PHY983 - Nuclear Astrophysics - Spring 2009
Homework Set 8
Due: April 3, 2009 at beginning of class
Key words: Laboratory measurements and supernovae

1. You propose to measure the 12C(a,g) reaction in the Gamow window for typical core helium burning conditions by bombarding a 1 micrometer thick carbon foil target with an alpha beam of an intensity of 1 mA. Use the central value of the S-factor range given in Buchmann et al. Phys. Rev. C 54 (1996) 393.

> 4.1. [4 pts] What is the correct (Laboratory!) energy of the alpha beam you need to set your accelerator to? (you can neglect the energy loss in the target)
>
> 4.2. [4 pts] Assuming a detection efficiency of 50%, how much beam time do you have to request to detect 100 events (for a 10% measurement assuming you have shielded the background very well).

2. [5pts] Describe in 1-2 sentence bullets the major steps of a core collapse supernova from the end of Si burning to the explosion of the surface of the star (observed brightening).

3. Calculate the total energy release **in erg**

> 2.1. [4 pts] from a core collapse supernova . Assume at the end of Si burning a 1.4 solar mass iron core with radius 10,000 km, and as the final compact remnant a typical neutron star with 10 km radius.
>
> 2.2. [4 pts] from a thermonuclear supernova. Assume a white dwarf reaches the Chandrasekhar mass limit with a composition of 50% 16O and 50% 12C (by mass), and assume the final product of the explosion is mainly 56Ni.

4. [4 pts] Calculate the energy the shock in a core collapse supernova looses by completely dissociating into protons and neutrons a typical outer core of 0.4 solar masses of 54Fe. Compare with a typical shock energy of about 1% of the explosion energy from 2.1. and discuss the consequences.