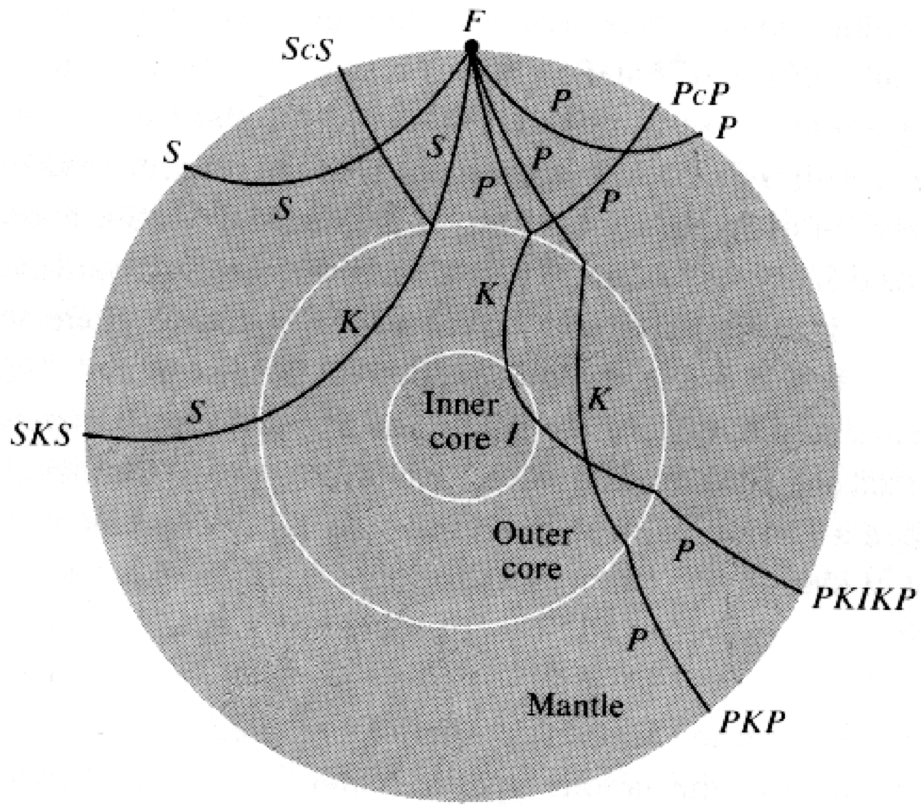
2nd class

- Elasto-dynamics equation
- P and S waves
- Potentials
- Refection and transmission of body waves
- Surface waves: Rayleigh and Love waves

