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Stochastic Approximation of Dynamical Exponent at Quantum Critical Point HIDEMARO SUWA, Department of Physics, The University of Tokyo, SHINYA YASUDA, Department of Applied Physics, The University of Tokyo, SYNGE TODO, Department of Physics, The University of Tokyo — We have developed a unified finite-size scaling method for quantum phase transitions that requires no prior knowledge of the dynamical exponent z. During a quantum Monte Carlo simulation, the temperature is automatically tuned by the Robbins-Monro stochastic approximation method, being proportional to the lowest gap of the finite-size system. The dynamical exponent is estimated in a straightforward way from the system-size dependence of the temperature. As a demonstration of our novel method, the two-dimensional $S = 1/2$ quantum XY model, or equivalently the hard-core boson system, in uniform and staggered magnetic fields is investigated in the combination of the world-line quantum Monte Carlo worm algorithm. In the absence of a uniform magnetic field, we obtain the fully consistent result with the Lorentz invariance at the quantum critical point, $z = 1$. Under a finite uniform magnetic field, on the other hand, the dynamical exponent becomes two, and the mean-field universality with effective dimension (2+2) governs the quantum phase transition. We will discuss also the system with random magnetic fields, or the dirty boson system, bearing a non-trivial dynamical exponent.
Reference: S. Yasuda, H. Suwa, and S. Todo *Phys. Rev. B* **92**, 104411 (2015); arXiv:1506.04837

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