

Home Work #2 Astro 680 Due March 12

Cluster of galaxies-

We shall use for all of the questions in this homework a cluster whose gas density follows a β model with $\beta = 0.7$, central density gas $n(0) = 10^{-2}$, effective virial radius (the maximum radius out to which should integrate) of 2Mpc and a core radius $a = 200$ kpc, $kT = 4$ keV and the gas density can be described by a β model gas density $n(r) = n(0)(1+(r/a)^2)^{-3\beta/2}$

1) 15 pts

- a) Use the equation of hydrostatic equilibrium and calculate the total mass of the cluster. Assume the cluster is isothermal
- b) what is the mass profile of the cluster and how does it compare to theory (e.g the NFW potential).
- c) What is the ratio of gas mass to total mass and as a function of radius. At the virial radius how does this compare to the cosmic baryon fraction.

2) 10 pts

How would one estimate the abundance of different elements in the gas?

What are the observables and how does one translate these into the abundance?

- b) At this temperature what are the strongest lines (largest flux and highest equivalent width (EW is the ratio of the flux in the line to the flux in the continuum at the same energy)) expected and why?

3) 10 pts

Calculate the S-Z decrement (y) and compare it to what is found for clusters in the literature. Assume the cluster is at $z = 0.2$ and the source is at $z = 1$. What are the effects of varying the distances?

4) 10 pts

For a path length through the center would this cluster be a strong lens? Calculate the Einstein radius using the isothermal sphere approximation.