structures for Polynomials Orthogonal with Respect to the Weight Function $(1-x^2)^{\alpha}|x|^{2\beta+1}$. Preliminary Report.

Let $T_n^{(\alpha,\beta)}(x)$ be the polynomials orthogonal on [-1,1] with respect to the weight function $(1-x^2)^{\alpha}|x|^{2\beta+1}$. We consider the dual pair of problems, analagous to those considered for Jacobi polynomials by Gasper [Can. J. Math 22 (1970), 582-593; Ann. of Math. 93 (1971), 261-280], of when the coefficients in the expansion

$$T_n^{(\alpha,\beta)}(x)T_m^{(\alpha,\beta)}(x) = \sum_{k=|n-m|}^{n+m} a(k,n,m;\ \alpha,\beta)T_k^{(\alpha,\beta)}(x)$$

and the kernel in the integral representation

$$T_n^{(\alpha,\beta)}(x)T_n^{(\alpha,\beta)}(y) = \int_{-1}^{1} T_n^{(\alpha,\beta)}(z)k(x,y,z;\alpha,\beta)(1-z^2)^{\alpha}|z|^{2\beta+1}dz$$

are non-negative. (Received February 18, 1977.)

745-B18 Joseph Miles, University of Illinois, Urbana, IL 61801. A theorem on entire functions of infinite order.

Let f be an entire function of infinite order with zeros lying on a ray through the origin. For $p > 1$ it is shown that $\lim_{r \to \infty} N(r,0)/m_p^+(r,f) = 0$ for such an f, where $N(r,0)$ denotes the integrated counting function of the zeros and $m_p^+(r,f)$ denotes the L^p norm of $\log^+|f(re^{i\theta})|$. This result is related to previous work of Edrei, Fuchs, and Hellerstein and of Hellerstein and Shea. (Received February 21, 1977.)

745-B19 N.V. RAO, University of Toledo, Toledo, OH 43606 and DANIEL F. SHEA, University of Wisconsin, Madison, WI 53706. Growth and Riesz mass of subharmonic functions of finite order. Preliminary report.

Let $u(x)$ be subharmonic in $\mathbb{R}^d$. We compare the growth of $n(r) = \int_{|x|\le r} d(\Delta u(x))$, the Riesz mass of $u(x)$ in $|x| \le r$, with that of the L^1 norm $m(r,u) = \int_{|\omega|=1} |u(r\omega)|\, d\sigma(\omega)$ where $d\sigma$ = normalized surface area on the unit sphere. We find that $k(u) \equiv \limsup_{r\to\infty} N(r)/m(r,u)$ satisfies

(*) $k(u) \ge A_d |\sin \pi\lambda| / (\lambda+1)^{\frac{1}{2}d}$ where A_d is a constant depending only on the dimension, $\lambda = \limsup_{r\to\infty} \log m(r,u)/\log r$ is the order of $u(x)$, and $N(r) = \int_0^r n(t)\, t^{1-d}\, dt$. Examples show estimate (*) has the correct order of magnitude for large λ. Further, if e.g. $\lambda < \infty$ and $k(u)$ is small in a certain precise sense, then λ is close to a positive integer p and $u(x)$ is asymptotically like a harmonic polynomial of degree p; this extends a result of Edrei and Fuchs for the case $d = 2$. (Received February 21, 1977.)

*745-B20 J.D. Buckholtz, University of Kentucky, Lexington, KY 40506. *Uniqueness theorems for entire functions.*

Let W be analytic in the closed unit disk and have radius of univalence 1. Denote by C the image under f of the unit circle $|z| = 1$. Let D denote the derivative operator and $W(D)$ the infinite order differential operator obtained formally by replacing z by D in the Maclaurin series for $W(z)$. The linear functionals under consideration are defined by $L_n(f) = ([W(D)]^n f)(0)$, $n = 0, 1, 2, \ldots$. An entire function f is said to be annihilated by $\{L_n\}$ if $L_n(f) = 0$, $n = 0, 1, 2, \ldots$. A space S of entire functions is said to be a uniqueness class for $\{L_n\}$ if 0 is the only member of S annihilated by $\{L_n\}$. Let E_0 denote the space of entire functions f which satisfy $f^{(k)}(0) = o(k)$, $k \to \infty$, and E_1 the space of entire functions f which satisfy $f^{(k)}(0) = O(k)$, $k \to \infty$. **Theorem 1.** The space E_0 is a uniqueness class for $\{L_n\}$ if and only if C is a simple closed curve. **Theorem 2.** If C is a simple closed curve, then the subspace of E_1 annihilated by $\{L_n\}$ is finite dimensional, and its dimension is equal to the number of cusps of C. (Received February 21, 1977.)

*745-B21 SIMON HELLERSTEIN, University of Wisconsin, Madison, WI 53706 and JACK WILLIAMSON, University of Hawaii, Honolulu, HI 96822. Derivatives of Entire Functions and a Conjecture of Pólya and Wiman.

In these notices (April, 1975) we announced a solution for functions of finite order of an old (ca. 1915) conjecture of Pólya and Wiman. Since then we have removed the finite order condition and in particular have proved the

Theorem 1: Suppose f is a constant multiple of a real entire function (i.e. real on the real axis) and f, f', f'' have only real zeros. Then $f(z) = cz^m \exp(-az^2 + bz) \prod (1 - \lambda_n z) \exp(\lambda_n z)$ where $a \ge 0$, b and the λ_n are real, m is a non-negative integer, and $\sum \lambda_n^2 < +\infty$.

A consequence of Theorem 1 is

Theorem 2: Suppose f is a constant multiple of a real entire function. If $f, f', f'', \ldots$ have only real, non-positive zeros, then either $f(z) = c \exp(az)$ or $f(z) = cz^m \exp(bz) \prod (1 + \lambda_n z)$ where a is real, $b > 0$, $\lambda_n > 0$, and $\sum \lambda_n < +\infty$. (Received February 21, 1977.)

*745-B22 N.V. RAO, University of Toledo, Math. Dept. Toledo, Ohio 43606. Carlson's theorem for harmonic functions in $\mathbb{R}^n$.

A function u defined in a cone $K_\alpha = \{x; x_1/r \ge \alpha\}$ where $-1 \le \alpha < 1$ is said to be of type τ in K_α if given any $\epsilon > 0$, there exists an A_ϵ such that

$$|u(x)| \le A_\epsilon e^{(\tau+\epsilon)r} \quad \text{for all } x \text{ in } K_\alpha .$$

A typical theorem that is proved is the following : If u is harmonic in a half-space and of type $\tau < \pi$ and further vanishes at all the lattice points in that half-space, then $u \equiv 0$. (Received February 21, 1977.) (Author introduced by Professor Simon Hellerstein).

745-B23 ALBERT EDREI, Syracuse University, Syracuse, New York 13210. Distribution of the zeros of Padé polynomials of an entire function.

Let (1) $f(z) = \sum a_j z^j$ $(a_0 \ne 0)$ represent an entire function of order λ and mean type σ $(0 < \lambda < +\infty,\ 0 < \sigma < +\infty)$. Denote by P_{mn}/Q_{mn} the irreducible Padé approximant of (1) characterized by the conditions: P_{mn} is a polynomial of degree $\le m$; Q_{mn} is a polynomial of degree $\le n$ $(Q_{mn}(0) = 1)$. Then, with every integer $n \ge 0$, it is possible to associate an **infinite** sequence $S = S(n)$ of positive, strictly increasing integers such that, for $m \in S$, the two following assertions hold. (A) P_{mn} is of exact degree m and $P_{mn}(0) = a_0$. (B) Let α and β be given $(\alpha < \beta < \alpha + 2\pi)$; it is then possible to determine two positive constants $\kappa = \kappa(\lambda, \sigma, \beta - \alpha)$ and $\tau = \tau(\lambda, \sigma, \beta - \alpha)$, both independent of m, and such that, for $m > m_0$, $m \in S$, there are at least τm zeros of P_{mn} in the sector $\{z: \kappa(m/\sigma\lambda)^{1/\lambda} \le |z|;\ \alpha \le \arg z \le \beta\}$. As $m \to \infty$ there are no more than $o(m)$ zeros of P_{mn} in the region $|z| \ge (1 + \eta)(m/\sigma\lambda)^{1/\lambda}$ $(\eta > 0)$.
(Received February 21, 1977.)

745-B24 S.M. Shah, University of Kentucky, Lexington, Kentucky 40506. Approximation to meromorphic functions on the positive real axis II.

Let $f(z) = \sum_{k=0}^{\infty} a_k z^k$, $a_0 > 0$, $a_k \ge 0$ be an entire function and $\lambda_{0,n}(\frac{1}{f}) = \lambda_{0,n}$ Chebyshev constants for $\frac{1}{f}$ (see Abstract 737-B111, 23(1976) p.A 439). Theorem 1. Let $\{d_n\}^{\infty}$ be any strictly increasing unbounded sequence of positive numbers. Then for $n \ge 1$, $\lambda_{0,n} \ge a_{n+1} d_n^{n+1}/2^{2n+2}(f(d_n))^2$. Theorem 2. Let $0 < \rho < \infty$ and $a_k \sim (1/kL(k))^{k/\rho}$ where for all large x, $xL(x) > 1$ and $x \log(xL(x))$ is convex and $\lim_{x\to\infty} xL'(x)/L(x) = 0$. Write $a = 2^{1/\rho}$. Then $\limsup \lambda_{0,n}^{1/n} \ge a$, $\liminf \lambda_{0,n}^{1/n} \ge \frac{a}{4}$. In Theorem 3 we construct an entire function of infinite order for which $\lambda_{0,n} \ge \exp(-n/L(n))$ for an infinity of n. (Received February 21, 1977.)

745-B25 L. R. SONS, Northern Illinois University, DeKalb, Illinois 60115. Another growth indicator for the study of value distribution. Preliminary report.

Let f be a function which is meromorphic in the plane (or in the unit disc). Define $m(r)$ for $r > 0$ by $m(r) = \{\frac{1}{2\pi} \int_0^{2\pi} (\log|f(re^{i\theta})|)^2 d\theta\}^{\frac{1}{2}}$. Using $m(r)$ as a growth indicator for f, some value distribution problems will be discussed. Functions in the unit disc will also be considered. (Received February 21, 1977.)

745-B26 HARRY POLLARD, Purdue University, West Lafayette, Indiana 47907. A new class of variational problems.

Berkovitz and Pollard have introduced the study of the following problem. Let C be the correlation function for the noise to be filtered from a class of signals; to minimize the functional

$$\left(\int_0^\infty |y|\,du\right)^2 + \int_0^\infty \int_0^\infty C(u-v)\,dy'(u)y'(v)$$

in the class of functions y that are absolutely continuous on $[0,\infty]$, that are in $L_1(0,\infty)$ and possess derivatives y' in a suitable class of functions. In all special cases solved thus far the solutions have compact support. The known results are reviewed and further results are suggested. (Received February 21, 1977.)

745-B27 I. I. HIRSCHMAN, JR., Washington University, St. Louis, MO, and DAVID S. LIANG, Chicago, IL, Szegö's theorem on SU(3). Preliminary report.

A classical theorem of Szegö asserts that if $c(\theta) \in R\ell L^1(T)$ where $T = R/2\pi Z$, if $M_n[c] = [c^\wedge(k-j)]_{j,k=0,\cdots,n}$, and if $\{\lambda_{n,k}\}_{k=0}^n$ are the necessarily real eigen values of $M_n[c]$, then (essentially) $\{k: \lambda_{n,k} > a\}^\#/(n+1) \to \frac{1}{2\pi}\lambda\{\theta: c(\theta) > a\}$ as $n \to \infty$ for all real a. Here λ is Lebesgue measure on T. An analogue of this result is given with SU(3) in place of T. (Received February 21, 1977.)

745-B28 HUGH L. MONTGOMERY, University of Michigan, Ann Arbor, MI 48109. Enflo's theorem on norms of products of polynomials in many variables. Preliminary report.

In disproving the invariant subspace conjecture, Enflo proved an inequality of the sort $\|FG\| \geq c\|F\|\,\|G\|$, where $F,G \in \mathbf{C}[z_1,\ldots,z_N]$, the norm is the ℓ_1-norm of the coefficients, and c depends on the degrees of F,G. For fixed N this is trivial by compactness, but Enflo proved that the inequality also holds with c independent of N. A simpler proof of this is given, with extensions to other norms. (Received February 21, 1977.)

*745-B29 ULRICH KARRAS, Purdue University, West Lafayette, Indiana 47907. On pencils of curves and surface singularities. Preliminary report.

A normal complex surface singularity (V,p) is called Kodaira-singularity if a resolution of (V,p) can be obtained by blowing up regular points on a fibre of a (lokal) pencil of curves of genus g. We only blow up points on components of multiplicity 1 of the fibre. Associated to the minimal good resolution of (V,p) is a weighted dual graph Γ which fully describes the local topological structure of (V,p) but not in general the analytic structure. Hence, one may ask whether every normal surface singularity associated to Γ is a Kodaira-singularity. As an example, one may consider the family of hypersurfaces $V_t: z^2 = x^3 + y^7 + txy^5$ (t is a parameter; V_t has a singularity at the origin). The family admits a resolution $\{X_t\} \to \{V_t\}$ such that each X_t is a resolution of V_t with $\Gamma_t = \Gamma_0$. However, it turns out that only $(V_0,0)$ is a Kodaira-singularity. More generally, we can point out that "small" variations of blown up points induce deformations of the minimal good resolution $M \to V$ of (V,p) which do not change Γ (called equitopological deformations). Thus the problem reduces to computing this contribution in the finite dimensional vector space of "first order" equitopological deformations of M. Complete results are available in the elliptic case. (Received February 21, 1977.) (Author introduced by Professor Henry B. Laufer).

