



Postdoctoral positions in asteroseismology of intermediate- and high-mass stars: clusters, binaries, and yields

The Institute of Astronomy of KU Leuven in Belgium is looking for **three junior post-doctoral researchers to join its asteroseismology research group for a period of 3 to 5 years each**. All three projects involve Kepler/TESS photometry, Gaia astrometry, and asteroseismic modelling of intermediate- and high-mass stars. The three positions concern 1.) gravity-mode asteroseismology of open clusters; 2.) dynamical asteroseismology of eclipsing binaries and tidal evolution; 3.) yield computations calibrated by asteroseismology and the chemical enrichment of galaxies.

The Institute

The Institute of Astronomy (IoA) of KU Leuven is a young and vibrant research group of some 90 scientists, engineers, and administrative staff, including 6 full-time and 3 part-time professors. The institute is an expertise centre in stellar and exoplanetary astrophysics and astronomical instrumentation, and is active in several international consortia and collaborations, involving telescopes at observatories worldwide and in space. Members of IoA have access to parallel computing facilities at the Flemish Supercomputer Centre. The IoA is responsible for the organisation of the Master of Astronomy & Astrophysics and the Advanced Master of Space Studies of the Faculty of Science, and operates the 1.2m Mercator telescope at Roque de los Muchachos, La Palma Observatory, Canary Islands. The institute has a long tradition in instrumental, observational, computational and theoretical studies of stellar structure and evolution, with emphasis on stellar variability.

The successful applicants will be embedded in a team of asteroseismologists led by Conny Aerts, Joris De Ridder, and Andrew Tkachenko. They will be working jointly on mapping the internal rotation and mixing profiles of stars as a function of their global stellar properties such as mass, age, metallicity, initial angular momentum, and multiplicity. The selected postdocs are expected to take up responsibilities in the supervision of BSc, MSc, and PhD students. They will receive ample training in the writing of personal competitive project applications as an important aspect of their future career development.

The Project

The projects rely heavily on data from the Kepler/TESS and Gaia space missions, as well as from ground-based spectroscopic surveys characterising stellar surface properties. The assembled time series contain a tremendous amount of information, yet to be exploited jointly. As an overarching aim, the three postdocs will work together with a group of PhD students to extract optimal observables from data of non-radial pulsators assembled by the surveys and exploit them to improve the theory of stellar structure and evolution.

The three projects cover a multitude of concrete aims and tasks to be done, requiring various skills. Candidates wishing to apply for more than one position are requested to express their order of preference.

1.) Gravity-mode asteroseismology of open clusters

The applicant will develop customized methods to extract optimal lightcurves from TESS full-frame images of open clusters, by maximally eliminating instrumental effects in the Fourier domain and by treating crowded fields. Thorough time series analysis will be carried out for all cluster stars to identify and extract signatures of gravity-mode oscillations, rotational modulation and possible binarity. The applicant will perform mode identification and model the identified modes of all pulsators and all binaries per clusters jointly with their Gaia data, featuring the strongest set of constraints on each member's properties. The pioneering goal is to evaluate current stellar evolution theory and to reveal empirical relations deduced from all observed properties of the cluster stars as new recipes for stellar evolution predictions.

2.) Dynamical asteroseismology of eclipsing binaries and tidal evolution

The applicant will extract optimally defined observables from the survey data to perform joint modelling of photometric, spectroscopic, and astrometric time series of eclipsing binaries, with the aim to deduce accurate dynamical masses and radii. The latter quantities will be used to deduce the ages of the binaries for two large samples of intermediate- and high-mass stars, from stellar modelling based on the latest evolutionary models of stellar interiors and atmospheres. This will lead to an assessment of the so-called mass discrepancy of binary stars, pulsating and non-pulsating, in terms of their metallicities, evolutionary stages, and orbital characteristics. From the multitude of observational constraints, the theory of binary evolution will then be re-evaluated and improved with the aim to assess the effects of tides on internal rotation and mixing of stars, and of angular momentum of the systems.

3.) Yield computations calibrated by asteroseismology and the chemical enrichment of galaxies

The applicant will calibrate internal mixing profiles due to convection, rotation, magnetism, and possible binarity from gravity-mode pulsators in the mass range [3,25] Msun. This will be achieved from asteroseismic modelling based on TESS, Gaia, and spectroscopy data. The asteroseismically calibrated mixing profiles and the resulting He and C core masses during the main sequence (MS) and post-MS evolution will be used to calculate new stellar models up to the remnant phase. The corresponding chemical yield predictions will be computed with tools from the ChETEC INFRA (<https://chetec-infra.eu/>) EU infrastructure (2021- 2026). These chemical yields will then be used to assess the difference between asteroseismically calibrated yields and those for current models not calibrated by asteroseismology. The final aim is to evaluate how much these differences impact chemical evolution models of the galaxy and Magellanic Clouds.

The Candidate

The project tasks require diverse sets of skills. We are looking for candidates having experience with several aspects of the projects, while expressing strong interests and proven aptitudes for learning those skills that are lacking at the start of the positions. A strong affinity with data processing, time series and binary analyses, and hands-on experience with asteroseismic modelling are particularly relevant assets to highlight in the application material.

Requirements

- You hold a PhD degree in astrophysics obtained after 1 September 2020 (this limited period may be extended by documented career breaks);
- Your research experience is in line with several of the topical descriptions, as illustrated by peer-reviewed publications you authored and talks you presented;

Offer

The selected candidates will be offered a 2+n-year contract, with the additional n=1, 2 or 3 year(s) being awarded after positive evaluation depending on the achievements during the first two years and on the group's funding portfolio. The salary will be commensurate to the standard scale for post-doctoral researchers in Belgium and will depend on the number of years of experience during and after PhD. It includes social and medical insurance as well as pension rights.

The selected candidates will be encouraged to take up training in science and people management, science communication and grant application writing with the aim to develop a personal independent career track.

Shortlisted candidates should be available for on-campus or online interviews between 28 & 31 March 2022. The final selection will be done by 15 April 2022. Starting dates: as soon as possible after the selection, ideally before 1 July and at the latest by 1 September 2022.

Application

Applications must be received no later than February 28, 2022.

Apply online: <https://www.kuleuven.be/personeel/jobsite/jobs/60088185?hl=en&lang=en>

The application package should contain:

- a curriculum vitae, with publication list;
- a motivation letter (max. 1 page);
- a research statement (max. 2 pages)
- the names, position, and email address of three experts prepared to provide reference letters (will be asked only for those shortlisted)

KU Leuven carries out an equal opportunity and diversity policy.

For more information please contact Prof. dr. Conny Aerts (conny.aerts@kuleuven.be) or Dr. Clio Gielen (clio.gielen@kuleuven.be).