# ElasticMatrix - An open-source partial-wave model for evaluating elastic-wave propagation in transverse-anisotropic layered media

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## Background, Motivation and Objective

Partial-wave (PW) methods are used to describe the interaction of elastic waves with layered structures. These methods are essential for many ultrasonic applications, including NDE and geophysics. For layered-structures it is not necessary to use techniques such as finite-element and finite-difference time-domain methods. For these problems, partial-wave models are often faster and can offer a greater insight as the components of the governing equations can be individually analyzed. For example, the directional response of Fabry-Pérot (FP) ultrasound sensors has recently been modelled and analyzed using these techniques. Partial-wave methods are not trivial to implement, and existing implementations are closed-source. ElasticMatrix is an open-source software in MATLAB which implements the partial-wave method to solve the problem of anisotropic elastic wave propagation in transverse-isotropic multilayered media.

## Statement of Contribution/Methods

The elastic wave-field within each layer is represented by a summation of partial waves which describe quasi-longitudinal and quasi-shear waves, see Fig. 1(a). The wave-vector components of each partial-wave are calculated by solving the Christoffel equation. A global matrix is constructed by imposing rigidly-bonded boundary conditions between adjacent elastic layers. When solved this returns the complex amplitude (B) of each partial-wave component. The code is implemented using object-oriented-programming in MATLAB giving the user a simple command-line interface and to allow easy integration of the code into other software.

## Results/Discussion

ElasticMatrix is currently capable of calculating slowness profiles, dispersion curves, stresses and displacements and reflection coefficients. An example FP directional response for a water-glass-air structure is given in Fig.1(b). The calculated dispersion curves have been superimposed and indicate the features correspond to Lamb and Rayleigh modes. An example slowness profile for graphite-epoxy is given in Fig 1(c). By IUS2019 this software will be released as part of the k-Wave simulation toolbox and published open-source including a website with tutorials.

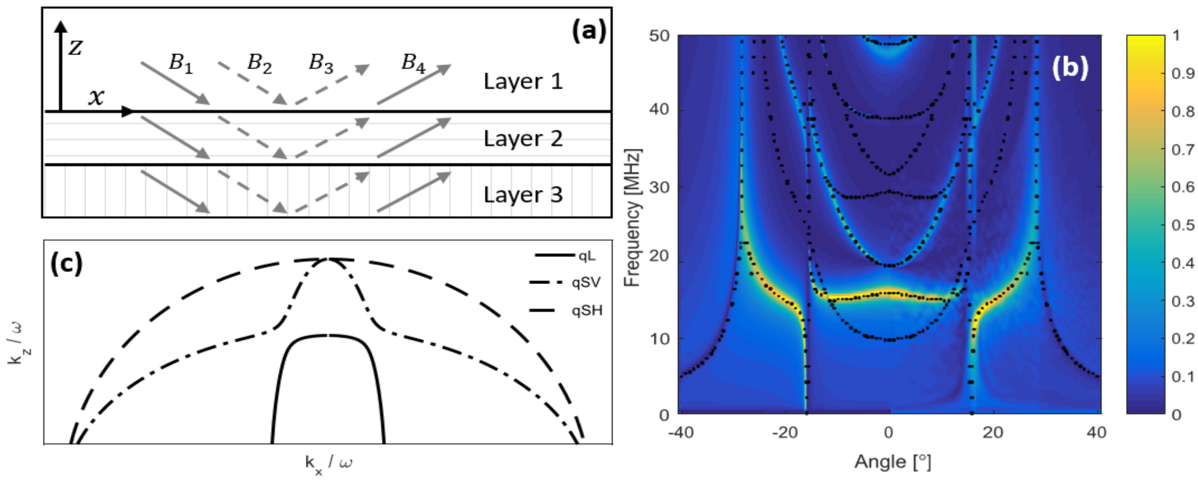


Figure 1: (a) Diagram of the model geometry. (b) Directional response and dispersion curves of a water-glass-air structure. The model has been plotted from (-40°-0°) and measured data from (0°-40°). (c) Slowness profiles for graphite-epoxy.