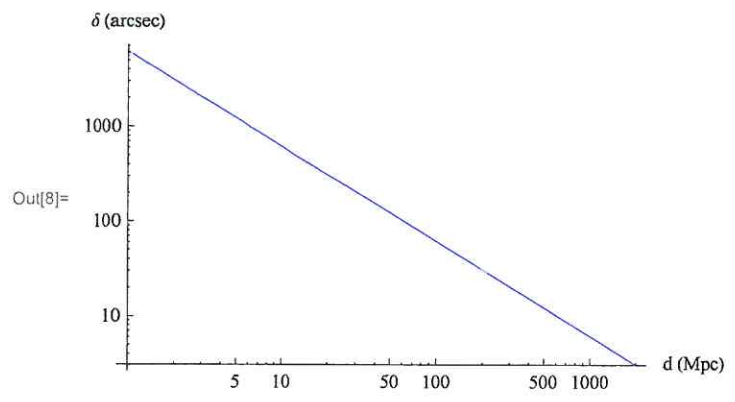


Homework ⁷ #1

```
In[1] = delta = (30 000 / (d * 10^6)) * 180 / Pi * 3600
```

Out[1] = $\frac{19\,440}{d \pi}$

```
In[6] = LogLogPlot[delta, {d, 1, 2000}, AxesLabel -> {"d (Mpc)", "delta (arcsec)"}]
```



$\delta = 4''$ at $d = 1547$ Mpc

- b. $d = 10$ Mpc $\delta = 620''$
 $d = 100$ Mpc $\delta = 62''$
 $d = 1000$ Mpc $\delta = 6.2''$ - barely resolvable
 } easily resolvable & classifiable
 } difficult to classify

(2)

$$\begin{aligned}
 2. a. \quad L_x &= 1.5 \times 10^{36} \text{ W} \\
 R &= 1.5 \times 10^6 \text{ pc} \cdot \frac{3.09 \times 10^{16} \text{ m}}{\text{pc}} = 4.64 \times 10^{22} \text{ m} \\
 T &= 7.0 \times 10^7 \text{ K}
 \end{aligned}$$

$$\begin{aligned}
 n_e &= \left[\frac{3L_x}{4\pi R^3 T^{1/2} (1.42 \times 10^{-40} \frac{\text{W}}{\text{m}^3})} \right]^{1/2} \\
 &= \left[\frac{3(1.5 \times 10^{36} \text{ W})}{4\pi (4.64 \times 10^{22} \text{ m})^3 (7.0 \times 10^7 \text{ K})^{1/2} (1.42 \times 10^{-40} \frac{\text{W}}{\text{m}^3})} \right]^{1/2} = 54.9 \text{ m}^{-3}
 \end{aligned}$$

For ionized hydrogen

$$\begin{aligned}
 M_{\text{gas}} &= \frac{4}{3} \pi R^3 n_e m_H = \frac{4}{3} \pi (4.64 \times 10^{22} \text{ m})^3 (54.9 \text{ m}^{-3}) (1.67 \times 10^{-27} \text{ kg}) \\
 &= 3.84 \times 10^{43} \text{ kg} = 1.93 \times 10^{13} M_{\odot}
 \end{aligned}$$

$$b. \quad L_v = 1.2 \times 10^{12} L_{\odot}$$

Assuming $\frac{M}{L} \approx 3 \frac{M_{\odot}}{L_{\odot}}$ (Milky Way bulge + thin disk)

$$M_v = 3.6 \times 10^{12} M_{\odot} \quad (\text{about } 1/5 \text{ of answer in (a)})$$

$$\begin{aligned}
 c. \quad t_{\text{cool}} &= \frac{u}{L_{\text{vol}}} = \frac{2n_e (\frac{3}{2} kT)}{1.42 \times 10^{-40} n_e^2 T^{1/2} \text{ W/m}^3} \\
 &= \frac{2(54.9 \text{ m}^{-3}) (\frac{3}{2}) (1.38 \times 10^{-23} \frac{\text{J}}{\text{K}}) (7.0 \times 10^7 \text{ K})}{(1.42 \times 10^{-40}) (54.9)^2 (7.0 \times 10^7)^{1/2} \text{ W/m}^3} \\
 &= 4.44 \times 10^{19} \text{ s} = 1.41 \times 10^3 \text{ Gyr}
 \end{aligned}$$

2 orders of magnitude longer than Hubble time.