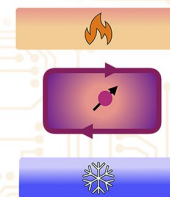


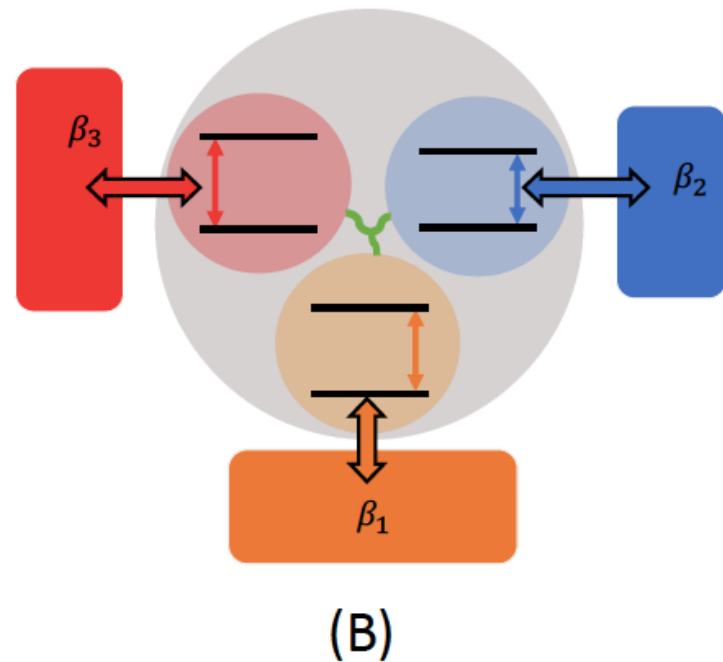
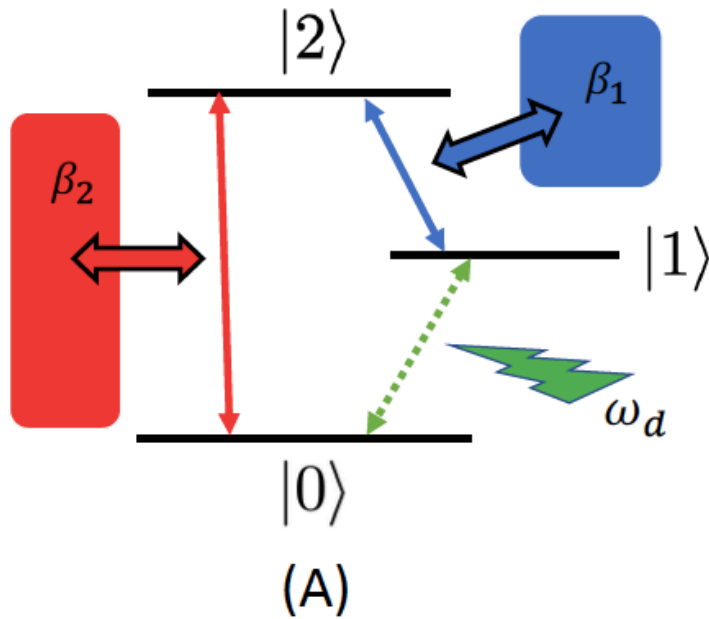
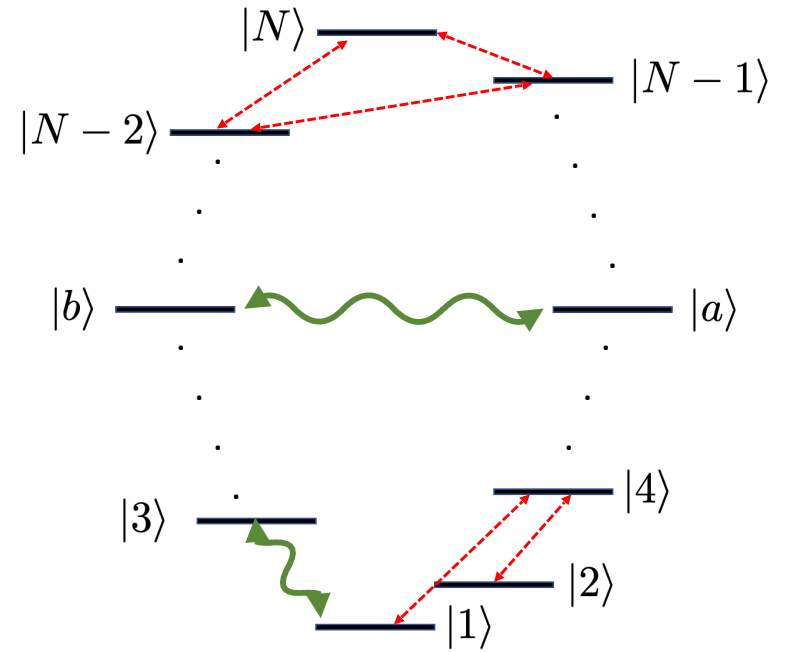
Coherence for quantum-enhanced thermodynamic performance in steady-state quantum thermal machines

