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Author(s)	Shirakawa, Tomonori; Jeckelmann, Eric
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Variational Cluster Approximation combined with Dynamical Density-Matrix Renormalization Group Method

Tomonori Shirakawa¹ and Eric Jeckelmann²

¹ Computational Condensed Matter Physics Laboratory, RIKEN ASI, 2-1, Hirosawa, Wako-shi, Saitama, 351-0198, Japan

² Institut für Theoretische Physik, Leibniz Universität Hannover, Appelstrasse 2, D-30167 Hannover, Germany

Motivated by the recent progress [1] of the variational cluster approximation method (VCA [2]) based on the self-energy functional theory (SFT [3]), we use the dynamical density-matrix renormalization group method (DDMRG [4]) to compute the Green's function of variational cluster. We first apply this approach to the one-dimensional Hubbard model. We then discuss the size dependence of the variational cluster, and compare our results with another method including Bethe ansatz solution, and direct calculation using DDMRG. Next, we calculate the staggered magnetic moment in the weakly coupled one-dimensional Hubbard chains. The calculation results are compared with the results of quantum Monte Carlo method for the weakly coupled one-dimensional Heisenberg model [5]. We also present the one-particle excitation spectra for the weakly coupled one-dimensional Hubbard model at half-filling, and discuss the crossover from the excitation characterized by the spin-charge separation to the dispersion of the antiferromagnetic state.

References

- [1] G. Li, W. Hanke, A. N. Rubtsov, S. Bäse, and M. Potthoff, *Phys. Rev. B* **80**, 195118 (2009).
- [2] M. Potthoff, M. Aichhorn, and C. Dahnken, *Phys. Rev. Lett.* **91**, 206402 (2003).
- [3] M. Potthoff, *Eur. Phys. J. B* **32**, 429 (2003)
- [4] E. Jeckelmann, *Phys. Rev. B* **66**, 045114 (2002).
- [5] A. W. Sandvik, *Phys. Rev. Lett.* **83**, 3069 (1999).