The interstellar medium and stellar population in the Galactic Centre

The Galactic Centre (GC) is the only galaxy nucleus in which we can observationally resolve its stars and thus probe its physics in detail. The GC therefore plays a central role in the study of the properties of and interactions between the common building blocks of galaxy nuclei: massive black holes, nuclear star clusters, nuclear stellar discs, and the interstellar medium. The GC is also the most extreme environment in the Milky Way and its most prolific star-forming region. It can serve as a unique proxy to understand star-forming conditions in high-redshift star-forming galaxies.

The IAA Galactic Centre Group (GCG) is a leader in high angular resolution observations of the GC and the study of its structure and stellar population. With the GALACTICNUCLEUS project, the GCG has delivered the so far most complete catalogue of stars in the inner 100 pc. Currently, we are working on obtaining the proper motions of a few million stars in the GC. The GCG is also active in radio observations of the centre of the Milky Way. We mainly use instruments from the ESO VLT, the Hubble Space Telescope, the James Webb Space Telescope, and the VLA radio interferometer.

This thesis in observational astrophysics will mainly focus on the following scientific and technical objectives:

1) Analysis and interpretation of the proper motions of the interstellar medium around the central black hole Sagittarius A*
2) Precision photometry and astrometry with PSF fitting on data from the ERIS instrument at the VLT and from NIRCam at the JWST.
3) Study of the unresolved stellar emission in the central parsec of the GC.
4) Studies of the star formation history of the nuclear star cluster in multi-wavelength, proper motion-cleaned data on off-center fields as well as with combined kinematic and photometric data from JWST, HST, VLT and Gemini telescopes.

5) Depending on the availability of new observations, work on new data from HAWK-I/VLT, (GALACTICNUCLEUS extension to the west), WFC3/HST or NIRCam/JWST.

Timeline

Year 1: Literature work to get familiar with the topic. Introduction into the necessary software (Python and relevant python packages, IDL and StarFinder). Work on VISIR/VLT data of the GC, analysis and interpretation of the results.
Year 2: Studies of NIRCam/JWST and ERI/VLT images to find the optimal way to extract precision photometry and astrometry as well as point-source subtraction, including the extended PSF wings. Analysis and interpretation of diffuse stellar emission in the GC (JWST and ERIS data).
Year 3: Study of stellar population in nuclear star cluster off-centre fields
Year 4: Work on GALACTICNUCLEUS extension or new JWST or HST data (if available). Writing of thesis.

Resources
The group disposes of ample computing resources (high-end laptop for student, linux servers for data processing). Sufficient funds are available to travel (participation in schools, conferences and work visits).

Training
Apart from the training offer by the postgraduate program of the University of Granada, the IAA offers ample opportunities, from the weekly seminars and colloquia to the specialised courses within our Severo Ochoa Excellence program (advanced astrophysics schools; courses on astrophysical software, outreach and neural networks; English and Spanish courses, etc.)

Collaborations
Important collaborators of the GCG are Andrea Ghez and her Galactic Center Group at UCLA (USA), Nadine Neumayer and her Galactic Nuclei Group at MPIA (Germany), Mathias Schultheis at Observatoire de la Côte d'Azur (France), Francisco Nogueras Lara at ESO (Germany,) and Francisco Najarro at CAB (Spain). The student will be encouraged and supported to carry out research stays and to apply for an ESO student fellowship.