

Projects

1. O(4) Scalar field theory

Simulate an O(4) scalar field theory in 2 dimensions using the Metropolis update. For given $\lambda = 6.0$, look for the critical κ , and measure the magnetization and the susceptibility around the critical point. Look for finite size scaling by comparing different lattice sizes. What is the critical exponent β , defined by

$$M \sim \frac{1}{(\kappa - \kappa_c)^\beta} ? \quad (1)$$

2. O(4) Scalar field theory

Simulate an O(4) scalar field theory in 2 dimensions using the Langevin algorithm. For given $\lambda = 6.0$, look for the critical κ , and measure the magnetization and the susceptibility around the critical point. Use a fixed (large) lattice size. Perform the $\Delta\tau \rightarrow 0$ limit, where $\Delta\tau$ is the Langevin timestep. What is the critical exponent β , defined by

$$M \sim \frac{1}{(\kappa - \kappa_c)^\beta} ? \quad (2)$$

3. O(4) Scalar field theory

Simulate an O(4) scalar field theory in 2 dimensions using the Hybrid monte carlo algorithm. For given $\lambda = 6.0$, look for the critical κ , and measure the magnetization and the susceptibility around the critical point. Use a fixed (large) lattice size. What is the critical exponent β , defined by

$$M \sim \frac{1}{(\kappa - \kappa_c)^\beta} ? \quad (3)$$

4. SU(2) Pure gauge theory

Simulate an SU(2) pure gauge theory on a 4 dimensional spacetime lattice of size N^4 , using the heatbath update (and optionally overrelaxation updates). For a fixed β parameter, measure the average of the Polyakov loop and its absolute value as a function of the lattice size N .

5. Real-time scalar field theory

Simulate the real time evolution of an O(1) scalar field theory. Start from initial conditions triggering parametric resonance

$$\Phi(x, t = 0) = \Phi_o + n(x), \quad (4)$$

where $n(x)$ is white noise satisfying $n \ll \Phi_o$. Compare the time evolution of the zero modes (and the spectra of higher modes) for the two regimes where $\lambda\Phi_o \gg 1$ and $\lambda\Phi_o \ll 1$. Is the decay of the zero mode exponential?