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Is there an Almeida Thouless line in spin glasses?[1]

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One of the most striking predictions of the mean field of spin glasses is a line of transitions in the magnetic field temperature plane, called the Almeida-Thouless (AT) line, which separates a high temperature, paramagnetic phase, with finite relaxation times, from a low temperature spin glass phase with infinite relaxation times. It is therefore represents an ergodic to non-ergodic transition with no change in symmetry. Whether or not an AT line occurs in real spin glasses has been controversial. Experiments have looked to see if there is a divergent relaxation time at finite field, and Ref. [1], for example, has argued their data indicates no AT line. However, other experimental papers have come to the opposite conclusion. Theoretically, it seems best to investigate a divergent *static* quantity, the "replicon" susceptibility (which is not accessible experimentally), and the corresponding correlation length. A finite size scaling analysis of the three-dimensional Ising spin glass in a field [2] found no AT line. It is, however, possible that an AT line could occur in higher dimensions, even if it does not occur in d=3. To investigate this question we used an analogous model, a one-dimensional system with long-range interactions which fall off with a power law, in which varying the power is analogous to varying the dimension in the short-range case. We do find an AT line [3] in models corresponding to short-range systems in dimension greater than 6.

[1] J. Mattsson, T. Jonsson, P. Nordblad, H. A. Katori, and A. Ito, Phys. Rev. Lett. 74, 4305 (1995).
[2] A.P. Young and Helmut G. Katzgraber, Phys. Rev. Lett. 93, 207203 (2004).
[3] Helmut G. Katzgraber and A.P. Young, Phys. Rev. E 72, 184416 (2005).

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