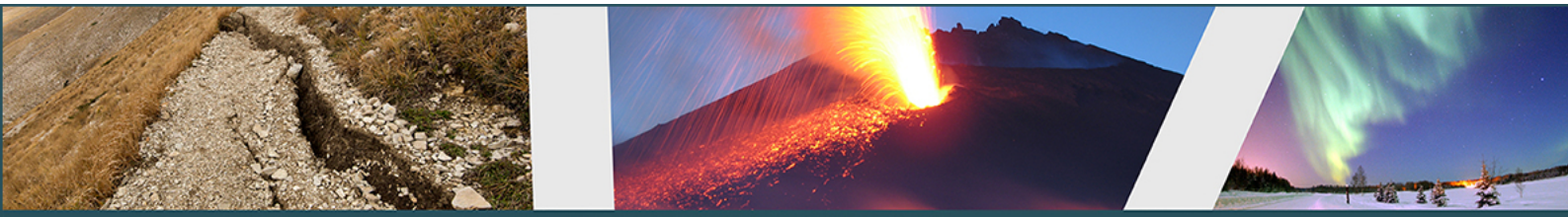

INGV ANNALS OF GEOPHYSICS

Mathematical analogies in physics. Thin-layer wave theory

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Abstract

Field theory applies to elastodynamics, electromagnetism, quantum mechanics, gravitation and other similar fields of physics, where the basic equations describing the phenomenon are based on constitutive relations and balance equations. For instance, in elastodynamics, these are the stress-strain relations and the equations of momentum conservation (Euler-Newton law). In these cases, the same mathematical theory can be used, by establishing appropriate mathematical equivalences (or analogies) between material properties and field variables. For instance, the wave equation and the related mathematical developments can be used to describe anelastic and electromagnetic wave propagation, and are extensively used in quantum mechanics. In this work, we obtain the mathematical analogy for the reflection/refraction (transmission) problem of a thin layer embedded between dissimilar media, considering the presence of anisotropy and attenuation/viscosity in the viscoelastic case, conductivity in the electromagnetic case and a potential barrier in quantum physics (the tunnel effect). The analogy is mainly illustrated with geophysical examples of propagation of S (shear), P (compressional), TM (transverse-magnetic) and TE (transverse-electric) waves. The tunnel effect is obtained as a special case of viscoelastic waves at normal incidence.

Keywords

Thin layer; Electromagnetism; Viscoelasticity; Reflection and transmission coefficient; Geophysics; Quantum mechanics

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PDF

References

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KEYWORDS

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