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Orbital-Current phases in one- and two-dimensional strongly correlated systems[1]

THIERRY GIAMARCHI, University of Geneva

Although we now know that strongly correlated systems can have several type of conventional order ranging from charge or spin order to superconductivity, the possibility that they present also more exotic phases remains an elusive but very challenging question. In particular whether such systems can have orbital current order for realistic interactions has been strongly debated. Recently this question has come to attention again due to theoretical proposals and subsequent neutron scattering experiments suggesting that this could be the case in the pseudogap phase of High Tc. Tackling this issue directly for the two dimensional case is difficult, since no uncontrolled method can be used beyond exact diagonalization for very small clusters. However this question can be looked at on the one dimensional (ladder) version of this problem, where such orbital current phases can be studied by well controlled methods such as bosonization. I will present the results we obtained on these systems and discuss in particular the comparison between the case of a simple Hubbard ladder [1] versus a three band model (Cu-O ladder) [2]. In order to tackle these issues for the two-dimensional case, we have performed a variational Monte Carlo analysis for a three band Cu-O model. This technique although depending on the quality of the variational wave function has the advantage of being essentially free of numerical problems. I will discuss the phases obtained by this approach as well as the possible experimental consequences.
These works are a collaboration with E. Orignac; P. Chudzinski and M. Gabay; C. Weber, A. Laüchli and F. Mila.
[1] E. Orignac and T. Giamarchi, PRB 56 7167 (1997);
[2] P. Chudzinskii, M. Gabay and T. Giamarchi, PRB 76, 161101 (R) (2007);

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