Proposal: PR12-13-005 **Scientific Rating: A-**
Recommendation: Approved

Title: Measurement of 16O(γ,α)12C with a bubble chamber and a bremsstrahlung beam

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Motivation:

In the field of nuclear astrophysics, the cross section for the low-energy $^{12}C(\alpha,\gamma)^{16}O$ is directly related to the carbon to oxygen ratio in stellar cores. Knowing this ratio has large implications for our understanding of stellar evolution as well as numerous issues in cosmological (e.g. Hubble constant). Although this reaction cannot be measured directly, it can be found by measuring the inverse photodisintegration reaction, $^{16}O(\gamma,\alpha)^{12}C$.

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 aims to measure the $^{16}O(\gamma,\alpha)^{12}C$ reaction at 7 energies with a bremsstrahlung beam ranging 7.9 to 8.5 MeV. The experiment will use a Penfold-Leiss decomposition to extract the energy dependence of the (γ,α) reaction rate. The collaboration has already performed preliminary measurements of the $^{19}F(\gamma,\alpha)^{15}N$ reaction using a bubble chamber at the HIGS facility. At JLAB the bubble chamber would not have the backgrounds observed at HIGS, because the photons are produced with low energy electron beams. Recent research and development on various bubble chamber liquids have been studied and indicate that N_2O is the likely liquid to be used for the experiment, although other molecules are still under investigation. This proposal is a new, but follows from proposal PR12-12-013, which aimed to first study the $^{19}F(\gamma,\alpha)^{15}N$ reaction rate at Jlab, but was deferred by PAC39.

Issues:

The PAC strongly supports the measurement of $^{16}O(\gamma,\alpha)^{12}C$ at JLAB. The PAC views the present proposal as viable and encourages the collaboration to move forward with the measurement. Measurements of the reaction rate down to center-of-mass energies of 700 keV with uncertainties at the ~20% level represents a large improvement compared to what exists today and could potentially allow for an extrapolation down to low enough energies to be of astrophysical interest. If possible, this measurement could be groundbreaking for the astrophysical community.

The PAC has concerns that the beam-induced background and low energy resonances may be significant and hard to estimate. The specifications for the beam energy determination are also challenging and at the moment represent the largest systematic uncertainty.

The PAC strongly encourages that this experiment be scheduled in such a way so as not to impact the 12 GeV program. Overall, the PAC finds the proposed experiment a promising road towards determining the $^{12}C(\alpha,\gamma)^{16}O$ cross section. The PAC approves the experiment for the requested amount of 336 hours (i.e. 2 weeks).