

SPIN

MONITORING A
RESTLESS EARTH



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ESR 1.1: Rotational motions of surface waves in weakly anisotropic media

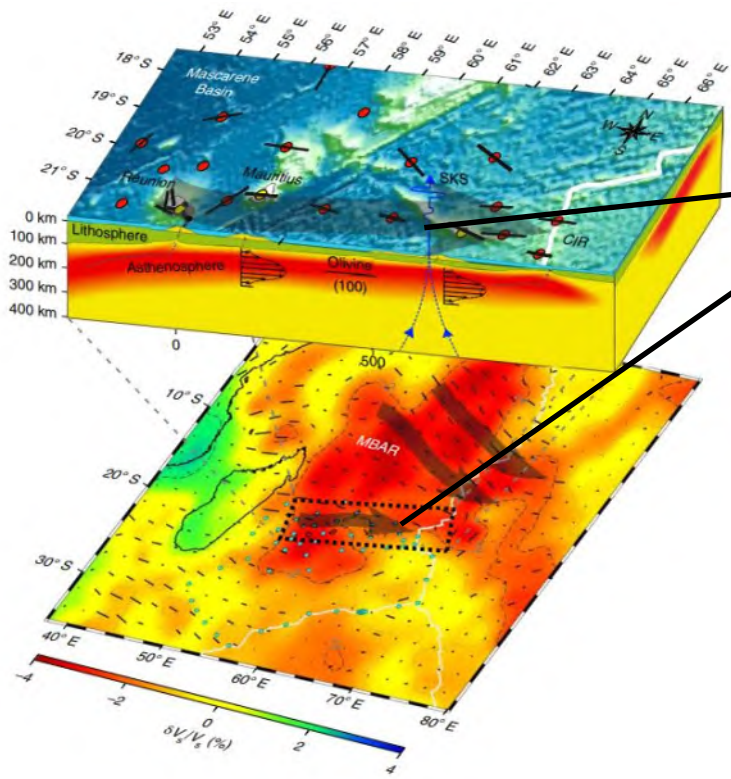
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²Institut de Physique du Globe de Paris, Université Paris Cité

26.05.2022, Bordeaux, France (SPIN workshop-2)

