Low energy undergournd study of ^{14}N(p,γ)^{15}O cross section

A.Lemut[1], D.Bemmerer[2], F.Confortola[1], R.Bonetti[3], C.Broggini[2], P.Corvisiero[1], H.Costantini[1], J.Cruz[4], A.Formicola[5], Zs.Fülöp[6], G.Gervino[7], A.Guglielmetti[3], C.Gustavino[5], G.Gyürky[6], G.Imbriani[8], A.P.Jesus[4], M.Junker[5], B.Limata[8], R.Menegazzo[2], P.Prati[1], V.Roca[8], C.Rolfs[9], D.Rogalla[8], M.Romano[8], C. Rossi Alvarez[2], F.Schümann[9], E.Somorjai[6], O.Straniero[10], F.Strieder[9], F.Terrasi[11], H.P.Trautvetter[9]

[1]Università degli Studi Genova and INFN Genova, Via dodecaneso 33, 16146 Genova, Italia
[2]INFN Sezione di Padova, Via Marzolo 8, 35131 Padova, Italia
[3]Istituto di Fisica Generale Appllicata, Università di Milano and INFN Milano, Italia
[4]Centro de Fisica Nuclear da Universidade de Lisboa, Lisboa, Portugal
[5]INFN, Laboratori Nazionali del Gran Sasso, S.S. 17bis km 18.890, Assergi, L'Aquila, Italia
[6]ATOMKI, Debrecen, Hungary [7]Dipartimento di fisica Sperimentale, Università di Torino and INFN Torino, Torino, Italia
[8]Dipartimento di Scienze Fisiche, Università "Federico II" and INFN Napoli, Napoli, Italia
[9]Institut für Experimentalphysik III, Ruhr-Universität Bochum, Bochum, Germany
[10]INAF, Osservatorio Astronomico di Collurania, Teramo, and INFN Napoli, Napoli, Italia
[11]Dipartimento di Scienze Ambientali, Seconda Università di Napoli, Caserta and INFN Napoli, Napoli, Italia

In stars, four hydrogen nuclei are converted into a helium nucleus by two competing nuclear fusion processes: the proton - proton chain (p-p) and the carbon - nitrogen - oxygen (CNO) cycle. At temperatures higher than 2×10^7 K, the CNO cycle dominates the energy production. In particular, its rate is determined by the slowest reaction: ^{14}N(p,γ)^{15}O. Direct measurement in a laboratory at the surface of the Earth is hampered by the background due to the cosmic rays. Here we report on an experiment performed with the LUNA (Laboratory for Underground Nuclear Astrophysics) accelerator placed deep underground in the INFN Gran Sasso laboratory (Italy). Thanks to the cosmic ray suppression provided by the mountain shield, we could measure the ^{14}N(p,γ)^{15}O cross section for the first time directly at energies corresponding to stellar temperatures and with unpreceedent accuracy. In particular we used a large solid angle BGO detector with a differentially pumped windowless gas target. The lowest measured energy is 70.1 keV. Our results have important consequences for the formation of carbon stars, for an independent lower limit on the age of the universe, and for solar neutrino flux.