Department of Physics and Astronomy Colloquium Series

Tuesday, November 18, 2025, 2:30pm in PSE 317

Speaker: Matthew Johnson

Institution: York University/Perimeter Institute

Title: Reflections on the Cosmic Microwave Background

Abstract:

Over the past half-century measurements of the cosmic microwave background (CMB) radiation, relic light from the big bang, have taken cosmology from philosophy to a precision science. As CMB telescopes become more sensitive, we are entering a new era of CMB science where the dominant measurable signals are from scattered (reflected) CMB light, rather than the pristine photons released in the early Universe. These are the 'secondary CMB anisotropies'. In this context, the CMB can be thought of as one of the most well-calibrated light sources in the Universe – with a near-perfect blackbody spectrum, and anisotropies whose intrinsic statistics are extremely well measured. Secondary CMB anisotropies are induced by the interactions of this light source with the intervening large-scale structure of the Universe, providing an opportunity to learn about everything between us and the CMB. In this talk, I describe how reflected CMB light measured by the Planck satellite and the Atacama Cosmology Telescope (ACT) in concert with massive galaxy surveys performed by the WISE satellite and Dark Energy Spectroscopic Instrument (DESI) have been be used in my research to: make a map of the velocity of structure in most of the observable Universe, make the strongest existing test of the cosmological principle, definitively establish the physical origin of the CMB dipole since its first measurement nearly 50 years ago, constrain fundamental interactions in the early Universe, and rule out light vector bosons beyond the Standard Model of particle physics. These measurements also indicate that baryonic feedback in groups of galaxies is far stronger than previously thought, which has the potential to transform our understanding of galaxy evolution. I will describe the future of the CMB secondaries program over the next three years with the rapid advances in CMB measurements performed by Simons Observatory and massive galaxy catalogues from DESI, LSST, and SPHEREx.