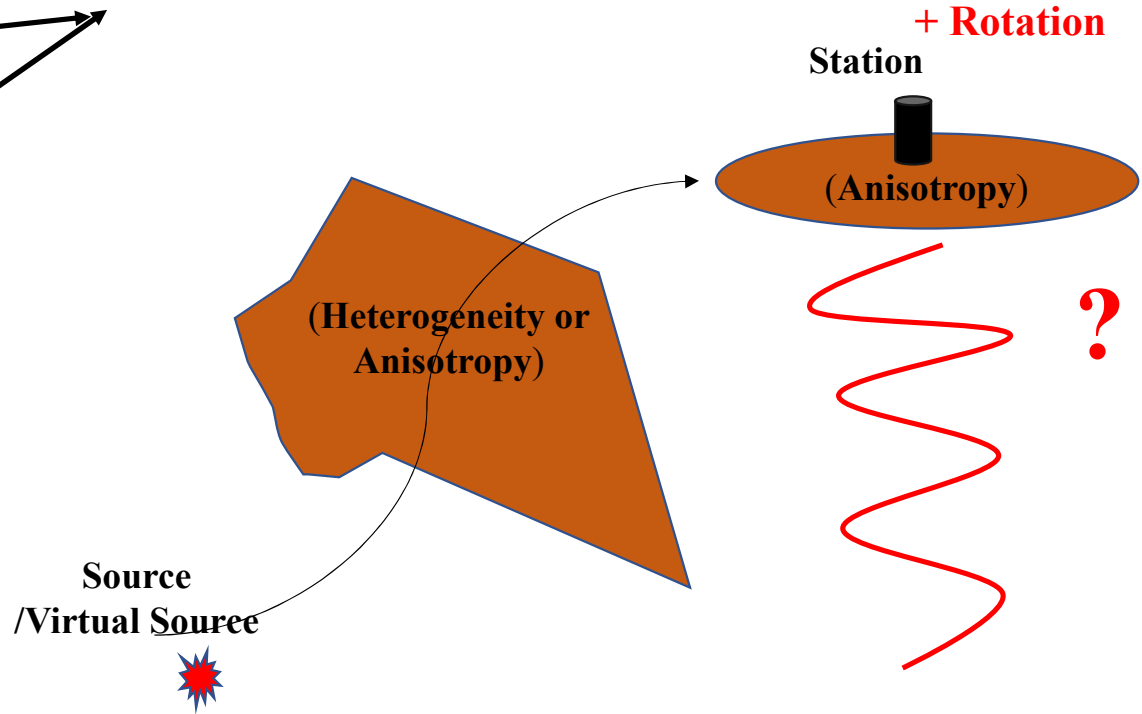
Background & Motivation



(Barruol et al. 2019, Nature Geo)

Azimuth anisotropy

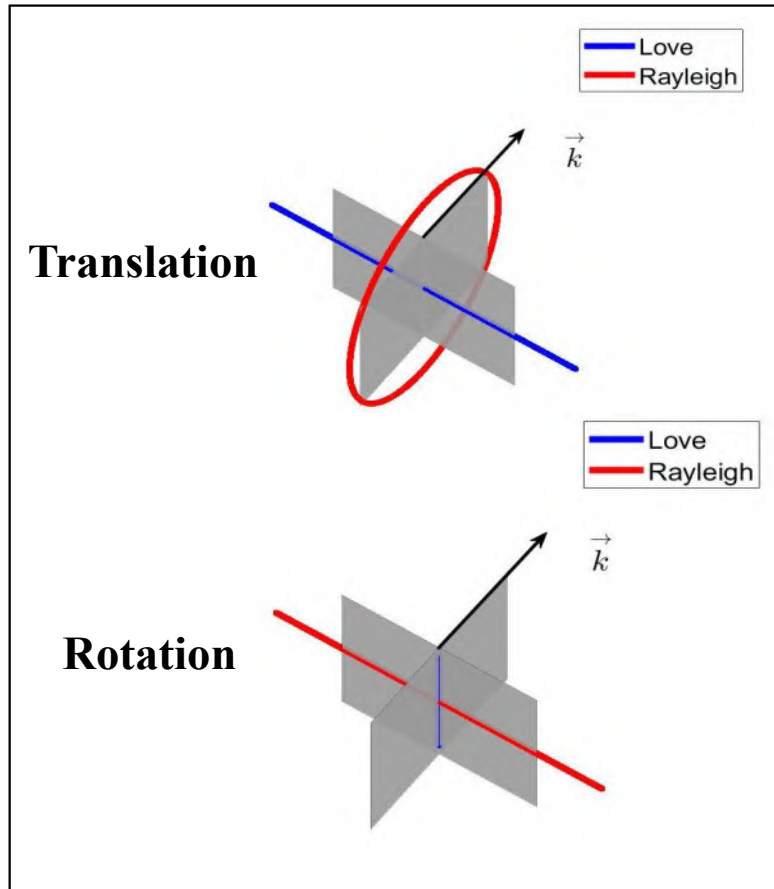
The fast wave direction is associated with the **flow direction**.