José A. Almanza Marrero, Roberta Zambrini and Gonzalo Manzano



5-6/06 @ IFISC (UIB-CSIC)
Novel trends in topological systems and quantum thermodynamics

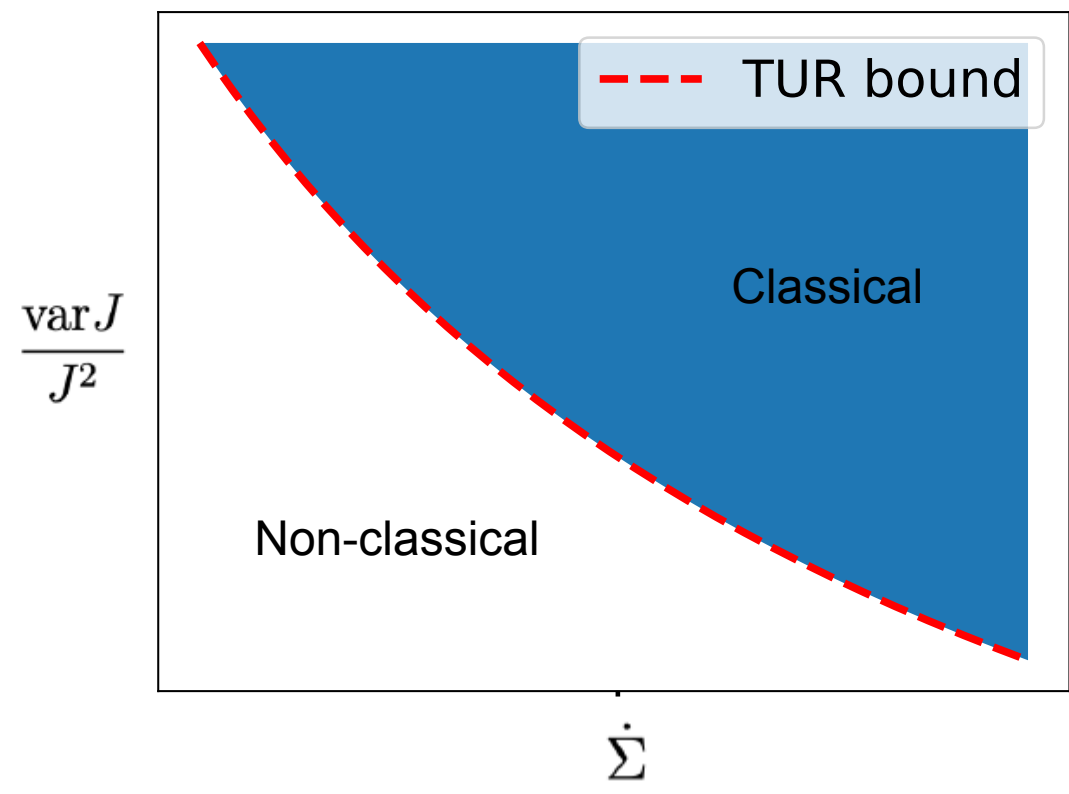
Can we exploit coherence for having a quantum thermodynamic advantage?



