Underground nuclear astrophysics and solar neutrinos

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The extremely small cross-section of the static stellar burning reactions, from pico- to femto-barn and even below, has always prevented their direct measurement in a laboratory at the Earth's surface, where the signal-to-background ratio is too small because of cosmic ray interactions. Indeed, the observed energy dependence of the cross-section measured at high energies is extrapolated to the low energy region, where the stellar burning takes place, leading to substantial uncertainties. Thanks to the background suppression achievable in a deep underground laboratory, thermonuclear reactions can now be studied at the same energy of stellar nucleosynthesis.

The main features of LUNA (Laboratory for Underground Nuclear Astrophysics in Gran Sasso) will be discussed, together with the most significant results obtained until now: the $^3He(^3He,2p)^4He$ cross section within the Gamow peak of the Sun and the $^{14}N(p,\gamma)^{15}O$ one down to very low energy.

In particular, the final analysis of $^{14}N(p,\gamma)^{15}O$, the key reaction of the CNO cycle in stars, will be presented. The consequences of the LUNA results, about a factor 2 lower than existing extrapolations, will then be discussed, both in astrophysics (solar neutrinos and AGB stars) and in cosmology (age of the Universe).