

## Condensed Matter Seminar Kato-lab

Date: 2024. Sep. 11(Wed) 15:00-16:30 (時間を変更しました)

Place: Room 621, Building 16, Komaba I Campus, The University of Tokyo

Title: Topological superconductivity and zero modes in double helical liquids

Speaker: **Dr. Chen-Hsuan Hsu** (Institute of Physics, Academia Sinica, Taiwan)

**Abstract:** Time-reversal-invariant topological insulators support helical liquids at their edges, providing a platform where topological phenomena and correlation effects interplay. In the first part of this talk, I will discuss earlier proposals that utilize two parallel channels of these helical liquids to induce topological superconductivity and topological zero modes, upon introducing local and nonlocal pairings from an adjacent superconductor [1,2]. In the second part, I will discuss recent analyses on the effects of electron-electron interactions and electron-phonon coupling on the topological superconducting phase in double helical liquids in proximity to superconductors [3]. We find that both interchannel interactions and electron-phonon coupling generally suppress nonlocal pairing. Contrary to earlier perturbative analyses, our nonperturbative approach reveals that phonons can induce transitions between topological and trivial phases, thereby suppressing topological superconductivity and associated zero modes. Our findings suggest that electrically tunable topological phase transitions can occur in proximitized double helical liquids by adjusting the strengths of intrachannel and interchannel interactions. Importantly, given the ubiquitous presence of electron-electron interactions and phonons, our results highlight practical challenges in achieving topological zero modes in setup utilizing helical channels, including quantum spin Hall insulators, higher-order topological insulators, and their fractional analogs recently identified in twisted bilayer systems [4].

\*This work was financially supported by National Science and Technology Council (NSTC), Taiwan through Grant No. NSTC-112-2112-M-001-025-MY3. References:

[1] Chen-Hsuan Hsu et al., **Semicond. Sci. Technol.** 36, 123003 (2021), topical review.

[2] Chen-Hsuan Hsu et al., **Phys. Rev. Lett.** 121, 196801 (2018).

[3] Chen-Hsuan Hsu, **Nanoscale Horiz.** DOI: [10.1039/D4NH00254G](https://doi.org/10.1039/D4NH00254G) (2024), in press.

[4] K. Kang et al., **Nature** 628, 522 (2024).

講演者の Chen-Hsuan Hsu 氏は台湾の中央研究院物理学研究所で量子物性理論グループ主宰しています。今月の日本物理学会のために来日する機会に最近のご研究についての講演をお願いしました。皆様の参加をお待ちしております。 連絡先 (加藤雄介 46534)