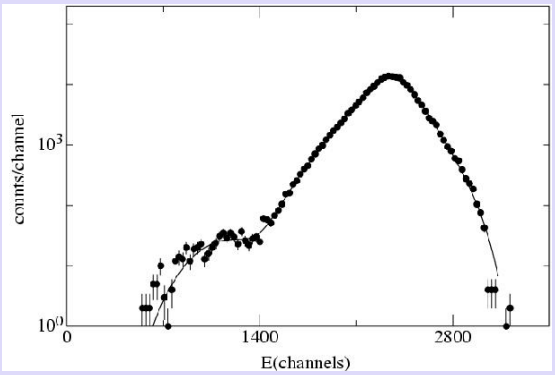
The Joint Institute for Nuclear Astrophysics

R-matrix analysis of the β-delayed α decay of ^{16}N



Spectrum of the β-delayed α decay of ^{16}N, obtained in this experiment. The solid line is the result of a R-matrix analysis, which is discussed below.

Array of twin-ionization chambers used in the study of the β-delayed α decay of ^{16}N.

The amount of carbon and oxygen on Earth is determined by the ratio of the cross sections for the triple-α process and the ^{12}C(α,γ)^{16}O reaction. During the last few years we have been involved in an experiment studying this reaction via the ^{16}N decay into α-unbound states in ^{16}O. We have developed a new high-efficiency detector system consisting of two twin-ionization chambers which are practically insensitive to the high flux of β-particles encountered in these experiments.

Extracting the relevant S-factor S_{E1}(300 keV) from the data is usually done using the R-matrix formalism, through a least-squares fit to data from the β-delayed α-decay of ^{16}N(shown above), in combination with experimental results from the capture reaction ^{12}C(α,γ)^{16}O performed at higher energies, as well as to phase shift parameters obtained from elastic scattering ^{12}C(α,α)^{12}C. For this we have used the R-matrix program from Ref.1. The number of fitting parameters is large, and there are strong correlations among some of the parameters. In a first step we have employed the same phase shifts and direct capture data as used in Ref. 1,2. The result of the fit is shown by the solid line in the figure above and gives a (preliminary) value of S_{E1}(300 keV)=72±16 keVb (statistical uncertainty only).

There are new data available for some of the input data used in the fit. The largest change is introduced by the new phase shift data from Ref.3 which increases S_{E1}(300 keV) to 87 keVb. Since these data and their uncertainties do not yet exist in tabulated form, no error bars are assigned to this value. Our results show that improvements in the accuracies of all input parameters are needed in order to reduce the uncertainty of S_{E1}(300 keV).

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