Astronomy 323
Homework 5
Due: Wednesday, 2018 Mar 7

21. Like the Coma cluster, the Virgo cluster of galaxies contains hot gas (about 70 million K) that emits x-rays.

a. The X-ray luminosity of Virgo is 1.5×10^{26} W. Find the number density of electrons and the mass in the hot gas. Assume that the gas is fully ionized hydrogen, that it is uniformly distributed and that the Virgo cluster is spherical in shape with radius 1.5 Mpc.

b. Suppose the luminosity of Virgo is $1.2\times10^{12}L_\odot$ in the visual, estimte the cluster's luminous mass.

c. Assume that Virgo only loses energy through x-rays. How long could Virgo maintain the hot gas? How does this cooling time compare to the Hubble time?

22. Two images of Q0142-100 are formed by a gravitational lens. The redshift of the QSO is $z = 0.2.727$ and the redshift of the imaging galaxy is $z = 0.493$. The images are separted by $2.22''$, and the lensing galaxy is along the line connecting the two galaxies, $0.8''$ from one of them. Estimate the mass of the lensing galaxy.

23. Assuming a flat universe, find the angular size of the largest causally connected region of the CMB. ‘

24. MACHOS

a. Suppose that 10^{-8} $M_\odot$ black holes made up all of the dark matter in the halo of our Galaxy. Roughly, how far away would the nearest black hole be? How frequently would one pass within 1 A.U. of the Sun?

b. Suppose MACHOS were about the mass of Jupiter, ~ 0.001 $M_\odot$, repeat the calculations of Part (a).

25. What is the proper distance to the surface of last scattering? What is the luminosity distance to the surface of last scattering? Assume the benchmark model is correct and that the surface of last scattering has $z = 1{,}100$.