TUR: $\frac{\text{var} J}{J^2} \geq \frac{2}{\dot{\Sigma}}$

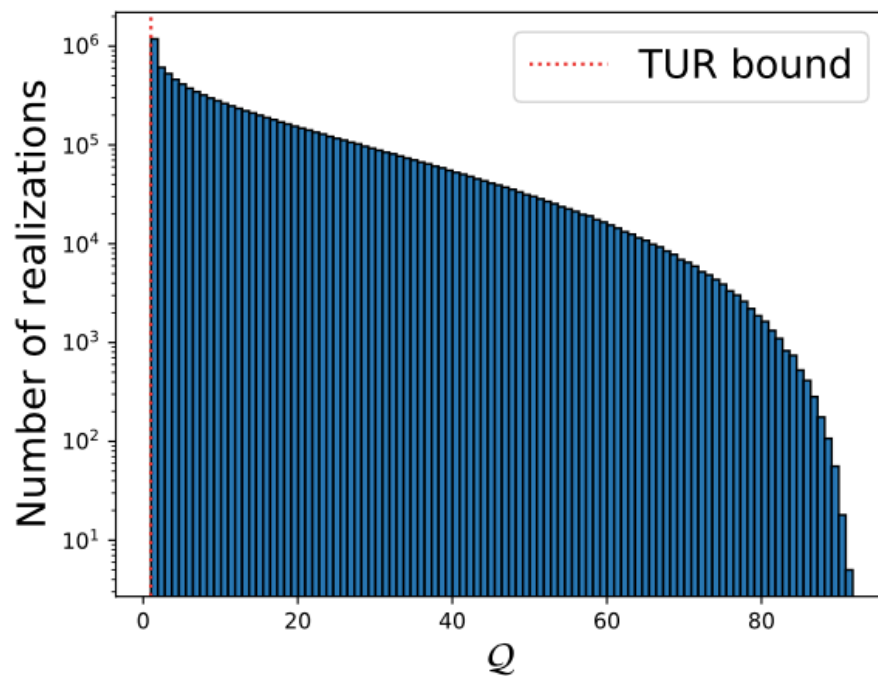
Barato & Seifert - **PRL** - 2015

Gingrich et al. - **PRL** - 2016

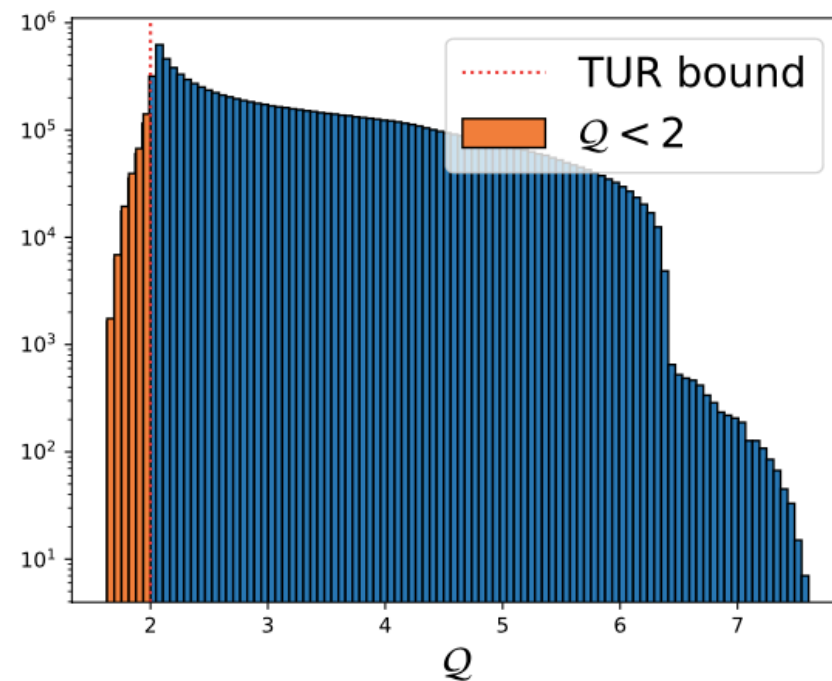


$$\text{TUR: } \frac{\text{var} J}{J^2} \geq \frac{2}{\dot{\Sigma}} \implies Q = \dot{\Sigma} \frac{\text{var} J}{J^2} \geq 2 \quad (\text{Witness})$$

Absorption fridge



Three level maser



Kalae et al. - [Physical Review E](#) - 2021

However

