Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Anatomy of a Spin: The Information-Theoretic Structure of Classical Spin Systems RYAN JAMES, VIKRAM VIJAYARAGHAVAN, JAMES CRUTCHFIELD, Univ of California - Davis — Collective organization in matter plays a significant role in its expressed physical properties. Typically, it is detected via an order parameter, appropriately defined for a given system's observed emergent patterns. Recent developments in information theory suggest how to quantify collective organization in a system- and phenomenon-agnostic way: decompose the system's thermodynamic entropy density into a localized entropy, that solely contained in the dynamics at a single location, and a bound entropy, that stored in space as domains, clusters, excitations, or other emergent structures. We compute this decomposition and related quantities explicitly for the nearest-neighbor Ising model on the 1D chain, the Bethe lattice with coordination number k = 3, and the 2D square lattice, illustrating its generality and the functional insights it gives near and away from phase transitions. In particular, we consider the roles that different spin motifs play (cluster bulk, cluster edges, and the like) and how these affect the dependencies between spins.

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Date submitted: 06 Nov 2015 Electronic form version 1.4