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Parallelized Multi-Worm Algorithm for Large Scale Quantum Monte-Carlo simulations TAKAFUMI SUZUKI, University of Hyogo, Japan, AKIKO MASAKI-KATO, University of Tokyo, Japan, KENJI HARADA, Kyoto University, Japan, SYNGE TODO, University of Tokyo, Japan, NAOKI KAWASHIMA, Univerisy of Tokyo, Japan — The quantum Monte Carlo (QMC) calculation is a powerful and accurate method for quantum many body interacting systems. In this study, we present a new algorithm for the worldline Monte Carlo method based on the Feynman path integral. While the worm algorithm (WA) [1-2] has been used widely because of its broader range of applicability, the parallelization of WA is not straightforward. We present a general QMC algorithm based on the directed-loop algorithm [2] with the domain decomposition. This new algorithm is referred to as Parallelized Multi-Worm Algorithm (PMWA). In PMWA, a large number of worms are introduced by controlling a fictitious transverse field. For a benchmark, we applied the PMWA to the hardcore Bose-Hubbard model on the square lattice, and computed the system-size dependence of the Bose-condensation order parameter up to $L^2 = 10240^2$ by using 3200 processors. The benchmark results showed high parallelization efficiency [3]. This indicates that the PMWA is suitable for parallelizing on a distributed-memory computer. [1] N. Prokof'ev, B. Svistunov and I. Tupitsyn, Sov. Phys. JETP 87, 310 (1998). [2] O. F. Syljuåsen and A. W. Sandvik, Phys. Rev. E 66, 046701 (2002). [3] A. Masaki-Kato, et al., arXiv:1307.0328 (2013).

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