- 1- No TUR violations \nRightarrow no quantum thermodynamic advantage
- 2- We are interested in the role that coherence plays

Classical analog using same (incoherent) resources and leading to same currents

González et al. - PRE (2019)

$$\frac{d}{dt}\rho_{nn} = \sum_{j \neq n} \gamma_{nj} \rho_{jj} - \rho_{nn} \sum_i \gamma_{in}, \quad \forall n \neq (a, b),$$

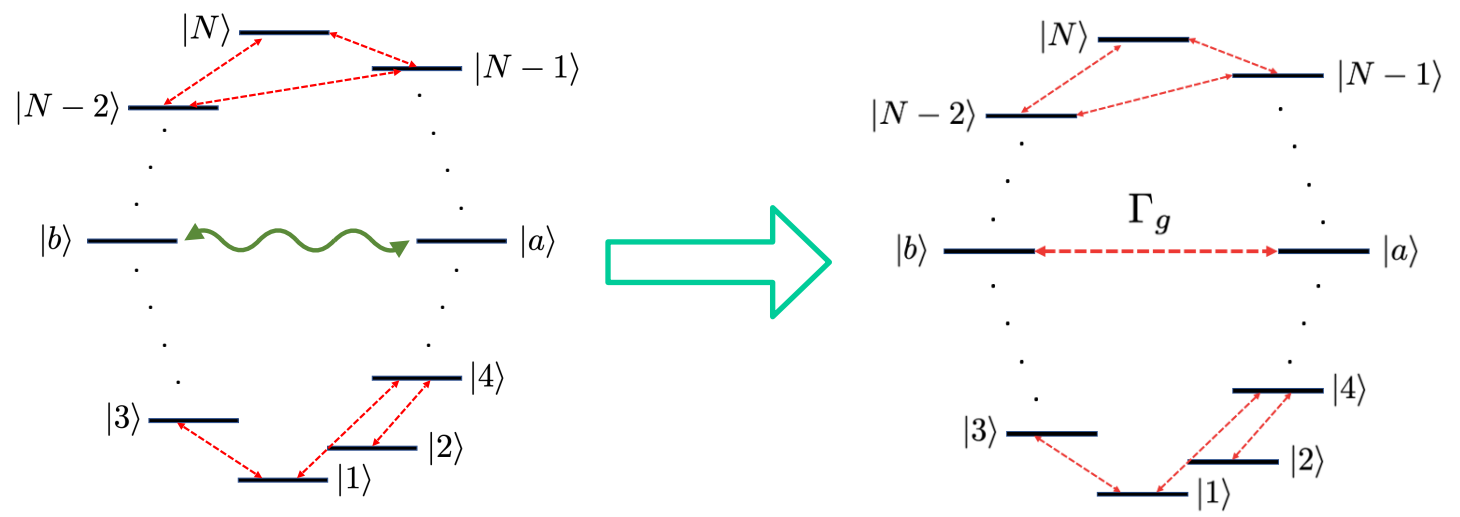
$$\frac{d}{dt}\rho_{aa} = \sum_{j \neq a} \gamma_{aj} \rho_{jj} - \rho_{aa} \sum_i \gamma_{ia} - 2g \text{Im}(\rho_{ab}),$$

