HIGH-ENERGY ASTROPHYSICS

Cosmic measurements with γ-rays

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As γ-rays traverse the Universe, their mutual annihilation with photons making up the extragalactic background light (EBL) attenuates them. The degree of attenuation depends on the density of photons in the way, as well as the distance travelled, which itself depends on how fast the Universe is expanding. Thus Alberto Domínguez and co-workers are able to use γ-ray attenuation measurements to further constrain the matter density Ω_m and expansion rate H_0 of the Universe at the same time.

Their technique is independent of other methods for measuring H_0, including supernova, cosmic microwave background, baryon acoustic oscillations, weak and strong lensing data. Domínguez et al. combine two sets of optical depth data that are estimated from attenuation measurements: (1) Fermi-LAT observations of 739 blazars and one γ-ray burst with redshifts up to $z \approx 3.10$ and energies up to 1 TeV; and (2) Imaging Atmospheric Cerenkov Telescopes measurements of 38 blazars up to $z \approx 0.6$ and 20 TeV. The photons that make up the EBL are modelled in two different ways. These are analysed separately and in combination to yield the most likely values of $H_0 = 67.4^{+6.0}_{-6.2}$ km s^{-1} Mpc^{-1} and $\Omega_m = 0.14^{+0.06}_{-0.07}$. The values are consistent with those determined from baryon acoustic oscillations and lower than previous γ-ray attenuation methods; here the energy and redshift ranges are larger, with systematic biases accounted for and a joint likelihood analysis. To further improve H_0 and Ω_m measurements, which we need to constrain dark matter and dark energy, we look to future observations of blazars and γ-ray bursts.

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