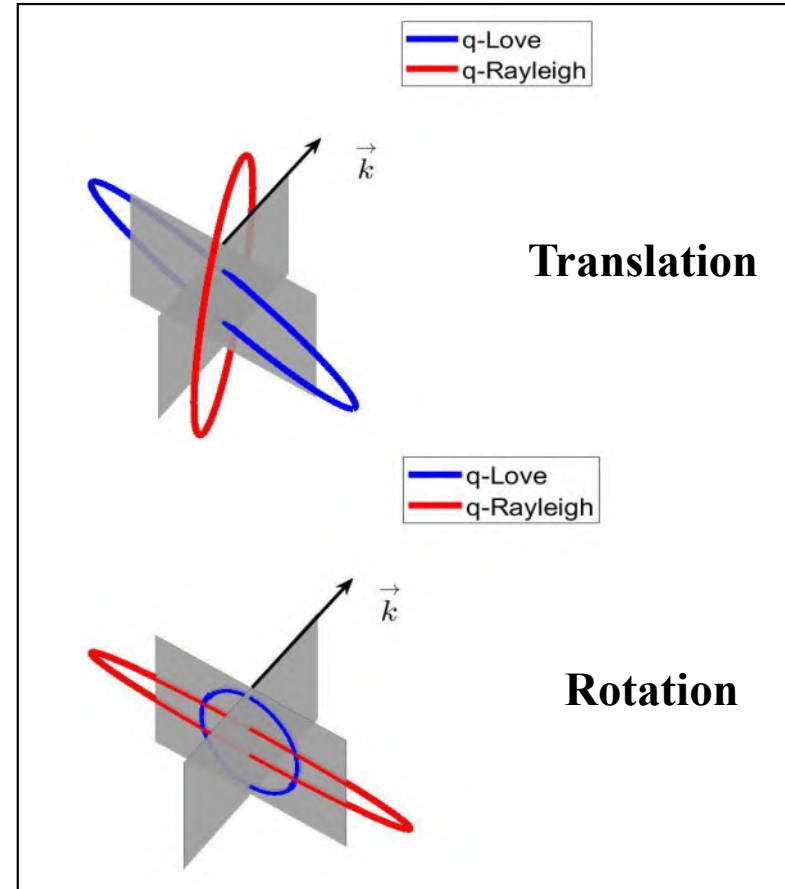
Theory

Polarization of surface waves

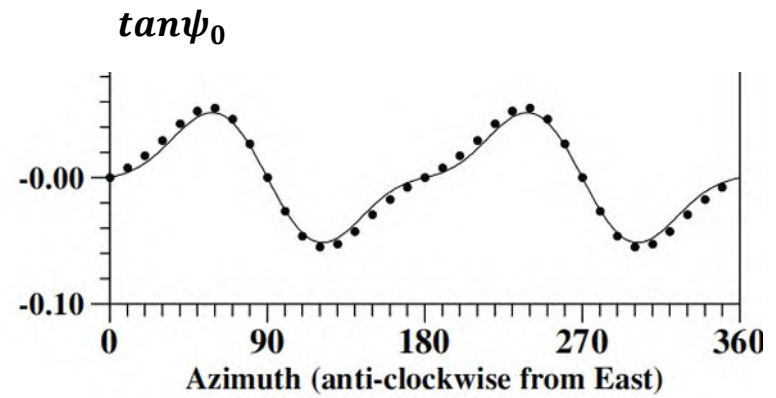
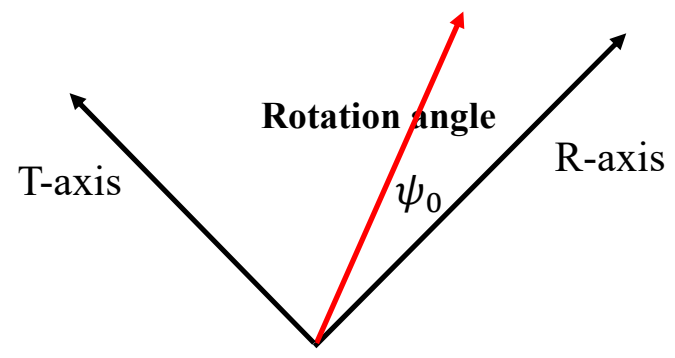
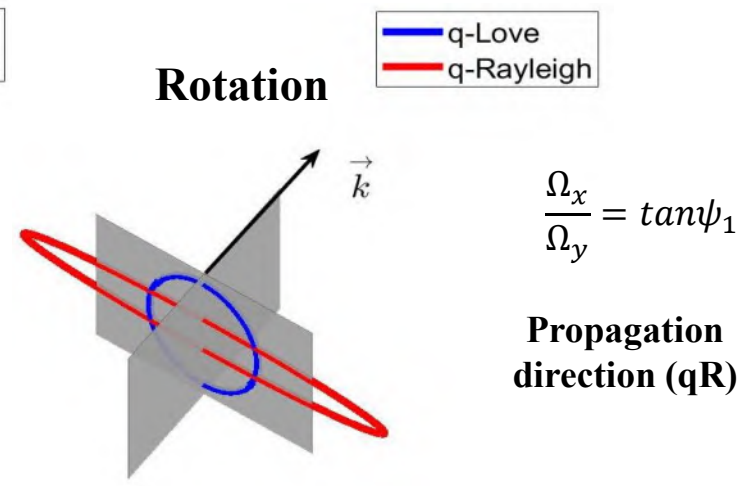
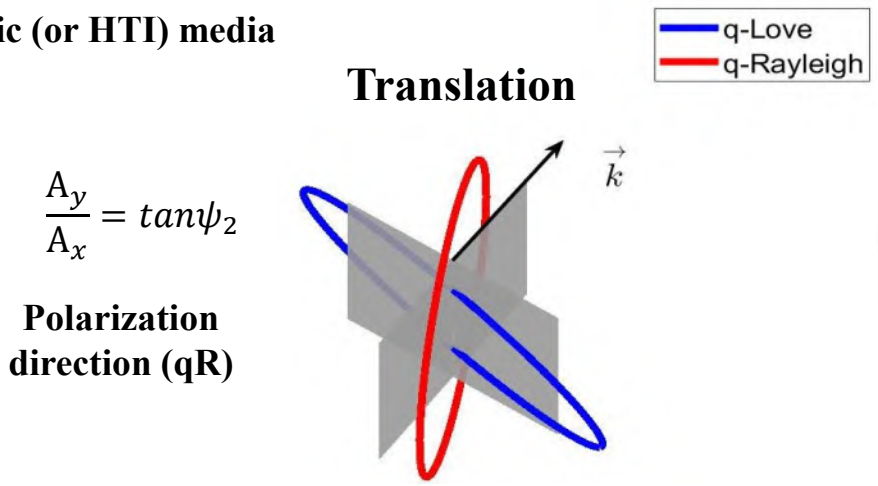
Isotropy



