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The Cosmological Optical Convergence: Extragalactic Background Light from TeV Gamma Rays

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The Extragalactic Background Light (EBL) is the aggregate of all photon emissions in the universe since the cosmic dark ages, dominated by the optical and infrared emissions from thermal processes. Using the EBL absorption imprint on the γ-ray spectra of extragalactic sources, we study the decade-old tension between EBL intensities inferred from galaxy counts (IGL) and from direct observations, the optical controversy. We use STeVECat, the most comprehensive catalog of archival TeV spectra resulting from three decades of extragalactic observations. We have developed a Bayesian framework to marginalize over the spectral parameters of the γ-ray data, as well as systematic uncertainties of instrumental origin. By integrating over the EBL redshift evolution, we present for the first time a fully model-independent γ-ray measurement of the EBL at $z = 0$, between 0.18 and 120 μm. In the optical band, at 600 nm, we measure an intensity of 7.4 ± 2.0 nW m^{-2} sr^{-1} $\times\, h_{70}$. This value is indistinguishable from IGL measurements, 7.6 ± 0.3 nW m^{-2} sr^{-1} , and is compatible with the latest intensity derived from New Horizons observations. The γ-ray data exclude at the 95% level EBL contributions from diffuse sources with an intensity relative to the IGL $f_{\rm diff} \geq 19\%$, and we are able to measure the local Hubble constant, $H_0 = 68 \pm 7$ km s^{-1} Mpc^{-1} $\times\, (1 + f_{\rm diff})$. γ-rays, IGL and direct measurements are in agreement for the first time on the EBL intensity in the optical band, finally achieving cosmological optical convergence.

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