This assignment can be returned to Prof. Perera during the class on 17 April or can be left in my mailbox in the physics office (400 SA). Note that I will be out of town from the afternoon of 12 April through the 17th, so if you have any questions about this assignment be sure to ask them before the 12th.

One hundred radio telescopes, each of an effective area of 150 m$^2$, operating continuously over the past 20 years, is a reasonable estimate of the total radio observing capabilities of our species. Assume that each of these telescopes operates at 1 GHz with a bandwidth of 10 MHz (most actually do have a band pretty close to 1 GHz and bandwidths of 5-50 MHz are common). Assume that the typical source they have been observing is an extragalactic radio source of total power $L_R = 10^{43}$ erg s$^{-1}$, and each has a spectral index, $\alpha = -0.75$ (defined so that $P_\nu \propto \nu^{+\alpha}$), with abrupt spectral cutoffs below 10 MHz and above 100 GHz. (This range is the usual “radio band”.)

Further, these radio sources have a typical redshift, $z$, of 0.15. Take the Hubble constant to be $H_0 = 75$ km s$^{-1}$Mpc$^{-1}$. Recall that $v = cz = H_0 d$, that 1 pc = $3.085678 \times 10^{18}$ cm, and that the heat capacity of water is 1.0 cal g$^{-1}$K$^{-1}$, where 1 cal = $4.18 \times 10^7$ erg.

**Compute, showing your work:**

(a) The specific power, $P_\nu(\nu = 10^9$Hz$)$ in erg s$^{-1}$Hz$^{-1}$, emitted by such a typical source.

(b) The distance, $d$, to the typical source.

(c) The flux (density), $F_\nu(\nu = 10^9$Hz$)$ in both erg s$^{-1}$cm$^{-2}$Hz$^{-1}$ and in Janskys arriving at the earth.

(d) The power absorbed by one typical radio telescope operating as defined above from this typical source.

(e) The antenna temperature while observing this source.

(f) The amount of water that would be raised 1$^\circ$K in temperature if all the radio energy collected by *all* of these radio telescopes, each operating as defined above, over *all* the abovementioned time were to be applied to heating it.

**HINTS:** The only really difficult part is (a); if you can’t derive the answer, here it is, for use in parts (c) and onwards: $8.78 \times 10^{32}$erg s$^{-1}$Hz$^{-1}$. In parts (d)–(f) do not neglect the bandwidth!