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SuGOHI! Dissecting a strong lensing interacting galaxy system

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Gravitational arcs are strongly magnified images of distant galaxies (known as sources) caused by the deflection of light produced by a foreground galaxy or galaxy cluster (the lens). This strong lensing phenomenon has been used to study high-redshift sources, to assess the mass distribution in the lens, to constrain cosmological parameters and to set limits on modified gravity. In addition, merging lensing systems have been used to set constraints on dark matter properties, such as a possible self-interaction cross section. In this work we present a detailed analysis of the strong lensing system J083933.4-014044.4, originally discovered in the Survey of Gravitationally-lensed Objects in HSC Imaging (SuGOHI). The lens is an early-type galaxy in the dense environment of a galaxy cluster and the images have the characteristic shape of a large arc with three bright peaks and a counter image. This configuration allows one to carry out the so-called lens inversion, providing parameters of the lens, such as the mass within the Einstein radius and the ellipticity of the mass distribution, and a coarse reconstruction of the (unlensed) source. A closer look into this system reveals the presence of tidal tails connecting the central galaxy with two dwarf spheroidals. Therefore, this object offers a unique opportunity of contrasting the complex dynamics of the merging systems with a lensing mass estimate. Furthermore, the unusual fact that the images are red, makes this system particularly relevant for studying the distant lensed galaxy. We have made a "dissection"of this system, first fitting and subtracting a smooth model of the lensing galaxy. This enhances the tidal features and removes contamination of the lens light for modeling the images. We then perform the lens inversion, obtaining parameters of the lens mass distribution and reconstructing the source shape. This lensing model is also used to subtract the arcs from the original images, providing a further "cleaned"view of the tidal features. Motivated by the potential applications of this system we have carried out spectroscopic observations with the Southern Astrophysical Research (SOAR) and Gemini telescopes, aiming at: i) obtaining the redshift of the source, ii) measuring the velocity dispersion of the lens, iii) obtaining redshifts of the dwarf spheroidals, to confirm the collision interpretation, iv) deriving physical properties of the lens and the source. Preliminary analysis of the data yielded the redshift of the source. A comparison between the lens velocity dispersion and the lensing mass estimate will allow us to quantify the effects of the mergers on the global dynamics of the lens galaxy. The detailed modelling of this peculiar lensing system may not only unveil aspects of its history and dynamics, but may also set constraints on dark matter properties.

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