

## Giovanni Granata



### Title

Improved strong lensing modelling of galaxy clusters using the Fundamental Plane: detailed mapping of the baryonic and dark matter mass distribution of Abell S1063

### Abstract

The usual choice of adopting simple power-law scaling relations to link the total mass of members with their luminosity is one of the possible inherent systematics within strong lensing (SL) models of galaxy clusters, and therefore on the derived cluster masses.

I will present how we use the Fundamental Plane (FP) relation to obtain more accurate and complex relations between the observables describing cluster members, and to completely fix their mass from their observed magnitudes and effective radii.

Using new information on their structural parameters (from HST imaging) and kinematics (from MUSE data), we build the FP for the early-type galaxies of the cluster Abell S1063. We take advantage of the calibrated FP to develop an improved SL model of the total mass of the cluster core.

The new method allows for a reduction of the uncertainty on the value of the core radius of the main DM halo. We also find a different relation between the mass and the velocity dispersion of members, which shows a significant scatter.

Thanks to a new estimate of the stellar mass of cluster members from HST data, we measure the two-dimensional, cumulative mass profiles out to a radius of 350 kpc, for all baryonic and dark matter components of the cluster. Finally, I will present a comparison between the physical properties of sub-halo in our model and those predicted by high-resolution hydrodynamical simulations. We find good agreement in terms of stellar mass fraction, and some discrepancies in terms of sub-halo compactness.

# Academic Curriculum Vitae - Giovanni Granata

## PERSONAL INFORMATION

Giovanni Granata, born in Desio (Monza e Brianza), Italy, on 15 October 1996, Italian citizen.

Work address: via Celoria 16, I-20133, Milan, Italy.

E-mail: giovanni.granata@unimi.it

## OVERVIEW

Giovanni Granata is a second-year PhD student at the University of Milan, supervised by Prof. Claudio Grillo and co-supervised by Dr. Amata Mercurio (INAF – OAC). He is part of the ZOOMING collaboration (PRIN 2017, PI: Piero Rosati), gathering scientists from several European research centres.

His PhD project aims at using strong lensing models of the total mass distribution of galaxy clusters to disentangle the mass distribution of the dark matter haloes and test the predictions of the Standard Cosmological Model. To improve the accuracy of strong lensing models, he has used recent information on the internal kinematics of cluster galaxies, from integral-field spectroscopic data, to derive more accurate and complex scaling laws describing the cluster members, compared to those commonly adopted in this type of analyses. He has also compared the results of his lensing analyses with high-resolution hydrodynamical simulations, confirming the recently reported discrepancy in terms of compactness of the cluster dark matter sub-haloes.

## EDUCATION

- Nov. 2020 – : **PhD student in Physics, Astrophysics, and Applied Physics** at the University of Milan.
- Jan. 2019 – Oct 2020: **Master Degree in Physics** at the University of Milan, **final mark: 110/110 cum laude**. Thesis: *Improving the strong lensing model of the galaxy cluster Abell S1063* (advisors: Claudio Grillo and Amata Mercurio).
- Oct. 2015 – Dec 2018: **Bachelor Degree in Physics** at the University of Milan, **final mark: 110/110 cum laude**. Thesis: *Mass distribution model of the gravitational lens HE 0435–1223* (advisors: Marco Lombardi and Claudio Grillo).

## SCHOOLS, WORKSHOPS AND VISITS

- Nov. 2021: XXXII Canary Island Winter School of Astrophysics, Formation and Evolution of Galaxy Clusters across cosmic time, IAC, San Cristobal de la Laguna, Tenerife, Spain.
- Oct. 2021: visitor at the Max Planck Institute for Astrophysics, Garching, Germany.
- Oct. 2021: ZOOMING PRIN meeting, University of Ferrara, Ferrara, Italy.
- Jun. 2021: XVI Summer School of Statistics for Astronomers, Pennsylvania State University (held online).

## CONTRIBUTIONS TO CONGRESSES AND SEMINARS

- Nov. 2021 (**poster**): XXXII Canary Island Winter School of Astrophysics, Formation and Evolution of Galaxy Clusters across cosmic time, IAC, San Cristobal de la Laguna, Tenerife.
- Oct. 2021 (**talk**): PhD school workshop, University of Milan (held online).
- Sept. 2021 (**poster**): A multi-wavelength view of galaxy clusters: deriving the masses in the era of wide-field surveys, ESA (ESAC, held online).

## TEACHING ACTIVITY AND SUPERVISION OF STUDENTS

- 2021 – : exercise classes for the course *Thermodynamics*, Undergraduate programme in Physics at the University of Milan.
- 2021 – : exercise classes for the course *Elements of Physics*, Undergraduate programme in Food Science and Technology at the University of Milan.
- 2021 – : supervision of two Bachelor Degree theses in Physics at the University of Milan (Jacopo Masnaghetti and Marta Corioni, ongoing).
- 2019 – 2020: Italian teacher for students for the *SPEAK Milan* association.
- 2016 – 2018: peer tutor for the Undergraduate programme in Physics at the University of Milan.

## INSTITUTIONAL ROLES

- Oct. 2021 – : President of the *PhD students' Committee* of the University of Milan.
- Oct. 2021 – : member of the *Right to Education Board* of the University of Milan.
- Jun. 2016 – May 2018, Dec. 2020 – : member of the *Physics Department Committee* of the University of Milan.
- Sept. 2019 – Oct. 2020: member of the *Centre for didactic innovation and multimedia technology* of the University of Milan.
- Jun. 2018 – Oct. 2020: member of the *Academic Senate* of the University of Milan.
- Jun. 2018 – Oct. 2020: member of the *Teaching Committee* of the University of Milan.
- Jun. 2016 – Oct. 2020: member of the *Students' Committee* of the University of Milan.

## LANGUAGE SKILLS

- Italian (native).
- English (fluent).
- Spanish (intermediate).
- Latin (six years of study).

## CODING SKILLS

- Languages: Python (usage of astronomical packages), C++.
- Astrophysical software, in particular strong gravitational lensing codes (e.g., Lenstool and Glafic).

## OUTREACH ACTIVITY

- As a PhD student: guest in the *90 91 in movimento* radio programme, Radio Bla Bla, Milan.
- As an Undergraduate student: organisation of several dissemination conferences on a wide array of topics at the University of Milan (e.g., Physics, Chemistry, Biology, and History).

## FIRST AUTHORED PUBLICATIONS (ORCID 0000-0002-9512-3788)

- **Granata, G.**, Mercurio, A., Grillo, C., Tortorelli, L., Bergamini, P., Meneghetti, M., Rosati, P., Caminha, G. B., and Nonino, M., 2021: *Improved strong lensing modelling of galaxy clusters using the Fundamental Plane: the case of Abell S1063*, submitted for publication to A&A (<https://arxiv.org/abs/2107.09079>).