745-B30 MARIO O. GONZALEZ, University of Alabama, University, Alabama 35486. Area theorems for nonanalytic univalent functions

In this paper the author gives area theorems for the following two classes of nonanalytic univalent functions in the unit (open) disc U. Class F_1: $f(z) = \sum_{n=1}^{\infty}\sum_{k=0}^{n} a_{n-k,k}\, z^{n-k}(\bar{z})^k$, where $|a_{10}| \neq |a_{01}|$ and the Jacobian $J_f(z)$ is either positive or negative in U. Class F_2: $f(z) = z^{-1} + b(\bar{z})^{-1} + \sum_{n=1}^{\infty}\sum_{k=0}^{n} b_{n-k,k}\, z^{n-k}(\bar{z})^k$, where $|b| \neq 1$ and $J_f(z)$ has constant sign in U. THEOREM (Interior area theorem). Suppose $f \in F_1$ and let A = signed area of f(U). Then $A = \pi \sum_{n=1}^{\infty}\sum_{k=0}^{n} (n-2k)\,|a_{n-k,k}|^2 + 2\pi \sum_{n=1}^{\infty}\Big(\sum_{k=0}^{n} (n-2k)\,\mathrm{Re}[a_{n-k,k} \sum_{p=1}^{\infty} \bar{a}_{n-k+p,k+p}]\Big)$ provided the series on the right-hand side are convergent. A similar (exterior) area theorem holds for functions of class F_2. (Received February 21, 1977.)

745-B31 CARL DE BOOR, University of Wisconsin-Madison, Madison, Wisconsin 53706. Splines as linear combinations of B-splines.

• The existing literature concerning polynomial B-splines, i.e., splines of minimal support, and their generalizations is discussed. In the process, an introduction to most areas of (univariate) spline theory is given. This expository talk is intended to promote the point of view that B-splines are truly basic splines: B-splines express the essentially local, but not completely local, character of splines; certain facts about splines take on their most striking form when put into B-spline terms, and many theorems about splines are most easily proved with the aid of B-splines; finally, the computational determination of a specific spline from some information about it is usually facilitated when B-splines are used in its construction. (Received February 22, 1977.)

*745-B32 STEPHEN S.-T. YAU, Institute for Advanced Study, Princeton, N.J. 08540. On strongly elliptic singularities.

Let p be the unique singularities of a normal two-dimensional Stein space V. Let $\pi : M \to V$ be a resolution. M. Artin developed a theory for those singularities with geometric genus equal to zero. Recently, Laufer developed a theory for those Gorenstein singularities with geometric genus equal to one. We are able to complete the theory for those singularities with geometric genus equal to one without assuming that the singularity is Gorenstein. A concept of Laufer sequence is introduced. This is defined purely topologically. Main Theorem: Let $\pi : M \to V$ be a minimal good resolution of a normal two-dimensional Stein space with p as its only strongly elliptic singularity. Let $\{Z_{L_0}, \ldots, Z_{L_n}\}$ be the Laufer sequence and m the maximal ideal of the local ring at p. Then $m \supsetneq \mathcal{O}(-\sum_{i=0}^{n} Z_{L_i})$. If $Z_{L_n}\cdot Z_E \leq -2$, then $m = \mathcal{O}(-\sum_{i=0}^{n} Z_{L_i})$ provided that either one of the following holds: (1) $Z_E = E$, i.e., π is the minimal resolution; (2) $Z_{L_n}/|E| = Z_E$. If $Z_E \cdot Z_E \leq -3$, then $\dim m^j/m^{j+1} = -j(\sum_{i=0}^{n} Z_{L_i}^2)$ provided that one of the above (1) or (2) holds. (Received February 22, 1977.)

745-B33 [illegible]

Let [illegible] of the [illegible] essentially [illegible] $F(f) = \|f'\|_{\infty}/\|f''\|_{\infty}^{\frac{1}{2}}$. [illegible] $L(\cdot) = \sup F(f)$, the supremum [illegible] $L(-a \leq x \leq a) = (2a)^{\frac{1}{2}}$, essentially [illegible]. The author has shown that if $0 < b < a$, then $L(b \leq |z| \leq a) = (a + (a^2 - b^2)^{\frac{1}{2}})^{\frac{1}{2}}$. Here we [illegible] the new problem of determining $L(E)$, where E is the ellipse $x^2/a^2 + y^2/b^2 = 1$. Another topic is an extension of the theorem of the brothers Markov to polynomials $P(t) = a_0 t^n + \cdots + a_n$ such that $(0 <)\ r \leq |P(t)| \leq 1$ if $-1 \leq t \leq 1$. (Received February 22, 1977.)

745-B34 Professor William Beckner, University of Chicago, Chicago, Illinois 60637. Convolution inequalities and Fourier analysis.

This expository paper will discuss the role of convolution estimates and rearrangement inequalities in Fourier analysis on Euclidean spaces. (Received February 22, 1977.)

745-B35 B. F. LOGAN, JR., Bell Laboratories, Murray Hill, New Jersey 07974. Bandlimited functions bounded below over an interval.

Denote by $B_2(\alpha)$ the subclass of $L_2(-\infty,\infty)$ consisting of those functions whose Fourier transforms vanish outside $[-\alpha,\alpha]$. Now suppose f is any function in $B_2(1)$ satisfying (i) $|f(t)| > 1$ for $-T/2 \leq t \leq T/2$, and let I(T) denote the greatest lower bound for the energy, $\|f\|^2$, of such a function f. An integral representation is given for the function I(T), which is piecewise analytic and satisfies (ii) $T + \pi\{1 + |\sin T|/T\}^{-1} < I(T) \leq T + \pi$, $(0 < T < \infty)$, (iii) $I(T) = T + \pi\{1 + |\sin T|/T\}^{-1} + O(T^{-2})$, $T \to \infty$. The extremal functions are also found. The key to the solution of the problem is the development of general quadrature formulas, (iv) $\int_{-\infty}^{\infty} |f(t)|^2\, dt = \sum_{-\infty}^{\infty} \mu_k |f(\lambda_k)|^2$, $f \in B_2(1)$. (Received February 22, 1977.) (Author introduced by Professor Richard A. Askey.)

745-B36 RICHARD A. HUNT, Purdue University, West Lafayette, Indiana 47907. Harmonic measure and estimates of Green's function.

• Positive harmonic functions on Lipschitz domains have finite nontangential limits on the boundary except for a set of harmonic measure zero. It is natural to ask if this exceptional set is of zero surface measure. This has recently been settled by B. Dahlberg, who showed that harmonic measure and surface measure on the boundary of a Lipschitz domain are equivalent. The equivalence of harmonic measure and surface measure depends on estimates of Green's function near the boundary. For domains with $C^{1+\epsilon}$ boundary or the sawtooth domains considered by A. P. Calderón and L. Carleson, a suitable estimate can be obtained by direct comparison of Green's function with a Poisson integral. This technique does not seem appropriate for Lipschitz domains. Dahlberg estimated Green's function by using the fact that (essentially) its partial derivative in a direction normal to the boundary is a positive harmonic function. (Received February 25, 1977.)

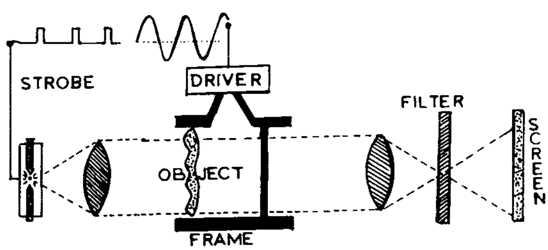
Applied Mathematics (65, 68, 70, 73, 76, 78, 80–83, 85, 86, 90, 92–94)

745-C1 EVELYN FRANK, University of Illinois at Chicago Circle, Chicago, Illinois 60680. Zeros of Polynomials.

New methods in the computation of the zeros of real and complex polynomials are presented. The results are compared with known theorems on the subject. The methods are used in certain applications. (Received February 16, 1977.)

*745-C2 RALPH H. ABRAHAM, University of California, Santa Cruz, California 95064. Electro-optical exploration of forced Navier-Stokes bifurcations.

A color schlieren optical system is used to observe bifurcations in a vibrating fluid.



(Received February 21, 1977.) (Author introduced by Professor George K. Francis).

*745-D1 Joel C. Gibbons, Illinois Institute of Technology, Chicago, Illinois 60616 and Cary Webb, Chicago State University, Chicago, Illinois 60628.
<u>A Characterization of Inversive Groups of Spheres</u>.

A well defined function $f:S^n \to S^{n+k}$ satisfies axiom An (resp. Bn) if a) f maps circles into circles and b) if c is an (n-1)-sphere, $\#(f(S^n)-c) \geq 2$ (resp. $\#(f(S^n)-c) \geq 3$). We prove Theorem 1: If $f: S^2 \to S^{2+k}$ satisfies A2 and if $\# f(S^2) \geq 6$, it is a homeomorphism. Theorem 2: If $F: S^3 \to S^{3+k}$ satisfies B3 and if $\# f(S^3) \geq 8$, it is a homeomorphism. Theorem 3: If $f: s^n \to s^n$ is a Bn map, and if there is a 2-sphere $\Sigma \subset s^n$ such that f/Σ is an A2 map, f is a homeomorphism. We note that if $f: S^n \to S^n$ and if f preserves all spheres of dimension k, for some $k < n$, f preserves circles unless $f(S^n)$ lies in an (n-1)-sphere. Thus these theorems apply for example to all k- sphere preserving functions of S^n.
(Received January 24, 1977.)

*745-D2 G.F.D. DUFF, University of Toronto, Toronto, Canada M5S 1A1. <u>**Variation of a maximal function**</u>.

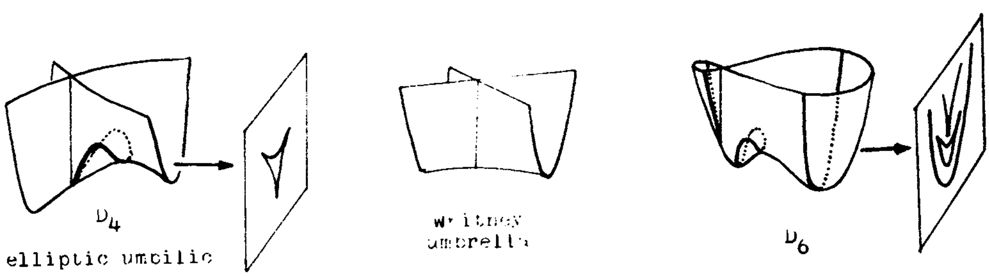
The one-sided maximal function of Hardy and Littlewood is defined as

$$\Theta(x) = \sup_{\xi < x} \frac{1}{x-\xi} \int_\xi^x f(t)dt \ , \quad \text{for} \quad f \in L_1 \ .$$

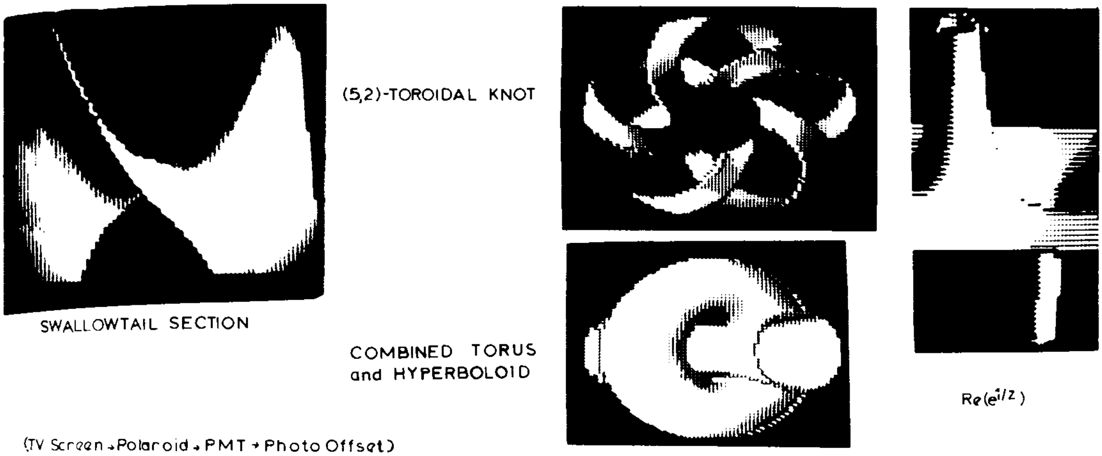
For functions f with first derivatives [illegible], it is shown that the mapping $f \to \Theta$ is variation diminishing in the [illegible] norm. In the analysis the role of the set $S_2 = \{x \mid \Theta(x) > f(x)\}$ plays a special role and the mapping is shown to be a strict contraction on S_2. (Received February 8, 1977.)

*745-D3 JAMES C. [illegible] HAN, [illegible], MA 0[illegible]063. [illegible] umbilics. [illegible].

Sections [illegible] $D_{k+1} = + x^k + xy^2$ [illegible] umbrella. [illegible] (Received February 16, 1977.)



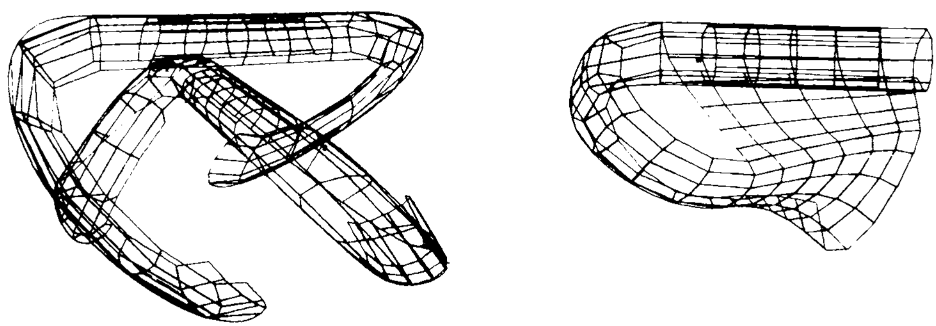
7-5-D4 ALYN P. ROCKWOOD and ROBERT P. BURTON, Brigham Young University, Provo, Utah 84601.
An inexpensive technique for displaying algebraically defined surfaces.



