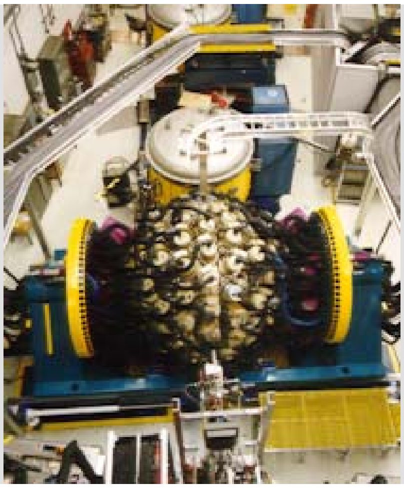
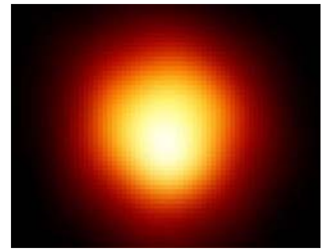
The ^{16}N β-Branching Ratio to the Sub-barrier State in ^{16}O



View of the gamma detector array GAMMASPHERE which was used in the experiment described below.It consists of about 100 Ge crystals used for the high-resolution detection of gamma rays from nuclear reactions.



The reaction ^{12}C(α,γ)^{16}O is sometimes called the 'holy grail of nuclear astrophysics' because of its importance for the production of Carbon and oxygen, two elements that are crucial for Life on Earth. Despite many experiments performed during the last decades the reaction rate is still only very poorly known. Direct measurements under stellar conditions suffer from the small cross sections (~10^{-17}b) and one, therefore, has to rely on indirect techniques.

The best method to determine the E1 component of the ^{12}C(α,γ)^{16}O cross sections comes from a measurement of the β-delayed α decay of ^{16}N. During the past few years we have been involved in a series of experiments studying the decay of ^{16}N, using a newly developed high-efficiency detector. The critical parameter S_{E1}(300 keV) is then determined from a least-squares fit to the β-delayed α spectrum, including data from alpha-capture measurements, elastic scattering and β-branching experiments. In the analysis of the ^{16}N experiment it was found that the systematic uncertainty of S_{E1}(300 keV) depends strongly on the β-branching of ^{16}N populating the sub-threshold 1^- state in ^{16}O which was known with an accuracy of only about 10%.

We have therefore re-measured this branching ratio using the high efficiency γ-detector array GAMMASPHERE (GS) at Argonne. The ^{16}N nuclei were produced via the d(^{15}N,^{16}N)p reaction by bombarding a deuterium-loaded Ti foil with a ^{15}N beam from ATLAS. By detecting the γ-rays that populate and depopulate the 7.117 MeV 1^- level in ^{16}O with GS, we were able to determine the β-branching to this level with a five-fold higher accuracy. Together with an improvement of the energy calibration

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in the α-spectrum we have reduced the systematic uncertainties of S_{E1}(300 keV) by about a factor of two.

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