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From cosmic lasagna to space-time spaghetti – obtaining the least-model-dependent strong gravitational lensing probe

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Strong gravitational lensing has advanced as a standard probe to map mass densities of cosmic structures or to try and infer parameters of the cosmological concordance model, like the Hubble Constant. Almost all approaches use a global assumption of the light-deflecting mass distribution at a specific redshift and fit the observed data to this model. With increasing data quality, the parameter space of these models becomes computationally costly to scan for optimum values. Besides this, degeneracies arise and there may be several best-fit models for a given set of observables.

In this talk, I will introduce those properties of a light-deflecting cosmic structure that can be *uniquely* and directly determined from observables without any global model assumption. They constitute the maximum information common to all model-based mass maps and require less than a second of computing time [1]. The derivation of these characteristics also reveals the most general class of degeneracies and a simple physical interpretation of all invariance transforms that can be applied to the equations of the single-plane formalism, leaving observable quantities unchanged [2].
As the formalism is only based on scale-free, purely gravitational light deflection, these *local* lens properties can be determined for any set of multiple images of a common background source independently and in exactly the same way on galaxy- or cluster-scales. Information can also be concatenated into a patch work of local lens properties to assemble a more global mass map and save resources at the same time.
As examples, I will showcase the power of this approach by two galaxy clusters: one that cannot be tackled by model-based approaches [3] and a second one where model-based approaches caused puzzling controversies [4].

References:
[1] https://arxiv.org/abs/1906.05285
[2] https://arxiv.org/abs/1809.03505, https://arxiv.org/abs/1904.07239, https://arxiv.org/abs/2203.06190
[3] https://arxiv.org/abs/2105.04562, https://arxiv.org/abs/2207.01630
[4] https://arxiv.org/abs/2306.11779

More information about the concept and further applications in cosmology:
https://thegravitygrinch.blogspot.com

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