$$\frac{d}{dt}\rho_{bb} = \sum_{j \neq b} \gamma_{bj} \rho_{jj} - \rho_{bb} \sum_i \gamma_{ib} + 2g \text{Im}(\rho_{ab}),$$

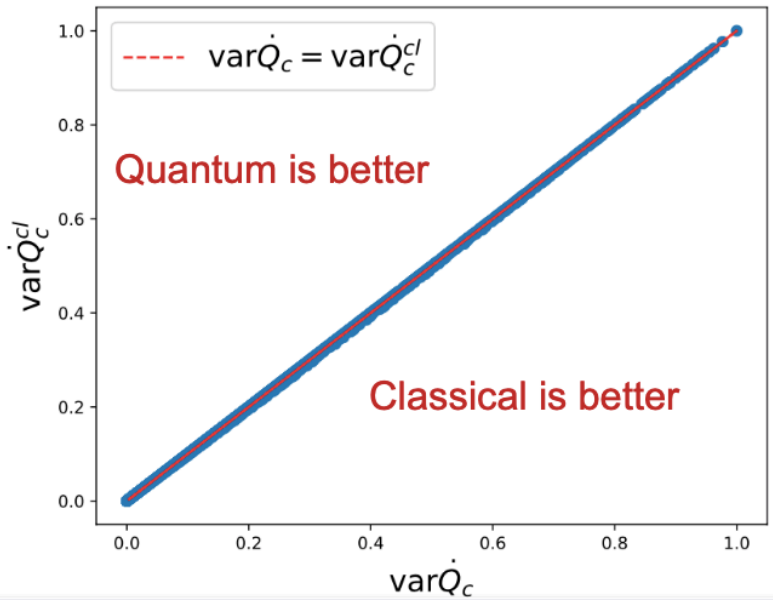
$$\frac{d}{dt}\rho_{ab} = -\frac{1}{2} \sum_i (\gamma_{ia} + \gamma_{ib}) \rho_{ab} - ig(\rho_{bb} - \rho_{aa}).$$

$$\Gamma_g = \frac{4g^2}{\sum_i (\gamma_{ia} + \gamma_{ib})}$$

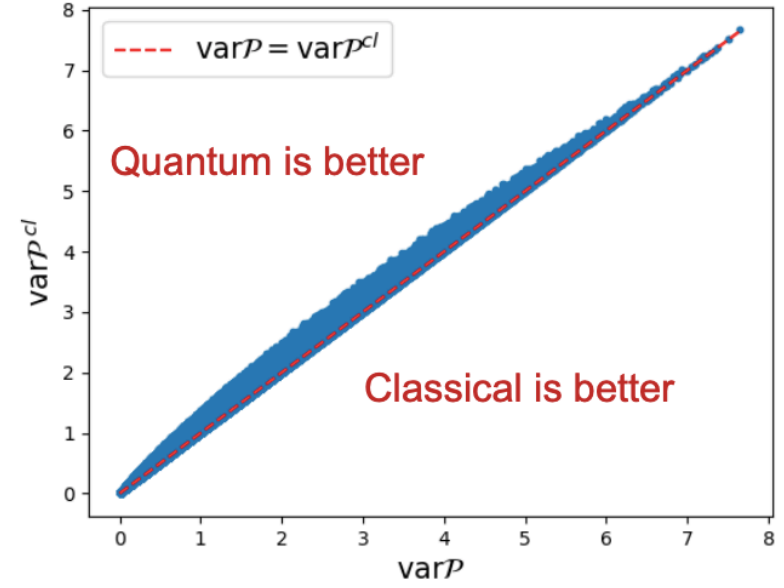
$$\rho_{ab}(\infty) = \frac{-2ig(\rho_{bb} - \rho_{aa})}{\sum_i (\gamma_{ia} + \gamma_{ib})}$$



