An Interaction Quench Heat Engine Using a One-Dimensional Bose Gas

R.S. Watson and K.V. Kheruntsyan,
School of Mathematics and Physics, University of Queensland, Brisbane, Queensland 4072, Australia.

Quantum thermodynamics is a highly active field thanks in part to its link with the development of future quantum technologies, but also to its connection with the advancement of theoretical and experimental physics. The quantum Otto cycle, shown in Figure 1, has been a particular focus due to its experimental realisability. In recent years there has been a growing focus on many-body quantum heat engines (QHE’s) since it was shown in Ref. [1] that these machines are capable of outperforming an ensemble of single-particle heat engines operating under a quantum Otto cycle with the same resources, thus theoretically demonstrating a many-body quantum advantage. The Lieb-Liniger model of the one-dimensional (1D) Bose gas is ideal for the implementation of QHE’s due to its rich phase diagram and experimental realisability. Recently, the concept of an interaction-driven many-particle QHE was introduced [2], where the control over inter-atomic interaction strength was utilized for the production of work in a uniform 1D Bose gas. Taking advantage of the many theoretical tools and exact results available for the Lieb-Liniger model at finite temperature, we investigate the performance, focusing on total work output and efficiency, of an interaction-driven many-body QHE, exploring the entire phase diagram for the experimentally relevant case of a harmonically trapped 1D Bose gas.