Level 2 Stars

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Problem Set S.7

a) Estimate the lifetime of a 12 $M_\odot$ star on the main sequence, given that nuclear burning converts about 0.7% of the matter involved into energy. The star has a luminosity of 10^4 $L_\odot$ and is ~70% hydrogen by mass.   [3 marks]

b) At the end of its life, the stellar core has a mass of 1.5 $M_\odot$. When it collapses what will the end product be? Give a reason for your answer. [2 marks]

c) Assuming that all of the gravitational potential energy liberated in the collapse is released in the form of neutrinos, and that the energy of a typical neutrino is 6 MeV, how many neutrinos are produced in total from the collapse? State what final radius you assumed. [3 marks]

d) Why are a large number of neutrinos produced during the collapse of the stellar core in massive stars? [2 marks]

[$M_\odot$ = 1.99 x 10^{30} kg; $L_\odot$ = 3.84 x 10^{26} W; 1 pc = 3.09 x 10^{16} m; 1 MeV=1.602 x 10^{-13} J; 1 AU = 1.50 x 10^{11} m; c = 3.00x10^8 m s^{-1}; G = 6.67 x 10^{-11} N m^2 kg^{-2}]