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# Prospects of the Ultra-Narrow Optical Feshbach Resonances in Yb Quantum Simulator

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[Keywords] Quantum Simulation, Hubbard-Model, Quantum Degenerate Gas, Ytterbium

The advancement in the field of quantum degenerate gas has enabled to engineer wide spectrum of experimental conditions. Particularly, the study of many-body physics using the cold atom has been equipped with well controllable temperature, dimensionality, interaction strength, and spin mixtures. The rich controllability resulted in exciting simulations, such as the observation of superfluid to Mott-insulator transition[1]. While many of these experiments are carried out with ultracold Alkali atoms, there has been a tremendous interest in a use of Alkaline-Earth-like atoms for these experiments. The features, including rich isotope selection, $SU(N)$ symmetric interaction of the ground states, long-lived excited states with ultra narrow line transition, enable to approach the simulation from slightly different perspective than the previous experiments in Alkali atoms. We show recent progress and prospectives of our quantum simulation of Hubbard model with ultracold ytterbium atoms in an optical lattice, with a particular focus on a use of the optical Feshbach resonances (OFR). Ultra-narrow transitions in ytterbium, $^1S_0$ state to the excited $^3P_{0,2}$, could play a key role in a future advancement of the Yb quantum simulator. We discuss the progress of the search for the ultra-narrow OFR as well as its implications. OFR techniques developed with $^1S_0$-$^3P_1$ transition is discussed. Connection between the recently performed ultra-narrow line spectroscopy of the Yb Mott-insulator state with the OFR physics is also presented.

[1] M. Greiner, *et al.*, Nature **415**, 39 (2001).