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WORKSHOP ON PATTERN RECOGNITION AND ANALYSIS OF SEISMICITY

(5 - 16 December 1983)

FRACTURE DYNAMICS

Modeling the Earthquake Source

L. KNOPOFF

These are preliminary lecture notes, intended only for distribution to participants.
Missing copies are available from Room 230.

L. KNOPOFF

FRACTURE DYNAMICS

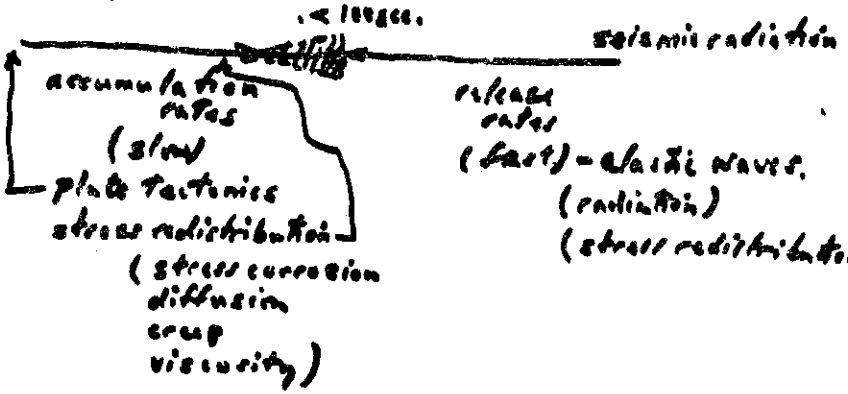
MODELING the EARTHQUAKE SOURCE

EQs ARE rapid release of stored potential energy: Containment

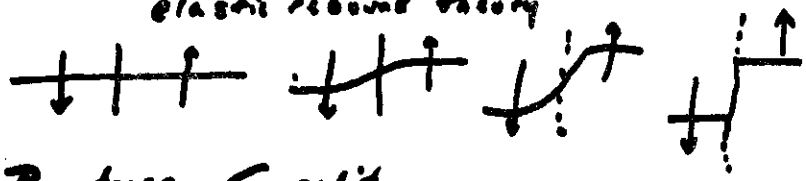
Types of conservative systems (for our purposes)
elastic, magnetic, electric, gravitational
atomic

for shallow earthquakes ⟶ elastic
deep earthquakes ⟶ elastic?, atomic?

Time Scale

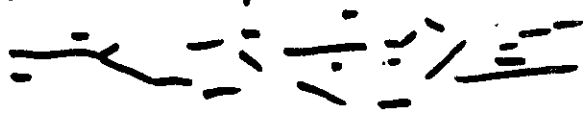


Critical Point: Fracture criterion
elastic rebound theory

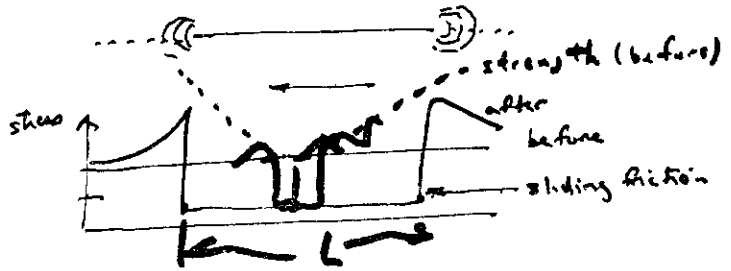


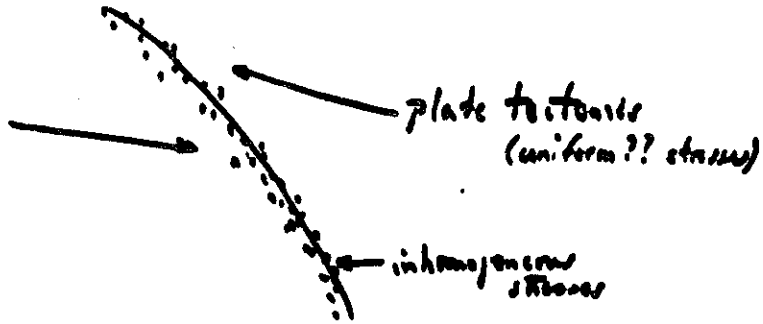
Prestress, Causality

Geometry of fracture
Pre-existing fracture surfaces
re-arrangement
crushing
Self-similarity



