A new measurement of the E1 component of the $^{12}C(\alpha,\gamma)^{16}O$ reaction.

The isotopes ^{16}O and ^{12}C, which are crucial to all living organisms, are produced by helium burning in red giant stars. Their abundance ratio, which is determined by the competition between the triple-α process ($\alpha + \alpha + \alpha \rightarrow {}^{12}C$) and the $^{12}C(\alpha,\gamma)^{16}O$ reaction also affects the future evolution of the star during its carbon, neon, and oxygen burning phases. While the cross section for the triple-α process is experimentally quite well determined our knowledge of the $^{12}C(\alpha,\gamma)^{16}O$ reaction is still puzzled by the complicated reaction mechanism.

We have performed a new experiment studying the β-delayed α decay of ^{16}N decay to gain information about the $^{12}C(\alpha,\gamma)^{16}O$ reaction rate. To produce the ^{16}N activity we used the in-flight production method at the radioactive beam facility at the ATLAS accelerator at Argonne National Laboratory. To reduce the sensitivity to β particles we have developed an array of high-acceptance ionization chambers of minimal thickness, to be used for the coincident detection of ^{12}C and α particles.

Fig.1 shows a schematic of the experimental setup. A ~60 MeV ^{16}N ($T_{1/2}$=7.1 sec) beam is slowed down in a gas-filled attenuator and stopped in a 10 $\mu g/cm^2$ thick carbon foil mounted on a rotating wheel located in the main part of the detection chamber. After irradiation the foil is rotated into the first pair of ionization chambers for counting, while a second foil is irradiated which is then counted by the second pair of detectors. The choice of gas-detectors reduces the sensitivity to β particles resulting in very clean, background-free spectra.

Fig.2 shows contour plots from one the detector pairs. The areas in the spectra which are sensitive to the S-factor S(E1) are indicated by the red arrows.

The analysis of the data using the R-matrix formalism is presently being performed.

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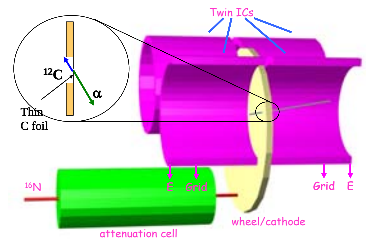

Fig.1 Schematic of the setup used in the experiment.

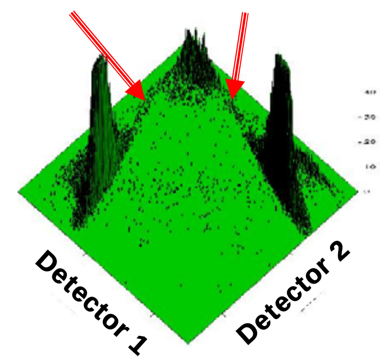

Fig.2: Energy spectrum of coincident ^{12}C-α particles. The arrows mark regions which are sensitive to S(E1).

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