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**Dana Randall\***, Georgia Institute of Technology, Atlanta, GA 30332. *Emergent phenomena in random structures and algorithms*. Preliminary report.

Markov chain Monte Carlo methods have become ubiquitous across science and engineering to model dynamics and explore large combinatorial sets. Over the last 20 years there have been tremendous advances in the design and analysis of efficient sampling algorithms for this purpose. One of the striking discoveries has been the realization that many natural Markov chains undergo phase transitions whereby they abruptly change from being efficient to inefficient as some parameter of the system is modified, also revealing interesting properties of the underlying stationary distributions.

We will explore valuable insights that phase transitions provide in three settings, First, they allow us to understand the limitations of certain classes of sampling algorithms, potentially leading to faster alternative approaches. Second, they reveal statistical properties of stationary distributions, giving insight into various interacting models, such as colloids, segregation models and interacting particle systems. Third, they predict emergent phenomena that can be harnessed for the design of distributed algorithms for certain asynchronous models of programmable active matter. We will see how these three research threads are closely interrelated and inform one another. (Received June 22, 2017)