Anisotropy (Orthotropic media/
HTI media)



orthotropic (or HTI) media



Modified from (Tanimoto, 2004, GJI)

Dispersion Measurement

Orthotropic media

Blue: coupled term

(in Prep, 2022)

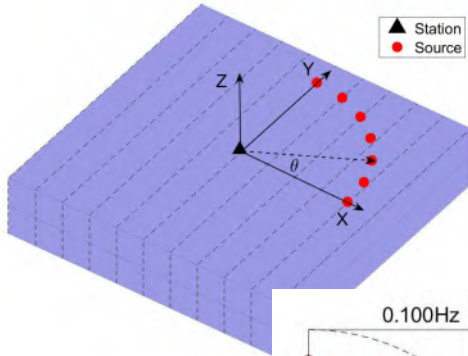
	translation	strain	rotation	Dispersion
Quasi-Rayleigh	$u_r = V(0)$ $u_z = iU(0)$ $u_t = TW(0)$	$\varepsilon_{rr} = ikV(0)$ $\varepsilon_{zz} = -\frac{C_{13}}{C_{33}} ikV(0)$ $\varepsilon_{rt} = ikTW(0)/2$	$\Omega_t = kU(0)$ $\Omega_z = ikTW(0)/2$	$C_R = \dot{u}_r / \varepsilon_{rr}$ $C_R = -\frac{C_{13}}{C_{33}} \dot{u}_r / \varepsilon_{zz}$ $C_R = -\dot{u}_z / \Omega_t$ $C_R = \dot{u}_t / (2\varepsilon_{rt})$ $C_R = \dot{u}_t / (2\Omega_z)$
Quasi-Love	$u_t = W(0)$ $u_r = TV(0)$ $u_z = iTU(0)$	$\varepsilon_{rt} = ikW(0)/2$ $\varepsilon_{rr} = ikTV(0)$ $\varepsilon_{zz} = -\frac{C_{13}}{C_{33}} ikTV(0)$	$\Omega_z = ikW(0)/2$ $\Omega_t = kTU(0)$	$C_L = \dot{u}_t / (2\varepsilon_{rt})$ $C_L = \dot{u}_t / (2\Omega_z)$ $C_L = \dot{u}_r / \varepsilon_{rr}$ $C_L = -\frac{C_{13}}{C_{33}} \dot{u}_r / \varepsilon_{zz}$ $C_L = -\dot{u}_z / 2\Omega_t$
		$\varepsilon_{rz} = 0$ $\varepsilon_{tz} = 0$ $\varepsilon_{tt} = 0$	$\Omega_r = 0$	

Numerical verification (HTI model)

