Adiabatic Evolution of the Random Transverse-field Ising Spin Chain

Peter Mason, Alexandre Zagoskin, and Joseph Betouras

Department of Physics, Loughborough University

A quantum adiabatic computation is one in which the governing Hamiltonian is slowly varied in time, starting from an initial Hamiltonian for which the ground state is known, and ending with a final Hamiltonian, the ground state of which encodes our desired solution. Throughout the evolution we always remain in the ground state. Such a technique to establish the solution of a computational task in a quantum simulation, together with quantum annealing, can be extremely effective, and is employed for instance in the D-wave devices.

Here we consider a renormalisation group treatment [1, 2] on the strongly disordered random one-dimensional transverse-field Ising spin chain where the bonds J_{ij} and horizontal fields h_i are time-dependent and chosen to reflect an adiabatic evolution of the governing Hamiltonian. Under the condition that the renormalisation process occurs at fixed time, a set of coupled second order, nonlinear PDE's can be written down in terms of the random distributions of the bonds and fields. Solution of these flow equations at the relevant critical fixed points leads us to the establish the critical behaviour of the flow as the Hamiltonian is adiabatically evolved. We will present these critical flows as well as discussing the issue of duality, before making connections to quantum adiabatic computations.

[1] D.S. Fisher, Phys. Rev B **51**, 6411 (1995).
[2] C. Dasgupta, S. Ma, Phys. Rev. B **22**, 1305 (1980).