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Wall Corrections for Wings Oscillating in Wind Tunnels of Closed Rectangular Section

Parts I and II

By W. E. A. ACUM, A.R.C.S., B.Sc.,
OF THE AERODYNAMICS DIVISION, N.P.L.

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Part I

Theory and Tables

With an Appendix

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Summary.

A method of calculating the tunnel interference due to oscillating loadings on wings in rectangular tunnels is described. This will apply to incompressible flow for all frequencies or to subsonic flow for small frequencies. The interference upwash due to a horse-shoe vortex of oscillating strength is derived from that for a steady horse-shoe vortex and hence the interference on wings with symmetrical or antisymmetrical loadings. An Appendix describes tables of a function basic to the theory for any rectangular section. Some other functions applicable in the particular case of a 9×7 tunnel are tabulated and their use is discussed. The effect of frequency variation on a typical interference upwash is illustrated.

1. *Introduction.*

The problem of determining the wall interference on an oscillating wing in a wind tunnel of closed circular section was considered in Ref. 1 (Acum and Garner, 1954). The present report describes a method of dealing with the corresponding problem for a closed tunnel of rectangular section. An approximate expression for the interference upwash due to an oscillating wing will be derived by replacing the vorticity distribution round it by horse-shoe vortices of strength periodic in time. It has been shown in Ref. 1 that the interference due to such an oscillating vortex can be computed from the upwash due to a steady vortex provided that this is known everywhere in its plane.

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The amount of work previously done on three-dimensional oscillating wings in wind tunnels is comparatively small. Goodman² (1953) has indicated a general method for small wings and applied it to the case of circular tunnel and a wing between two horizontal or vertical walls. W. P. Jones³ (1943) has determined the corrections for wings of rectangular planform in square tunnels.

The two-dimensional case has been more extensively treated by Reissner⁴, Jones⁵, Timman⁶, and others. These analytical investigations indicate two facts which may complicate the three-dimensional case. Some theoretical work of Jones⁷ and Runyan and Watkins⁸ indicates that at certain frequencies the interference may become very large due to compressibility effects. This resonance phenomenon appears to occur in practice⁹ (Runyan, Woolston and Rainey, 1956), but the present report cannot deal with it, as the theory is restricted to either incompressible flow or low-frequency oscillations in compressible flow. The other fact is that in practice the trailing vortices are not of infinite length as is usually assumed in the theory, but are truncated at some distance downstream of the wing determined by the tunnel geometry. P. F. Jordan¹⁰ (1953) has shown that in two dimensions this effect can be significant under some circumstances. A similar investigation in three dimensions could be made using the functions tabulated in this report.

The steady interference upwash is determined by the function $f(X, Y)$ defined in equation (3) by an infinite series which can be summed straightforwardly for any particular pair of values of X and Y . However, since $f(X, Y)$ is required for all values of X and Y an interpolable table of $f(X, Y)$ has been prepared in the Mathematics Division, N.P.L. Its use is described in the Appendix.

2. Steady Interference Upwash.

It has been shown by Glauert (Ref. 11, Section 12.2) that in the absence of tunnel walls the upwash due to a horse-shoe vortex of constant strength, K , situated as in Fig. 1 is given by

$$w = \frac{K}{4\pi} \left\{ \frac{x(y-t)}{\sqrt{\{x^2 + (y-t)^2 + z^2\}}} \left[\frac{1}{(y-t)^2 + z^2} + \frac{1}{x^2 + z^2} \right] - \frac{x(y+t)}{\sqrt{\{x^2 + (y+t)^2 + z^2\}}} \left[\frac{1}{(y+t)^2 + z^2} + \frac{1}{x^2 + z^2} \right] + \frac{y-t}{(y-t)^2 + z^2} - \frac{(y+t)}{(y+t)^2 + z^2} \right\}. \quad (1)$$

The presence of tunnel walls may be simulated in the usual way by introducing a doubly infinite array of image vortices spaced at a distance h in the vertical, or z -direction, and distance b in the horizontal or y -direction. In any horizontal row the vortices all have the same sign but in a vertical column their signs alternate.

From (1) it follows that the upwash at $(x, y, 0)$ due to the column including the original vortex is given by

$$w = \frac{K}{4\pi} \sum_{n=-\infty}^{+\infty} (-1)^n \left\{ \frac{x(y-t)}{\sqrt{\{x^2 + (y-t)^2 + n^2h^2\}}} \left[\frac{1}{(y-t)^2 + n^2h^2} + \frac{1}{x^2 + n^2h^2} \right] - \frac{x(y+t)}{\sqrt{\{x^2 + (y+t)^2 + n^2h^2\}}} \left[\frac{1}{(y+t)^2 + n^2h^2} + \frac{1}{x^2 + n^2h^2} \right] + \frac{(y-t)}{(y-t)^2 + n^2h^2} - \frac{(y+t)}{(y+t)^2 + n^2h^2} \right\}. \quad (2)$$

Now define the functions $f(X, Y)$ and $f_1(X, Y)$ by

$$f(X, Y) = \frac{XY}{\sqrt{(X^2 + Y^2)}} \left(\frac{1}{X^2} + \frac{1}{Y^2} \right) + 2 \sum_{n=1}^{\infty} (-1)^n \frac{XY}{\sqrt{(X^2 + Y^2 + n^2)}} \left(\frac{1}{X^2 + n^2} + \frac{1}{Y^2 + n^2} \right) \quad (3)$$

and

$$f_1(X, Y) = f(X, Y) - \frac{XY}{\sqrt{(X^2 + Y^2)}} \left(\frac{1}{X^2} + \frac{1}{Y^2} \right). \quad (4)$$

Since it is known that

$$\frac{1}{Y} + 2 \sum_{n=1}^{\infty} (-1)^n \frac{Y}{Y^2 + n^2} = \pi \operatorname{cosech} \pi Y, \quad (5)$$

equation (2) may now be written,

$$w = \frac{K}{4\pi h} \left\{ f\left(\frac{x}{h}, \frac{y-t}{h}\right) - f\left(\frac{x}{h}, \frac{y+t}{h}\right) + \pi \operatorname{cosech} \frac{\pi(y-t)}{h} - \pi \operatorname{cosech} \frac{\pi(y+t)}{h} \right\}. \quad (6)$$

For the other columns y is replaced by $(y+mb)$, ($m = \pm 1, \pm 2, \dots$). In order to obtain the interference upwash the expressions (6) corresponding to each column must be summed with the exception that in the column passing through the original vortex the term in equation (2) corresponding to $n = 0$ must be omitted. Hence the interference upwash is given by

$$\begin{aligned} w = & \frac{K}{4\pi h} \left\{ f_1\left(\frac{x}{h}, \frac{y-t}{h}\right) - f_1\left(\frac{x}{h}, \frac{y+t}{h}\right) + \left[\pi \operatorname{cosech} \frac{\pi(y-t)}{h} - \frac{h}{(y-t)} \right] - \right. \\ & - \left[\pi \operatorname{cosech} \frac{\pi(y+t)}{h} - \frac{h}{(y+t)} \right] + \sum_{m=1}^{\infty} \left[f\left(\frac{x}{h}, \frac{y-t+mb}{h}\right) + \right. \\ & + f\left(\frac{x}{h}, \frac{y-t-mb}{h}\right) - f\left(\frac{x}{h}, \frac{y+t+mb}{h}\right) - f\left(\frac{x}{h}, \frac{y+t-mb}{h}\right) + \\ & + \pi \operatorname{cosech} \frac{\pi(y-t+mb)}{h} + \pi \operatorname{cosech} \frac{\pi(y-t-mb)}{h} - \pi \operatorname{cosech} \frac{\pi(y+t+mb)}{h} - \\ & \left. \left. - \pi \operatorname{cosech} \frac{\pi(y+t-mb)}{h} \right] \right\}. \quad (7) \end{aligned}$$

The function $f(X, Y)$ is tabulated in Table 1; instructions for interpolation are given in the Appendix. With equation (7) this permits the calculation of the interference upwash at the point $(x, y, 0)$ due to a steady horse-shoe vortex in any rectangular wind tunnel.

3. Oscillatory Interference Upwash.

Consider now a vortex of oscillatory strength such that the transverse part has the circulation

$$K = \bar{K} \exp(i\omega T). \quad (8)$$

Downstream of this in the strip, $x > 0$, $|y| \leq t$, there will be a trailing vortex sheet. Since the pressure must be continuous across this strip it follows that on its upper surface the velocity potential, ϕ , satisfies the equation

$$\frac{\partial \phi}{\partial T} + V \frac{\partial \phi}{\partial x} = 0$$

so that

$$\phi = \frac{1}{2} \bar{K} \exp \left[i\omega \left(T - \frac{x}{V} \right) \right], \quad (9)$$

and since the value of ϕ on the lower surface is equal and opposite to that on the upper surface,

$$\begin{aligned} \phi_{\text{upper}} - \phi_{\text{lower}} &= \bar{K} \exp(i\omega T) \exp(-i\omega x/V) \\ &= \bar{K} \exp(i\omega T) \left\{ H(x) + \int_0^\infty (-i\omega/V) \exp(-i\omega x'/V) H(x-x') dx' \right\} \end{aligned} \quad (10)$$

where

$$H(x) = 0 \text{ if } x < 0, \quad H(x) = 1 \text{ if } x > 0.$$

Now the velocity potential for a steady horse-shoe vortex of strength \bar{K} with its transverse part at $x = x'$ satisfies

$$\phi_{\text{upper}} - \phi_{\text{lower}} = \bar{K} H(x-x'). \quad (11)$$

Moreover if the fluid is incompressible the velocity potential satisfies Laplace's equation in unsteady as well as in steady flow. On the tunnel walls both have zero normal gradient, or in free-stream flow both vanish at infinity. Then the distribution of ϕ in the boundary condition (10) may be regarded as the limiting sum of those in equation (11), and the velocity potential and velocities in unsteady flow obtained by combining those for steady flow in the same proportion.

Now let the interference upwash angle be

$$\frac{w}{V} = \frac{\bar{w}}{V} e^{i\omega T} = e^{i\omega T} \frac{\bar{K}}{Vb} \delta \left(\frac{x}{b}, \frac{y}{b}; \frac{t}{b}, \frac{\omega b}{V} \right). \quad (12)$$

It follows from equation (10) that

$$\begin{aligned} \delta \left(\frac{x}{b}, \frac{y}{b}; \frac{t}{b}, \frac{\omega b}{V} \right) &= \delta \left(\frac{x}{b}, \frac{y}{b}; \frac{t}{b}, 0 \right) + \\ &+ \int_{x'=0}^\infty \left(-\frac{i\omega}{V} \right) e^{-i\omega x'/V} \delta \left(\frac{x-x'}{b}, \frac{y}{b}; \frac{t}{b}, 0 \right) dx'. \end{aligned} \quad (13)$$

Let $\xi = x/b$, $\eta = y/b$, $\tau = t/b$, $\mu = \omega b/V$, and change the variable of integration by putting $\theta = \xi - x'/b$. Then

$$\delta(\xi, \eta; \tau, \mu) = \delta(\xi, \eta; \tau, 0) - i\mu e^{-i\mu\xi} \int_{-\infty}^{\xi} e^{i\mu\theta} \delta(\theta, \eta; \tau, 0) d\theta. \quad (14)$$

Since $\delta(\xi, \eta; \tau, 0)$ can easily be derived from equations (7) and (12) this gives the required method of calculating the interference due to an oscillating vortex. This was proved by another method in Ref. 1, and applies to any closed cylindrical tunnel.

If the fluid is not incompressible, ϕ will not satisfy Laplace's equation. However, in subsonic flow of Mach number M if a new variable ϕ_1 is taken defined by

$$\phi_1 = \phi \exp \left[-\frac{i\omega x}{V} \frac{M^2}{1-M^2} \right] \exp(-i\omega T), \quad (15)$$

then ϕ_1 satisfies

$$(1-M^2) \frac{\partial^2 \phi_1}{\partial x^2} + \frac{\partial^2 \phi_1}{\partial y^2} + \frac{\partial^2 \phi_1}{\partial z^2} + \frac{\omega^2}{V^2} \frac{M^2}{1-M^2} \phi_1 = 0 \quad (16)$$

which is simply transformed to Laplace's equation provided $\mu^2 M^2$ is negligible. Then ϕ_1 satisfies the same equation as does the velocity potential for steady flow and a relation analogous to (14) may be constructed by similar arguments.

4. Symmetrically Oscillating Wings.

It will now be assumed that the wing is symmetrical with respect to y , both in planform and mode of oscillation, and further that the vorticity and lift distributions associated with it have been determined, theoretically or experimentally, to an accuracy sufficient for tunnel-interference calculations. The lift distribution can be expressed by

$$l = (l_r + il_i) e^{i\omega T} = \frac{p_b - p_a}{\frac{1}{2}\rho V^2} \quad (17)$$

where l_r and l_i are functions of x and y . The functions l_r and l_i will be treated quite separately and the resulting interference added at the end of the calculation.

With l_r will be associated a centre-of-pressure locus whose position is given by $x = \bar{x}_r(y)$ and a complex circulation $\Gamma_r(y)$ defined by the lift distribution at each spanwise section. It is assumed that for the purpose of tunnel-interference calculations it is sufficiently accurate to take the vorticity as concentrated at the local centre of pressure. This could be refined if necessary by assuming two or more such concentrations of vorticity. The interference upwash due to $l_r e^{i\omega T}$ is then given approximately by

$$\begin{aligned} \frac{w(x, y)}{V} &= \int_0^s \frac{\Gamma_r(t)}{Vb} \frac{\partial}{\partial t} \delta \left(\frac{x - \bar{x}_r(t)}{b}, \frac{y}{b}; \frac{t}{b}, \mu \right) dt \\ &= \int_0^\sigma \frac{\Gamma_r(\tau)}{Vb} \frac{\partial}{\partial \tau} \delta \{ \xi - \bar{\xi}_r(\tau), \eta; \tau, \mu \} d\tau, \end{aligned} \quad (18)$$

where $\sigma = s/b$ and $\bar{\xi}_r(\tau) = \bar{x}_r(\tau b)/b$. In the differentiations with respect to t and τ the variation of $\bar{x}_r(t)$ and $\bar{\xi}_r(\tau)$ is to be ignored.

A similar equation may be written down for the interference upwash due to $il_i e^{i\omega T}$.

It can be shown that the interference upwash is given exactly by the equation

$$\frac{w}{V} = \int_{t=0}^s \int_{x'=x_t}^{x_t} \frac{l(x', t)}{2b} \frac{\partial}{\partial t} \delta \left(\frac{x - x'}{b}, \frac{y}{b}; \frac{t}{b}, \mu \right) dx' dt, \quad (19)$$

but the more elaborate computation implied by this expression is not likely to be justified.

Now by equation (14)

$$\frac{\partial}{\partial \tau} \delta(\xi, \eta; \tau, \mu) = \frac{\partial}{\partial \tau} \delta(\xi, \eta; \tau, 0) - i\mu e^{-i\mu\xi} \int_{-\infty}^{\xi} e^{i\mu\theta} \frac{\partial}{\partial \tau} \delta(\theta, \eta; \tau, 0) d\theta, \quad (20)$$

and by equation (7)

$$\delta(\xi, \eta; \tau, 0) = F_1(\xi, \eta - \tau) - F_1(\xi, \eta + \tau) \quad (21)$$

where

$$\begin{aligned} F_1(\xi, \lambda) = & \frac{b}{h} \frac{1}{4\pi} \left\{ f_1 \left(\frac{b}{h} \xi, \frac{b}{h} \lambda \right) + \pi \operatorname{cosech} \frac{\pi b \lambda}{h} - \frac{h}{b \lambda} + \right. \\ & + \sum_{m=1}^{\infty} \left[f \left(\frac{b}{h} \xi, \frac{b}{h} (\lambda + m) \right) + f \left(\frac{b}{h} \xi, \frac{b}{h} (\lambda - m) \right) + \right. \\ & \left. \left. + \pi \operatorname{cosech} \frac{\pi b (\lambda + m)}{h} + \pi \operatorname{cosech} \frac{\pi b (\lambda - m)}{h} \right] \right\}. \quad (22) \end{aligned}$$

Hence in equation (20)

$$\frac{\partial}{\partial \tau} \delta(\xi, \eta; \tau, 0) = F_2(\xi, \eta - \tau) + F_2(\xi, \eta + \tau) \quad (23)$$

where

$$F_2(\xi, \lambda) = - \frac{\partial}{\partial \lambda} F_1(\xi, \lambda). \quad (24)$$

Thus for the calculation of interference the tabulation of F_2 is required for the tunnel concerned; this is a straightforward matter when f is known, since the infinite series in equation (22) is rapidly convergent.

5. Antisymmetrically Oscillating Wings.

Consider the system of vorticity consisting of two equal and opposite horse-shoe vortices on opposite sides of the centreline of the tunnel, as shown in Fig. 2. The vorticity distribution round a wing whose lift distribution is antisymmetrical with respect to y may be expressed as a distribution of vortices of this sort. The upwash due to such a vortex distribution is

$$\begin{aligned} \frac{w}{V} = & \frac{K}{4\pi V} \left\{ \frac{x(y-t)}{\sqrt{\{x^2 + (y-t)^2 + z^2\}}} \left[\frac{1}{(y-t)^2 + z^2} + \frac{1}{x^2 + z^2} \right] + \right. \\ & + \frac{x(y+t)}{\sqrt{\{x^2 + (y+t)^2 + z^2\}}} \left[\frac{1}{(y+t)^2 + z^2} + \frac{1}{x^2 + z^2} \right] - \\ & \left. - \frac{2xy}{\sqrt{\{x^2 + y^2 + z^2\}}} \left[\frac{1}{y^2 + z^2} + \frac{1}{x^2 + z^2} \right] + \frac{(y-t)}{(y-t)^2 + z^2} + \frac{(y+t)}{(y+t)^2 + z^2} - \frac{2y}{y^2 + z^2} \right\}. \quad (25) \end{aligned}$$

Hence for a column of images

$$\begin{aligned} \frac{w}{V} = & \frac{K}{4\pi V h} \left\{ f \left(\frac{x}{h}, \frac{y-t}{h} \right) + f \left(\frac{x}{h}, \frac{y+t}{h} \right) - 2f \left(\frac{x}{h}, \frac{y}{h} \right) + \right. \\ & \left. + \pi \operatorname{cosech} \frac{\pi(y-t)}{h} + \pi \operatorname{cosech} \frac{\pi(y+t)}{h} - 2\pi \operatorname{cosech} \frac{\pi y}{h} \right\}. \quad (26) \end{aligned}$$

The calculation may now be carried through in a manner analogous to that used in the symmetrical case, and leads to the formula

$$\delta = F_3\{\xi, (\eta - \tau)\} + F_3\{\xi, (\eta + \tau)\} - 2F_3(\xi, \eta) \quad (27)$$

where

$$\begin{aligned} F_3(\xi, \lambda) = & \frac{1}{4\pi} \frac{b}{h} \left\{ f\left(\frac{b}{h}\xi, \frac{b}{h}\lambda\right) + \pi \operatorname{cosech} \frac{\pi b \lambda}{h} - \frac{h}{b\lambda} + \right. \\ & + \sum_{m=1}^{\infty} (-1)^m \left[f\left(\frac{b}{h}\xi, \frac{b}{h}(\lambda + m)\right) + f\left(\frac{b}{h}\xi, \frac{b}{h}(\lambda - m)\right) + \right. \\ & \left. \left. + \pi \operatorname{cosech} \frac{\pi b(\lambda + m)}{h} + \pi \operatorname{cosech} \frac{\pi b(\lambda - m)}{h} \right] \right\} \quad (28) \end{aligned}$$

and so to further expressions corresponding to those of Section 4.

6. Small Wings.

If a symmetrical wing is small enough the interference may be calculated by regarding its vorticity distribution as being concentrated into a single vortex of small span. If $t \rightarrow 0$ and $K \rightarrow \infty$ in such a way that Kt tends to a constant, then in steady flow by equation (7)

$$\begin{aligned} \frac{*w(\xi, \eta; 0, 0)}{V} = & \operatorname{Lim}_{\tau \rightarrow 0} \frac{Kt}{Vb^2} \frac{1}{4\pi} \frac{b}{h} \frac{1}{\tau} \left\{ f_1\left(\frac{b}{h}\xi, \frac{b}{h}(\eta - \tau)\right) - f_1\left(\frac{b}{h}\xi, \frac{b}{h}(\eta + \tau)\right) + \right. \\ & + \left[\pi \operatorname{cosech} \frac{\pi b(\eta - \tau)}{h} - \frac{h}{b(\eta - \tau)} \right] - \left[\pi \operatorname{cosech} \frac{\pi b(\eta + \tau)}{h} - \frac{h}{b(\eta + \tau)} \right] + \\ & + \sum_{m=1}^{\infty} \left[f\left(\frac{b}{h}\xi, \frac{b}{h}(\eta - \tau \pm m)\right) - f\left(\frac{b}{h}\xi, \frac{b}{h}(\eta + \tau \pm m)\right) + \right. \\ & \left. + \pi \operatorname{cosech} \frac{\pi b(\eta - \tau \pm m)}{h} - \pi \operatorname{cosech} \frac{\pi b(\eta + \tau \pm m)}{h} \right] \left. \right\} \\ = & \frac{Kt}{Vb^2} \left(\frac{b}{h}\right)^2 \frac{1}{2\pi} \left\{ -\frac{\partial f_1}{\partial Y}\left(\frac{b}{h}\xi, \frac{b}{h}\eta\right) - \left[\frac{d}{dx} \left(\pi \operatorname{cosech} \pi x - \frac{1}{x} \right) \right]_{x=b\eta/h} - \right. \\ & \left. - \sum_{m=1}^{\infty} \left[\frac{\partial f}{\partial Y}\left(\frac{b}{h}\xi, \frac{b}{h}\eta\right) + \left(\frac{d}{dx} (\pi \operatorname{cosech} \pi x) \right)_{x=b(\eta \pm m)/h} \right] \right\}. \end{aligned}$$

Hence, by equations (22) and (24)

$$\frac{w(\xi, \eta; 0, 0)}{V} = \frac{2Kt}{Vb^2} F_2(\xi, \eta), \quad (29)$$

and in the oscillating case

$$\frac{\bar{w}(\xi, \eta; 0, \mu)}{V} = \frac{2Kt}{Vb^2} \left\{ F_2(\xi, \eta) - i\mu \exp(-i\mu\xi) \int_{-\infty}^{\xi} \exp(i\mu\theta) F_2(\theta, \eta) d\theta \right\}, \quad (30)$$

and in particular

$$\frac{\bar{w}(0, 0; 0, \mu)}{V} = \frac{2Kt}{Vb^2} \left\{ F_2(0, 0) - i\mu \int_{-\infty}^0 \exp(i\mu\theta) F_2(\theta, 0) d\theta \right\}. \quad (31)$$

* \pm indicates that the sum of both possible terms is to be taken.

For sufficiently small wings

$$\frac{2Kt}{Vb^2} = \frac{SC_L}{bh} \frac{h}{2b}, \quad (32)$$

so that in the low-frequency case

$$\begin{aligned} \frac{\bar{w}(\xi, 0; 0, \mu)}{V} &= \frac{SC_L}{bh} \frac{h}{2b} \left\{ F_2(0, 0) + \xi \left[\frac{\partial}{\partial \xi} F_2(\xi, 0) \right]_{\xi=0} - \right. \\ &\quad \left. - i\mu \int_{-\infty}^0 F_2(\theta, 0) d\theta - i\mu \xi F_2(0, 0) + O(\xi^2) \right\} \\ &= \frac{SC_L}{bh} \left\{ \delta_0 + \frac{x}{h} \delta_1 + i \frac{h}{b} \mu \left(\delta'_0 + \frac{x}{h} \delta'_1 \right) + O\left(\left(\frac{x}{h}\right)^2\right) \right\}, \end{aligned} \quad (33)$$

where

$$\begin{aligned} \delta_0 &= \frac{h}{2b} F_2(0, 0), & \delta_1 &= \frac{h^2}{2b^2} \left[\frac{\partial}{\partial \xi} F_2(\xi, 0) \right]_{\xi=0}, \\ \delta'_0 &= -\frac{1}{2} \int_{-\infty}^0 F_2(\theta, 0) d\theta, & \delta'_1 &= -\frac{h}{2b} F_2(0, 0). \end{aligned} \quad (34)$$

Values of δ_0 , δ_1 , δ'_0 , and δ'_1 calculated from a table of F_2 for $b/h = 9/7$ agree with those calculated by a different method in Table AII of Ref. 1.

The circulation round any section of a wing is

$$\Gamma(y) = \frac{V}{2} \int_{x_l}^{x_t} l \exp\left(\frac{i\omega(x-x_l)}{V}\right) dx. \quad (35)$$

Equation (32) is obtained by taking the exponential factor in the integrand to be unity. Evidently this will be valid provided $\omega c/V$ is small enough, that is when the wing is small and the frequency is low. The error in equation (32) will be of order $i\mu\bar{c}/b$ and this implies that in equation (33) δ'_0 and δ'_1 may be in error by amounts of order $(\bar{c}/h)\delta_0$ and $(\bar{c}/h)\delta_1$ respectively.

7. Discussion.

It will have become apparent from the preceding sections that, in order to carry out the evaluation of interference upwash as a matter of routine, it is necessary to have a table of the function $F_2(\xi, \lambda)$ for the tunnel concerned. The range of values of λ for which this is needed is finite, namely $-1 < \lambda < 1$, but equations (20), (23) and (24) show that values of $F_2(\xi, \lambda)$ are needed for all values of ξ from $-\infty$ up to a positive value which will depend on the possible streamwise extent of the models. An upper limit of $\xi = 1$ will probably cover most practical cases. As ξ tends to $-\infty$, $F_2(\xi, \lambda) = O(1/\xi^2)$ and an asymptotic form for large negative ξ may be obtained. Such a table of $F_2(\xi, \lambda)$ has been tabulated in the Mathematics Division of the N.P.L. for the case $b/h = 9/7$, but unfortunately it is far too lengthy to be included in this report. A similar table of $F_3(\xi, \lambda)$ would be required for antisymmetrically loaded wings.

This difficulty may to some extent be overcome by the use of tables such as those given in Table 2. This gives $\text{Re}(wb/\Gamma)$ and $\mu^{-1}\text{Im}(wb/\Gamma)$ as functions of ξ and η for various values of σ , due to an oscillating horse-shoe vortex of circulation Γ and span $2\sigma b$ when the origin is at the mid-point of the finite part of the vortex. The frequency is assumed to be small in Table 2 but a similar table could be constructed for any other value of μ .

Table 2 may be used to calculate the interference upwash due to either the in-phase or out-of-phase lift distribution on a symmetrical wing in a 9×7 rectangular tunnel in the following manner. The wing is divided up spanwise by the lines $\eta = -\tau_k, -\tau_{k-1}, -\tau_{k-2}, \dots, -\tau_1, 0, \tau_1, \tau_2, \dots, \tau_{k-1}, \tau_k$, where $2b\tau_k$ is the span of the wing (*see* Fig. 3). It is assumed that in any interval (τ_n, τ_{n+1}) the circulation is constant, i.e.,

$$\begin{aligned}\Gamma &= \frac{1}{2}\{\Gamma(\tau_n) + \Gamma(\tau_{n+1})\} \\ &= \Gamma_n, \text{ say.}\end{aligned}\tag{36}$$

Moreover the distributed vorticity in this strip is assumed to be at the local centre of pressure, i.e., at

$$\xi = \bar{\xi}(\frac{1}{2}[\tau_n + \tau_{n+1}])$$

where $\xi = \bar{\xi}(\tau)$ is the locus of the centre of pressure. Then the effect of the vorticity between τ_n and τ_{n+1} and the equal vorticity between $-\tau_{n+1}$ and $-\tau_n$ is approximately that due to the sum of two horse-shoe vortices, one of span $2\tau_{n+1}$ and strength $+\Gamma_n$, and the other of span $2\tau_n$ and strength $-\Gamma_n$, both with their spanwise parts on the line $\xi = \bar{\xi}(\frac{1}{2}[\tau_n + \tau_{n+1}])$. Since the upwash due to these two vortices may be obtained from Table 2, the interference due to the whole wing may be obtained by summation with respect to n . In fact equation (18) is the limiting form of such a summation.

Since in Table 2 the frequency is assumed to be small, $\text{Re}(wb/\Gamma)$ gives the interference upwash due to a steady horse-shoe vortex of strength Γ , and calculations of steady interference may be carried through simply as particular cases of oscillatory calculations.

Table 3 illustrates the effect of frequency for the case $\sigma = 0.2$, by giving the interference upwash on the line $\eta = 0$ for $\mu = 0(0.4)2.0$. These values have been plotted in Figs. 4 and 5 which show the marked effect of variations in frequency especially for points well downstream of the vortex. This suggests that frequency effects may be important especially for wings of large streamwise extent.

There remains the problem of calculating the overall interference forces and moments on the wing. Satisfactory methods exist for doing this when μ is small, for example that of Ref. 12, but when μ is not small the matter is more difficult and it is not clear what is the best course to adopt. A discussion of some lifting-surface theories which have recently been proposed is given in Ref. 13. Fortunately for most tunnel-interference calculations high accuracy is not required in this stage of the computation. In particular the range of frequency for which the low-frequency theory is adequate is likely to be larger than in ordinary wing calculations.

As far as pitching wings are concerned a procedure analogous to that used in steady flow may be adopted, that is a correction may be applied to the incidence of the wing rather than to the forces acting on it. The numbers concerned are now all complex. Assume that the following quantities have been determined:

(1) The experimentally determined lift coefficient, C'_L , and pitching-moment coefficient, C'_m , for a wing oscillating in the tunnel about a known axis, with a known instantaneous incidence $\alpha = \alpha_0 \exp(i\omega T)$.

(2) The theoretical free-stream lift and pitching-moment derivatives, $\partial C_{L_f}/\partial\alpha$ and $\partial C_{m_f}/\partial\alpha$ for oscillations of small amplitude about the same axis.

(3) The additional theoretical lift and pitching-moment derivatives due to the tunnel-induced upwash caused by the lift distribution giving rise to $\partial C_{L_t}/\partial\alpha$ and $\partial C_{m_t}/\partial\alpha$. Let these quantities be denoted by $\partial(\Delta C_L)/\partial\alpha$ and $\partial(\Delta C_m)/\partial\alpha$, respectively.

Then the lift corresponding to C'_L would theoretically be caused by an incidence $C'_L/\partial C_L/\partial\alpha$. The theoretical interference lift due to this would be

$$C'_L \frac{\partial(\Delta C_L)}{\partial\alpha} / \frac{\partial C_L}{\partial\alpha}$$

and the corresponding mean angle of incidence is

$$(\Delta\alpha)_m = C'_L \frac{\partial(\Delta C_L)}{\partial\alpha} / \left(\frac{\partial C_L}{\partial\alpha} \right)^2. \quad (37)$$

The angle of incidence corresponding to C'_L is therefore taken to be $\alpha + (\Delta\alpha)_m$. In general $(\Delta\alpha)_m$ is complex so a phase shift as well as a change in magnitude is implied. This process is in effect an averaging of the interference upwash using lifting-surface theory.

The residual interference contribution to the measured C'_m is now the moment due to the interference upwash less that due to the distribution of upwash corresponding to $(\Delta\alpha)_m$. Hence

$$\begin{aligned} (C'_m)_{\text{corrected}} &= (C'_m)_{\text{measured}} - \left\{ \frac{C'_L}{\frac{\partial C_L}{\partial\alpha}} \frac{\partial(\Delta C_m)}{\partial\alpha} - (\Delta\alpha)_m \frac{\partial C_m}{\partial\alpha} \right\} \\ &= (C_m)_{\text{measured}} + \frac{C'_L}{\left(\frac{\partial C_L}{\partial\alpha} \right)^2} \left[\frac{\partial C_m}{\partial\alpha} \frac{\partial(\Delta C_L)}{\partial\alpha} - \frac{\partial(\Delta C_m)}{\partial\alpha} \frac{\partial C_L}{\partial\alpha} \right]. \end{aligned} \quad (38)$$

In general as much reliable experimental information as possible should be employed in computing corrections. In equations (37) and (38) the measured C'_L is used but C'_m is not. This might be improved if the in-phase and out-of-phase concentrations of vorticity on $\xi = \bar{\xi}_r(\eta)$ and $\xi = \bar{\xi}_i(\eta)$ were moved bodily streamwise until

$$C'_m/C'_L = \frac{\partial C_m}{\partial\alpha} / \frac{\partial C_L}{\partial\alpha}.$$

Some applications of the method to an actual planform are described in Part II.

