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An interaction-driven quantum heat engine using a Lieb-Liniger gas

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Quantum heat engines have been the subject of growing interest in recent years in the emerging field of quantum thermodynamics. Such engines can utilize uniquely quantum many-body effects to enhance the performance of classical engines, implying a quantum advantage. In my contribution, I will introduce and discuss the performance of a quantum many-body Otto cycle operating under a sudden interaction quench protocol, with a harmonically trapped 1D Bose gas as a working fluid. I will show how the very operation of this Otto cycle as a heat engine is enabled by atom-atom correlations in the gas. These correlations are a result of the interplay between quantum statistics, interparticle interactions, and thermal fluctuations; extracting net positive work from this system without such correlations would be impossible. I will also show how the performance of the engine can be further enhanced by allowing particle exchange between the system and the thermal reservoirs, in addition to heat exchange. The performance of this Otto heat engine can be evaluated using approximate analytic or exact thermodynamic Bethe ansatz results available for the Lieb-Liniger model that describes the 1D Bose gas, but the broad conclusions that we arrive at are not limited to this particular model.

Primary author: KHERUNTSYAN, Karen (University of Queensland)

Co-author: Mr WATSON, Raymon (University of Queensland)

Presenter: KHERUNTSYAN, Karen (University of Queensland)

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