2017 HGF - GSI - OCPC - Programme

for the involvement of postdocs in bilateral collaboration projects

Part A:

Title of the project:

Measurement of bound state beta decay of 205Tl in the ESR

Helmholtz Centre and institute:

GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Project leader:

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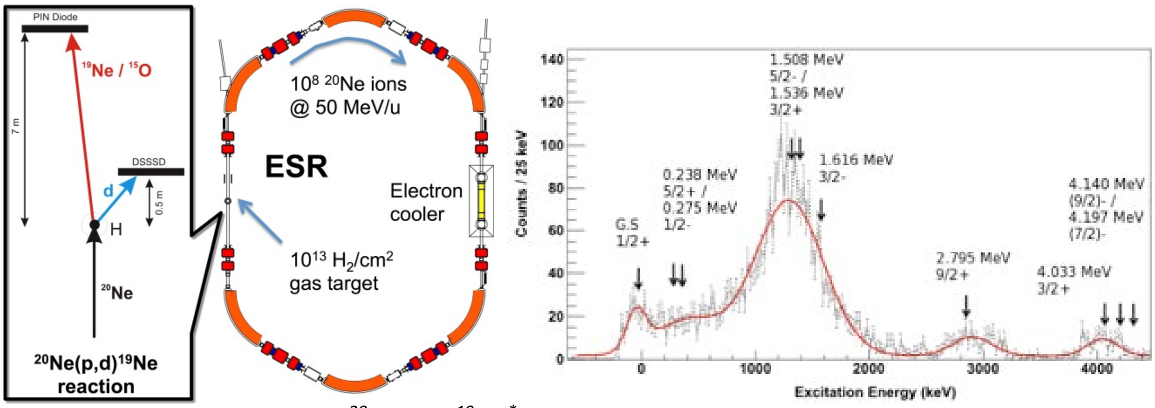
Description of the project (max. 1 page):



Left: Schematic view of the ^{20}Ne(p,d)^{19}Ne* proof-of-principle experiment performed in the ESR. The main parameters are indicated. Right: measured (preliminary) energy spectrum of emitted deuterons with the corresponding identification of excited states in ^{19}Ne.

Space-based x-ray observatories such as Chandra and XMM/Newton have enabled extensive studies of astrophysical X-ray burst events. X-ray bursts have been interpreted as being generated by thermonuclear explosions in the atmosphere of an accreting neutron star in a close binary system. These bursts are characterized by sudden enormous spikes (~seconds) in X-ray emission, with repeating cycles ~hours to days. In between bursts, energy is thought to generate by the CNO cycles driven by the in-flow of hydrogen- and helium-rich material from the less evolved companion star. Breakout from these CNO cycles is then able to proceed via reactions on the β-decaying waiting point isotopes 14O, 15O and 18Ne, with the α-capture reaction 15O(α,γ)19Ne thought to be the most probable path. Capture reactions then fuel the rp-process resulting in the production of very neutron-deficient nuclei perhaps as heavy as Sn-Sb. This process might be a possible candidate for the production of p-nuclei such as 92Mo and 96Ru, though the mechanism to eject them from the star surface remains unclear (the p- and νp-processes are alternate sources). The strength of the 15O(α,γ)19Ne reaction rate controls the conditions for the ignition of the X-ray burst, and influences its recurrence rate. Furthermore, by determining the ignition conditions bridging the steady state and thermonuclear runaway conditions, it can be used to estimate the accretion rate at this critical point. Given the extremely important impact, great efforts have been made to determine the 15O(α,γ)19Ne reaction rate, yet without success.

We will investigate this reaction at the ESR. We will use enriched 21Ne primary beam (provided within the ERC supported ASTRUm project), which will directly be stored in the ESR. We will use the 21Ne(p,t)19Ne* reaction to populate the state of interest at 4.033 MeV in 19Ne. As a source of protons we will use the hydrogen cluster target with 1013 H2 molecules/cm3. The 4.033 MeV state will be identified by measuring the energy of the emitted triton. The gamma, Γγ, and alpha, Γα, decay widths will be determined by detecting either 19Ne or 15O daughter ion in coincidence to each of the detected tritons corresponding to 4.033 MeV state.

Within this project the successful candidate will work on the preparation, conduction and analysis of this experiment and be responsible for the interpretation of the data (also after the 2-years stay).

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

A successful collaboration with Institute of Modern Physics, Chinese Academy of Sciences (IMP) in Lanzhou exists since several years. The collaboration is motivated by the fact that both institutions, GSI and IMP, operate modern storage ring facilities as well as are planning the next generation radioactive ion beam facilities FAIR and HIAF, respectively, with a strong storage ring component. Within this collaboration, numerous results were obtained which is reflected by a number of highest-level publications. The proposed project can presently be realized only at GSI. However, one of the strongest motivations for the construction of the next-generation radioactive-ion beam facility HIAF in Huizhou is the nuclear astrophysics. Therefore, we think that attracting a postdoc who would be returning after the 2-years stay at GSI to IMP/HIAF to employ his gained experience in helping to realize the corresponding experimental research would be of a great added value for the physics research.

Required qualification of the post-doc:

- PhD in Nuclear, Atomic or Astro- physics is required
- Experience with modern digital electronics, statistical data analysis, data analysis software is required; any experience with conducting complex experiments at radioactive beam facilities and/or any knowledge of physics at heavy-ion storage rings would be of advantage
- Additional skills in C++ and/or Python programming will be helpful

Part B:

Documents to be provided by the post-doc:

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae (CV)
- copies of degrees as a proof of education qualification
- List of publications (if any)
- 2 letters of recommendation

Part C:

Additional requirements to be fulfilled by the post-doc:

- PhD degree not older than 5 years
- Very good command of the English language
- Strong ability to work independently and in a team