Coherent backscattering of weakly interacting ultracold atoms

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We study the momentum-space dynamics of a weakly interacting quantum gas of bosons propagating in a spatially disordered medium. Specifically, we focus on the impact of weak interactions on the time evolution of the Coherent Backscattering (CBS) peak [1]. For a non-interacting gas initially prepared as a plane wave state $|\mathbf{k_0}\rangle$ in a random potential, CBS usually manifests itself as an interference peak around the backscattering direction of the momentum distribution [2]. When weak interactions are present, the evolution is governed by the Gross-Pitaevskii equation for the condensed, disordered Bose gas.
Recent simulations suggest that interactions have three main effects on the CBS peak. At very short times first, they prevent the CBS peak from reaching its maximum value of twice the height of the diffusive background. Then on a longer time scale, interactions mimic a decoherence mechanism and make the CBS peak constrast slowly decay in time (Fig. 1). Finally, at very long times, interactions are expected to thermalize the whole momentum distribution. The study of these effects will give some insight on how the interactions affect phase coherence and the energy distribution of quantum gases in disordered environments.

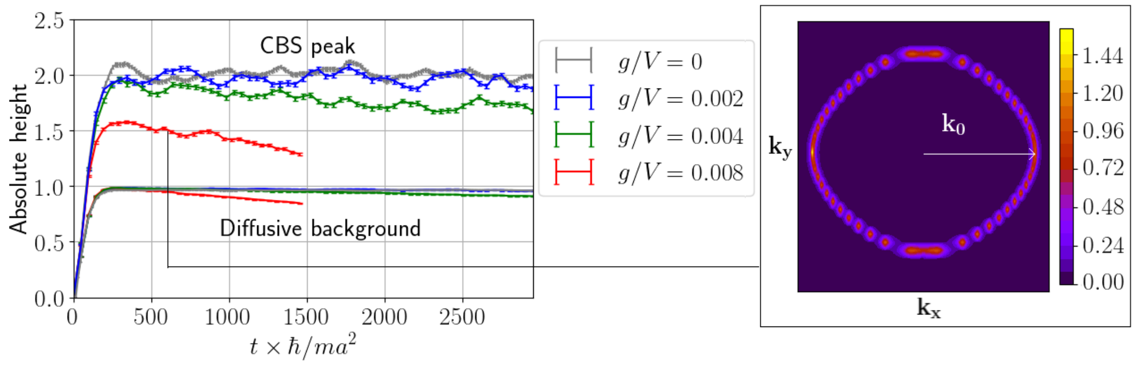

Figure 1: Left : Time evolution of the CBS peak and the diffusive background amplitudes in momentum space for various values of the interaction energy scale g/V (V is the volume of the system). We use a delta-correlated disorder of strength $V_0 = 0.2 \times \hbar^2/ma$, and $k_0 = \frac{\pi}{2a}$ such that $k_0 l \sim 100$. the result is averaged over 3000 realizations of the disorder. Right : Density plot of the momentum distribution at time $t = 600 \times \hbar/ma^2$ (a is the lattice spacing).

[1] N. Cherroret et al., Phys. Rev. A **85**, 011604 (2012).
[2] F. Jendrzejewski et al., Phys. Rev. Lett. **109**, 195302 (2012).