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Abstract for an Invited Paper
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Direct observation of Anderson localization of matter-waves in an optical disorder[1]

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In 1958, P.W. Anderson predicted the localization[1] 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 physics[2], and this has prompted an intense activity to observe it with light, 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 experimental scheme to quantum gases in higher dimensions (2D and 3D), and with controlled interactions. We will also discuss its significance in the rapidly growing field of quantum simulators.

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 Juliette Billy, Vincent Josse, Zhanchun Zuo, Alain Bernard, Ben Hambrecht, Pierre Lugan, David Clément, Laurent Sanchez-Palencia, Philippe Bouyer& Alain Aspect. *Direct observation of Anderson localization of matter-waves in a controlled disorder* Nature, 453, 891 (2008).

Work published back to back with a related work in the Inguscio's group in Florence: G. Roati et al., Nature, 453, 895 (2008).

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