Tuesday, April 20, 2021 At 3:45 pm

CYCLOTRON COLLOQUIUM (Zoom Mtg)

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From Dilute to Dense, One Particle at a Time: Calculating and Resumming the Virial Expansion of Quantum Gases

Abstract:

Strongly interacting quantum gases, from ultracold atomic clouds to neutron stars, represent a challenging many-body problem. Typically, these systems undergo spontaneous symmetry breaking into a superfluid phase (in some cases of exotic types) at some critical temperature, which is calculated with quantum Monte Carlo methods, if possible. Above that critical temperature, these systems usually display a quantum-classical crossover with distinct interaction effects, captured by the so-called virial expansion. The latter contains, at a given order n, the contributions of the n-body system to the many-body problem. The second-order virial coefficient has been known since the 1930's, encoded in the celebrated Beth-Uhlenbeck formula, but progress towards higher orders has been slow, with predictions for the third- and fourth-order coefficients in very limited cases appearing only in the 21st century.

In this talk, I will show and discuss the results of a new, non-perturbative, analytic approach to calculating virial coefficients beyond fifth order, which has recently enabled the application of series resummation techniques. With the latter, we have been able to make predictions for the thermodynamics of quantum gases in 1, 2, and 3 spatial dimensions, for a wide range of coupling strengths (up to unitarity in 3D) and temperatures, beyond the expected regime of validity of the virial expansion. The new approach can be extended to other observables and physical situations, including nuclear matter and real-time dynamics of small systems.

Via Zoom Meeting