Mechanism of symmetry breaking in matrix-product states

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I will discuss matrix-product states for the transverse-field Ising chain of finite and infinite size N and small matrix sizes; D=2-8. The matrices are variationally optimized using several methods. For finite N, below the critical field, there are energy minimums for symmetric as well as symmetry-broken states. The energies cross at field strength hc(N,D); thus the transition is first-order in this approximation. However, as N increases, the discontinuity becomes smaller with increasing N, and for infinite N the transition is continuous for any D. The asymptoticcritical behavior is then always mean-field like (the magnetization exponent beta=1/2), but a window of field-strengths where the exactly known power-law scaling holds (beta=1/8) emerges as D increases. An important technical point is that even if the energy is optimized to the level of double precision (smaller than 1/10^12 relative error) there is significant finite-size smoothing of the magnetization curve. Higher precision is required to access the asymptotic critical behavior.