Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Reversibility in Quantum Models of Stochastic Processes DAVID GIER, University of Kansas, JAMES CRUTCHFIELD, JOHN MAHONEY, RYAN JAMES, University of California at Davis — Natural phenomena such as time series of neural firing, orientation of layers in crystal stacking and successive measurements in spin-systems are inherently probabilistic. The provably minimal classical models of such stochastic processes are ε-machines, which consist of internal states, transition probabilities between states and output values. The topological properties of the ε-machine for a given process characterize the structure, memory and patterns of that process. However ε-machines are often not ideal because their statistical complexity (C_μ) is demonstrably greater than the excess entropy ($\mathbf{E}$) of the processes they represent. Quantum models (q-machines) of the same processes can do better in that their statistical complexity (C_q) obeys the relation $C_\mu \geq C_q \geq \mathbf{E}$. q-machines can be constructed to consider longer lengths of strings, resulting in greater compression. With code-words of sufficiently long length, the statistical complexity becomes time-symmetric – a feature apparently novel to this quantum representation. This result has ramifications for compression of classical information in quantum computing and quantum communication technology.

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Date submitted: 06 Nov 2015 Electronic form version 1.4