Coherence-assisted single-shot cooling by quantum absorption refrigerators

Mark Mitchison[*†1], Mischa Woods[2], Javier Prior[3], and Marcus Huber[‡4,5]

[1]Quantum Optics and Laser Science, Blackett Laboratory (QOLS) – QOLS, Blackett Laboratory, Imperial College London, London SW7 2BW, UK, United Kingdom

[2]University College London - London's Global University (UCL) – Gower Street - London, WC1E 6BT, United Kingdom

[3]Universidad Politecnica de Cartagena (UPCT) – Spain

[4]Universitat Autonoma de Barcelona (UAB) – Bellaterra, Barcelona, Spain

[5]ICFO-Institut de Ciencies Fotoniques (ICFO) – Spain

Abstract

The extension of thermodynamics into the quantum regime has received much attention in recent years. A primary objective of current research is to find thermodynamic tasks which can be enhanced by quantum mechanical effects. With this goal in mind, we explore the finite-time dynamics of absorption refrigerators composed of three qubits. The aim of this finite-time cooling is to reach low temperatures as fast as possible and subsequently extract the cold particle to exploit it for information processing purposes. We show that the coherent oscillations inherent to quantum dynamics can be harnessed to reach temperatures that are colder than the steady state in orders of magnitude less time, thereby providing a fast source of low-entropy qubits. This effect demonstrates that quantum thermal machines can surpass classical ones, reminiscent of quantum advantages in other fields, and is applicable to a broad range of technologically important scenarios.

[*]Speaker

[†]Corresponding author: mark.mitchison11@imperial.ac.uk

[‡]Corresponding author: marcus.huber@uab.cat