Absorption fridge



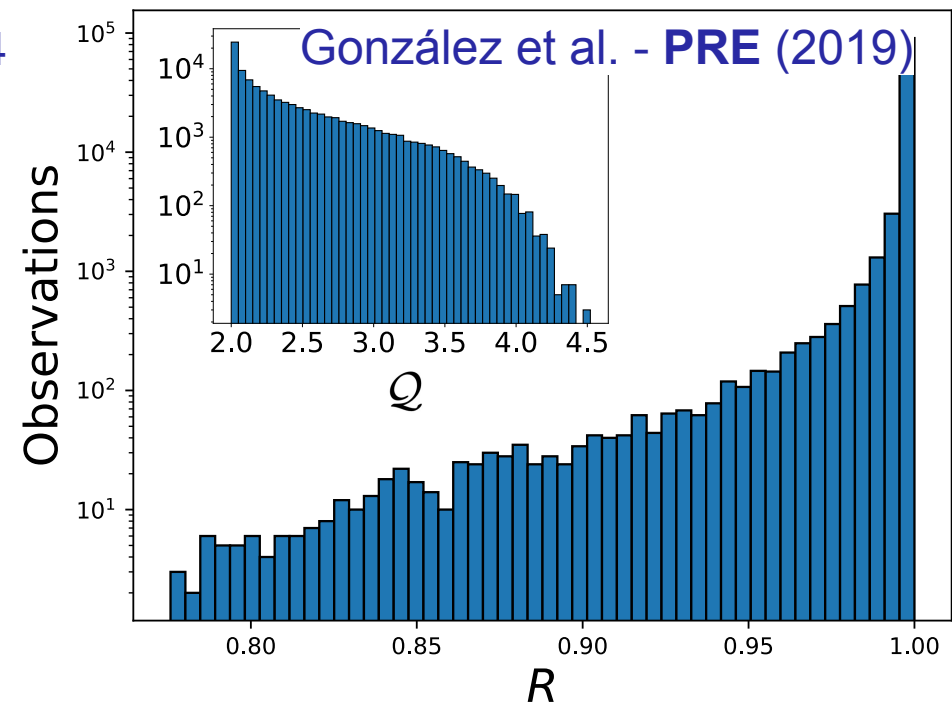
Three level maser

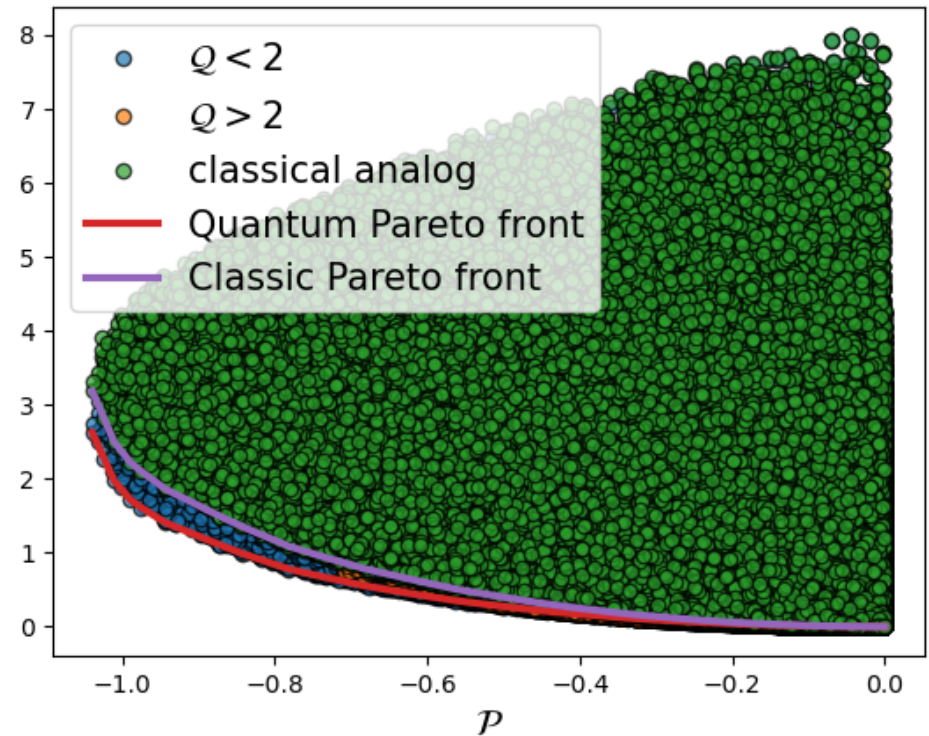
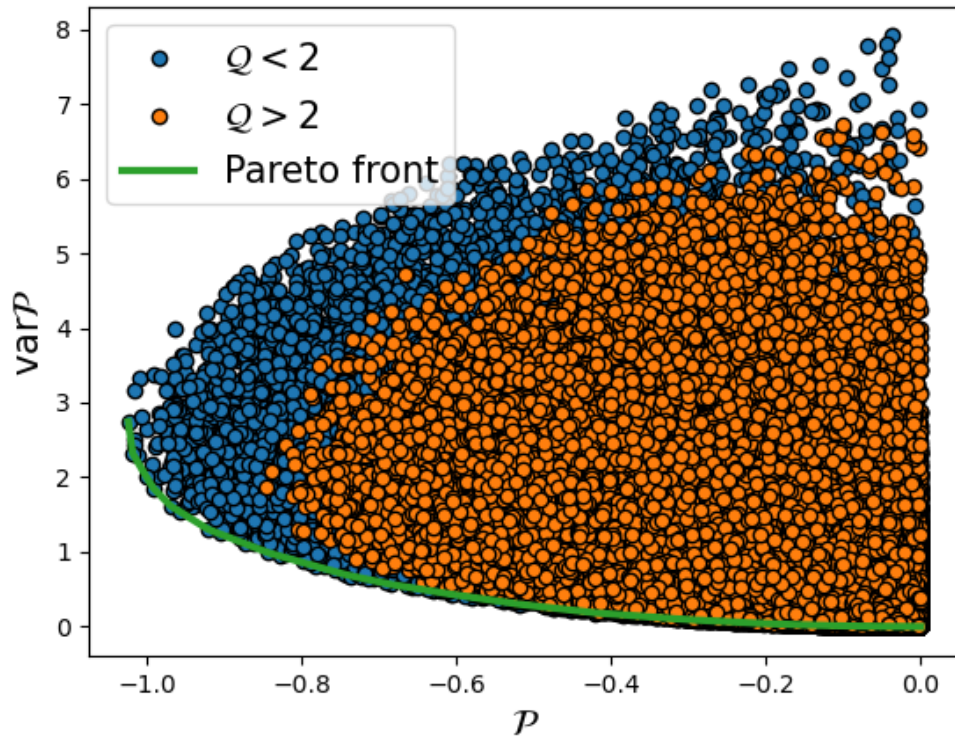


Brunner et al. - PRE - 2014

$$R = \frac{\text{var}J}{\text{var}J^{cl}}$$

González et al. - PRE (2019)





The Pareto front is divided in engines that violate and not violate the TUR.

TUR violations are near the maximum power regime.

The quantum Pareto front is not reachable by any classical analog.

- Thermodynamic emulability of QTM with non-energetic coherence.
- Quantum advantage in the case of QTM with energetic coherence.



THANK YOU

for your attention