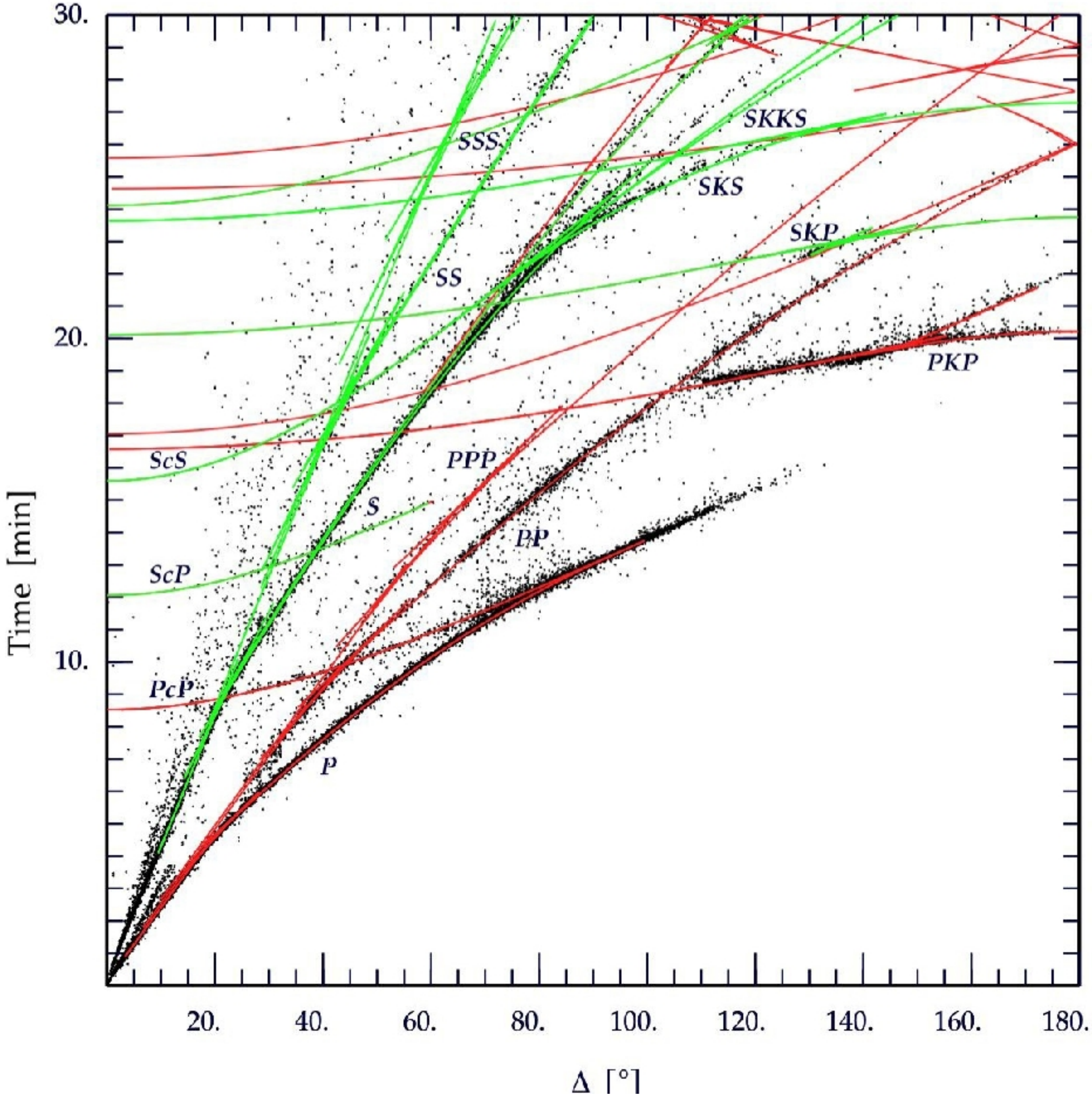
Overview
Large scale Seismology: an observational field

- Data (Seismic source) + Instrument (Seismometer) -> Observations (seismograms)
- Historical evolution: Ray theory, Normal mode theory, Numerical techniques (SEM, NM-SEM)
- Scientific Issues: earthquakes, structure of the Earth and planets
- NM-SEM and time reversal
- Tomographic Technique
- Seismic Experiment: Plume detection

RAY PATHS INSIDE THE EARTH



"Travel time" of certain seismic phases vs. epicentral dis



Duality wave - particle:

- λ seismic wavelength
- Λ scale heterogeneity

- Particle: Ray theory (XXth century)

$\lambda \ll \Lambda$

- Wave: Normal mode theory (>1970)

Tenseur des contraintes: $\boldsymbol{\sigma}$

Tenseur des déformations $\varepsilon = \frac{1}{2}\left(\boldsymbol{\nabla}\mathbf{u} + (\boldsymbol{\nabla}\mathbf{u})^T\right)$

eq. du mouvement $\rho(\mathbf{r})\ddot{\mathbf{u}}(\mathbf{r}) = \boldsymbol{\nabla}\cdot\boldsymbol{\sigma}(\mathbf{r}) + \mathbf{f}(\mathbf{r})$

Hypothesis: Elastic Medium

$$\sigma_{ij} = C_{ijkl}\, \varepsilon_{kl}$$

Where ε_{kl} **is the strain tensor,** σ_{ij} **the stress tensor**

C_{ijkl} **the elastic tensor: 81 elastic moduli**

Symmetries of ε_{kl}**,** σ_{ij} **and of the strain energy**

W= 1/2 $\boldsymbol{\sigma}_{ij}\, \varepsilon_{ij}$ => 21 independent elements

Isotropic case:

$$C_{ijkl} = \lambda\, \delta_{ij}\, \delta_{kl} + \mu\, (\delta_{ik}\, \delta_{jl} + \delta_{il}\, \delta_{jk})$$

λ , μ are Lamé parameters

Elastodynamic equation

$$\partial_j(C_{ijkl}\,\partial_k\,u_l) + \rho\,\partial_{tt}\,u_i = 0$$

In the isotropic case:

$$\sigma_{ij} = \lambda\,\delta_{ij}\,\varepsilon_{kk} + 2\,\mu\,\varepsilon_{ij}$$

$$\rho\partial_{tt}\mathbf{u} = (\lambda + 2\,\mu\,)\mathrm{grad}\,\theta + \Delta\mathbf{u}$$

