Contribution ID: **131** Type: **Poster**

Systematic errors in strong gravitational lensing reconstructions, a numerical simulation perspective.

Wednesday 25 March 2020 19:13 (1 minute)

We present the analysis of a sample of twenty-four galaxy-galaxy strong gravitational lens systems with a background source and deflectors from the Illustris-1 simulation. We create mock lensing observations with a data quality comparable to known samples such as the SLACS lenses, to study the degeneracy between the complex mass distribution of the lenses, subhaloes, the surface brightness distribution of the sources, and the time delays. Using a novel inference framework based on Approximate Bayesian Computation, we find that for all the considered lens systems, an elliptical and cored power-law mass density distribution provides a good fit to the data. However, due to the presence of cores in the simulated lenses, most reconstructions are affected by some form of the Source Position Transformation. The latter leads to a systematic underestimation of the source sizes by 50 percent on average, and a fractional error in the Hubble constant of 36 percent. On the other hand, we find no degeneracy between complexity in the lensing potential and the inferred amount of substructure. We recover an average total projected mass fraction in subhaloes of $f_{\rm sub} < 1.7 - 2.0 \times 10^{-3}$ at the 68 percent confidence level which is consistent with zero and in agreement with the fact that all subhaloes had been removed from the simulation. Our work highlights the need for even higher-resolution simulations to quantify the lensing effect of more realistic galactic potentials better. Finally, our results confirm that additional observational constraints may be required to break existing degeneracies.

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Session Classification: RECEPTION and POSTER SESSION IN THE SAME ROOM

Track Classification: Dark matter and structure in the Universe