

## PhLAM RESEARCH SEMINAR SERIES May 22nd, 2025, 10:30 AM IRCICA Building

## Dynamics of an integrable many-body system probed using cold atom experiments

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Many theoretical progress has been done over the last decade on the physics of many-body quantum integrable systems, culminating in the establishment of the Generalized Hydrodynamics (GHD) theory and its numerous developments. In this seminar we will focus on the integrable model that consists of one-dimensional Bosons with contact repulsive interactions, dubbed the Lieb-Liniger model. Because of its integrability, stationary states of the Lieb-Liniger model do not have to be thermal states. Instead they are expected to be characterized by a whole function, their rapidity distribution, which can be seen as the velocity distribution of the infinite-lifetime quasi-particles. For systems with slow and long wave length variations, one introduces the notion of local rapidity distribution, the system as a whole being described by a spatially dependent rapidity distribution. This key notion is at the heart of the Generalized Hydrodynamics (GHD) theory, which provides a prediction for its time evolution.

The Lieb-Liniger model can be realized in cold atom experiments providing strong enough transverse confinements are used to freeze out transverse degrees of freedom. The GHD theory has been tested successfully in those experiments since 2019, the first test being done in our setup, where Rubidium atoms are confined in micro-magnetic traps[1]. However, these first tests were indirect since the local rapidity distribution is not probed. More recently, we implemented a procedure to measure the local rapidity distribution and we applied it to out-of-equilibrium protocols[2]. This permits a much more stringent test of the GHD theory and it opens many perspectives to deepen our understanding of the physics of integrable systems.

During this seminar, we will review the experimental results obtained in cold atoms setups on the dynamics of the Lieb-Liniger model. We will finish by a brief discussion about the extension of the notions developed within the Lieb-Liniger model to its classical limit, namely the Non-Linear Shrödinger model.

[1] M. Schemmer et al. ``Generalized Hydrodynamics on an Atom Chip". Phys. Rev. Let., vol. 122, p.090601 (2019)

[2] L. Dubois et al., "Probing the Local Rapidity Distribution of a One-Dimensional Bose Gas", Phys. Rev. Lett. vol (133), p.113402 (2024)