(TV Screen→Polaroid→PMT→Photo Offset)

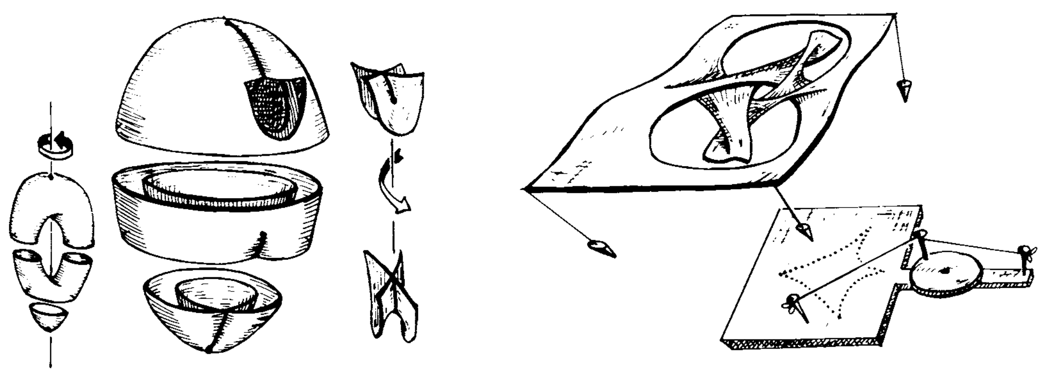
(Received February 22, 1977.) (Author introduced by Professor George K. Francis).

7-5-D5 NELSON L. MAX, Case Western Reserve University, Cleveland, Ohio 44106.
Turning a Sphere Inside Out with Computer Graphics.



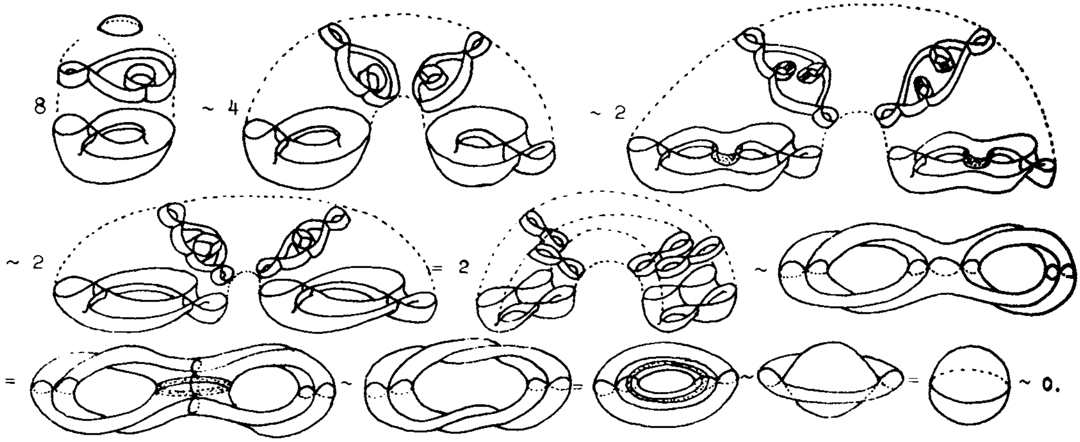
The parts of the surface shown here are formed from cubic polynomial coordinate patches, with smoothed profiles. (Received February 22, 1977.)

7-5-D6 GEORGE K. FRANCIS, University of Illinois, Urbana, Illinois 60801.
From Riemann surfaces to catastrophe machines. Preliminary report.



(Received February 22, 1977.)

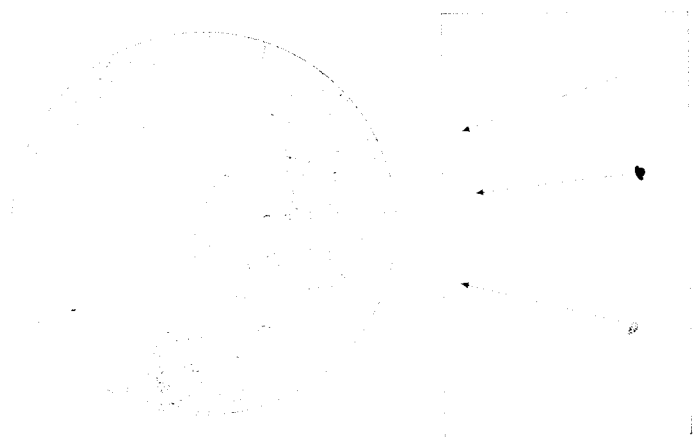
745-D7 A.V.PHILLIPS, S.U.N.Y., Stony Brook, NY 11794. An illustration for Robert Wells' Cobordism of Immersions*: 8 times Boy's surface ($\mathbb{P}^2 \looparrowright \mathbb{R}^3$) is null-cobordant.



=:regularly homotopic;~:cobordant;▨:surgery locus. *Topology 5 (1966) 281-294.

(Received February 22, 1977.)

745-D8 TIM POSTON, Battelle Advanced Studies Center, Geneva, Switzerland. Visualizing relativistic gravitation. Preliminary report.



(Received February 22, 1977.) (Author introduced by Professor George K. Francis).

745-D9 Thomas F. Banchoff and Charles M. Strauss, Brown University, Providence, Rhode Island 02912. A Reinvestigation of the Centro-Surface of the Ellipsoid.

In 1870, Cayley presented a classical investigation of the locus of centers of curvature of the ellipsoid, consisting of two interpenetrating focal surfaces with lines of cuspoidal singularity and four umbilical points. Using an interactive graphics approach we reinvestigate this surface by means of a computer animated film with special attention to the significance of this surface to the global geometry of catastrophes.

(Received February 22, 1977.)

745-D10 Cary Webb, Chicago State University, Chicago 60628, and Joel Gibbons Illinois Institute of Technology, Chicago 60616. The Inversive Group of S^n.

Theorem. Suppose (1) n and m are non-negative integers, (2) f is a function from the sphere S^n to the sphere S^{n+m}, (3) f sends every circle into a circle (not necessarily unique), (4) the image set of f contains n+2 points not contained in any (n-1)-sphere, (5) there is a 2-sphere containing four of these image points together with at least two additional image points such that no circle on this 2-sphere contains more than four of these six points. Then f is 1-1, onto, and preserves (n-1)-spheres, that is, f is an element of the inversive group of S. This generalizes results previously announced in these Notices, 22, A-682 and 23, A-617. (Received February 22, 1977.)

Statistics and Probability (60, 62)

*745-F1 Heinz W.Engl, Kepler-Universitaet Linz, Austria 4045. A random fixed point theorem for nonexpansive mappings with stochastic domain.

Let X be a separable reflexive Banach space which is uniformly convex in every direction, (O,A,m) a measure space. A mapping $T:\{(w,x)/w\varepsilon O, x\varepsilon C(w)\}\to X$ will be called "random operator with stochastic domain C" iff $C:O\to 2^X-\{\emptyset\}$ is a measurable correspondence and for all open D $\{w\varepsilon O/x\varepsilon C(w), T(w)x\varepsilon D\}\varepsilon A$. $x:O\to X$ is called "random fixed point of T" iff for m-almost $w\varepsilon O$ $x(w)\varepsilon C(w)$ and $T(w)x(w)=x(w)$ and x is measurable.

After proving some lemmata about the measurablity of Chebyshef-centers of certain measurable sequences we prove the following stochastic version of the Browder-Goehde-Klee-Kirk-Theorem:

If C is a separable measurable correspondence with closed,convex and uniformly bounded values, T a random operator with stochastic domain C such that every T(w) is a nonexpansive self-map of C(w), then T has a random fixed point.

The method of Chebshef-centers yields also similiar results in Opial spaces without convexity assumptions. (Received January 21, 1977.)

*745-F2 A. KUMAR, Northeastern Illinois University, Chicago, Illinois 60625 and B. M. SCHREIBER, Wayne State University, Detroit, Michigan 48202. Stability conditions for Banach-space-valued random variables.

Self-decomposable probability measures on a separable Banach space E were introduced by the authors in [Studia Math. 53 (1975), 55-71], where it was shown that they arise as the weak limits of uniformly infinitesimal normed sums of E-valued random variables and that they are all infinitely divisible. The set $L_0(E)$ of self-decomposable measures on E can be filtered by means of certain stability conditions into a decreasing sequence $\{L_m(E) : 0 \le m \le \infty\}$ of subclasses, each of which is closed under translation, convolution and passages to weak limits. For those spaces E for which a Lévy-Khinchine representation is known to exist, the classes $L_m(E)$ can be characterized in terms of their Lévy measures, and a representation for their ch.f.'s has been developed. When E is Hilbert space, the filtration is complete: $L_\infty(E)$ is the smallest subset of $L_0(E)$ with the closure properties above containing all the stable measures. The talk will consist of a survey of these results and the methods used to derive them. One of the key steps is the introduction of a convenient compactification of E^*. On the line analogous classes were introduced by K. Urbanik and studied also by the authors [Abstract 76T-F3, these Notices 23 (1976), A-290]. (Received January 27, 1977.)

*745-F3 BURGESS DAVIS, Purdue University, West Lafayette, Indiana, 47907. On stopping times for n dimensional Brownian motion.

Let τ be a stopping time for a standard n dimensional Brownian motion $X(t) = (Y_1(t),\ldots,Y_n(t))$, $t \geq 0$, and let $p > 0$. It is shown that there is a constant A depending on p but not on τ or n such that $||(|X(\tau)/n^{1/2}|) - \tau^{1/2}||_p \leq A||\tau^{1/2}||_p/n^{1/2}$. It is also shown that if $||\tau^{1/2}||_k < \infty$ and k is a positive integer then most of the moments $E\,Y_i(\tau)^k$, $i=1,2,\ldots,n$, are about what they would be if τ were independent of $X(t)$, $t \geq 0$. (Received February 7, 1977.)

745-F4 Victor Goodman, Indiana University, Bloomington, Indiana 47401. Asymptotic behavior of certain exit probabilities for vector-valued symmetric random walk and Brownian motion.

Sufficient conditions are given for the submartingale inequality

$$P(\max_{r \leq n}\|S_r\| > \lambda) \leq 2P(\|S_n\| > \lambda)$$

to be asymptotically sharp (λ large). Similar conditions are found for vector-valued Brownian motions, and an application is given where the tail distributions of the supremum of the n-parameter Wiener process and the supremum of its absolute value are estimated. The tail distributions are asymptotically

$$2^n N(-\lambda) \quad , \quad 2^{n+1} N(-\lambda)$$

respectively, where $N(\lambda)$ denotes the standard normal distribution. (Received February 7, 1977.)

*745-F5 ANATOLE BECK, University of Wisconsin, Madison, Wisconsin 53706. Conditional Independence.

A collection of random variables is called conditionally independent if the conditional expectation of each with respect to the field of sets generated by the others is a constant. Equivalently, it is so called if every sequence of distinct members is a partingale. (A sequence of random variables is called a partingale if its partial sums form a martingale.) Conditional independence is a strictly weaker condition than independence, but strictly stronger than uncorrelatedness. It develops that many of the theorems which seem to rely on independence as a hypothesis require only conditional independence, e.g. the Kolmogorov Strong Law of Large Numbers. Many of the examples which show that uncorrelatedness is insufficient for some result are in fact not merely uncorrelated, but actually conditionally independent. The condition extends to B-space valued random variables, where it is again weaker than independence, but stronger than weak orthogonality. Examples are shown and discussed. (Received February 4, 1977.)

*745-F6 J.D. Kuelbs, University of Wisconsin, Madison, Wisconsin 53706. Some exponential Moments with applications to density estimation and the empirical distribution function.

Let $X_1, X_2, \ldots$ be independent mean zero random variables with values in a measurable linear space $(B, \mathcal{B}, \|\cdot\|)$. Let $S_n = X_1 + \ldots + X_n$ $(n \geq 1)$, $a_n = \sqrt{2n \log\log n}$ $(n \geq 3)$, and define

$$M = \sup_{n \geq 3} \left\|\frac{S_n}{a_n}\right\| .$$

If $\{\frac{S_n}{\sqrt{n}} : n \geq 1\}$ is bounded in probability and $\sup_j E(\exp(\beta\|X_j\|^2)) < \infty$ for some $\beta > 0$, then there exists $\beta_0 > 0$ such that for $\beta \le \beta_0$

$$E(\exp\{\beta M^2\}) < \infty .$$

The exponential moments of M apply readily to obtain rates of convergence results for the empirical distribution and in density estimation. (Received February 10, 1977.)

745-F7 WOJBOR A. WOYCZYNSKI, Northwestern University, Evanston, Illinois 60201, and Wroclaw University, Wroclaw, Poland 50384, Domains of attraction of stable measures on Banach spaces. Preliminary report.

In Banach spaces E if $X = \Sigma\, \theta_n x_n$ is a stable random vector in E (θ_n i.i.d with ch. f. $\exp -|t|^p$, $0 < p < 2$, $(x_n) \subset E$) then the distribution law of $y = \Sigma\, \xi_n x_n$ is in the domain of normal attraction of the law of X whenever (ξ_n) are i.i.d. with the law of ξ_1 being in the domain of normal attraction of θ_1 on the real line. Similar statement fails in general if one drops the assumption that (ξ_n) are identically distributed. This is a joint work with Professor Michael B. Marcus. (Received February 14, 1977.)

*745-F8 MARJORIE G. HAHN, Department of Statistics, University of California, Berkeley, California 94720. A characterization of the Kolmogorov difference property and its relationship to the central limiting behavior of square-integrable stochastic processes.

Let $\{X_t,\ t \in [0,1]\}$ be a stochastic process and f a nonnegative function on [0,1]. Conditions of the form

$$(*) \qquad E(X_t - X_s)^2 \leqslant f(|t-s|)$$

are studied, as they pertain to sample-continuity and the central limiting behavior of the process X_t.

A function f is said to have the Kolmogorov difference property (KDP) if any stochastic process X_t which satisfies (*) , for all $s,t \in [0,1]$, has continuous sample paths. A characterization of all functions having KDP is given by a condition obtained in collaboration with M. Klass. Furthermore, (*) alone provides a sufficient condition for X_t to satisfy the central limit theorem (CLT) in C[0,1] if and only if f has KDP. A method for constructing sample-continuous processes which do not satisfy the CLT is discussed. (Received February 16, 1977.)

*745-F9 G. Pisier and J. Zinn, Ecole Polytechnique, Center de Mathematiques, 91120 Palaiseau, France and University of Massachusetts, Amherst, Massachusetts, 01003. The central limit theorem in ℓ^p (p > 2) and the log log law in Hilbert space.

