Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

Index theorem and quantum order of d-wave superconductors in the vortex state[1] OSKAR VAFEK, Stanford University, ASHOT MELIKYAN, University of Florida — It is argued that the ground state of the lattice d-wave superconductor in the lattice of singly quantized $hc/2e$ vortices can posses quantum order. This is due to simultaneous crystallization of both the superflow and the fluxes of the Z_2 gauge field, the second of which has no classical analog. In the presence of particle hole symmetry we prove an index theorem which puts a lower bound on the number of zero energy modes. This bound is equal to 4 times the number of lattice sites coinciding with the centers of inversion within the magnetic unit cell. Generic cases are constructed in which this bound exceeds the number of zero modes of an equivalent lattice of doubly quantized vortices (as well as singly quantized vortices without Z2), despite identical classical symmetries. The spectrum around the zero modes is doubly degenerate and Dirac-like, with velocities that become universal functions of Δ/t in the limit of low magnetic field. For small, but finite strength of particle-hole symmetry breaking, the gapped state can be characterized by a topological quantum number, related to spin Hall conductivity, which differs in the case of $hc/2e$ and hc/e vortex lattice.

[1]cond-mat/0509258

Oskar Vafek
Stanford University

Date submitted: 22 Nov 2005 Electronic form version 1.4