Extractable work, the role of correlations, and asymptotic freedom in quantum batteries

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We investigate a quantum battery made of N two-level systems, which is charged by an optical mode via an energy-conserving interaction. We quantify the fraction of energy stored in the battery that can be extracted in order to perform thermodynamic work. We first demonstrate that this quantity is highly reduced by the presence of correlations between the charger and the battery or between the subsystems composing the battery. We then show that the correlation-induced suppression of extractable energy, however, can be mitigated by preparing the charger in a coherent optical state. We conclude by proving that the charger-battery system is asymptotically free of such locking correlations in the $N \to \infty$ limit. [1]

[1]G.M. Andolina, M. Keck, A. Mari, M. Campisi, V. Giovannetti, and M. Polini, *Phys. Rev. Lett.* **122**, 047702 (2019).