Peter Schlagheck (University of Liège)

Quantum and semiclassical dynamics of interacting bosons

Recent experimental studies of thermalization and localization phenomena with ultracold bosonic atoms in optical lattices have underlined the role of such bosonic many-body systems as quantum simulators and pose new challenges for numerical simulations. As genuine quantum many-body methods are often limited in applicability for large systems and/or do not always provide sufficient insight into relevant mechanisms, semiclassical approaches become useful in order to obtain a theoretical understanding of bosonic many-body dynamics.

In my talk I shall focus on two complementary semiclassical approaches. On the one hand, the van Vleck-Gutzwiller propagator can be generalized to the many-body domain. This framework allows one to predict a significant deviation from quantum ergodicity due to coherent backscattering in Fock space, which is confirmed by numerical simulations [1]. On the other hand, the time evolution of a Bose-Einstein condensate that loses its matter-wave coherence due to significantly strong interaction effects can be faithfully predicted by an adaptation of Maslov's WKB method, which amounts to representing the quantum many-body system in terms of a discrete sum over complexified Gross-Pitaevskii trajectories [2]. We discuss how the insight provided by these semiclassical approaches allows one to enhance the applicability of the quasiclassical Truncated Wigner method.

[1] T. Engl, J. Dujardin, A. Argüelles, P. Schlagheck, K. Richter, and J.D. Urbina, Phys. Rev. Lett. 112, 140403 (2014).

[2] S. Tomsovic, P. Schlagheck, D. Ullmo, J.D. Urbina, and K. Richter, Phys. Rev. A 97, 061606(R) (2018).