Revision of the 15N(p,γ)16O reaction rate and oxygen abundance in H-burning zones

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(Submitted on 22 Jul 2011)

The NO cycle takes place in the deepest layer of a H-burning core or shell, when the temperature exceeds T {\simeq} 30 {\cdot} 106 K. The O depletion observed in some globular cluster giant stars, always associated with a Na enhancement, may be due to either a deep mixing during the RGB (red giant branch) phase of the star or to the pollution of the primordial gas by an early population of massive AGB (asymptotic giant branch) stars, whose chemical composition was modified by the hot bottom burning. In both cases, the NO cycle is responsible for the O depletion. The activation of this cycle depends on the rate of the 15N(p,{\gamma})16O reaction. A precise evaluation of this reaction rate at temperatures as low as experienced in H-burning zones in stellar interiors is mandatory to understand the observed O abundances. We present a new measurement of the 15N(p,{\gamma})16O reaction performed at LUNA covering for the first time the center of mass energy range 70-370 keV, which corresponds to stellar temperatures between 65 {\cdot} 106 K and 780 {\cdot}106 K. This range includes the 15N(p,{\gamma})16O Gamow-peak energy of explosive H-burning taking place in the external layer of a nova and the one of the hot bottom burning (HBB) nucleosynthesis occurring in massive AGB stars. With the present data, we are also able to confirm the result of the previous R-matrix extrapolation. In particular, in the temperature range of astrophysical interest, the new rate is about a factor of 2 smaller than reported in the widely adopted compilation of reaction rates (NACRE or CF88) and the uncertainty is now reduced down to the 10% level.

Comments: 6 pages, 5 figures

Subjects: **Solar and Stellar Astrophysics (astro-ph.SR)**; Nuclear Experiment (nucl-ex)
Journal reference: A&A 533 (2011) A66
DOI: 10.1051/0004-6361/201117475
Cite as: **arXiv:1107.4514v1 [astro-ph.SR]**

Submission history

From: Antonio Caciolli [view email]
[v1] Fri, 22 Jul 2011 13:20:11 GMT (242kb)