Appearance of magnetization around a pair of half quantum vortices in chiral *p*-wave superconductors

Yuhei Niwa[a, c], Masaru Kato[a, c], and Kazumi Maki[b]

[a]Department of Mathematical Sciences, Osaka Prefecture University, Naka-ku, Sakai, Osaka, Japan
[b]Department of Physics and Astronomy, University of Southern California, Los Angels, USA
[c]JST-CREST, 5, Sanbancho, Chiyoda-ku, Tokyo, Japan

Recently, triplet p-wave ($p_x \pm ip_y$) superconductors such as Sr_2RuO_4 were found.[1] It was phenomenologically suggested that in these superconductors, a pair of half-quantum vortices (HQVs) exists due to spin degree of freedom and in some cases it is more stable than a singly quantized vortex.[2] Although a pair of HQVs has not been discovered directly, recently a half height magnetization steps are observed in micrometer-sized annular shaped Sr_2RuO_4.[3] In order to investigate quasi-particle excitation around two vortices, we developed a new numerical method using elliptic coordinates and Mathieu functions.[4] We applied this method to a pair of vortices and a pair of HQVs cases in p-wave superconductors. And we found that a magnetic dipole moment appears along a pair of HQVs, because quasi-particle bound states for up or down spin exist only around each of the HQVs.

[1]A. P. Mackenzie, Y. Maeno, Rev. Mod. Phys. **75**, 657 (2003).
[2]H. -Y. Kee, Y.B. Kim, K. Maki, Phys. Rev. B **62**, R9275 (2000).
[3]J. Jang et. al. Science **331**, 186-188 (2011).
[4]Y. Niwa, M. Kato, K. Maki, Physica C **470**, 1151 (2010).