PHY983 - Nuclear Astrophysics - Spring 2013
Homework Set 7
Due: March 15, 2013 beginning of lecture
Key words: Photodisintegration, branchings

1. [6 pts] Calculate and the lifetime against (γ,α) photodisintegration of 16O and 20Ne under typical neon burning conditions (T=1.5GK, density=10e6 g/cm^3) from the alpha capture rates given in the JINA reaclib database. What is the main cause for the difference?

2. [14 pts} The ^{15}O(α,γ) reaction is the lowest temperature reaction that can provide breakout of the CNO cycle. A open question is whether such breakout can occur in Nova explosions. The most extreme conditions achieved in Novae are peak temperatures of 0.4 GK and peak densities of 10^4 g/cm^3. The most important resonance governing the reaction at these conditions is the 4.035 MeV state in ^{19}Ne. Use the information given in http://link.aps.org.proxy1.cl.msu.edu/doi/10.1103/PhysRevC.79.055805 (Tan et al. Phys. Rev. C 79, 055805 (2009)) to answer the following questions about the 4.035 MeV resonance:
    a. What is the resonance energy in the center of mass system in MeV?
    b. Suppose you wanted to measure this reaction by bombarding a helium target with a radioactive ^{15}O beam. What laboratory beam energy in MeV per nucleon do you need to choose to measure the most important resonance?
    c. What are the alpha and gamma widths in eV for this resonance?
    d. Which of the two widths determines the reaction rate?
    e. What is the minimum value this width needs to have for breakout to occur in Novae (for a 50% breakout branch of the hot CNO cycle)? Assume solar composition to be optimistic.
    f. What is the corresponding resonance width, total width, and alpha branching for this minimum value?
    g. Compare with the data and error bars given in the paper. Do you think this is possible?