Stress redistribution ⟶

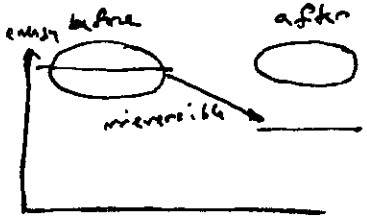




Short-term energy balance

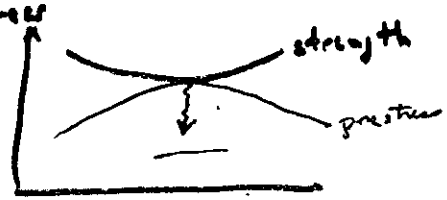
Prestress energy → radiation
frictional sliding
redistribution

Fracture criteria
Griffith



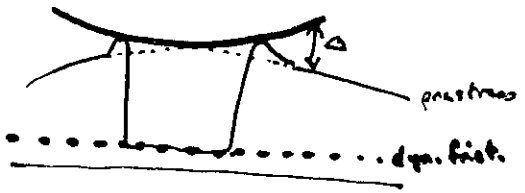
(new surface)

Irwin



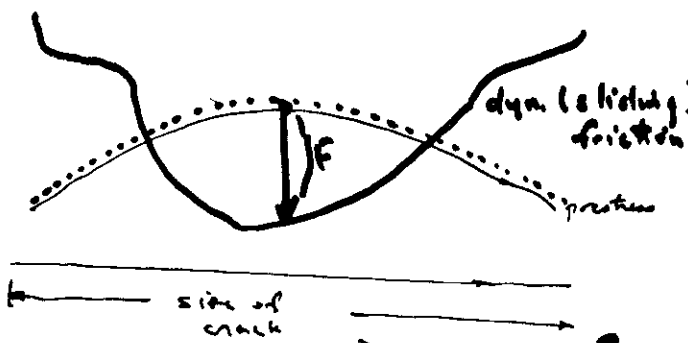
Compatible?

What stops a crack?



rate of expansion → self-regulating
(by inertia Δ)

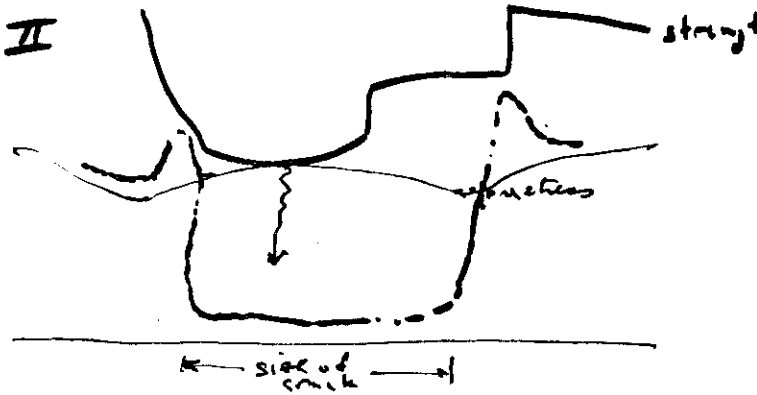
I



F = ma

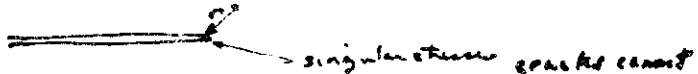
Burridge + Halliday Geophys J. R.A.S. 1972 ± 1

