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Valence-Bond Monte Carlo Study of Random-Singlet Phase Formation HUAN TRAN, NICHOLAS BONESTEEL, Department of Physics and NHMFL, Florida State University — In valence-bond Monte Carlo (VBMC)[1] the ground state of a quantum spin system is sampled directly from the valence-bond (VB) basis — a useful basis for visualizing the properties of singlet ground states. For example, the ground state of the uniform AFM spin-$\frac{1}{2}$ Heisenberg chain is characterized by strongly fluctuating bonds with power-law length distribution, while in the random-singlet phase (RSP) of a *random* Heisenberg chain these bonds, while still having a power-law length distribution, lock into a particular VB state on long length scales.[2] We use VBMC to directly probe the formation of a RSP by calculating both the average number of bonds n_L leaving a block of L spins (the VB entanglement entropy[3]), and its *fluctuations*, $\sigma^2_{n_L} = \langle\langle n_L^2\rangle - \langle n_L\rangle^2\rangle$. For the uniform chain they have been calculated exactly[4] and shown to grow logarithmically with L — signaling the strong bond fluctuations. For random chains while n_L grows logarithmically with L, we find $\sigma^2_{n_L}$ *saturate* for large L, signaling the "freezing" of the bonds into a particular random singlet state.

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