SEARCH OF THE GROUND STATE(S) OF SPIN GLASSES AND QUANTUM ANNEALING

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We review our earlier studies on the order parameter distribution of the quantum Sherrington-Kirkpatrick (SK) model. Through Monte Carlo technique, we investigate the behavior of the order parameter distribution at finite temperatures. The zero temperature study of the spin glass order parameter distribution is made by the exact diagonalization method. We find in low-temperature (high-transverse-field) spin glass region, the tail (extended up to zero value of order parameter) and width of the order parameter distribution become zero in thermodynamic limit. Such observations clearly suggest the existence of a low-temperature (high-transverse-field) ergodic region. We also find in high-temperature (low-transverse-field) spin glass phase the order parameter distribution has nonzero value for all values of the order parameter even in infinite system size limit, which essentially indicates the nonergodic behavior of the system. We study the annealing dynamics by the paths which pass through both ergodic and nonergodic spin glass regions. We find the average annealing time becomes system size independent for the paths which pass through the quantum-fluctuation-dominated ergodic spin glass region. In contrast to that, the annealing time becomes strongly system size dependent for annealing down through the classical-fluctuation-dominated nonergodic spin glass region. We investigate the behavior of the spin autocorrelation in the spin glass phase. We observe that the decay rate of autocorrelation towards its equilibrium value is much faster in the ergodic region with respect to the nonergodic region of the spin glass phase.