An introduction to Physics of Seismic Sources

SP-10: Phenomenology of kinematic models

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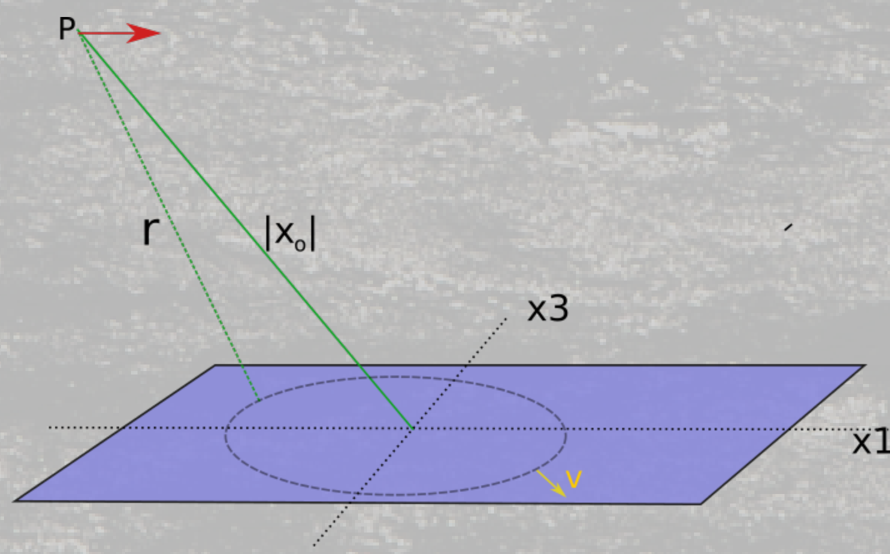
Kinematic models

Far field displacement

$$u^P(x',t) = A \iint_\Sigma \frac{1}{r} R_P\left(n_k, l_k(\xi_i)\gamma_k(x',x_i)\right) \Delta\dot{u}\left(x_1, x_3, t-\frac{r}{\alpha}\right) dx_1 dx_3$$



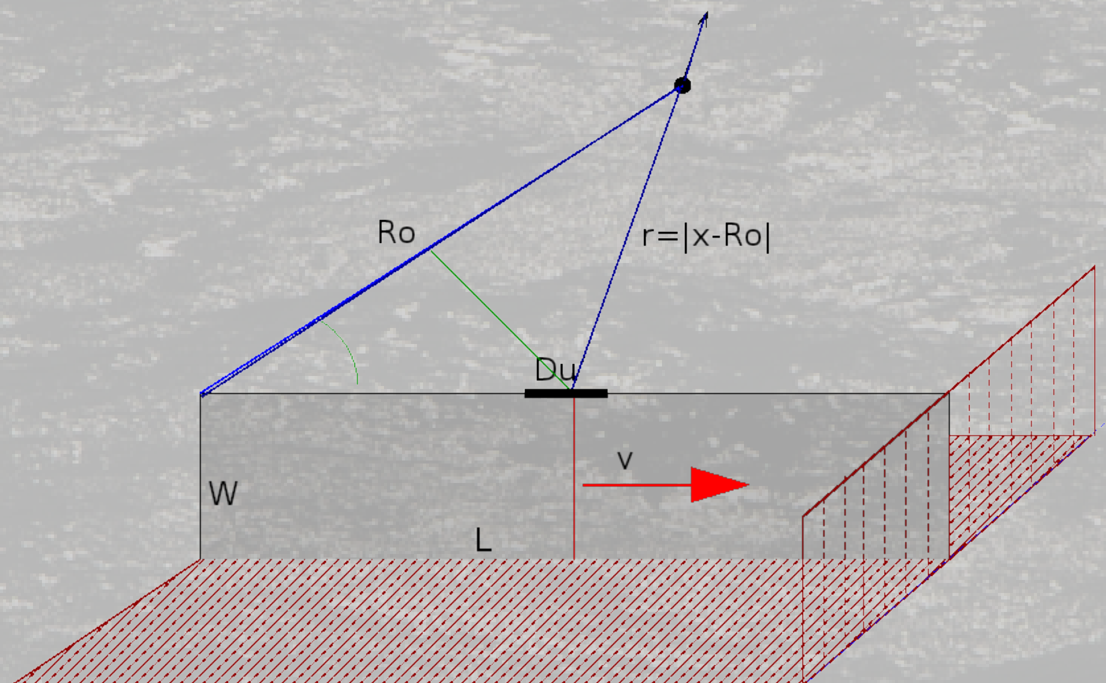
Fraunhoffer approximation

$$u^P(x',t) \approx \frac{A}{x_o} R_P\left(n_k, l_k, \gamma_k\right) \iint_{\Sigma} \Delta\dot{u}\left(x_1, x_3, t - \frac{x_o - \xi_i\gamma_i}{\alpha}\right) dx_1 dx_3$$

