

Title: Measurement of $^{19}\text{F}(\gamma,\alpha)^{15}\text{N}$ with a bubble chamber and a bremsstrahlung beam**Spokespersons:** C. Ugalde (contact), R. Holt, R. Suleiman**Motivation:**

There are two motivations presented for this experiment. One is to test the suitability of using the CEBAF injector to determine the rate of the astrophysically important reaction $^{12}\text{C}(\alpha,\gamma)^{16}\text{O}$. The determination of this rate is perhaps the most important open problem for stellar evolution models as it determines many features of stellar evolution including the lower mass limit for formation of a black hole and the ratio of carbon to oxygen in the universe. The second motivation is to determine the site of ^{19}F production in the Galaxy. Fluorine is one of the few lighter elements whose origin in the galaxy is unknown. Recent observations of post-AGB stars show significant amounts of fluorine, but these observations cannot be reproduced by nucleosynthesis models. A possible explanation could be a severe underestimation of the reaction rate of $^{15}\text{N}(\alpha,\gamma)^{19}\text{F}$.

Measurement and Feasibility:

The experiment will use a novel approach employing bubble chamber technology. Alpha particles produced from a (γ,α) reaction would trigger a bubble that is detected by a camera. The chamber is relatively insensitive to gamma rays; hence very low cross sections can be determined. This technique has the capability to determine (α,γ) reaction rates at astrophysical energies if the backgrounds are low enough. This proposal is to measure the $^{19}\text{F}(\gamma,\alpha)^{15}\text{N}$ reaction at 9 energies with a bremsstrahlung end point from 4.55 to 5.35 MeV. This would cover a region above, but including part of astrophysically interesting range. The experiment will use a Penfold-Leiss decomposition to extract the energy dependence of the (γ,α) reaction rate.

The collaboration has performed preliminary measurements at the HIGS facility, but background from high-energy bremsstrahlung photons from HIGS limits the lowest cross section that can be measured to about 1 nb. At JLAB they would not have the background observed at HIGS because the photons are produced with low energy electron beams.

This proposal is a follow-on to the letter of intent submitted to PAC38 describing the intent to measure the $^{12}\text{C}(\alpha,\gamma)^{16}\text{O}$ reaction rate. The PAC viewed a test run of this reaction as very important.

Issues:

The PAC views the primary motivation for these measurements is to test the suitability of performing the $^{12}\text{C}(\alpha,\gamma)^{16}\text{O}$ at JLAB. However, the current experiment will not test all the backgrounds since the two targets are different and the energy range is somewhat different. Success or failure of a measurement of $^{19}\text{F}(\gamma,\alpha)^{15}\text{N}$ would not guarantee or rule out success at a determination of $^{12}\text{C}(\alpha,\gamma)^{16}\text{O}$. The PAC had concerns that strong low-energy resonances in the $^{19}\text{F}(\gamma,\alpha)^{15}\text{N}$ reaction may confuse a proper background determination at the low cross section level required. As a stand-alone experiment, the motivation to determine the site of ^{19}F production is good, but the proposal did not convincingly make that case that a measurement with the required precision to resolve the astrophysical questions could be made. The proposal did not quantify the errors in a measurement of resonant and non-resonant cross sections, nor did it provide an estimate of the level of information needed for a resolution of the problem of the origin of ^{19}F .

Recommendation:

Defer the current proposal and encourage the proponents to come back with another proposal that would either more completely demonstrate that the $^{16}\text{O}(\gamma,\alpha)^{12}\text{C}$ reaction can be measured with sufficient accuracy using a bremsstrahlung beam at JLAB or demonstrate the astrophysical importance and accuracy of the information obtained for $^{19}\text{F}(\gamma,\alpha)^{15}\text{N}$. A future proposal would benefit from a presentation of the proposed measurements in the context of a broad picture.

Discretionary time directed aimed at testing $^{16}\text{O}(\gamma,\alpha)^{12}\text{C}$ might be warranted if there are resource available prior to the next PAC.