Revisiting the problem of the single hole in an antiferromagnet

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The problem of the propagation of the single hole introduced into the antiferromagnetic ground state is one of the most studied in the "cuprate physics", for it can be solved in a relatively controlled manner [1]. Nevertheless, the possibility of simulating hole-doped antiferromagnets in the cold atom experiments [2] have recently triggered a renewed interest into this problem.

In this contribution, I plan to give an overview of some of our most recent studies which try to understand the propagation of the single hole in the antiferromagnet using the magnon language, with a special attention paid to the interaction between the magnons [3-4]. Thus, first I will present a novel intuitive picture which explains why the electron's spin and charge degree of freedom can separate in a one-dimensional lattice, though a similar situation cannot occur in two dimensions [3]. Next, I will show that the string potential, which is believed to be felt by the hole moving in a two-dimensional Ising antiferromagnet, is more easily destroyed than one could naively expect [4]. Finally, I will discuss what might be the impact of such findings on the future studies of the superconducting cuprates or the optical lattice simulations of the Hubbard model.

References:

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