Measurements of Cosmic Microwave Background Polarization from the SPTpol 500 Square-Degree Survey

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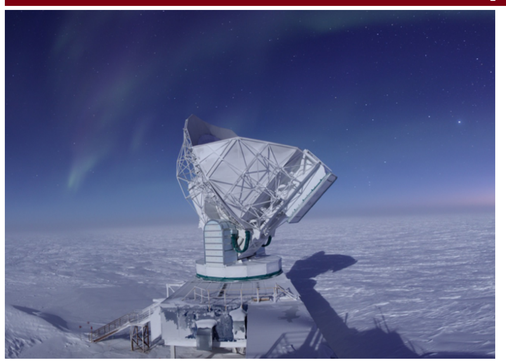
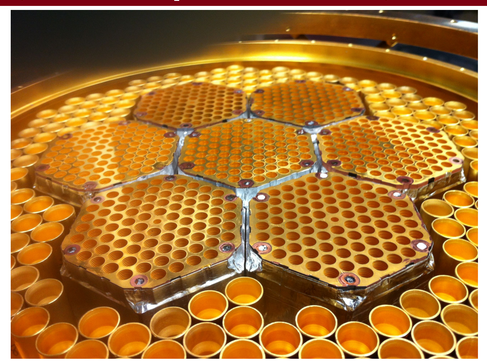
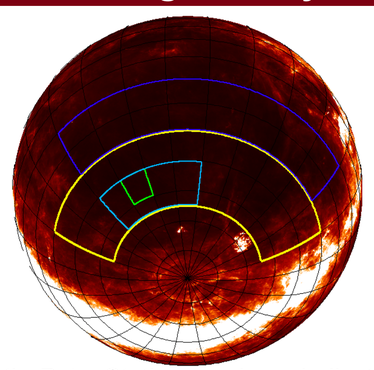
The South Pole Telescope, the SPTpol Receiver, and the 500 deg^2 Survey

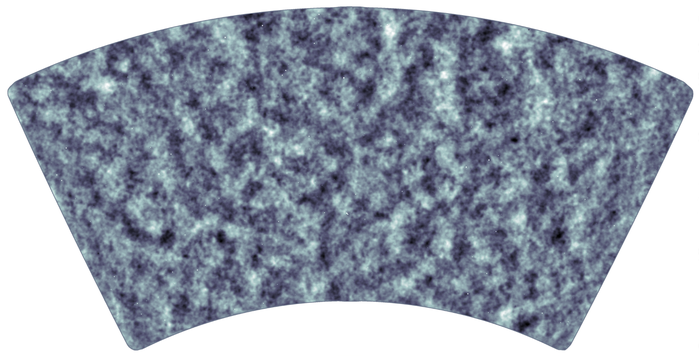


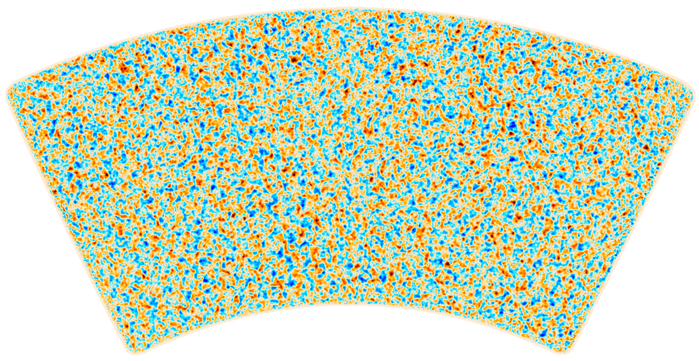


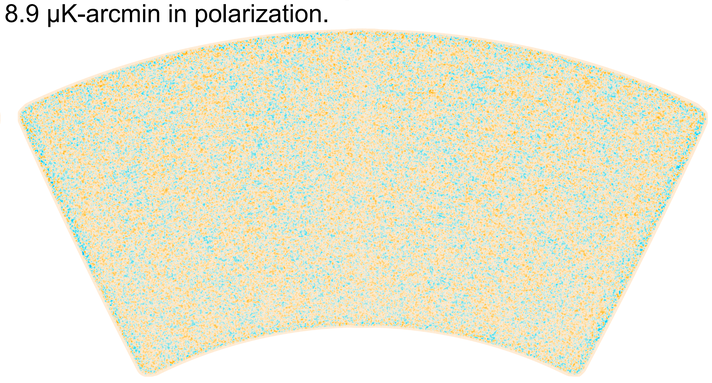


The 10-m South Pole Telescope (SPT) **(Left)**, installed at the Amundsen-Scott South Pole Station, makes dedicated measurements of the cosmic microwave background (CMB). The SPT has thus far been used for two surveys: the completed 2500 deg^2 SPT-SZ survey (2007-2011), and the ongoing 500 deg^2 SPTpol survey (2012-2016). The SPTpol receiver **(Middle)** contains 588 dual-polarization pixels sensitive to 150 GHz surrounded by 180 dual-polarization pixels at 95 GHz. The SPT survey fields are highlighted against a galactic dust model **(Right)**, which shows the "southern hole," a region of low thermal dust emission. The SPT-SZ survey is in yellow while the SPTpol survey is in cyan. The 100 deg^2 SPTpol "Deep Field" is marked in green, and an independent 2500 deg^2 region in blue marks new area observed with the SPTpol receiver during austral summers in search of massive galaxy clusters.

