Relaxation of single-mode excitations in a quasi-condensate

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The dynamics and relaxation of interacting quantum many-body systems are highly complicated. Ultracold gases in reduced dimensions offer a powerful experimental platform for studying these phenomena, however, the complexity of such systems makes it challenging to distinguish competing mechanisms of relaxation. Here we present the realization of a one-dimensional quasi-condensate in a box-potential with an adjustable trap bottom. By switching the trap bottom shape from an eigenmode of the box to a flat potential we can accurately excite a single mode of the condensate. The very controlled manner in which the quench is conducted allows for excellent comparison to theory, thus facilitating an in-depth study of the many-body dynamics. We find simple Luttinger-Liquid descriptions unable to capture the observed relaxation, indicating the presence of phonon-phonon interactions. Instead, the dynamics accurately follow predictions of Generalized Hydrodynamics (GHD) [1][2], which describes the relaxation as caused by individual constituents of the mode dephasing with respect to one another. Further, our setup is an ideal platform for observing diffusive dynamics, which constitutes higher-order corrections to GHD.

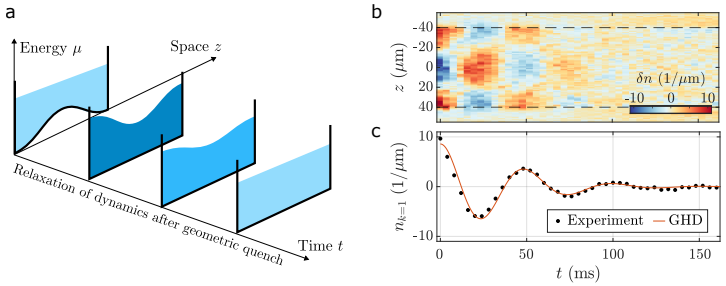

Fig. 1: a, Sketch of the experimental protocol, addressing a single mode of the condensate. **b**, Observed evolution of imprinted density perturbation. **c**, Evolution of the addressed mode and comparison to Generalized Hydrodynamics (GHD) predictions.

References

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