Can intersubjectivity emerge from thermodynamics?

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Based on:

1. ***Emanuel Schwarzhans, Felix C. Binder, Marcus Huber, Maximilian P. E. Lock,***
   Quantum measurements and equilibration: the emergence of objective outcomes via entropy maximisation
   Phys. Rev. Research 7, 043279 (2025)

2. ***Alessandro Candeloro, Tiago Debarba, Felix C. Binder****,*
   Thermodynamic Constraints on the Emergence of Intersubjectivity in Quantum Systems
   Phys. Rev. A 113, 032201 (2026)

Abstract:

Understanding how classical, observer-independent measurement outcomes emerge from underlying quantum dynamics remains a central challenge at the interface of quantum foundations and quantum thermodynamics. I will present two complementary approaches to this problem, based on two recent publications [Phys. Rev. Research 7, 043279 (2025) and Phys. Rev. A 113, 032201 (2026)].

The first question is whether objectivity – the independent agreement on a measurement outcome between observers – can be achieved by an equilibration process within a larger closed system. Such an objective state of affairs is represented by spectrum-broadcast-structure (SBS) states – a privileged set of states that encapsulate the atypical situation where classical measurement information about a central system is independently available to surrounding observer system. We show that while exact equilibration to such an SBS state is not possible it can be approximated arbitrarily closely with growing macroscopicity of the observer systems.

Second, we incorporate thermodynamic constraints on this emergence of objectivity by analysing intersubjectivity – a closely-related but slightly relaxed version of objectivity – under finite resources. This framework establishes no-go results for perfect intersubjectivity with finite-resource settings and identifies the physical requirements needed to recover approximate classical objectivity.

Taken together, these results show that classical objectivity is neither generic nor free, but instead arises as an emergent, resource-dependent phenomenon. Our unified picture connects closed-system equilibration and finite-resource thermodynamics with the measurement problem, and provides quantitative benchmarks for when many-body quantum systems can support effectively classical, observer-independent records.