# The Quest for the Quantum Pokéball for Topological Quantum Computing

**Joon Young Park**

**Department of Physics, Sungkyunkwan University (SKKU)**

**Email: park.jy@skku.edu**

Realizing a fault-tolerant quantum computer is one of the ultimate goals of modern physics. At the heart of this endeavor lies a mysterious quasiparticle known as the Majorana bound state. Unlike ordinary particles, Majoranas are predicted to be their own antiparticles and possess a unique non-Abelian memory, making them the perfect candidates for stable qubits. However, catching these elusive creatures in a solid-state device has proven to be a formidable challenge.

In this talk, I will guide you through our experimental journey to trap and manipulate these particles on the surface of a topological insulator—a material that acts as an insulator on the inside but a conductor on the outside [1]. We have developed a specific trap: a doughnut-shaped superconducting device known as a Corbino geometry [2,3]. Using this device, we recently observed a superconducting diode effect that switches its polarity depending on whether the number of magnetic vortices inside is even or odd. This peculiar even-odd behavior serves as a signature for the topological physics we are hunting.

Finally, I will unveil our blueprint for the next generation of experiments [4]: the "Quantum Pokéball." This hybrid device, embedding a trijunction within the Corbino geometry, is designed not just to catch "quantum Pokémon" (Majoranas—you will see why I call them so), but to braid them—moving them around each other to weave quantum information. Join us as we explore how this quantum Pokéball could open the gateway to the future of topological quantum computing.

[1] J.Y.P., …, G.-C.Y.*, P.K.*, *Nat. Mater.* 24, 399 (2025)

[2] J.Y.P.†,*, T.W.†,*, J.Z.†, …, P.K.*, arXiv:2601.14384

[3] O. L., J. Y. P., …, Y.O.*, arXiv:2601.14364

[4] J.Z.†, T.W.†, …, P.K.*, J.Y.P.*, in preparation