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We shall report on some work in progress in understanding various aspects of Gibbs distributions on combinatorial structures. We shall first look at the space of all unordered trees, labeled trees and consider the case where the Hamiltonian consists of the number of leaves. We shall identify various regimes of this model (star like, continuum random tree like and path like regimes). We show how these methods can be used to get large deviation results for the uniform random tree model.

We then consider the case of the exponential random graph model, a random graph model which has been explored intensively in the social networks literature. We shall report our findings on the mixing time of various Markov chain algorithms in this context. We shall identify where the mixing is quick and where it takes an exponentially long time. The last bit is based on joint work done with Guy Bresler and Allan Sly of UC Berkeley. (Received August 10, 2008)