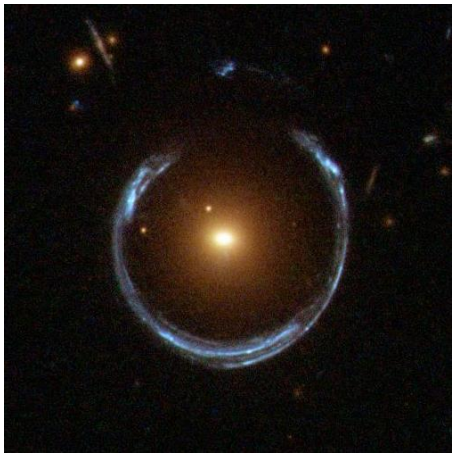
Mini-Grant 2022 (RSN1)

Mass profiles of gravitational LEnses: MOdelling with Neural networks and scientific exploitation



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The project

Scientific objectives: Gravitational lensing is a unique tool for constraining the mass of galaxies. In the immediate future, the number of known gravitational lenses will reach numbers which were unimaginable until a few years ago. It is therefore necessary to plan automatic, efficient and fast techniques to model them, determining total mass, dark matter fraction, mass density slope and Initial Mass Function of lens galaxies. This type of analysis has been described in the "schede" LENS-ML and MASSE. With this proposal (mini-grant) we aim at:

a) developing a stand-alone procedure for modelling gravitational lenses (LEMON), and thus
b) constrain physical processes using statistically large samples of lens galaxies as a function of redshift, mass and environment.

Main participants: C. Tortora (OACN), F. Gentile (UniBo, PhD student), V. Busillo (OACN, PhD student). V. Busillo was not part of the grant request, but is a new PhD who is working on LEMON and the comparison of the results with simulations

Request: 20000 € to support hardware and travel expenses.

Duration: 2 years

Awarded: 18000 €

Budget

A portion of the budget was initially allocated for the purchase of a server. However, these funds were redirected towards computers, drives, and travel expenses. Additionally, the budget covers now the expenses of my new PhD student, Valerio Busillo, who is dedicated to implementing LEMON.

The following expenses have been made:

Expenses	Amount (€)
Laptop for the PhD student V. Busillo	2804.78
2 hard-drives	158.6
Euclid meeting at Copenhagen	2128.27
Work visit to Napoli (F. Gentile)	105.30
Congress of SIF – Salerno	197.7
Congress of SIF - Salerno (V. Busillo)	135
Total	5529.65

A high-performance GPU-equipped desktop PC will be procured and specifically designated for LEMON runs, along with other computer equipment (estimated cost: around €4500).

Progress status and achieved objectives

- The first version of LEMON has been presented in Gentile et al. (2023), where we demonstrate to be able to model efficiently, using an isothermal ellipsoid model, Euclid- and HST-like strong gravitational lenses, measuring the Einstein radius and lens ellipticity and their uncertainties. The results have also been presented in this MEDIA INAF paper.
- Nearly one year into the project, Valerio Busillo is actively engaged in implementing more complex lens models, specifically a power-law model. This involves utilizing officially simulated lenses provided by the Euclid collaboration and collaborating closely with colleagues in the Euclid Strong Lensing - SWG. We have successfully modeled various parameters, including those related to the lens model (ellipticity, Einstein radius, and power-law slope) and the lens galaxy's light parameters (e.g., total magnitude and effective radius). The next step involves commencing the writing of a related paper (**Busillo et al., in prep.**).
- In preparation for future data exploitation, we have started to work with mock galaxies from simulations, to constrain astrophysical and cosmological parameters. In the initial paper, Busillo et al. (2023), we have contrasted simulated and observed scaling relations for star-forming galaxies. In future papers, we plan to perform a similar analysis using passive and massive galaxies, with a particular focus on strong gravitational lenses.
- Outreach talks have been focussed on the search and modelling of gravitational lenses (e.g. see here).

- Regarding the planned schedule, our current emphasis is on power-law models and determining the parameters of the galaxy light. This latest step is essential for subtracting the lens light and enhancing the accuracy of the power-law slope estimation—a critical parameter in studies related to galaxy evolution. Additionally, we intend to test LEMON on Euclidized HST lenses (or lenses found in the first Euclid data) and ground-based data, such as KiDS@VST.