

Condensed Matter Physics Seminar Series

Photonic control of flat band superconductivity: fundamentals and applications

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Photonic control of correlated phases offers a powerful route to advancing and manipulating the functionality of quantum materials. In this talk, I will focus on the photonic control of flat band superconductivity, which owing to its quantum geometric origin provides an ideal platform for exploring topological collective phenomena. I will highlight how quantum geometry mediates microwave enhancement of superconducting order through a novel mechanism of radiation absorption that goes beyond the conventional Fermi velocity paradigm. I will show that unlike in conventional superconductors, flat band superconductivity can even be enhanced at zero temperature through direct modification of the quantum metric, addressing one of today's central questions: how to measure the quantum metric.

I will then discuss the emergence of a chiral cavity-controlled superconducting diode effect. Specifically, I will demonstrate how chiral photons reshape the superconducting ground state, leading to a quantum-geometric form of nonreciprocity. Extending this framework to gate-defined twisted bilayer graphene Josephson junctions, I will present results on photocontrolled diode efficiencies approaching 40%. Finally, I will show that this platform enables the realization of a photo-controlled, on-demand $0-\pi$ qubit.

Arpit joined the NarangLab in the fall of 2023 as a postdoctoral fellow. He is a condensed matter theorist interested in emergent phenomena in quantum systems and exploring modern problems using theoretical tools. His focus is not only to seek a fundamental understanding but also to provide insights about quantum materials for experimentalists to use as a toolkit for device design. His research interests range from mesoscopic transport, non-linear optical responses, plasmonics, and more. Recently discovered van der Waals heterostructures provide a perfect ground for these explorations with a potential of engineering the physics of solids. Before joining the NarangLab, he worked with Justin Song for his Ph.D in Physics at NTU, Singapore.

**Friday, October 17th at 10am
4-330 PAB**