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New Tools for Dark Matter and Gravitational Wave Detection: Cryogenic Optical Resonators and Long-Baseline Atom Interferometers

Saturday 19 April 2025 13:30 (1 hour)

Abstract: The search for dark matter and for new sources of gravitational waves offers potentially revolutionary opportunities to learn about the fundamental properties of the Universe. Strong astrophysical evidence indicates that dark matter makes up most of the matter in the Universe, yet its nature remains a great mystery. The detection of gravitational waves in currently unexplored frequency ranges could provide unique insights into astrophysics and cosmology. In this talk, I will discuss two emerging techniques for probing dark matter and gravitational waves. The first method involves precise optical comparisons of the lengths of cryogenic, vibration-isolated optical resonators. I will discuss the results from the first dark matter search using this approach, as well as prospects for using this method for high-frequency gravitational wave detection. The second method, long-baseline atom interferometry, involves the coherent splitting of the wavefunctions of atoms over large distances and the subsequent observation of interference of the recombined wave packets. I will introduce MAGIS-100—a 100-meter-tall atom interferometer currently under construction at Fermilab—and describe experimental demonstrations of a new approach to atom interferometry that paves the way for long-baseline atom interferometers to reach their full scientific potential.

Presenter: KOVACHY, Timothy

Session Classification: Afternoon keynote