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Two-years postdoc position at Langevin Institute (Paris)

Multiple scattering theory of coherent control in resonant complex systems

Information

Nature of the postdoc : theoretical
Duration : 2 years (starting date negotiable)
Advisor : Arthur Goetschy (arthur.goetschy@espci.psl.eu)
Co-advisor : Romain Pierrat (romain.pierrat@espci.psl.eu)
Location : Institut Langevin, 1 rue Jussieu, 75005 Paris

Proposal

With the recent development of coherent control of light waves, a large variety of interference effects in complex open systems has been demonstrated and exploited [1, 2]. The goal of the project is to push forward this evolution by providing a theory for the scattering matrix of strongly disordered media made of resonant units. Although resonant materials are nowadays at the heart of atomic and molecular physics and nanophotonics, they have not been considered in wavefront shaping protocols so far. We propose to study the statistical properties of various operators built from the scattering matrix, which characterize both stationary and dynamical transport features. This includes the reflection and transmission matrices on the one hand [3–6], and the delay-time and dwell-time matrices on the other [2, 7]. By means of analytical and numerical methods, we aim at taking advantage of the interplay between scattering and internal resonances to identify new strategies useful for light confinement, energy delivery, or information processing.

The analysis will include the development of efficient numerical algorithms that compute the matrices mentioned above for 2D and 3D resonant materials, both for scalar and vector waves. In addition, we propose to elaborate an analytical model for the main statistical features of these matrices, by using tools of random matrix theory [3, 7]. Collaboration with experimental teams at the Langevin Institute — where previous ideas could be experimentally demonstrated — will be encouraged.

Application

Applicants should have a PhD in wave physics with a solid background on waves propagation in complex systems and statistical physics. Specific analytical or numerical skills are welcome. Applicants should submit a motivation letter and a resume to Arthur Goetschy. Please provide also the name and contact information of two reference persons if possible. The successful candidate will be integrated to the team "Wave theory and mesoscopic physics" of the Langevin Institute (https ://www.institut-langevin.espci.fr/waves_theory_and_mesoscopic_physics).

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[2] S. Rotter and S. Gigan, Rev. Mod. Phys. **89**, 015005 (2017).
[3] A. Goetschy and A. D. Stone, Phys. Rev. Lett. **111**, 063901 (2013).
[4] S. M. Popoff, A. Goetschy, S. F. Liew, A. D. Stone, and H. Cao, Phys. Rev. Lett. **112**, 133903 (2014).
[5] C. W. Hsu, A. Goetschy, Y. Bromberg, A. D. Stone, and H. Cao, Phys. Rev. Lett. **115**, 223901 (2015).
[6] C. W. Hsu, S. F. Liew, A. Goetschy, H. Cao, and A. D. Stone, Nat. Phys. **13**, 497 (2017).
[7] M. Durand, S. M. Popoff, R. Carminati, and A. Goetschy, Phys. Rev. Lett. **123**, 243901 (2019).