Institut d'Astronomie et d'Astrophysique - ULB
Campus Plaine – CP 226, Boulevard du Triomphe
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Post-doctorate fellowship in Nuclear Astrophysics: "Constructing large-scale nuclear models with linear response information for astrophysical applications"

One of the major issues in modern astrophysics concerns the analysis and understanding of the present composition of the Universe and its various constituting objects. Nucleosynthesis models aim to explain the origin of the different nuclei observed in nature by identifying the possible processes able to synthesize them. Though the origin of most of the nuclides lighter than iron through the various hydrostatic and explosive burning stages in stars is now quite well understood, the synthesis of the heavy elements (i.e. heavier than iron) remains unexplained in many respects.

The rapid neutron-capture process, or r-process, is known to be of fundamental importance for explaining the origin of approximately half of elements heavier than iron observed in nature. Despite important efforts, the astrophysical site of the r-process remains unidentified. For this reason, the r-process has been considered as one of the top eleven questions in Physics and Astronomy by the USA national research council of the national academies.
Supernovae have for long been envisioned as the dominant producer of r-process nuclei, but so far have failed to provide the right conditions for a successful nucleosynthesis. Recently, special attention has been paid to neutron star mergers following the confirmation by hydrodynamic simulations that a non-negligible amount of matter can be ejected and by nucleosynthesis calculations combined with the predicted astrophysical event rate that such events can account for the majority of r-material in our Galaxy. The recent observation of the gravitational wave signal GW170817 and its optical counterpart in August 2017 has confirmed the efficient contribution of binary neutron star mergers to Galactic nucleosynthesis, though a great part of this observation still remains to be explained.

This post-doctorate fellowship will focus on the development of new large-scale models of nuclear structure to provide nuclear inputs to astrophysical simulations of the r-process. More specifically, the goal is to progressively remove phenomenological ingredients from mean-field models with microscopic information obtained from linear response (or QRPA) calculations of the atomic nuclei. The successful candidate will develop a so-called QFAM implementation of the QRPA formalism to be integrated with existing numerical tools in Brussels and, as a first application, use this implementation to improve large-scale predictions for the ground state properties of atomic nuclei with a specific focus on nuclear masses. Further extensions of this framework to other quantities of astrophysical interest (beta-decay and fission rates) can be envisioned.

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At the same time, this project, in collaboration with the experimental nuclear physics group of the KU Leuven, will contribute to the interpretation of new measurements of nuclear structure properties obtained at ISOLDE-CERN, in particular concerning super-heavy elements. Such measurements also aim at validating global mean-field models developed for astrophysics applications.

The Post-doctorate position is available at the Institut d'Astronomie et d'Astrophysique (IAA) of the Université Libre de Bruxelles and is part of the EOS (Excellence of Science) research project MANASLU in collaboration with the KU Leuven University. The position is funded for 2 years. Screening of applications begins immediately and continues until an outstanding candidate is selected. The position is to start as soon as possible.

Profile requested:

- The candidate must have a PhD in nuclear physics (for less than 5 years)
- The candidate must have programming skills and a strong interest in numerical simulations; knowledge of programming languages Fortran, C/C++ and Python is desirable.
- The applicant should have good organizational skills, a taste for interdisciplinary research, excellent scientific writing and presenting skills and be able to work independently.
- Working in our international team requires capacity of team work as well as good English language skills

Interested candidates should send their CV and request two referees to send their recommendation letter directly to S. Goriely at stephane.goriely@ulb.be and W. Ryssens at wouter.ryssens@ulb.be.

Contact:

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