Magnetically driven superconducting pairing interaction in the two dimensional Hubbard model within a spin-rotationally invariant approach

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For understanding of the mechanism of superconductivity in strongly correlated electron systems the knowledge of bosons mediating the pairing is of pivotal importance. Here, the underlying attraction potential appears very puzzling since it is hard to reconcile the attractive interaction with the completely repulsive bare electron-electron forces. In the present contribution we extend the spin-rotationally invariant approach to the Hubbard model [1], which makes no assumptions regarding the magnitude of the Coulomb energy U to accommodate on equal footing spin and charge degrees of freedom. To preserve the spin-rotational invariance we formulate the problem in terms of the effective action of using new bosonic and fermionic variables. In this scheme the charge and spin excitations emerge in terms of a U(1) phase and variable spin quantization axis governed by the SU(2) group, respectively [2]. Furthermore, using U(1) and SU(2) transformation we factorize the charge and spin contribution to the original electron operator in terms of the corresponding gauge fields. We show that these fields play a similar role as phonons in the BCS theory: they provide the "glue" for fermion pairing in the strongly correlated system. By tracing out gauge bosons we extract the effective pairing potential and explicate the role of antiferromagnetic correlations.

[1] H. J. Schulz, Phys. Rev. Lett. **65**, 2462 (1990).
[2] T. K. Kopeć, Phys. Rev. B **73**, 132512 (2006); V. A. Apinyan and T. K. Kopeć, J. Supercond. Nov. Magn., **57** (2009).