ASTRONOMY 220C

Problem Set 5
Due March 19, 2019

Short answers

1) If a red supergiant with radius 3×10^{13} cm and a blue supergiant with radius 3×10^{12} cm both explode with an initial internal energy of $\sim 10^{51}$ erg in their envelopes (approximately equal to the kinetic energy of the shock that went through), ignoring any radioactivity and assuming that the two envelopes have the same masses, about what will be the approximate ratio of the luminosities of the two supernovae on their plateaus? Why?

2) What measurements would you need to make in order to get the distance to a Type IIp supernova using the expanding photosphere method (aka Baade Wesselink method)? Is any theoretical modeling needed?

3) What are the distinguishing characteristics of a deflagration as opposed to a detonation? How do the pressure, temperature, and density change as the front passes in each?

4) What is the key difference between a pulsational-pair instability supernova and a regular pair-instability supernova? For what ranges of helium core and main sequence masses is each expected to occur if mass loss is neglected?

5) What is the difference between the Blandford-Znajek mechanism and the Blandford-Payne mechanism.?

Numerical Problem:

1) A red supergiant presupernova star has a wind speed of 50 km s^{-1} and a mass loss rate of 10^{-5} $M_\odot$. It explodes and ejects a shell of matter having mass 0.005 $M_\odot$ moving at a speed of 15,000 km s^{-1}. Neglect the slower moving matter beneath. a) What is the kinetic energy of this shell? b) What would be the luminosity from circumstellar medium interaction? c) Approximately how long would this luminosity exist before substantially declining?