The following theorems and corollaries are proven for an i.i.d sequence $X, X_1, \ldots$.

Theorem 1. An ℓ^p-valued random variable, X, $2 < p < \infty$ satisfies the central limit theorem (CLT) if and only if (a) X is pre-Gaussian, (b) $t^2 P(\|X\|_p > t) \to 0$ as $t \to \infty$.

Corollary 1. For each $2 < p < \infty$ there exists an ℓ^p-valued X which does not satisfy the CLT and yet $\sup_n E\left\|\frac{X_1 + \ldots + X_n}{\sqrt{n}}\right\|_p < \infty$ (which implies, since we're in ℓ^p, that X is pre-Gaussian.)

Theorem 2. Let X be a Hilbert space valued random variable. Then the following three conditions imply that X satisfies the law of the iterated logarithm on H: (i) $E[\|X\|^2/(\ln \ln(\|X\| \vee e^e))] < \infty$; (ii) $EX = 0$; (iii) $E(<X_1, X_2>)^2 < \infty$.

Corollary 2. There exists a mean zero, Hilbert space-valued random variable, X, with $E\|X\|^2 = \infty$, which satisfies the law of the iterated logarithm. (Received February 21, 1977.) (Author introduced by Professor Richard Ellis).

Topology (22, 54, 55, 57, 58)

*745-G1 **STEVE DIBNER, Washington University, St. Louis, Missouri 63130**
<u>An alternate method of finding certain link groups</u>.

Suppose K is a knot or a 2-component unknotted link, in S^3. A simple arc $v \subset S^3$ with $v \cap K = \partial v$ is called a <u>freeing arc</u> for K if $\pi_1(S^3 - (K \cup v)) = F_2$, the free group of rank 2. For a particular family of links $L_{i,j}$, we have described motions of S^3 which untwist $(K \cup v)/v$ into standard position, yielding a standard genus-2 Heegaard splitting for any manifold obtained from S^3 by surgery along K [abstract 742-57-1, Notices 24 #1 (Jan., '77); also Genus-2 Heegaard splittings for certain 3-manifolds (preprint), Washington U., 1976]. Now, if K is any knot or link whose freeing arc admits such an untwisting of $(K \cup v)/v$, we find a presentation of the group $\pi(K) = \pi_1(S^3 - K)$, as follows. Since $S^3 - K$ is regained from $S^3 - (K \cup v)$ by filling in the arc v, a relation defining $\pi(K)$ is found by expressing the class of a meridian of v in terms of generators of $\pi_1(S^3 - (K \cup v)) = F_2$. This expression is provided by the untwisting. (Received January 3, 1977.)

745-G2 Victor P. Snaith, The University of Western Ontario, London, Ontario N6A 5B9. <u>Some new elements in the stable homotopy of BO</u>.

The following result is proved.

Theorem: (i) There exist isomorphisms $\pi_j^S(BO(2n)) \cong \pi_j^S(BO(2n-2)) \oplus B_j(n)$ for all $j \geq 0$, $n \geq 1$.

(ii) $B_j(n)$ contains the $\delta(j)$-fold sum of copies of $Z/2$ where

$$\delta(j) = \begin{cases} 0 & \text{if } j < 2n-1, \\ 1 & \text{if } j = 2n-1, \\ d(j-2n+1) + d(j-2n) & \text{if } 2n \leq j \leq 4n-3, \end{cases}$$

where $d(h)$ is the number of partitions of h into positive integers not of the form $2^m - 1$.

(iii) Each $Z/2$ in (ii) is detected by the Hurewicz homomorphism.

The proof proceeds by embedding copies of $\pi_k(MO)$ in $\pi_*^S(BO)$. Similar constructions yield $\pi_*(MU)$ - and $\pi_*(MSp)$ - elements in $\pi_*^S(BU)$ and $\pi_*^S(BU)$ and $\pi_*^S(BSp)$ respectively.
(Received January 24, 1977.)

*745-G3 Howard Osborn, University of Illinois, Urbana, Illinois 61801.
<u>The Hopf ring</u>.

There is a "scissors-and-glue" equivalence relation for which the equivalence classes of orientable (<u>not</u> oriented) smooth closed manifolds X of even positive dimension form a graded commutative semi-ring S. Let $I \subset S$ be the ideal of those classes which contain manifolds with non-vanishing vector fields. Then S/I is a graded commutative <u>ring</u> generated by the classes $[S^2] \in S/I$ and $[E^4]$ of the 2-sphere S^2 and a 4-dimensional manifold E^4, respectively, with one relation $[S^2]\cdot[S^2] = 4\,[E^4]$.

The Euler characteristic $\chi(X)$ of X depends only on the class $[X] \in S/I$, and the assignment $\chi([X]) = \chi(X)$ is the unique ring homomorphism $\chi : S/I \to Z$ with $\chi([S^2]) = 2$. Uniqueness of the homomorphism χ provides a brief and uniform way to prove that other constructions also yield the Euler characteristic; this includes the Hopf index sum theorem, the Gauss-Bonnet theorem, and the Euler class computation $\langle e(\tau(X)), \mu_X \rangle = \chi(X)$. (Received February 7, 1977.)

745-G4 RICHARD J. ALLEN, St. Olaf College, Northfield, Minnesota 55057. Equivariant embeddings of finite abelian group actions. Preliminary report.

Let G be a finite abelian group and let $G = R_1 \oplus \cdots \oplus R_r \oplus H_1 \oplus \cdots \oplus H_s$, where the R's are cyclic groups of order $\neq 2$ and the H's are all of order 2. Suppose X is a compact n-dimensional metric space and suppose G acts on X. It is shown that X equivariantly embeds in a euclidean space with an orthogonal G-action; a minimum dimension for the euclidean space is also obtained.

A corollary of this result is that if X and G are as above, then X equivariantly embeds in an orthogonal G-action on R^N, where $N = \max\{2n+1, 2r+s\}$. (Received February 7, 1977.)

745-G5 Mark Feshbach, Northwestern University, Evanston, Illinois 60201. The Transfer and Characteristic Classes. Preliminary report.

A double coset theorem for the transfer and classifying spaces of compact Lie groups (to appear Bull. AMS May 1977) has been proved by the author. This theorem specializes to theorems relating the cohomologies of a compact Lie group, G, and that of its maximal torus, T. The classical theorem $H^*(BG, Q) \cong H^*(BT, Q)^W$, where W is the Weyl group, follows immediately from one of these formulas. Other results including the Whitney product formula for Chern classes follow from this approach. Some of these formulas and applications were obtained originally by Brumfiel and Madsen. (Received February 14, 1977.)

745-G6 Robert J. Zimmer, U.S. Naval Academy, Annapolis, Maryland 21402. Restricting Lie group actions to lattice subgroups.

Let G be a connected Lie group and H be a lattice subgroup. Suppose that G acts ergodically on a standard Borel space with quasi-invariant measure. The question arises as to whether the action of H is still ergodic. We provide criteria for this ergodicity for the cases in which G is simple or nilpotent. (Received February 14, 1977.)

745-G7 MICHAEL BARRATT, Northwestern University, Evanston, IL 60201 and CHRISTOPHER HANKS, Millikin University, Decatur, IL 62522. On the structure of Thom spaces. Preliminary report.

By the Thom space of an X-G-bundle $X \to E \xrightarrow{p} Y$ induced by $\alpha: Y \to BG$ we mean the mapping cone $T(\alpha) = Y \cup_p C(E)$. This generalizes the view of the Thom complex of a vector bundle as the mapping cone of the associated sphere bundle. Clearly $T(\alpha)$ contains $T(\alpha|\text{basepoint}) = \Sigma X$ and two classical results are:

(1) if $Y = B \cup C(A)$ then $T(\alpha) = T(\alpha|B) \cup C(A*X)$ and

(2) if $Y = \Sigma A$ then $T(\alpha) = \Sigma X \cup_{J(\alpha)} C(A*X)$ where $J(\alpha)$ is the Hopf construction on the map $A \times X \to X$ induced by the adjoint $A \to G$ of α and the action of G on X.

If Y is a mapping cone $B \cup C(A)$ and $\xi: \Sigma P \to Y$, there is induced a map of Thom spaces $\xi': T(\alpha \circ \xi) \to T(\alpha)$ and hence a map $\xi'': T(\alpha \circ \xi)/\Sigma X = \Sigma(P*X) \to T(\alpha)/T(\alpha|B) = \Sigma(A*X)$. This map can be described by using ξ; $J(\alpha \circ \varepsilon)$, where $\varepsilon: \Sigma\Omega Y \to Y$ is the evaluation map; and a certain relative Hopf invariant $\mathcal{H}(\xi): \Sigma P \to \Sigma(A \wedge \Omega Y)$ of ξ, defined by means of the co-operation $\rho: Y = B \cup C(A) \to Y \vee \Sigma A$.

The theorem, expressed in terms of maps $\Sigma^2 P \wedge X \to \Sigma^2 A \wedge X$ is

(3) ξ'' is the track sum of the two compositions:

(a) $\Sigma P \xrightarrow{\xi} Y \xrightarrow{\text{pinch}} \Sigma A$, smashed with the identity map of ΣX and

(b) $\mathcal{H}(\xi): \Sigma P \to \Sigma A \wedge \Omega Y$, smashed with the identity map of ΣX, composed with $J(\alpha \circ \varepsilon): \Sigma\Omega Y \wedge X \to \Sigma X$ smashed with the identity map of ΣA.

In the case that $Y = \Sigma A$, the composition (b) can be expressed as a sum of compositions of the James-Hopf invariants (for $n = 1, 2, 3 \ldots$) $H_{n+1}(\xi): \Sigma P \to \Sigma A^{(n+1)}$ smashed with the identity map of ΣX, with maps $J_n(\alpha): \Sigma A^{(n+1)} \wedge \Sigma X \to \Sigma A \wedge \Sigma X$ obtained by using $J(\alpha): \Sigma A \wedge X \to \Sigma X$ n times. (Received February 14, 1977.)

745-G8 Jay E. Goldfeather, University of Wisconsin-Milwaukee, Milwaukee, WI. 53201. Incompressible Maps.

Let G be a finitely generated abelian group. Methods are developed to detect whether non-trivial maps $\Omega\Sigma X \to K(G,n)$ are incompressible, where X is homotopic to a finite dimensional complex. In particular, under certain conditions on n, all non-trivial maps $\Omega S^{k+1} \to K(G,nk)$ are incompressible, generalizing a result of Weingram. Also, it is shown that all non-trivial maps $\Omega SM(Q/Z,2n-1) \to K(G,2n)$ and $\Omega SM(Z_{p^\infty},2n-1) \to K(G,2n)$ are incompressible. These theorems produce new results in the theory of finite dimensional H-spaces. (Received February 16, 1977.)

745-G9 PETRIE, TED, Rutgers University, New Brunswick, N.J. 08903. Proper equivariant maps between representations of Lie groups. Preliminary report.

Given two complex representations N and M of a compact Lie group and a proper G map $f:N \to M$, define for each subgroup $K \subset G$ an integer $d_K(f)$ as the degree of the induced map $f^K:N^K \to M^K$ between the K fixed sets. If the dimension of N^K and M^K differ, $d_K(f)=0$.
Question 1. What are the relations among the integers $\{d_K(f) | K \subset G\}$?
Question 2. Given a collection of integers $\{n_K | K \subset G\}$ when is this realized as $\{d_K(f) | K \subset G\}$ for some f? These questions are answered entirely in terms of the difference M-N in the complex representation ring of G and the structure of the subgroups of G. (Received February 16, 1977.) (Author introduced by Professor Peter Orlik).

*745-G10 Jerrold Siegel, University of Missouri-St. Louis, St. Louis, Missouri 63121. β - Representable Homotopy Functors.

Consider $[-,B]$ as a functor on suitable subcategories of finite complexes (e.g. n-connected, in a given Serre class). It is shown that the Čech extension of such functors to C Reg T_2 is of the form $[\beta-, B']$ for a suitable B' (β being Stone-Cech compactification). In certain situations these functors are seen to be homotopy functors (not nec. representable). In particular, the pro-representable functors of Deleanu and Hilton are shown to be of this form. Advantage is taken of the geometric form of the representation. (Received February 16, 1977.)

745-G11 Mark Mahowald, Northwestern University, Evanston, Illinois 60201. New infinite [illegible] in the [illegible] of the homotopy of spheres.

The following theorem [illegible] new family of homotopy classes. Theorem: The element $h_i h_j \in Ext_A^{2,2^j+\ldots}$ [illegible] represents a non zero stable homotopy class if $j \neq 2$. (Top. 1977). In this report [illegible] of this result are discussed.
(Received February 17, 1977.)

745-G12 Laurence R. Taylor, University of Notre Dame, Notre Dame, Indiana 46556. A bordism spectral sequence. Preliminary report.

Thm: Let $F \to E \to B$ be a fibration and suppose given a spherical fibration over E. Let M_E denote the Thom space of this fibration, and let M_F denote the Thom space of the fibration restricted to F. Then there is a spectral sequence whose E^2 term is $H_p(B; \tilde{h}_q(M_F))$ which abuts to $\tilde{h}_{p+q}(M_E)$ for any extraordinary homology theory h_*. There exist relative versions of this spectral sequence and all the naturality one could hope for. Alas the homology may be twisted.
If h_* is stable homotopy theory, the theorem gives spectral sequences from one bordism theory to another, mimicking classical fibrations. From $BSU \to BU \to CP^\infty$ we will recover known structure of MSU_* as far as N. Ray's result that KO_* decides MSU.
(Received February 17, 1977.)

*745-G13 ARUNAS LIULEVICIUS, University of Chicago, Chicago, Illinois 60637. Characters tell all.

