Contribution ID: **15** Type: **Contributed talk**

How to deduce the entropy from atom-atom correlations

Thursday 5 September 2024 12:20 (20 minutes)

We derive a thermodynamic Maxwell relation by which the entropy of an ultracold atomic gas can be deduced from the local (same point) atom-atom correlation function. The Maxwell relation in question is applicable to many-body systems with short-range interactions that can be characterised by s-wave scattering. For such systems, the local atom-atom correlation function represents a thermodynamic quantity that can be calculated from the Helmholtz free energy using the Hellmann-Feynman theorem [1]. Here, we exploit this property to derive a Maxwell relation that relates the atom-atom correlation to the thermodynamic entropy of the system [2]. As a practical application of this Maxwell relation, we utilise it to calculate the entropy of a weakly interacting one-dimensional (1D) Bose gas from its atom-atom correlations in the context of the c-field approach of the stochastic projected Gross-Pitaevskii equation (SPGPE). The SPGPE is a well established and widely used numerical approach for computing thermal equilibrium and dynamical properties of finite temperature Bose gases, such as partially condensed Bose-Einstein condensates in 2D and 3D, or phase-fluctuating quasicondensates in 1D. Despite its wide applicability to ultracold quantum gas systems, computing the entropy of such systems within the SPGPE has not been accomplished prior to this work. Our calculations can also be viewed as a numerical experiment that serves as a proof-of-principle demonstration of an experimental method to deduce the entropy of an ultracold quantum gas from the measurements of atom-atom correlations.

References

[1] K. V. Kheruntsyan, D. M. Gangardt, P. D. Drummond, and G. V. Shlyapnikov, Phys. Rev. Lett. 91, 040403 (2003).

[2] R. S. Watson, C. Coleman, and K. V. Kheruntsyan, arXiv:2405.04159 (2024).

Short bio (50 words) or link to website

https://people.smp.uq.edu.au/KarenKheruntsyan/index.html

Relevant publications (optional)

Career stage

Professor

Author: KHERUNTSYAN, Karen

Co-authors: Mr WATSON, Raymon (University of Queensland); Mr COLEMAN, Caleb (University of Queensland)

Presenter: KHERUNTSYAN, Karen

Track Classification: FINESS