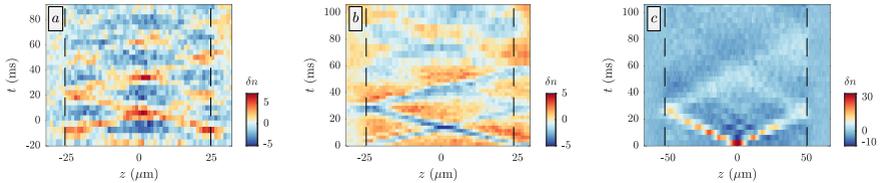


# Damping of phonons in one-dimensional Bose gases

F. Cataldini<sup>\*1</sup>, N. Bazhan<sup>1</sup>, J. Sabino<sup>1</sup>, P. Schüttelkopf<sup>1</sup>, M. Tajik<sup>1</sup>, F. Møller<sup>1</sup>,  
S.C. Ji<sup>1</sup>, S. Erne<sup>1</sup>, I. Mazets<sup>1</sup>, J. Schmiedmayer<sup>1</sup>

*1. Vienna Center for Quantum Science and Technology (VCQ), Atominsttitut, TU Wien, Vienna, Austria*

One-dimensional (1D) quantum fluids are often modelled by Luttinger Liquid (LL) theory. The collective excitations (phonons) are expected to propagate almost without dissipation. Thermal fluctuations and deviations from linear dispersion are predicted to introduce subtle mechanisms of damping even in the deep 1D regime. Here we directly excite phonon modes in a weakly interacting 1D Bose gas and study their time evolution [1]. For weak excitations (linear response), the damping is surprisingly fast and follows the non-analytic scaling  $\Gamma_k \propto k^{3/2}$  predicted by Andreev's self-consistent hydrodynamics [2]. The extracted exponent  $1.48 \pm 0.03$  and a scaling pre-factor of  $0.76 \pm 0.02$  proves the quantitative agreement between experiment and hydrodynamic prediction and establishes phonon-phonon scattering as the dominant relaxation mechanism for low-momentum excitations in near-equilibrium 1D quantum fluids. For strong excitations, we observe a crossover to a highly non-linear regime characterized by wave breaking, captured by finite-temperature non-polynomial Schrödinger equation simulations.



**Fig. 1:** Dynamics of a single (on the left) and collective (at the center and on the right) phononic modes in a 1D Bose gas.

## References

- [1] F. Cataldini et al., arXiv:2511.13681
- [2] A. F. Andreev, Soviet Phys. JETP 51, 1038 (1980)

---

<sup>\*</sup> federica.cataldini@tuwien.ac.at