8. Acknowledgements.

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LIST OF SYMBOLS

b	Breadth of tunnel
c	Chord of wing
\bar{c}	Mean chord of wing
C_L, C_m	Theoretical lift and pitching-moment coefficients for wing in free stream
C'_L, C'_m	Experimentally measured values of C_L, C_m
f, f_1	Functions defined by equations (3) and (4)
F_1, F_2, F_3	Functions defined by equations (22), (24) and (28)
h	Height of tunnel
H	Unit step function; $H \equiv 0$ if $x < 0$, $H \equiv 1$ if $x > 0$
K	Circulation of horse-shoe vortex
\bar{K}	Modulus of K
l	Non-dimensional lift distribution on wing {see equation (17)}
l_r, l_i	In- and out-of-phase parts of l
p	Pressure
s	Semi-span of wing
S	Area of wing planform
t	Semi-span of horse-shoe vortex
T	Time
V	Velocity of air stream in tunnel
w	Upwash
\bar{w}	Modulus of complex upwash
x, y, z	Cartesian co-ordinates (see Fig. 1)
x_l, x_t	Co-ordinates of leading and trailing edges of wing respectively
\bar{x}_r, \bar{x}_i	Co-ordinates of in- and out-of-phase local centres of pressure
X, Y	Independent variables
α	Instantaneous incidence of wing, $\alpha = \alpha_0 e^{i\omega}$

LIST OF SYMBOLS—*continued*

Γ	Circulation of wing or vortex
Γ_r, Γ_i	Circulations corresponding to l_r and l_i respectively
δ	Non-dimensional interference upwash { <i>see</i> equation (12)}
$\delta_0, \delta'_0, \delta_1, \delta'_1$	Parameters for the interference upwash of a small wing { <i>see</i> equation (33)}
Δ	(Prefix) increment due to tunnel interference
η	Non-dimensional spanwise co-ordinate, y/b
μ	Frequency parameter $\omega b/V$
ξ	Non-dimensional streamwise co-ordinate, x/b
$\bar{\xi}_r, \bar{\xi}_i$	$\bar{x}_r/b, \bar{x}_i/b$
ρ	Density of air stream
σ	Non-dimensional semi-span of wing, s/b
τ	Non-dimensional semi-span of horse-shoe vortex, t/b
ϕ	Velocity potential
ϕ_1	<i>See</i> equation (15)
ω	Angular frequency of oscillation.

Suffixes

a, b	Values on upper and lower surfaces of wing respectively
r, i	Real and imaginary parts of complex number.

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APPENDIX

Tables of Functions Used in Calculating Tunnel-Wall Corrections

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Description of Tables.

The function

$$f(X, Y) = \sum_{n=-\infty}^{\infty} \frac{(-1)^n XY}{(X^2 + Y^2 + n^2)^{1/2}} \left\{ \frac{1}{X^2 + n^2} + \frac{1}{Y^2 + n^2} \right\} \quad (\text{A.1})$$

occurs in aerodynamic theory, and Table 1 is designed to facilitate its evaluation. To simplify interpolation we have found it convenient to tabulate the auxiliary functions

$$F(X, Y) = -f(X, Y) + (X^2 + Y^2)^{1/2}/XY \quad (\text{A.2})$$

$$G(X, Y) = -f(X, Y) + \pi \operatorname{cosech} \pi X + \pi \operatorname{cosech} \pi Y \quad (\text{A.3})$$

from which the required $f(X, Y)$ can be obtained with little difficulty. We have also used auxiliary arguments X/Y and Y , in place of X and Y , to reduce the number of entries in the table.

The arrangement of the table, and the range of values of X/Y and Y for which $F(X, Y)$ and $G(X, Y)$ are given, are as follows

	Function	Values of Y	Values of X/Y
Table 1a	F	0.0(0.05)0.50	0.000(0.005)1.015
Table 1b	G	0.50(0.05)1.00	0.000(0.005)1.015
Table 1c	G	1.0(0.1)2.0	0.00(0.01)1.01
Table 1d	G	2.0(0.1)4.0	0.00(0.02)1.06

Tabular values are given to five decimal places, and the error in the last figure nowhere exceeds 2 units and is generally not greater than 0.8 units. When $Y > 4$ the function $G(X, Y)$ is zero to this precision.

The calculation of $f(X, Y)$ from (A.3) is facilitated by the fact that

$$G(0, Y) = \pi \operatorname{cosech} \pi Y, \quad (\text{A.4})$$

so that

$$f(X, Y) = G(0, Y) + G(0, X) - G(X, Y) \quad (\text{A.5})$$

and no tables of $\operatorname{cosech} \pi X$ are needed.

Interpolation.

Linear interpolation is accurate everywhere in the X/Y -direction.

In the Y -direction second differences δ_m^2 modified according to the formula

$$\delta_m^2 = \delta^2 - 0.184\delta^4 \quad (\text{A } 6)$$

are given where needed, for use either with the modified formula of Everett

$$\phi(a+nh) = (1-n)\phi(a) + n\phi(a+h) + E_2\delta_m^2\phi(a) + F_2\delta_m^2\phi(a+h), \quad (\text{A.7})$$

or that of Bessel

$$\phi(a+nh) = (1-n)\phi(a) + n\phi(a+h) + B_2\{\delta_m^2\phi(a) + \delta_m^2\phi(a+h)\}, \quad (\text{A.8})$$

where h denotes the argument interval, and ϕ denotes either F or G . Suitable tables of the coefficients E_2 , F_2 and B_2 are given in Ref. 14. Formula (A.8) should be used only when

$$|\delta_m^2\phi(a+h) - \delta_m^2\phi(a)| < 60 \quad (\text{A.9})$$

in units of the last decimal place.

Provided that a guarding figure is retained in carrying out the interpolation, the total error in an unrounded interpolate will in no case exceed 3 units in the fifth decimal place.

TABLE 1a

X/Y	0.000		0.005		0.010		0.015		0.020		0.025	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000		0.00000	+ 9	0.00000	+18	0.00000	+27	0.00000	+36	0.00000	+45
.05	.00000		.00004	9	.00009	18	.00013	27	.00018	36	.00022	45
.10	.00000		.00018	8	.00036	17	.00053	25	.00071	34	.00089	42
.15	.00000		.00040	8	.00079	16	.00119	23	.00158	31	.00198	39
.20	.00000		.00069	7	.00138	14	.00207	21	.00277	28	.00346	35
0.25	0.00000		0.00106	+ 6	0.00211	+12	0.00317	+18	0.00422	+24	0.00528	+30
.30	.00000		.00148	5	.00296	10	.00444	15	.00592	20	.00740	25
.35	.00000		.00195	4	.00391	8	.00586	11	.00781	15	.00976	19
.40	.00000		.00246	3	.00493	6	.00739	9	.00986	12	.01232	14
.45	.00000		.00300	2	.00601	4	.00901	6	.01202	8	.01502	10
0.50	0.00000		0.00356	+ 1	0.00713	+ 2	0.01069	+ 3	0.01426	+ 5	0.01782	+ 5

X/Y	0.030		0.035		0.040		0.045		0.050		0.055	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+54	0.00000	+63	0.00000	+72	0.00000	+81	0.00000	+90	0.00000	+99
.05	.00027	53	.00031	62	.00036	71	.00040	80	.00045	89	.00049	98
.10	.00107	51	.00125	59	.00143	68	.00161	76	.00178	85	.00196	93
.15	.00238	47	.00277	54	.00317	62	.00356	70	.00396	78	.00436	86
.20	.00415	42	.00484	49	.00553	55	.00622	62	.00691	69	.00761	76
0.25	0.00634	+36	0.00739	+42	0.00845	+48	0.00950	+53	0.01056	+59	0.01161	+65
.30	.00888	29	.01036	34	.01184	39	.01332	44	.01480	49	.01628	54
.35	.01172	23	.01367	27	.01562	31	.01757	34	.01952	38	.02148	42
.40	.01479	17	.01725	20	.01971	23	.02217	26	.02464	28	.02710	31
.45	.01803	12	.02103	14	.02403	15	.02703	17	.03003	19	.03303	21
0.50	0.02138	+ 7	0.02495	+ 8	0.02851	+ 9	0.03207	+10	0.03563	+11	0.03918	+13

X/Y	0.060		0.065		0.070		0.075		0.080		0.085	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+108	0.00000	+118	0.00000	+127	0.00000	+136	0.00000	+145	0.00000	+154
.05	.00054	107	.00058	116	.00063	125	.00067	133	.00072	142	.00076	151
.10	.00214	102	.00232	110	.00250	119	.00268	127	.00285	136	.00303	144
.15	.00475	93	.00515	101	.00554	109	.00594	117	.00634	125	.00673	132
.20	.00830	83	.00899	90	.00968	97	.01037	104	.01106	111	.01175	118
0.25	0.01267	+ 71	0.01372	+ 77	0.01478	+ 83	0.01583	+ 89	0.01689	+ 95	0.01794	+101
.30	.01775	59	.01923	64	.02071	68	.02219	73	.02367	78	.02514	83
.35	.02343	46	.02538	50	.02733	54	.02928	57	.03122	61	.03317	65
.40	.02956	34	.03202	37	.03448	39	.03694	42	.03939	45	.04185	48
.45	.03603	23	.03903	25	.04203	27	.04502	29	.04802	31	.05101	32
0.50	0.04274	+ 13	0.04629	+ 14	0.04985	+ 15	0.05340	+ 16	0.05695	+ 17	0.06049	+ 18

X/Y	0.090		0.095		0.100		0.105		0.110		0.115	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+163	0.00000	+172	0.00000	+181	0.00000	+190	0.00000	+199	0.00000	+208
.05	.00081	160	.00085	169	.00090	178	.00094	187	.00099	196	.00103	205
.10	.00321	152	.00339	161	.00357	169	.00375	178	.00392	186	.00410	195
.15	.00713	140	.00752	148	.00792	156	.00832	163	.00871	171	.00911	179
.20	.01244	125	.01313	132	.01382	138	.01451	146	.01520	152	.01589	159
0.25	0.01900	+107	0.02005	+113	0.02111	+118	0.02216	+124	0.02321	+130	0.02427	+136
.30	.02662	88	.02810	93	.02957	97	.03105	102	.03252	107	.03400	111
.35	.03512	68	.03707	72	.03901	76	.04096	80	.04290	83	.04484	87
.40	.04430	51	.04676	53	.04921	56	.05166	58	.05411	61	.05656	64
.45	.05400	34	.05699	36	.05997	38	.06296	40	.06594	41	.06892	43
0.50	0.06403	+ 20	0.06758	+ 20	0.07111	+ 21	0.07465	+ 22	0.07818	+ 23	0.08171	+ 24

TABLE 1a—continued

X/Y	0·120		0·125		0·130		0·135		0·140		0·145	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0·00	0·00000	+217	0·00000	+226	0·00000	+235	0·00000	+244	0·00000	+253	0·00000	+262
·05	·00108	214	·00112	222	·00117	231	·00121	240	·00126	249	·00130	258
·10	·00428	203	·00446	212	·00464	220	·00482	228	·00499	237	·00517	245
·15	·00950	187	·00990	195	·01029	202	·01069	210	·01109	218	·01148	226
·20	·01659	166	·01728	173	·01797	180	·01866	186	·01934	193	·02003	200
0·25	0·02532	+142	0·02637	+148	0·02743	+153	0·02848	+159	0·02953	+165	0·03058	+171
·30	·03547	116	·03695	121	·03842	126	·03989	130	·04136	135	·04284	140
·35	·04679	91	·04873	94	·05067	98	·05261	102	·05455	105	·05649	109
·40	·05901	66	·06146	69	·06390	71	·06635	74	·06879	76	·07123	79
·45	·07190	44	·07488	46	·07785	48	·08082	49	·08379	51	·08676	52
0·50	0·08524	+ 25	0·08876	+ 26	0·09228	+ 26	0·09580	+ 27	0·09931	+ 28	0·10282	+ 29

X/Y	0·150		0·155		0·160		0·165		0·170		0·175	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0·00	0·00000	+271	0·00000	+280	0·00000	+289	0·00000	+298	0·00000	+308	0·00000	+317
·05	·00135	267	·00139	276	·00144	285	·00148	294	·00153	302	·00157	311
·10	·00535	254	·00553	262	·00571	271	·00588	279	·00606	288	·00624	296
·15	·01188	233	·01227	241	·01267	249	·01306	256	·01346	264	·01385	272
·20	·02072	207	·02141	214	·02210	221	·02279	227	·02348	234	·02417	241
0·25	0·03163	+177	0·03269	+182	0·03374	+188	0·03479	+194	0·03584	+199	0·03689	+205
·30	·04431	144	·04578	149	·04725	153	·04872	158	·05018	163	·05165	167
·35	·05842	112	·06036	116	·06229	119	·06423	123	·06616	126	·06809	130
·40	·07366	81	·07610	84	·07853	86	·08097	89	·08340	91	·08582	93
·45	·08972	54	·09268	55	·09564	57	·09860	58	·10155	59	·10450	61
0·50	0·10633	+ 29	0·10983	+ 30	0·11333	+ 30	0·11682	+ 31	0·12030	+ 32	0·12379	+ 31

X/Y	0·180		0·185		0·190		0·195		0·200		0·205	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0·00	0·00000	+326	0·00000	+335	0·00000	+344	0·00000	+353	0·00000	+362	0·00000	+371
·05	·00162	320	·00166	329	·00171	338	·00175	347	·00180	356	·00184	365
·10	·00642	304	·00660	313	·00678	321	·00695	330	·00713	338	·00731	346
·15	·01425	279	·01464	287	·01504	295	·01543	302	·01583	310	·01622	318
·20	·02486	248	·02555	254	·02624	261	·02692	268	·02761	275	·02830	281
0·25	0·03794	+211	0·03899	+217	0·04003	+222	0·04108	+228	0·04213	+233	0·04318	+239
·30	·05312	172	·05458	176	·05605	181	·05751	185	·05898	189	·06044	194
·35	·07002	133	·07195	136	·07387	140	·07580	143	·07772	146	·07964	149
·40	·08825	96	·09067	98	·09310	100	·09552	102	·09793	104	·10035	107
·45	·10745	62	·11039	63	·11333	65	·11626	66	·11919	67	·12212	68
0·50	0·12727	+ 32	0·13074	+ 32	0·13421	+ 33	0·13767	+ 33	0·14113	+ 34	0·14458	+ 34

X/Y	0·210		0·215		0·220		0·225		0·230		0·235	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0·00	0·00000	+380	0·00000	+389	0·00000	+398	0·00000	+407	0·00000	+416	0·00000	+425
·05	·00189	373	·00193	382	·00198	391	·00202	400	·00207	409	·00211	418
·10	·00749	355	·00767	363	·00784	372	·00802	380	·00820	389	·00838	397
·15	·01662	325	·01701	333	·01741	341	·01780	348	·01820	356	·01859	364
·20	·02899	288	·02968	294	·03036	301	·03105	308	·03174	315	·03242	321
0·25	0·04423	+244	0·04527	+250	0·04632	+256	0·04736	+261	0·04841	+267	0·04945	+272
·30	·06190	199	·06336	203	·06482	207	·06628	211	·06774	216	·06920	220
·35	·08157	153	·08348	156	·08540	159	·08732	162	·08923	165	·09114	168
·40	·10276	109	·10517	111	·10757	113	·10998	115	·11238	116	·11478	119
·45	·12504	69	·12797	70	·13088	71	·13379	72	·13670	73	·13961	74
0·50	0·14803	+ 34	0·15147	+ 34	0·15491	+ 34	0·15834	+ 34	0·16176	+ 34	0·16518	+ 34

TABLE 1a—continued

X/Y	0.240		0.245		0.250		0.255		0.260		0.265	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+434	0.00000	+443	0.00000	+452	0.00000	+461	0.00000	+470	0.00000	+479
.05	.00216	427	.00220	436	.00225	445	.00229	453	.00234	462	.00238	471
.10	.00856	405	.00873	414	.00891	422	.00909	430	.00927	439	.00945	447
.15	.01899	371	.01938	379	.01977	386	.02017	394	.02056	401	.02096	409
.20	.03311	328	.03380	334	.03448	341	.03517	347	.03585	354	.03654	361
0.25	0.05050	+278	0.05154	+283	0.05258	+288	0.05363	+294	0.05467	+299	0.05571	+304
.30	.07066	224	.07211	229	.07356	233	.07502	237	.07647	241	.07792	245
.35	.09306	171	.09496	174	.09687	177	.09878	180	.10068	183	.10258	186
.40	.11717	120	.11957	122	.12196	124	.12434	126	.12673	127	.12911	129
.45	.14250	75	.14540	76	.14829	76	.15118	77	.15406	78	.15693	79
0.50	0.16859	+ 34	0.17200	+ 34	0.17540	+ 34	0.17879	+ 34	0.18217	+ 33	0.18555	+ 33
X/Y	0.270		0.275		0.280		0.285		0.290		0.295	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+488	0.00000	+498	0.00000	+507	0.00000	+516	0.00000	+525	0.00000	+534
.05	.00243	480	.00247	489	.00252	498	.00256	507	.00261	515	.00265	524
.10	.00963	455	.00980	464	.00998	472	.01016	480	.01034	489	.01051	497
.15	.02135	417	.02175	424	.02214	432	.02253	439	.02293	447	.02332	454
.20	.03722	367	.03791	374	.03859	380	.03928	386	.03996	393	.04065	399
0.25	0.05675	+310	0.05779	+315	0.05883	+320	0.05987	+326	0.06091	+331	0.06195	+336
.30	.07937	249	.08082	253	.08227	257	.08372	261	.08516	265	.08661	269
.35	.10448	189	.10638	192	.10828	194	.11017	197	.11206	200	.11395	202
.40	.13149	131	.13386	132	.13623	134	.13860	136	.14096	137	.14332	138
.45	.15981	79	.16267	79	.16553	80	.16839	80	.17124	81	.17409	81
0.50	0.18893	+ 33	0.19229	+ 32	0.19565	+ 32	0.19900	+ 31	0.20234	+ 30	0.20568	+ 30
X/Y	0.300		0.305		0.310		0.315		0.320		0.325	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+543	0.00000	+552	0.00000	+561	0.00000	+570	0.00000	+579	0.00000	+588
.05	.00270	533	.00274	542	.00279	551	.00283	560	.00288	569	.00292	578
.10	.01069	506	.01087	514	.01105	522	.01123	530	.01140	539	.01158	547
.15	.02371	461	.02411	469	.02450	476	.02489	484	.02529	491	.02568	499
.20	.04133	406	.04201	412	.04270	419	.04338	425	.04406	431	.04474	437
0.25	0.06299	+341	0.06402	+347	0.06506	+352	0.06610	+357	0.06713	+362	0.06816	+367
.30	.08805	273	.08949	276	.09093	280	.09237	284	.09381	288	.09524	292
.35	.11584	205	.11772	207	.11961	210	.12149	212	.12336	215	.12524	217
.40	.14568	139	.14804	141	.15039	142	.15273	143	.15508	144	.15741	146
.45	.17693	81	.17977	81	.18260	81	.18542	82	.18824	82	.19106	82
0.50	0.20901	+ 29	0.21232	+ 28	0.21564	+ 27	0.21894	+ 27	0.22224	+ 26	0.22553	+ 25
X/Y	0.330		0.335		0.340		0.345		0.350		0.355	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+597	0.00000	+606	0.00000	+615	0.00000	+624	0.00000	+633	0.00000	+642
.05	.00297	586	.00301	595	.00306	604	.00310	613	.00315	622	.00319	631
.10	.01176	555	.01194	564	.01212	572	.01229	580	.01247	589	.01265	597
.15	.02607	506	.02647	514	.02686	521	.02725	528	.02764	536	.02804	543
.20	.04543	444	.04611	450	.04679	456	.04747	463	.04815	469	.04883	475
0.25	0.06920	+372	0.07023	+377	0.07126	+382	0.07230	+387	0.07333	+392	0.07436	+396
.30	.09668	295	.09811	299	.09955	302	.10098	306	.10241	309	.10384	313
.35	.12711	220	.12899	222	.13085	224	.13272	226	.13459	228	.13645	231
.40	.15975	147	.16208	148	.16441	149	.16673	150	.16905	150	.17137	151
.45	.19386	82	.19667	82	.19946	81	.20225	81	.20504	81	.20781	81
0.50	0.22881	+ 24	0.23208	+ 22	0.23534	+ 21	0.23860	+ 20	0.24184	+ 19	0.24508	+ 17

TABLE 1a—continued

X/Y	0.360		0.365		0.370		0.375		0.380		0.385	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+651	0.00000	+661	0.00000	+670	0.00000	+679	0.00000	+688	0.00000	+697
.05	.00324	640	.00328	648	.00333	657	.00337	666	.00342	675	.00346	684
.10	.01283	605	.01300	613	.01318	622	.01336	630	.01354	638	.01371	646
.15	.02843	550	.02882	558	.02921	565	.02961	573	.03000	580	.03039	587
.20	.04951	481	.05019	487	.05087	494	.05155	499	.05223	506	.05291	512
0.25	0.07539	+401	0.07642	+406	0.07744	+411	0.07847	+416	0.07950	+420	0.08052	+425
.30	.10526	316	.10669	320	.10811	323	.10954	326	.11096	330	.11238	333
.35	.13831	233	.14016	234	.14202	236	.14387	238	.14572	240	.14756	242
.40	.17368	152	.17599	153	.17829	153	.18059	154	.18288	155	.18517	155
.45	.21059	80	.21335	79	.21611	79	.21887	78	.22161	78	.22435	77
0.50	0.24831	+ 16	0.25153	+ 15	0.25474	+ 13	0.25794	+ 12	0.26113	+ 10	0.26431	+ 8
X/Y	0.390		0.395		0.400		0.405		0.410		0.415	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+706	0.00000	+715	0.00000	+724	0.00000	+733	0.00000	+742	0.00000	+751
.05	.00351	693	.00355	701	.00360	710	.00364	719	.00368	728	.00373	737
.10	.01389	655	.01407	663	.01425	671	.01442	679	.01460	687	.01478	696
.15	.03078	594	.03117	602	.03157	609	.03196	616	.03235	623	.03274	630
.20	.05359	518	.05426	524	.05494	530	.05562	536	.05630	542	.05697	548
0.25	0.08155	+429	0.08257	+434	0.08359	+439	0.08462	+443	0.08564	+448	0.08666	+452
.30	.11379	336	.11521	339	.11663	342	.11804	346	.11945	348	.12086	352
.35	.14940	244	.15124	246	.15308	247	.15492	249	.15675	250	.15858	252
.40	.18746	155	.18974	156	.19202	156	.19429	156	.19656	157	.19882	157
.45	.22708	77	.22981	75	.23253	75	.23524	74	.23795	+ 72	.24065	+ 72
0.50	0.26749	+ 6	0.27065	+ 4	0.27381	+ 2	0.27695	+ 1	0.28009	- 1	0.28321	- 4
X/Y	0.420		0.425		0.430		0.435		0.440		0.445	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+760	0.00000	+769	0.00000	+778	0.00000	+787	0.00000	+796	0.00000	+805
.05	.00377	746	.00382	754	.00386	763	.00391	772	.00395	781	.00400	790
.10	.01496	704	.01513	712	.01531	720	.01549	728	.01567	737	.01584	745
.15	.03313	638	.03352	645	.03391	652	.03430	659	.03469	666	.03508	673
.20	.05765	554	.05832	560	.05900	565	.05968	571	.06035	577	.06103	583
0.25	0.08768	+457	0.08870	+461	0.08972	+466	0.09073	+470	0.09175	+474	0.09277	+479
.30	.12227	354	.12368	357	.12508	360	.12648	363	.12788	366	.12928	369
.35	.16040	254	.16223	255	.16405	256	.16586	258	.16768	259	.16949	260
.40	.20108	156	.20333	156	.20558	157	.20783	157	.21007	156	.21230	157
.45	.24334	+ 71	.24603	+ 70	.24871	+ 68	.25138	+ 67	.25404	+ 65	.25670	+ 64
0.50	0.28633	- 6	0.28943	- 8	0.29253	- 10	0.29561	- 13	0.29869	- 15	0.30175	- 17
X/Y	0.450		0.455		0.460		0.465		0.470		0.475	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+815	0.00000	+824	0.00000	+833	0.00000	+842	0.00000	+851	0.00000	+860
.05	.00404	799	.00409	807	.00413	816	.00418	825	.00422	834	.00427	843
.10	.01602	753	.01620	761	.01637	769	.01655	777	.01673	785	.01691	794
.15	.03548	680	.03587	687	.03626	694	.03665	702	.03704	708	.03743	716
.20	.06170	589	.06237	594	.06305	600	.06372	606	.06439	611	.06506	617
0.25	0.09378	+483	0.09480	+487	0.09581	+491	0.09682	+495	0.09783	+499	0.09884	+504
.30	.13068	371	.13208	374	.13347	376	.13487	379	.13626	381	.13764	384
.35	.17130	261	.17310	262	.17490	263	.17670	264	.17850	265	.18029	266
.40	.21453	156	.21676	156	.21897	155	.22119	155	.22340	154	.22560	154
.45	.25935	+ 63	.26199	+ 61	.26462	+ 60	.26725	+ 58	.26987	+ 56	.27248	+ 54
0.50	0.30481	- 20	0.30785	- 22	0.31088	- 25	0.31390	- 28	0.31692	- 31	0.31992	- 33

TABLE 1a—continued

X/Y	0.480		0.485		0.490		0.495		0.500		0.505	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+869	0.00000	+878	0.00000	+887	0.00000	+896	0.00000	+905	0.00000	+914
.05	.00431	852	.00436	860	.00440	869	.00445	878	.00449	887	.00454	896
.10	.01708	802	.01726	810	.01744	818	.01761	826	.01779	834	.01797	842
.15	.03782	722	.03820	730	.03859	737	.03898	743	.03937	750	.03976	757
.20	.06573	622	.06641	628	.06708	633	.06775	639	.06842	644	.06909	650
0.25	0.09985	+507	0.10086	+511	0.10187	+515	0.10287	+519	0.10388	+523	0.10488	+527
.30	.13903	386	.14042	389	.14180	391	.14318	393	.14456	395	.14594	397
.35	.18208	267	.18386	268	.18564	269	.18742	269	.18920	270	.19097	270
.40	.22780	153	.23000	152	.23218	152	.23437	151	.23655	150	.23872	149
.45	.27508	+ 52	.27768	+ 50	.28027	+ 48	.28285	+ 47	.28542	+ 44	.28798	+ 42
0.50	0.32291	- 36	0.32589	- 39	0.32885	- 42	0.33181	- 45	0.33476	- 48	0.33769	- 52
X/Y	0.510		0.515		0.520		0.525		0.530		0.535	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+923	0.00000	+932	0.00000	+941	0.00000	+951	0.00000	+960	0.00000	+969
.05	.00458	904	.00463	913	.00467	922	.00472	931	.00476	940	.00481	948
.10	.01814	850	.01832	858	.01850	866	.01867	874	.01885	882	.01903	890
.15	.04015	764	.04054	771	.04093	778	.04132	785	.04170	791	.04209	798
.20	.06975	655	.07042	661	.07109	666	.07176	671	.07243	677	.07309	682
0.25	0.10589	+531	0.10689	+534	0.10789	+538	0.10889	+542	0.10989	+545	0.11089	+549
.30	.14731	400	.14869	402	.15006	403	.15143	406	.15279	408	.15416	409
.35	.19274	271	.19450	271	.19627	272	.19802	272	.19978	272	.20153	272
.40	.24088	148	.24305	147	.24520	146	.24735	145	.24950	144	.25164	143
.45	.29054	+ 40	.29309	+ 38	.29563	+ 35	.29816	+ 33	.30068	+ 31	.30320	+ 28
0.50	0.34062	- 55	0.34353	- 58	0.34643	- 61	0.34932	- 65	0.35220	- 68	0.35507	- 72
X/Y	0.540		0.545		0.550		0.555		0.560		0.565	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+ 978	0.00000	+ 987	0.00000	+ 996	0.00000	+1005	0.00000	+1014	0.00000	+1023
.05	.00485	957	.00490	966	.00494	975	.00499	984	.00503	992	.00508	1001
.10	.01921	898	.01938	906	.01956	914	.01974	922	.01991	930	.02009	938
.15	.04248	805	.04287	812	.04326	818	.04364	825	.04403	832	.04442	839
.20	.07376	688	.07443	693	.07509	698	.07576	703	.07642	708	.07708	713
0.25	0.11188	+ 553	0.11288	+ 556	0.11388	+ 560	0.11487	+ 563	0.11586	+ 567	0.11685	+ 570
.30	.15552	411	.15688	413	.15824	415	.15960	416	.16096	418	.16231	420
.35	.20328	273	.20502	273	.20676	273	.20850	273	.21023	273	.21196	273
.40	.25377	141	.25590	140	.25802	138	.26014	137	.26225	135	.26436	134
.45	.30571	+ 25	.30820	+ 23	.31069	+ 20	.31318	+ 17	.31565	+ 15	.31811	+ 12
0.50	0.35792	- 75	0.36076	- 79	0.36360	- 83	0.36642	- 86	0.36923	- 90	0.37202	- 94
X/Y	0.570		0.575		0.580		0.585		0.590		0.595	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1032	0.00000	+1041	0.00000	+1050	0.00000	+1059	0.00000	+1068	0.00000	+1077
.05	.00512	1010	.00517	1019	.00521	1027	.00526	1036	.00530	1045	.00534	1054
.10	.02026	946	.02044	954	.02062	962	.02079	970	.02097	978	.02115	986
.15	.04480	846	.04519	852	.04558	859	.04596	865	.04635	872	.04674	878
.20	.07775	718	.07841	723	.07907	728	.07974	734	.08040	738	.08106	743
0.25	0.11784	+ 573	0.11883	+ 576	0.11982	+ 580	0.12081	+ 583	0.12179	+ 586	0.12278	+ 589
.30	.16366	421	.16501	422	.16635	424	.16770	425	.16904	426	.17038	428
.35	.21369	272	.21541	272	.21713	272	.21884	272	.22055	271	.22226	271
.40	.26645	132	.26855	130	.27064	128	.27272	+ 126	.27479	+ 125	.27686	+ 122
.45	.32057	+ 8	.32302	+ 6	.32546	+ 3	.32789	0	.33031	- 4	.33272	- 7
0.50	0.37480	- 98	0.37758	- 102	0.38034	- 106	0.38309	- 110	0.38582	- 114	0.38855	- 119

TABLE 1a—continued

X/Y	0.600		0.605		0.610		0.615		0.620		0.625	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1087	0.00000	+1096	0.00000	+1111	00000	+1114	0.00000	+1123	0.00000	+1132
.05	.00539	1063	.00543	1071	.00548	1080	.00552	1089	.00557	1098	.00561	1106
.10	.02132	994	.02150	1001	.02168	1010	.02185	1017	.02203	1025	.02220	1033
.15	.04712	885	.04751	892	.04789	898	.04828	905	.04866	911	.04905	918
.20	.08172	748	.08238	753	.08304	758	.08370	763	.08436	768	.08502	772
0.25	0.12376	+ 592	0.12475	+ 595	0.12573	+ 598	0.12671	+ 601	0.12769	+ 604	0.12866	+ 607
.30	.17172	429	.17305	430	.17438	431	.17571	432	.17704	433	.17837	434
.35	.22396	270	.22566	269	.22736	269	.22905	268	.23073	267	.23242	267
.40	.27893	+ 120	.28098	+ 118	.28304	+ 116	.28508	+ 114	.28712	+ 111	.28915	+ 109
.45	.33513	- 10	.33752	- 14	.33991	- 17	.34229	- 20	.34465	- 24	.34701	- 28
0.50	0.39126	- 123	0.39396	- 127	0.39665	- 131	0.39932	- 135	0.40199	- 140	0.40464	- 144

X/Y	0.630		0.635		0.640		0.645		0.650		0.655	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1141	0.00000	+1150	0.00000	+1159	0.00000	+1168	0.00000	+1177	0.00000	+1186
.05	.00566	1115	.00570	1124	.00575	1133	.00579	1141	.00584	1150	.00588	1159
.10	.02238	1041	.02256	1049	.02273	1057	.02291	1064	.02308	1072	.02326	1080
.15	.04944	924	.04982	930	.05020	937	.05059	943	.05097	950	.05136	956
.20	.08567	777	.08633	781	.08699	786	.08764	791	.08830	795	.08895	800
0.25	0.12964	+ 609	0.13062	+ 612	0.13159	+ 615	0.13256	+ 617	0.13354	+ 620	0.13451	+ 622
.30	.17969	435	.18101	436	.18233	436	.18365	437	.18496	438	.18627	438
.35	.23410	266	.23577	265	.23744	264	.23911	263	.24077	261	.24243	260
.40	.29118	+ 107	.29320	+ 104	.29521	+ 102	.29722	+ 99	.29922	+ 97	.30122	+ 94
.45	.34936	- 31	.35171	- 35	.35404	- 38	.35636	- 42	.35868	- 46	.36098	- 50
0.50	0.40728	- 149	0.40990	- 154	0.41252	- 158	0.41512	- 163	0.41771	- 167	0.42028	- 173

X/Y	0.660		0.665		0.670		0.675		0.680		0.685	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1196	0.00000	+1205	0.00000	+1214	0.00000	+1223	0.00000	+1232	0.00000	+1241
.05	.00593	1168	.00597	1176	.00602	1185	.00606	1194	.00611	1203	.00615	1211
.10	.02344	1088	.02361	1096	.02379	1103	.02396	1111	.02414	1119	.02432	1126
.15	.05174	962	.05212	968	.05251	975	.05289	981	.05327	987	.05366	993
.20	.08961	804	.09026	809	.09091	813	.09157	818	.09222	822	.09287	826
0.25	0.13548	+ 625	0.13644	+ 628	0.13741	+ 630	0.13838	+ 632	0.13934	+ 635	0.14030	+ 637
.30	.18758	439	.18889	439	.19019	440	.19150	440	.19280	440	.19409	441
.35	.24409	259	.24574	258	.24739	256	.24903	255	.25067	254	.25230	252
.40	.30321	+ 91	.30519	+ 88	.30716	+ 86	.30914	+ 82	.31110	+ 79	.31305	+ 76
.45	.36328	- 54	.36556	- 58	.36784	- 62	.37011	- 66	.37237	- 70	.37462	- 75
0.50	0.42285	- 177	0.42540	- 182	0.42794	- 187	0.43046	- 192	0.43298	- 197	0.43548	- 201

