Homework 12

Problem 1 (5 points)

Using Schönberg-Chandrasekhar limit estimate the mass of the iron core assuming that the mass of the star is 100 $M_\odot$ and that outside of the core material consist of ionized hydrogen only.

Problem 2 (5 points)

Assume that outer layers of the star from above are blown away and all we left is the isothermal iron core with temperature 10^8 K. At what size of the core electrons degeneracy pressure overcomes the ideal gas pressure? Make the same calculation for neutron degeneracy pressure.

Problem 3 (5 points)

Assuming ingoing collapse, will the core from the above problem able to resist gravitational collapse?

Problem 4 (5 points)

Derive the exact formula for degeneracy pressure due to electrons (eq. 16.12). Do not use prior text book derivation based on uncertainty principal (it gives wrong numerical factor). Assume temperature of the gas to be zero.

Hints: It is convenient to derive using concentration of electrons n_e and arrive to the formula between eqs 16.11 and 16.12. You will need to know number of electron with given energy $n(E)dE$, we derived such formula for total number of fermions with energy $\leq$ to a given one (i.e. $\int_0^{E_f} n(E)dE = N(E_f)$). You will need to differentiate it. Find first total energy of such gas, then use formula $PV = (2/3)E$, where E is total energy of the gas.

Problem 5 bonus (5 points)

The section 15.3 of the text book describes observations of SN 1987A neutrinos arrival. Neutrinos arrive to Earth 3 hours before photons hit the Earth. How would you explain that light which is supposedly the fastest was beaten by neutrinos?