Let G be a compact group, $\alpha: G \to U$ a representation into a unitary group $U = U(m)$. Suppose H is a closed subgroup of U; then α induces an action on U/H which we call a linear action and denote the G-space $(U/H, \alpha)$. We will show the following remarkable rigidity property of linear actions: suppose $\alpha, \beta: G \to U = U(m+k)$ are representations, H is conjugate to $U(m) \times T^k$ where T^k is the k-torus, and $k \leq m$; then a G-map $f: (U/H, \alpha) \to (U/H, \beta)$, which is a homotopy equivalence (if the action of G is ignored), exists if and only if either β or its complex conjugate $\overline{\beta}$ is similar to $\chi\alpha$ for a suitable homomorphism $\chi: G \to U(1)$. The Picard group of G-equivariant line bundles on a G-space X is a key tool. Complete information on algebra automorphisms of $H^*(U/H; Z)$ is obtained. The results allow one to read off the G-homotopy type of $(U/H, \alpha)$ from the character table of G. For example, if the character of α at some conjugacy class differs in absolute value from the character of β, then $(U/H, \alpha)$ is not G-homotopy equivalent to $(U/H, \beta)$. (Received February 18, 1977.)

*745-G14 LOUIS H. KAUFFMAN, University of Michigan, Ann Arbor, Michigan 48109. Signature of Branched Fibrations. Preliminary report.

A branched fibration, $\pi: E \longrightarrow M$, is a topological generalization of a pencil of algebraic varieties over a manifold M, with degenerate fibers along a co-dimension-two submanifold $F \subset M$. We shall discuss problems of computing signatures for branched fibrations, and relationships with hypersurface singularities, knot theory and branched coverings. (Received February 18, 1977.)

*745-G15 LOUIS SOLOMON, University of Wisconsin, Madison, Wisconsin, 53706 and PETER ORLIK, University of Wisconsin, Madison, Wisconsin, 53706. Automorphism groups of forms.

Let V be an n-dimensional vector space over $\mathbb{C}$ and let A be the algebra of polynomial functions on V. Let $f \in A$ be a non-singular form of degree $m \geq 3$. Let $G = \mathrm{Aut}(f) = \{s \in GL(V): sf = f\}$, a finite group. Let $Y = \{v \in V: f(v) = 1\}$. We compute the character χ of the representation of G on the complex cohomology of Y. Theorem: If $s \in G$ then $\chi(s) = (-1)^{n-k(s)}(m-1)^{k(s)}$ where k(s) is the dimension of the subspace of V fixed by s. (Received February 22, 1977.)

Miscellaneous Fields (00, 01, 96–99)

745-H1 RAY REDHEFFER, University of California, Los Angeles, California 90024. Mathematics with and without Words.

Five short films made by Redheffer in the Office of Charles Eames. The titles are Alpha, Two Laws of Algebra, Exponents, Exponents (with a different sound track), and Newton's Method of Fluxions. The shortest is 80 seconds, the longest under 4 minutes. Fast-paced and mathematically subtle, the films are meant to be seen and studied, and seen again. All but the last are done to music rather than words, hence are independent of language skills. The underlying philosophy is influenced by the author's experience teaching disadvantaged students in grades K-5, including the totally deaf. However, the films operate on more than one level. For example, Film 2, though based partly on elementary teaching, also motivates some of the axioms for a vector space. Since commutativity is not exploited, a development in Film 3 isomorphic to that in Film 2 leads to several laws of exponents. About 1/4 of the last film is devoted to a derivation of Leibniz' rule by Newton's Method in exact synchronism to the music of Greensleeves. This old English tune was first used as a Christmas carol on Christmas, 1642, which is the day Newton was born. (Received February 17, 1977.)

746TH MEETING

California State University
Hayward, California
April 22–23, 1977

Algebra and Theory of Numbers (05, 06, 08, 10, 12–18, 20)

*746-A1 RUSSELL MERRIS, California State University, Hayward, CA 94542. Generalized Matrix Functions.

Let λ be an irreducible character of the symmetric group S_m. The generalized matrix function of $A=(a_{ij})$ corresponding to S_m and λ is

$$d(A) = \sum_{\sigma \in S_m} \lambda(\sigma) \prod_{t=1}^{m} a_{t\sigma(t)}$$

Assume λ corresponds to the Young frame $(m_1,\ldots,m_t)$, where $m_1 \geq \ldots \geq m_t \geq 1$, and $m_1+\ldots+m_t = m$. Theorem 1. If A has more than m_1 equal rows (columns), then $d(A)=0$. (Cor. If A has 2 equal rows, $\det(A)=0$.) Theorem 2. If rank $A<t$, then $d(A)=0$. (Cor. If A is singular, $\det(A)=0$.) Theorem 3. Suppose A is positive semidefinite hermitian with no zero rows. If $d(A)=0$, then rank $A<m-m_1+1$. (Cor. If $\det(A)=0$, A is singular.) (Received January 3, 1977.)

746-A2 ERIC VERHEIDEN, California Institute of Technology, Pasadena, California 91125. Completions of Integral Matrices. Preliminary report.

Using elementary linear algebra and certain classical results from the theory of integral quadratic forms, it is possible to show that for any integral (n-r) by n matrix X satisfying $XX^T = mI$ with $r \leq 7$, there is an integral matrix A of order n by n with X as its first n-r rows and satisfying $XX^T = mI$. This result is an extension of a result derived by Marshall Hall for the case $r \leq 2$. (Received January 11, 1977.)

746-A3 Marvin Marcus, University of California, Santa Barbara, California 93106 and B. N. Moyls, University of British Columbia, Canada and I. Filippenko, University of California, Santa Barbara, California 93106. Some convexity properties of the higher numerical range.

Let A be an n-square complex matrix with eigenvalues $\lambda_1, \ldots, \lambda_n$. Using the standard inner product in C^n define $W_m(A)$, the m^{th} numerical range of A, to be the set of numbers $\sum_{i=1}^{m}(Ax_k,x_k)$ where $x_1, \ldots, x_m$ vary over all o.n. sets of m vectors in C^n. Let $\lambda_{\omega(1)},\ldots,\lambda_{\omega(m)}$ be any m of the λ_i and define $P_m(A)$ to be the convex hull of all $\binom{n}{m}$ sums $\sum_{i=1}^{m}\lambda_{\omega(k)}$. It is well known that $P_m(A) \subset W_m(A)$ and if A is normal that $P_m(A) = W_m(A)$. A is said to be m-convex if $P_m(A) = W_m(A)$. THEOREM: A is normal iff A is m-convex for each m, $1 \leq m \leq [\frac{n}{2}]$. To see that the theorem is best possible let $n = 2m+3$ and define $A = \mathrm{diag}(e^{k\theta i}:k=0,\ldots,2m) + \begin{bmatrix} 0 & \epsilon \\ 0 & 0 \end{bmatrix}$ where $\theta = \frac{2\pi}{2m+1}$. Then for $|\epsilon| \leq 2\cos(\frac{m\pi}{2m+1})$, A is k-convex, $k = 1, \ldots, m$. However, unless $\epsilon = 0$, i.e., A is normal, A is not (m+1)-convex. A program for plotting $P_m(A)$ and $W_m(A)$ has been developed. Transparencies of both sets illustrating the theorem are available for: $n = 5$, $m = 1, 2, 3$; $n = 7$, $m = 1, 2, 3$; $n = 9$, $m = 1, 2, 3, 4$. (Received January 17, 1977.)

746-A4 Stanley J. Benkoski, Tetra Tech Inc., ARPA Research Center, Unit 1, Moffett Field Ca. 94035. The Probability that k Polynomials are Relatively r-Prime. Preliminary report.

Let P[x] be the domain of polynomials in x with coefficients from a finite field F of order $q=p^v$. Since P[x] is a unique factorization domain, we can define a generalized Euler function. If p_1, $p_2, \ldots, p_k \in P[x]$, then $(p_1, p_2, \ldots, p_k)_r = s$ if s is the monic polynomial of highest degree such that $s^r|p_1$, $s^r|p_2, \ldots, s^r|p_k$. s is the r^{th} power g.c.d. of $p_1, p_2, \ldots, p_k$ and if s=1, then p_1, $p_2, \ldots, p_k$ are relatively r-prime. If B(n) is the number of k-tuples $(p_1, p_2, \ldots, p_k)$ with the degree of $p_i \leq n$ for all i and A(k,r,n) is the number of k-tuples in B(n) with $(p_1, p_2, \ldots, p_k)=1$ then the limit as n goes to infinity of A(k,r,n)/B(n) is $1/\zeta(rk)=q^{rk-1}-1/q^{rk}-1$. This can be interpreted as the probability that k polynomials chosen at random will be relatively r-prime. (Received January 17, 1977.)

746-A5 Robert Grone, Institute for Algebra and Combinatorics, Decomposable tensors as a quadratic variety.

Let F be a field and let z denote a tensor in $F^{n_1} \otimes \cdots \otimes F^{n_m}$. In this paper a set of quadratic polynomials in the coordinates of z is exhibited for which the associated variety is the set of decomposable tensors. This extends the known fact that the set of rank 1 n_1-by-n_2 matrices is a quadratic variety corresponding to the set of 2-by-2 minors of the matrix. Connections are also exhibited between these quadratic relations and the quadratic Plücker relations which obtain among the order m minors of an n_1-by-n_2 matrix. (Received February 4, 1977.) (Author introduced by Dr. M. Marcus).

*746-A6 Moshe Goldberg, University of California, Los Angeles, CA, 90024. Some inclusion relations for c-numerical ranges.

Let $c = (\gamma_1, \ldots, \gamma_n)$ be a fixed complex vector. The c-numerical range of an $n \times n$ matrix A, is the set $W_c(A) = \{\Sigma\, \gamma_j(Ax_j, x_j)\}$, where $(x_1, \ldots, x_n)$ vary over all orthonormal systems in $\mathbb{C}^n$. Given c, c', we study inclusion relations of the form $W_c(A) \subset W_{c'}(A)$ which hold uniformly for all n-square matrices A. In particular we consider the case where c, c' are real. Such inclusion relations imply inequalities among c-numerical radii which are defined by $r_c(A) = \max\{|z| : z \in W_c(A)\}$. (Received February 7, 1977.)

746-A7 R. C. Thompson, University of California, Santa Barbara, California, 93106. Similarity invariants for principal submatrices.

Necessary and sufficient conditions have been found for the existence of a matrix (over a field) such that it and its leading principal submatrices have prescribed similarity invariants. (Received February 9, 1977.)

746-A8 Marvin Marcus and Ivan Filippenko, Institute for Algebra and Combinatorics, University of California, Santa Barbara, California 93106. Linear operators preserving the decomposable numerical range.

Let V be an n-dimensional unitary space and $1 \leq m \leq n$. The Grassmannian manifold $G_m(V)$ is the set of all unit length decomposable symmetrized tensors in the m^{th} Grassmann space $\bigwedge^m V$ over V. For a linear operator $A \in \mathrm{Hom}(V,V)$, let $C_m(A) : \bigwedge^m V \to \bigwedge^m V$ denote the m^{th} compound of A, and define the m^{th} decomposable numerical range of A to be the set of complex

numbers $W_m^{\wedge}(A) = \{(C_m(A)z,z) \mid z \in G_m(V)\}$. Observe that $W_1^{\wedge}(A) = W(A)$, the classical numerical range of A. THEOREM. Let $1 \leq m \leq n-1$. Then $A \in \mathrm{Hom}(V,V)$ is unitary if and only if $W_m^{\wedge}(A)$ is contained in the closed unit disc and every eigenvalue of A has modulus 1. THEOREM. Let $1 \leq m \leq n-1$, and let $T : \mathrm{Hom}(V,V) \to \mathrm{Hom}(V,V)$ be a linear operator such that $W_m^{\wedge}(T(A)) = W_m^{\wedge}(A)$ for all $A \in \mathrm{Hom}(V,V)$. Then there exist a unitary operator $U \in \mathrm{Hom}(V,V)$ and a complex m^{th} root of unity ξ such that (i) $T(A) = \xi U^* A U$ for all $A \in \mathrm{Hom}(V,V)$, or (ii) $T(A) = \xi U^* A^T U$ for all $A \in \mathrm{Hom}(V,V)$.
(Received February 11, 1977.)

746-A9 H. J. RYSER, California Institute of Technology, Pasadena, California 91125.
Indeterminates and incidence matrices, Preliminary report.

This paper broadly surveys some of the recent activity dealing with indeterminates and incidence matrices. We discuss the role of indeterminates in certain set intersection problems. We also discuss their role in the study of fully indecomposable and irreducible matrices. (Received February 14, 1977.)

746-A10 MORRIS NEWMAN, University of California, Santa Barbara, California 93106.
Positive definite matrices and Catalan numbers.

Let S_n be the set of all $n \times n$ integral positive definite unimodular triple diagonal matrices such that the elements on the sub and super diagonals are all 1. Then it is shown that S_n is a finite set, and that the cardinality of S_n is given by $S_n = \binom{2n}{n} / (n+1)$, the Catalan number. Related results are proved; for example. it is shown that if A is a fixed $n \times n$ integral symmetric matrix, then there are only finitely many integral diagonal matrices D such that $D + A$ has a given determinant and is positive definite. This paper represents joint work of F. T. Leighton and M. Newman. (Received February 14, 1977.)

*746-A11 John de Pillis, University of California, Santa Cruz, CA 95064.
An inequality on ranks in sums of decomposable tensors.

For matrices A and B, we define the decomposable dyadic product $(A\rceil\lceil B)$ by $(A\rceil\lceil B):C = \mathrm{trace}\,(CB^*)\,A$ and the decomposable Kronecker product $A \otimes B^t$, by $A \otimes B^t : D = ADB$ for all appropriately dimensioned C,D. If r_A, r_B denote the ranks of $\{A_i\}$, $\{B_i\}$, then we have the following.
Theorem. Consider the matrix sum $\sum_{i=1}^{N} (A_i \rceil\lceil B_i) = T$. Then $2 \cdot \mathrm{rank}\,(T) < r_A + r_B \leq \mathrm{rank}\,(T) + N$. A dual theorem is valid for matrix sums of the form $\sum_{i=1}^{N} A_i \otimes B_i^t$. This inequality is useful in determining necessary conditions for N dyads (or Kronecker products) to sum to a decomposable dyad (or Kronecker product). (Received February 16, 1977.)

*746-A12 CHRISTOPHER L. MORGAN, California State University, Hayward; Hayward, California 94542.
Linear Relations with Small Support for Group Representations.

Let G be a finite group, and let $A : G \to GL(n, \mathbb{C})$ be a representation. We show how characters on subgroups of G induce linear relations on $A(G)$, and we determine the span of these relations. (Received February 18, 1977.)