X/Y	0.690		0.695		0.700		0.705		0.710		0.715	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1250	0.00000	+1259	0.00000	+1268	0.00000	+1277	0.00000	+1286	0.00000	+1295
.05	.00620	1220	.00624	1229	.00629	1238	.00633	1246	.00638	1255	.00642	1264
.10	.02449	1134	.02467	1142	.02484	1150	.02502	1157	.02519	1165	.02537	1173
.15	.05404	999	.05442	1006	.05481	1012	.05519	1018	.05557	1024	.05595	1030
.20	.09352	830	.09417	834	.09482	839	.09547	843	.09612	847	.09677	851
0.25	0.14126	+ 639	0.14222	+ 641	0.14318	+ 643	0.14414	+ 646	0.14510	+ 647	0.14605	+ 650
.30	.19539	441	.19668	441	.19797	441	.19926	441	.20054	441	.20182	441
.35	.25393	250	.25556	249	.25718	247	.25880	245	.26041	243	.26202	242
.40	.31500	+ 73	.31695	+ 70	.31888	+ 67	.32082	+ 64	.32274	+ 60	.32466	+ 57
.45	.37685	- 79	.37909	- 83	.38131	- 87	.38352	- 92	.38572	- 96	.38791	- 101
0.50	0.43796	- 207	0.44044	- 212	0.44290	- 217	0.44535	- 222	0.44779	- 227	0.45021	- 232

TABLE 1a—continued

X/Y	0.720		0.725		0.730		0.735		0.740		0.745	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1305	0.00000	+1314	0.00000	+1323	0.00000	+1332	0.00000	+1341	0.00000	+1350
.05	.00646	1272	.00651	1281	.00655	1290	.00660	1299	.00664	1307	.00669	1316
.10	.02554	1180	.02572	1188	.02590	1195	.02607	1203	.02625	1211	.02642	1218
.15	.05633	1036	.05672	1042	.05710	1048	.05748	1054	.05786	1060	.05824	1066
.20	.09741	855	.09806	859	.09871	863	.09935	867	.10000	871	.10064	875
0.25	0.14701	+ 652	0.14796	+ 653	0.14891	+ 655	0.14986	+ 657	0.15081	+ 659	0.15175	+ 660
.30	.20310	441	.20438	441	.20565	441	.20692	441	.20819	440	.20946	440
.35	.26362	240	.26522	238	.26682	236	.26841	233	.27000	231	.27158	229
.40	.32657	+ 54	.32847	+ 50	.33037	+ 47	.33226	+ 43	.33414	+ 39	.33602	+ 35
.45	.39010	- 105	.39227	- 110	.39443	- 115	.39659	- 119	.39873	- 124	.40087	- 128
0.50	0.45262	- 238	0.45502	- 243	0.45741	- 248	0.45978	- 254	0.46214	- 259	0.46449	- 265
X/Y	0.750		0.755		0.760		0.765		0.770		0.775	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1359	0.00000	+1368	0.00000	+1377	0.00000	+1386	0.00000	+1395	0.00000	+1405
.05	.00673	1325	.00678	1333	.00682	1342	.00687	1351	.00691	1359	.00696	1368
.10	.02660	1226	.02677	1234	.02695	1241	.02712	1249	.02730	1256	.02747	1264
.15	.05862	1072	.05900	1077	.05938	1083	.05976	1089	.06014	1095	.06052	1101
.20	.10129	879	.10193	883	.10257	886	.10322	890	.10386	894	.10450	897
0.25	0.15270	+ 662	0.15364	+ 664	0.15459	+ 665	0.15553	+ 667	0.15647	+ 668	0.15741	+ 670
.30	.21072	439	.21198	439	.21324	438	.21450	438	.21575	437	.21700	436
.35	.27316	227	.27473	225	.27630	222	.27786	220	.27942	217	.28098	215
.40	.33789	+ 32	.33975	+ 28	.34161	+ 24	.34346	+ 21	.34530	+ 16	.34714	+ 12
.45	.40300	- 133	.40511	- 138	.40722	- 143	.40932	- 148	.41140	- 153	.41348	- 158
0.50	0.46682	- 270	0.46914	- 276	0.47145	- 281	0.47375	- 286	0.47603	- 292	0.47830	- 297
X/Y	0.780		0.785		0.790		0.795		0.800		0.805	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1414	0.00000	+1423	0.00000	+1432	0.00000	+1441	0.00000	+1450	0.00000	+1459
.05	.00700	1377	.00705	1385	.00709	1394	.00714	1403	.00718	1411	.00723	1420
.10	.02765	1271	.02782	1279	.02800	1286	.02817	1294	.02835	1301	.02852	1309
.15	.06090	1106	.06128	1112	.06166	1118	.06203	1124	.06241	1129	.06279	1135
.20	.10514	901	.10578	905	.10642	908	.10705	912	.10769	915	.10833	918
0.25	0.15834	+ 671	0.15928	+ 673	0.16021	+ 674	0.16115	+ 675	0.16208	+ 676	0.16301	+ 677
.30	.21825	436	.21949	435	.22074	434	.22198	433	.22321	432	.22445	431
.35	.28253	212	.28408	209	.28562	+ 207	.28716	+ 204	.28869	+ 201	.29022	+ 198
.40	.34897	+ 8	.35079	+ 4	.35261	0	.35442	- 4	.35622	- 8	.35801	- 13
.45	.41555	- 163	.41761	- 168	.41966	- 173	.42169	178	.42372	183	.42574	189
0.50	0.48056	- 303	0.48280	- 309	0.48503	- 315	0.48725	- 320	0.48946	- 326	0.49165	- 332
X/Y	0.810		0.815		0.820		0.825		0.830		0.835	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1468	0.00000	+1477	0.00000	+1486	0.00000	+1496	0.00000	+1505	0.00000	+1514
.05	.00727	1429	.00732	1437	.00736	1446	.00740	1455	.00745	1463	.00749	1472
.10	.02870	1316	.02887	1324	.02904	1331	.02922	1338	.02939	1346	.02957	1353
.15	.06317	1140	.06355	1146	.06392	1152	.06430	1157	.06468	1162	.06505	1168
.20	.10897	922	.10960	925	.11024	928	.11087	932	.11150	935	.11214	938
0.25	0.16394	+ 678	0.16486	+ 679	0.16579	+ 680	0.16671	+ 681	0.16763	+ 682	0.16856	+ 683
.30	.22568	430	.22691	429	.22813	427	.22936	426	.23058	425	.23179	423
.35	.29174	+ 195	.29326	+ 192	.29478	+ 189	.29629	+ 186	.29779	+ 183	.29929	+ 180
.40	.35980	- 17	.36158	- 21	.36336	- 26	.36512	- 30	.36688	- 34	.36864	- 39
.45	.42775	194	.42975	199	.43174	205	.43372	210	.43569	215	.43765	220
0.50	0.49383	- 337	0.49599	- 343	0.49815	- 349	0.50029	- 355	0.50242	- 360	0.50453	- 367

TABLE 1a—continued

X/Y	0.840		0.845		0.850		0.855		0.860		0.865	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1523	0.00000	+1532	0.00000	+1541	0.00000	+1550	0.00000	+1559	0.00000	+1568
.05	.00754	1481	.00758	1489	.00763	1498	.00767	1507	.00772	1515	.00776	1524
.10	.02974	1360	.02992	1368	.03009	1375	.03027	1382	.03044	1390	.03061	1397
.15	.06543	1173	.06581	1179	.06618	1184	.06656	1190	.06693	1195	.06731	1200
.20	.11277	941	.11340	944	.11403	948	.11466	950	.11529	954	.11592	956
0.25	0.16947	+ 684	0.17039	+ 684	0.17131	+ 685	0.17222	+ 686	0.17314	+ 686	0.17405	+ 687
.30	.23301	422	.23422	421	.23543	419	.23663	417	.23784	416	.23904	414
.35	.30079	+ 177	.30228	+ 173	.30377	+ 170	.30525	+ 167	.30673	+ 163	.30820	+ 160
.40	.37038	- 44	.37212	- 48	.37385	- 53	.37558	- 58	.37730	- 62	.37901	- 68
.45	.43961	226	.44155	232	.44348	237	.44540	243	.44731	248	.44921	254
0.50	0.50663	- 372	0.50872	- 378	0.51080	- 384	0.51286	- 390	0.51492	- 396	0.51695	- 402

X/Y	0.870		0.875		0.880		0.885		0.890		0.895	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1577	0.00000	+1587	0.00000	+1596	0.00000	+1605	0.00000	+1614	0.00000	+1623
.05	.00781	1533	.00785	1541	.00790	1550	.00794	1558	.00799	1567	.00803	1576
.10	.03079	1404	.03096	1412	.03114	1419	.03131	1426	.03148	1433	.03166	1440
.15	.06769	1205	.06806	1211	.06844	1216	.06881	1221	.06918	1226	.06956	1231
.20	.11655	960	.11718	962	.11780	965	.11843	968	.11906	970	.11968	973
0.25	0.17496	+ 687	0.17587	+ 688	0.17677	+ 688	0.17768	+ 688	0.17858	+ 689	0.17949	+ 689
.30	.24023	412	.24143	410	.24262	409	.24381	407	.24500	405	.24618	403
.35	.30967	+ 156	.31113	+ 153	.31259	+ 149	.31404	+ 145	.31549	+ 142	.31693	+ 138
.40	.38071	- 77	.38241	- 77	.38410	- 82	.38578	- 87	.38746	- 92	.38912	- 97
.45	.45111	259	.45299	265	.45486	271	.45672	276	.45858	282	.46042	288
0.50	0.51898	- 408	0.52099	- 413	0.52299	- 420	0.52498	- 425	0.52695	- 431	0.52892	- 437

X/Y	0.900		0.905		0.910		0.915		0.920		0.925	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1632	0.00000	+1641	0.00000	+1650	0.00000	+1659	0.00000	+1669	0.00000	+1678
.05	.00807	1584	.00812	1593	.00816	1602	.00821	1610	.00825	1619	.00830	1627
.10	.03183	1448	.03201	1455	.03218	1462	.03235	1469	.03253	1476	.03270	1483
.15	.06993	1236	.07031	1241	.07068	1247	.07105	1251	.07142	1256	.07180	1262
.20	.12030	976	.12093	979	.12155	981	.12217	984	.12279	986	.12341	988
0.25	0.18039	+ 689	0.18129	+ 689	0.18219	+ 689	0.18308	+ 689	0.18398	+ 689	0.18487	+ 689
.30	.24736	401	.24854	399	.24971	397	.25088	394	.25205	392	.25321	390
.35	.31837	+ 134	.31981	+ 130	.32124	+ 126	.32266	+ 122	.32408	+ 118	.32550	+ 114
.40	.39079	- 102	.39244	- 107	.39409	- 112	.39573	- 117	.39736	- 123	.39898	- 128
.45	.46225	294	.46408	299	.46589	305	.46770	311	.46949	317	.47128	323
0.50	0.53086	- 443	0.53280	- 449	0.53473	- 455	0.53664	- 461	0.53854	- 467	0.54042	- 473

X/Y	0.930		0.935		0.940		0.945		0.950		0.955	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1687	0.00000	+1696	0.00000	+1705	0.00000	+1714	0.00000	+1723	0.00000	+1732
.05	.00834	1636	.00839	1644	.00843	1653	.00848	1662	.00852	1670	.00857	1679
.10	.03287	1491	.03305	1498	.03322	1505	.03339	1512	.03357	1519	.03374	1526
.15	.07217	1266	.07254	1271	.07291	1276	.07328	1281	.07366	1286	.07403	1291
.20	.12403	991	.12465	993	.12527	996	.12589	998	.12651	1000	.12712	1002
0.25	0.18576	+ 689	0.18665	+ 689	0.18754	+ 688	0.18842	+ 688	0.18931	+ 688	0.19019	+ 688
.30	.25438	388	.25554	385	.25669	383	.25785	380	.25900	378	.26014	375
.35	.32691	+ 110	.32831	+ 106	.32971	+ 102	.33111	+ 98	.33250	+ 93	.33389	+ 89
.40	.40060	- 133	.40222	- 139	.40382	- 144	.40542	- 149	.40701	- 155	.40859	- 160
.45	.47305	329	.47482	334	.47657	340	.47832	347	.48005	352	.48178	358
0.50	0.54229	- 479	0.54416	- 485	0.54600	- 491	0.54784	- 497	0.54966	- 503	0.55147	- 509

TABLE 1a—continued

X/Y	0.960		0.965		0.970		0.975		0.980		0.985	
	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1742	0.00000	+1751	0.00000	+1760	0.00000	+1769	0.00000	+1778	0.00000	+1787
.05	.00861	1687	.00866	1696	.00870	1704	.00874	1713	.00879	1722	.00883	1730
.10	.03391	1533	.03409	1540	.03426	1547	.03443	1554	.03461	1561	.03478	1568
.15	.07440	1295	.07477	1300	.07514	1305	.07551	1310	.07588	1314	.07625	1319
.20	.12774	1005	.12835	1007	.12897	1009	.12958	1011	.13019	1013	.13080	1015
0.25	0.19108	+ 687	0.19195	+ 687	0.19283	+ 686	0.19371	+ 686	0.19459	+ 685	0.19546	+ 684
.30	.26129	372	.26243	370	.26357	367	.26470	364	.26583	361	.26696	358
.35	.33527	+ 85	.33665	+ 80	.33802	+ 76	.33938	+ 71	.34075	+ 67	.34210	+ 62
.40	.41017	- 166	.41173	- 171	.41330	- 177	.41485	- 182	.41640	- 188	.41794	- 193
.45	.48350	364	.48520	370	.48690	376	.48859	382	.49027	388	.49193	394
0.50	0.55327	- 515	0.55506	- 521	0.55683	- 527	0.55860	- 533	0.56034	- 539	0.56208	- 545
X/Y	0.990		0.995		1.000		1.005		1.010		1.015	
Y	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2	F	δ_m^2
0.00	0.00000	+1796	0.00000	+1805	0.00000	+1815	0.00000	+1824	0.00000	+1833	0.00000	+1842
.05	.00888	1739	.00892	1747	.00897	1756	.00901	1764	.00906	1773	.00910	1781
.10	.03495	1575	.03512	1582	.03530	1589	.03547	1596	.03564	1603	.03582	1609
.15	.07662	1323	.07699	1328	.07735	1333	.07772	1337	.07809	1341	.07846	1346
.20	.13141	1017	.13202	1019	.13263	1020	.13324	1022	.13385	1024	.13446	1025
0.25	0.19633	+ 684	0.19720	+ 683	0.19807	+ 682	0.19894	+ 681	0.19980	+ 680	0.20066	+ 679
.30	.26809	355	.26921	352	.27033	349	.27145	346	.27256	343	.27367	340
.35	.34346	+ 57	.34480	+ 53	.34614	+ 48	.34748	+ 43	.34881	+ 39	.35014	+ 34
.40	.41947	- 199	.42100	- 205	.42251	- 210	.42403	- 216	.42553	- 222	.42703	- 227
.45	.49359	400	.49524	406	.49688	413	.49851	418	.50013	424	.50174	431
0.50	0.56381	- 551	0.56552	- 557	0.56722	- 562	0.56891	- 568	0.57058	- 574	0.57225	- 580

TABLE 1b

X/Y	0.000		0.005		0.010		0.015		0.020		0.025	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.36514	+4589	1.35959	+4580	1.35404	+4572	1.34850	+4563	1.34295	+4554	1.33741	+4545
.55	1.15266	3578	1.14773	3572	1.14280	3564	1.13786	3558	1.13293	3550	1.12800	3544
.60	0.97653	2855	0.97214	2849	0.96775	2843	0.96336	2837	0.95897	2832	0.95459	2826
.65	.82930	2318	.82539	2313	.82149	2308	.81759	2303	.81369	2298	.80979	2293
.70	.70549	1907	.70202	1902	.69855	1898	.69509	1893	.69162	1889	.68815	1885
0.75	0.60092	+1584	0.59784	+1581	0.59476	+1577	0.59168	+1572	0.58861	+1569	0.58553	+1565
.80	.51232	1326	.50959	1323	.50686	1319	.50413	1316	.50140	1312	.49868	1308
.85	.43707	1116	.43465	1113	.43223	1110	.42982	1106	.42741	1103	.42499	1100
.90	.37305	943	.37091	940	.36878	937	.36664	935	.36451	931	.36238	929
0.95	.31852	800	.31663	797	.31475	794	.31287	791	.31099	789	.30911	786
1.00	0.27203	+ 679	0.27037	+ 677	0.26871	+ 675	0.26705	+ 672	0.26539	+ 670	0.26374	+ 667
X/Y	0.030		0.035		0.040		0.045		0.050		0.055	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.33186	+4537	1.32632	+4528	1.32078	+4519	1.31524	+4511	1.30970	+4502	1.30417	+4493
.55	1.12307	3537	1.11815	3530	1.11322	3523	1.10830	3516	1.10337	3509	1.09845	3502
.60	0.95020	2820	0.94582	2814	0.94143	2809	0.93705	2803	0.93267	2797	0.92830	2791
.65	.80589	2288	.80199	2283	.79809	2278	.79419	2273	.79030	2268	.78640	2263
.70	.68469	1880	.68122	1876	.67776	1872	.67429	1867	.67083	1862	.66738	1858
0.75	0.58245	+1561	0.57938	+1557	0.57631	+1553	0.57323	+1549	0.57016	+1545	0.56709	+1541
.80	.49595	1305	.49322	1301	.49050	1297	.48778	1294	.48506	1290	.48234	1286
.85	.42258	1097	.42017	1093	.41776	1090	.41535	1087	.41294	1084	.41053	1081
.90	.36025	926	.35812	923	.35599	920	.35386	916	.35173	914	.34960	911
0.95	.30722	783	.30535	781	.30347	778	.30159	775	.29971	772	.29783	770
1.00	0.26208	+ 665	0.26042	+ 662	0.25877	+ 660	0.25711	+ 657	0.25546	+ 655	0.25381	+ 653
X/Y	0.060		0.065		0.070		0.075		0.080		0.085	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.29864	+4484	1.29311	+4476	1.28758	+4467	1.28206	+4458	1.27654	+4449	1.27102	+4441
.55	1.09353	3495	1.08862	3488	1.08370	3481	1.07879	3474	1.07389	3467	1.06898	3460
.60	0.92392	2786	0.91955	2779	0.91518	2774	0.91081	2768	0.90645	2762	0.90209	2756
.65	.78251	2258	.77863	2253	.77474	2248	.77086	2242	.76698	2237	.76310	2233
.70	.66392	1853	.66046	1849	.65701	1845	.65356	1840	.65011	1836	.64667	1831
0.75	0.56402	+1537	0.56096	+1533	0.55790	+1529	0.55483	+1525	0.55178	+1521	0.54872	+1517
.80	.47962	1283	.47690	1279	.47419	1276	.47147	1272	.46877	1268	.46606	1265
.85	.40813	1077	.40572	1074	.40332	1070	.40092	1067	.39853	1064	.39613	1061
.90	.34748	908	.34536	905	.34323	902	.34111	899	.33900	896	.33688	892
0.95	.29596	767	.29409	764	.29222	762	.29035	759	.28848	756	.28661	754
1.00	0.25215	+ 650	0.25051	+ 647	0.24886	+ 645	0.24721	+ 643	0.24557	+ 640	0.24392	+ 638
X/Y	0.090		0.095		0.100		0.105		0.110		0.115	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.26551	+4433	1.26000	+4424	1.25449	+4415	1.24899	+4406	1.24350	+4398	1.23801	+4389
.55	1.06408	3453	1.05919	3446	1.05429	3439	1.04941	3432	1.04452	3425	1.03964	3419
.60	0.89773	2751	0.89337	2745	0.88902	2739	0.88468	2733	0.88033	2728	0.87600	2722
.65	.75922	2228	.75535	2223	.75149	2218	.74762	2213	.74376	2207	.73991	2202
.70	.64323	1827	.63979	1822	.63636	1818	.63292	1814	.62950	1809	.62607	1805
0.75	0.54567	+1513	0.54262	+1509	0.53957	+1505	0.53653	+1501	0.53349	+1497	0.53045	+1493
.80	.46335	1261	.46065	1258	.45795	1254	.45526	1251	.45256	1247	.44987	1243
.85	.39374	1058	.39135	1054	.38896	1051	.38658	1047	.38420	1044	.38182	1041
.90	.33477	890	.33266	887	.33055	884	.32845	881	.32634	878	.32424	875
0.95	.28475	751	.28289	748	.28103	745	.27917	743	.27732	740	.27547	737
1.00	0.24228	+ 635	0.24064	+ 633	0.23901	+ 630	0.23737	+ 628	0.23574	+ 625	0.23411	+ 623

TABLE 1b—continued

X/Y	0.120		0.125		0.130		0.135		0.140		0.145	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.23252	+4380	1.22704	+4372	1.22157	+4363	1.21610	+4355	1.21063	+4345	1.20518	+4337
.55	1.03477	3412	1.02990	3405	1.02504	3398	1.02018	3390	1.01532	3384	1.01048	3377
.60	0.87166	2716	0.86733	2710	0.86301	2704	0.85869	2699	0.85438	2693	0.85007	2687
.65	.73605	2197	.73221	2193	.72836	2188	.72453	2183	.72069	2178	.71687	2172
.70	.62265	1801	.61924	1796	.61583	1792	.61242	1787	.60902	1783	.60562	1778
0.75	0.52742	+1489	0.52439	+1485	0.52136	+1481	0.51834	+1477	0.51533	+1473	0.51231	+1469
.80	.44719	1240	.44451	1236	.44183	1232	.43915	1229	.43648	1225	.43382	1221
.85	.37945	1038	.37707	1035	.37471	1031	.37234	1028	.36998	1025	.36763	1022
.90	.32215	872	.32005	869	.31797	866	.31588	863	.31380	860	.31172	857
0.95	.27362	734	.27178	732	.26994	729	.26810	726	.26626	723	.26443	721
1.00	0.23249	+ 620	0.23086	+ 618	0.22924	+ 616	0.22762	+ 613	0.22601	+ 611	0.22440	+ 608

X/Y	0.150		0.155		0.160		0.165		0.170		0.175	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.19973	+4328	1.19428	+4320	1.18884	+4311	1.18341	+4303	1.17799	+4294	1.17257	+4285
.55	1.00563	3370	1.00080	3363	0.99597	3356	0.99115	3349	0.98633	3342	0.98152	3336
.60	0.84576	2681	0.84147	2676	.83718	2670	.83289	2664	.82861	2658	.82434	2652
.65	.71304	2167	.70923	2162	.70542	2158	.70161	2153	.69781	2148	.69402	2143
.70	.60223	1774	.59884	1769	.59546	1765	.59208	1760	.58871	1756	.58535	1751
0.75	0.50931	+1465	0.50631	+1461	0.50331	+1457	0.50032	+1453	0.49733	+1449	0.49435	+1445
.80	.43116	1218	.42850	1214	.42585	1211	.42320	1207	.42056	1204	.41792	1200
.85	.36528	1018	.36293	1015	.36059	1012	.35825	1008	.35591	1005	.35358	1002
.90	.30964	854	.30757	851	.30551	848	.30344	845	.30138	842	.29933	839
0.95	.26260	718	.26078	716	.25896	713	.25714	710	.25533	707	.25352	704
1.00	0.22279	+ 606	0.22118	+ 603	0.21958	+ 601	0.21798	+ 599	0.21639	+ 597	0.21480	+ 594

X/Y	0.180		0.185		0.190		0.195		0.200		0.205	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.16717	+4277	1.16177	+4268	1.15637	+4260	1.15099	+4251	1.14561	+4243	1.14024	+4234
.55	0.97672	3328	0.97192	3322	0.96714	3315	0.96236	3308	0.95759	3301	0.95282	3294
.60	.82007	2647	.81582	2641	.81157	2635	.80732	2629	.80308	2624	.79885	2618
.65	.69023	2138	.68645	2133	.68268	2128	.67891	2123	.67515	2117	.67139	2113
.70	.58199	1747	.57863	1742	.57529	1738	.57195	1734	.56861	1729	.56529	1725
0.75	0.49137	+1442	0.48840	+1438	0.48544	+1434	0.48248	+1430	0.47953	+1426	0.47659	+1422
.80	.41529	1196	.41266	1193	.41004	1189	.40743	1186	.40482	1182	.40221	1178
.85	.35126	999	.34894	995	.34663	992	.34432	989	.34201	986	.33971	982
.90	.29728	836	.29523	834	.29320	830	.29116	827	.28913	825	.28711	821
0.95	.25172	702	.24992	699	.24812	697	.24633	694	.24454	691	.24276	689
1.00	0.21321	+ 592	0.21163	+ 589	0.21006	+ 587	0.20848	+ 584	0.20691	+ 582	0.20535	+ 579

X/Y	0.210		0.215		0.220		0.225		0.230		0.235	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.13489	+4225	1.12953	+4217	1.12419	+4209	1.11886	+4200	1.11354	+4192	1.10823	+4183
.55	0.94807	3288	0.94332	3281	0.93858	3274	0.93385	3267	0.92913	3260	0.92442	3253
.60	.79463	2612	.79042	2607	.78621	2601	.78202	2595	.77783	2589	.77364	2584
.65	.66765	2108	.66391	2103	.66018	2098	.65646	2093	.65274	2088	.64903	2083
.70	.56197	1720	.55865	1716	.55535	1712	.55205	1707	.54876	1703	.54547	1699
0.75	0.47365	+1418	0.47071	+1414	0.46779	+1410	0.46487	+1406	0.46196	+1402	0.45905	+1398
.80	.39962	1175	.39703	1171	.39444	1168	.39186	1164	.38929	1160	.38672	1157
.85	.33742	979	.33514	976	.33286	972	.33058	969	.32831	966	.32605	963
.90	.28509	819	.28307	815	.28106	813	.27906	809	.27706	807	.27507	804
0.95	.24099	686	.23921	683	.23745	680	.23569	678	.23393	675	.23218	672
1.00	0.20379	+ 577	0.20223	+ 574	0.20068	+ 572	0.19913	+ 569	0.19759	+ 567	0.19606	+ 565

TABLE 1b—continued

X/Y	0.240		0.245		0.250		0.255		0.260		0.265	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.10292	+4175	1.09763	+4166	1.09235	+4158	1.08708	+4149	1.08181	+4141	1.07656	+4132
.55	0.91971	3247	0.91502	3240	0.91034	3233	0.90566	3226	0.90100	3220	0.89634	3213
.60	.76947	2578	.76531	2572	.76115	2567	.75701	2561	.75287	2555	.74875	2549
.65	.64533	2078	.64164	2073	.63796	2068	.63429	2063	.63062	2058	.62697	2053
.70	.54220	1694	.53893	1689	.53567	1685	.53241	1681	.52917	1677	.52593	1672
0.75	0.45615	+1394	0.45326	+1390	0.45038	+1386	0.44751	+1382	0.44464	+1378	0.44178	+1374
.80	.38417	1153	.38161	1149	.37907	1146	.37653	1143	.37400	1139	.37148	1135
.85	.32380	959	.32155	956	.31930	953	.31707	950	.31484	947	.31261	943
.90	.27309	801	.27111	798	.26913	795	.26717	792	.26520	789	.26325	786
0.95	.23044	670	.22870	667	.22696	664	.22523	661	.22351	659	.22179	656
1.00	0.19452	+562	0.19300	+560	0.19148	+557	0.18996	+555	0.18845	+553	0.18695	+550

X/Y	0.270		0.275		0.280		0.285		0.290		0.295	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.07132	+4125	1.06609	+4116	1.06087	+4108	1.05566	+4099	1.05047	+4091	1.04528	+4083
.55	0.89170	3206	0.88706	3199	0.88244	3192	0.87783	3186	0.87322	3179	0.86863	3172
.60	.74463	2544	.74052	2538	.73642	2532	.73234	2527	.72826	2521	.72419	2515
.65	.62332	2048	.61968	2043	.61605	2038	.61243	2033	.60882	2028	.60522	2023
.70	.52271	1668	.51949	1663	.51628	1659	.51308	1654	.50988	1650	.50670	1646
0.75	0.43893	+1370	0.43608	+1366	0.43325	+1362	0.43042	+1358	0.42760	+1354	0.42479	+1350
.80	.36896	1132	.36645	1128	.36395	1124	.36146	1121	.35898	1117	.35650	1114
.85	.31040	940	.30819	937	.30599	934	.30379	930	.30161	927	.29943	924
.90	.26130	783	.25936	780	.25742	777	.25549	774	.25357	771	.25166	768
0.95	.22008	654	.21838	651	.21668	648	.21499	646	.21330	643	.21162	640
1.00	0.18545	+548	0.18395	+545	0.18247	+543	0.18098	+541	0.17951	+538	0.17803	+536

X/Y	0.300		0.305		0.310		0.315		0.320		0.325	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.04011	+4074	1.03495	+4066	1.02980	+4057	1.02467	+4049	1.01954	+4041	1.01443	+4033
.55	0.86405	3166	0.85948	3158	0.85492	3152	0.85038	3145	0.84584	3139	0.84132	3132
.60	.72013	2509	.71609	2504	.71205	2498	.70803	2493	.70401	2487	.70001	2481
.65	.60163	2018	.59805	2013	.59448	2008	.59092	2003	.58737	1999	.58383	1994
.70	.50353	1641	.50036	1637	.49721	1633	.49406	1628	.49093	1624	.48780	1619
0.75	0.42199	+1346	0.41920	+1343	0.41641	+1339	0.41364	+1335	0.41087	+1331	0.40812	+1327
.80	.35403	1110	.35157	1106	.34912	1103	.34667	1099	.34424	1096	.34181	1092
.85	.29726	920	.29509	918	.29294	914	.29079	911	.28865	908	.28651	904
.90	.24975	766	.24785	762	.24596	760	.24407	756	.24219	753	.24032	751
0.95	.20995	637	.20829	635	.20663	632	.20497	630	.20333	627	.20169	624
1.00	0.17657	+533	0.17511	+531	0.17366	+528	0.17221	+526	0.17077	+524	0.16934	+522

X/Y	0.330		0.335		0.340		0.345		0.350		0.355	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	1.00933	+4025	1.00425	+4016	0.99917	+4008	0.99411	+4000	0.98906	+3992	0.98403	+3984
.55	0.83681	3125	0.83231	3119	.82782	3112	.82334	3106	.81888	3099	.81443	3092
.60	.69602	2476	.69204	2470	.68807	2465	.68411	2459	.68016	2453	.67623	2448
.65	.58030	1989	.57678	1984	.57327	1979	.56977	1974	.56629	1969	.56281	1964
.70	.48468	1615	.48158	1610	.47848	1606	.47539	1601	.47232	1597	.46925	1593
0.75	0.40537	+1323	0.40263	+1319	0.39990	+1315	0.39718	+1311	0.39447	+1307	0.39177	+1303
.80	.33939	1088	.33698	1085	.33458	1081	.33219	1078	.32981	1074	.32743	1071
.85	.28439	901	.28227	898	.28016	895	.27806	891	.27597	888	.27389	885
.90	.23846	747	.23660	745	.23475	742	.23291	739	.23108	736	.22925	733
0.95	.20006	622	.19843	619	.19681	616	.19520	614	.19360	611	.19200	608
1.00	0.16791	+519	0.16649	+517	0.16508	+514	0.16367	+512	0.16227	+509	0.16087	+507

