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A TeV-based Determination of the Local Extragalactic Background Light and its Consistency with Galaxy Counts and Direct Measurements

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Abstract

The extragalactic background light (EBL) is the cumulative radiation from all extragalactic sources and traces galaxy formation and cosmic evolution. We use very-high-energy gamma rays to measure the local EBL intensity and test its consistency with galaxy counts and direct photometric measurements. Our analysis uses a sample of 308 spectra from 53 sources observed with Imaging Atmospheric Cherenkov Telescopes. A model-dependent study of seven recent EBL templates shows that they require only up to 10% rescaling to reproduce the attenuation observed in the gamma-ray spectra. The empirical model anchored to galaxy counts provides the closest match. We then derive template-marginalized TeV optical depths using a representative subset of models and combine them with GeV measurements from the Fermi-LAT to reconstruct the EBL at redshift zero using both an empirical and a physically motivated model. The two reconstructions agree and follow the integrated galaxy light to within 2 to 3 nW m^{-2} sr^{-1}, typically less than 25%, over wavelengths from 0.5 to 30 micrometers. They are also consistent, within uncertainties, with low-zodiacal-light observations, including measurements from the outer solar system and dark clouds. In contrast, the near-infrared excess reported by IRTS and CIBER exceeds our reconstructed intensity by 3 to 5 sigma. This implies an additional contribution of roughly 5 to 10 nW m^{-2} sr^{-1} that is incompatible with the gamma-ray optical depths. Together with recent GeV-based studies that constrain the EBL evolution up to redshift about 4, these TeV optical depths provide a determination of the local EBL intensity anchored by very-high-energy gamma-ray observations. The agreement with galaxy counts and deep-space measurements indicates that known galaxy populations account for most of the optical and near-infrared background, leaving limited room for an additional diffuse component.

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