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Whispers from the dark universe about weak lensing one-point statistics

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Weak lensing offers a way to directly probe the matter distribution that is sensitive to the physics of the dark universe, in particular dark matter and dark energy. Since weak lensing is a projected effect, it is not possible to fully recover the time evolution of the density field. Tomography is crucial to recover this evolution for disentangling physical effects. The one-point probability distribution function (PDF) carries additional information about density environments compared to standard two-point statistics. At intermediate scales, the large deviation theory accurately predicts the convergence PDF and its changes with cosmological parameters at different redshifts. Additionally, the theoretical model for the convergence PDF can be adapted to include weak lensing systematics. This work investigates the constraining power of the tomographic convergence PDF using these predictions. We cross-validate predicted and measured convergence PDFs derived from convergence maps reconstructed with shear catalogues from an N-body simulation. Fisher forecasts show enhanced constraints with tomography compared to non-tomography and shear two-point correlation functions. This is due to the additional information provided by the skewness at different redshift bins. The tomographic convergence PDF can track structure growth and capture non-Gaussian information across scales, demonstrating strong potential for constraining cosmological parameters.

Primary author: CASTIBLANCO, Lina (Newcastle University)

Co-author: Prof. UHLEMANN, Cora (Bielefeld University)

Presenter: CASTIBLANCO, Lina (Newcastle University)

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