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The Dark Energy Survey: Cosmology Results With ~1500 New High-redshift Type Ia Supernovae Using The Full 5-year Dataset

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Abstract

We present cosmological constraints from the sample of Type Ia supernovae (SN Ia) discovered during the full five years of the Dark Energy Survey (DES) Supernova Program. In contrast to most previous cosmological samples, in which SN are classified based on their spectra, we classify the DES SNe using a machine learning algorithm applied to their light curves in four photometric bands. Spectroscopic redshifts are acquired from a dedicated follow-up survey of the host galaxies. After accounting for the likelihood of each SN being a SN Ia, we find 1635 DES SN in the redshift range $0.10<z<1.13$ that pass quality selection criteria and can be used to constrain cosmological parameters. This quintuples the number of high-quality $z>0.5$ SNe compared to the previous leading compilation of Pantheon+, and results in the tightest cosmological constraints achieved by any SN data set to date. To derive cosmological constraints we combine the DES supernova data with a high-quality external low-redshift sample consisting of 194 SNe Ia spanning $0.025<z<0.10$. Using SN data alone and including systematic uncertainties we find $\Omega M=0.352\pm0.017$ in a flat ΛCDM model, and $(\Omega M,w)=(0.264^{+0.074}_{-0.096},-0.80^{+0.14}_{-0.16})$ in a flat wCDM model. For a flat w0waCDM model, we find $(\Omega M, w0,wa)=(0.495^{+0.033}_{-0.043},-0.36^{+0.36}_{-0.30},-8.8^{+3.7}_{-4.5})$, consistent with a constant equation of state to within ~2σ. Including Planck CMB data, SDSS BAO data, and DES 3×2-point data gives $(\Omega M,w)=(0.321\pm0.007,-0.941\pm0.026)$. In all cases dark energy is consistent with a cosmological constant to within ~2σ In our analysis, systematic errors on cosmological parameters are subdominant compared to statistical errors; these results thus pave the way for future photometrically classified supernova analyses.

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