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Edited by

Hannah Stacey
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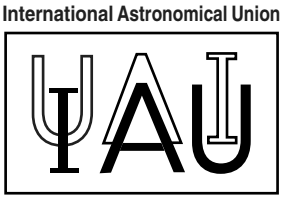

STRONG GRAVITATIONAL LENSING IN THE ERA OF BIG DATA

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Preface

Strong gravitational lensing is a powerful and mature technique for probing galaxies and the Universe as a whole. In the past twenty years, strong lensing observations have enabled unique studies, such as measurements of the dark matter distribution in galaxies and galaxy clusters, detections of substructure in galaxies, measurements of the expansion rate of the Universe with time-delay lenses, and high-resolution analyses of strongly lensed high-redshift galaxies. While these efforts have improved our understanding of galaxy evolution and cosmology, there are still open questions that strong lensing observations can help to address. What is the nature of dark matter and dark energy? Is the history of the Universe well described by a flat $\wedge$ cold dark matter model? The answers to these questions have profound fundamental physics implications.

The field of strong lensing is about to be revolutionised by the advent of new observational facilities, such as Euclid, the Rubin Observatory, the Roman Space Telescope and the Chinese Space Station Telescope. These telescopes and their associated surveys are expected to lead to the discovery of around 100000 new strong lenses, an increase of more than two orders of magnitude with respect to the current sample size of confirmed lenses. Such a large amount of data gives us the potential for carrying out strong lensing studies with very high precision. At the same time, however, it poses new challenges: to fully take advantage of this improvement in precision, it is necessary for the accuracy of the models used to interpret these data to improve as well. Furthermore, traditional analysis methods, based on the detailed study of a few select systems, do not scale well to very large sample sizes. With this symposium, we brought together observational and theoretical researchers in the community to review the progress of the field and develop a roadmap for the new era of strong gravitational lensing.

The goals of the symposium were

- to understand the preparedness of the community to analyse and adapt to forthcoming big data;
- to assess the progress of the field in regard to precision lens modelling and modelling of high-angular-resolution data, and to understand what developments are needed;
- to find synergies between observations and simulations of dark matter and the high-redshift Universe;
- to determine the scientific questions that strong lensing will address over the next decade and foster collaboration.

Four major subjects were covered during the week: cosmology, dark matter, galaxies and galaxy clusters, and high-redshift sources. Each subject had dedicated sessions with invited and contributed talks, as well as posters and discussion sessions. Sessions dedicated to the same subject were spread out over multiple days to encourage synergies between the different science aspects and methodology.

The proposed symposium date of June, 2023, was auspicious as it preceded the first data release from flagship survey facilities. In the past few years, many new astronomers have entered the field, started groups and introduced fresh and innovative ideas. During the symposium, these researchers presented the state-of-the-art techniques they developed to resolve structure in the early Universe, test the nature of dark matter, test fundamental physics and efficiently analyse forthcoming big data sets, demonstrating

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that the strong lensing community is well-placed to address critical scientific questions in astrophysics. A selection of the work presented is summarised in these proceedings.

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