*746-A13 S. Verma, University of Nevada, Las Vegas, Las Vegas, NV 89154.
On a Rotation of Pascal's Triangle Giving the Number of Terms in a Multinomial Expansion. Preliminary report.

The purpose of this note is to present at the freshman level, appealing only to binomial theorem, some geometrical properties, and Pascal's triangle, a very elementary and elegant proof of the fact that the number of terms T(n,k) in the expansion of a multinomial $(a_1+\dots+a_k)^n$ is given by $T(n,k) = \binom{n+k-1}{n}$. In order to achieve this result in a simple manner, rotation of Pascal's triangle through 45° about its vertex is needed. After this is achieved the number of terms in a multinomial expansion can then be directly read from the resulting infinite rectangle by making use of simple geometrical properties of lines and properties of the coefficients T(n,k) derived in this note by making use of binomial theorems. Other complicated and advanced proof of this fact exists in the literature. (Received February 21, 1977.) (Author introduced by L. J. Simonoff).

746-A14 JAMES A. ANDERSON, Northern Arizona University, Flagstaff, Arizona 86001 and TOM HEAD University of Alaska, Fairbanks, Alaska 99701. Pure diagrams of abelian groups. Preliminary report.

Let $\mathcal{R} = (\mathcal{S}, \rho)$ where $\mathcal{S}$ is a set and $\rho \subset \mathcal{S} \times \mathcal{S}$. Let $\mathbb{D}$ consist of Abelian groups $\mathbb{D}(S)$ and homomorphisms $\mathbb{D}(S,T): \mathbb{D}(S) \to \mathbb{D}(T)$, $S \in \mathcal{S}$, $(S,T) \in \rho$. Call $\mathbb{D}$ an $\mathcal{R}$-diagram. All diagrams considered are assumed commutative. $\mathbb{D}$ has the diamond property if: $s \in \mathbb{D}(S)$, $0 \neq t \in \mathbb{D}(T)$, $(S,U) \in \rho$, $(T,U) \in \rho$, and $\mathbb{D}(S,U)(s) = \mathbb{D}(T,U)(t)$ imply there is an $X \in \mathcal{S}$, and $x \in \mathbb{D}(X)$ such that $\mathbb{D}(X,S)(x) = s$ and $\mathbb{D}(X,T)(x) = t$. For each nonnegative integer n we have a diagram $\mathbb{D}_n(S) = \mathbb{D}(S)/n\mathbb{D}(S)$, $\mathbb{D}_n(S,T)$ induced by $\mathbb{D}(S,T)$. For each Abelian group G we have a diagram $(G \otimes \mathbb{D})(S) = G \otimes \mathbb{D}(S)$, $(G \otimes \mathbb{D})(S,T) = 1_G \otimes \mathbb{D}(S,T)$. $\mathbb{D}$ is pure if each $\mathbb{D}_n$ has the diamond property. (The diagram $A \to B$ has the diamond property iff the map is monic and it is pure iff the map is monic with pure image.) $\mathcal{R}$ is a saddle relation if: (A,U), (A,V), (B,U), $(B,V) \in \rho$ imply there is an $S \in \mathcal{S}$ for which (A,S), (B,S), (S,U), $(S,V) \in \rho$. Theorem. Let $\mathcal{R}$ be a saddle relation, $\mathbb{D}$ a pure $\mathcal{R}$-diagram, and G an Abelian group. Then $G \otimes \mathbb{D}$ is pure. This result will be used in the study of regular commutative semigroups. (Received February 21, 1977.)

746-A15 [illegible] OLGA TAUSSKY TODD, California Institute of Technology, Pasadena, California [illegible]5. Integral group matrices.

In two previous publications the author studied the representation of an integral p × p circulant A (p a prime) as BB' (B' the transpose) where B is again an integral circulant. It was shown that the condition that all characteristic roots of A are norms of integers in $Q(\zeta_p)$ is necessary and sufficient, ζ_p a p-th root of unity. This study is now extended to n × n circulants and abelian group matrices. (Received February 21, 1977.)

746-A16 D. H. LEHMER, University of California, Berkeley 94720. Permanent Problems concerning combinatorial matrices.

Matrices whose elements are 0 or 1 are important examples of combinatory matrices and the permanent function of such matrices has particular use in the study of the index of mobility of points on a crowded lattice. If the crowding is the result of the application of democratic restrictions, one often obtains for a lattice of size n a linear recurrence of high order for the number of permutations so restricted. In this case a goodly number of initial permanents are required. Hence an effective method for permanent evaluation of (0,1) matrices is desirable. The forthright use of the definition, usually considered too expensive, becomes practical with a highly parallel machine, such as the ILLIAC IV, since 60 permutations can be driven abreast. Another method of evaluating permanents of matrices of special types by means of vector manipulation is also described. (Received February 21, 1977.)

746-A17 **ALLAN B. CRUSE, University of San Francisco, San Francisco, California 94117.** **Some analogues of the assignment polytope. Preliminary report.**

Let S_n denote the full symmetric group of the n! permutation matrices of size n×n. The convex hull of S_n in n^2-dimensional Euclidean space is known as the assignment polytope.

L. Mirsky, in his well-known survey paper on doubly-stochastic matrices (Z. Wahrscheinlichkeitstheor. 1 (1963), 319-334), suggested the problem of determining, for a specified subgroup G of S_n, the convex hull of G. In general (as Mirsky noted) this problem seems very difficult. However, in certain interesting cases the problem is solvable: for example, if G is the normalizer in S_n of an element J, then the convex hull of G consists of those doubly-stochastic $n \times n$ matrices $X = (x_{ij})$ which satisfy the equations: $x_{ij} = x_{\theta i, \theta j}$ for all indices i, j in $\{1, 2, \ldots, n\}$, and $x_{ij} = 0$ if i and j belong to orbits of θ having unequal lengths. (Here θ denotes the permutation on $1, 2, \ldots, n$ represented by the matrix J.) When J is the identity-matrix, this result reduces to the well-known theorem of G. Birkhoff. In general the result extends recent work by the author on centrosymmetric matrices (Lin. Alg. Appl. 16 (1977), 65-77). (Received February 22, 1977.)

746-A18 Robert J. Douglas, San Francisco State University, San Francisco, California 94132. Bounds on the number of Hamiltonian circuits in the n-cube.

New upper and lower bounds are found for the number of Hamiltonian circuits in the graph of the n-cube. (Received February 22, 1977.)

Analysis (26, 28, 30–35, 39–47, 49)

746-B1 J. L. Brenner, 10 Phillips Rd., Palo Alto, California 94303. A unified treatment of some means of classical analysis. Preliminary report.

Let $a = (a_1, \ldots, a_n)$ be an n-vector of positive numbers, not all equal. Let $\alpha = (\alpha(1), \ldots, \alpha(n))$ $[\beta = (\beta(1), \ldots, \beta(n))]$ be a vector of real numbers. The symbol a^α denotes the sum $\sum a_1^{\alpha(1)} \ldots a_n^{\alpha(n)}$ obtained by permuting the (inferior) subscripts $1 \ldots n$, but keeping the same exponents in each of the n! terms. Set $|\alpha| = \sum \alpha(i)$. The mean $M(a) = [a^\alpha / a^\beta]^{1/(|\alpha| - |\beta|)}$ is clearly homogeneous $[M(ka) = k\, M(a)]$ and symmetric in the a_i. Specializations: for $\alpha = (p, 0, \ldots, 0)$, $\beta = 0$, $M(a)$ is the Hölder $[L_p]$ mean. For $\alpha = (r, 0, \ldots, 0)$, $\beta = (s, 0, \ldots, 0)$ $[(r-1, 0, \ldots, 0)]$, $M(a)$ is the Dresher [Beckenbach] mean. For $|\alpha| = 1$, $\beta = 0$, $M(a)$ is the Muirhead mean. For $\alpha = (1, \ldots, 1, 0, \ldots, 0)$, $\beta = 0$, $M(a)$ is the Maclaurin mean. Theorem 1. If $\forall_{j>1} [\alpha(j) = \beta(j)]$, then $M(a)$ increases as $\alpha(1)$ increases. This generalizes (greatly) the well-known result of Hölder that $[\sum a^p/n]^{1/p}$ increases with p. Corollary. The Beckenbach mean increases with r. Extension to (Stieltjes-Lebesgue) integral means is immediate. Further classes of means, further monotonicity properties, appear. This article will appear in "Proceedings of the First International Conference on General Inequalities." (Received November 12, 1976.)

746-B2 JUNIOR STEIN, The University of Toledo, Toledo, Ohio 43606. Conjugate gradient algorithms in non-Hilbertizable Banach spaces.

The algorithms of Daniel, Fletcher-Reeves, and Polak-Ribière are extended to non-Hilbertizable Banach spaces. These methods apply to two classical norms used in the calculus of variations, namely, $\|x\|_0 = \sup |x(t)|$ and $\|x\|_1 = \sup |x(t)| + \sup |\dot{x}(t)|$. The gradient used is the metric gradient of M. Golomb and R. Tapia (Numer. Math. 20 (1972), 115-124). Positive definiteness of the Hessian is assumed. (Received November 18, 1976.)

*746-B3 Hubert Halkin, University of California, San Diego, La Jolla, California 92093. Set-Valued Differentials and Optimization Theory.

The theory of set-valued differentials which was started in an earlier paper (Jour. An. Math., 30, 1976, pp. 200-207) is now extended and applied to the optimal control of nonlinear systems. The strength of those results lies in the fact that they deal with set-valued differentials instead of dealing only with set-valued strong differentials. In otherwords those results can be specialized to the case in which the data is differentiable at the nominal solution and not only to the case in which the data is continuously differentiable in a neighborhood of (or strongly differentiable at) the nominal solution. (Received January 21, 1977.)

746-B4 E.M. Landesman, University of California, Santa Cruz, California 95064 and Ian G. Walton*, University of California, Santa Cruz, California 95064. A Generalized Saddle Point Characterization for Solutions of Singular Problems in Differential Equations. Preliminary report.

The second author has generalized the techniques of A.C. Lazer, E.M. Landesman and D.R. Meyers (J. Math. Anal. & Appl. V.52, #3, Dec. 75) in characterizing solutions to a class of elliptic partial differential equations as "saddle points to certain functionals" by considering special singular problems. These problems include the equations of Legendre, Jacobi, and Bessel. One can now generalize the ideas to a large class of singular problems. The techniques include a Rayleigh Ritz procedure for determining numerical approximations to the solutions and studying the convergence of the approximations. (Received January 27, 1977.)

746-B5 ELDON HANSEN, Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304. Global optimization using interval analysis. Preliminary report.

A frequently recurring problem is that of finding the global minimum (or maximum) over some region of a function of n variables. There are many numerical algorithms for finding a local minimum but previous attempts to find the global minimum for a general function have been singularly unsuccessful. In this paper, we show how interval analysis can be used to find the global minimum and verify that it is, in fact, global.

To gain efficiency, we assume the function has continuous first and second derivations which are available; although this is not necessary. We then apply Taylor's theorem and use interval analytic methods to bound the remainder. We dynamically eliminate subsets of the region of interest in which the function exceeds the current best estimate of the global minimum. We also eliminate subsets in which the gradient is nonzero. We consider only the unconstrained case; although the procedure can be applied to most constrained problems. (Received February 16, 1977.) (Author introduced by Peter A. Szego)

*746-B6 RALPH DEMARR, University of New Mexico, Albuquerque, New Mexico 87131. A property related to ordered group algebras. Preliminary report.

This research is inspired by the work of Marc A. Rieffel (Pacific Jour. Math., 1966) on ordered group algebras. We consider an arbitrary Dedekind sigma-complete partially ordered linear algebra (dsc-pola) A with $1 \geq 0$. The author and T-Y. Dai have studied various properties for A. Here we consider the following special property: Let $G = \{x: x \geq 0 \text{ and } x^{-1} \geq 0\}$; thus, G is a group. If $x_0 \geq 0$, $y_0 \geq 0$ and $x_0 y_0 \geq 1$, then there exist $x, y \in G$ such that $x \leq x_0$

and $y \leq y_0$. Example: let A be the direct product of group algebras of various finite groups. The dsc-pola of m-by-m real matrices does <u>not</u> have this property. Theorem: If $0 \leq z \leq x \in G$, then $xz = zx$. (Received February 17, 1977.)

*746-B7 James A. Cochran, on leave at Washington State University, Pullman, Washington 99164 and Charles Oehring, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061. An analogue of the Hausdorff-Young theorem for integral operators.

One of the important general theorems concerning Fourier constants is the celebrated result of Young and Hausdorff which asserts, in part, that the classical Fourier coefficients of functions in $\mathcal{L}^p[a,b]$ are p'-summable, where $1 < p \leq 2$, $p' = p/(p-1)$. In this paper we discuss an analogous result which we have recently established for integral operators, in which the characteristic numbers (s-numbers) of the operator assume the role of the Fourier constants. Our work both complements and extends related considerations of Karadzhov [J. Soviet Math. 1(1973), 200-204]. (Received February 17, 1977.)

746-B8 Magnus Hestenes, University of California, Los Angeles, CA 90024. A role for augmentability in optimization theory. Preliminary report.

The objective function in a constrained minimum problem can be modified so that it possesses the same local minimum points and the same local minimum values when the constraints are removed. Connections between augmentability and the Lagrange multiplier rule are given. This is done for finite dimensional problems and for variational and optimal control problems. Relations between augmentability and [illegible] A role for augmentability in computational procedures is described. (Received February 21, 1977.)

*746-B9 SALAH M. YOUSIF, California State University, Sacramento, CA. 95819. Optimal Control in Hilbert Space. Preliminary report.

This paper presents the problem of linear optimal control in terms of linear operator on Hilbert spaces. The problem of optimal control in Hilbert space and existing results will be provided first. Then a special problem of this type presents the optimal control that minimizes a specified objective functional utilizing the generalized inverse of linear operator. The results obtained in Hilbert space will yield, in Euclidean space, interesting optimal control policies for the minimum energy control problem. In this case, the generalized inverse of a matrix will play a major role both in derivation and synthesis of the optimal control. (Received February 21, 1977.)(Author introduced by Ira Bert Russak).

