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Underground Measurements of the 16O(p,γ)17F Reaction at LUNA

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The ^{16}O(p,γ)^{17}F reaction is the slowest proton-induced reaction in the CNO cycle because at energies of astrophysical interest it has no resonances, making it an example of a pure direct capture reaction. The ratio of ^{16}O/^{17}O in AGB stars depends strongly on the rate of this reaction. This ratio is an important probe of nucleosynthesis and mixing processes in the interior of these stars, as it can be measured directly. At low energies, i.e. centre of mass energies below around 500 keV, there is little experimental data for this reaction, and the data that exists has relatively large uncertainties. In addition, Bayesian estimations of the reaction S-factors carried out by Iliadis et al. in 2022 do not closely match the low energy experimental data, particularly for direct capture to the ground state.

An experimental campaign has been carried out at the LUNA underground accelerator at Gran Sasso National Laboratory in Italy, aiming to measure the cross section for ^{16}O(p,γ)^{17}F. The very low background in the underground laboratory combined with lead shielding allows for direct measurements of this weak reaction to be carried out at low energies.

The experiment was carried out in two parts, using two different techniques: the prompt gamma rays from the reaction were detected using two $CeBr_3$ scintillators and a HPGe detector; and the β^+ decay of the resulting ^{17}F was measured using a segmented BGO detector (the activation method).

I will report on the setup and data taking, and will present the results.

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