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Lensing of ’69 – Free lensing from its lens models

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After more than a century of modern cosmology in which model assumptions were indispensable to interpret the sparse and vague data, we are finally able to replace model assumptions by observational evidence. With telescopes like Hubble, the development of adaptive optics for ground-based facilities, and installations of integrated field units, the amount of high-quality data has vastly increased in the last decades. It will continue to improve and increase with next generation telescopes like the James Webb Space Telescope. The gaps between data shrinking, the necessity to fill in blanks by models decreases.

Within the growing framework of data-driven cosmology, this talk introduces observation-based strong gravitational lensing. It reconstructs a deflecting mass density and properties of the multiply-imaged background source without employing any assumptions about the overall shape of the deflecting mass density profile or properties of the source object. Freeing strong gravitational lensing from its lens models, we can characterise the general class of invariance transformations rooted in the lensing formalism beyond the famous mass-sheet transform. We are also able to determine the maximum set of local lens and source properties all model-based reconstructions agree upon, and we can efficiently reconstruct multi-scale lensing phenomena, even for a single system of multiple images in an otherwise uncharted lensing region.

The method of reducing an under-determined system of equations to its local, uniquely determined, non-degenerate solutions can also be transferred to other astrophysical probes like plasma lensing. Being a dispersive phenomenon, the wavelength dependence of plasma lensing observables allows to break degeneracies that are inherently invincible in non-dispersive gravitational lensing.

Thus, using data not models, various applications become possible to gain new, less biased insights into light deflection phenomena.

J. Wagner. A Model-Independent Characterisation of Strong Gravitational Lensing by Observables. Universe (2019)

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