746-B10 PAUL C. FIFE, University of Arizona, Tucson, Arizona 85721. The equations of reaction and diffusion.

• Semilinear systems of diffusion equations $u_t - D\Delta u = f(u)$, $u = (u_1, \ldots, u_m)$ are called equations of reaction and diffusion. They can model the dynamics of large populations (including chemical reactors) in which random spatial migration is allowed, and can also model other phenomena in the physical and biological sciences. Solutions $u(x,t): R^n \times R^+ \to R^m$ defined for x in all space can be separated into equivalence classes by the equivalence relation: $u_1 \sim u_2$ if $\lim_{t\to\infty} \sup_x |u_1(x,t) - u_2(x-x_0, t-t_0)| = 0$ for some (x_0, t_0). We call the classes "asymptotic states", and define the property of stability for them. Given a R-D system, it is important to determine its stable asymptotic states. The results along this line for scalar equations in one space variable $(m = n = 1)$ are fairly near to being complete, but beyond that, existing results are mainly for special cases. Most of the known nontrivial results for $D \neq 0$ are reviewed. Particular forms the stable asymptotic states may take are rest states (constant or periodic in x), functions periodic in t, wave trains, wave fronts, pulses, and some combinations of these. (Received February 24, 1977.)

Applied Mathematics
(65, 68, 70, 73, 76, 78, 80–83, 85, 86, 90, 92–94)

*746-C1 GEORGE LEITMANN, University of California, Berkeley, California, 94720. Avoidance Control.

We consider dynamical systems subject to control by two agents, one of whom desires that no trajectory of the system, emanating from outside a given set, intersects that set no matter what the admissible actions of the other agent. Conditions are given whose satisfaction assures that a given control results in avoidance. Furthermore, these conditions are constructive in that they yield an avoidance feedback control. Some examples are presented. (Received January 11, 1977.) (Author introduced by I.E.Russak).

746-C2 Walter T. Kyner, University of New Mexico, Albuquerque, NM 87131 and David A. Sánchez, University of California, Los Angeles, CA 90024. Lotka's demographic equation - some asymptotic results and a new numerical approach.

For the linear-agedependent population model of Lotka-Von Foerster the exponential series expansion for the birth rate is determined by finding roots of the Lotka equation, $\int_0^\infty e^{-za} f(a)da = 1$, where $f(a)$ is the age-specific fertility function. Some asymptotic estimates for these roots are obtained, and an ordinary differential equation initial value problem numerical technique is suggested as a root finding technique. Some examples will also be given. (Received January 24, 1977.)

*746-C3 C. M. ABLOW and S. SCHECHTER, Stanford Research Institute, Menlo Park, California 94025. Campylotropic Coordinates.

In boundary value problems for ordinary differential equations the finite difference calculations of solutions having large variation over a narrow region lose accuracy because of mesh irregularity, short steps being needed in the boundary layer and large steps elsewhere. This loss is eliminated by transformation to coordinates where a uniform mesh can be used. Several examples show that it is advantageous to take a linear combination of length and angular variation along the solution curve as the transformed coordinate, only one-tenth as many nodes being needed in some cases as for other current methods. (Received February 7, 1977.)

746-C4 R. Tyrrell Rockafellar, University of Washington, Seattle, WA 98195. A generic characterization of optimality in nonconvex programming. Preliminary report.

Let $P(u)$ for $u = (u_1,\dots,u_m) \in R^m$ denote the problem of minimizing $f_0(x)$ over all $x \in C$ satisfying $f_1(x) \le u_1,\dots,f_m(x) \le u_m$, where the f_i's are arbitrary real-valued functions on the set C. Let U be the set of parameter vectors u such that $P(u)$ has a feasible solution, and suppose that for each $u \in U$ the infimum in $P(u)$ is finite. Then for almost every $u \in U$ (with respect to m-dimensional Lebesgue measure) there exist nondecreasing, differentiable, convex "price" functions $p_i: R \to R$, $i = 1,\dots,m$, such that the elements x where the function

$$F(x) = f_0(x) + p_1(f_1(x)) + \cdots + p_m(f_m(x))$$

attains its minimum over C are precisely the optimal solutions to $P(u)$. (Received February 17,1977.) (Author introduced by Professor B. Russak).

746-C5 JOSEPH B. KELLER, Stanford University, Stanford, California 94305. Population genetics and diffusion equations.

The relevant principles of genetics will be explained and applied to study the genetic composition $\underset{\sim}{X}$ of a population as a function of the time t. Each component of $\underset{\sim}{X}$ represents the fraction of the population having a particular genetic trait. Because inheritance is random, $\underset{\sim}{X}(t)$ is a stochastic process. The probability density $u(\underset{\sim}{x},t)$ for this process satisfies a diffusion equation, i.e., a parabolic partial differential equation, when there is a small change in composition per generation.

Examples of such equations will be presented, all of which are singular at the boundary. It will be shown that the process can continue onto the boundary, along the boundary to its boundary, etc. Methods of solution of such equations, including equations on the boundaries, will be described, with emphasis on asymptotic methods. These methods are valid for small times or for small values of certain parameters in the equations. They involve phase and amplitude functions, rays, transport equations, boundary layers, composite and uniform expansions, etc. D. Ludwig, R. Voronka, C. Tier and the author have used them. Much further work is needed to obtain the long time behavior of solutions, to develop numerical methods, etc. (Received February 16, 1977.)

*746-C6 HERBERT D. LANDAHL, University of California at San Francisco, San Francisco, California 94143. Simulation of transient and steady state transport in the kidney.

Exchange of water, sodium, urea and non-reabsorbable solute among tubules of the kidney has been treated in terms of a model in which the fluxes are given by linear partial differential equations. Only sodium is assumed to be actively transported. The nephron is treated as a tubule consisting of a descending and ascending Henle loop, distal tubule and collecting duct. Except for the distal tubule, these tubules, as well as the descending and ascending blood vessels, are mingled together, their degrees of association being given by the elements of an association matrix, assumed symmetric. Measured values for lengths and diameters of the tubules, the velocities and concentrations entering the descending loop and blood vessel, and estimates for the transport coefficients, were used together with rough estimates for the elements of the association matrix, to obtain steady state values of the concentrations and solvent flow along the tubule in reasonable agreement with data. Using the same parameter values, transient and steady state effects following those changes in input velocity or concentration, corresponding to experiments reported in the literature, were obtained numerically. The results from ten different kinds of experiments can be accounted for semi-quantitatively by the model. (Received February 1?, 1977.) (Author introduced by Professor Susann Shaw).

746-C7 RICHARD E. PLANT, University of California, Davis, California 95616. Constrained Differential Equations for the Crustacean Cardiac Pacemaker.

A model has been developed to simulate the neurogenic cardiac pacemaker of the mantis shrimp Squilla (R. E. Plant, Math. Biosci. 32:275, 1976). The model consists of coupled nonlinear ordinary differential equations in the normalized variables v,n,x,l, and p_c, representing membrane voltage membrane potassium conductance, contractile element length, ventricular circumference, and circulatory system pressure, respectively. Numerical solution indicates that the model predicts many observed properties of the crustacean heart. By making certain physically motivated assumptions, the model's zero-order approximation may be reduced to a system of constrained differential equations consisting of two differential equations and two equations of constraint. The physically based properties of the model are sufficient to ensure the existence of a periodic discontinuous solution to this system. (Received February 1?, 1977.) (Author introduced by Professor Susann Shaw).

746-C8 Janusz S. Kowalik, Washington State University, Pullman, WA 99164. Hydroelectric Power System Optimization is a Large Scale Mathematical Programming Problem.

A large scale hydroelectric system optimization is considered and solved by using a nonlinear programming method. The largest numerical case involves approximately 6000 variables, 4000 linear equations, 11000 linear and nonlinear inequality constraints and a nonlinear objective function. The solution method is based on (i) partial elimination of independent variables by solving linear equations, (ii) essentially unconstrained optimization of a compound function that consists of the objective function, nonlinear inequality constraints and part of the linear inequality constraints. The compound function is obtained via penalty formulation. The algorithm takes full advantage of the problem's structure and provides useful solutions for real life problems that, in general, are defined over empty feasible regions. (Received February 18, 1977) (Author introduced by Burt Russak).

746-C9 HANS J. BREMERMANN, Department of Mathematics, University of California, Berkeley, Cal. 94720. Algorithms and Optimization in Biology. Survey.

Algorithms have an important place in theoretical biology: 1) Biological organisms are intrinsically complex. Algorithms are indispensible to realistic modelling. 2) Theories about optimal life history strategies are making rapid progress. They use the mathematics and algorithms of optimization. 3) There are considerable opportunities for biological systems models with controls. Analytical solutions exist only in special cases, algorithmic solutions are often required. 4) Complexity theory investigates the intrinsic complexity of algorithms. Very complex algorithms cannot be implemented physically. (Received February 21, 1977.)

746-C10 FRANK D. FAULKNER and CRAIG COMSTOCK Naval Postgraduate School, Monterey, California 93940 Statistical Corrections to Improve Weather Prediction

Consider a weather variable such as the 500 mb height field, expressed in spherical coordinates. Starting with initial values, we may integrate its differential equation to obtain predicted or forecast values. These are combined with observations at regular intervals to generate a set of filtered values. The change, or corrections to the predicted coefficients, defines a time series, Z_n. We are analyzing this series for statistical properties. If there is a correlation between values at different time steps, we will use it to improve the forecast. The vector Z_n has dimension from 90 to 8800 in different problems. We are relying on the feeling of meteorologists that most of the data are uncorrelated. (Received February 21, 1977.)

*746-C11 R. T. WILLIAMS and R. G. KELLEY, JR., Naval Postgraduate School, Monterey, California 93940. Variable scale finite element models, Preliminary report.

There are a variety of meteorological forecast problems which require high spatial resolution in only a limited area. An important example of this type of problem is the prediction of tropical cyclones. This study tests a simple finite element prediction model with a variable element size. The shallow water equations are used and the motion is confined in a periodic channel on a f-plane. The Galerkin technique is applied to linear basis functions on triangular elements. The model uses leapfrog time differencing and periodic restarts. The model is tested with a wave imbedded in a mean flow and also with an isolated vortex. The experiments with a uniform element size show excellent phase propagation, but some small scale noise is generated. The introduction of momentum diffusion terms helps to control the noise. The model is also tested with elements which decrease abruptly in scale along a line and with elements which decrease smoothly. Both of these cases generate more noise than with uniform elements. At this time finite element models are not as efficient as finite difference models for limited area models. This is in part a result of the fact that current finite element models require a fixed timestep, while finite difference models can use a larger timestep in the low resolution areas. (Received February 21, 1977.) (Author introduced by Professor Craig Comstock).

*746-C12 GERALD G. BROWN, Naval Postgraduate School, Monterey, California 93940 and GLENN W. GRAVES, University of California, Los Angeles, California 90024. Use of simple algebraic structures for implementing algorithms in large scale mathematical programming. Preliminary report.

Exploitation of special problem structure has contributed significantly to the efficiency of successful contemporary large scale mathematical programming packages. Implementation of algorithms which take advantage of special structure requires a surprising variety of data representation schemes commonly called data structures. These are actually simple algebraic constructs which, when viewed in this way, give new theoretical insights about the optimization process. Several examples are given of the use of lattices, maps, and other simple mechanisms to build very efficient computer programs and to aid in the design of new algorithms. In some cases, tenfold improvements in solution efficiency have been achieved. (Received February 22, 1977.) (Authors introduced by Bert Russak).

746-C13 THOMAS E. ROSMOND, Naval Environmental Prediction Research Facility, Monterey, California 93940. Global Atmospheric Modeling with Spherical Harmonics.

In recent years considerable interest has developed in the use of spectral methods for atmospheric modeling. The principal reason for this interest was the introduction of the so-called transform method for the evaluation of the non-linear terms in the primitive equations of atmospheric motion. This technique involves transforming the dependent variables from spectral space to grid point space, computing the tendencies due to the non-linear terms on grid points, and then transforming these values back to spectral space to update the dependent variables. Some care is necessary to ensure that aliasing is avoided in the evaluation of these non-linear terms, however.

The chief advantage of the transform method over the interaction coefficient method is computational efficiency. If N is the number of zonal wavenumbers being represented in a numerical model, then a spectral model using the transform method requires $O(N^3)$ operations per time step versus $O(N^4)$ for the interaction coefficient method. In addition, methods have recently been developed which reduce the transform method operation count to $O(N^2 \ln_2 N)$.

Compared to grid point atmospheric models, a spectral model has several advantages. They are (1) no phase speed error for resolved waves, (2) easily programmed, especially for vector processing, (3) wavenumber decomposition of integration results more easily interpreted physically than grid point values, (4) more amenable to semi-implicit time differencing than grid point models.

Examples of real data forecasts from a multi-level global model will be presented and results discussed. (Received February 22, 1977.) (Author introduced by Professor Craig Comstock).

Statistics and Probability (60, 62)

746-F1 MICHAEL J. SHARPE, University of California, San Diego, La Jolla, California 92093. Some applications of Markov additive functionals.

• The principal topic that will be discussed is a recent joint paper with R. K. Getoor in which a generalization is given of Itô's formula in the theory of stochastic integrals over Brownian motion, (B_t), in $\mathbb{R}^d$. The formula of Itô expresses, for $f \in C^2$, the process $f(B_t)$ as $f(B_0) + \int_0^t \operatorname{grad} f(B_s) \cdot dB_s + 1/2 \int_0^t \Delta f \circ B_s \, ds$. By using some techniques from the potential theory of Markov processes, a formula of similar type, though involving additive functionals of the Brownian motion in place of the last term in the above formula, is given for a class of functions that includes all subharmonic and superharmonic functions. A well known special case is the formula of Tanaka in $\mathbb{R}^1$, where $f(x) = |x|$ and the additive functional is local time at the origin. Some analytic applications will be given. (Received March 3, 1977.)

Topology (22, 54, 55, 57, 58)

746-G1 DAVID GILLMAN, University of California, Los Angeles, California 90024, On localizing Dehn's Lemma. Preliminary report.

