SPT-3G: THE THIRD GENERATION CAMERA FOR THE SOUTH POLE TELESCOPE

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The scientific questions currently being pursued by cosmic Microwave Background (CMB) experiments tie together the most disparate scales possible in science: quantum mechanics and cosmology; the beginning of the universe to the present day. The advances in CMB science are being driven largely by advances in detector technology. These detector technologies consist of large, background-limited arrays of superconducting transition-edge sensor (TES) couple bolometers. In addition to making polarization-sensitive detectors, numerous groups are developing multi-chroic detectors. These new multi-chroic detectors place new requirements on the optics, in particular the need for large format optics with efficient transmission and low scattering properties across a broad-band (roughly 50–300 GHz).

The South Pole Telescope (SPT) is a 10-m telescope optimized for low-noise, high-resolution imaging of the cosmic microwave background (CMB). SPT is located at the NSF Amundsen-Scott South Pole station, one of the best developed sites on Earth for mm-wave observations. I will discuss the scientific goals, design, and status of the third generation camera and survey for SPT (SPT-3G). The camera will be equipped with ~2,500 polarization-sensitive, multi-chroic pixels operating simultaneously at 95, 150, and 220 GHz. The SPT-3G camera will observe for four years, from 2017-2012, and cover 2500 square degrees: an area equal to the original SPT-SZ survey but observed at a noise level 10× lower in temperature.

I will give an overview of the technology enabling SPT-3G, in particular focusing on multi-chroic detectors, along with the requirements for large-format optics with broad-band anti-reflection coatings for use at cryogenic temperatures and mm-wavelengths. I will discuss the design and fabrication of lenslet arrays for SPT-3G detectors. These lenslets are made of alumina and anti-reflection coated with a multi-layer PTFE-based plastic which is molded and laser machined. I will also discuss our process for anti-reflection coating large aluminum oxide lenses. This technology, while generally applicable to microwave astronomy and even telecommunications, is crucial to our science goal of experimentally constraining the era of inflation and measuring the masses of the neutrinos by observing the polarization of the CMB.