



2019 HGF – GSI – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

Title of the project:

Sensitivity of kilonova light curves to nuclear physics input

Helmholtz Centre and institute:

GSI Helmholtzzentrum für Schwerionenforschung

Project leader:

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Description of the project (max. 1 page):

The observation of a Kilo nova electromagnetic transient associated with the gravitational wave event GW170817 has confirmed that the r process operates in neutron star mergers. Once LIGO/Virgo resume operation during 2019, further observations are expected providing us with a wealth of data to test current nucleosynthesis predictions. By comparing models against future observations, we will address many issues that have not been fully answered by GW170817. Those observations provided indirect evidence of the production of heavy elements in the merger but so far, we do not know exactly which exact elements are produced in mergers and how their production depends on the properties of the merging system. It becomes fundamental to identify signatures on the light curves that can point to the production of particular elements. However, we need to understand the sensitivity of those signatures to uncertainties in the nuclear physics input and whenever necessary improve such an input by advanced nuclear modelling. To identify the production of particular elements is not only relevant from the point of view of nucleosynthesis but will also help to determine the conditions of temperature, density and neutron-richness reached in the merger and hence learn about the merger dynamics to be confronted with simulations.

In this project we plan to explore the sensitivity of light curves to the nuclear physics properties, including beta-decay rates and neutron capture rates, of nuclei around $N = 50$ near to ^{78}Ni where experimental data is currently becoming available. Our aim is to determine if mergers are producing nuclei around the first r-process peak and its sensitivity to current nuclear uncertainties by comparing our nucleosynthesis predictions with light curve data. We plan to perform shell-model calculations guided by current experimental data to improve our understanding of beta-decay properties in the region. This will be combined with merger models currently being developed in the theory group. The successful candidate will be responsible of performing the shell-model calculations and implementing the results in network codes.

Description of existing or sought Chinese collaboration partner institute (max. half page):

At the moment I have ongoing collaborations with Professors Yong-Zhong Qian and Yang Sun, directors of the Center for Nuclear Astrophysics at the Shanghai Jiao Tong University. Yong-Zhong Qian is an expert on nucleosynthesis and neutrino oscillations in dense media. A previous PhD student from Prof. Qian, Gang Guo, is currently postdoc at the GSI theory department. Yang Sun is an expert in nuclear structure for heavy nuclei and was the PhD advisor of Han-Kui Wang that is currently Assistant Professor at the Zhoukou Normal University. He will be an ideal candidate for this application.

Required qualification of the post-doc:

- PhD in Theoretical Nuclear Physics
 - Experience with in shell-model calculations and nuclear structure of exotic nuclei with applications in nuclear astrophysics
 - Programming experience in Fortran and Python and the usage of high performance computing
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