TABLE 1b—continued

X/Y	0.360		0.365		0.370		0.375		0.380		0.385	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.97901	+3975	0.97400	+3968	0.96901	+3959	0.96403	+3951	0.95906	+3943	0.95411	+3935
.55	.80999	3085	.80557	3079	.80115	3072	.79676	3065	.79237	3059	.78799	3052
.60	.67231	2442	.66840	2436	.66450	2431	.66061	2425	.65674	2420	.65287	2414
.65	.55935	1959	.55590	1955	.55245	1950	.54902	1945	.54561	1940	.54220	1935
.70	.46620	1588	.46315	1584	.46012	1579	.45710	1575	.45408	1571	.45108	1567
0.75	0.38908	+1299	0.38640	+1295	0.38373	+1291	0.38107	+1287	0.37842	+1283	0.37578	+1279
.80	.32507	1067	.32271	1064	.32037	1060	.31803	1056	.31570	1053	.31339	1049
.85	.27181	882	.26975	879	.26769	875	.26564	872	.26360	869	.26157	866
.90	.22744	730	.22563	727	.22382	724	.22203	721	.22025	718	.21847	715
0.95	.19041	606	.18883	603	.18725	600	.18569	598	.18413	595	.18257	593
1.00	0.15949	+ 505	0.15810	+ 502	0.15673	+ 500	0.15536	+ 498	0.15400	+ 495	0.15265	+ 493
X/Y	0.390		0.395		0.400		0.405		0.410		0.415	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.94917	+3927	0.94425	+3919	0.93934	+3911	0.93445	+3903	0.92957	+3895	0.92470	+3887
.55	.78364	3046	.77929	3039	.77495	3033	.77064	3026	.76633	3019	.76204	3013
.60	.64903	2408	.64519	2403	.64136	2397	.63755	2392	.63375	2386	.62997	2381
.65	.53880	1930	.53542	1925	.53205	1920	.52869	1915	.52534	1910	.52200	1905
.70	.44809	1562	.44511	1558	.44214	1554	.43919	1549	.43624	1545	.43331	1540
0.75	0.37315	+1275	0.37053	+1271	0.36792	+1268	0.36533	+1264	0.36274	+1260	0.36016	+1256
.80	.31108	1046	.30878	1042	.30649	1038	.30421	1035	.30194	1031	.29968	1028
.85	.25955	862	.25753	859	.25553	856	.25353	853	.25155	850	.24957	846
.90	.21670	713	.21494	710	.21319	707	.21144	704	.20971	701	.20798	698
0.95	.18103	590	.17949	587	.17797	584	.17644	582	.17493	579	.17342	577
1.00	0.15130	+ 491	0.14996	+ 488	0.14863	+ 486	0.14731	+ 484	0.14599	+ 481	0.14468	+ 479
X/Y	0.420		0.425		0.430		0.435		0.440		0.445	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.91985	+3879	0.91501	+3870	0.91019	+3863	0.90539	+3855	0.90059	+3847	0.89582	+3839
.55	.75776	3007	.75349	3000	.74924	2993	.74501	2987	.74078	2980	.73657	2974
.60	.62619	2375	.62243	2369	.61869	2364	.61495	2358	.61123	2353	.60753	2347
.65	.51868	1900	.51537	1896	.51207	1890	.50879	1886	.50551	1881	.50225	1876
.70	.43038	1536	.42747	1532	.42457	1528	.42168	1523	.41881	1519	.41594	1514
0.75	0.35760	+1252	0.35504	+1248	0.35250	+1244	0.34996	+1240	0.34744	+1236	0.34493	+1232
.80	.29744	1024	.29520	1021	.29297	1017	.29075	1014	.28854	1010	.28634	1006
.85	.24760	843	.24564	840	.24370	837	.24176	833	.23983	830	.23791	827
.90	.20626	695	.20455	692	.20285	689	.20116	687	.19948	684	.19780	681
0.95	.17193	574	.17044	572	.16895	569	.16748	566	.16602	564	.16456	561
1.00	0.14337	+ 476	0.14208	+ 474	0.14079	+ 472	0.13951	+ 469	0.13823	+ 467	0.13696	+ 465
X/Y	0.450		0.455		0.460		0.465		0.470		0.475	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.89106	+3831	0.88631	+3823	0.88158	+3815	0.87687	+3808	0.87217	+3799	0.86749	+3792
.55	.73238	2967	.72820	2961	.72404	2955	.71989	2948	.71575	2942	.71163	2935
.60	.60383	2342	.60015	2336	.59649	2330	.59284	2325	.58920	2319	.58557	2314
.65	.49900	1871	.49577	1866	.49254	1862	.48933	1856	.48614	1852	.48295	1847
.70	.41309	1510	.41025	1506	.40742	1501	.40460	1497	.40180	1493	.39901	1488
0.75	0.34243	+1228	0.33994	+1224	0.33746	+1220	0.33499	+1217	0.33254	+1213	0.33009	+1209
.80	.28415	1003	.28198	999	.27981	996	.27765	992	.27551	989	.27337	985
.85	.23600	824	.23409	821	.23220	817	.23032	814	.22845	811	.22658	808
.90	.19614	678	.19448	675	.19283	672	.19119	669	.18956	666	.18794	663
0.95	.16311	559	.16167	556	.16023	553	.15881	551	.15739	548	.15598	546
1.00	0.13570	+ 462	0.13445	+ 460	0.13321	+ 458	0.13197	+ 455	0.13074	+ 453	0.12952	+ 451

TABLE 1b—continued

X/Y	0.480		0.485		0.490		0.495		0.500		0.505	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.86282	+3784	0.85817	+3776	0.85353	+3769	0.84892	+3760	0.84431	+3753	0.83973	+3745
.55	.70752	2929	.70343	2922	.69935	2916	.69529	2910	.69125	2903	.68721	2897
.60	.58196	2309	.57836	2303	.57478	2297	.57121	2292	.56766	2287	.56412	2281
.65	.47978	1842	.47662	1837	.47348	1833	.47035	1828	.46723	1823	.46412	1818
.70	.39623	1484	.39346	1479	.39070	1475	.38796	1470	.38523	1466	.38251	1462
0.75	0.32766	+1205	0.32524	+1201	0.32283	+1197	0.32043	+1193	0.31804	+1189	0.31566	+1186
.80	.27124	982	.26913	978	.26702	975	.26493	971	.26285	967	.26078	964
.85	.22473	805	.22289	802	.22106	799	.21923	795	.21742	792	.21562	788
.90	.18633	661	.18473	658	.18313	654	.18155	652	.17997	649	.17840	646
0.95	.15458	543	.15319	540	.15180	538	.15043	535	.14906	533	.14770	530
1.00	0.12831	+ 448	0.12710	+ 446	0.12590	+ 444	0.12471	+ 442	0.12352	+ 440	0.12235	+ 437

X/Y	0.510		0.515		0.520		0.525		0.530		0.535	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.83515	+3737	0.83060	+3729	0.82606	+3722	0.82154	+3714	0.81703	+3706	0.81254	+3699
.55	.68320	2890	.67920	2884	.67521	2877	.67124	2871	.66729	2865	.66335	2858
.60	.56059	2275	.55708	2270	.55358	2265	.55010	2259	.54663	2253	.54317	2248
.65	.46103	1813	.45795	1808	.45489	1803	.45183	1799	.44880	1794	.44577	1789
.70	.37980	1457	.37711	1453	.37443	1449	.37176	1444	.36910	1440	.36646	1436
0.75	0.31330	+1182	0.31095	+1178	0.30861	+1174	0.30628	+1170	0.30396	+1166	0.30165	+1162
.80	.25872	961	.25667	957	.25463	954	.25260	950	.25058	946	.24857	943
.85	.21382	786	.21204	782	.21027	779	.20850	776	.20675	773	.20500	770
.90	.17685	643	.17530	640	.17376	638	.17223	635	.17071	632	.16920	629
0.95	.14635	528	.14501	525	.14368	523	.14235	520	.14104	517	.13973	515
1.00	0.12118	+ 435	0.12002	+ 432	0.11886	+ 430	0.11772	+ 428	0.11658	+ 426	0.11545	+ 423

X/Y	0.540		0.545		0.550		0.555		0.560		0.565	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.80807	+3691	0.80361	+3683	0.79918	+3676	0.79475	+3668	0.79035	+3660	0.78596	+3653
.55	.65942	2852	.65551	2846	.65162	2839	.64774	2833	.64388	2827	.64003	2820
.60	.53973	2243	.53631	2237	.53290	2231	.52950	2226	.52612	2221	.52275	2215
.65	.44276	1784	.43976	1779	.43678	1774	.43381	1769	.43085	1764	.42791	1760
.70	.36383	1432	.36121	1427	.35861	1423	.35601	1419	.35343	1415	.35087	1410
0.75	0.29936	+1158	0.29708	+1154	0.29481	+1150	0.29255	+1146	0.29030	+1142	0.28807	+1139
.80	.24658	940	.24459	936	.24262	933	.24065	929	.23870	925	.23676	922
.85	.20327	766	.20155	763	.19984	760	.19813	757	.19644	754	.19476	751
.90	.16769	626	.16620	623	.16472	621	.16324	618	.16178	615	.16032	612
0.95	.13843	512	.13714	510	.13585	507	.13458	505	.13331	502	.13205	500
1.00	0.11433	+ 421	0.11321	+ 419	0.11210	+ 417	0.11100	+ 414	0.10991	+ 412	0.10883	+ 410

X/Y	0.570		0.575		0.580		0.585		0.590		0.595	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.78158	+3646	0.77723	+3638	0.77289	+3630	0.76857	+3623	0.76426	+3615	0.75997	+3608
.55	.63620	2814	.63239	2808	.62859	2802	.62481	2795	.62104	2789	.61729	2783
.60	.51940	2210	.51606	2204	.51274	2199	.50943	2193	.50614	2188	.50286	2183
.65	.42498	1755	.42207	1750	.41917	1745	.41628	1741	.41340	1735	.41054	1731
.70	.34831	1406	.34577	1401	.34324	1397	.34073	1393	.33822	1389	.33573	1384
0.75	0.28585	+1135	0.28364	+1131	0.28144	+1127	0.27925	+1123	0.27708	+1119	0.27491	+1115
.80	.23483	918	.23291	915	.23100	911	.22911	908	.22722	905	.22535	901
.85	.19308	748	.19142	744	.18977	741	.18813	738	.18649	735	.18487	732
.90	.15887	609	.15744	606	.15601	604	.15459	601	.15318	598	.15178	595
0.95	.13081	497	.12957	495	.12833	492	.12711	490	.12589	487	.12469	485
1.00	0.10775	+ 408	0.10668	+ 406	0.10562	+ 403	0.10457	+ 401	0.10352	+ 399	0.10248	+ 396

TABLE 1b—continued

X/Y	0.600		0.605		0.610		0.615		0.620		0.625	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.75570	+3600	0.75145	+3593	0.74721	+3585	0.74299	+3578	0.73879	+3570	0.73460	+3563
.55	.61355	2776	.60983	2770	.60613	2764	.60244	2757	.59877	2751	.59511	2745
.60	.49960	2177	.49635	2172	.49311	2166	.48990	2161	.48669	2155	.48350	2150
.65	.40770	1726	.40487	1721	.40205	1716	.39924	1712	.39645	1707	.39368	1702
.70	.33326	1380	.33079	1375	.32834	1371	.32590	1367	.32348	1363	.32107	1359
0.75	0.27276	+1111	0.27062	+1108	0.26850	+1103	0.26638	+1100	0.26428	+1096	0.26219	+1092
.80	.22348	897	.22163	894	.21979	890	.21796	887	.21614	884	.21433	880
.85	.18326	729	.18166	726	.18007	723	.17849	720	.17692	716	.17535	713
.90	.15039	592	.14901	590	.14763	587	.14627	584	.14492	581	.14357	578
0.95	.12349	482	.12230	480	.12112	477	.11995	475	.11878	472	.11762	470
1.00	0.10145	+ 394	0.10043	+ 392	0.09942	+ 390	0.09841	+ 388	0.09741	+ 386	0.09642	+ 383

X/Y	0.630		0.635		0.640		0.645		0.650		0.655	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.73043	+3555	0.72628	+3548	0.72214	+3541	0.71803	+3533	0.71392	+3526	0.70984	+3518
.55	.59147	2739	.58785	2733	.58424	2726	.58065	2720	.57707	2714	.57351	2708
.60	.48033	2145	.47717	2139	.47403	2134	.47090	2128	.46778	2123	.46468	2118
.65	.39091	1697	.38817	1692	.38543	1688	.38271	1683	.38000	1678	.37731	1673
.70	.31867	1354	.31628	1350	.31391	1345	.31155	1341	.30920	1337	.30687	1332
0.75	0.26011	+1088	0.25804	+1084	0.25599	+1080	0.25394	+1077	0.25191	+1073	0.24989	+1069
.80	.21253	877	.21075	873	.20897	870	.20721	866	.20545	863	.20371	859
.85	.17381	710	.17226	707	.17073	704	.16921	701	.16770	698	.16620	694
.90	.14224	576	.14091	573	.13960	570	.13829	568	.13699	564	.13570	562
0.95	.11648	467	.11534	465	.11421	463	.11308	460	.11197	458	.11087	455
1.00	0.09543	+ 381	0.09446	+ 379	0.09349	+ 377	0.09252	+ 375	0.09157	+ 373	0.09062	+ 371

X/Y	0.660		0.665		0.670		0.675		0.680		0.685	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.70577	+3511	0.70173	+3504	0.69769	+3497	0.69368	+3489	0.68968	+3482	0.68570	+3475
.55	.56997	2701	.56644	2696	.56293	2689	.55943	2683	.55595	2677	.55249	2671
.60	.46160	2113	.45853	2107	.45548	2101	.45244	2096	.44941	2091	.44641	2085
.65	.37463	1668	.37197	1664	.36932	1659	.36668	1654	.36406	1649	.36145	1645
.70	.30455	1328	.30224	1324	.29994	1319	.29766	1315	.29539	1311	.29314	1307
0.75	0.24789	+1065	0.24589	+1061	0.24391	+1057	0.24194	+1053	0.23998	+1049	0.23803	+1046
.80	.20198	856	.20026	852	.19855	849	.19685	845	.19516	842	.19349	839
.85	.16471	692	.16323	688	.16176	685	.16030	682	.15885	679	.15741	676
.90	.13442	559	.13315	557	.13189	554	.13064	551	.12939	548	.12816	545
0.95	.10977	453	.10868	450	.10760	448	.10653	446	.10546	443	.10440	441
1.00	0.08968	+ 368	0.08875	+ 366	0.08783	+ 364	0.08691	+ 362	0.08600	+ 360	0.08510	+ 358

X/Y	0.690		0.695		0.700		0.705		0.710		0.715	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.68174	+3467	0.67779	+3460	0.67387	+3453	0.66995	+3446	0.66606	+3438	0.66218	+3431
.55	.54904	2665	.54561	2658	.54220	2652	.53880	2646	.53542	2640	.53205	2634
.60	.44341	2080	.44043	2075	.43747	2069	.43452	2064	.43159	2058	.42867	2053
.65	.35886	1640	.35628	1635	.35371	1630	.35116	1625	.34862	1620	.34609	1616
.70	.29089	1302	.28866	1298	.28645	1294	.28424	1290	.28205	1286	.27987	1281
0.75	0.23610	+1042	0.23417	+1038	0.23226	+1034	0.23036	+1030	0.22848	+1026	0.22660	+1022
.80	.19182	835	.19017	832	.18853	828	.18689	825	.18527	822	.18366	818
.85	.15598	673	.15456	670	.15315	667	.15175	664	.15036	661	.14898	657
.90	.12693	543	.12572	540	.12451	537	.12331	535	.12212	532	.12094	530
0.95	.10336	438	.10232	436	.10129	434	.10026	431	.09925	429	.09824	426
1.00	0.08421	+ 356	0.08332	+ 354	0.08244	+ 351	0.08157	+ 349	0.08070	+ 347	0.07984	+ 345

TABLE 1b—continued

X/Y	0.720		0.725		0.730		0.735		0.740		0.745	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.65833	+3424	0.65448	+3417	0.65066	+3410	0.64685	+3402	0.64306	+3395	0.63929	+3388
.55	.52870	2628	.52536	2621	.52204	2615	.51874	2609	.51546	2603	.51219	2597
.60	.42576	2048	.42288	2042	.42000	2037	.41714	2032	.41430	2026	.41147	2021
.65	.34358	1611	.34108	1606	.33860	1602	.33613	1597	.33368	1592	.33124	1587
.70	.27770	1277	.27555	1272	.27341	1268	.27128	1264	.26917	1260	.26707	1256
0.75	0.22474	+1019	0.22288	+1015	0.22104	+1011	0.21922	+1007	0.21740	+1003	0.21560	+1000
.80	.18206	815	.18047	811	.17889	808	.17733	805	.17577	801	.17422	798
.85	.14761	654	.14625	652	.14490	649	.14356	645	.14223	642	.14091	639
.90	.11977	527	.11861	524	.11745	521	.11631	519	.11517	516	.11405	513
0.95	.09724	424	.09625	422	.09527	419	.09429	417	.09333	415	.09237	412
1.00	0.07899	+ 343	0.07815	+ 341	0.07731	+ 339	0.07648	+ 337	0.07566	+ 335	0.07485	+ 333
X/Y	0.750		0.755		0.760		0.765		0.770		0.775	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.63553	+3381	0.63179	+3373	0.62807	+3367	0.62436	+3360	0.62068	+3352	0.61700	+3345
.55	.50893	2591	.50569	2585	.50247	2579	.49926	2573	.49607	2567	.49290	2560
.60	.40865	2016	.40586	2010	.40307	2005	.40030	2000	.39755	1994	.39481	1989
.65	.32881	1582	.32639	1577	.32399	1573	.32161	1568	.31923	1563	.31687	1559
.70	.26498	1252	.26290	1247	.26084	1243	.25879	1238	.25675	1234	.25472	1230
0.75	0.21380	+ 996	0.21202	+ 992	0.21025	+ 988	0.20849	+ 985	0.20675	+ 981	0.20501	+ 977
.80	.17269	794	.17116	791	.16965	787	.16814	784	.16665	781	.16517	777
.85	.13960	636	.13829	633	.13700	630	.13572	628	.13444	625	.13318	622
.90	.11293	510	.11182	508	.11072	505	.10963	503	.10854	500	.10747	497
0.95	.09141	410	.09047	408	.08954	405	.08861	403	.08769	401	.08677	399
1.00	0.07404	+ 330	0.07324	+ 328	0.07244	+ 326	0.07166	+ 325	0.07088	+ 323	0.07010	+ 320
X/Y	0.780		0.785		0.790		0.795		0.800		0.805	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.61335	+3338	0.60971	+3331	0.60610	+3324	0.60249	+3317	0.59891	+3310	0.59534	+3303
.55	.48974	2555	.48660	2548	.48347	2543	.48036	2536	.47726	2530	.47418	2524
.60	.39208	1983	.38937	1978	.38668	1973	.38399	1968	.38133	1962	.37868	1957
.65	.31453	1554	.31220	1549	.30988	1544	.30758	1539	.30528	1535	.30301	1530
.70	.25271	1226	.25071	1222	.24872	1218	.24674	1213	.24478	1209	.24283	1204
0.75	0.20329	+ 973	0.20157	+ 969	0.19987	+ 965	0.19818	+ 962	0.19651	+ 958	0.19484	+ 954
.80	.16370	774	.16224	770	.16078	767	.15934	764	.15791	760	.15649	757
.85	.13193	618	.13068	616	.12945	612	.12822	609	.12701	607	.12580	604
.90	.10640	495	.10534	492	.10429	490	.10325	487	.10222	484	.10120	482
0.95	.08587	396	.08497	394	.08408	392	.08320	389	.08233	387	.08146	385
1.00	0.06934	+ 318	0.06858	+ 316	0.06783	+ 314	0.06708	+ 312	0.06634	+ 310	0.06561	+ 309
X/Y	0.810		0.815		0.820		0.825		0.830		0.835	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.59179	+3296	0.58825	+3288	0.58473	+3282	0.58123	+3274	0.57775	+3268	0.57428	+3260
.55	.47112	2518	.46807	2513	.46504	2506	.46202	2500	.45902	2494	.45604	2488
.60	.37604	1952	.37342	1946	.37081	1941	.36821	1936	.36564	1930	.36307	1925
.65	.30074	1526	.29849	1521	.29626	1516	.29403	1511	.29182	1506	.28962	1502
.70	.24089	1200	.23897	1196	.23705	1192	.23515	1188	.23326	1183	.23139	1179
0.75	0.19319	+ 950	0.19154	+ 947	0.18991	+ 943	0.18829	+ 939	0.18668	+ 936	0.18508	+ 931
.80	.15508	754	.15368	751	.15230	747	.15092	744	.14955	740	.14819	737
.85	.12460	601	.12341	597	.12223	595	.12106	591	.11990	589	.11875	586
.90	.10018	479	.09918	477	.09818	474	.09719	472	.09620	469	.09523	466
0.95	.08060	383	.07975	380	.07891	378	.07807	376	.07724	374	.07642	371
1.00	0.06488	+ 307	0.06417	+ 305	0.06345	+ 303	0.06275	+ 301	0.06205	+ 299	0.06136	+ 297

TABLE 1b—continued

X/Y	0.840		0.845		0.850		0.855		0.860		0.865	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.57083	+3254	0.56740	+3247	0.56398	+3240	0.56058	+3233	0.55720	+3226	0.55383	+3219
.55	.45307	2482	.45011	2476	.44717	2470	.44425	2464	.44134	2458	.43845	2452
.60	.36052	1920	.35799	1914	.35546	1909	.35296	1904	.35046	1899	.34799	1893
.65	.28744	1497	.28527	1492	.28311	1488	.28097	1483	.27884	1478	.27672	1473
.70	.22952	1175	.22767	1171	.22583	1166	.22400	1162	.22219	1158	.22038	1154
0.75	0.18349	+ 928	0.18192	+ 924	0.18035	+ 920	0.17879	+ 917	0.17725	+ 913	0.17572	+ 909
.80	.14684	734	.14550	731	.14417	727	.14286	724	.14155	721	.14025	717
.85	.11761	583	.11647	580	.11535	577	.11423	574	.11313	571	.11203	569
.90	.09426	464	.09331	461	.09236	459	.09142	456	.09048	453	.08956	451
0.95	0.07560	369	0.07480	367	0.07400	364	0.07320	362	0.07242	360	0.07164	358
1.00	0.06067	+ 295	0.05999	+ 293	0.05932	+ 291	0.05865	+ 289	0.05799	+ 287	0.05733	+ 285
X/Y	0.870		0.875		0.880		0.885		0.890		0.895	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.55048	+3212	0.54715	+3205	0.54383	+3198	0.54053	+3191	0.53724	+3184	0.53398	+3177
.55	.43557	2446	.43271	2440	.42986	2434	.42703	2428	.42422	2422	.42142	2416
.60	.34552	1888	.34307	1883	.34064	1877	.33822	1872	.33581	1867	.33341	1862
.65	.27462	1469	.27253	1464	.27045	1459	.26838	1455	.26633	1450	.26429	1445
.70	.21859	1150	.21681	1146	.21504	1142	.21328	1137	.21154	1133	.20981	1129
0.75	0.17420	+ 905	0.17269	+ 902	0.17119	+ 898	0.16970	+ 894	0.16822	+ 891	0.16675	+ 887
.80	.13896	714	.13768	711	.13641	707	.13515	704	.13390	701	.13266	698
.85	.11094	566	.10986	563	.10879	560	.10773	557	.10667	554	.10563	551
.90	.08864	448	.08773	446	.08683	443	.08593	441	.08505	438	.08417	436
0.95	0.07086	356	0.07010	354	0.06934	352	0.06859	349	0.06785	347	0.06711	345
1.00	0.05669	+ 283	0.05605	+ 281	0.05541	+ 280	0.05478	+ 278	0.05416	+ 276	0.05354	+ 274
X/Y	0.900		0.905		0.910		0.915		0.920		0.925	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.53072	+3170	0.52749	+3163	0.52427	+3157	0.52107	+3149	0.51788	+3143	0.51471	+3136
.55	.41863	2410	.41586	2404	.41311	2398	.41037	2392	.40764	2386	.40493	2380
.60	.33104	1856	.32867	1851	.32632	1846	.32398	1840	.32166	1835	.31935	1830
.65	.26226	1440	.26025	1436	.25825	1431	.25626	1426	.25429	1422	.25232	1417
.70	.20809	1125	.20638	1121	.20468	1117	.20299	1112	.20132	1108	.19966	1104
0.75	0.16529	+ 883	0.16385	+ 879	0.16241	+ 875	0.16099	+ 872	0.15957	+ 868	0.15817	+ 865
.80	.13143	694	.13021	691	.12900	688	.12780	685	.12660	682	.12542	678
.85	.10459	548	.10357	545	.10255	543	.10154	540	.10053	537	.09954	534
.90	.08330	433	.08243	431	.08158	428	.08073	426	.07989	423	.07905	421
0.95	0.06638	343	0.06565	341	0.06494	339	0.06423	337	0.06352	335	0.06283	332
1.00	0.05293	+ 272	0.05232	+ 270	0.05172	+ 268	0.05113	+ 266	0.05054	+ 265	0.04996	+ 263
X/Y	0.930		0.935		0.940		0.945		0.950		0.955	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0.50	0.51156	+3129	0.50842	+3122	0.50530	+3115	0.50219	+3108	0.49910	+3101	0.49603	+3094
.55	.40224	2374	.39956	2368	.39689	2362	.39424	2356	.39161	2350	.38898	2344
.60	.31705	1824	.31477	1819	.31250	1814	.31024	1809	.30800	1803	.30578	1798
.65	.25037	1412	.24844	1408	.24651	1403	.24460	1398	.24270	1393	.24081	1389
.70	.19800	1100	.19636	1096	.19474	1092	.19312	1087	.19151	1083	.18992	1079
0.75	0.15677	+ 861	0.15539	+ 857	0.15401	+ 853	0.15265	+ 850	0.15130	+ 846	0.14995	+ 843
.80	.12425	675	.12308	672	.12193	669	.12078	665	.11964	662	.11852	659
.85	.09855	531	.09757	529	.09661	526	.09564	523	.09469	520	.09375	517
.90	.07823	419	.07741	416	.07660	414	.07579	411	.07500	409	.07421	407
0.95	0.06214	330	0.06145	328	0.06077	326	0.06010	324	0.05944	322	0.05878	320
1.00	0.04938	+ 261	0.04881	+ 259	0.04825	+ 258	0.04769	+ 256	0.04713	+ 254	0.04659	+ 252

TABLE 1b—continued

X/Y	0-960		0-965		0-970		0-975		0-980		0-985	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0-50	0-49297	+3088	0-48993	+3081	0-48690	+3074	0-48389	+3067	0-48089	+3061	0-47792	+3053
55	0-38638	2338	0-38379	2332	0-38121	2326	0-37865	2321	0-37610	2314	0-37357	2309
60	0-30356	1793	0-30136	1788	0-29917	1782	0-29700	1777	0-29484	1772	0-29269	1766
65	0-23893	1384	0-23707	1380	0-23522	1375	0-23338	1370	0-23155	1365	0-22974	1361
70	0-18834	1075	0-18676	1070	0-18520	1067	0-18365	1062	0-18211	1058	0-18058	1054
0-75	0-14862	+ 839	0-14730	+ 835	0-14599	+ 832	0-14468	+ 828	0-14339	+ 825	0-14211	+ 821
80	0-11740	656	0-11629	653	0-11519	650	0-11410	646	0-11301	643	0-11194	640
85	0-09281	515	0-09188	512	0-09096	509	0-09005	506	0-08914	504	0-08825	500
90	0-07343	404	0-07265	402	0-07188	399	0-07112	397	0-07037	395	0-06962	392
0-95	0-05813	318	0-05748	316	0-05684	314	0-05621	311	0-05558	310	0-05496	308
1-00	0-04604	+ 251	0-04551	+ 249	0-04497	+ 247	0-04445	+ 245	0-04393	+ 244	0-04341	+ 242
X/Y	0-990		0-995		1-000		1-005		1-010		1-015	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
0-50	0-47495	+3047	0-47200	+3040	0-46907	+3033	0-46615	+3026	0-46325	+3019	0-46037	+3013
55	0-37105	2303	0-36854	2297	0-36605	2291	0-36358	2285	0-36111	2279	0-35866	2273
60	0-29056	1761	0-28843	1756	0-28633	1751	0-28423	1745	0-28215	1740	0-28008	1735
65	0-22794	1356	0-22615	1352	0-22437	1347	0-22260	1342	0-22085	1338	0-21910	1333
70	0-17907	1050	0-17756	1046	0-17606	1042	0-17458	1038	0-17311	1034	0-17164	1029
0-75	0-14083	+ 817	0-13957	+ 814	0-13832	+ 810	0-13707	+ 806	0-13584	+ 803	0-13461	+ 799
80	0-11087	637	0-10982	634	0-10877	631	0-10773	627	0-10670	624	0-10568	621
85	0-08736	498	0-08648	495	0-08560	493	0-08473	490	0-08388	487	0-08303	485
90	0-06888	390	0-06815	388	0-06742	385	0-06670	383	0-06598	381	0-06528	378
0-95	0-05434	306	0-05374	304	0-05313	302	0-05253	300	0-05194	298	0-05136	296
1-00	0-04290	+ 240	0-04240	+ 238	0-04190	+ 237	0-04140	+ 235	0-04091	+ 233	0-04043	+ 232

TABLE 1c

X/Y	0.00		0.01		0.02		0.03		0.04		0.05	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.27203	+2693	0.26871	+2673	0.26539	+2653	0.26208	+2634	0.25877	+2614	0.25546	+2594
1.1	.19852	1953	.19595	1937	.19339	1921	.19083	1905	.18826	1889	.18571	1873
1.2	.14493	1421	.14296	1408	.14098	1396	.13901	1383	.13704	1370	.13507	1357
1.3	.10583	1036	.10432	1026	.10281	1015	.10130	1005	.09979	995	.09828	985
1.4	.07729	756	.07614	747	.07498	740	.07383	731	.07268	723	.07153	715
1.5	0.05645	+ 552	0.05557	+ 546	0.05469	+ 539	0.05381	+ 533	0.05294	+ 526	0.05207	+ 520
1.6	.04123	403	.04056	398	.03990	393	.03923	388	.03857	383	.03790	378
1.7	.03011	294	.02961	291	.02910	287	.02860	283	.02810	279	.02760	275
1.8	.02199	215	.02161	212	.02123	209	.02085	206	.02047	203	.02009	200
1.9	.01606	157	.01578	155	.01549	153	.01520	150	.01492	148	.01463	146
2.0	0.01173	+ 115	0.01152	+ 113	0.01130	+ 111	0.01109	+ 109	0.01087	+ 108	0.01066	+ 106
X/Y	0.06		0.07		0.08		0.09		0.10		0.11	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.25215	+2575	0.24886	+2555	0.24557	+2535	0.24228	+2516	0.23901	+2496	0.23574	+2477
1.1	.18315	1857	.18061	1841	.17806	1825	.17553	1809	.17300	1793	.17048	1777
1.2	.13311	1344	.13115	1331	.12920	1318	.12725	1305	.12531	1292	.12337	1280
1.3	.09678	974	.09528	964	.09378	954	.09229	944	.09080	933	.08932	923
1.4	.07038	707	.06924	699	.06810	691	.06696	683	.06582	675	.06467	667
1.5	0.05119	+ 514	0.05032	+ 507	0.04946	+ 501	0.04859	+ 495	0.04773	+ 488	0.04687	+ 482
1.6	.03724	373	.03658	368	.03593	364	.03527	359	.03462	353	.03397	349
1.7	.02710	272	.02660	268	.02610	264	.02561	260	.02511	257	.02462	253
1.8	.01972	197	.01934	194	.01897	191	.01859	189	.01822	186	.01785	182
1.9	.01435	144	.01407	141	.01378	139	.01350	137	.01322	135	.01295	132
2.0	0.01044	+ 104	0.01023	+ 103	0.01002	+ 101	0.00981	+ 99	0.00960	+ 97	0.00939	+ 96
X/Y	0.12		0.13		0.14		0.15		0.16		0.17	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.23249	+2457	0.22924	+2438	0.22601	+2418	0.22279	+2399	0.21958	+2379	0.21639	+2360
1.1	.16797	1761	.16546	1745	.16297	1729	.16049	1713	.15802	1698	.15556	1682
1.2	.12144	1267	.11952	1254	.11761	1241	.11570	1229	.11381	1216	.11193	1203
1.3	.08785	912	.08638	902	.08492	892	.08346	882	.08202	872	.08058	862
1.4	.06357	659	.06245	651	.06134	643	.06024	635	.05914	627	.05805	619
1.5	0.04602	+ 476	0.04517	+ 469	0.04433	+ 464	0.04349	+ 457	0.04266	+ 451	0.04183	+ 445
1.6	.03332	344	.03268	340	.03204	334	.03141	329	.03078	325	.03015	320
1.7	.02414	249	.02365	245	.02317	242	.02269	238	.02222	234	.02175	230
1.8	.01748	180	.01712	177	.01676	174	.01640	171	.01604	168	.01569	166
1.9	.01267	130	.01239	128	.01212	126	.01185	123	.01158	122	.01132	120
2.0	0.00918	+ 94	0.00897	+ 93	0.00877	+ 91	0.00857	+ 90	0.00837	+ 88	0.00817	+ 86
X/Y	0.18		0.19		0.20		0.21		0.22		0.23	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.21321	+2341	0.21006	+2321	0.20691	+2301	0.20379	+2282	0.20068	+2263	0.19759	+2243
1.1	.15312	1666	.15068	1650	.14827	1635	.14587	1618	.14348	1603	.14111	1587
1.2	.11005	1191	.10819	1178	.10634	1165	.10451	1152	.10268	1140	.10087	1127
1.3	.07916	852	.07774	842	.07633	832	.07493	822	.07354	812	.07217	802
1.4	.05696	611	.05588	603	.05482	595	.05376	588	.05270	580	.05166	572
1.5	0.04101	+ 439	0.04019	+ 433	0.03938	+ 427	0.03858	+ 420	0.03779	+ 415	0.03700	+ 409
1.6	.02953	315	.02892	310	.02831	305	.02771	301	.02711	296	.02652	291
1.7	.02128	226	.02081	223	.02036	220	.01990	216	.01945	212	.01901	209
1.8	.01533	163	.01499	160	.01464	157	.01430	155	.01397	152	.01363	149
1.9	.01105	118	.01079	115	.01054	113	.01028	111	.01003	109	.00978	107
2.0	0.00797	+ 84	0.00778	+ 83	0.00758	+ 81	0.00739	+ 79	0.00720	+ 78	0.00702	+ 76

