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Quantum Monte Carlo studies of the random antiferromagnetic Ising spin chain in transverse and longitudinal magnetic fields

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Ultracold atomic ensembles confined in optical lattices offer experimental access to the study of out-of-equilibrium physics in a controlled environment. Recent experimental techniques have also enabled the quantum simulation of strongly correlated spin systems using bosonic atoms in an optical lattice, such as simulating antiferromagnetic Ising spin chains via mapping of a site-occupation onto a pseudo-spin [1]. We have used quantum Monte Carlo simulations to study the phase diagram and critical properties of the random antiferromagnetic Ising spin chain in transverse and longitudinal magnetic fields. Without longitudinal fields, it is known that the dynamical exponent of this random system diverges at the quantum critical point, indicating extremely slow dynamics [2]. We have performed some initial calculations to see whether this disordered quantum critical behavior will be altered by longitudinal fields.

[1] J. Simon, W. S. Bakr, R. Ma, M. E. Tai, P. M. Preiss, and M. Greiner, Nature **472**, 307 (2011).
[2] D. S. Fisher, Phys. Rev. Lett. **69**, 534 (1992); D. S. Fisher, Phys. Rev. B **51**, 6411 (1995).