

**Contratación de personal investigador predoctoral en formación del Gobierno de Aragón  
2026-2030 -- Proyectos de Tesis ofertados**

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**Title: Study of Galaxies in the Cosmic Web of Pisces-Perseus**

**Abstract:** The distribution of matter in the Universe on Megaparsec scales is not homogeneous. On the contrary, it exhibits a wide variety of structures that make up the so-called large-scale structure of the Universe. These structures are the result of the anisotropic gravitational collapse of the initial fluctuations in the primordial Universe. The large-scale structure (cosmic web) forms a network of roads and highways along which dark matter and galaxies flow from low-density regions (cosmic voids) to intermediate-density regions (filaments and walls), eventually accumulating in the highest-density regions (galaxy clusters and nodes). Each of these environments produces different effects, which accumulate over the evolutionary history of galaxies. Understanding the impact of environment on galaxy evolution is one of the key topics in modern astrophysics.

The Pisces-Perseus supercluster is an extended region located at a redshift of  $z = 0.016$ , and is composed of three massive clusters (Abell 426, Abell 347, and Abell 262), along with at least ten smaller clusters or groups, all connected by filaments. This rich structure represents a compendium of all the components that make up the cosmic web, making it an ideal laboratory for studying galaxy evolution in different environments. Approximately 400 square degrees of the Pisces-Perseus region are covered by the J-PLUS survey. Additionally, two of its main clusters (Abell 262 and Abell 260) are part of nearby cluster studies in spectroscopic surveys such as WEAVE/SDSS, from which thousands of redshifts are expected to be obtained in that region—especially for dwarf galaxies, for which J-PLUS photo- $z$  estimates are less accurate. This combination of unique, precise photometric redshift data from J-PLUS and spectroscopic data from WEAVE/SDSS will enable the student to carry out a thesis focused on topics such as: luminosity functions, structural parameters, and stellar populations of galaxies in different environments. All these data will allow us to uniquely characterize the structures of Pisces-Perseus and their impact on galaxy evolution.

The student will work within an interdisciplinary group of researchers, mainly based at CEFCA and IAC, with extensive collaborations in European countries (Italy, the Netherlands, UK). The student will have full access to galaxy survey data (J-PLUS, WEAVE, SDSS), which represent the state of the art in modern astronomy.

**Supervisor:** Dr. S. Zarattini.

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**Title: The physics of binary systems: a tale of interactions**

**Abstract:** The evolution of multiple-star systems is a fundamental question in stellar astrophysics. Around 25% of binary systems are compact enough to exchange mass, changing the structures and subsequent evolution of both stars. For these “close” binaries, as the more massive MS component evolves to the RGB, the stars undergo a stage of common envelope (CE) evolution, where mass can be transferred to the MS star and eventually leave behind a post-CE binary (PCEB) containing a WD and its MS companion (e.g., Webbink 2008; Ivanova et al. 2013). PCEBs are the progenitors of many interesting astrophysical transients, including cataclysmic variables (CVs), novae, Type Ia supernovae (SNe Ia), and some core-collapse SN subtypes (see Toloza et al. 2019, and references therein). Thus,

the properties of WD+MS systems provide fundamental clues to understanding the evolution of PCEBs.

To better understand the mass transfer processes in interacting systems, J-PLUS and J-PAS will be used to assemble a unique sample of PCEBs containing a WD+MS star (Fig. 7). When available, GALEX will be used to characterize the hot companion (Anguiano et al. 2022) and 2MASS, WISE, Euclid, and SPHEREx for the redder star. Combining the previous photometry with Gaia parallaxes and epoch-level astrometry and radial velocities, available in the upcoming DR4, will generate one of the largest, most complete, and most homogeneous binary catalog ever published (VAC PCEB), including not only derived properties (luminosities, temperatures, chemical compositions, radii, etc.) of the component stars, but also the binary system architectures (period, separation, masses, eccentricities) for hundred of thousands of systems. This will allow multivariate statistical analyses to characterize multiple intermediate stages in the evolutionary path between main sequence binaries and PCEBs, explore systematic trends with stellar parameters like mass and chemical composition, and provide a solid observational framework to benchmark binary population synthesis codes.

Supervisor: Dr. B. Anguiano.

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**Title: Planetary defence and astronomical survey data analysis**

Abstract: This PhD project will focus on the detection of small Solar System objects (asteroids and comets) in wide-field CCD survey data from the Observatorio Astrofísico de Javalambre (OAJ), with an emphasis on planetary-defence applications. The main goal will be to develop and test methods for moving-object detection, false-detection filtering, and linking of detections across multiple exposures and observing nights. The project will also contribute to the preparation of a new wide-field telescope programme dedicated to planetary defence and space situational awareness, including simulations of survey performance and observing strategies. This work is part of CEFCA's broader effort to strengthen its role as a leading European centre for planetary defence, supported by the construction of a new dedicated telescope with an investment of nearly 10 million euros.

The candidate will gain experience with large imaging datasets and computational methods relevant to modern astronomical surveys, including CCD image processing, astrometry, moving-object detection, linking algorithms, and survey simulations. Additional topics may include databases, parallel computing, and machine-learning methods for classification or false-positive rejection.

Experience with scientific programming, preferably in Python, would be an advantage, but motivated candidates with strong quantitative skills are also encouraged to apply.

Supervisor: Dr. B. Novakovic

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**Title: Extragalactic Tidal Streams as Probes of Baryonic Physics and Dark Matter**

Abstract: Tidal streams are powerful probes of galaxy formation and evolution, preserving information about both baryonic processes and the underlying dark matter distribution in nearby

galaxies. Their structural properties provide a unique opportunity to test cosmological models and constrain the nature of dark matter.

Upcoming observations from Euclid, complemented by deep ground-based imaging, will enable the first statistical census of several thousand tidal streams, many of them with unprecedented resolution. The primary goal of this PhD project is to exploit this unique dataset to identify the stellar stream observables that most effectively disentangle the effects of baryonic physics from those of dark matter, and to evaluate their power to discriminate between different dark matter scenarios, including Cold Dark Matter (CDM), Warm Dark Matter (WDM), and Self-Interacting Dark Matter (SIDM).

Supervisor: Dr. D. Martínez Delgado