Research Plan

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In the past, I have developed new algorithm of quantum Monte Carlo method and applied it to various problems of statistical physics. The quantum Monte Carlo method is based on the path-integral formulation. Sampling the paths of the imaginary time development, we can calculate partition functions and obtain thermodynamic properties of the system.

Listed as bellow, I focus on quantum liquid, especially the superfluidity of the liquid ^{4}He, and development of the algorithm of the Monte Carlo method for the calculation.

(1) Algorithm for continuous space

To perform the quantum Monte Carlo simulation, we have to discretize the imaginary-time-space. There are two ways of the discretization: one is that the imaginary time direction is discretized (real space is continuous), and the other is that the real space is discretized (imaginary time direction is continuous). Up to now, I have used the algorithm for the system with continuous imaginary time. However, we must use the algorithm for the system with continuous real space if we consider the system of quantum liquid and want to have a quantitative consistency with experimental results.

(2) Simulation for quantum liquid

I am interested in the phenomena that are observed in quantum liquid , such as Bose-Einstein condensation (BEC) and the superfluidity of the liquid ^{4}He. I numerically study the Bose-Hubbard model that can describe bosonic many-body systems extensively, and investigate the effects of confinement in a restricted geometry, a disordered potential, and the dimensionality of the system on the BEC and the superfluidity. Recently, many experiments for the superfluid ^{4}He in various circumstances have been achieved. It is useful to compare the experimental results with the results of the calculation for understanding the properties of the superfluidity of the quantum liquid.