Phase diagrams of polarized ultra-cold gases on attractive-U Hubbard ladders

E.A. Burovski[1], R.Sh. Ikhsanov[1], A.A. Kuznetsov[1], V.I. Levchenko[1], M.Yu.Kagan[1,2]

[1] National Researh University Higher School of Economics, 101000 Moscow, Russia

[2] Kapitza Institute for Physical Problems, 119334, Moscow, Russia

Recent advances in experimental technique of creation and manipulation of strongly correlated systems using ultra-cold gases in traps with varying forms and effective dimensionality of the trapping potential [1, 2] stimulates an interest in mathematical modeling of quasi-one-dimensional polarized Fermi gases at ultralow temperatures. In such systems a motion of the particles in two spatial dimensions out of three is almost completely "frozen". Moreover the spatial structure of the atomic cloud was found to be significantly different for quasi 1D cigar-shaped magnetic traps and 3D spherically symmetric traps.

In this paper we consider a quasi-one-dimensional model of a two-component Fermi gas at zero temperature on one, two and three leg attractive-U Hubbard ladders. We construct a phase diagram of a two-component spin-polarized gas in the convenient coordinates specified by chemical potential and effective magnetic field" [3-6].

We present phase diagrams for the attractive-U Hubbard model on the one leg (single chain), two-leg and three-leg ladders for various values of the onsite Hubbard attraction U, fermion density n, and hopping amplitude t (or correspondingly the 1D bandwidth $W=4t$). The phase diagram typically contains equal density phase with local bound pairs, partially polarized phase and different fully polarized phases. We obtain that the topology of the phase diagram in attractive-U Hubbard model for two, three or more legs does not qualitatively change with the increase of the number of legs, but qualitatively differs from the topology of the phase diagram of a single chain.

REFERENCES

1. *M. C. Revelle, J. A. Fry, B. A. Olsen, and R. G. Hulet* "1D to 3D Crossover of a Spin-Imbalanced Fermi Gas", Phys. Rev. Lett. 117, 235301 (2016).

2. *R. Ono*frio “Cooling and thermometry of atomic Fermi gases”, Phys. Usp. 59, 1129–1153 (2016).

3. *A. E. Feiguin and F. Heidrich-Meisner* “Pair Correlations of a Spin-Imbalanced Fermi Gas on Two-Leg Ladders”, Phys. Rev. Lett. 102, 076403.

4. *F. Heidrich-Meisner, G. Orso, and A.E. Feiguin* “Phase separation of trapped spin-imbalanced Fermi gases in one-dimensional optical lattices”, arxiv cond-mat 1001.4720, Phys. Rev. Lett. (2010).

5. *M. Yu. Kagan, S. Haas, and T.M. Rice* “Phase diagram of three-leg ladders at strong coupling along the rungs”, Physica C: Superconductivity 317-318, 185-193 (1999).

6. *E. Burovski, G. Orso, and Th. Jolicoeur* “Multiparticle Composites in Density-Imbalanced Quantum Fluids”, Phys. Rev. Lett. 103, 215301 (2009).