COSMOLOGY

A distorted Universe

Mon. Not. R. Astron. Soc. (in the press); preprint at https://arxiv.org/abs/2007.07956

Weak lensing due to collective foreground matter can lead to minuscule distortions of the shape and brightness of background sources. Despite its insidious nature, however, weak lensing studies can constrain cosmological parameters such as Ω_m. Edward Macaulay and the Dark Energy Survey (DES) collaboration use DES to understand the effects of weak lensing on a sample of ~200 Type Ia supernovae (SNe) and in the process constrain the σ_8 cosmological parameter.

Through weak lensing, overdense regions magnify SNe lying behind them, while the opposite is true for SNe behind voids. Because voids are more frequent than overdensities, this effect translates to a skewness in the way that SNe magnitudes deviate from their expected standardized values across the sky. As this skewness depends on Ω_m and σ_8, the distribution of magnitude residuals can constrain these parameters.

Macaulay et al. apply an existing technique to the DES data and also to SNe Ia data from the Joint Light-curve Analysis (JLA) sample. Due to their limited sample, the authors find little statistical evidence for weak lensing affecting their SNe sample (1.3σ significance), with a corresponding σ_8 value of $1.2^{+0.9}_{-0.8}$. The same analysis for an appropriate subsample of the JLA estimates σ_8 to be $0.8^{+1.1}_{-0.7}$. Given that the JLA sample is almost twice as large, the smaller uncertainties achieved with the DES data indicate the importance of DES's homogeneous data quality and improved photometric calibration.

While very much a preliminary result with far larger uncertainties than other cosmological probes, it showcases the potency of this independent tool for future SNe surveys with the Vera C. Rubin Observatory and the Nancy Grace Roman Space Telescope.

Marios Karouzos

Published online: 29 July 2020
https://doi.org/10.1038/s41550-020-1189-x