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**Microscopic investigation of vortex-vortex interaction in conventional and unconventional superconductors**<sup>1</sup> MASARU KATO, YUHEI NIWA, Department of Mathematical Sciences, Osaka Prefecture University — Recently, we have investigated the vortex structures in nano-sized superconductors. We found the interference of vortex bound states around multiple vortices. And their interaction is affected by such quasi-particle interference. Vortex structures becomes different from which phenomenological theory predicts [1]. Therefore we clarify how such quasi-particle structure changes the vortex-vortex interaction. In order for this, we investigate the quasi-particle structures around a pair of vortices, using the Bogoliubov-de Gennes equation in the elliptical coordinates, where two vortices sit at two foci We expand quasi-particle wave functions by the (modified) Mathieu function. From the numerical results, we discuss the distance dependence of interference of the quasi-particle bound states and free energies. We will extend our method to unconventional superconductors.

[1] H. Suematsu, T. Ishida, T. Koyama, M. Machida, M. Kato, J. Phys. Soc. Jpn. 79, no.12 (2010) in press.

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