δ

ϵ

V_x

ϵ

$V_x^2(V_z^{-2} - V_x^{-2})/2,$

V_x^2

$(1+2\epsilon)V_z^2,$ and

V_x

$(1+\epsilon)V_z.$

δ

$$V_n^2(V_z^{-2} - V_n^{-2})/2,$$

V_n^2

$(1+2\delta)V_z^2,$ and

$$(1+\delta)V_z.$$

$\epsilon > 0$

$\delta < 0$

V_s/V_p

V_s

$$V_n \leq V_z \leq V_x$$

$\delta > 0$

$(\epsilon - \delta)/(1 + 2\delta)$

$$V_x^2(V_n^{-2} - V_x^{-2})/2,$$

$(1+2\eta)V_n^2,$ and

$$(1+\eta)V_n.$$

$\eta > 0$

$V_z, V_x, V_n, \epsilon, \delta, \eta$

$V_z, V_x,$

$V(\phi)$

$V(\phi)^{-2}$

$$V_z^{-2}\cos^2\phi + \left(V_n^{-2} - V_x^{-2}\right)\cos^2\phi\sin^2\phi + V_x^{-2}\sin^2\phi,$$

$V(\phi)^{-1}$

$$V_x^{-1}\sqrt{1+2\eta\cos^2\phi\sin^2\phi+2\epsilon\cos^2\phi}$$

$$V_x^{-1}(1+\eta\cos^2\phi\sin^2\phi+\epsilon\cos^2\phi)$$

$$V_x^{-1}[1+\eta\cos^2\phi(1+\sin^2\phi)+\delta\cos^2\phi].$$

θ

$$v(\theta)^2 = V_z^2 \cos^2\theta + (V_n^2 - V_x^2)\cos^2\theta \sin^2\theta + V_x^2 \sin^2\theta.$$

t_0

$$z = V_z t_0$$

h

$$t_h^2 = t_0^2 + \left[V_n^{-2} + (V_x^{-2} - V_n^{-2}) \frac{h^2}{h^2 + V_z^2 t_0^2} \right] h^2.$$

$h \ll V_z t_0$

$h \gg V_z t_0$

$V_h(h)^{-2}$

$(t_h^2 - t_0^2)/h^2$

$$V_n^{-2} + (V_x^{-2} - V_n^{-2}) \frac{h^2}{h^2 + V_z^2 t_0^2}$$

$$V_n^{-2}\left(1-\frac{2\eta}{1+2\eta}\cdot\frac{h^2}{h^2+V_z^2t_0^2}\right).$$

$$t_h^2 = t_0^2 + h^2 / V_h(h)^2.$$

$$V_n \leq V_h(h) \leq V_x$$

$\eta = 0$

$$V_n = V_x$$

$$V_h(h)^{-2} \approx V_n^{-2} \left(1 - 2\eta \frac{h^2}{h^2 + V_n^2 t_0^2}\right) .$$

$$V_z \approx V_n^2 / V_x$$

$$\epsilon \approx 2\delta$$

$$t_h^2 \approx t_0^2 + \left[V_n^{-2} + (V_x^{-2} - V_n^{-2}) \frac{h^2}{h^2 + V_n^4 V_x^{-2} t_0^2} \right] h^2.$$

$$V_h(h)^{-2} \approx V_n^{-2} \left(1 - 2\eta \frac{h^2}{h^2 + V_n^4 V_x^{-2} t_0^2} \right) .$$

$V_h(h_{\max})$

$$V_n \left(1 + \eta \frac{h_{\max}^2}{h_{\max}^2 + V_n^2 t_0^2} \right) .$$

$V_n(1+\eta\sin^2\alpha)$, where $\tan\alpha = h_{\max}/V_z t_0$.

$$V_{\mathrm{iso}} \approx V_x(1 - \eta \cos^2 \alpha).$$

$$V_h(h)^{-2} \approx V_{\mathrm{iso}}^{-2} \left[1 + 2\eta \left(\frac{h_{\mathrm{max}}^2}{h_{\mathrm{max}}^2 + V_{\mathrm{iso}}^2 t_0^2} - \frac{h^2}{h^2 + V_{\mathrm{iso}}^2 t_0^2} \right) \right].$$

V_x^{-1}

$$V_h(h_{\max})^{-1}\left(1-\eta\frac{V_z^2t_0^2}{h_{\max}^2+V_z^2t_0^2}\right)$$

$V_{\mathrm{iso}}^{-1}(1-\eta\cos^2\alpha).$

$$V(\phi)^{-1} \approx V_{\rm iso}^{-1}(1-\eta\cos^2\alpha)(1+\eta\cos^2\phi\sin^2\phi+\epsilon\cos^2\phi).$$

$0 < \epsilon$

$\eta/2 < \epsilon < 2\eta$

$$V(\phi)^{-1} \approx V_{\rm iso}^{-1}(1-\eta\cos^2\alpha)[1+\eta\cos^2\phi(1+\sin^2\phi)+\delta\cos^2\phi].$$

$V_n^{-1}(1 - \eta \sin^4 \phi + \delta \cos^2 \phi)$

$$V_n^{-1}[1-\eta(1-\cos^2\phi\sin^2\phi)+\epsilon\cos^2\phi].$$