

# Nonlinear scattering of atomic bright solitons in disorder.

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We observe nonlinear scattering of  $^{39}\text{K}$  atomic bright solitons [1] launched in a one-dimensional (1D) speckle disorder. We directly compare it with the scattering of non-interacting particles in the same disorder. The atoms in the soliton tend to be collectively either reflected or transmitted, in contrast with the behavior of independent particles in the singlescattering regime, thus demonstrating a clear nonlinear effect in scattering. The observed strong fluctuations in the reflected fraction, between zero and 100%, are interpreted as a consequence of the strong sensitivity of the system to the experimental conditions and in particular to the soliton velocity [2]. This behavior is reproduced in a mean-field framework by Gross-Pitaevskii simulations, and mesoscopic quantum superpositions of the soliton being fully reflected and fully transmitted are not expected for our parameters. We discuss the conditions for observing such superpositions, which would find applications in atom interferometry beyond the standard quantum limit [3].

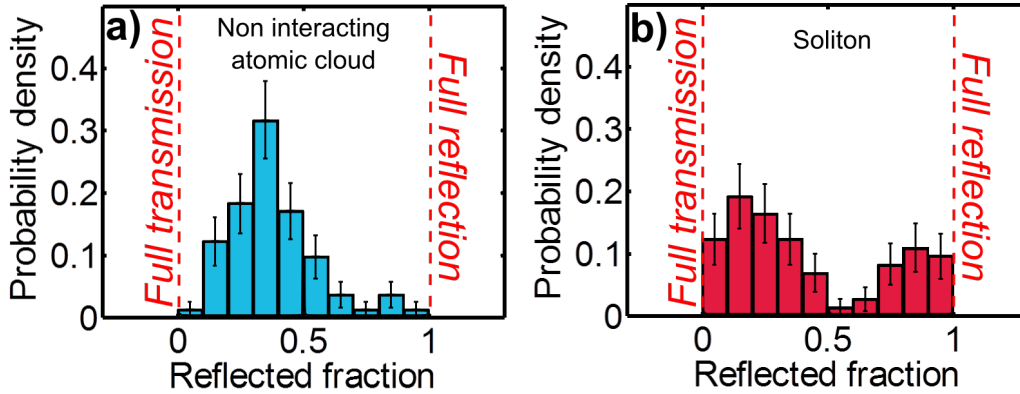


Figure 1: **Figure 1.** (Color online) Histograms of the experimentally measured reflected fractions of non-interacting atoms ((a) in blue) and solitons ((b) in red). The double-peak structure in (b) is a clear signature of nonlinear scattering.

[1] S. Lepoutre, L. Fouché, A. Boissé, G. Berthet, G. Salomon, A. Aspect, and T. Bourdel, *Phys. Rev. A* **94**, 053626 (2016).

[2] A. Boissé, G. Berthet, L. Fouché, G. Salomon, A. Aspect, S. Lepoutre and T. Bourdel, *EPL* **117**, 10007 (2017).

[3] Alexej I. Streltsov, Ofir E. Alon, and Lorenz S. Cederbaum, *Phys. Rev. A* **80**, 043616 (2009).