SPTpol Maps of CMB Temperature and E-mode Polarization

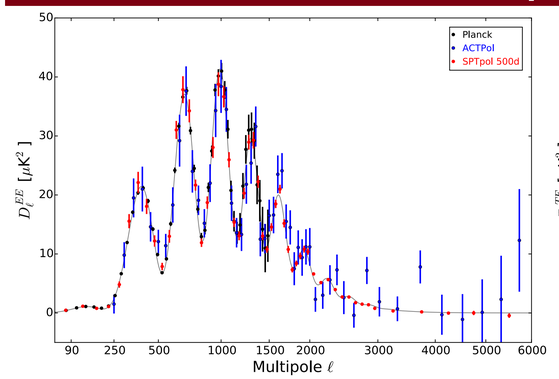


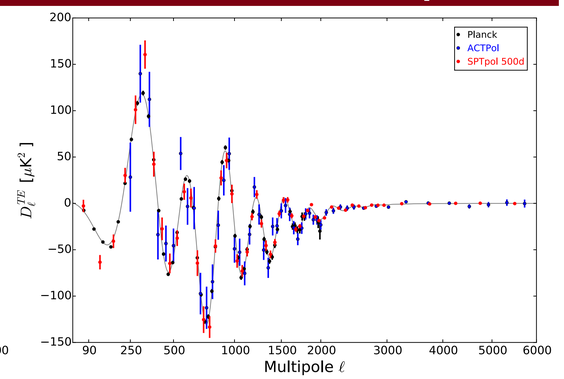




(Left): CMB temperature at 150 GHz. The map has been smoothed by a 1 arcminute full-width at half-maximum (FWHM) gaussian. The color scale corresponds to ±400μK$_{CMB}$. Bright points are active galactic nuclei and gravitationally lensed dusty star-forming galaxies. Dark points are galaxy clusters that manifest as shadows in the CMB through the thermal Sunyaev-Zel'dovich Effect. **(Bottom Left):** E-mode signal at 150 GHz. The map has been smoothed by a 4 arcminute FWHM gaussian. The color scale is ±20 μK$_{CMB}$. **(Bottom Right):** E-mode differenced map with ±20 μK$_{CMB}$ scale, demonstrating the level of noise in the survey field, which is measured to be 8.9 μK-arcmin in polarization.

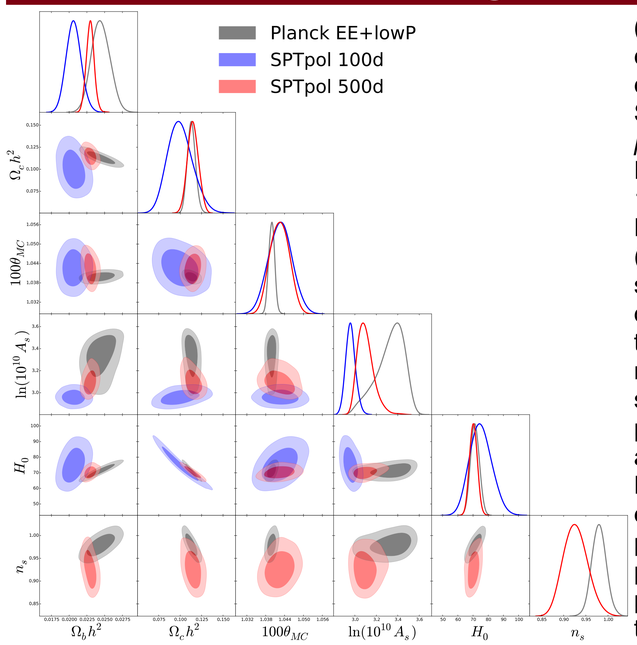
E-Mode Auto-Power and Temperature-E-mode Cross-Spectra





(Left): The CMB E-mode polarization angular auto-power spectrum at 150 GHz, showing measurements from SPTpol (Henning et al. 2016, *in prep*), ACTPol (Naess et al. 2014; arXiv: 1405.5524), and Planck (arXiv:1502.01589). The Planck spectrum is cut off at angular multipole ℓ > 1500. A theoretical spectrum calculated from Planck best-fit cosmological parameters is plotted in gray. SPTpol has the most sensitive constraints on the E-mode spectrum at ℓ > 1100. We detect at least 9 acoustic peaks between 50 < ℓ < 3000. Above 3000, our data place tight upper limits on residual polarized foreground power after masking point sources with intensity > 50 mJy in either 95 or 150 GHz. Low foregrounds mean we can use more of the polarized CMB damping tail for cosmological parameter estimation compared to the temperature damping tail. **(Right):** The CMB temperature-E-mode cross-power spectrum from SPTpol, ACTPol, and Planck. Within sample variance, measurements made with SPTpol are in good agreement with Planck even at large angular scales.

Cosmological Constraints



(Left): 2-D marginalized ΛCDM cosmological parameter constraints, comparing sensitivities of the 500 deg^2 SPTpol survey (Henning et al. 2016, *in prep*) (red), the SPTpol 100 deg^2 "Deep Field" (Crites et al. 2015; arXiv: 1411.1042) (blue), and the Planck 2015 EE+lowP dataset (arXiv:1502.01589) (gray). The two SPTpol surveys have similar polarization map depths, but decreased sample variance from five times greater area greatly improves the marginalized constraints of the larger survey. The combined EE+TE SPTpol parameter constraints are comparable to and in good agreement with the full-sky Planck EE+lowP constraints. The expanded range of angular scales probed by the 500 deg^2 survey also provides sensitivity to parameters previously untested by SPTpol, such as the scalar spectral index n_s.

Institutions participating in the SPTpol collaboration

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