

Research Program

Title: Direct holographic measurement of elastic wave localization in scattering plates

Supervisor: Prof. Patrick Sebbah

Group: Mesoscopic Optics and Complex Media

Mesoscopic effects of waves propagating in multiply scattering media are the result of complex interference processes on scales where temporal wave coherence is preserved. They give rise to enhanced fluctuations, long-range spectral and spatial correlations, suppression of transport and Anderson localization. Predicted 60 years ago by P. W. Anderson for electronic waves, the localization of waves remains a strongly debated topic. To date, it has not yet been observed for light in 3D, the mechanism responsible for the transition from diffusion to localization is not yet understood and predicting the nature of localized states, their region of localization or their robustness to nonlinear effect remain open challenges.

In the present research project, the objective is to build and test a new instrument at Bar Ilan, in collaboration with Prof. Michael Atlan (Langevin Institute, CNRS, Paris) and to measure both the “localization landscape” and the modes of vibration in metallic plates.

This instrument is based on digital holography and can achieve steady-state vibration measurements down to amplitudes of 10 picometers, which is the current world record for wide-field vibrometry. With this approach, the localized modes of vibrating randomly-pinned plates can be captured instantaneously (in contrast to point-by-point scanning methods we are using) by scanning frequency and searching for resonances. Moreover, static measurements of the plate deformation when uniformly loaded can also be performed to retrieve the “localization landscape”. Prof. Atlan will provide with his expertise in this instrumentation and with the high throughput digital hologram rendering software Holovibes (www.holovibes.com) he developed for his instrumentation.

This method will also be used to explore localization transition in hyperuniform disordered plates. Indeed, a new class of disorder, called hyperuniform disorder, has been recently introduced to describe heterogeneous systems with suppressed long-range fluctuations, though statistically isotropic at short range. With a single parameter, scattering systems can be classified from purely periodic to fully disordered (Poisson point pattern), including the special case of quasicrystals. This parameter is a measure of the hidden order in scattering media such as porous media, foams or colloids. This work will be a joint collaboration with Prof. Marian Florescu at the University of Surrey (UK).

The candidate is expected to have a strong background in optics and skills in numerical techniques. He will be trained to the physics of light scattering in disordered system (Course #86602-01).

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