2 solutions:

S-wave: $V_s = \sqrt{\mu/\rho}$

P wave: $V_P = \sqrt{(\lambda + 2\,\mu)/\,\rho}$

In heterogeneous media, comparison between

Wavelength λ and scale of heterogeneity Λ

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Champs de potentiel

$u = \text{grad}\,\phi + \text{rot}\,\Psi$

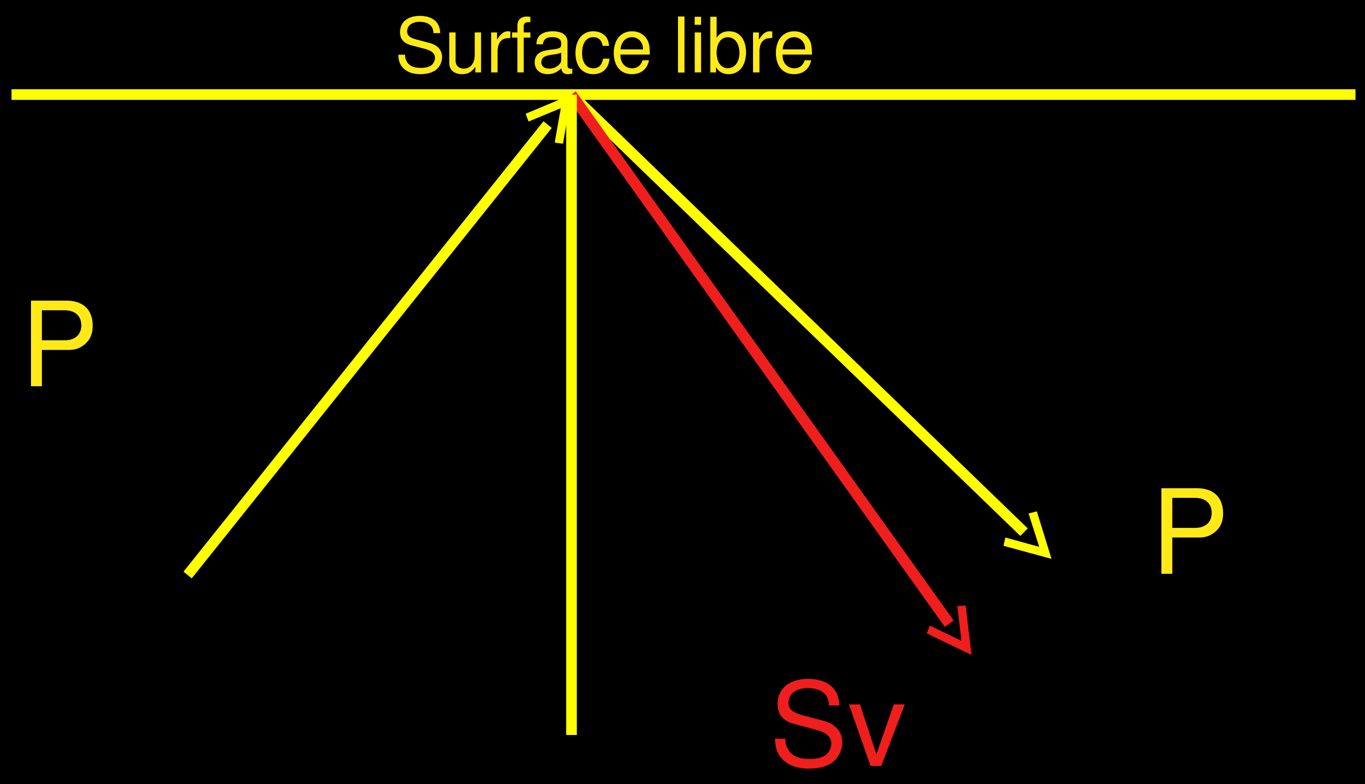
In the isotropic case:
2 solutions:

Potentiel ϕ : P wave: $V_P = \sqrt{(\lambda + 2\mu)/\rho}$

Potentiel Ψ: S-wave: $V_s = \sqrt{\mu/\rho}$

Propriétés ondes P, ondes S

Réflexion et transmission d'une onde plane à une interface plane



Conditions de Continuité

-Déplacements

- Contraintes

Selon les interfaces: solide, fluide, vide