UNIDIRECTIONAL CHARGE INSTABILITY OF THE $d$-WAVE RVB SUPERCONDUCTOR

Manuela Capello$^a$, Marcin Raczkowski$^b$, and Didier Poilblanc$^a$

$^a$Laboratoire de Physique Théorique UMR5152, CNRS, F-31062 Toulouse, France
$^b$Marian Smoluchowski Institute of Physics, Jagellonian University, Reymonta 4, PL-30059 Kraków, Poland

Recent scanning tunneling microscopy on Ca$_{2-x}$Na$_x$CuO$_2$Cl$_2$ has revealed unidirectional modulation in local electronic density of states that coexists with $d$-wave superconductivity [1]. Motivated by this result we investigated in the previous studies the emergence of such modulations by assuming out-of-phase $d$-wave order parameters in neighboring domains [2]. Here we use a different strategy: starting from a uniform $d$-wave superconducting phase we study the energy cost due to imposed unidirectional defects with a vanishing pairing amplitude [3]. Both renormalized mean-field theory and variational Monte Carlo calculations within the $t$-$J$ model yield that the energies of inhomogeneous and uniform phases are very close to each other, especially in the presence of a tetragonal lattice distortion. This suggests that small perturbations in the microscopic Hamiltonian, might lead to inhomogeneous superconducting phases in real materials.