Emergence of constructor-based irreversibility in quantum systems

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The emergence of irreversibility from time symmetric physical laws is a central problem in contemporary physics. Here we present an innovative take on this topic adopting the recently proposed constructor theory framework [1,2], in which irreversibility is expressed as the requirement that a task is possible, while its inverse is not. We prove the compatibility of such constructor-based irreversibility with quantum theory's time-reversal symmetric laws, using a dynamical model based on the universal quantum homogenizer. We also test the physical realizability of this model by means of an experimental demonstration exploiting high-quality single-photon qubits [3].

[1] D. Deutsch, Constructor theory, Synthese 190, 4331 (2013).

[2] D. Deutsch and C. Marletto, Constructor theory of information, Proc. R. Soc. A 471, 20140540 (2015).

[3] C. Marletto et al., Emergence of Constructor-Based Irreversibility in Quantum Systems: Theory and Experiment, Phys. Rev. Lett. 128, 080401 (2022).