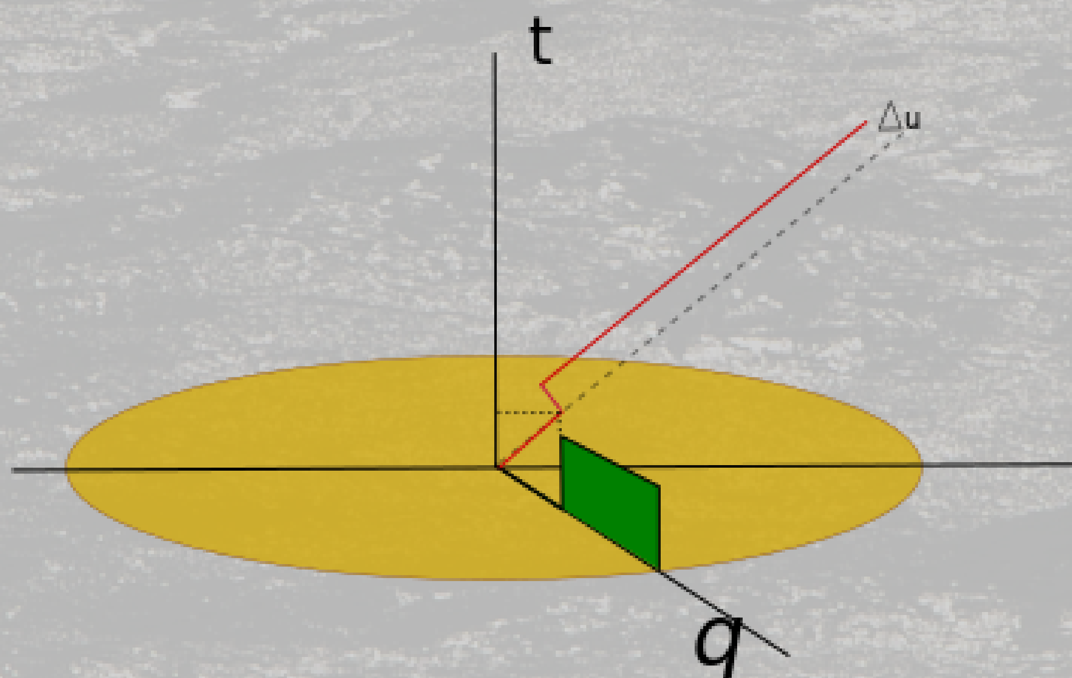
Kinematical models

- Haskel (unilateral rectangular)
- Savage (circular)
- Heaton (self healing pulse)
- Sato Hirasawa (circular, nonuniform)

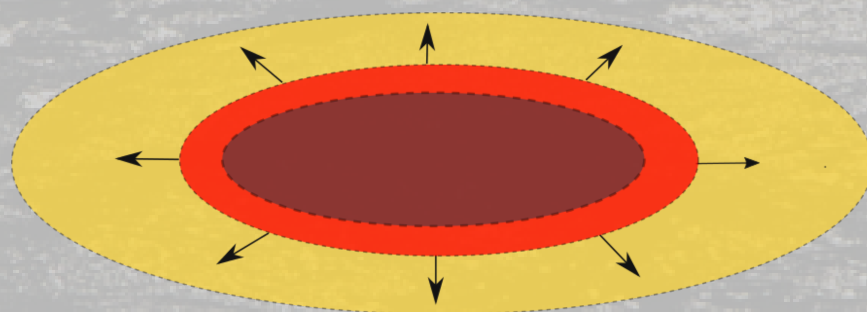
Haskel model



Sawage model



Heaton model



Sato-Hirasawa model

Their model describes a circular fault rupturing with constant velocity from the center outwards (like Savage's one), but now the slip is not constant but is a function of the stress drop over the fault

Limitations of kinematical models

The discussed kinematic source models were very successful in describing basic source characteristics and established the theoretical base for for source physics inference based on seismic data. However, all of them have more or less serious problems with displacement continuity at edges of fault, instantaneous rupturing, or stopping, etc. From the point of view continuous mechanics are simply not acceptable. Dealing with this issue requires considering dynamical rupture models. The first step in this direction was done by Sato and Hirasawa (1973).

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