THE EMERGENCE OF IRREVERSIBILITY IN QUANTUM THEORY: ENTROPY AND MEASUREMENT

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ABSTRACT

Irreversible entropy growth implied by the second law of thermodynamics appears to conflict with the unitary, entropy-preserving evolution of isolated quantum systems. Effective irreversibility emerges in large isolated systems due to the mismatch between the effective dimension of the microscopic unitary dynamics and the resolving power of the observables in question. A quantum version of the second law can be recovered, with equilibrium fluctuations that are found to shrink as system size increases. The apparent irreversibility of quantum measurement can then argued to be a thermodynamic effect, leading to criteria for when a physical system functions as an observer.