Singlet formation mediated by frustration in two dimensional quarter-filled systems

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The consequences of lattice frustration have been intensively studied within quantum spin models. In comparison relatively little is known about the effect of frustration in strongly correlated fermionic models. Much of the work done on fermionic systems is for the ½-filled band, corresponding to carrier density of $\rho=1$ per lattice site. Away from ½-filling much less is known regarding the effects of lattice frustration on strongly-correlated systems. We have recently considered the effect of frustration in two-dimensional interacting ¼-filled systems [1,2].

In the ½-filled band frustration destroys antiferromagnetic (AFM) order but can also lead to the formation of a valence-bond solid (VBS) ordered state. We show that at ¼-filling, frustration similarly destroys AFM order, but can lead to a singlet-pair ordered state that coexists with charge order. We have termed this state a Paired Electron Crystal (PEC) [1,2]. The PEC is analogous to the VBS state, but instead of having a uniform charge density consists of pairs of charge-rich sites separated by pairs of charge-poor sites.

In this talk I review the theoretical basis for the PEC and compare our theoretical calculations with experimental data from the organic charge transfer solid superconductors, specifically those of the beta and kappa lattice structures. In materials that show the PEC state, application of pressure leads to superconductivity. We further suggest that under an increase of frustration the singlet pairs in the insulating PEC state can acquire mobility, forming a superconducting paired electron liquid.

[1] H. Li, R. T. Clay, and S. Mazumdar, *J. Phys.: Condens. Matter* **2010**, *22*, 272201.
[2] S. Dayal, R. T. Clay, H. Li, and S. Mazumdar, *Phys. Rev. B* **2011**, *83*, 245106.