PHYSICS AND ASTRONOMY
COLLOQUIUM

Dr. Scott Chapman

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"Studying the Epoch of Inflation with the Cosmic Microwave Background: Lithographic Fabrication of Cold, Superconducting Electronics for Use in the Polarbear-2 and SPT-3G Experiments"

Abstract

In the first fraction of a second after the birth of the Universe, space underwent a period of superluminal expansion which we call cosmic inflation. The theory of cosmic inflation was originally proposed in the 1980s to explain the observed geometry and smoothness of the universe. The residual quantum fluctuations from this epoch of inflation seeded the formation of structure in the Universe and left behind a relic background of gravitational waves. These gravitational waves imprint a unique pattern of polarization onto the CMB which may have been recently detected by the BICEP2 experiment operating at the South Pole. This groundbreaking measurement would suggest that the epoch of cosmic inflation occurred at 1e-36 seconds after the Big Bang. The energy-density of the universe at this epoch was 13 orders-of-magnitude larger than the energies probed by the LHC and near the GUT scale, where the strengths of the strong, weak and electromagnetic forces are thought to converge. The detection of this signal is a revolution in our understanding of the beginning of the Universe. It ties together the most disparate scales possible in science: quantum mechanics and cosmology; the beginning of the universe to the present day.

Dr. Chapman will present an overview of the scientific questions which are currently being addressed by studying the cosmic microwave background (CMB). He will discuss the signature of inflation, experimental techniques, and focus on detector technology for POLARBEAR-2 and SPT-3G.

Dr. Chapman's group has initiated a program to lithographically develop cold, superconducting electronics for reading out arrays of Transition-Edge Sensor (TES) Bolometers. The POLARBEAR experiment faced a challenging problem in that the LC resonators used in previous experiments were found to have too much loss to be used at the higher frequencies needed for the high multiplexing factor in second generation POLARBEAR-2 / Simons Array / SPT-3G experiments. Our group has played a key role in lithographically developing a new fully superconducting resonator which is now these experiments' baseline. The two layer process has explored Nb, Va, and Al, along with various etch and lift-off techniques. We describe the fabrication process and testing of devices leading to a mature technology which is entering a "mass production" phase for the POLARBEAR-2 and South Pole Telescope experiments.

Wednesday, March 4, 2015
3:30 p.m.
Bob Wright Centre
Room A104