We restrict our attention to functions from the plane to 3-dimensional space which are the identity except on a compact set. In this setting, Dehn's Lemma becomes

Theorem 1. Given $f : R^2 \to R^3$ and an open set N containing $f(R^2)$, there is an embedding $g : R^2 \to R^3$ such that $g(R^2) \subset N$.

Indeed, the standard proof of Dehn's Lemma establishes a stronger result:

Theorem 2. Given $f : R^2 \to R^3$ and an open set N containing the singular set of $f(R^2)$, there is an embedding $g : R^2 \to R^3$ such that $g(R^2) \subset f(R^2) + N$.

Consider the following question which localizes the above theorems: Given $\varepsilon > 0$, is there a $\delta > 0$ such that if f moves each point less than δ, then g moves each point less than ε? We answer this question negatively for the case of Theorem 2. The important case of a localized Theorem 1 remains unsolved. (Received February 4, 1977.)

*746-G2 ROBION KIRBY and PAUL MELVIN, University of California, Berkeley, California 94720. Slice knots and property R.

Theorem Let M be the 4-manifold obtained by adding a 2-handle to B^4 along a knot K in S^3 with the zero framing. If ∂M is diffeomorphic to $S^2 \times S^1$, then (1) K is the slice of an unknotted 2-sphere in S^4 (2) M is homeomorphic to $S^2 \times B^2$. The proof is a simple handlebody argument, crossing with I when appropriate to allow geometric cancellation of handles which cancel algebraically. Somewhat stronger results, as suggested to us by L. Taylor and M. Freedman, will also be discussed. (Received February 14, 1977.)

*746-G3 Kenneth M. deCesare, DeAnza College, Cupertino, CA 95014. A Codimension-Two Version of Novikov's Theorem on Foliations without Limit Cycles.

The "classical" theorem of Novikov (5.1, Trans. Moscow Math. Soc.(1965)), gives a very complete description of codimension-one foliations without limit cycles(i.e., without holonomy). In codimension one, the foliations without limit cycles are essentially the same as the transversely parallelizable foliations(those whose normal bundles admit globally trivial basic connections- see Conlon, T.A.M.S. 194). This note announces a theorem in codimension two which extends Novikov's theorem and completes work of Conlon and Meyer(Thesis, Washington University, 1975) on the problem. The proof is an application of their results, together with more general results of the author (in preparation) in another direction.

THEOREM. Suppose $\mathcal{F}$ is a transversely parellelizable, codimension-two foliation of a compact, connected, smooth manifold M. Let L be a leaf of $\mathcal{F}$. Then there are three possibilities:

1) L is closed. Then $\mathcal{F}$ is given by the fibers of a smooth fibration $M \to T^2$.
2) L is dense. Then $\mathcal{F}$ is given by two closed one-forms, each having at least two rationally independent periods.
3) L is neither closed nor dense. Then $\bar{L} = N$ is the fiber of a smooth fibration $p: M \to S^1$ such that each fiber of p is the closure of a leaf of $\mathcal{F}$. Further, $\mathcal{F}|N$ is given by a closed one-form γ which has at least two rationally independent periods and $M = (N \times \mathbb{R})_f$ is the suspension of $f \in \mathrm{Diff}(N)$. Two cases can then occur: a) $f^*\gamma = \gamma$ and $\mathcal{F}$ is given by $\{\gamma, dx\}$ on $N \times \mathbb{R}$, b) $f^*\gamma = \lambda \cdot \gamma$, $\lambda \neq 1$ a positive real number and $\mathcal{F}$ is given by $\{e^x \cdot \gamma, dx\}$ on $N \times \mathbb{R}$. (Received February 15, 1977.)

746-G4 E. J. MAYLAND, JR., Rice University, Houston, TX. 77001. Examples of non-fibred knots with Π_c knot group. Preliminary report.

A group G is Π_c (has finitely separable cyclic subgroups) if for each pair of elements g_1, g_2 in G either $g_1 = g_2{}^t$ or there exists a homomorphism φ mapping G onto a finite group such that $\varphi(g_1) \neq \varphi(g_2{}^t)$ for any t.

If a knot k has a non-orientable spanning surface with regular neighborhood N satisfying ∂N-k is an incompressible surface in S^3-k, then we give some sufficient conditions for $\pi_1(S^3\text{-}k)$ to be Π_c.

For example, a Whitehead double of the trivial knot has a Π_c knot group. (Received February 17, 1977.)

*746-G5 SELMAN AKBULUT, University of Wisconsin, Madison, WI 53706 and ROBION KIRBY, University of California, Berkeley, CA 94720. An exotic involution on S^4.

Cappell and Shaneson (Ann. Math. 104 (1976), 61-72) construct some 4-manifolds which are homotopy equivalent to RP^4, but are not diffeomorphic to RP^4. We prove that the double cover of one of these (u = 0, v = 1 in the matrix on page 67) is diffeomorphic to S^4. Thus S^4 has an exotic, smooth, free involution. The proof involves a detailed picture of a handlebody decomposition of the double cover. (Received February 18, 1977.)

746-G6 KENNETH C. MILLET, University of California, Santa Barbara, California 93106. Embeddings of D^n in $D^m \times S^n$.

In my AMS Memoir #153, Piecewise Linear Concordances and Isotopies, I showed that in the p.l. category there is a homomorphism $\pi_s(E_\partial(D^m, D^m \times S^n)) \to \pi_0(E_\partial(D^{m+s}, D^{m+s} \times S^n))$, for $n \geq 3$, which is an isomorphism if $s < 2n-3$ and an epimorphism if $s = 2n-3$. I shall describe and discuss the problems associated with giving explicit examples, in the limiting case $n = 3$, $s = 3$, $n = 1$ and the case (not covered by the theorem) $n = 2$, $s = 1$, $m = 1$, of nontrivial homotopically trivial embeddings of D^4 in $D^4 \times S^3$ and D^2 in $D^2 \times S^2$. (Received February 21, 1977.)

*746-G7 Michael H. Freedman, University of California, San Diego, La Jolla, California 92093. Multiple Points of an Immersion. Preliminary report.

An old theorem states that the number of triple points of a generically immersed surface in S^3 is congruent to its Euler characteristic mod 2. It is a consequence of Thom transversality that the number (mod 2) of generic n+1-tuple points of an n-manifold immersed in an n+1-manifold is invariant under bordism of the immersion and the target. An attractive place to try to compute this number is "oriented bordism of immersed n-manifolds in S^{n+1}" since this group (under connected sum) is isomorphic to stable homotopy of spheres, π_n. Counting generic n+1-tuple points yields a homomorphism $\theta_n : \pi_n \longrightarrow Z_2$. For $n = 1, 2,$ or 3 θ_n is the stable Hopf map. We conjecture that this is true for all $n > 0$. (Received February 21, 1977.)

746-G8 Martin Scharlemann, University of California, Santa Barbara, Santa Barbara, California 93106. Approximating CAT CE maps. Preliminary report.

Let CAT = DIFF or PL.

Theorem: Let $f : M \to N$ be a CAT CE map of CAT n-manifolds, $n \geq 5$. There is one obstruction in $H^3(N; \theta_3^h)$ which vanishes if and only if there is a CAT CE concordance $F : M \times I \to N \times I$ such that $F | M \times \{0\} = f$, $F | M \times \{1\}$ is a CAT homeomorphism.

Theorem: The above conclusion holds for n arbitrary and with F level-preserving if and only if all CAT homotopy k-spheres ($k = 3$ or 4) are CAT homeomorphic to S^k.

Notes: θ_3^h is the group of CAT homotopy 3-spheres mod those bounding CAT homotopy 4-disks. DIFF homeomorphism $\neq$ DIFF isomorphism. The distinction between this theory and that of L. Siebenmann for TOP results from the glut of regular values with which PL and DIFF maps are endowed. (Received February 22, 1977.)

746-G9 **JAMES M. VAN BUSKIRK, University of Oregon, Eugene, Oregon 97403** **Kawauchi's conjecture for strongly amphicheiral knots**

A knot is strongly amphicheiral if it is equivalent to a knot k which is invariant under the autohomeomorphism h of S^3 which restricts to the antipodal map on $E^3 = S^3 - \{\infty\}$. The classical (≤ 10 crossing) amphicheiral knots are strongly amphicheiral [Abstract 737-55-7, these *Notices*]. Employing D. Rolfsen's surgical view of Alexander's polynomial $\Delta(t)$ [Springer-Verlag Lecture Notes, Vol. 438], k is unknotted by symmetric Dehn surgeries so that the infinite cyclic covering space $\tilde{X}$ of $X = S^3$-k has, in addition to its group (t:) of deck transformations, a "half"-transformation $t^{\frac{1}{2}}$ induced by h. Considering $H_*(\tilde{X},Z)$ as a module over the integral group ring of $(t^{\frac{1}{2}}:)$ yields a polynomial f such that $\Delta(t) = f(t^{\frac{1}{2}})f(-t^{\frac{1}{2}})$; thereby verifying A. Kawauchi's conjecture [Issue 173, p. 410, of these *Notices*] for strongly amphicheiral knots. (Received February 22, 1977.)

746-G10 JOSEPH MARTIN, University of Wyoming, Laramie, Wyoming 82071. Surgery on Solid Tori. Preliminary report.

Let T_1 and T_2 be solid tori such that $T_1 \subset \text{int } T_2$, winding $\#(T_1,T_2) = 0$ and wrapping $\#(T_1,T_2) \neq 0$. If T_1 is removed and sewn back differently, can the result be a solid torus^2 A discussion of results and consequences of this question will be given. (Received February 22, 1977.)

746-H1 JOHN R. STALLINGS, University of California, Berkeley, California 94720. Fibred links.

A "fibre surface" is a surface in the 3-sphere, whose interior is the fibre of a fibration of the complement of its boundary in the 3-sphere over the circle. A "fibred link" is the boundary of a fibre surface. It is shown how to make complicated fibre surfaces out of simpler ones–by plumbing them together, by twisting them around certain curves on the surface, by joining up several parallel copies with a fibre surface located within a tube around a boundary component. The behavior of the Alexander matrices is described, and questions about the lower central series of the fundamental group of the complement of a fibred link are proposed. (Received February 22, 1977.)

American Mathematical Society Short Course Series FUNDAMENTALS OF APPLIED COMBINATORICS August 12 and 13, 1977

SC77-7 RONALD L. GRAHAM, Bell Laboratories, Murray Hill, New Jersey 07974. Combinatorial scheduling theory.

Scheduling problems arise in almost all areas of human activity. Typically, such problems can range from the allocation of manpower and resources in a highly complex project (such as the Apollo lunar landing) or the real-time control of a modern electronic telephone switching system, to the assignment of school classroom schedules or simply the preparation of a nontrivial meal. However, it has been realized for some time the certain natural and commonly used scheduling procedures can produce quite subtle and often apparently paradoxical behavior, e.g., an increase in available resources might cause an unavoidable increase in the time required to finish–an example of the well-known "too many cooks spoil the broth" effect. In order to understand the underlying causes of this anomalous behavior, a number of scheduling models have been rather thoroughly investigated during the past few years. From this work general guidelines have emerged which can be useful not only in efficiently finding acceptable solutions to particular scheduling problems but also in avoiding many of the unsuspected (and perhaps costly) pitfalls along the way. What we would like to do in the two lectures is to describe some of the recent results of this type which apply to one of the most basic scheduling models. Frequently we will examine a particular problem from several different viewpoints, showing how a variety of approaches can furnish us with a powerful arsenal of tools with which to attack such problems. A very important aspect of this subject, both from the point of view of understanding specific scheduling procedures as well as for discovering exactly what is true and what is not true, is the use of examples. Indeed, much of the talks will be devoted to various examples, often which illustrate very vividly the unexpected subtleties which can occur in this subject. From this discussion, we hope that the reader can gain insight not only into scheduling theory itself but also into the kind of productive interaction which can (and often does) occur between mathematics (in this case, combinatorics), computer science (in this case, the theory of algorithms) and problems from the real world. (Received February 10, 1977.)

SC77-8 ROBERT J. McELIECE, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91103. Combinatorial analysis of convolutional codes.

In 1948 Claude Shannon invented the branch of applied mathematics called information theory (or coding theory) to deal with the fundamental problems of communication. Shannon's key idea was that of an error-correcting code, which is a way of processing data prior to transmission in order to combat channel noise. Shannon showed that very powerful codes must exist, but did not show how to find them. Since then researchers have sought, quite successfully, to develop practical error correcting codes. One of the most successful types of code yet developed is the class of convolutional codes. In this lecture we will give an elementary introduction to the theory of convolutional codes, and show how certain parts of classical combinatorial mathematics (graph theory, enumeration by generating functions) can be used to analyze the performance of these codes. (Received February 14, 1977.)

Reading List

1. A. V. Aho, J. E. Hopcroft and J. O. Ullman, The design and analysis of computer algorithms (especially chapter 5), Addison-Wesley, Reading, Mass., 1974.

2. A. J. Viterbi, Convolutional codes and their performance in communication systems, IEEE Trans. Comm. Tech. COM-19(1971), 751-772. MR 52 #16858.

3. A. D. Wyner, Another look at the coding theorem of information theory—a tutorial, Proc. IEEE 58(1970), 894-913. MR 47 #1540.

SC77-9 DANIEL J. KLEITMAN, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139. Fast but imperfect algorithms.

The travelling salesman problem is difficult to solve in worst case, yet in practice it is sometimes necessary to "solve" it rapidly and often. What is usually done and what one can do under these and similar circumstances will be discussed. (Received March 7, 1977.)

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FEMALE MATHEMATICIAN. Ph.D. 1975. Age 26. Speciality: Functional Analysis, Topology. Ten published articles. One and a half years teaching experience. References on request. Will relocate if necessary. Seek industrial or educational position. Available immediately. Ms. A. Bhagat, 2044 Dorset Drive, Lexington, Kentucky 40504.

ANONYMOUS

APPLIED MATHEMATICIAN. Ph.D. 1976, M.B.A. 1966. Speciality: Numerical Methods and History of Mathematics. M.B.A. degree and business experience make possible teaching business-oriented students. Two years teaching experience. Have taught commercial data processing and introductory computer courses. In or near large city preferred. Available September, 1977. SW 54

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Abstract 742-54-28, Pages A-144—A-145.

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