TABLE 1c—continued

X/Y	0.24		0.25		0.26		0.27		0.28		0.29	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.19452	+2224	0.19148	+2205	0.18845	+2185	0.18545	+2166	0.18247	+2147	0.17951	+2128
1.1	.13876	1571	.13642	1556	.13410	1540	.13181	1525	.12952	1509	.12726	1494
1.2	.09908	1115	.09730	1103	.09553	1090	.09378	1078	.09205	1065	.09033	1053
1.3	.07080	792	.06945	782	.06811	772	.06678	763	.06547	753	.06417	743
1.4	.05063	565	.04961	557	.04859	549	.04759	541	.04660	534	.04562	527
1.5	0.03622	+ 402	0.03545	+ 397	0.03469	+ 390	0.03393	+ 385	0.03319	+ 379	0.03245	+ 373
1.6	.02593	287	.02535	282	.02478	278	.02421	274	.02365	269	.02310	264
1.7	.01857	205	.01813	202	.01770	198	.01728	195	.01686	192	.01645	188
1.8	.01330	146	.01298	144	.01266	141	.01234	138	.01203	136	.01172	133
1.9	.00953	105	.00929	103	.00905	101	.00881	99	.00858	97	.00835	95
2.0	0.00683	+ 75	0.00665	+ 73	0.00647	+ 72	0.00630	+ 70	0.00613	+ 69	0.00596	+ 67

X/Y	0.30		0.31		0.32		0.33		0.34		0.35	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.17657	+2109	0.17366	+2089	0.17077	+2070	0.16791	+2052	0.16508	+2032	0.16227	+2013
1.1	.12502	1478	.12280	1463	.12060	1448	.11842	1432	.11627	1417	.11413	1401
1.2	.08862	1041	.08694	1028	.08527	1016	.08362	1004	.08199	992	.08037	980
1.3	.06288	734	.06161	724	.06035	715	.05910	705	.05787	695	.05666	686
1.4	.04465	519	.04369	512	.04274	504	.04181	496	.04088	489	.03997	482
1.5	0.03172	+ 367	0.03100	+ 361	0.03029	+ 356	0.02959	+ 350	0.02890	+ 344	0.02822	+ 339
1.6	.02255	260	.02201	256	.02148	251	.02096	247	.02045	242	.01994	238
1.7	.01604	184	.01564	181	.01524	178	.01485	175	.01447	171	.01409	168
1.8	.01142	131	.01112	128	.01082	126	.01053	123	.01025	121	.00997	118
1.9	.00813	93	.00791	91	.00769	89	.00747	87	.00726	86	.00705	84
2.0	0.00579	+ 66	0.00562	+ 64	0.00546	+ 63	0.00530	+ 62	0.00515	+ 60	0.00499	+ 59

X/Y	0.36		0.37		0.38		0.39		0.40		0.41	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.15949	+1994	0.15673	+1975	0.15400	+1957	0.15130	+1938	0.14863	+1918	0.14599	+1900
1.1	.11202	1387	.10993	1371	.10786	1356	.10582	1341	.10380	1327	.10180	1311
1.2	.07878	968	.07720	956	.07564	944	.07410	932	.07258	920	.07108	909
1.3	.05546	677	.05427	668	.05310	658	.05195	649	.05081	640	.04969	631
1.4	.03907	475	.03819	467	.03731	460	.03645	453	.03560	446	.03477	439
1.5	0.02755	+ 333	0.02689	+ 328	0.02624	+ 322	0.02560	+ 317	0.02497	+ 311	0.02434	+ 306
1.6	.01944	234	.01895	230	.01846	225	.01799	221	.01752	218	.01706	214
1.7	.01372	164	.01336	162	.01300	159	.01265	155	.01230	152	.01196	149
1.8	.00969	116	.00942	114	.00916	111	.00890	109	.00864	106	.00839	104
1.9	.00685	82	.00665	80	.00646	78	.00626	76	.00608	75	.00589	73
2.0	0.00484	+ 57	0.00470	+ 56	0.00455	+ 55	0.00441	+ 54	0.00427	+ 52	0.00414	+ 51

X/Y	0.42		0.43		0.44		0.45		0.46		0.47	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.14337	+1881	0.14079	+1863	0.13823	+1844	0.13570	+1826	0.13321	+1807	0.13074	+1789
1.1	.09983	1297	.09788	1282	.09596	1267	.09406	1252	.09218	1238	.09033	1223
1.2	.06960	897	.06814	885	.06670	874	.06528	862	.06388	851	.06250	840
1.3	.04858	622	.04749	613	.04642	604	.04536	595	.04432	586	.04330	577
1.4	.03394	432	.03313	425	.03234	418	.03155	412	.03078	405	.03002	399
1.5	0.02373	+ 301	0.02313	+ 296	0.02254	+ 290	0.02197	+ 285	0.02140	+ 280	0.02084	+ 275
1.6	.01661	209	.01617	205	.01573	202	.01530	198	.01488	194	.01447	190
1.7	.01163	146	.01130	143	.01098	140	.01067	137	.01036	135	.01006	132
1.8	.00815	102	.00791	100	.00767	97	.00744	96	.00722	93	.00700	91
1.9	.00571	71	.00554	69	.00536	68	.00520	66	.00503	65	.00487	63
2.0	0.00401	+ 50	0.00388	+ 49	0.00375	+ 47	0.00363	+ 46	0.00351	+ 45	0.00339	+ 44

TABLE 1c—continued

X/Y	0.48		0.49		0.50		0.51		0.52		0.53	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.12831	+1770	0.12590	+1752	0.12352	+1734	0.12118	+1715	0.11886	+1697	0.11658	+1679
1.1	0.08851	1209	0.08671	1194	0.08493	1179	0.08319	1165	0.08146	1151	0.07976	1137
1.2	0.06114	828	0.05980	817	0.05849	806	0.05719	795	0.05591	784	0.05465	773
1.3	0.04229	569	0.04130	560	0.04032	551	0.03936	543	0.03842	535	0.03750	526
1.4	0.02928	392	0.02855	385	0.02783	379	0.02712	372	0.02643	366	0.02575	359
1.5	0.02029	+ 270	0.01975	+ 265	0.01922	+ 260	0.01871	+ 256	0.01820	+ 250	0.01770	+ 246
1.6	0.01407	186	0.01368	183	0.01329	179	0.01291	175	0.01254	172	0.01218	168
1.7	0.00977	129	0.00948	126	0.00920	123	0.00892	121	0.00865	118	0.00839	115
1.8	0.00678	89	0.00657	87	0.00637	85	0.00617	83	0.00597	81	0.00578	79
1.9	0.00471	62	0.00456	60	0.00441	59	0.00427	57	0.00412	56	0.00398	54
2.0	0.00328	+ 43	0.00317	+ 41	0.00306	+ 40	0.00295	+ 39	0.00285	+ 38	0.00275	+ 37

X/Y	0.54		0.55		0.56		0.57		0.58		0.59	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.11433	+1661	0.11210	+1643	0.10991	+1625	0.10775	+1608	0.10562	+1590	0.10352	+1572
1.1	0.07809	1123	0.07644	1109	0.07482	1095	0.07322	1081	0.07164	1067	0.07010	1053
1.2	0.05342	762	0.05220	751	0.05100	741	0.04983	730	0.04867	719	0.04754	709
1.3	0.03659	518	0.03569	510	0.03482	501	0.03396	494	0.03311	485	0.03228	478
1.4	0.02509	353	0.02443	347	0.02379	341	0.02316	335	0.02255	329	0.02195	323
1.5	0.01722	+ 241	0.01674	+ 236	0.01627	+ 232	0.01582	+ 227	0.01537	+ 223	0.01493	+ 218
1.6	0.01183	165	0.01148	161	0.01114	158	0.01081	155	0.01049	151	0.01017	148
1.7	0.00813	113	0.00788	110	0.00763	108	0.00740	105	0.00716	103	0.00693	100
1.8	0.00559	77	0.00541	75	0.00524	73	0.00506	72	0.00489	70	0.00473	68
1.9	0.00385	53	0.00372	52	0.00359	50	0.00347	49	0.00335	48	0.00323	46
2.0	0.00265	+ 36	0.00256	+ 35	0.00247	+ 35	0.00238	+ 34	0.00229	+ 33	0.00221	+ 32

X/Y	0.60		0.61		0.62		0.63		0.64		0.65	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.10145	+1554	0.09942	+1537	0.09741	+1520	0.09543	+1502	0.09349	+1485	0.09157	+1468
1.1	0.06857	1040	0.06707	1026	0.06560	1013	0.06415	1000	0.06273	986	0.06133	973
1.2	0.04642	698	0.04533	688	0.04425	678	0.04320	667	0.04216	657	0.04114	647
1.3	0.03147	470	0.03067	462	0.02989	454	0.02912	447	0.02837	439	0.02764	432
1.4	0.02136	317	0.02078	311	0.02021	305	0.01966	300	0.01912	294	0.01859	288
1.5	0.01451	+ 214	0.01409	+ 210	0.01368	+ 206	0.01328	+ 201	0.01290	+ 197	0.01252	+ 193
1.6	0.00987	145	0.00956	142	0.00927	139	0.00898	136	0.00871	133	0.00843	129
1.7	0.00671	98	0.00650	96	0.00629	94	0.00608	91	0.00588	89	0.00569	87
1.8	0.00457	67	0.00442	65	0.00427	63	0.00412	62	0.00398	60	0.00384	58
1.9	0.00312	45	0.00301	44	0.00290	43	0.00279	41	0.00269	40	0.00259	39
2.0	0.00212	+ 31	0.00205	+ 30	0.00197	+ 29	0.00190	+ 28	0.00182	+ 27	0.00175	+ 27

X/Y	0.66		0.67		0.68		0.69		0.70		0.71	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.08968	+1451	0.08783	+1434	0.08600	+1416	0.08421	+1400	0.08244	+1383	0.08070	+1366
1.1	0.05996	960	0.05860	947	0.05728	934	0.05597	921	0.05469	908	0.05344	895
1.2	0.04015	638	0.03917	628	0.03821	618	0.03727	608	0.03635	599	0.03544	589
1.3	0.02692	424	0.02621	417	0.02552	409	0.02485	402	0.02419	395	0.02354	388
1.4	0.01807	283	0.01757	277	0.01707	272	0.01659	267	0.01612	262	0.01566	257
1.5	0.01215	+ 189	0.01178	+ 185	0.01143	+ 181	0.01109	+ 177	0.01075	+ 174	0.01042	+ 170
1.6	0.00817	127	0.00791	124	0.00766	121	0.00742	118	0.00718	115	0.00695	113
1.7	0.00550	85	0.00532	83	0.00514	81	0.00496	79	0.00480	77	0.00463	75
1.8	0.00371	57	0.00358	55	0.00345	54	0.00333	53	0.00321	51	0.00309	50
1.9	0.00250	38	0.00241	37	0.00232	36	0.00223	35	0.00215	34	0.00207	33
2.0	0.00169	+ 26	0.00162	+ 25	0.00156	+ 24	0.00150	+ 24	0.00144	+ 23	0.00138	+ 22

TABLE 1c—continued

X/Y	0.72		0.73		0.74		0.75		0.76		0.77	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.07899	+1349	0.07731	+1333	0.07566	+1317	0.07404	+1300	0.07244	+1284	0.07088	+1268
1.1	0.05220	883	0.05099	870	0.04981	858	0.04864	846	0.04750	834	0.04638	821
1.2	0.03456	580	0.03369	570	0.03284	561	0.03201	552	0.03119	543	0.03040	534
1.3	0.02291	381	0.02229	375	0.02169	368	0.02110	361	0.02052	354	0.01995	348
1.4	0.01521	252	0.01477	247	0.01434	242	0.01392	237	0.01351	232	0.01311	227
1.5	0.01010	+166	0.00979	+163	0.00949	+159	0.00920	+156	0.00891	+152	0.00863	+147
1.6	0.00672	110	0.00650	108	0.00629	105	0.00608	102	0.00588	100	0.00568	99
1.7	0.00447	73	0.00432	71	0.00417	69	0.00402	67	0.00388	66	0.00375	62
1.8	0.00298	48	0.00287	47	0.00277	46	0.00267	45	0.00257	43	0.00247	43
1.9	0.00199	32	0.00191	31	0.00184	30	0.00177	29	0.00170	28	0.00163	28
2.0	0.00133	+21	0.00127	+21	0.00122	+20	0.00117	+20	0.00112	+19	0.00108	+18

X/Y	0.78		0.79		0.80		0.81		0.82		0.83	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.06934	+1252	0.06783	+1236	0.06634	+1220	0.06488	+1205	0.06345	+1189	0.06205	+1174
1.1	0.04528	810	0.04420	798	0.04314	786	0.04211	774	0.04110	763	0.04010	751
1.2	0.02962	525	0.02885	517	0.02811	508	0.02738	499	0.02666	491	0.02596	482
1.3	0.01940	341	0.01886	335	0.01834	329	0.01782	323	0.01732	317	0.01683	311
1.4	0.01273	223	0.01235	218	0.01198	213	0.01162	209	0.01127	205	0.01093	200
1.5	0.00836	+145	0.00809	+142	0.00784	+139	0.00758	+136	0.00734	+133	0.00710	+130
1.6	0.00549	95	0.00531	93	0.00513	90	0.00496	88	0.00479	86	0.00462	84
1.7	0.00361	62	0.00349	61	0.00336	59	0.00324	57	0.00312	56	0.00301	54
1.8	0.00238	41	0.00229	40	0.00221	39	0.00212	37	0.00204	36	0.00196	35
1.9	0.00157	27	0.00151	26	0.00145	25	0.00139	24	0.00133	24	0.00128	23
2.0	0.00103	+18	0.00099	+17	0.00095	+17	0.00091	+16	0.00087	+16	0.00084	+15

X/Y	0.84		0.85		0.86		0.87		0.88		0.89	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.06067	+1158	0.05932	+1143	0.05799	+1128	0.05669	+1113	0.05541	+1098	0.05416	+1083
1.1	0.03913	740	0.03818	729	0.03724	717	0.03633	707	0.03543	695	0.03456	685
1.2	0.02528	474	0.02461	466	0.02396	458	0.02332	450	0.02270	442	0.02209	434
1.3	0.01636	305	0.01589	299	0.01544	293	0.01500	287	0.01456	282	0.01414	276
1.4	0.01060	196	0.01028	192	0.00996	188	0.00966	184	0.00936	180	0.00907	176
1.5	0.00687	+127	0.00665	+123	0.00643	+121	0.00622	+118	0.00602	+115	0.00582	+112
1.6	0.00446	82	0.00431	80	0.00416	78	0.00402	76	0.00388	74	0.00374	72
1.7	0.00290	53	0.00280	51	0.00269	50	0.00259	49	0.00250	47	0.00240	46
1.8	0.00189	34	0.00181	33	0.00174	32	0.00168	31	0.00161	30	0.00155	30
1.9	0.00123	22	0.00118	21	0.00113	21	0.00108	20	0.00104	19	0.00100	19
2.0	0.00080	+15	0.00077	+14	0.00073	+14	0.00070	+13	0.00067	+13	0.00064	+12

X/Y	0.90		0.91		0.92		0.93		0.94		0.95	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.05293	+1068	0.05172	+1054	0.05054	+1039	0.04938	+1025	0.04825	+1011	0.04713	+996
1.1	0.03370	674	0.03286	663	0.03204	653	0.03124	642	0.03045	632	0.02968	622
1.2	0.02150	426	0.02092	419	0.02035	411	0.01980	404	0.01926	397	0.01873	389
1.3	0.01373	270	0.01333	265	0.01294	260	0.01256	255	0.01220	249	0.01183	244
1.4	0.00879	172	0.00851	168	0.00824	165	0.00799	161	0.00773	157	0.00749	154
1.5	0.00563	+109	0.00544	+107	0.00526	+104	0.00508	+102	0.00491	+99	0.00474	+97
1.6	0.00361	70	0.00348	68	0.00336	66	0.00324	65	0.00312	63	0.00301	61
1.7	0.00232	45	0.00223	43	0.00214	42	0.00206	41	0.00199	40	0.00191	39
1.8	0.00149	29	0.00143	28	0.00137	27	0.00132	26	0.00126	25	0.00121	25
1.9	0.00096	18	0.00092	18	0.00088	17	0.00084	16	0.00081	16	0.00077	15
2.0	0.00061	+12	0.00059	+11	0.00056	+11	0.00054	+11	0.00051	+10	0.00049	+10

TABLE 1c—*continued*

X/Y	0.96		0.97		0.98		0.99		1.00		1.01	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
1.0	0.04604	+983	0.04497	+969	0.04393	+955	0.04290	+941	0.04190	+928	0.04091	+914
1.1	.02893	612	.02820	602	.02748	592	.02678	582	.02609	573	.02542	563
1.2	.01821	382	.01771	375	.01722	368	.01675	361	.01628	355	.01583	348
1.3	.01148	239	.01114	234	.01081	230	.01049	225	.01017	220	.00987	216
1.4	.00725	150	.00702	147	.00680	143	.00658	140	.00637	137	.00616	134
1.5	0.00458	+ 94	0.00443	+ 92	0.00428	+ 90	0.00413	+ 88	0.00399	+ 85	0.00385	+ 83
1.6	.00290	60	.00280	58	.00269	56	.00260	55	.00250	53	.00241	52
1.7	.00184	38	.00177	36	.00170	35	.00163	34	.00157	33	.00151	32
1.8	.00117	24	.00112	23	.00107	22	.00103	22	.00099	21	.00095	20
1.9	.00074	15	.00071	14	.00068	14	.00065	13	.00062	13	.00059	13
2.0	0.00047	+ 10	0.00045	+ 9	0.00043	+ 9	0.00041	+ 9	0.00039	+ 8	0.00037	+ 8

TABLE 1d

X/Y	0.00		0.02		0.04		0.06		0.08		0.10	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
2.0	0.01173	+115	0.01130	+111	0.01087	+108	0.01044	+104	0.01002	+101	0.00960	+97
2.1	.00857	84	.00825	81	.00792	79	.00760	76	.00728	74	.00697	71
2.2	.00626	61	.00602	59	.00577	57	.00553	55	.00529	53	.00506	51
2.3	.00457	45	.00439	43	.00421	41	.00403	40	.00385	38	.00367	37
2.4	.00334	33	.00320	32	.00307	30	.00293	29	.00280	28	.00267	27
2.5	0.00244	+24	0.00234	+23	0.00224	+22	0.00213	+21	0.00204	+20	0.00194	+19
2.6	.00178	17	.00170	17	.00163	16	.00155	16	.00148	15	.00141	15
2.7	.00130	13	.00124	12	.00119	12	.00113	11	.00108	11	.00102	10
2.8	.00095	9	.00091	9	.00087	9	.00082	9	.00078	8	.00074	7
2.9	.00069	7	.00066	6	.00063	7	.00060	6	.00057	6	.00054	5
3.0	0.00051	+5	0.00048	+5	0.00046	+4	0.00044	+5	0.00041	+4	0.00039	+4
3.1	.00037	4	.00035	3	.00033	3	.00032	3	.00030	3	.00028	3
3.2	.00027	3	.00026	3	.00024	3	.00023	3	.00022	2	.00021	2
3.3	.00020	2	.00019	2	.00018	1	.00017	1	.00016	1	.00015	1
3.4	.00014	+1	.00014	+1	.00013	+1	.00012	+1	.00012	+1	.00011	+1
3.5	0.00011		0.00010		0.00009		0.00009		0.00008		0.00008	
3.6	.00008		.00007		.00007		.00006		.00006		.00006	
3.7	.00006		.00005		.00005		.00005		.00004		.00004	
3.8	.00004		.00004		.00004		.00003		.00003		.00003	
3.9	.00003		.00003		.00003		.00002		.00002		.00002	
4.0	0.00002		0.00002		0.00002		0.00002		0.00002		0.00002	

X/Y	0.12		0.14		0.16		0.18		0.20		0.22	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
2.0	0.00918	+94	0.00877	+91	0.00837	+88	0.00797	+84	0.00758	+81	0.00720	+78
2.1	.00665	68	.00635	66	.00604	63	.00575	61	.00546	59	.00518	56
2.2	.00482	50	.00459	47	.00437	46	.00415	43	.00393	42	.00372	40
2.3	.00350	35	.00332	34	.00316	33	.00299	32	.00283	30	.00267	29
2.4	.00254	26	.00241	25	.00228	24	.00216	23	.00204	22	.00192	21
2.5	0.00184	+19	0.00174	+18	0.00165	+17	0.00156	+16	0.00147	+15	0.00138	+15
2.6	.00133	14	.00126	13	.00119	12	.00112	12	.00106	11	.00099	11
2.7	.00097	10	.00091	9	.00086	9	.00081	9	.00076	8	.00072	8
2.8	.00070	7	.00066	7	.00062	6	.00059	6	.00055	6	.00051	6
2.9	.00051	5	.00048	5	.00045	5	.00042	5	.00040	4	.00037	4
3.0	0.00037	+4	0.00035	+4	0.00033	+3	0.00031	+3	0.00029	+3	0.00027	+3
3.1	.00027	3	.00025	2	.00024	3	.00022	2	.00021	2	.00019	2
3.2	.00019	2	.00018	2	.00017	2	.00016	2	.00015	2	.00014	1
3.3	.00014	1	.00013	1	.00012	1	.00012	1	.00011	1	.00010	1
3.4	.00010	+1	.00010	+1	.00009	+1	.00008	+1	.00008	+1	.00007	+1
3.5	0.00007		0.00007		0.00006		0.00006		0.00006		0.00005	
3.6	.00005		.00005		.00005		.00004		.00004		.00004	
3.7	.00004		.00004		.00003		.00003		.00003		.00003	
3.8	.00003		.00003		.00002		.00002		.00002		.00002	
3.9	.00002		.00002		.00002		.00002		.00002		.00001	
4.0	0.00001		0.00001		0.00001		0.00001		0.00001		0.00001	

TABLE 1d—continued

X/Y	0.24		0.26		0.28		0.30		0.32		0.34	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
2.0	0.00683	+75	0.00647	+72	0.00613	+69	0.00579	+66	0.00546	+63	0.00515	+60
2.1	0.00490	54	0.00463	51	0.00437	49	0.00412	47	0.00388	45	0.00365	43
2.2	0.00352	38	0.00332	37	0.00312	35	0.00294	33	0.00276	32	0.00259	30
2.3	0.00252	27	0.00237	26	0.00223	25	0.00210	24	0.00196	22	0.00184	21
2.4	0.00181	20	0.00170	19	0.00160	18	0.00149	17	0.00140	16	0.00130	15
2.5	0.00130	+14	0.00122	+14	0.00114	+13	0.00107	+12	0.00099	+11	0.00093	+11
2.6	0.00093	10	0.00087	10	0.00082	9	0.00076	9	0.00071	8	0.00066	8
2.7	0.00067	7	0.00063	7	0.00058	7	0.00054	6	0.00050	6	0.00047	5
2.8	0.00048	5	0.00045	5	0.00042	5	0.00039	5	0.00036	4	0.00033	4
2.9	0.00035	+4	0.00032	+4	0.00030	+3	0.00028	+3	0.00026	+3	0.00024	+3
3.0	0.00025		0.00023		0.00021		0.00020		0.00018		0.00017	
3.1	0.00018		0.00017		0.00015		0.00014		0.00013		0.00012	
3.2	0.00013		0.00012		0.00011		0.00010		0.00009		0.00008	
3.3	0.00009		0.00009		0.00008		0.00007		0.00007		0.00006	
3.4	0.00007		0.00006		0.00006		0.00005		0.00005		0.00004	
3.5	0.00005		0.00004		0.00004		0.00004		0.00003		0.00003	
3.6	0.00003		0.00003		0.00003		0.00003		0.00002		0.00002	
3.7	0.00002		0.00002		0.00002		0.00002		0.00002		0.00002	
3.8	0.00002		0.00002		0.00001		0.00001		0.00001		0.00001	
3.9	0.00001		0.00001		0.00001		0.00001		0.00001		0.00001	
4.0	0.00001		0.00001		0.00001		0.00001		0.00001		0.00001	

X/Y	0.36		0.38		0.40		0.42		0.44		0.46	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
2.0	0.00484	+58	0.00455	+55	0.00427	+52	0.00401	+50	0.00375	+48	0.00351	+45
2.1	0.00343	41	0.00321	39	0.00301	37	0.00281	35	0.00263	33	0.00245	31
2.2	0.00242	29	0.00227	27	0.00212	26	0.00197	24	0.00184	23	0.00171	22
2.3	0.00172	20	0.00160	19	0.00149	18	0.00139	17	0.00129	16	0.00119	15
2.4	0.00121	14	0.00113	14	0.00105	13	0.00097	12	0.00090	11	0.00083	11
2.5	0.00086	+10	0.00080	+9	0.00074	+9	0.00068	+8	0.00063	+8	0.00058	+7
2.6	0.00061	7	0.00056	7	0.00052	6	0.00048	6	0.00044	5	0.00041	5
2.7	0.00043	5	0.00040	5	0.00037	5	0.00034	4	0.00031	4	0.00029	3
2.8	0.00031	4	0.00028	3	0.00026	3	0.00024	3	0.00022	3	0.00020	3
2.9	0.00022	3	0.00020	+2	0.00018	+2	0.00017	+2	0.00015	+2	0.00014	+2
3.0	0.00015		0.00014		0.00013		0.00012		0.00011		0.00010	
3.1	0.00011		0.00010		0.00009		0.00008		0.00007		0.00007	
3.2	0.00008		0.00007		0.00006		0.00006		0.00005		0.00005	
3.3	0.00005		0.00005		0.00005		0.00004		0.00004		0.00003	
3.4	0.00004		0.00003		0.00003		0.00003		0.00003		0.00002	
3.5	0.00003		0.00002		0.00002		0.00002		0.00002		0.00002	
3.6	0.00002		0.00002		0.00002		0.00001		0.00001		0.00001	
3.7	0.00001		0.00001		0.00001		0.00001		0.00001		0.00001	
3.8	0.00001		0.00001		0.00001		0.00001		0.00001		0.00001	
3.9	0.00001		0.00001		0.00001		0.00000		0.00000		0.00000	
4.0	0.00000		0.00000		0.00000		0.00000		0.00000		0.00000	

TABLE 1d—continued

X/Y	0.48		0.50		0.52		0.54		0.56		0.58	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
2.0	0.00328	+43	0.00306	+41	0.00285	+38	0.00265	+37	0.00247	+35	0.00229	+33
2.1	0.00228	30	0.00212	28	0.00197	27	0.00183	25	0.00169	23	0.00157	22
2.2	0.00159	21	0.00147	19	0.00136	18	0.00126	17	0.00116	16	0.00107	15
2.3	0.00111	14	0.00102	13	0.00094	13	0.00087	12	0.00080	11	0.00074	10
2.4	0.00077	10	0.00071	9	0.00065	9	0.00060	8	0.00055	8	0.00050	7
2.5	0.00054	+7	0.00049	+6	0.00045	+6	0.00041	+6	0.00038	+5	0.00035	+5
2.6	0.00037	5	0.00034	4	0.00031	4	0.00029	4	0.00026	4	0.00024	3
2.7	0.00026	3	0.00024	3	0.00022	3	0.00020	3	0.00018	3	0.00016	2
2.8	0.00018	2	0.00017	2	0.00015	2	0.00014	2	0.00012	2	0.00011	1
2.9	0.00013	+2	0.00012	+1	0.00010	+1	0.00009	+1	0.00009	+1	0.00008	+1
3.0	0.00009		0.00008		0.00007		0.00007		0.00006		0.00005	
3.1	0.00006		0.00006		0.00005		0.00004		0.00004		0.00004	
3.2	0.00004		0.00004		0.00003		0.00003		0.00003		0.00002	
3.3	0.00003		0.00003		0.00002		0.00002		0.00002		0.00002	
3.4	0.00002		0.00002		0.00002		0.00001		0.00001		0.00001	
3.5	0.00001		0.00001		0.00001		0.00001		0.00001		0.00001	
3.6	0.00001		0.00001		0.00001		0.00001		0.00001		0.00001	
3.7	0.00001		0.00001		0.00001		0.00000		0.00000		0.00000	
3.8	0.00000		0.00000		0.00000		0.00000		0.00000		0.00000	
3.9	0.00000		0.00000		0.00000		0.00000		0.00000		0.00000	
4.0	0.00000		0.00000		0.00000		0.00000		0.00000		0.00000	

X/Y	0.60		0.62		0.64		0.66		0.68		0.70	
	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
2.0	0.00212	+31	0.00197	+29	0.00182	+27	0.00169	+26	0.00156	+24	0.00144	+23
2.1	0.00145	21	0.00134	20	0.00124	18	0.00114	17	0.00105	16	0.00096	15
2.2	0.00099	14	0.00091	13	0.00084	13	0.00077	12	0.00071	11	0.00065	10
2.3	0.00068	10	0.00062	9	0.00057	8	0.00052	8	0.00048	7	0.00043	7
2.4	0.00046	7	0.00042	6	0.00039	6	0.00035	5	0.00032	5	0.00029	5
2.5	0.00032	+5	0.00029	+4	0.00026	+4	0.00024	+4	0.00022	+3	0.00020	+3
2.6	0.00022	3	0.00020	3	0.00018	3	0.00016	2	0.00015	2	0.00013	2
2.7	0.00015	2	0.00013	2	0.00012	2	0.00011	2	0.00010	1	0.00009	1
2.8	0.00010	1	0.00009	1	0.00008	1	0.00007	1	0.00007	1	0.00006	1
2.9	0.00007	+1	0.00006	+1	0.00006	+1	0.00005	+1	0.00004	+1	0.00004	+1
3.0	0.00005		0.00004		0.00004		0.00003		0.00003		0.00003	
3.1	0.00003		0.00003		0.00003		0.00002		0.00002		0.00002	
3.2	0.00002		0.00002		0.00002		0.00002		0.00001		0.00001	
3.3	0.00002		0.00001		0.00001		0.00001		0.00001		0.00001	
3.4	0.00001		0.00001		0.00001		0.00001		0.00001		0.00001	
3.5	0.00001		0.00001		0.00001		0.00000		0.00000		0.00000	

TABLE 1d—continued

X/Y	0.72		0.74		0.76		0.78		0.80		0.82	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
2.0	0.00133	+21	0.00122	+20	0.00112	+19	0.00103	+18	0.00095	+17	0.00087	+15
2.1	.00089	14	.00081	13	.00075	12	.00068	12	.00062	11	.00057	10
2.2	.00059	9	.00054	9	.00049	8	.00045	8	.00041	7	.00037	7
2.3	.00040	6	.00036	6	.00033	5	.00030	5	.00027	5	.00025	4
2.4	.00026	+4	.00024	+4	.00022	+4	.00020	+3	.00018	+3	.00016	+3
2.5	0.00018		0.00016		0.00014		0.00013		0.00012		0.00011	
2.6	.00012		.00011		.00010		.00009		.00008		.00007	
2.7	.00008		.00007		.00006		.00006		.00005		.00005	
2.8	.00005		.00005		.00004		.00004		.00003		.00003	
2.9	.00004		.00003		.00003		.00002		.00002		.00002	
3.0	0.00002		0.00002		0.00002		0.00002		0.00001		0.00001	
3.1	.00002		.00001		.00001		.00001		.00001		.00001	
3.2	.00001		.00001		.00001		.00001		.00001		.00001	
3.3	.00001		.00001		.00001		.00000		.00000		.00000	
3.4	.00000		.00000		.00000		.00000		.00000		.00000	
3.5	0.00000		0.00000		0.00000		0.00000		0.00000		0.00000	

X/Y	0.84		0.86		0.88		0.90		0.92		0.94	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
2.0	0.00080	+14	0.00073	+13	0.00067	+13	0.00062	+12	0.00056	+11	0.00051	+10
2.1	.00052	9	.00048	9	.00043	8	.00040	8	.00036	7	.00033	7
2.2	.00034	6	.00031	6	.00028	5	.00026	5	.00023	4	.00021	4
2.3	.00022	4	.00020	4	.00018	3	.00016	3	.00015	3	.00013	3
2.4	.00014	+3	.00013	+2	.00012	+2	.00011	+2	.00010	+2	.00009	+2
2.5	0.00009		0.00008		0.00008		0.00007		0.00006		0.00005	
2.6	.00006		.00006		.00005		.00004		.00004		.00004	
2.7	.00004		.00004		.00003		.00003		.00003		.00002	
2.8	.00003		.00002		.00002		.00002		.00002		.00001	
2.9	.00002		.00002		.00001		.00001		.00001		.00001	
3.0	0.00001		0.00001		0.00001		0.00001		0.00001		0.00001	
3.1	.00001		.00001		.00001		.00000		.00000		.00000	
3.2	.00000		.00000		.00000		.00000		.00000		.00000	
3.3	.00000		.00000		.00000		.00000		.00000		.00000	
3.4	.00000		.00000		.00000		.00000		.00000		.00000	
3.5	0.00000		0.00000		0.00000		0.00000		0.00000		0.00000	

