Two-years postdoc position at Langevin Institute (Paris)

Matrix approach for resonant multiple scattering of light

Information

Nature of the postdoc : theoretical
Duration : 2 years (starting date negotiable, ideally January 2021)
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 wavefront shaping techniques for light waves, a large variety of coherent effects in disordered 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 scattering 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 (also called Wigner-Smith) matrix and dwell-time matrix on the other [2, 7]. By means of numerical and analytical methods, we aim at taking advantage of the interplay between scattering and internal resonances to identify states and protocols useful for imaging, energy delivery, light confinement, 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 made of electro-magnetic dipoles or Mie-type resonators, 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 strongly encouraged.

Application

Applicants should have a PhD in wave physics with a solid background on waves propagation in complex systems. Specific 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).