

Title	DMRG Studies for Itinerant Ferromagnetism in a Two-leg Optical Lattice System(New Development of Numerical Simulations in Low-Dimensional Quantum Systems: From Density Matrix Renormalization Group to Tensor Network Formulations)
Author(s)	Okumura, M.; Yamada, S.; Machida, M.; Aoki, H.
Citation	物性研究 (2011), 95(6): 638-638
Issue Date	2011-03-05
URL	<a href="http://hdl.handle.net/2433/169431">http://hdl.handle.net/2433/169431</a>
Right	
Type	Departmental Bulletin Paper
Textversion	publisher

# DMRG Studies for Itinerant Ferromagnetism in a Two-leg Optical Lattice System

M. Okumura<sup>1,2</sup>, S. Yamada<sup>3,2</sup>, M. Machida<sup>3,2</sup>, and H. Aoki<sup>4</sup>

<sup>1</sup> CCMP, RIKEN, Wako, Saitama 351-0198, JAPAN

<sup>2</sup> CREST(JST), Kawaguchi, Saitama 332-0012, JAPAN

<sup>3</sup> CCSE, Japan Atomic Energy Agency, Taito-ku, Tokyo 110-0015, JAPAN

<sup>4</sup> Department of Physics, The University of Tokyo, Hongo, Tokyo 113-0033, Japan

Density matrix renormalization group (DMRG) is one of the most powerful methods for investigating strongly correlated systems. Recently, three of the present authors have developed a parallel DMRG code [1] that enables us to calculate the ground state of  $n$ -leg lattice models efficiently. We can thus explore multi-leg ladder systems to look for intriguing physics that is specific to ladder structures, e.g., ferromagnetism in the Hubbard model.

It has been well-known that the lattice structure in addition to strong on-site repulsion is responsible for non-trivial ground state. A typical example is the itinerant ferromagnetism, which still deserves full understanding. Besides electron systems, cold Fermionic atom systems is an ideal test-bench for such studies due to its flexibility and controllability on lattice structures. In fact, three itinerant ferromagnetism, i.e., Stoner's, Nagaoka's, and flat-band mechanisms have been so far discussed in ultra-cold atom experiments, and the first one has been reported very recently [2].

With this background, here we propose that a two-leg ladder optical lattice system should accommodate a stable itinerant ferromagnetism for cold fermionic atoms with finite hole densities [3], which may be regarded as an extended Nagaoka's ferromagnetism. A special interest in the cold atom system is that, on top of the optical lattice potential, we have a trapping potential. We predict that this causes an interesting phase separation into magnetic and nonmagnetic phases in real space. We show the phase-separated magnetism specially in spin-imbalanced situations, and the phase diagram obtained here indicates that the required strength of correlation is realistic.

## References

- [1] S. Yamada, M. Okumura, and M. Machida, *J. Phys. Soc. Jpn.* **78**, 094004 (2009).
- [2] G.-B. Jo *et al.*, *Science* **325**, 1521 (2009).
- [3] M. Okumura, S. Yamada, M. Machida, and H. Aoki, arXiv:1008.3055.