X/Y	0.96		0.98		1.00		1.02		1.04		1.06	
Y	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2	G	δ_m^2
2.0	0.00047	+10	0.00043	+9	0.00039	+8	0.00036	+7	0.00032	+7	0.00030	+7
2.1	.00030	6	.00027	6	.00025	5	.00022	5	.00020	4	.00018	4
2.2	.00019	4	.00017	4	.00016	3	.00014	3	.00013	3	.00011	2
2.3	.00012	2	.00011	2	.00010	2	.00009	2	.00008	2	.00007	2
2.4	.00008	+2	.00007	+1	.00006	+1	.00005	+2	.00005	+1	.00004	+1
2.5	0.00005		0.00004		0.00004		0.00004		0.00003		0.00003	
2.6	.00003		.00003		.00002		.00002		.00002		.00002	
2.7	.00002		.00002		.00002		.00001		.00001		.00001	
2.8	.00001		.00001		.00001		.00001		.00001		.00001	
2.9	.00001		.00001		.00001		.00001		.00000		.00000	
3.0	0.00001		0.00000		0.00000		0.00000		0.00000		0.00000	

TABLE 2

The Interference Upwash due to a Slowly Oscillating Horse-shoe Vortex in a 9 × 7 Section Rectangular Wind Tunnel

w = interference upwash, Γ = circulation, $\sigma = (\text{span of vortex})/(2b)$

Table 2(i). $\text{Re} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.05$. Real part of wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	-0.0017	-0.0017	-0.0016	-0.0016	-0.0016	-0.0015	-0.0015	-0.0014	-0.0013
-0.9	-0.0014	-0.0014	-0.0014	-0.0014	-0.0013	-0.0012	-0.0012	-0.0011	-0.0010
-0.8	-0.0009	-0.0009	-0.0009	-0.0009	-0.0008	-0.0007	-0.0006	-0.0005	-0.0003
-0.7	-0.0001	-0.0001	0.0000	0.0000	0.0001	0.0002	0.0004	0.0005	0.0007
-0.6	0.0014	0.0014	0.0014	0.0015	0.0016	0.0017	0.0019	0.0021	0.0024
-0.5	0.0035	0.0035	0.0036	0.0036	0.0037	0.0039	0.0041	0.0044	0.0049
-0.4	0.0067	0.0067	0.0067	0.0068	0.0068	0.0070	0.0073	0.0077	0.0084
-0.3	0.0111	0.0111	0.0110	0.0110	0.0111	0.0113	0.0116	0.0122	0.0130
-0.2	0.0167	0.0167	0.0166	0.0165	0.0165	0.0166	0.0170	0.0177	0.0189
-0.1	0.0235	0.0234	0.0232	0.0230	0.0229	0.0229	0.0233	0.0242	0.0259
0	0.0309	0.0308	0.0305	0.0301	0.0298	0.0298	0.0302	0.0314	0.0335
0.1	0.0383	0.0382	0.0378	0.0372	0.0368	0.0366	0.0371	0.0384	0.0412
0.2	0.0451	0.0449	0.0444	0.0438	0.0432	0.0429	0.0434	0.0450	0.0481
0.3	0.0507	0.0505	0.0500	0.0492	0.0486	0.0483	0.0488	0.0506	0.0540
0.4	0.0551	0.0549	0.0543	0.0535	0.0528	0.0525	0.0531	0.0550	0.0587
0.5	0.0583	0.0581	0.0575	0.0566	0.0559	0.0556	0.0563	0.0583	0.0622
0.6	0.0605	0.0603	0.0596	0.0588	0.0581	0.0578	0.0585	0.0606	0.0647
0.7	0.0619	0.0617	0.0611	0.0602	0.0595	0.0593	0.0600	0.0622	0.0663
0.8	0.0628	0.0625	0.0619	0.0611	0.0604	0.0602	0.0610	0.0632	0.0674
0.9	0.0633	0.0630	0.0624	0.0616	0.0610	0.0608	0.0616	0.0638	0.0680
1.0	0.0635	0.0633	0.0627	0.0619	0.0612	0.0611	0.0619	0.0641	0.0684

Table 2(ii). $\mu^{-1}\text{Im} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.05$. Factor of μi in wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0033	0.0033	0.0033
-0.9	0.0036	0.0036	0.0036	0.0035	0.0035	0.0035	0.0035	0.0034	0.0034
-0.8	0.0037	0.0037	0.0037	0.0036	0.0036	0.0036	0.0036	0.0035	0.0035
-0.7	0.0037	0.0037	0.0037	0.0037	0.0037	0.0036	0.0036	0.0035	0.0034
-0.6	0.0037	0.0037	0.0037	0.0036	0.0036	0.0035	0.0035	0.0034	0.0033
-0.5	0.0034	0.0034	0.0034	0.0034	0.0033	0.0033	0.0032	0.0031	0.0029
-0.4	0.0029	0.0029	0.0029	0.0029	0.0028	0.0027	0.0026	0.0025	0.0023
-0.3	0.0021	0.0021	0.0020	0.0020	0.0019	0.0018	0.0017	0.0015	0.0012
-0.2	0.0007	0.0007	0.0007	0.0006	0.0006	0.0004	0.0003	0.0000	-0.0004
-0.1	-0.0013	-0.0013	-0.0013	-0.0013	-0.0014	-0.0015	-0.0017	-0.0021	-0.0026
0	-0.0040	-0.0040	-0.0040	-0.0040	-0.0040	-0.0042	-0.0044	-0.0049	-0.0056
0.1	-0.0075	-0.0075	-0.0074	-0.0074	-0.0074	-0.0075	-0.0078	-0.0084	-0.0093
0.2	-0.0117	-0.0116	-0.0115	-0.0114	-0.0114	-0.0115	-0.0118	-0.0125	-0.0138
0.3	-0.0165	-0.0164	-0.0163	-0.0161	-0.0160	-0.0160	-0.0164	-0.0173	-0.0189
0.4	-0.0218	-0.0217	-0.0215	-0.0212	-0.0210	-0.0211	-0.0215	-0.0226	-0.0246
0.5	-0.0275	-0.0274	-0.0271	-0.0268	-0.0265	-0.0265	-0.0270	-0.0283	-0.0306
0.6	-0.0334	-0.0333	-0.0330	-0.0325	-0.0322	-0.0322	-0.0328	-0.0342	-0.0370
0.7	-0.0395	-0.0394	-0.0390	-0.0385	-0.0381	-0.0380	-0.0387	-0.0404	-0.0435
0.8	-0.0458	-0.0456	-0.0452	-0.0446	-0.0441	-0.0440	-0.0447	-0.0466	-0.0502
0.9	-0.0521	-0.0519	-0.0514	-0.0507	-0.0502	-0.0501	-0.0509	-0.0530	-0.0570
1.0	-0.0584	-0.0582	-0.0576	-0.0569	-0.0563	-0.0562	-0.0570	-0.0594	-0.0638

Table 2(iii). $\operatorname{Re} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.10$. Real part of wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	-0.0033	-0.0033	-0.0033	-0.0032	-0.0032	-0.0031	-0.0029	-0.0028	-0.0026
-0.9	-0.0028	-0.0028	-0.0028	-0.0027	-0.0026	-0.0025	-0.0023	-0.0021	-0.0019
-0.8	-0.0018	-0.0018	-0.0018	-0.0017	-0.0016	-0.0014	-0.0012	-0.0009	-0.0006
-0.7	-0.0001	-0.0001	0.0000	0.0001	0.0002	0.0005	0.0008	0.0012	0.0015
-0.6	0.0027	0.0028	0.0028	0.0030	0.0032	0.0034	0.0038	0.0043	0.0049
-0.5	0.0071	0.0071	0.0072	0.0073	0.0075	0.0078	0.0083	0.0090	0.0099
-0.4	0.0134	0.0134	0.0135	0.0136	0.0138	0.0142	0.0148	0.0157	0.0169
-0.3	0.0222	0.0222	0.0221	0.0221	0.0223	0.0227	0.0234	0.0246	0.0264
-0.2	0.0334	0.0334	0.0332	0.0331	0.0331	0.0335	0.0343	0.0359	0.0385
-0.1	0.0469	0.0468	0.0465	0.0461	0.0459	0.0462	0.0471	0.0492	0.0528
0	0.0616	0.0614	0.0610	0.0603	0.0599	0.0600	0.0611	0.0637	0.0684
0.1	0.0764	0.0761	0.0754	0.0746	0.0739	0.0739	0.0751	0.0782	0.0841
0.2	0.0898	0.0895	0.0887	0.0876	0.0867	0.0866	0.0879	0.0916	0.0984
0.3	0.1011	0.1007	0.0998	0.0985	0.0975	0.0974	0.0988	0.1028	0.1105
0.4	0.1098	0.1094	0.1084	0.1071	0.1060	0.1059	0.1075	0.1118	0.1200
0.5	0.1162	0.1158	0.1147	0.1134	0.1123	0.1122	0.1139	0.1185	0.1270
0.6	0.1205	0.1201	0.1191	0.1177	0.1166	0.1166	0.1184	0.1232	0.1320
0.7	0.1233	0.1230	0.1219	0.1206	0.1195	0.1195	0.1215	0.1263	0.1354
0.8	0.1251	0.1247	0.1237	0.1224	0.1214	0.1214	0.1234	0.1284	0.1375
0.9	0.1261	0.1257	0.1247	0.1234	0.1224	0.1225	0.1246	0.1296	0.1388
1.0	0.1266	0.1262	0.1252	0.1239	0.1230	0.1231	0.1252	0.1302	0.1395

Table 2(iv). $\mu^{-1}\text{Im}\left\{\frac{wb}{\Gamma}\right\}$, $\sigma = 0.10$. Factor of μi in wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	0.0068	0.0068	0.0068	0.0068	0.0067	0.0067	0.0067	0.0066	0.0065
-0.9	0.0071	0.0071	0.0071	0.0071	0.0070	0.0070	0.0069	0.0069	0.0068
-0.8	0.0074	0.0074	0.0073	0.0073	0.0072	0.0072	0.0071	0.0070	0.0069
-0.7	0.0075	0.0075	0.0074	0.0074	0.0073	0.0072	0.0071	0.0070	0.0069
-0.6	0.0074	0.0073	0.0073	0.0072	0.0072	0.0071	0.0069	0.0068	0.0066
-0.5	0.0069	0.0069	0.0068	0.0068	0.0067	0.0065	0.0063	0.0061	0.0058
-0.4	0.0059	0.0059	0.0058	0.0057	0.0056	0.0054	0.0052	0.0049	0.0045
-0.3	0.0041	0.0041	0.0040	0.0040	0.0038	0.0036	0.0033	0.0029	0.0024
-0.2	0.0014	0.0013	0.0013	0.0012	0.0011	0.0008	0.0004	-0.0001	-0.0008
-0.1	-0.0026	-0.0026	-0.0027	-0.0027	-0.0029	-0.0032	-0.0036	-0.0044	-0.0054
0	-0.0081	-0.0080	-0.0080	-0.0080	-0.0082	-0.0084	-0.0090	-0.0100	-0.0114
0.1	-0.0150	-0.0149	-0.0149	-0.0148	-0.0149	-0.0152	-0.0158	-0.0171	-0.0191
0.2	-0.0233	-0.0232	-0.0231	-0.0229	-0.0229	-0.0232	-0.0240	-0.0256	-0.0282
0.3	-0.0329	-0.0328	-0.0325	-0.0323	-0.0321	-0.0324	-0.0334	-0.0353	-0.0387
0.4	-0.0434	-0.0433	-0.0430	-0.0425	-0.0423	-0.0426	-0.0437	-0.0461	-0.0502
0.5	-0.0547	-0.0546	-0.0541	-0.0536	-0.0532	-0.0535	-0.0548	-0.0576	-0.0626
0.6	-0.0666	-0.0664	-0.0658	-0.0652	-0.0647	-0.0650	-0.0664	-0.0697	-0.0756
0.7	-0.0788	-0.0785	-0.0779	-0.0771	-0.0765	-0.0768	-0.0784	-0.0822	-0.0890
0.8	-0.0912	-0.0909	-0.0902	-0.0892	-0.0886	-0.0888	-0.0907	-0.0949	-0.1026
0.9	-0.1038	-0.1035	-0.1026	-0.1015	-0.1008	-0.1010	-0.1031	-0.1078	-0.1164
1.0	-0.1164	-0.1160	-0.1151	-0.1139	-0.1130	-0.1133	-0.1156	-0.1208	-0.1303

Table 2(v). $\operatorname{Re} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.15$. Real part of wb/Γ .

η	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	-0.0050	-0.0049	-0.0049	-0.0048	-0.0047	-0.0046	-0.0044	-0.0042	-0.0039
-0.9	-0.0042	-0.0042	-0.0041	-0.0040	-0.0039	-0.0037	-0.0034	-0.0032	-0.0028
-0.8	-0.0027	-0.0027	-0.0026	-0.0025	-0.0023	-0.0020	-0.0017	-0.0013	-0.0009
-0.7	-0.0001	-0.0001	0.0000	0.0002	0.0004	0.0008	0.0012	0.0018	0.0024
-0.6	0.0041	0.0042	0.0043	0.0045	0.0048	0.0052	0.0058	0.0066	0.0075
-0.5	0.0107	0.0107	0.0108	0.0111	0.0114	0.0120	0.0127	0.0138	0.0151
-0.4	0.0202	0.0202	0.0203	0.0205	0.0209	0.0215	0.0225	0.0239	0.0259
-0.3	0.0332	0.0332	0.0332	0.0334	0.0337	0.0344	0.0357	0.0378	0.0405
-0.2	0.0500	0.0499	0.0498	0.0498	0.0501	0.0508	0.0524	0.0551	0.0593
-0.1	0.0700	0.0699	0.0696	0.0694	0.0694	0.0702	0.0721	0.0757	0.0816
0	0.0920	0.0918	0.0913	0.0907	0.0905	0.0912	0.0935	0.0982	0.1062
0.1	0.1139	0.1136	0.1129	0.1121	0.1116	0.1123	0.1150	0.1207	0.1308
0.2	0.1339	0.1336	0.1327	0.1316	0.1310	0.1317	0.1347	0.1413	0.1531
0.3	0.1507	0.1503	0.1493	0.1480	0.1473	0.1481	0.1514	0.1588	0.1719
0.4	0.1637	0.1633	0.1622	0.1609	0.1602	0.1610	0.1646	0.1725	0.1865
0.5	0.1732	0.1728	0.1717	0.1704	0.1696	0.1706	0.1744	0.1827	0.1973
0.6	0.1798	0.1793	0.1782	0.1769	0.1762	0.1772	0.1813	0.1898	0.2049
0.7	0.1840	0.1836	0.1825	0.1812	0.1806	0.1817	0.1859	0.1947	0.2100
0.8	0.1866	0.1862	0.1851	0.1839	0.1834	0.1845	0.1888	0.1977	0.2133
0.9	0.1881	0.1877	0.1866	0.1854	0.1849	0.1862	0.1905	0.1996	0.2152
1.0	0.1889	0.1885	0.1874	0.1862	0.1858	0.1871	0.1915	0.2006	0.2164

Table 2(vi). $\mu^{-1}\text{Im}\left\{\frac{wb}{\Gamma}\right\}$, $\sigma = 0.15$. Factor of μi in wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	0.0102	0.0102	0.0102	0.0102	0.0101	0.0101	0.0100	0.0099	0.0098
-0.9	0.0107	0.0107	0.0106	0.0106	0.0105	0.0105	0.0104	0.0103	0.0102
-0.8	0.0110	0.0110	0.0110	0.0109	0.0109	0.0108	0.0107	0.0105	0.0104
-0.7	0.0112	0.0112	0.0111	0.0111	0.0110	0.0108	0.0107	0.0105	0.0103
-0.6	0.0110	0.0110	0.0109	0.0108	0.0107	0.0105	0.0103	0.0101	0.0098
-0.5	0.0103	0.0103	0.0102	0.0101	0.0099	0.0097	0.0094	0.0091	0.0087
-0.4	0.0088	0.0088	0.0087	0.0085	0.0083	0.0081	0.0077	0.0072	0.0067
-0.3	0.0061	0.0061	0.0060	0.0059	0.0056	0.0053	0.0048	0.0042	0.0034
-0.2	0.0020	0.0020	0.0019	0.0017	0.0015	0.0011	0.0005	-0.0004	-0.0016
-0.1	-0.0040	-0.0040	-0.0040	-0.0042	-0.0045	-0.0050	-0.0058	-0.0069	-0.0086
0	-0.0121	-0.0121	-0.0121	-0.0122	-0.0125	-0.0130	-0.0140	-0.0156	-0.0180
0.1	-0.0224	-0.0223	-0.0223	-0.0223	-0.0226	-0.0232	-0.0245	-0.0266	-0.0298
0.2	-0.0348	-0.0347	-0.0346	-0.0345	-0.0347	-0.0354	-0.0370	-0.0397	-0.0440
0.3	-0.0490	-0.0489	-0.0487	-0.0486	-0.0487	-0.0495	-0.0513	-0.0547	-0.0603
0.4	-0.0648	-0.0647	-0.0643	-0.0640	-0.0641	-0.0649	-0.0671	-0.0713	-0.0783
0.5	-0.0817	-0.0815	-0.0811	-0.0806	-0.0806	-0.0815	-0.0841	-0.0891	-0.0975
0.6	-0.0993	-0.0991	-0.0986	-0.0980	-0.0979	-0.0989	-0.1019	-0.1078	-0.1176
0.7	-0.1175	-0.1173	-0.1166	-0.1159	-0.1158	-0.1169	-0.1203	-0.1270	-0.1384
0.8	-0.1361	-0.1358	-0.1350	-0.1342	-0.1340	-0.1352	-0.1390	-0.1466	-0.1596
0.9	-0.1548	-0.1545	-0.1536	-0.1527	-0.1524	-0.1538	-0.1580	-0.1665	-0.1810
1.0	-0.1737	-0.1733	-0.1723	-0.1713	-0.1709	-0.1725	-0.1771	-0.1865	-0.2026

Table 2(vii). $\operatorname{Re} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.20$. Real part of wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	-0.0066	-0.0066	-0.0065	-0.0064	-0.0062	-0.0060	-0.0058	-0.0055	-0.0052
-0.9	-0.0056	-0.0055	-0.0054	-0.0053	-0.0051	-0.0049	-0.0045	-0.0042	-0.0037
-0.8	-0.0036	-0.0035	-0.0034	-0.0032	-0.0030	-0.0026	-0.0022	-0.0017	-0.0010
-0.7	0.0000	0.0000	0.0002	0.0004	0.0007	0.0012	0.0018	0.0025	0.0034
-0.6	0.0056	0.0057	0.0059	0.0062	0.0066	0.0072	0.0080	0.0090	0.0103
-0.5	0.0143	0.0144	0.0146	0.0150	0.0155	0.0163	0.0174	0.0188	0.0206
-0.4	0.0270	0.0270	0.0272	0.0276	0.0282	0.0292	0.0307	0.0327	0.0355
-0.3	0.0442	0.0443	0.0445	0.0448	0.0455	0.0467	0.0487	0.0516	0.0557
-0.2	0.0665	0.0665	0.0665	0.0668	0.0675	0.0690	0.0716	0.0758	0.0819
-0.1	0.0929	0.0929	0.0928	0.0929	0.0936	0.0953	0.0987	0.1045	0.1136
0	0.1219	0.1218	0.1215	0.1214	0.1221	0.1241	0.1284	0.1360	0.1486
0.1	0.1509	0.1507	0.1502	0.1500	0.1505	0.1528	0.1580	0.1676	0.1836
0.2	0.1773	0.1771	0.1765	0.1761	0.1766	0.1791	0.1851	0.1963	0.2152
0.3	0.1995	0.1993	0.1986	0.1981	0.1986	0.2014	0.2080	0.2204	0.2414
0.4	0.2168	0.2165	0.2158	0.2153	0.2159	0.2189	0.2260	0.2393	0.2717
0.5	0.2294	0.2291	0.2284	0.2279	0.2286	0.2318	0.2393	0.2532	0.2765
0.6	0.2381	0.2378	0.2372	0.2367	0.2375	0.2409	0.2486	0.2630	0.2868
0.7	0.2438	0.2435	0.2429	0.2425	0.2434	0.2469	0.2549	0.2695	0.2938
0.8	0.2473	0.2471	0.2464	0.2461	0.2471	0.2507	0.2589	0.2737	0.2982
0.9	0.2493	0.2491	0.2485	0.2482	0.2492	0.2530	0.2612	0.2762	0.3008
1.0	0.2504	0.2501	0.2495	0.2493	0.2503	0.2542	0.2625	0.2776	0.3023

Table 2(viii). $\mu^{-1}\text{Im}\left\{\frac{wb}{\Gamma}\right\}$, $\sigma = 0.20$. Factor of $i\mu$ in wb/Γ .

$\xi_c \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	0.0136	0.0136	0.0136	0.0135	0.0135	0.0134	0.0133	0.0132	0.0131
-0.9	0.0142	0.0142	0.0142	0.0141	0.0140	0.0139	0.0138	0.0137	0.0135
-0.8	0.0147	0.0147	0.0146	0.0146	0.0145	0.0143	0.0142	0.0140	0.0138
-0.7	0.0149	0.0148	0.0148	0.0147	0.0146	0.0144	0.0142	0.0140	0.0137
-0.6	0.0146	0.0146	0.0145	0.0144	0.0142	0.0140	0.0137	0.0134	0.0130
-0.5	0.0136	0.0136	0.0135	0.0134	0.0132	0.0129	0.0125	0.0120	0.0115
-0.4	0.0116	0.0116	0.0115	0.0113	0.0110	0.0106	0.0101	0.0095	0.0087
-0.3	0.0081	0.0081	0.0079	0.0077	0.0074	0.0069	0.0062	0.0053	0.0042
-0.2	0.0026	0.0026	0.0024	0.0022	0.0017	0.0011	0.0002	-0.0010	-0.0026
-0.1	-0.0053	-0.0054	-0.0055	-0.0058	-0.0063	-0.0071	-0.0083	-0.0100	-0.0124
0	-0.0161	-0.0161	-0.0162	-0.0165	-0.0171	-0.0180	-0.0196	-0.0220	-0.0254
0.1	-0.0297	-0.0297	-0.0298	-0.0301	-0.0307	-0.0319	-0.0339	-0.0372	-0.0421
0.2	-0.0462	-0.0462	-0.0462	-0.0464	-0.0471	-0.0485	-0.0511	-0.0554	-0.0620
0.3	-0.0650	-0.0650	-0.0650	-0.0652	-0.0659	-0.0676	-0.0708	-0.0763	-0.0849
0.4	-0.0859	-0.0858	-0.0857	-0.0859	-0.0866	-0.0886	-0.0926	-0.0993	-0.1101
0.5	-0.1082	-0.1082	-0.1080	-0.1081	-0.1089	-0.1112	-0.1159	-0.1240	-0.1371
0.6	-0.1317	-0.1315	-0.1313	-0.1313	-0.1322	-0.1349	-0.1403	-0.1498	-0.1653
0.7	-0.1558	-0.1556	-0.1553	-0.1553	-0.1563	-0.1593	-0.1655	-0.1765	-0.1943
0.8	-0.1803	-0.1802	-0.1798	-0.1798	-0.1808	-0.1842	-0.1912	-0.2037	-0.2239
0.9	-0.2052	-0.2050	-0.2046	-0.2045	-0.2057	-0.2094	-0.2172	-0.2312	-0.2539
1.0	-0.2302	-0.2300	-0.2295	-0.2294	-0.2307	-0.2347	-0.2434	-0.2589	-0.2841

Table 2(ix). $\operatorname{Re} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.25$. Real part of wb/Γ .

ζ \backslash η	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	-0.0081	-0.0081	-0.0080	-0.0079	-0.0077	-0.0075	-0.0072	-0.0068	-0.0064
-0.9	-0.0068	-0.0068	-0.0067	-0.0065	-0.0063	-0.0059	-0.0055	-0.0051	-0.0045
-0.8	-0.0043	-0.0043	-0.0041	-0.0039	-0.0035	-0.0031	-0.0025	-0.0019	-0.0011
-0.7	0.0001	0.0002	0.0004	0.0007	0.0011	0.0017	0.0025	0.0034	0.0045
-0.6	0.0073	0.0073	0.0076	0.0080	0.0086	0.0094	0.0104	0.0118	0.0133
-0.5	0.0181	0.0182	0.0185	0.0190	0.0198	0.0209	0.0224	0.0243	0.0266
-0.4	0.0339	0.0340	0.0343	0.0349	0.0359	0.0374	0.0395	0.0422	0.0458
-0.3	0.0554	0.0555	0.0559	0.0566	0.0578	0.0598	0.0627	0.0668	0.0724
-0.2	0.0829	0.0830	0.0834	0.0842	0.0857	0.0883	0.0924	0.0984	0.1072
-0.1	0.1157	0.1158	0.1162	0.1170	0.1188	0.1222	0.1278	0.1366	0.1500
0	0.1516	0.1517	0.1520	0.1529	0.1550	0.1592	0.1665	0.1787	0.1978
0.1	0.1875	0.1875	0.1878	0.1887	0.1911	0.1962	0.2053	0.2208	0.2457
0.2	0.2202	0.2203	0.2205	0.2215	0.2242	0.2300	0.2407	0.2590	0.2885
0.3	0.2478	0.2478	0.2481	0.2492	0.2521	0.2585	0.2704	0.2906	0.3233
0.4	0.2693	0.2693	0.2696	0.2708	0.2740	0.2809	0.2936	0.3152	0.3498
0.5	0.2851	0.2851	0.2854	0.2867	0.2901	0.2974	0.3107	0.3331	0.3690
0.6	0.2959	0.2960	0.2964	0.2978	0.3014	0.3089	0.3226	0.3456	0.3823
0.7	0.3031	0.3031	0.3036	0.3051	0.3088	0.3166	0.3306	0.3540	0.3912
0.8	0.3075	0.3076	0.3080	0.3096	0.3135	0.3214	0.3356	0.3593	0.3968
0.9	0.3100	0.3101	0.3106	0.3123	0.3162	0.3242	0.3386	0.3625	0.4002
1.0	0.3113	0.3114	0.3119	0.3136	0.3177	0.3258	0.3403	0.3642	0.4021

Table 2(x). $\mu^{-1}\text{Im} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.25$. Factor of $i\mu$ in wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	0.0170	0.0170	0.0169	0.0169	0.0168	0.0167	0.0166	0.0165	0.0163
-0.9	0.0177	0.0177	0.0177	0.0176	0.0175	0.0174	0.0172	0.0170	0.0169
-0.8	0.0183	0.0183	0.0182	0.0181	0.0180	0.0178	0.0177	0.0174	0.0172
-0.7	0.0185	0.0185	0.0184	0.0183	0.0182	0.0179	0.0177	0.0174	0.0170
-0.6	0.0182	0.0182	0.0181	0.0179	0.0177	0.0174	0.0171	0.0166	0.0162
-0.5	0.0170	0.0169	0.0168	0.0166	0.0163	0.0159	0.0155	0.0149	0.0142
-0.4	0.0144	0.0144	0.0142	0.0139	0.0136	0.0131	0.0124	0.0116	0.0106
-0.3	0.0100	0.0099	0.0097	0.0094	0.0089	0.0082	0.0074	0.0062	0.0048
-0.2	0.0031	0.0030	0.0028	0.0024	0.0018	0.0009	-0.0003	-0.0020	-0.0041
-0.1	-0.0068	-0.0069	-0.0071	-0.0076	-0.0084	-0.0096	-0.0113	-0.0137	-0.0169
0	-0.0201	-0.0202	-0.0205	-0.0211	-0.0221	-0.0236	-0.0260	-0.0294	-0.0343
0.1	-0.0371	-0.0372	-0.0375	-0.0382	-0.0394	-0.0412	-0.0446	-0.0494	-0.0565
0.2	-0.0575	-0.0576	-0.0580	-0.0587	-0.0602	-0.0628	-0.0670	-0.0735	-0.0832
0.3	-0.0810	-0.0811	-0.0814	-0.0823	-0.0840	-0.0872	-0.0926	-0.1010	-0.1139
0.4	-0.1069	-0.1070	-0.1074	-0.1084	-0.1104	-0.1143	-0.1208	-0.1314	-0.1476
0.5	-0.1346	-0.1347	-0.1352	-0.1363	-0.1387	-0.1432	-0.1511	-0.1638	-0.1836
0.6	-0.1637	-0.1638	-0.1643	-0.1655	-0.1683	-0.1736	-0.1828	-0.1978	-0.2212
0.7	-0.1937	-0.1938	-0.1943	-0.1957	-0.1988	-0.2049	-0.2155	-0.2328	-0.2599
0.8	-0.2243	-0.2243	-0.2249	-0.2265	-0.2300	-0.2368	-0.2488	-0.2685	-0.2994
0.9	-0.2551	-0.2553	-0.2559	-0.2576	-0.2615	-0.2691	-0.2825	-0.3046	-0.3392
1.0	-0.2862	-0.2864	-0.2870	-0.2889	-0.2932	-0.3016	-0.3165	-0.3410	-0.3794

Table 2(xi). $\operatorname{Re} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.30$. Real part of wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	-0.0096	-0.0096	-0.0095	-0.0094	-0.0091	-0.0088	-0.0085	-0.0081	-0.0076
-0.9	-0.0081	-0.0080	-0.0079	-0.0077	-0.0074	-0.0070	-0.0065	-0.0059	-0.0053
-0.8	-0.0050	-0.0049	-0.0047	-0.0044	-0.0040	-0.0035	-0.0028	-0.0020	-0.0011
-0.7	0.0004	0.0005	0.0007	0.0011	0.0017	0.0024	0.0034	0.0045	0.0058
-0.6	0.0090	0.0091	0.0094	0.0100	0.0108	0.0118	0.0131	0.0147	0.0166
-0.5	0.0221	0.0222	0.0227	0.0234	0.0245	0.0259	0.0278	0.0302	0.0331
-0.4	0.0410	0.0412	0.0417	0.0427	0.0441	0.0462	0.0489	0.0525	0.0571
-0.3	0.0667	0.0670	0.0676	0.0689	0.0709	0.0738	0.0778	0.0834	0.0907
-0.2	0.0996	0.0999	0.1008	0.1024	0.1050	0.1091	0.1152	0.1238	0.1358
-0.1	0.1387	0.1390	0.1401	0.1421	0.1456	0.1513	0.1600	0.1732	0.1926
0	0.1814	0.1818	0.1830	0.1855	0.1900	0.1975	0.2095	0.2284	0.2574
0.1	0.2241	0.2245	0.2259	0.2289	0.2343	0.2437	0.2590	0.2835	0.3223
0.2	0.2632	0.2636	0.2653	0.2686	0.2749	0.2858	0.3039	0.3329	0.3791
0.3	0.2961	0.2966	0.2984	0.3021	0.3091	0.3212	0.3412	0.3733	0.4241
0.4	0.3218	0.3224	0.3243	0.3283	0.3358	0.3487	0.3701	0.4042	0.4578
0.5	0.3407	0.3413	0.3434	0.3476	0.3555	0.3690	0.3912	0.4265	0.4817
0.6	0.3538	0.3544	0.3566	0.3610	0.3692	0.3831	0.4059	0.4420	0.4982
0.7	0.3624	0.3631	0.3653	0.3699	0.3782	0.3925	0.4157	0.4522	0.5091
0.8	0.3678	0.3685	0.3707	0.3754	0.3839	0.3984	0.4218	0.4587	0.5160
0.9	0.3709	0.3716	0.3739	0.3787	0.3873	0.4019	0.4255	0.4626	0.5201
1.0	0.3725	0.3732	0.3755	0.3803	0.3890	0.4038	0.4275	0.4648	0.5225

Table 2(xii). $\mu^{-1}\text{Im} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.30$. Factor of $i\mu$ in wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	0.0203	0.0203	0.0203	0.0202	0.0201	0.0200	0.0199	0.0197	0.0195
-0.9	0.0212	0.0212	0.0211	0.0211	0.0210	0.0208	0.0206	0.0204	0.0202
-0.8	0.0219	0.0219	0.0218	0.0217	0.0215	0.0213	0.0211	0.0208	0.0205
-0.7	0.0221	0.0221	0.0220	0.0219	0.0217	0.0214	0.0211	0.0207	0.0203
-0.6	0.0217	0.0216	0.0215	0.0214	0.0211	0.0207	0.0203	0.0198	0.0192
-0.5	0.0202	0.0201	0.0200	0.0197	0.0194	0.0189	0.0183	0.0176	0.0168
-0.4	0.0171	0.0170	0.0168	0.0165	0.0160	0.0153	0.0145	0.0136	0.0124
-0.3	0.0117	0.0117	0.0114	0.0110	0.0103	0.0094	0.0083	0.0068	0.0051
-0.2	0.0035	0.0034	0.0030	0.0024	0.0016	0.0003	-0.0013	-0.0034	-0.0062
-0.1	-0.0084	-0.0085	-0.0090	-0.0097	-0.0109	-0.0126	-0.0150	-0.0182	-0.0225
0	-0.0244	-0.0246	-0.0251	-0.0261	-0.0277	-0.0300	-0.0335	-0.0383	-0.0449
0.1	-0.0447	-0.0449	-0.0456	-0.0468	-0.0489	-0.0521	-0.0569	-0.0639	-0.0740
0.2	-0.0691	-0.0693	-0.0702	-0.0717	-0.0744	-0.0786	-0.0851	-0.0948	-0.1091
0.3	-0.0971	-0.0974	-0.0984	-0.1003	-0.1037	-0.1090	-0.1174	-0.1302	-0.1494
0.4	-0.1281	-0.1284	-0.1296	-0.1319	-0.1360	-0.1426	-0.1531	-0.1691	-0.1936
0.5	-0.1612	-0.1616	-0.1630	-0.1658	-0.1706	-0.1786	-0.1912	-0.2107	-0.2406
0.6	-0.1960	-0.1965	-0.1981	-0.2012	-0.2069	-0.2162	-0.2311	-0.2542	-0.2897
0.7	-0.2319	-0.2324	-0.2342	-0.2378	-0.2443	-0.2550	-0.2722	-0.2989	-0.3401
0.8	-0.2684	-0.2690	-0.2710	-0.2751	-0.2824	-0.2946	-0.3141	-0.3445	-0.3914
0.9	-0.3053	-0.3060	-0.3083	-0.3128	-0.3210	-0.3346	-0.3565	-0.3906	-0.4432
1.0	-0.3425	-0.3433	-0.3458	-0.3508	-0.3598	-0.3749	-0.3992	-0.4370	-0.4953

