Plenarvortrag PV III Di 8:30 Audi-A

Anderson localization of matter-waves in a controlled disorder: a quantum simulator? — •Alain Aspect — Institut d'Optique, Campus Polytechnique, Palaiseau, France

In 1958, P.W. Anderson predicted the localization1 of electronic wave functions in disordered crystals, and the resulting absence of diffusion. It has been realized later that Anderson Localization is ubiquitous in wave physics2 as it originates from the interference between multiple scattering paths, and this has prompted an intense activity to observe it with light waves, microwaves, sound waves, and electron gases, but to our knowledge there was no direct observation of exponential spatial localization of matter-waves (electrons or others). We have observed directly [3] exponential localization of the wave function of ultracold atoms released into a one-dimensional waveguide in the presence of a controlled disorder created by laser speckle. We will present this work, and the prospects of extending that type of study to quantum gases in higher dimensions (2D and 3D) and with controlled interactions. We will also discuss its significance in the rapidly growing domain of quantum simulators to study difficult problems of Condensed Matter.

[1] Anderson, P.W. Absence of diffusion in certain random lattices. Phys. Rev. 109, 1492-1505 (1958).

[2] Van Tiggelen, B. Anderson localization of waves. In Wave diffusion in complex media 1998, edited by J.P. Fouque, Les Houches Lectures (Kluwer, Dordrecht, 1999).

[3] J. Billy, V. Josse, Z. Zuo, A. Bernard, B. Hambrecht, P. Lugan, D. Clément, L. Sanchez-Palencia, P. Bouyer & A. Aspect. Direct observation of Anderson localization of matter-waves in a controlled disorder, Nature, 453, 891 (2008); published back to back with a related work in the Inguscio's group at Florence: G. Roati et al., Anderson localization of a non interacting Bose-Einstein Condensate, Nature, 453, 895 (2008).