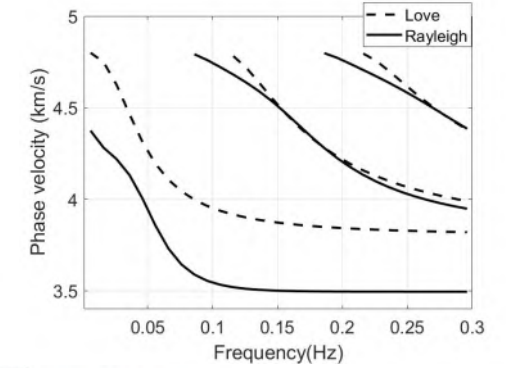
(Smith and Dahlen, 1973)

$$C(\theta) = C_0 + R_2(\omega)\cos 2\theta + R_3(\omega)\sin 2\theta + R_4(\omega)\cos 4\theta + R_5(\omega)\sin 4\theta$$

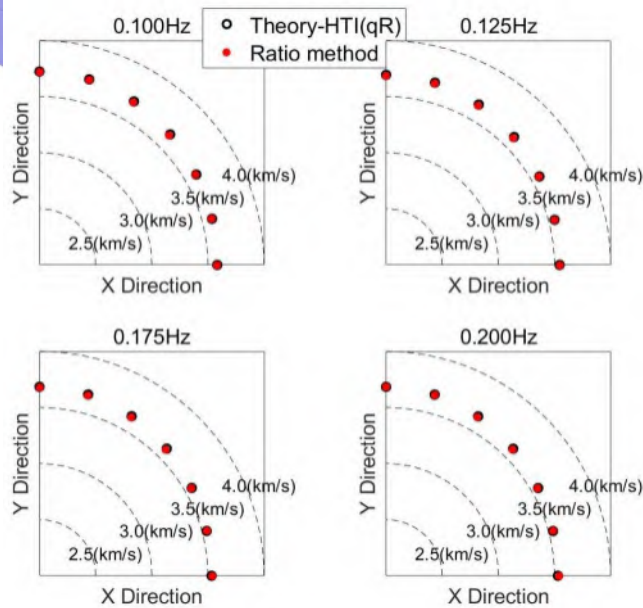
5% anisotropy



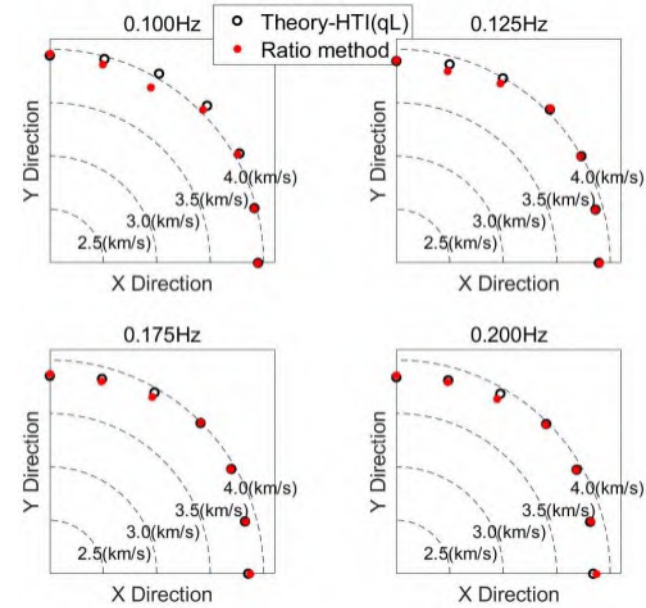
Layer	Depth(km)	V_p (km/s)	V_s (km/s)	ρ (kg/m ³)	γ	ϵ	δ
1	0-30	6.6	3.8	3000	0.05	0.05	0
2	30-∞	8.0	4.6	3300	0.05	0.05	0



