INPC 2025
May 25-30, 2025
DCC, Daejeon, Korea

Contribution ID: **96** Type: **Contributed Oral Presentation**

The Galactic Aluminum Conundrum in the Light of New Data at Astrophysical Energies

Tuesday, 27 May 2025 11:25 (15 minutes)

The abundance of ^{26}Al carries a special role in astrophysics, since it probes active nucleosynthesis in the Milky Way and constrains the Galactic core-collapse supernovae rate. It is estimated through the detection of the 1809 keV γ-line and from the superabundance of ^{26}Mg in comparison with ^{24,25}Mg in solar-system meteorites. For this reason, high precision is necessary also in the investigation of the stable Al and Mg isotopes.
These nuclei also enter the so-called MgAl cycle playing an important role in the production of ^{27}Al and ^{24}Mg. Recently, high-resolution stellar surveys have shown that the Mg-Al anti-correlation in red-giant stars in globular clusters may hide the existence of multiple stellar populations, triggering the acquisition of new high-precision astronomical data and the development of new stellar models.
The common thread running through these astrophysical scenarios is the ^{27}Al(p,α)^{24}Mg and ^{27}Al(p,γ)^{28}Si reactions, which are the main ^{27}Al destruction channels.
Since available spectroscopic data and reaction rates show large uncertainties owing to the vanishingly small cross section at astrophysical energies, we have applied the Trojan Horse Method to the reaction investigation. This has allowed us to extract important information on the ^{27}Al(p,α)^{24}Mg and ^{27}Al(p,γ)^{28}Si cross sections in the energy region of interest for astrophysics, below about 100 keV, not accessible to direct measurements. In particular, the indirect measurement made it possible to assess the contribution of the 84~keV resonance and to lower upper limits on the strength of nearby resonances. Therefore, for both destruction channels a factor of 3 lower reaction rates have been determined with respect to those routinely used in present-day astrophysical models. Given the competition between the two destruction channels, important impact for astrophysics, especially for massive-star nucleosynthesis, is foreseen.

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Session Classification: Parallel Session

Track Classification: Nuclear Astrophysics