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Neutrino physics and nuclear astrophysics: the LUNA MV project at Gran Sasso

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Nuclear astrophysics is an extremely rich field, correlated with many other research fields like observational neutrino physics, stellar modeling and cosmology.

As example, the precise knowledge of reactions producing neutrinos is mandatory to use neutrinos as probes of the stellar interior but at stellar energies the cross sections are usually extremely low, down to the femto-barn level.

The LUNA (Laboratory for Underground Nuclear Astrophysics) collaboration has exploited the low-background environment of the underground Gran Sasso Laboratory to perform direct measurements at the stellar energies. Among the most relevant LUNA contribution to the neutrino physics we remind: the exclusion of a resonance in the cross section of $3\text{He}+3\text{He}$ at solar energies that ruled out a nuclear explanation to the solar neutrino problem and the direct measurement down to 70 keV of the bottleneck reaction of the CNO cycle, $14\text{N}+p$, that pointed out a cross section lower by a factor two than expected and halved the predictions of the solar CNO neutrino fluxes.

Presently, a new LUNA MV facility based on a 3.5 MV accelerator will be installed in the Hall B at the beginning of 2018: the aim is to study the key processes of helium and carbon burning such as the $12\text{C}+\alpha$ reaction that shapes the outcomes of both Ia and core-collapse supernovae.

Contemporary a new effort will be devoted to improve the knowledge of solar reactions: the $14\text{N}+p$ reaction will be the first step of the new experimental program with the aim to extend the measurement over a wider energy range.

The error budget on 13N and 15O neutrino fluxes is dominated by the uncertainty ($\sim 10\%$) in the $14\text{N}+p$ cross section: an accurate measurement at LUNA MV will importantly contribute to constrain the chemical composition of the Sun.

The present talk is aimed to summarize all the LUNA results relevant to neutrino astrophysics and to present the scientific program related to the years 2018-2022.

Experimental Collaboration

LUNA

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