II

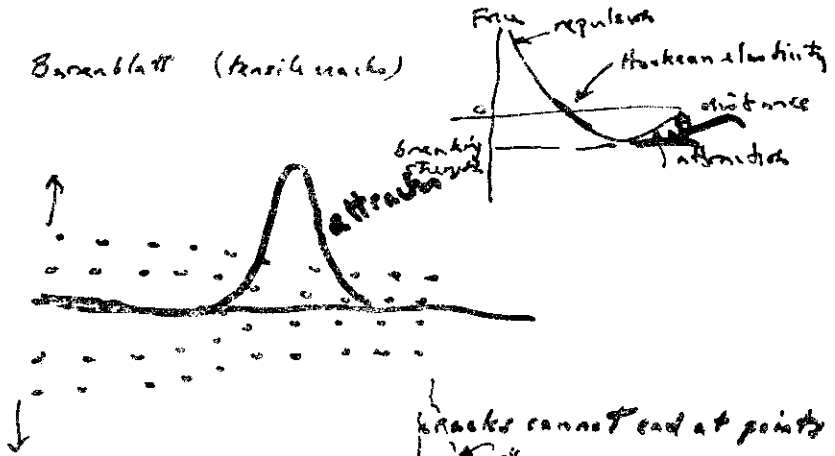


Mathematics → plane fractures: 1-D / 2-D

cracks (dynamically) end at a point (1D, 2D)



Barenblatt (brittle cracks)

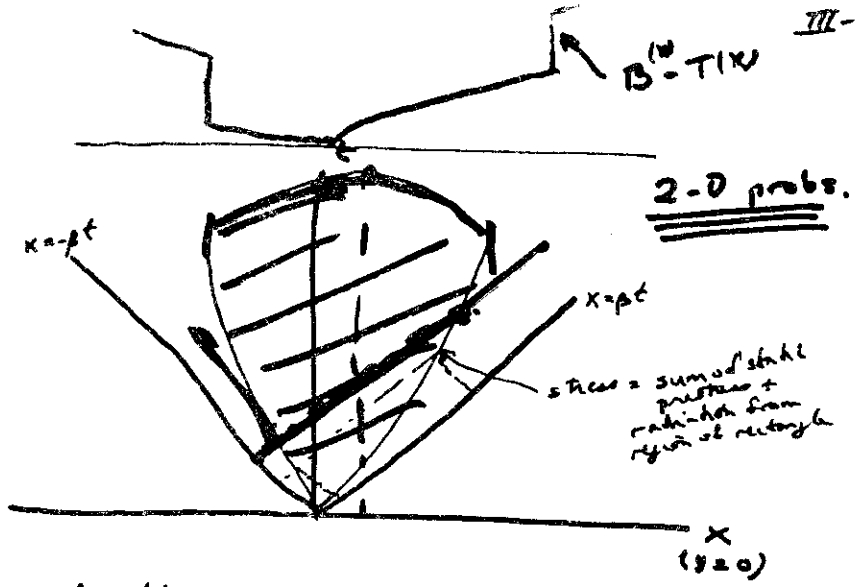


$\sigma \sim k r^{-1/2}$

$= \frac{\tau L^{1/2}}{r^{1/2}}$

k = stress intensity factor

Dynamical crack problems - non-linear



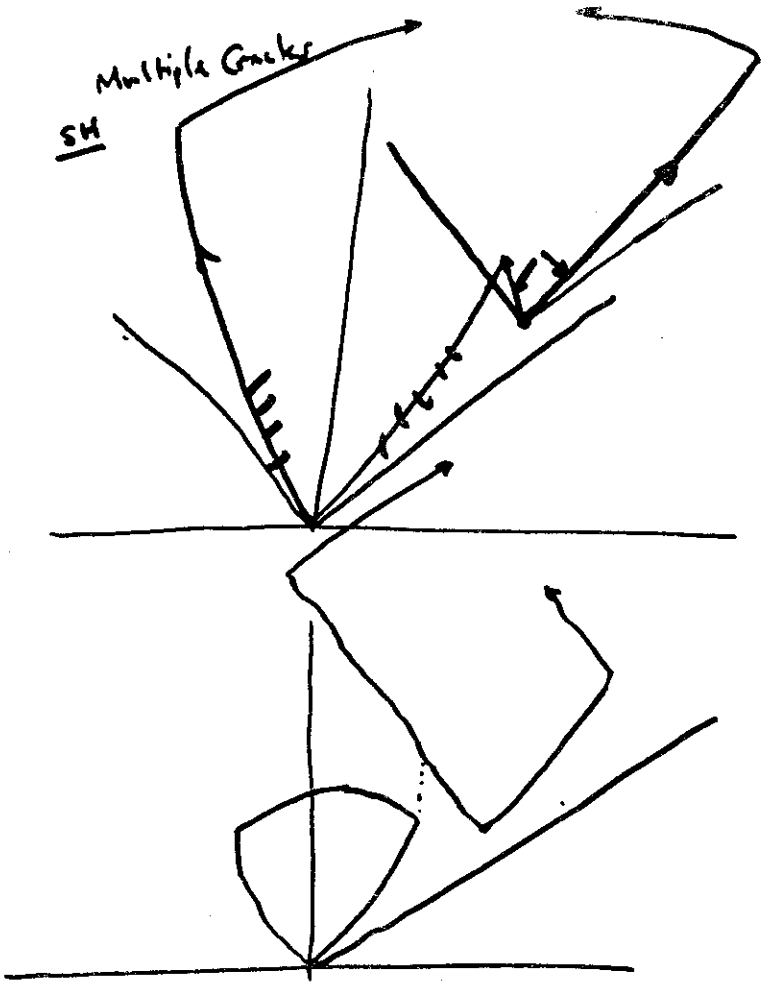
type of motion:

