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, 13 November 2019

“Non-Hermitian Fermionic Superfluidity Subject to Inelastic Collisions in Ultracold Atoms”

Speaker:

Kazuki Yamamoto (Condensed Matter Theory Group)

Abstract:

In recent years, non-Hermitian (NH) quantum systems have been actively studied both experimentally and theoretically. It has been revealed that non-Hermiticity drastically alters the properties of a number of quantum phenomena that have been established in the Hermitian physics [1,2]. Such theoretical predictions have been confirmed experimentally by using optical systems and ultracold atoms. However, since most of the previous studies dealt with single-particle physics, understanding of many-body physics in NH systems is yet in its infancy.

Motivated by recent experimental advances in ultracold fermionic atoms, we analyze a non-Hermitian (NH) BCS Hamiltonian with complex-valued interactions arising from inelastic scattering between fermions [3]. We develop a mean-field theory to obtain a NH gap equation for order parameters, which are similar to but different from the standard BCS ones because of the inequivalence of left and right eigenstates in the NH physics. We find unconventional phase transitions unique to NH systems: the superfluidity breaks down and reappears with increasing dissipation, featuring non-diagonalizable (exceptional) points, lines, and surfaces in the quasiparticle Hamiltonian for weak attractive interactions. As for strong attractive interactions, the superfluid gap never collapses but is enhanced by dissipation due to an interplay between the BCS-BEC crossover and the quantum Zeno effect.

References:

[1] Yuto Ashida, Shunsuke Furukawa, Masahito Ueda, Nature Commun. **8**, 15791 (2017).

[2] Masaya Nakagawa, Norio Kawakami, Masahito Ueda, Phys. Rev. Lett. **121**, 203001 (2018).

[3] Kazuki Yamamoto, Masaya Nakagawa, Kyosuke Adachi, Kazuaki Takasan, Masahito Ueda, and Norio Kawakami, Phys. Rev. Lett. **123**, 123601 (2019).