Comparison of ray methods with the exact solution in the 1-D anisotropic "twisted crystal" model

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The *isotropic ray theory*, presuming equal velocities of both S–wave polarizations, and the *anisotropic ray theory*, presuming both S–wave polarizations strictly decoupled, are the limiting cases of the *coupling ray theory* proposed by Coates & Chapman (1990). In the isotropic ray theory, the S–wave polarization vectors do not rotate about the ray, whereas in the anisotropic ray theory, they coincide with the eigenvectors of the Christoffel matrix which may rotate rapidly about the ray. The coupling ray theory provides continuous transition between the isotropic and anisotropic ray theories, correctly approximating the polarization at all degrees of anisotropy. In weakly anisotropic models, at moderate frequencies, the S–wave polarization tends to stay unrotated about the ray but is partly attracted by the rotation of the eigenvectors of the Christoffel matrix. The intensity of the attraction increases with frequency.

The 1-D "twisted crystal" model consists of a homogeneous anisotropic elastic material, uniformly helicoidally twisted about the axis of spirality. The relative deviations of the three ray methods from the exact analytical solution for the time–harmonic plane S wave, propagating along the axis of spirality, are plotted on a log–log scale in Figure 1.

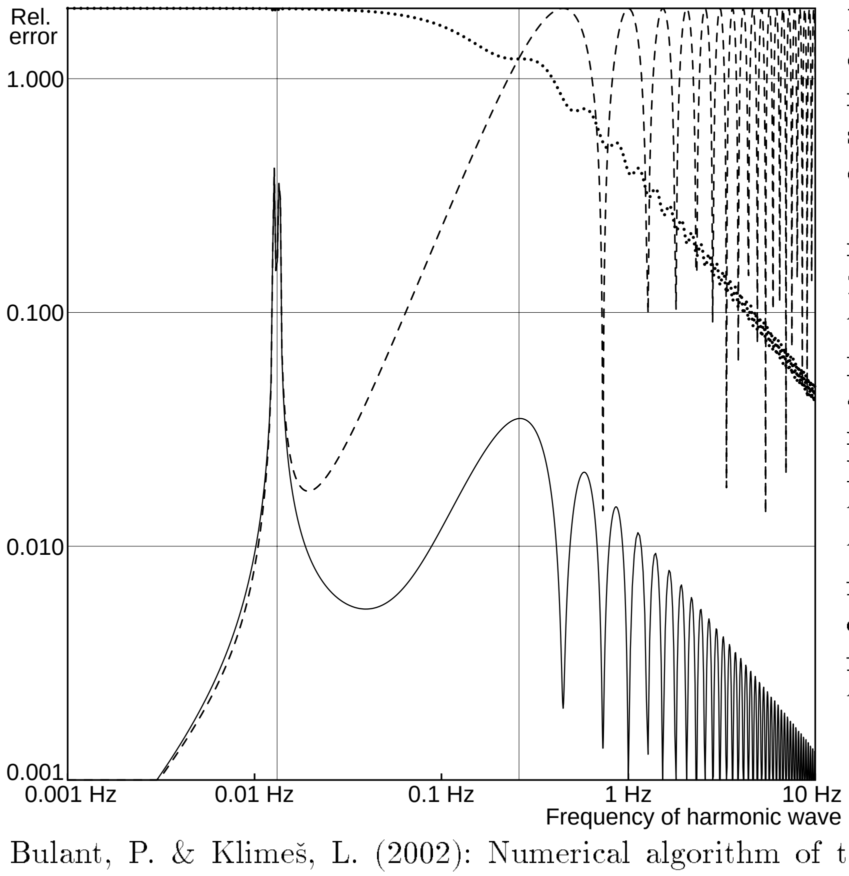

Figure 1: The relative differences of various ray methods from the exact solution in the "twisted crystal" model. *Dashed line*: Zero–order isotropic ray theory. *Dotted line*: Zero–order anisotropic ray theory. *Solid line*: Coupling ray theory by Coates & Chapman (1990), implemented according to Bulant & Klimeš (2002). The two vertical lines denote the resonant and coupling frequencies. The relative error of 200% occurs, e.g., for an opposite polarization or an opposite phase.

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Coates, R.T. & Chapman, C.H. (1990): Quasi–shear wave coupling in weakly anisotropic 3-D media. *Geophys. J. int.*, **103**, 301–320.

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