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Acoustic Wave Propagation Through a Random Array of Dislocations

Agnes Maurel[(1)], Jean F. Mercier[(2)], **Fernando Lund**[(3)]

(1) *LOA-ESPCI, Paris, France*
(2) *LSMPP-ENSTA, Paris, France*
(3) *CIMAT, Santiago, Chile*

We compute the scattering amplitude for the scattering of anti-plane shear waves by screw dislocations, and of in-plane shear and acoustic waves by edge dislocations, within the framework of elasticity theory. The former case reproduces well known results obtained on the basis of an electromagnetic analogy. The latter case involves four scattering amplitudes in order to fully take into account mode conversion. These results are then used to compute the coherent wave number of an elastic wave propagating through an elastic medium filled with randomly placed dislocations. The calculation is perturbative, with a wave equation whose right-hand-side takes into account the wave-dislocation interaction The effective velocity of the coherent wave appears at first order in perturbation theory, while the attenuation length appears at second order. The possibility of utilizing these results in the design of non intrusive probes of dislocation mediated phenomena, such as the brittle-to-ductile transition, is discussed.

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