Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Quantum oscillations in d-wave superconductors with loop current order LUYANG WANG, OSKAR VAFEK, National High Magnetic Field Laboratory and Department of Physics, Florida State University — Coexistence of d-wave superconductivity and Fermi pockets in underdoped high temperature cuprate superconductors has been suggested by recent quantum oscillation experiments. The origin of Fermi pockets in the superconducting state has been under debate. Here we report numerical results of quantum oscillations of the specific heat in the vortex state of a d-wave superconductor in the presence of loop current order, which gives rise to Fermi pockets coexisting with nodal d-wave superconductivity. First, we calculate the specific heat within a lattice tight-binding model, varying the loop current order and the external magnetic field. Second, we investigate the same problem in the continuum linearized limit, performing Franz-Tesanovic transformation, and find that the Bogoliubov Dirac quasiparticles also couple to a vector-like potential which corresponds to a highly nonuniform magnetic field. The results thus found are consistent with the tight-binding calculation. While the energy spectrum is qualitatively different from Landau levels, we find oscillations of the specific heat that in an intermediate temperature range approximately follow Onsager relation.

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Date submitted: 27 Nov 2012 Electronic form version 1.4