



Internship proposal | Proposition de stage

Laboratory: Institut Langevin (1, rue Jussieu, 75005 Paris) – ESPCI, CNRS, Université PSL

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Anisotropic stiffness characterization with guided waves

Background: Due to their polycrystalline nature, industrial materials exhibit complex and diverse mechanical behavior. Determining their macroscopic stiffness tensor is not only important for design engineers, but also reveals information about the underlying microstructure. Guided elastic waves in plates are excellent candidates for high-sensitivity and high-accuracy stiffness characterization thanks to their strong dispersion. This is visualized in Fig. 1. Two resonances can be seen in the spectrum. The k_x - k_y -wavenumber spectra associated to four different frequencies are also depicted. The abrupt change of the wavenumber spectra is due to anisotropy.

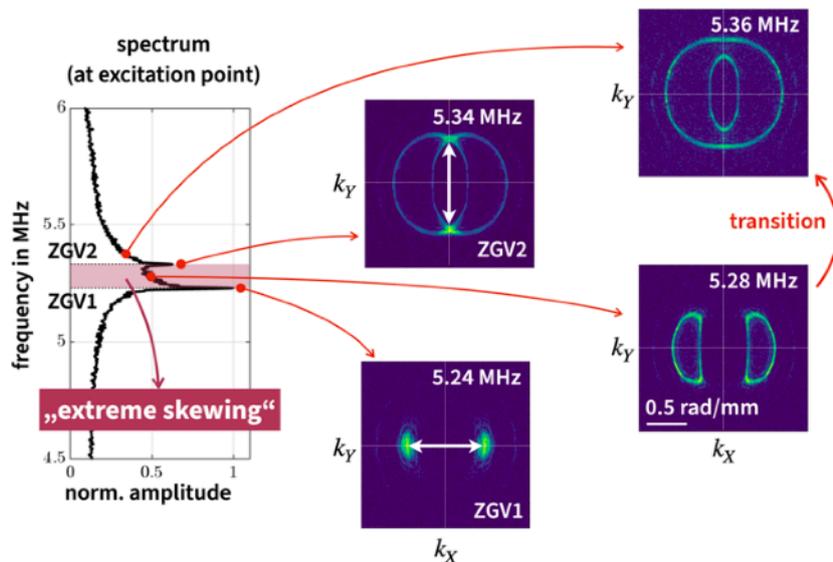


Fig. 1: Measured guided waves in a steel plate. Left: spectrum at excitation point. Right: four wavenumber spectra at the indicated frequencies.

Objective: The task is to implement a robust inverse characterization procedure to obtain the full anisotropic stiffness tensor of the material. This requires a well-designed cost function that will be optimized with appropriate methods, such as genetic algorithms. The cost function assesses how well the theoretical model matches the measurements. At Institut Langevin we have a convenient software (GEWtool) to model these waves. Furthermore, we have laser-ultrasonic experiments to acquire detailed wave fields. Initial optimization codes are already available but need to be extended and adapted. Samples of interest are nano-porous silicon, steel and chromium coated zirconium alloy.

Literature: Kiefer, Mezil, and Prada, Phys. Rev. Res., 7(1), 2025, doi: [10.1103/PhysRevResearch.7.L012043](https://doi.org/10.1103/PhysRevResearch.7.L012043)
Diboune et al., J. Acoust. Soc. Am., 159(1), 2026, doi: [10.1121/10.0042186](https://doi.org/10.1121/10.0042186).

Internship: Master-level

Required qualifications: fundamental knowledge in wave propagation and continuum mechanics, fundamental programming skills, interest in doing measurements is advantageous.