Probing the emergent physics of quasi-1D Bose gases

Frederik Møller[1], Federica Cataldini[1], Mohammadamin Tajik[1], Philipp Schüttelkopf[1], Nataliia Bazhan[1], Si-Cong Ji[1], Igor Mazets[1], and Jörg Schmiedmayer[1]

[1] *(Presenting author underlined) Vienna Center for Quantum Science and Technology (VCQ), Atominstitut, TU Wien, Vienna, Austria*

Over the past decade, one-dimensional (1D) ultracold gases trapped on atom chips have proven a powerful platform for studying the emergent physics of quantum many-body systems. Using techniques of in-*situ* imaging and matter-wave interference, along with advances analysis techniques, transport and higher-order correlation functions on the emergent scale can be probed. I will present an overview of the capabilities and limitations of these approaches, focusing, in particular, on recent results regarding transport:

In a series of experiments, a fully adjustable 1D potential was employed to perform highly controlled quenches [1], where measurements of the subsequent dynamics facilitate testing the predictions of transport theories such as Generalized Hydrodynamics (GHD). Indeed, following quenches of a single momentum mode of the condensate, a surprisingly good agreement with GHD predictions was found, even at relatively high energies [2]. In highly energetic 1D systems, 3D scattering events are known to break integrability and drive the system towards thermalization [3]. However, as identified by the Bethe Ansatz, the elementary excitations of the 1D Bose gas are actually fermionic; the slow relaxation observed (in agreement with 1D GHD) can be explained via an emergent Pauli blocking of the non-integrable scattering and is thus an indication of the underlying quasi-particle statistics [2].

[1] M. Tajik, B. Rauer, T. Schweigler, F. Cataldini, J. Sabino, F. Møller, S.-C. Ji, I. Mazets, and J. Schmiedmayer, Opt. Express **27**, 33474-33487 (2019).

[2] F. Cataldini, F. Møller, M. Tajik, J. Sabino, S.-C. Ji, I. Mazets, T. Schweigler, B. Rauer, and J. Schmiedmayer, Phys. Rev. X **12**, 041032 (2022).

[3] F. Møller, C. Li, I. Mazets, H.-P. Stimming, T. Zhou, Z. Zhu, X. Chen, and J. Schmiedmayer, Phys. Rev. Lett. **126**, 090602 (2021).