
Tan's Contact for Trapped Lieb-Liniger Bosons at Finite Temperature

Hepeng Yao^{*1}, David Clément², Anna Minguzzi³, Patrizia Vignolo⁴, and Laurent Sanchez-Palencia⁵

¹Centre de Physique Théorique [Palaiseau] – Polytechnique - X, Centre National de la Recherche Scientifique : UMR7644 – France

²Laboratoire Charles Fabry (LCF) – Université Paris-Sud - Paris 11, Institut d'Optique Graduate School, Centre National de la Recherche Scientifique : UMR8501, Institut d'Optique Graduate School – 2 avenue Augustin Fresnel, 91127 Palaiseau Cedex, France

³Laboratoire de physique et modélisation des milieux condensés (LPMMC) – CNRS : UMR5493, Université Joseph Fourier - Grenoble I – Maison des Magistères/CNRS 25 Av des martyrs - BP 166 38042 GRENOBLE CEDEX 9, France

⁴Institut de Physique de Nice – CNRS : UMR7010, Université Nice Sophia Antipolis (UNS), Université Nice Sophia Antipolis [UNS] – France

⁵Centre de Physique Théorique [Palaiseau] (CPHT) – Polytechnique - X, Centre National de la Recherche Scientifique : UMR7644 – Ecole Polytechnique 91128 Palaiseau cedex, France

Abstract

The universal Tan relations connect a variety of microscopic features of many-body quantum systems with two-body contact interactions to a single quantity, called the contact. The latter has become pivotal in the description of quantum gases. We provide a complete characterization of the Tan contact of the harmonically trapped Lieb-Liniger gas for arbitrary interactions and temperature. Combining thermal Bethe ansatz, local density approximation, and exact quantum Monte Carlo calculations, we show that the contact is a universal function of only two scaling parameters, and determine the scaling function. We find that the temperature-dependence of the contact, or equivalently the interaction-dependence of the entropy, displays a maximum. The presence of this maximum provides an unequivocal signature of the crossover to the fermionized regime and it is accessible in current experiments.

*Speaker