Table 2(xiii). $\operatorname{Re} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.35$. Real part of wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	-0.0111	-0.0110	-0.0109	-0.0107	-0.0105	-0.0102	-0.0098	-0.0093	-0.0088
-0.9	-0.0092	-0.0091	-0.0090	-0.0087	-0.0084	-0.0079	-0.0074	-0.0067	-0.0060
-0.8	-0.0055	-0.0054	-0.0052	-0.0049	-0.0044	-0.0037	-0.0030	-0.0021	-0.0010
-0.7	0.0008	0.0009	0.0012	0.0017	0.0024	0.0033	0.0044	0.0057	0.0072
-0.6	0.0110	0.0111	0.0115	0.0122	0.0132	0.0145	0.0161	0.0180	0.0202
-0.5	0.0264	0.0266	0.0271	0.0281	0.0295	0.0314	0.0337	0.0366	0.0401
-0.4	0.0485	0.0487	0.0495	0.0509	0.0529	0.0556	0.0593	0.0638	0.0693
-0.3	0.0785	0.0789	0.0800	0.0819	0.0848	0.0889	0.0945	0.1018	0.1111
-0.2	0.1169	0.1174	0.1188	0.1215	0.1257	0.1319	0.1405	0.1525	0.1686
-0.1	0.1623	0.1630	0.1650	0.1686	0.1745	0.1835	0.1967	0.2160	0.2440
0	0.2120	0.2128	0.2153	0.2201	0.2280	0.2403	0.2593	0.2882	0.3332
0.1	0.2616	0.2626	0.2657	0.2716	0.2814	0.2972	0.3218	0.3605	0.4223
0.2	0.3071	0.3082	0.3118	0.3187	0.3302	0.3488	0.3780	0.4240	0.4977
0.3	0.3454	0.3467	0.3507	0.3583	0.3711	0.3917	0.4240	0.4747	0.5552
0.4	0.3755	0.3768	0.3811	0.3893	0.4030	0.4250	0.4593	0.5127	0.5970
0.5	0.3976	0.3990	0.4035	0.4121	0.4265	0.4493	0.4848	0.5398	0.6262
0.6	0.4130	0.4144	0.4191	0.4280	0.4428	0.4662	0.5024	0.5584	0.6461
0.7	0.4231	0.4246	0.4294	0.4385	0.4536	0.4773	0.5141	0.5708	0.6591
0.8	0.4295	0.4310	0.4359	0.4451	0.4603	0.4844	0.5215	0.5785	0.6674
0.9	0.4331	0.4347	0.4396	0.4489	0.4643	0.4886	0.5259	0.5832	0.6723
1.0	0.4350	0.4366	0.4416	0.4510	0.4664	0.4908	0.5283	0.5858	0.6751

Table 2(xiv). $\mu^{-1}\text{Im} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.35$. Factor of $i\mu$ in wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
-1.0	0.0236	0.0236	0.0236	0.0235	0.0234	0.0233	0.0231	0.0229	0.0227
-0.9	0.0247	0.0246	0.0246	0.0245	0.0244	0.0242	0.0240	0.0238	0.0235
-0.8	0.0254	0.0254	0.0253	0.0252	0.0250	0.0248	0.0245	0.0242	0.0239
-0.7	0.0257	0.0256	0.0255	0.0254	0.0251	0.0248	0.0245	0.0241	0.0236
-0.6	0.0251	0.0251	0.0249	0.0247	0.0244	0.0240	0.0235	0.0229	0.0223
-0.5	0.0233	0.0232	0.0231	0.0228	0.0223	0.0218	0.0211	0.0202	0.0193
-0.4	0.0196	0.0195	0.0193	0.0189	0.0183	0.0175	0.0165	0.0153	0.0139
-0.3	0.0133	0.0132	0.0129	0.0123	0.0115	0.0103	0.0089	0.0071	0.0050
-0.2	0.0036	0.0035	0.0030	0.0022	0.0010	-0.0006	-0.0028	-0.0055	-0.0088
-0.1	-0.0103	-0.0105	-0.0111	-0.0123	-0.0140	-0.0163	-0.0196	-0.0238	-0.0293
0	-0.0290	-0.0292	-0.0301	-0.0317	-0.0341	-0.0375	-0.0423	-0.0490	-0.0581
0.1	-0.0527	-0.0530	-0.0542	-0.0563	-0.0596	-0.0644	-0.0714	-0.0814	-0.0959
0.2	-0.0811	-0.0816	-0.0831	-0.0858	-0.0902	-0.0968	-0.1065	-0.1208	-0.1417
0.3	-0.1138	-0.1144	-0.1163	-0.1198	-0.1253	-0.1339	-0.1466	-0.1658	-0.1949
0.4	-0.1500	-0.1507	-0.1530	-0.1572	-0.1641	-0.1748	-0.1909	-0.2153	-0.2526
0.5	-0.1887	-0.1895	-0.1923	-0.1974	-0.2056	-0.2186	-0.2382	-0.2680	-0.3138
0.6	-0.2292	-0.2302	-0.2334	-0.2394	-0.2492	-0.2644	-0.2876	-0.3230	-0.3775
0.7	-0.2711	-0.2722	-0.2759	-0.2828	-0.2940	-0.3116	-0.3385	-0.3795	-0.4428
0.8	-0.3137	-0.3150	-0.3192	-0.3270	-0.3397	-0.3597	-0.3903	-0.4370	-0.5092
0.9	-0.3569	-0.3583	-0.3630	-0.3717	-0.3860	-0.4084	-0.4427	-0.4951	-0.5762
1.0	-0.4003	-0.4019	-0.4071	-0.4167	-0.4326	-0.4574	-0.4954	-0.5535	-0.6436

Table 2(xv). $\operatorname{Re} \left\{ \frac{wb}{\Gamma} \right\}$, $\sigma = 0.40$. Real part of wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35
-1.0	-0.0124	-0.0124	-0.0123	-0.0121	-0.0118	-0.0114	-0.0110	-0.0104
-0.9	-0.0102	-0.0102	-0.0100	-0.0097	-0.0093	-0.0088	-0.0081	-0.0074
-0.8	-0.0059	-0.0058	-0.0056	-0.0052	-0.0046	-0.0039	-0.0030	-0.0020
-0.7	0.0015	0.0016	0.0019	0.0025	0.0033	0.0044	0.0057	0.0072
-0.6	0.0132	0.0134	0.0139	0.0148	0.0159	0.0175	0.0194	0.0216
-0.5	0.0310	0.0312	0.0320	0.0332	0.0350	0.0373	0.0402	0.0436
-0.4	0.0565	0.0568	0.0579	0.0598	0.0624	0.0660	0.0705	0.0761
-0.3	0.0910	0.0916	0.0932	0.0959	0.1000	0.1056	0.1129	0.1222
-0.2	0.1351	0.1358	0.1381	0.1422	0.1484	0.1572	0.1692	0.1854
-0.1	0.1872	0.1883	0.1915	0.1974	0.2065	0.2200	0.2394	0.2675
0	0.2441	0.2455	0.2499	0.2578	0.2705	0.2898	0.3190	0.3641
0.1	0.3010	0.3028	0.3082	0.3182	0.3344	0.3596	0.3986	0.4607
0.2	0.3532	0.3552	0.3616	0.3734	0.3925	0.4224	0.4689	0.5428
0.3	0.3972	0.3995	0.4066	0.4197	0.4409	0.4740	0.5252	0.6060
0.4	0.4318	0.4342	0.4418	0.4558	0.4785	0.5136	0.5676	0.6521
0.5	0.4573	0.4598	0.4678	0.4824	0.5059	0.5422	0.5979	0.6845
0.6	0.4750	0.4776	0.4858	0.5008	0.5250	0.5621	0.6187	0.7066
0.7	0.4867	0.4894	0.4978	0.5131	0.5376	0.5752	0.6324	0.7210
0.8	0.4941	0.4968	0.5053	0.5208	0.5455	0.5834	0.6411	0.7301
0.9	0.4985	0.5012	0.5097	0.5253	0.5502	0.5883	0.6462	0.7356
1.0	0.5007	0.5034	0.5120	0.5277	0.5527	0.5910	0.6490	0.7386

Table 2(xvi). $\mu^{-1}\text{Im}\left\{\frac{wb}{\Gamma}\right\}$, $\sigma = 0.40$. Factor of $i\mu$ in wb/Γ .

$\xi \backslash \eta$	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35
-1.0	0.0269	0.0269	0.0269	0.0268	0.0267	0.0265	0.0264	0.0262
-0.9	0.0281	0.0280	0.0280	0.0279	0.0277	0.0275	0.0273	0.0270
-0.8	0.0289	0.0289	0.0288	0.0286	0.0284	0.0282	0.0279	0.0275
-0.7	0.0292	0.0291	0.0290	0.0288	0.0286	0.0282	0.0278	0.0273
-0.6	0.0285	0.0284	0.0283	0.0280	0.0276	0.0272	0.0266	0.0259
-0.5	0.0263	0.0262	0.0260	0.0257	0.0251	0.0245	0.0237	0.0228
-0.4	0.0220	0.0219	0.0216	0.0211	0.0204	0.0194	0.0182	0.0169
-0.3	0.0147	0.0146	0.0141	0.0134	0.0123	0.0109	0.0092	0.0071
-0.2	0.0035	0.0033	0.0026	0.0016	0.0000	-0.0021	-0.0048	-0.0081
-0.1	-0.0126	-0.0129	-0.0138	-0.0154	-0.0177	-0.0209	-0.0251	-0.0306
0	-0.0341	-0.0345	-0.0358	-0.0381	-0.0415	-0.0463	-0.0530	-0.0621
0.1	-0.0614	-0.0620	-0.0638	-0.0669	-0.0718	-0.0788	-0.0889	-0.1034
0.2	-0.0942	-0.0949	-0.0973	-0.1016	-0.1082	-0.1180	-0.1324	-0.1534
0.3	-0.1318	-0.1327	-0.1358	-0.1413	-0.1500	-0.1629	-0.1822	-0.2114
0.4	-0.1733	-0.1745	-0.1783	-0.1852	-0.1960	-0.2124	-0.2370	-0.2744
0.5	-0.2178	-0.2193	-0.2238	-0.2321	-0.2453	-0.2653	-0.2954	-0.3413
0.6	-0.2645	-0.2662	-0.2716	-0.2814	-0.2969	-0.3206	-0.3562	-0.4110
0.7	-0.3126	-0.3146	-0.3208	-0.3321	-0.3501	-0.3775	-0.4189	-0.4824
0.8	-0.3617	-0.3639	-0.3710	-0.3838	-0.4043	-0.4354	-0.4826	-0.5550
0.9	-0.4113	-0.4139	-0.4218	-0.4362	-0.4591	-0.4941	-0.5470	-0.6283
1.0	-0.4613	-0.4641	-0.4729	-0.4888	-0.5142	-0.5530	-0.6118	-0.7020

TABLE 3

Effect of Frequency on the Interference Upwash due to a Horse-shoe Vortex in a 9×7 Section Wind Tunnel. $\sigma = 0.2, \eta = 0$

Table 3(i). $\text{Re} \left\{ \frac{wb}{\Gamma} \right\}$.

ξ	$\mu = 0$	$\mu = 0.4$	$\mu = 0.8$	$\mu = 1.2$	$\mu = 1.6$	$\mu = 2.0$
-1.0	-0.0066	-0.0046	-0.0025	-0.0009	+0.0001	+0.0008
-0.9	-0.0056	-0.0035	-0.0012	+0.0005	+0.0016	+0.0023
-0.8	-0.0036	-0.0013	+0.0012	+0.0030	+0.0041	+0.0048
-0.7	0.0000	+0.0023	+0.0050	+0.0069	+0.0080	+0.0085
-0.6	+0.0056	+0.0081	+0.0109	+0.0129	+0.0138	+0.0141
-0.5	+0.0143	+0.0169	+0.0199	+0.0217	+0.0223	+0.0221
-0.4	+0.0270	+0.0296	+0.0325	+0.0341	+0.0342	+0.0331
-0.3	+0.0442	+0.0470	+0.0497	+0.0507	+0.0498	+0.0475
-0.2	+0.0665	+0.0691	+0.0715	+0.0714	+0.0691	+0.0649
-0.1	+0.0929	+0.0955	+0.0970	+0.0954	+0.0908	+0.0839
0	+0.1219	+0.1241	+0.1245	+0.1206	+0.1127	+0.1021
+0.1	+0.1509	+0.1526	+0.1511	+0.1439	+0.1318	+0.1162
+0.2	+0.1773	+0.1784	+0.1743	+0.1628	+0.1450	+0.1232
+0.3	+0.1995	+0.1995	+0.1921	+0.1750	+0.1502	+0.1211
+0.4	+0.2168	+0.2155	+0.2037	+0.1798	+0.1467	+0.1092
+0.5	+0.2294	+0.2264	+0.2094	+0.1773	+0.1347	+0.0883
+0.6	+0.2381	+0.2330	+0.2098	+0.1684	+0.1155	+0.0599
+0.7	+0.2438	+0.2363	+0.2059	+0.1540	+0.0902	+0.0262
+0.8	+0.2473	+0.2370	+0.1985	+0.1353	+0.0605	-0.0107
+0.9	+0.2493	+0.2358	+0.1883	+0.1131	+0.0278	-0.0487
+1.0	+0.2504	+0.2333	+0.1759	+0.0883	-0.0067	-0.0858

Table 3(ii). $\text{Im} \left\{ \frac{wb}{\Gamma} \right\}$.

ξ	$\mu = 0$	$\mu = 0.4$	$\mu = 0.8$	$\mu = 1.2$	$\mu = 1.6$	$\mu = 2.0$
-1.0	0	+0.0031	+0.0038	+0.0037	+0.0033	+0.0027
-0.9	0	+0.0032	+0.0040	+0.0038	+0.0032	+0.0024
-0.8	0	+0.0033	+0.0040	+0.0036	+0.0027	+0.0017
-0.7	0	+0.0033	+0.0038	+0.0030	+0.0018	+0.0004
-0.6	0	+0.0031	+0.0031	+0.0018	0.0000	-0.0018
-0.5	0	+0.0026	+0.0019	-0.0002	-0.0028	-0.0054
-0.4	0	+0.0017	-0.0001	-0.0035	-0.0073	-0.0108
-0.3	0	+0.0002	-0.0034	-0.0086	-0.0140	-0.0188
-0.2	0	-0.0021	-0.0082	-0.0158	-0.0234	-0.0300
-0.1	0	-0.0054	-0.0149	-0.0258	-0.0362	-0.0449
0	0	-0.0098	-0.0238	-0.0388	-0.0525	-0.0635
+0.1	0	-0.0153	-0.0348	-0.0547	-0.0721	-0.0855
+0.2	0	-0.0219	-0.0479	-0.0732	-0.0943	-0.1095
+0.3	0	-0.0295	-0.0626	-0.0935	-0.1181	-0.1341
+0.4	0	-0.0378	-0.0784	-0.1149	-0.1419	-0.1573
+0.5	0	-0.0467	-0.0950	-0.1363	-0.1645	-0.1772
+0.6	0	-0.0559	-0.1118	-0.1572	-0.1846	-0.1921
+0.7	0	-0.0653	-0.1284	-0.1765	-0.2012	-0.2008
+0.8	0	-0.0748	-0.1446	-0.1939	-0.2133	-0.2024
+0.9	0	-0.0842	-0.1601	-0.2089	-0.2204	-0.1964
+1.0	0	-0.0936	-0.1747	-0.2210	-0.2221	-0.1830

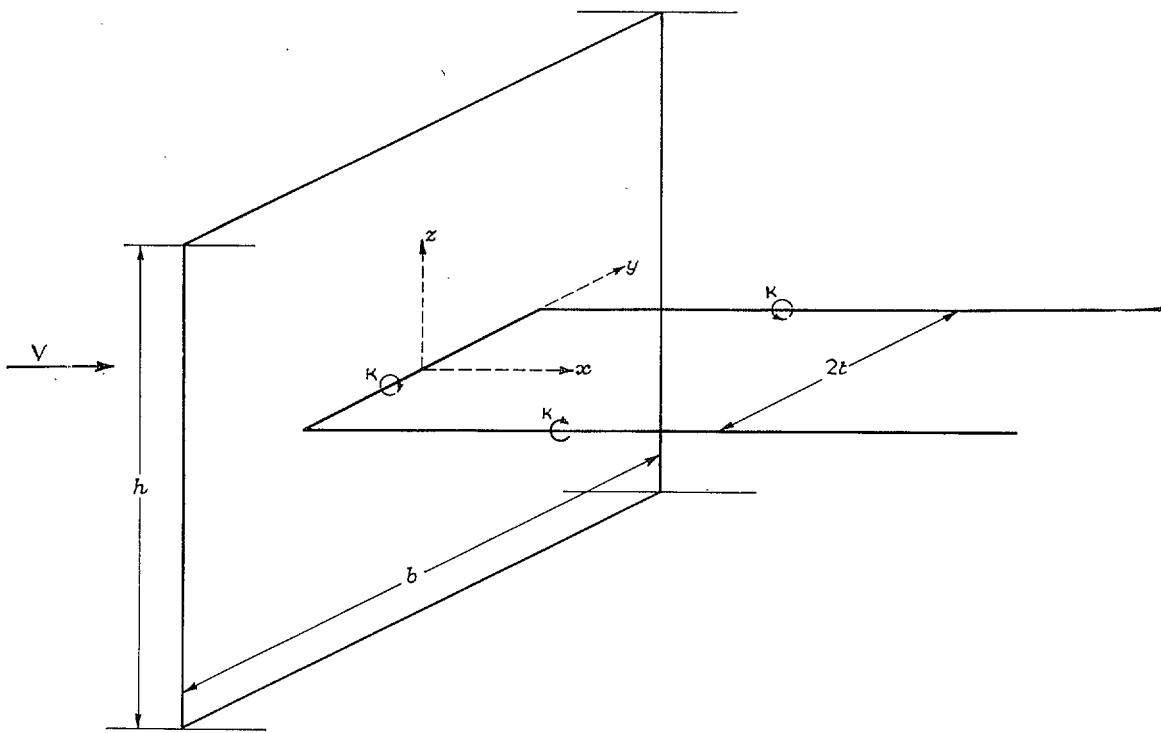


FIG. 1. Horse-shoe vortex in rectangular tunnel.

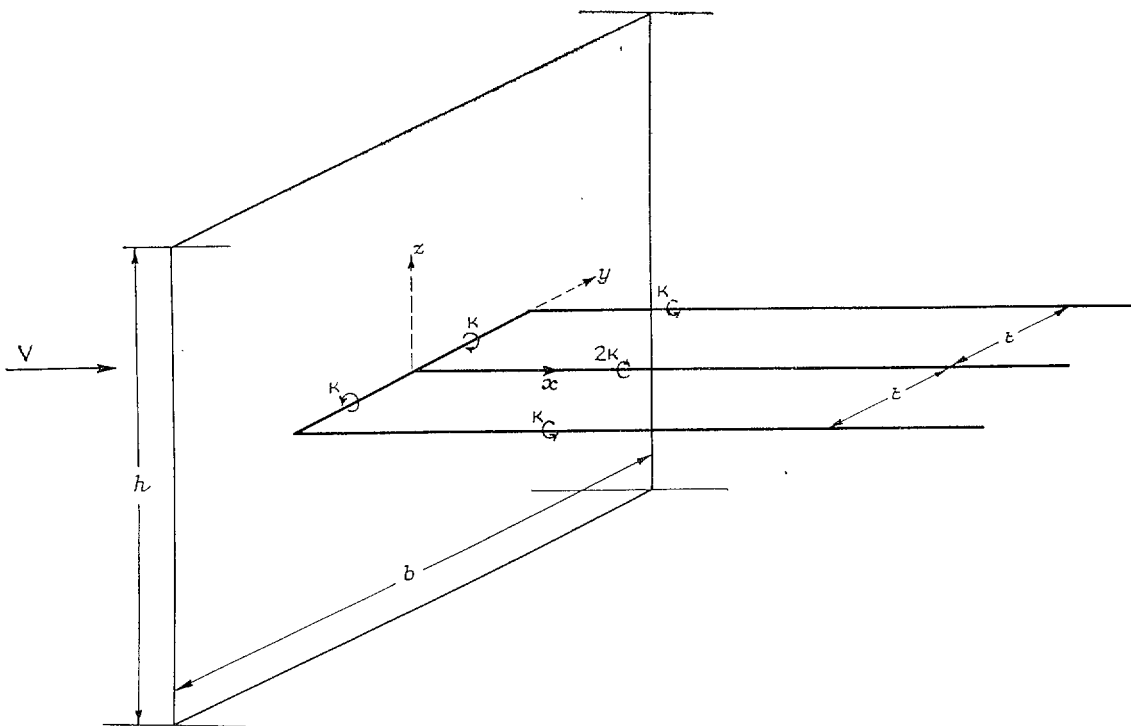


FIG. 2. Antisymmetrical horse-shoe vortices in rectangular tunnel.

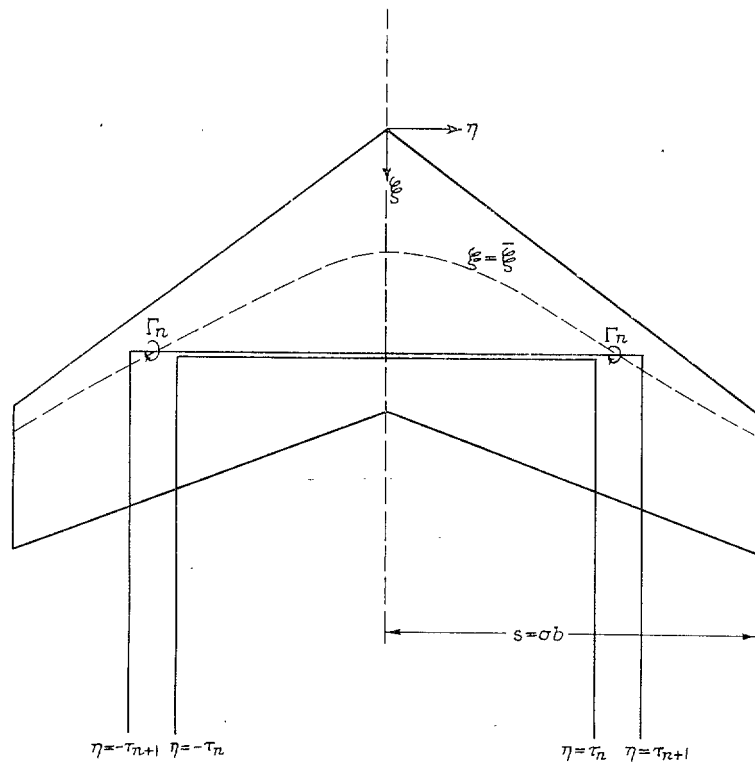


FIG. 3. The distribution of vorticity on a typical wing.

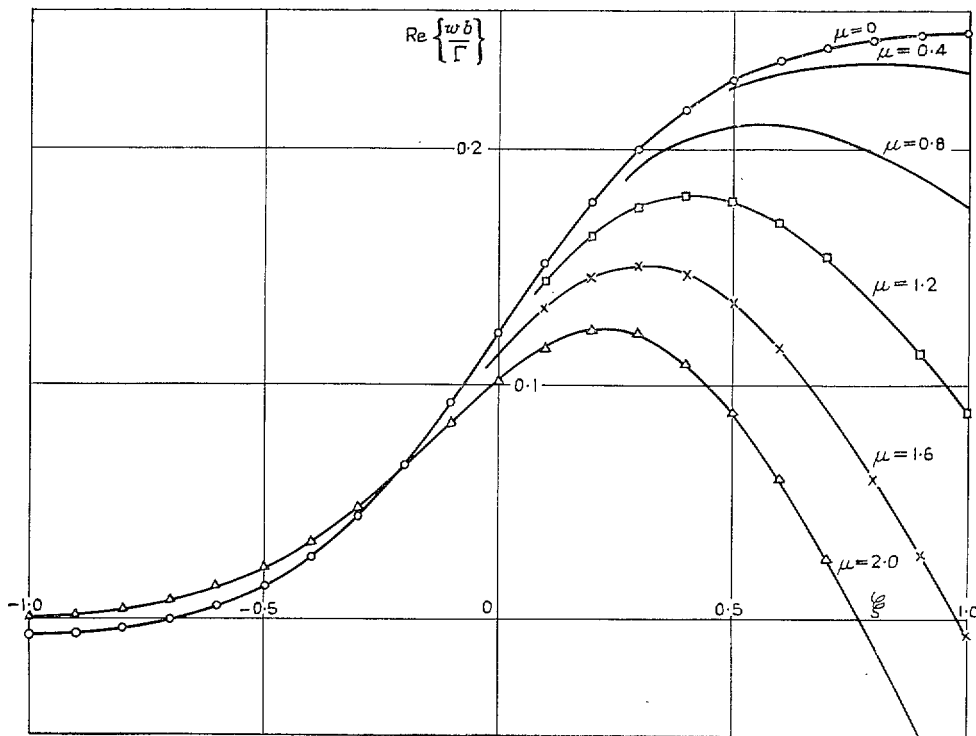


FIG. 4. Effect of frequency on the upwash due a horse-shoe vortex in a 9×7 section wing tunnel; $\sigma = 0.2$, $\eta = 0$.

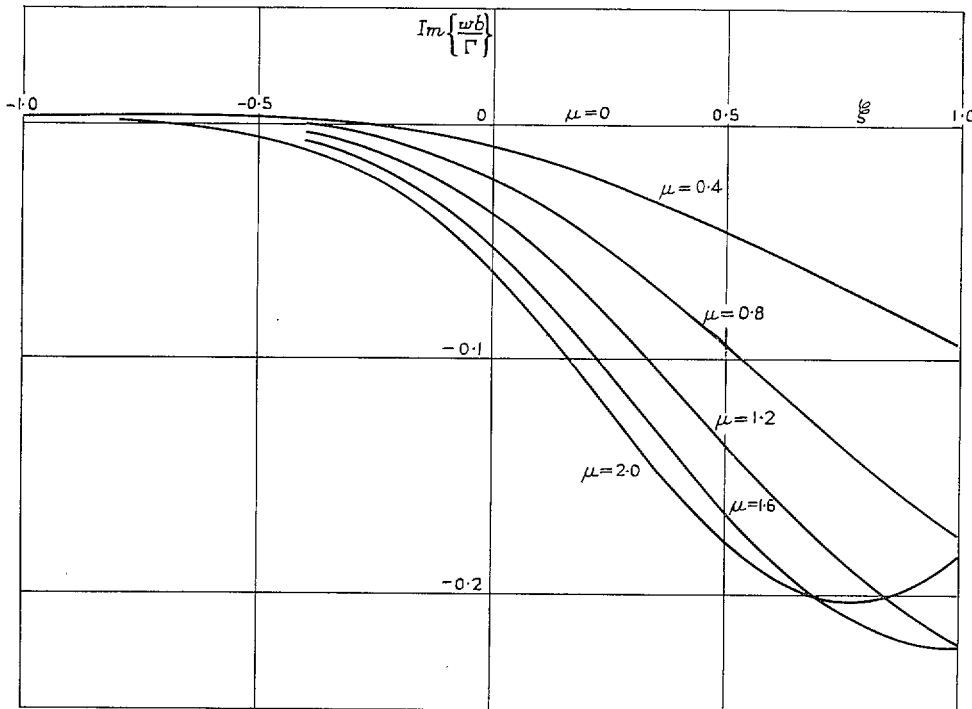


FIG. 5. Effect of frequency on the upwash due to a horse-shoe vortex in a 9×7 section wind tunnel; $\sigma = 0.2$, $\eta = 0$.

Part II

Applications to a Delta Planform in a 9×7 Tunnel

1. Introduction.

Part II contains an application of the method proposed in Part I to a cropped delta wing of aspect ratio 1.8. All the computation applies to incompressible flow in a 9×7 rectangular tunnel. In Section 2 the formulae necessary for the calculations are quoted or derived, and in Section 3 they are used for three ratios of wing span to tunnel breadth on the assumption that the frequency is small. The wing is assumed to be pitching or to have a full-span trailing-edge flap which is oscillating. Some calculations for the wing in pitching or heaving motion at a higher frequency are described in Section 4. In conclusion Section 5 contains a brief discussion of computability and accuracy.

2. The Calculation of Circulation and Interference Upwash.

Consider a wing oscillating in such a way that it always lies close to the plane $z = 0$. It will be assumed that the lift distribution, $l(x, y)$, has been determined to an accuracy sufficient for tunnel-interference calculations. As extensive pressure plotting of oscillating wings is not usually undertaken at present these values of l will normally have to be found theoretically. Linearized lifting-surface theories such as those of Refs. 1, 2 and 3 provide ways of doing this.

The circulation, Γ , at any section $y = \text{constant}$ may be obtained from l . According to linearized theory

$$p - p_\infty = -\rho(V\phi_x + i\omega\phi),$$

and for thin wings the velocity potential on the upper and lower surfaces satisfies $\phi_a = -\phi_b$. It follows that

$$\frac{1}{2}\rho V^2 l = p_b - p_a = 2\rho(V\partial\phi_a/\partial x + i\omega\phi_a). \quad (1)$$

Thus

$$\begin{aligned} \int_{x_l}^{x_t} (p_b - p_a) \exp(i\omega x/V) dx &= 2\rho V \int_{x_l}^{x_t} \exp(i\omega x/V) (\partial\phi_a/\partial x + i\omega\phi_a/V) dx \\ &= 2\rho V(\phi_a)_t \exp(i\omega x_t/V), \quad \{\text{since } (\phi_a)_l = 0\}. \end{aligned}$$

Hence

$$\Gamma = 2(\phi_a)_t = \frac{1}{2}V \int_{x_l}^{x_t} l \exp\left[\frac{i\omega(x-x_l)}{V}\right] dx. \quad (2)$$

Let

$$l = l_r + il_i, \quad (3)$$

where l_r and l_i are real. Then the corresponding circulations are

$$\frac{\Gamma_r}{Vb} = \frac{1}{2b} \int_{x_l}^{x_t} l_r \exp\left[\frac{i\omega(x-x_l)}{V}\right] dx, \quad (4)$$

and

$$\frac{\Gamma_i}{Vb} = \frac{1}{2b} \int_{x_l}^{x_t} l_i \exp\left[\frac{i\omega(x-x_l)}{V}\right] dx. \quad (5)$$

These complex circulations are connected with the quantities $\bar{x}_r(y)$ and $\bar{x}_i(y)$ which give the positions of the centre-of-pressure loci corresponding to l_r and l_i and are determined by straightforward integration.

