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A MEASUREMENT OF THE COSMIC MICROWAVE BACKGROUND DAMPING TAIL FROM THE 2500-SQUARE-DEGREE SPT-SZ SURVEY

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ABSTRACT

We present a measurement of the cosmic microwave background (CMB) temperature power spectrum using data from the recently completed South Pole Telescope Sunyaev-Zel'dovich (SPT-SZ) survey. This measurement is made from observations of 2540 deg^2 of sky with arcminute resolution at 150 GHz, and improves upon previous measurements using the SPT by tripling the sky area. We report CMB temperature anisotropy power over the multipole range $650 < \ell < 3000$. We fit the SPT bandpowers, combined with the results from the seven-year Wilkinson Microwave Anisotropy Probe (*WMAP*7) data release, with a six-parameter ΛCDM cosmological model and find that the two datasets are consistent and well fit by the model. Adding SPT measurements significantly improves ΛCDM parameter constraints, and in particular tightens the constraint on the angular sound horizon θ_s by a factor of 2.7. The impact of gravitational lensing on the CMB power spectrum is detected with $8.1\,\sigma$, the most significant detection to date. The inferred amplitude of the lensing spectrum is consistent with the ΛCDM prediction. This sensitivity of the SPT+*WMAP*7 data to lensing by large-scale structure at low redshifts allows us to constrain the mean curvature of the observable universe with CMB data alone to be $\Omega_k = -0.003^{+0.014}_{-0.018}$. Using the SPT+*WMAP*7 data, we measure the spectral index of scalar fluctuations to be $n_s = 0.9623 \pm 0.0097$ in the ΛCDM model, a $3.9\,\sigma$ preference for a scale-dependent spectrum with $n_s < 1$. The SPT measurement of the CMB damping tail helps break the degeneracy that exists between the tensor-to-scalar ratio r and n_s in large-scale CMB measurements, leading to an upper limit of $r < 0.18$ (95% C.L.) in the ΛCDM+r model. Adding low-redshift measurements of the Hubble constant (H_0) and the baryon acoustic oscillation (BAO) feature to the SPT+*WMAP*7 data leads to further improvements. The combination of SPT+*WMAP*7+H_0+BAO constrains $n_s = 0.9538 \pm 0.0081$ in the ΛCDM model, a $5.7\,\sigma$ detection of $n_s < 1$, and places an upper limit of $r < 0.11$ (95% C.L.) in the ΛCDM+r model. These new constraints on n_s and r have significant implications for our understanding of inflation, which we discuss in the context of selected single-field inflation models.

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