Vortex Structure in Chiral p-wave Superconductors Studied by Eilenberger Theory

M. Ichioka[a], K. Machida[a], and J.A. Sauls[b]

[a] Department of Physics, Okayama University, Okayama 700-8530, Japan
[b] Department of Physics & Astronomy, Northwestern University, Evanston, Illinois 60208, USA

In chiral $p_{\pm}$-wave superconductors, there is a possibility that double-winding vortex is stabilized instead of conventional single-winding vortex,[1] because the opposite chiral ($p_{\mp}$-wave) component is induced around vortices. By the induced component, double-winding vortex becomes core-less vortex. The vortex structures for both winding cases are studied by Eilenberger theory in the vortex lattice state. We selfconsistently calculate the spatial structure of pair potential, internal magnetic fields and local electronic states, and discuss which winding vortex is stabilized depending on magnetic fields. We find that double-winding vortex has lower free energy than that of single-winding vortex at higher fields.
On the other hand, in Sr_2RuO_4 which is considered as a chiral p-wave superconductor, square vortex lattice of single-winding vortices is observed by small angle neutron scattering experiments, where nearest neighbor vortex is located along (1,1)-direction. [2] In order to discuss the condition to reproduce this vortex lattice configuration and orientation, we study the vortex lattice state considering detailed form of possible gap functions and Fermi surface structure of Sr_2RuO_4.

[1] J.A. Sauls and M. Eschrig, New J. Phys. **11**, 075008 (2009).
[2] T.M. Riseman, *et al.*, Nature **396**, 242 (1998); **404**, 629(E) (2000).