Description of Masters and Ph.D. projects 2026

Amy Stutz: Masters: Cloud kinematics and cluster formation / destruction. Sub-mm, mm-wave radio (ALMA, APEX, IRAM) and catalogue data (e.g. Gaia, SDSSV) data. Observational characterization of cloud kinematics in star forming regions in the Milky Way, with a focus on more massive regions, and the LVM project. Possibly also observation diagnostics of the magnetic fields (tentative) via polarization (data not yet in hand). One project will likely be offered. Ph.D.: No projects envisioned currently, but happy to discuss.

Neil Nagar: (a) black hole mass measurements (and improvements, and estimations) in individual galaxies from high resolution ionized gas kinematics; (b) demographics of sub-pc binary supermassive black holes (including identification via optical and mm light curves); (c) clues to binarity or accretion physics from millimeter light and spectral index curves (hours to years); (d) characterizing atmospheric water vapor with relevance to mm-wave astronomy and global warming.

Mary Loli Martínez Aldama: Understanding the geometry and dynamics of the broad line region (BLR) in type 1 Active Galactic Nuclei (AGN) through spectroscopic and variability analysis using SDSS-V (Reverberation Mapping (RM) and/or AQMES samples) and Zwicky Transient Facility (ZTF) data. Reliable spectroscopic measurements are needed to reduce the scatter and establish solid connections between both properties, which cannot be achieved using automatic measurements available in the literature. The analysis will be performed in the context of the Quasar Main Sequence and compared with recent theoretical models based on dust-failed winds (FRADO model). The results can be applied to a variety of analyses. For example, reliable spectroscopic measurements will help to decrease the scatter in Radius-Luminosity (RL) relation and explore the departure from the classical relation as a function of the Eddington ratio.

Ronald Mennickent Cid: (A) Magister: to calculate stellar and accretion disk parameters of close interacting binaries using spectroscopic and photometric data. To estimate the evolutionary stage of binary stars using the MESA code. To write and submit professional observational proposals for high resolution spectrographs and to use archival and survey photometry to get insights on relevant variable stars. **(B) PhD:** To investigate the nature of the binaries Double Periodic Variables (DPVs), especially the hypothesis of the magnetic dynamo. To study the corresponding populations in the Magellanic Cloud and the Galaxy. To investigate the flow dynamics in close interacting binaries aimed to constrain the accretion efficiency and the role played by winds and mass loss in the evolution of the systems. To investigate the rotation of the gainer star in DPVs, especially its synchronicity with the orbital period.

Nathan Leigh: This project addresses recent observations from the JWST telescope, which claim to have found star clusters at high redshifts with incredibly high densities. In order to understand this better, we must calculate a “maximum packing fraction”, calculated using the observed densities and the mean free path approximation. This will address the questions: Could such a star cluster with such high densities persist? If so, for how long? If the packing fraction is high, does this mean that all stars would have merged on short timescales? If so, what timescales? Could the result of these calculations help to explain how super-massive black holes formed in the early Universe? Etc.

Pierluigi Cerulo: A model for the automatic morphological classification of galaxies in the RELICS survey. RELICS is a survey of clusters of galaxies at z=0.2-0.8 conducted with the Hubble Space Telescope. Automatic morphology is one of the main fields in current astroinformatics, and several supervised and unsupervised models have been proposed to categorise galaxies in different morphological types. On the other hand, the classification is an essential preliminary step in the study of the structural properties of galaxies, which are an important part of their physics. Finally, most studies in galaxy evolution focus on the field, and recent studies of cluster galaxies (e.g. van der Burg et al. 2020) challenged the evolutionary models proposed for the field. In this project you will work on the development of a Deep Learning model to determine the morphology of galaxies in the RELICS survey (additional top-up funding available).

Pierluigi Cerulo: The morphology of galaxies in the outskirts of local clusters. Galaxy clusters grow by the continuous accretion of dark matter haloes; the remnants of the accreted groups are detected as substructures in the spatial distribution of cluster members. It has been shown (e.g. Haines et al. 2015) that the fraction of star-forming galaxies in cluster outskirts is lower than that of the coeval field, supporting the notion that the passive galaxy population in clusters is composed of galaxies in which star formation was quenched in the cluster and passive galaxies that were accreted during the assembly of the cluster. The latter phenomenon is known as preprocessing, the study of which represents one of the key aspects of extragalactic astronomy. In this project you will use archival data from the SDSS and focus on clusters at z < 0.1 to study the morphology of galaxies in cluster outskirts (additional top-up funding available).

Leonardo Krapp: In the field of planetary sciences, the formation of natural satellites is a topic of significant interest and ongoing debate. This project focuses on investigating the migration conditions of the Galilean moons during their formation stage. Dominant models, such as the Minimum Mass Subnebula (MMSN) and satellite formation from a gas-starved accretion disk [Canup & Ward 2002, Batygin & Morbidelli 2020], suggest that without a mechanism to counteract migration, many moons would have collapsed into Jupiter, preventing their formation. However, these models overlook the effect of solid-induced migration identified by [Benítez-Llambay & Pessah 2018]. Incorporating the dynamic effects of dust could be crucial, motivating a comprehensive analysis of Galilean moon formation models. Therefore, this project will assess the significance of dynamic interactions between Jupiter's protosatellites and dust, including torque effects described by Benítez-Llambay & Pessah (2018). Our models integrate theoretical analysis with cost-effective numerical simulations using the open-source FARGO3D code**.**

Alessandro A. Trani: I offer projects on stellar dynamics and the formation of gravitational wave sources. The first project looks at the evolution of black holes embedded in active galactic nucleus (AGN) disks using N-body simulations (see arXiv:2506.02173) and forecasts the properties of merging compact objects (see for example arXiv:2501.02907). The second project complements the first, focusing on how black hole-gas interactions affect AGN physics, and extends the models developed in arXiv:2403.00060. Other possibilities include disentangling the properties of chaotic versus regular mergers in 3-body interactions in stellar clusters (follow-up to arXiv:2403.03247), as well as smaller projects on chaos in few-body systems. These projects require a good understanding of theoretical astrophysics and computation.

Jhon Yana Galarza. I have four projects for Master's and PhD students focusing on stellar abundances and exoplanets using high-resolution spectroscopy: (1) discover new solar twins to study the chemical evolution of the Galactic disk; (2) investigate the star–planet connection using wide binaries; (3) explore mixing processes in stellar interiors through lithium and beryllium measurements in solar twins and wide binaries; (4) detect exoplanets around thick-disk and halo stars to explore planet formation and conduct demographic studies. Although I already have data for most of the proposed projects, the students will regularly prepare and submit observing proposals for high-resolution instruments (e.g., ESO, LCO).

Rodrigo Herrera-Camus: (a) Characterization of the interstellar dust properties of high-redshift (z~4-6) galaxies based on novel ALMA multiband (Band 9 to 4) observations; (b) Characterization of the cold gas, stellar, metal, and dust properties of giant star-forming clumps in high-redshift galaxies based on combined ALMA and JWST imaging and spectroscopy.