I SH: u_z

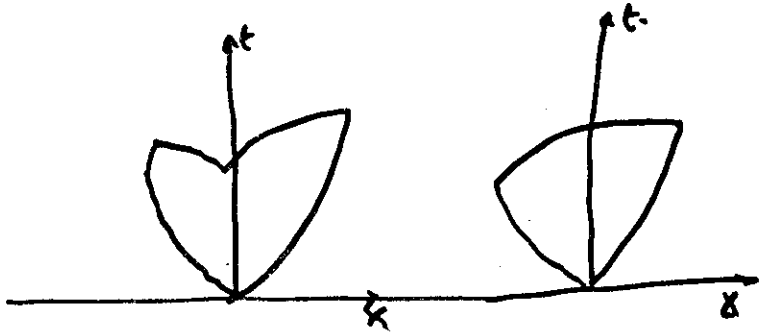
If we know $u_z(x, y=0, t)$ we can calculate motion $u(x, y, t)$.

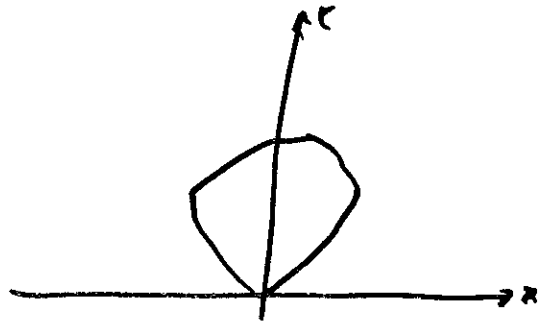
We can also solve

II SV: u_x, u_y

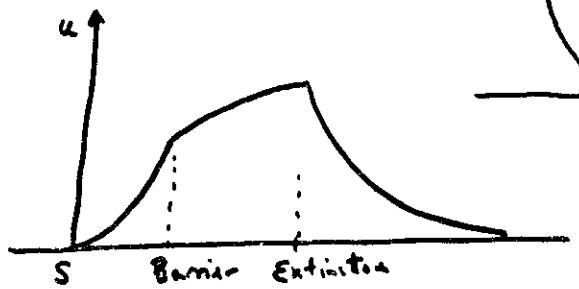


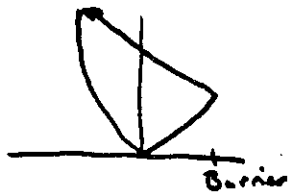
stereographs

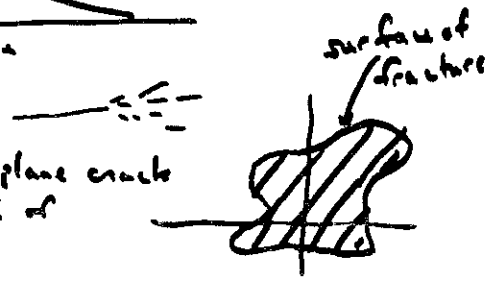




seismograms







Inserted: General 3-D plane crack
Stochastic model of Crack

Fracture Dynamics

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