The interference upwash for symmetrical loading may now be calculated. By equation (21) of Part I

$$\frac{\partial \delta}{\partial \tau}(\xi, \eta; \tau, 0) = F_2(\xi, \eta - \tau) + F_2(\xi, \eta + \tau)$$

where F_2 is defined by equations (22) and (24) of Part I. Hence by equation (20) of Part I

$$\begin{aligned} \frac{\partial \delta}{\partial \tau}(\xi, \eta; \tau, \mu) &= \frac{\partial \delta}{\partial \tau}(\xi, \eta; \tau, 0) - i\mu e^{-i\mu\xi} \int_{-\infty}^{\xi} e^{i\mu\theta} \frac{\partial \delta}{\partial \tau}(\theta, \eta; \tau, \theta) d\theta \\ &= \bar{G}(\xi, \eta - \tau) + \bar{G}(\xi, \eta + \tau), \end{aligned} \quad (6)$$

where

$$\bar{G}(\xi, \lambda) = F_2(\xi, \lambda) - i\mu e^{-i\mu\xi} \int_{-\infty}^{\xi} e^{i\mu\theta} F_2(\theta, \lambda) d\theta. \quad (7)$$

Since $-\frac{1}{2} < \tau < \frac{1}{2}$ and $-\frac{1}{2} < \eta < \frac{1}{2}$, F_2 and G are required for $0 \leq \lambda < 1$ since they are even functions of λ . As $\xi \rightarrow -\infty$, $F_2 = O(\xi^{-2})$ so that the infinite integral in (7) is convergent. Then the part of the interference due to Γ_r is w_I , given by

$$\frac{w_I}{V} = \int_0^\sigma \frac{\Gamma_r(\tau)}{Vb} \{ \bar{G}(\xi - \bar{\xi}_r(\tau), \eta - \tau) + \bar{G}(\xi - \bar{\xi}_r(\tau), \eta + \tau) \} d\tau, \quad (8)$$

and similarly the part due to Γ_i is

$$\frac{w_{II}}{V} = \int_0^\sigma \frac{\Gamma_i(\tau)}{Vb} \{ \bar{G}(\xi - \bar{\xi}_i(\tau), \eta - \tau) + \bar{G}(\xi - \bar{\xi}_i(\tau), \eta + \tau) \} d\tau, \quad (9)$$

and the total interference upwash is

$$\frac{w}{V} = \frac{w_I + iw_{II}}{V}. \quad (10)$$

The assumption that the vorticity may be regarded as concentrated on the curves $\xi = \bar{\xi}_r(\eta)$ and $\xi = \bar{\xi}_i(\eta)$ may be a cause of significant error for wings of large streamwise extent. In order to obtain a more accurate expression consider the velocity potential, ϕ_a , on the upper surface of a symmetrically oscillating wing. Divide the wing by a number of lines, $y = \text{constant}$, into a number of streamwise strips. Consider first the symmetrical pair of strips $-(t + \delta t) < y < -t$ and $t < y < t + \delta t$, and assume that δt is sufficiently small for the variation of ϕ_a with y to be neglected. By symmetry the variation of ϕ_a with x is the same in each strip.

For an oscillating horse-shoe vortex of span $2t$ with its finite part on the line $x = 0$

$$\left. \begin{aligned} &\text{if } |y| > t, \quad \phi_a = 0 \\ &\text{if } |y| < t, \quad \phi_a = \frac{1}{2} \bar{K} e^{i\omega t} \psi_0(x), \end{aligned} \right\} \quad (11)$$

where

$$\left. \begin{aligned} \psi_0(x) &= 0 && \text{for } x < 0 \\ \psi_0(x) &= \exp\left(\frac{-i\omega x}{V}\right) && \text{for } x > 0 \end{aligned} \right\}. \quad (12)$$

Now suppose $\phi_a(x, t)$ can be expressed as the weighted sum of the corresponding potentials for a distribution of horse-shoe vortices, so that a function \bar{K} exists such that

$$\phi_a(x, t) = \int_{-\infty}^{+\infty} \frac{1}{2} \bar{K}(x', t) e^{i\omega T} \psi_0(x-x') dx'. \quad (13)$$

Then, since the interference upwash corresponding to a vortex described by equations (11) and (12) is given by

$$\frac{w}{V} = \frac{\bar{K}}{Vb} e^{i\omega T} \delta \left(\frac{x}{b}, \frac{y}{b}; \frac{t}{b}, \frac{\omega b}{V} \right),$$

(Part I, Section 3) the upwash due to the symmetrical pair of strips is

$$\begin{aligned} \frac{w}{V} &= \int_{-\infty}^{+\infty} \frac{\bar{K}(x', t)}{Vb} e^{i\omega T} \left[\delta \left(\frac{x-x'}{b}, \frac{y}{b}; \frac{t+\delta t}{b}, \frac{\omega b}{V} \right) - \right. \\ &\quad \left. - \delta \left(\frac{x-x'}{b}, \frac{y}{b}; \frac{t}{b}, \frac{\omega b}{V} \right) \right] dx' \\ &= \int_{-\infty}^{+\infty} \frac{\bar{K}(x', t)}{Vb} e^{i\omega T} \frac{\partial \delta}{\partial t} \left(\frac{x-x'}{b}, \frac{y}{b}; \frac{t}{b}, \frac{\omega b}{V} \right) \delta t dx' \end{aligned}$$

to the first order in δt .

The interference due to the whole wing is then obtained by integrating with respect to t :

$$\frac{w}{V} = \int_{t=0}^s \int_{-\infty}^{+\infty} \frac{\bar{K}(x', t)}{Vb} e^{i\omega T} \frac{\partial \delta}{\partial t} \left(\frac{x-x'}{b}, \frac{y}{b}; \frac{t}{b}, \frac{\omega b}{V} \right) dx' dt. \quad (14)$$

It remains to determine \bar{K} to satisfy equation (13). Since $\psi_0(x-x') \equiv 0$ for $x' > x$, the upper limit may be replaced by x . Then (13) becomes

$$\phi_a(x, t) = \int_{-\infty}^x \frac{1}{2} \bar{K}(x', t) e^{i\omega T} \exp \left(\frac{i\omega(x'-x)}{V} \right) dx'.$$

By differentiation

$$\frac{1}{2} \bar{K}(x, t) e^{i\omega T} = \frac{\partial \phi_a}{\partial x} + \frac{i\omega}{V} \phi_a$$

and hence by equation (1) $\bar{K} = \frac{1}{2} V l(x, t) e^{-i\omega T}$.

Substitution in (14) gives

$$\begin{aligned} \frac{w}{V} &= \int_{t=0}^s \int_{x_l}^{x_t} \frac{l(x', t)}{2b} \frac{\partial \delta}{\partial t} \left(\frac{x-x'}{b}, \frac{y}{b}; \frac{t}{b}, \frac{\omega b}{V} \right) dx' dt \\ &= \int_{\tau=0}^{\sigma} \int_{\xi_l}^{\xi_t} \frac{1}{2} l(\xi', \tau) \{ \bar{G}(\xi - \xi', \eta - \tau) + \bar{G}(\xi - \xi', \eta + \tau) \} d\xi' d\tau \end{aligned} \quad (15)$$

by (6).

Evidently an alternative approximation to (8) and (9) would be to replace Γ_r/Vb and Γ_i/Vb by $\frac{1}{2} \dot{l}_r$ and $\frac{1}{2} \dot{l}_i$ respectively and to use mean values $\xi' = \bar{\xi}_r(\tau)$ and $\xi' = \bar{\xi}_i(\tau)$ in the functions \bar{G} :

$$\frac{w_I}{V} = \int_{\tau=0}^{\sigma} \left\{ \int_{\xi_l}^{\xi_t} \frac{1}{2} \dot{l}_r(\xi', \tau) d\xi' \right\} \{ \bar{G}(\xi - \bar{\xi}_r(\tau), \eta + \tau) + \bar{G}(\xi - \bar{\xi}_r(\tau), \eta - \tau) \} d\tau \quad (16)$$

and

$$\frac{w_{II}}{V} = \int_{\tau=0}^{\sigma} \left\{ \int_{\xi_l}^{\xi_t} \frac{1}{2} \dot{l}_i(\xi', \tau) d\xi' \right\} \{ \bar{G}(\xi - \bar{\xi}_i(\tau), \eta + \tau) + \bar{G}(\xi - \bar{\xi}_i(\tau), \eta - \tau) \} d\tau. \quad (17)$$

The relative merits of the approximations in (8) and (9) as compared with those in (16) and (17) could only be assessed by evaluating (15) in representative cases. In the present calculations (8) and

(9) were mostly used. In the low-frequency case additional calculations using (16) and (17) gave results which were little different. (*See* Table 1.) However, such agreement is not to be expected for high frequency; indeed either approximation may then be erroneous.

When the chord is small the two approximations tend to equality. For the limiting case of a horse-shoe vortex of span $2s$ and strength $\bar{K}e^{i\omega T}$ on the line $\xi = 0$, $\bar{\xi}_r \equiv \bar{\xi}_i \equiv 0$, $\Gamma_r = \bar{K}e^{i\omega T}$, $\Gamma_i = 0$. Hence

$$\frac{w}{b} = \frac{\bar{K}e^{i\omega T}}{Vb} \int_0^\sigma [\bar{G}(\xi, \eta - \tau) + \bar{G}(\xi, \eta + \tau)] d\tau, \quad (18)$$

which may be useful in estimating the order of magnitude of interference effects.

3. The Low-frequency Case.

This section describes the calculation of the tunnel interference for the cropped delta wing shown in Fig. 1, when it is oscillating at a low frequency in a tunnel of breadth to height ratio 9/7.

It is first necessary to assume some distribution of lift, l . For the present purpose this was taken to be the free-stream distribution as given by the theory of Ref. 1, which was known from previous calculations. In this method the load distribution is obtained as

$$l = \frac{8se^{i\omega T}}{\pi c(y)} \{ \bar{\gamma}(y) \cot \frac{1}{2}\bar{\theta} + 4\bar{\mu}(y) [\cot \frac{1}{2}\bar{\theta} - 2 \sin \bar{\theta}] + \bar{\kappa}(y) [\cot \frac{1}{2}\bar{\theta} - 2 \sin \bar{\theta} - 2 \sin 2\bar{\theta}] + \dots \}, \quad (19)$$

where $\bar{\theta}$ is the angular chordwise co-ordinate defined by

$$x = x_i(y) + \frac{1}{2}c(y)(1 - \cos \bar{\theta}), \quad (20)$$

and $\bar{\gamma}(y)$, $\bar{\mu}(y)$, $\bar{\kappa}(y)$, \dots are complex functions known for certain values of y in the wing span $-s < y < s$. Of course $\bar{\gamma}$, $\bar{\mu}$, $\bar{\kappa}$, \dots are also functions of the frequency parameter ν but, provided $\nu^2 \log \nu$ is small, they may be expressed in the form

$$\left. \begin{aligned} \bar{\gamma} &= \bar{\gamma}_1 + i\nu(\bar{\gamma}_2 + \bar{\gamma}_3) \\ \bar{\mu} &= \bar{\mu}_1 + i\nu(\bar{\mu}_2 + \bar{\mu}_3) \\ \bar{\kappa} &= \bar{\kappa}_1 + i\nu(\bar{\kappa}_2 + \bar{\kappa}_3) \end{aligned} \right\}, \quad (21)$$

where $\bar{\gamma}_1, \dots, \bar{\kappa}_3$ are all real functions of y .

The method of calculation adopted below is such that the tunnel-induced lift and pitching moment, ΔC_L and ΔC_m , are proportional to l . Together with the mode of application outlined in Part I, leading to $(\Delta\alpha)_m/C'_L$ and the residual correction to pitching moment, this means that an arbitrary factor in l is permissible. The shape of the distribution alone is important as the appropriate size is determined by the measured C'_L .

When equations (21) are substituted into equation (4) and terms of order μ^2 are neglected it follows that

$$\frac{\Gamma_r}{Vb} = (\Gamma_0 + i\mu\Gamma_1)e^{i\omega T} \quad (22)$$

where

$$\Gamma_0 = 2\sigma\bar{\gamma}_1$$

and

$$\Gamma_1 = -\sigma \frac{c(y)}{b} \left(\frac{3}{2}\bar{\gamma}_1 + 2\bar{\mu}_1 \right). \quad (23)$$

Similarly from equation (5)

$$\frac{\Gamma_i}{Vb} = i\mu\Gamma_2^{-i\omega T}, \quad (24)$$

where

$$\Gamma_2 = 2\sigma \frac{\bar{c}}{b} (\bar{\gamma}_2 + \bar{\gamma}_3). \quad (25)$$

The centre-of-pressure loci follow by simple integration.

$$\text{and } \left. \begin{aligned} \bar{\xi}_r(\eta) &= \frac{x_l}{b} + \frac{c(\eta)}{b} \left(\frac{1}{4} - \frac{\mu_1}{\gamma_1} \right) \\ \bar{\xi}_i(\eta) &= \frac{x_l}{b} + \frac{c(\eta)}{b} \left(\frac{1}{4} - \frac{\bar{\mu}_2 + \bar{\mu}_3}{\bar{\gamma}_2 + \bar{\gamma}_3} \right) \end{aligned} \right\}, \quad (26)$$

except at kinks in the leading or trailing edges, where these formulae have to be modified as described in Ref. 1.

When μ^2 is negligible, equation (7) becomes

$$\bar{G}(\xi, \lambda) = F_2(\xi, \lambda) - i\mu \int_{-\infty}^{\xi} F_2(\theta, \lambda) d\theta. \quad (27)$$

Equations (22) to (25) and (27) may now be used to reduce (9) and (10) to the forms

$$\begin{aligned} \frac{w_I}{V} &= e^{i\omega T} \int_0^{\sigma} \Gamma_0 [F_2(\xi - \bar{\xi}_r(\tau), \eta - \tau) + F_2(\xi - \bar{\xi}_r(\tau), \eta + \tau)] d\tau + \\ &+ i\mu e^{i\omega T} \int_0^{\sigma} \{ \Gamma_1 [F_2(\xi - \bar{\xi}_r(\tau), \eta - \tau) + F_2(\xi - \bar{\xi}_r(\tau), \eta + \tau)] - \\ &- \Gamma_0 \int_{-\infty}^{\xi - \bar{\xi}_r(\tau)} [F_2(\theta, \eta - \tau) + F_2(\theta, \eta + \tau)] d\theta \} d\tau \end{aligned} \quad (28)$$

and

$$\frac{w_{II}}{V} = \mu e^{i\omega T} \int_0^{\sigma} \Gamma_2 [F_2(\xi - \bar{\xi}_i(\tau), \eta - \tau) + F_2(\xi - \bar{\xi}_i(\tau), \eta + \tau)] d\tau. \quad (29)$$

The function $F_2(\xi, \lambda)$ was computed in the Mathematics Division, N.P.L. for the case $b/h = 9/7$ over the ranges $-1.6 \leq \xi \leq 1.6$, $-0.9 \leq \lambda \leq 0.9$. $F_2 \rightarrow 0$ as $\xi \rightarrow -\infty$, and a fairly simple asymptotic expression exists for $\xi < 1.6$. The integration to obtain $\int_{-\infty}^{\xi} F_2(\theta, \lambda) d\theta$ can be carried out quite easily by numerical methods. Thus the interference upwash due to any given lift distribution can be computed at any designated points, (ξ, η) .

In the example considered the interference forces were calculated by the vortex-lattice theory² with 6 collocation points. The interference upwashes were therefore calculated by the method outlined above for the collocation points indicated in Fig. 1. Three sizes of wing were considered, $\sigma = 0.125, 0.250, 0.375$, for two modes of oscillation,

- (i) pitching about an axis through the apex of the wing,
- (ii) oscillation of a full-span control.

Interference forces and moments ΔC_L and ΔC_m were evaluated by the procedure of Ref. 2, and are given in Tables 1 and 2.

Using the alternative formulae (16) and (17) is equivalent to putting $\Gamma_1 = 0$, so that the calculation is now slightly simpler. Values of the interference forces and moments thus computed are given in Tables 1 and 2. The difference in the out-of-phase parts is small except for $\sigma = 0.375$, which represents a model larger than would normally be used. Probably for low frequencies it matters little which is used.

In order to facilitate comparison between Tables 1 and 2 they contain also the interference forces divided by the corresponding lift coefficients. The difference between corresponding values in Tables 1 and 2 is now due entirely to the shape of the lift distribution.

Table 3a gives values of the corrected mean incidence $(\Delta\alpha)_m$ and the residual correction to measured pitching moment, as defined by equations (37) and (38) of Part I. The lower half of Table 3a was calculated by taking C'_L to be the theoretical free-stream value. The corrected value of the incidence, $\alpha + (\Delta\alpha)_m$, shows such a rapid increase with σ , that a model of the size $\sigma = 0.375$ could be rather too large for an accurate experiment. The residual corrections to pitching moment are much smaller.

4. Calculations for Finite Frequency.

When the frequency is not small the calculations are more complicated, although there is no difference in principle. In this section an application to the same delta wing in the same tunnel is described. The frequency was taken to be $\mu = 1.6$, which implies that $\nu = \omega\bar{c}/V = 4/9$. The oscillations treated were rigid pitching and vertical heaving.

As in the low-frequency case it was assumed that the lift distribution, l , had its theoretical free-stream value. In order to carry through the calculation it was therefore necessary to have available a lifting-surface theory applicable for $\nu = 4/9$. In the present case the vortex-lattice method of Ref. 3 was used with the same 6 collocation points (Fig. 1). If the upwash is assigned at each of these points then the corresponding lift distribution may be calculated in the form

$$l(x, y) = 2e^{i\omega x} \frac{s}{c} \left[2 \cot \frac{1}{2} \bar{\theta} \left(C_{01} + C_{03} \frac{y^2}{s^2} + C_{05} \frac{y^4}{s^4} \right) \sqrt{\left(1 - \frac{y^2}{s^2} \right)} + \left(\cot \frac{1}{2} \bar{\theta} - 2 \sin \bar{\theta} + \frac{i\omega c}{2V} \{ \sin \bar{\theta} + \frac{1}{2} \sin 2\bar{\theta} \} \right) \left(C_{11} + C_{13} \frac{y^2}{s^2} + C_{15} \frac{y^4}{s^4} \right) \right] \quad (30)$$

where $C_{01} \dots C_{15}$ are complex numbers. The circulation and centre-of-pressure distributions may be calculated by simple integration if it is remembered that (Ref. 4, p. 21)

$$\int_0^\pi \exp \left(- \frac{i\omega c}{2V} \cos \bar{\theta} \right) \cot \frac{1}{2} \bar{\theta} \sin \bar{\theta} d\bar{\theta} = \pi J_0 \left(\frac{\omega c}{2V} \right) - i\pi J_1 \left(\frac{\omega c}{2V} \right)$$

and that there are similar expressions for the other integrals.

$F_2(\xi, \lambda)$ had already been calculated in connection with the low-frequency case, and the evaluation of $\bar{G}(\xi, \lambda)$ as given by equation (7) involved mostly straightforward numerical integration. The ranges $\xi = -0.8(0.1)0.8$ and $\lambda = 0(0.025)0.45$, were sufficient for the present example.

The interference upwashes were then obtained from equations (8), (9) and (10) and the interference forces calculated. The values thus obtained are given in Table 4 together with the corresponding low-frequency values. The frequency effect is seen to be quite large especially for heaving motion. Table 4 also gives the corrections for pitching about any axis, obtained by taking a suitable linear combination of heaving and pitching about the apex.

Table 3b contains values of $(\Delta\alpha)_m/C'_L$, $(\Delta\alpha)_m/\alpha$ and residual corrections to pitching moment for $\mu = 1.6$. The frequency effect is greater on $(\Delta\alpha)_m/C'_L$ than on $(\Delta\alpha)_m/\alpha$ and this in turn is greater than that on $\partial(\Delta C_L)/\partial\alpha$ and $\partial(\Delta C_m)/\partial\alpha$. This indicates that it may be possible to use low-frequency ΔC_L and ΔC_m with finite-frequency $\partial C_L/\partial\alpha$, $\partial C_m/\partial\alpha$ and extend somewhat the range of frequency for which the low-frequency tunnel-interference forces are useful.

A possible complication in such calculations is that at certain sections of the wing the real or imaginary part of the local lift may vanish. In such a case $\bar{\xi}_r$ (or $\bar{\xi}_i$) has an infinite discontinuity of the form

$$\bar{\xi}_r = \frac{\text{Constant}}{\eta - \eta_0} + \text{continuous function},$$

when the lift vanishes at $\eta = \eta_0$. Since \bar{G} remains finite for $\xi \rightarrow +\infty$ or $\xi \rightarrow -\infty$ the integral remains convergent, but the calculation is much simplified if the curve of $\xi = \bar{\xi}(\eta)$ is faired to be smooth at $\eta = \eta_0$. This can probably be done without seriously affecting the accuracy.

5. Discussion.

The calculations required by the method of this report are of unusual length for tunnel-interference work. First it is necessary to use a lifting-surface theory covering the frequency range required; the computation for this is likely to be fairly lengthy whichever of the available methods is used. However, such calculations are often carried out on digital computers in connection with tunnel tests.

The tabulation of $F_2(\xi, \lambda)$ is also lengthy but need only be carried out once for each shape of tunnel, while \bar{G} need only be calculated once for each tunnel and each frequency parameter. If such tables are available, the low-frequency case, which should be adequate for many experiments, does not involve undue labour, but the work necessary for the higher frequencies is considerably more and some simplification is desirable. Tables such as Table 2 of Part I may help here, especially in estimating the order of magnitude of corrections.

The choice of evaluating the interference upwash from a concentrated circulation as in equations (8) and (9) or the lift distribution as in equations (16) and (17) appears to have little effect on the results provided μ is small. The difference between upwashes calculated by the two methods is $O(\mu)$ and hence may be significant. Probably equations (16) and (17) are preferable in such cases but only a check against the complete formula (15) could settle this.

6. Acknowledgements.

The calculations leading to Tables 1 to 4 were carried out by Miss B. Burnham and Miss S. W. Skan.

LIST OF SYMBOLS

As for Part I, with the addition of the following:

A	Aspect ratio of wing ($= 2s/c$)	
c_0	Root chord of wing	
C_L	Lift coefficient ($= \text{lift}/\frac{1}{2}\rho V^2 S$)	
C_m	Pitching-moment coefficient ($= \text{nose-up pitching moment}/\frac{1}{2}\rho V^2 S \bar{c}$)	
C_{01}, C_{11} C_{03}, C_{13} C_{05}, C_{15}	Coefficients in a formula for the lift distribution {see equation (30)}	
\bar{G}		See equation (7)
\bar{h}		Distance of pitching axis downstream of apex/mean chord
p_∞	Pressure at infinity upstream	
w_I, w_{II}	Parts of the interference upwash due to in- and out-of-phase lift distributions respectively	
z_0	Amplitude of heaving oscillation (upward displacement $= z_0 e^{i\omega t}$)	
$(\Delta\alpha)_m$	Mean interference upwash	
$\bar{\gamma}, \bar{\mu}, \bar{\kappa}$	Coefficients in a formula for the lift distribution {see equation (19)}	
$\bar{\gamma}_1, \bar{\mu}_1, \bar{\kappa}_1$ $\bar{\gamma}_2, \bar{\mu}_2, \bar{\kappa}_2$ $\bar{\gamma}_3, \bar{\mu}_3, \bar{\kappa}_3$	Coefficients in a formula for the lift distribution {see equation (21)}	
$\bar{\theta}$		Angular chordwise co-ordinate {see equation (20)}
ν		Frequency parameter based on mean wing chord ($\omega \bar{c}/V$)
ξ_0	Downward angle of control deflection	
$\psi_0(x)$	See equation (13)	

Suffixes

l	Value at leading edge of wing
t	Value at trailing edge of wing

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TABLE 1

Rigid Delta Wing Pitching about its Apex with Low Frequency

$$\left. \begin{aligned} \partial C_L / \partial \alpha &= 2.22 + i\nu 4.00 \\ -\partial C_m / \partial \alpha &= 2.09 + i\nu 4.43 \end{aligned} \right\} \text{Values assumed to occur in tunnel}$$

Values of incremental lift and pitching moment due to tunnel interference

From equations (8) and (9)		From equations (16) and (17)		
σ	$\partial(\Delta C_L) / \partial \alpha$	$-\partial(\Delta C_m) / \partial \alpha$	$\partial(\Delta C_L) / \partial \alpha$	$-\partial(\Delta C_m) / \partial \alpha$
0.125	0.031 + $i\mu$ 0.000	0.031 + $i\mu$ 0.000	0.031 - $i\mu$ 0.001	0.031 - $i\mu$ 0.001
0.250	0.142 + $i\mu$ 0.010	0.147 + $i\mu$ 0.010	0.142 + $i\mu$ 0.007	0.147 + $i\mu$ 0.002
0.375	0.372 + $i\mu$ 0.053	0.395 + $i\mu$ 0.075	0.372 + $i\mu$ 0.038	0.395 + $i\mu$ 0.061
σ	$\Delta C_L / C_L$	$-\Delta C_m / C_L$	$\Delta C_L / C_L$	$-\Delta C_m / C_L$
0.125	0.014 - $i\mu$ 0.003	0.014 - $i\mu$ 0.003	0.014 - $i\mu$ 0.003	0.014 - $i\mu$ 0.003
0.250	0.064 - $i\mu$ 0.012	0.066 - $i\mu$ 0.012	0.064 - $i\mu$ 0.013	0.066 - $i\mu$ 0.016
0.375	0.168 - $i\mu$ 0.102	0.178 - $i\mu$ 0.100	0.168 - $i\mu$ 0.109	0.178 - $i\mu$ 0.106

Pitching moments are taken about the wing apex

TABLE 2

Delta Wing with Full-Span Trailing-Edge Control Oscillating with Low Frequency

$$\left. \begin{aligned} \partial C_L / \partial \xi_0 &= 1.57 + i\nu 0.24 \\ -\partial C_m / \partial \xi_0 &= 2.09 + i\nu 0.44 \end{aligned} \right\} \text{Values assumed to occur in tunnel}$$

Values of incremental lift and pitching moment due to tunnel interference

From equations (8) and (9)		From equations (16) and (17)		
σ	$\partial(\Delta C_L) / \partial \xi_0$	$-\partial(\Delta C_m) / \partial \xi_0$	$\partial(\Delta C_L) / \partial \xi_0$	$-\partial(\Delta C_m) / \partial \xi_0$
0.125	0.020 - $i\mu$ 0.003	0.020 - $i\mu$ 0.004	0.020 - $i\mu$ 0.004	0.020 - $i\mu$ 0.004
0.250	0.084 - $i\mu$ 0.018	0.089 - $i\mu$ 0.020	0.084 - $i\mu$ 0.021	0.089 - $i\mu$ 0.022
0.375	0.211 - $i\mu$ 0.063	0.235 - $i\mu$ 0.070	0.211 - $i\mu$ 0.078	0.235 - $i\mu$ 0.084
σ	$\Delta C_L / C_L$	$-\Delta C_m / C_L$	$\Delta C_L / C_L$	$-\Delta C_m / C_L$
0.125	0.013 - $i\mu$ 0.002	0.013 - $i\mu$ 0.003	0.013 - $i\mu$ 0.003	0.013 - $i\mu$ 0.003
0.250	0.054 - $i\mu$ 0.014	0.057 - $i\mu$ 0.015	0.054 - $i\mu$ 0.016	0.057 - $i\mu$ 0.016
0.375	0.134 - $i\mu$ 0.049	0.150 - $i\mu$ 0.054	0.134 - $i\mu$ 0.058	0.150 - $i\mu$ 0.063

Pitching moments are taken about the wing apex

TABLE 3

Rigid Delta Wing Pitching about its Apex, Values of Overall Corrections(a) Low Frequency, $\mu \rightarrow 0$

	$(\Delta\alpha)_m/C'_L$	$\frac{(C'_m)_{\text{corrected}} - (C'_m)_{\text{measured}}}{C'_L}$
$\sigma = 0.125$	$0.006 - i\mu 0.003$	$0.001 - i\mu 0.001$
$\sigma = 0.250$	$0.029 - i\mu 0.027$	$0.006 - i\mu 0.008$
$\sigma = 0.375$	$0.076 - i\mu 0.103$	$0.020 - i\mu 0.025$

Values calculated assuming $C'_L = \alpha(2.22 + i\nu 4.00)$

	$(\Delta\alpha)_m/\alpha$	$\frac{(C'_m)_{\text{corrected}} - (C'_m)_{\text{measured}}}{\alpha}$
$\sigma = 0.125$	$0.013 - i\mu 0.003$	$0.002 - i\mu 0.002$
$\sigma = 0.250$	$0.064 - i\mu 0.027$	$0.013 - i\mu 0.011$
$\sigma = 0.375$	$0.169 - i\mu 0.102$	$0.044 - i\mu 0.022$

(b) Finite Frequency, $\mu = 1.6$

	$(\Delta\alpha)_m/C'_L$	$\frac{(C'_m)_{\text{corrected}} - (C'_m)_{\text{measured}}}{C'_L}$
$\sigma = 0.250$	$0.000 - i\mu 0.008$	$-0.001 - i\mu 0.002$

Values calculated assuming $C'_L = \alpha(2.09 + i\nu 4.00)$

	$(\Delta\alpha)_m/\alpha$	$\frac{(C'_m)_{\text{corrected}} - (C'_m)_{\text{measured}}}{\alpha}$
$\sigma = 0.250$	$0.022 - i\mu 0.016$	$0.002 - i\mu 0.005$

TABLE 4

Cropped Delta Wing, A = 1.8, σ = 0.25

	<u>Pitching about the apex</u>	
	$\mu = 1.6$	$\mu \rightarrow 0$
Free stream- $\partial C_L/\partial\alpha$	$2.02 + i\mu 1.11$	$2.22 + i\mu 1.11$
*Free-stream $-\partial C_m/\partial\alpha$	$1.82 + i\mu 1.23$	$2.09 + i\mu 1.23$
$\partial(\Delta C_L)/\partial\alpha$	$0.091 - i\mu 0.008$	$0.142 + i\mu 0.010$
* $-\partial(\Delta C_m)/\partial\alpha$	$0.093 - i\mu 0.007$	$0.147 + i\mu 0.010$
	<u>Heaving</u>	
Free-stream C_L	$(z_0/b)(0.51 - i\mu 2.15)$	$(z_0/b)(-i\mu 2.22)$
*Free-stream $-C_m$	$(z_0/b)(0.63 - i\mu 2.01)$	$(z_0/b)(-i\mu 2.09)$
ΔC_L	$(z_0/b)(0.084 - i\mu 0.060)$	$(z_0/b)(-i\mu 0.142)$
* ΔC_m	$(z_0/b)(0.085 - i\mu 0.061)$	$(z_0/b)(-i\mu 0.147)$
	<u>Pitching about an axis $\bar{h}c$ downstream of the apex</u>	
Free-stream $\partial C_L/\partial\alpha$	$\begin{cases} \mu = 1.6 & (2.02 + 0.14\bar{h}) + i\mu(1.11 - 0.60\bar{h}) \\ \mu \rightarrow 0 & 2.22 + i\mu(1.11 - 0.62\bar{h}) \end{cases}$	
†Free-stream $-\partial C_m/\partial\alpha$	$\begin{cases} \mu = 1.6 & (1.82 - 1.84\bar{h} - 0.14\bar{h}^2) + i\mu(1.23 - 1.67\bar{h} + 0.60\bar{h}^2) \\ \mu \rightarrow 0 & (2.09 - 2.22\bar{h}) + i\mu(1.23 - 1.69\bar{h} + 0.62\bar{h}^2) \end{cases}$	
$\partial(\Delta C_L)/\partial\alpha$	$\begin{cases} \mu = 1.6 & (0.091 - 0.023\bar{h}) + i\mu(-0.008 - 0.017\bar{h}) \\ \mu \rightarrow 0 & 0.142 + i\mu(0.010 - 0.039\bar{h}) \end{cases}$	
$-\partial(\Delta C_m)/\partial\alpha$	$\begin{cases} \mu = 1.6 & (0.093 - 0.115\bar{h} + 0.023\bar{h}^2) + i\mu(-0.007 - 0.009\bar{h} + 0.017\bar{h}^2) \\ \mu \rightarrow 0 & (0.147 - 0.142\bar{h}) + i\mu(0.010 - 0.051\bar{h} + 0.039\bar{h}^2) \end{cases}$	

* Moment about an axis through the apex.

† Moment about the pitching axis.

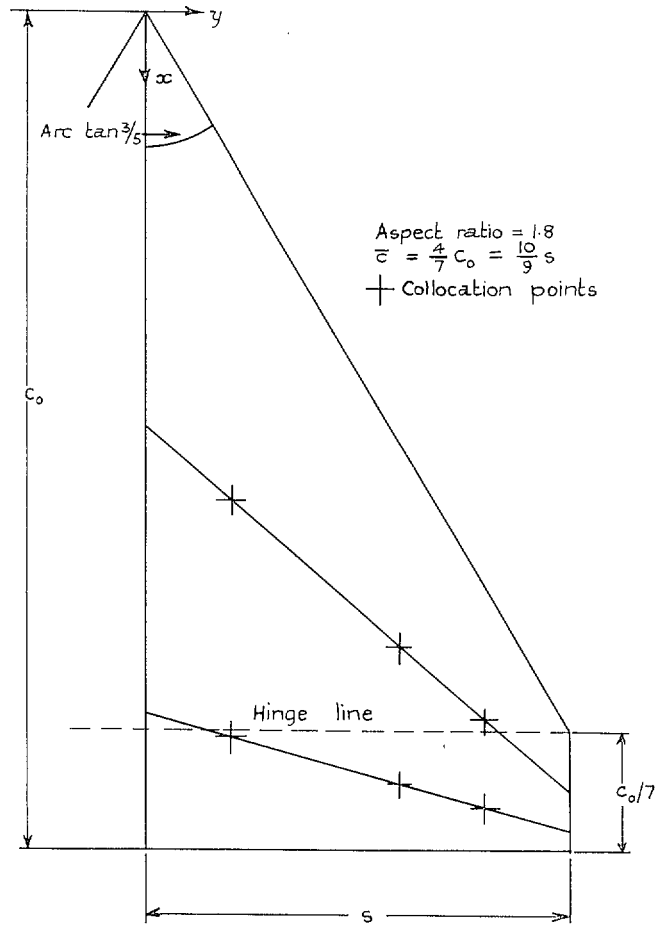


FIG. 1. Planform of delta wing.

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