The Earthquake Dissipative Engine: Energy Budget and Partition Part J:Revision of main concepts and equations

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Short course on earthquake physics

Geoscienze, Università di Padova Oct 2025

27 Oct. - 16:30-18:30 classroom 2G
28 Oct. - 14:30-16:30 classroom 2H
29 Oct. - 10:30-12:30 classroom Lab Paleo
31 Oct. - 14:30-16:30 classroom 2L

$$\tau(r) = \frac{K_*}{\sqrt{2\pi r}} = \boxed{\frac{1}{\sqrt{2}}\,\Delta\tau\,\sqrt{\frac{L}{r}}}\,(+\ldots\text{ weaker singular terms})$$ **stress concentration**

$$K_* = K_I = K_{II} = K_{III} = \boxed{\Delta\tau\sqrt{\pi L}}$$ **stress intensity factor**

$$G_0 = \frac{K_{II}^2}{2\mu} = C_2\,\frac{\Delta\tau^2}{2\mu}\,L\ \boxed{G_0 = C_2\,\frac{\Delta\tau^2}{2\mu}\,L} = \frac{K_{III}^2}{2\mu}$$ **energy release rate, static**

$$G(v) = \boxed{G_0\,\frac{\sqrt{1-\frac{v^2}{c^2}}}{1+\frac{v}{c}} \approx G_0\left(1-\frac{v}{c}\right)}$$ **energy release rate, dynamic:**
Lorentz contraction and Doppler approx.

$$\boxed{G(v) \equiv \Gamma}$$ **rupture propagation criterion**

$$\tau(x,t) = \tau_0(x,t) \boxed{-\frac{\mu}{c_s}\dot{\delta}(x,t)} + \tau_{hist}(x,t)$$ **radiation damping**

Two fundamental scaling in earthquake sources:

$$\frac{\Delta\tau}{\mu} \propto \frac{\dot{\delta}}{c_s} \qquad (\longrightarrow \dot{\delta} \approx 1 \text{ m/s})$$

$$\frac{\Delta\tau}{\mu} \propto \frac{u}{L} \qquad (\longrightarrow \delta \approx 10^{-4} L)$$

$$L_c = \frac{1}{A_0} \frac{\Gamma \mu'}{\Delta\tau^2}$$

$$G(v) \approx G_0 \left(1 - \frac{v}{c}\right) \qquad G_0 = C \frac{\Delta\tau^2}{2\mu} L$$

$$\frac{\Gamma}{G_0} = \frac{L_c}{L} \qquad G(v) \equiv \Gamma$$

$$\frac{1}{C_{lim}} \frac{\partial L}{\partial t} = \left(1 - \frac{L_c}{L}\right)$$

$$\boxed{L(t) = L_c \left(1 + W_0 \left[\exp\left(\frac{C_{lim}}{L_c}(t - t_0)\right)\right]\right)}$$