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Generalised BBGKY hierarchy for near-integrable dynamics

We consider quantum or classical many-body Hamiltonian systems characterized by integrable contact interactions supplemented by a generic two-body potential, potentially long-range. We show how the hydrodynamics of local observables is given in terms of a generalised version of Bogoliubov–Born–Green–Kirkwood–Yvon hierarchy, which we denote as gBBGKY, which is built for the densities, and their correlations, of the quasiparticles of the underlying integrable model. Unlike the usual cases of perturbation theory from free gases, the presence of local interactions in the integrable model "lifts"the so-called kinetic blocking, presenting thermalization time scales quadratic in the perturbing potential.
In particular, we check our results with exact molecular dynamics simulations for the perturbed Hard rod gas, finding convincing agreement.
Unlike previous approaches based on Fermi's golden rule and matrix elements, the gBBGKY allows one to directly access the late time scattering integrals and the time evolution of multi-point correlations in generic perturbed integrable models at hydrodynamic length and time scales.
It can be also applied to systems on a lattice such as long-range spin chains or fermionic systems as first experimentally driven examples.
Finally, we show how it can be straightforwardly extended to interacting multi-tubes systems, already implemented in cold-atoms experiments.

Author: BIAGETTI, Leonardo (CY Cergy paris University)

Co-authors: DE NARDIS, Jacopo (CY Cergy Paris University); Mr LEBEK, Maciej (University of Warsaw); Prof. PANFIL, Milosz (University of Warsaw)

Presenter: BIAGETTI, Leonardo (CY Cergy paris University)

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