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BICEP/Keck: Constraining primordial gravitational waves with CMB polarization observations from the South Pole

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The theory of cosmological inflation was developed in response to longstanding questions about the origins of our universe. It predicts a specific spectrum of density perturbations that arose during the Big Bang, which has been corroborated by observations of the Cosmic Microwave Background (CMB). This talk will focus on a decisive prediction of inflation that has so far eluded observational confirmation: B-mode polarization of the CMB imprinted by primordial gravitational waves. The BICEP/Keck telescopes target this signature by observing the microwave sky at degree-scale resolution from the South Pole. The intrinsic faintness of the signal, bright Galactic emission at the same observing frequencies, and distortion from gravitational lensing, all contribute to making this measurement extremely challenging. I will explain how the BICEP/Keck program overcomes these experimental challenges, successfully producing world-leading constraints on primordial gravitational waves. As a high-altitude environment with an exceptionally stable atmosphere, the South Pole is the only ground-based site that has allowed such measurements. I will report on the ongoing deployment of the “Stage-3” BICEP Array telescope, which will continue to set limits on inflationary models and probe the early universe. Finally, I will outline how these efforts inform next-generation “Stage-4” experiments, which will also probe the thermal history of our Universe, dark energy and general relativity, and neutrino properties.

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