Report on increase of synergy, on the major upgrades, and on improved theoretical determination and experimental evaluation of input parameters

Nuclear physics related to p-process nucleosynthesis

There are many examples across the participants of ATHENA's task 2 for collaborations established with the aim to understand the nuclear physics related to p-process nucleosynthesis. The subject of collaboration differs each time, *e.g.*, from the exchange of expensive target material to plans to measure a certain reaction with different methods to reduce systematic uncertainties or to perform a proof-of-principle study.

An example for the former is the investigations of the groups at ATOMKI Institute for Nuclear Research, Hungary, and at University of Cologne, Germany, using a barium carbonate target enriched in ^{130}Ba, one of the rare p nuclei. The target was prepared and characterized at ATOMKI. The a-particle induced cross sections were investigated at ATOMKI while the proton-induced cross sections were observed at Cologne. This division was chosen according to the characteristics of the experimental facilities available at the institutes, especially the beam intensities and the detection systems, respectively. During the experimental campaigns, an exchange of personnel took place. In addition, the theoretical description of the experimental results was derived in collaboration with members of THEXO.

An example for the latter is the experimental investigation of the reactions ^{93}Mo(γ,n) and ^{94}Mo(γ,n) as described more detailed in milestone MS42.

Reactions related to stellar evolution

The determination of reaction rates related to stellar evolution is usually hindered by natural background. Therefore, the idea to measure these rates in underground laboratories and the pioneering work performed and established at LUNA, Italy, were important milestones for our understanding of the nuclear physics influencing stellar evolution.

In the last years, it became evident that an upgrade of the LUNA facility is just as important as an additional underground facility in Europe to keep up with the requested higher beam energies and the extended need of beam time if further stages of stellar evolution are to be explored. Here, ATHENA's task 2 provided one of the platforms to discuss the needed developments and to collect important points for the defence of the ideas against local and third-party funds agencies. Today, an upgrade of LUNA with a MV-accelerator is as well in progress as the construction of an additional underground facility located at Felsenkeller, Dresden, Germany.