凝縮系物理学ゼミナール

Condensed Matter Seminar

Location: **Room 413**, School of Science Bldg. 5 (理学 5 号館 413 号室)

Date: **13:30-15:00**, Wednesday, 23 May 2018

“Rayleigh-Taylor instability and quantum vortex rings in coupled Gross-Pitaevskii equations”

Speaker:

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Abstract:

The Rayleigh-Taylor instability (RTI) is one of the gravitational instability in two fluids where the heavier fluid lies on the lighter fluid [1]. RTI plays crucial roles in a variety of nonequilibrium phenomena, ranging from visible examples to supernova explosion of Crab Nebula. Moreover, RTI is closely related to vortex rings appearing in fluid motion. When a fluid is locally heated near the bottom, a plume is created and a vortex ring appears at the forefront of the plume. Plumes with vortex rings can keep stable even in strong turbulence [2]. As another example, when a drop of fluid falls into a lighter fluid, the droplet transforms into a torus and a vortex ring is created inside the torus due to the Kelvin-Helmholtz instability, and then the torus breaks up as a result of the RTI [3,4].

The RTI occurs even in quantum fluids. For example, the instability observed in a superfluid system of ^{3}He [5]. The RTI also occurs in two-component Bose-Einstein condensates induced by gradient of magnetic field. Sasaki *et al.* calculated linear stability of the two-layered solution of the coupled Gross-Pitevskii equation using Bogoliubov-de Gennes equations [6]. In addition, the quantum vortex rings were observed. Although several studies have been performed, they were focused on the system with the steady state.

We numerically studied the RTI using coupled Gross-Pitevskii equations for two-component Bose-Einstein condensates. Additionally, we carried out numerical simulations that the torus of heavier component was set initially which was surrounded by the lighter component. When the torus falls, the RTI promotes and a sagging pattern appears. We found that vortex rings suppressed the RTI when the outer radius of the torus is small.

References:

[1] G. Taylor, Proc. R. Soc. London, Ser. A **201**, 192 (1950).

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[4] M. Shimokawa *et al*., Phys. Rev. E **93**, 062214 (2016).

[5] R. Blaauwgeers *et al*., Phys. Rev. Lett. **89**, 155301 (2002).

[6] K. Sasaki *et al*., Phys. Rev. A **80**, 063611 (2009).