qR



qL



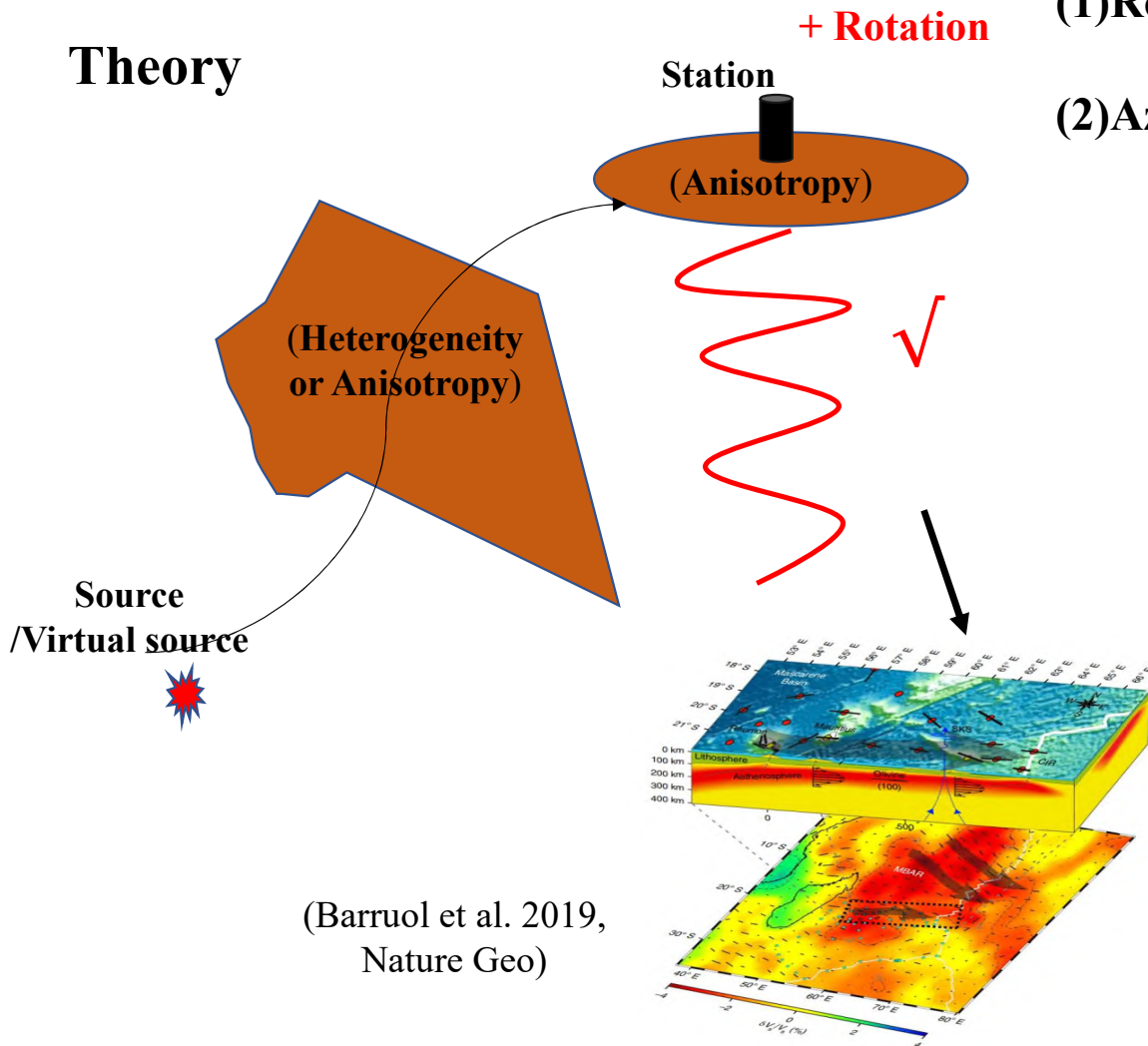
Conclusion & Outlook

Azimuth anisotropy

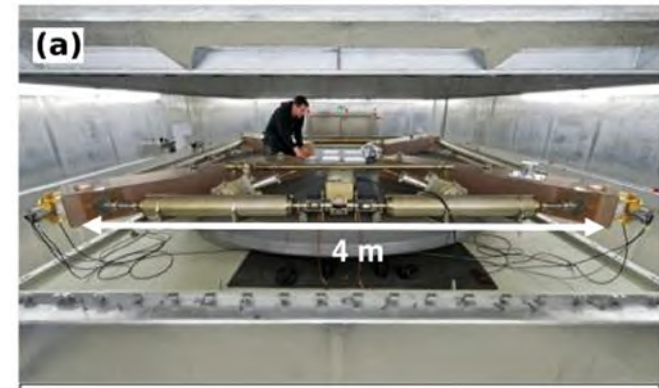
(1) Rotation angle

(2) Azimuth-dependent Dispersion

Theory



→ Field data



Ringlaser (G-ring) installed at the Wettzell observatory, SE Germany.

Effect of the coupling term (poster)