Nuclear Astrophysics at Gran Sasso Laboratory: present and future of the LUNA experiment

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Why measuring cross sections of thermonuclear reactions?
- Nucleosynthesis and stellar models
- Neutrino Physics
- Cosmology

Why going underground?
Cross sections in the range of pb-fb at stellar energies (Gamow peak)
Cross section decreasing exponentially with decreasing energy
With typical laboratory conditions reaction rate \( R \) can be as low as few events per month
\( R \) should be higher than the background-\( \gamma \)-underground

Laboratory for Underground Nuclear Astrophysics

LUNA: background reduction
\( E > 3 \text{MeV} \), reduction of a factor 2000 simply going underground

LUNA 400 kV accelerator: very intense and stable proton and alpha beams.
Very low energy spread

The last 25 y at LUNA: H burning

From Hydrogen burning to Helium and Carbon burning
or... from LUNA to LUNA MV

The LUNA MV accelerator

The scientific program of LUNA MV for the first 5 years (2019-2023)

- \(^{14}\text{N}(p,p')^{14}\text{O}\): the bottleneck reaction of the CNO cycle in connection with the solar-abundance problem
- Also commissioning measurement for the LUNA MV facility
- \(^{12}\text{C}+\alpha\): energy production and nucleosynthesis in Carbon burning. Globally chemical evolution of the Universe
- \(^{12}\text{C}(\alpha,\alpha')^{16}\text{O}\) and \(^{12}\text{C}(\alpha,\alpha')^{15}\text{N}\): neutron sources for the \( s \)-process (nucleosynthesis beyond Fe)

The LUNA MV time schedule

- Beginning of the construction works in hall A
- Construction of the plant in the LUNA MV building
- Completion of the new hall B MV building
- LUNA MV detector: installation of LUNA
- Conclusion of the commissioning phase
- Beginning of the first experiment