Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Quantum Speed Limits, coherence and asymmetry IMAN MARVIAN, massachusetts institute of technology, ROBERT SPEKKENS, Perimeter Institute for theoretical physics, PAOLO ZANARDI, University of Southern California
— The resource theory of asymmetry is a framework for classifying and quantifying the symmetry-breaking properties of both states and operations relative to a given symmetry. In the special case where the symmetry is the set of translations generated by a fixed observable, asymmetry can be interpreted as coherence relative to the observable eigenbasis, and the resource theory of asymmetry provides a framework to study this notion of coherence. We here show that this notion of coherence naturally arises in the context of quantum speed limits. Indeed, the very concept of speed of evolution, i.e., the inverse of the minimum time it takes the system to evolve to another (partially) distinguishable state, is a measure of asymmetry relative to the time translations generated by the system Hamiltonian. Furthermore, the celebrated Mandelstam-Tamm and Margolus-Levitin speed limits can be interpreted as upper bounds on this measure of asymmetry by functions which are themselves measures of asymmetry in the special case of pure states. Using measures of asymmetry that are not restricted to pure states, such as the Wigner-Yanase skew information, we obtain extensions of the Mandelstam-Tamm bound which are significantly tighter in the case of mixed states.

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Date submitted: 06 Nov 2015 Electronic form version 1.4