Quantum Information Seminar

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Entropy, majorization and thermodynamics in quantum theory and beyond

Abstract:

Great progress has recently been made in understanding thermodynamics beyond macroscopic limits by developing quantum thermodynamics as a resource theory, describing what state transitions are possible given specified thermodynamic resources. Thermodynamics has been cited as one of the most robust aspects of physical theory; for example, it has made the transition from classical to quantum. I report preliminary results in an investigation of simple, physically meaningful properties of a physical theory that underlie the possibility of such a thermodynamic resource theory, by studying quantum thermodynamics within the broader realm of "general probabilistic theories". Four such physical properties were shown by Barnum, Mueller, and Ududec to give rise to the finite-dimensional quantum framework of density matrices and positive operator valued measures: they are (1) abstract spectrality (2) strong symmetry (3) no higher-order interference and (4) energy observability. I will explain this result and discuss whether or not all four are needed for a reasonable thermodynamics. With a slight strengthening of (1), to unique spectrality, and a significant weakening of (2), to the conjunction of (a) projectivity (an abstraction of certain aspects of the quantum projection postulate (Lders' version)) and (b) symmetry of transition probabilities under exchange of states with the unique fine-grained effects they make certain, we have the property, important in quantum thermodynamics, that the outcome probabilities for any fine-grained measurement are majorized by the spectrum of a state, and hence that measurement-probability-based generalizations of classical entropy-like functions are given by the classical function applied to the spectrum.

This is joint work with Markus Mueller and Cozmin Ududec (characterization of quantum formalism) and with Jonathan Barrett, Marius Krumm, and Markus Mueller (thermodynamics).

Host: David Meyer

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