Nick Luedtke

Astro 404 HW #1

1a) $B_\lambda(T) = \frac{2hc^2}{\lambda^5}\left(e^{hc/\lambda kT} - 1\right)^{-1}$

$x = hc/\lambda kT$

$hc/\lambda kT \ll 1 \Rightarrow e^x \to 1 + \frac{hc}{\lambda kT}$

$$\boxed{* \; B_\lambda(T) \approx \frac{2kT}{\lambda^4}}$$

b)

$\frac{hc}{\lambda kT} \gg 1 \Rightarrow e^{hc/\lambda kT} - 1 \to e^{hc/\lambda kT}$

$B_\lambda(T)\ \frac{2hc^2}{\lambda^5} e^{-hc/\lambda kT}$

$$\boxed{a = 2hc^2 \quad b = \frac{hc}{k} \quad \text{in} \quad B_\lambda(T) \approx \frac{a}{\lambda^5} e^{-b/\lambda T}}$$

2.

$T = 8525\ K$

$R = 7.72 \times 10^{10}\ m$

$d = 440\ pc$

$1\ pc = 3.086 \times 10^{16}\ m$

a) $L = 4\pi R^2 \sigma_{SB} T^4$

$$\boxed{L = 2.24 \times 10^{31}\ W}$$

b) $\text{arcsec} = \frac{1}{d} = \boxed{.00227''}$

$d = 5 \log_{10}\left(\frac{r}{10}\right)$

$d = \boxed{1.6}$

c) $F = 5.67 \times 10^{-8} \cdot (8525)^4 = \boxed{2.99 \times 10^8\ \frac{W}{m^2}}$

d) $F_{D\odot\oplus} = \frac{L}{4\pi R^2} = \frac{2.24 \times 10^{31}\ W}{4\pi (440 \cdot 3.086 \times 10^{16}\ m)^2} = \boxed{9.68 \times 10^{-9}\ \frac{W}{m^2}}$

$F_{\odot\oplus E} = \frac{L_\odot}{4\pi R^2} = \frac{3.8 \times 10^{26}}{4\pi (1.5 \times 10^{11})^2} = 1360\ \frac{W}{m^2}$

$$\boxed{F_{D\odot\oplus} = 7.12 \times 10^{-12}\ F_{\odot\odot\oplus}}$$

2e)

$$\lambda_{peak} = \frac{2.9 \times 10^{-3}\ mK}{8525\ K} = \boxed{340\ nm}$$

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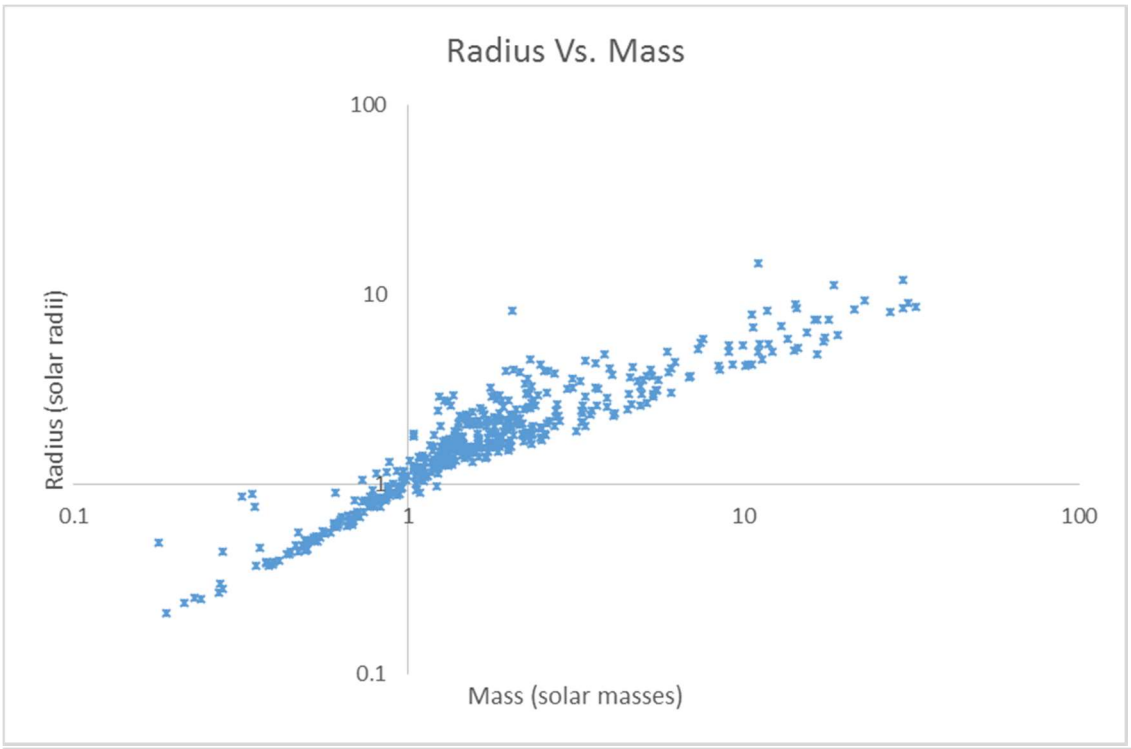
3. a) For RvM the log log relationship is approximately linear with a slope slightly less than 1. The greater the mass the higher the scatter

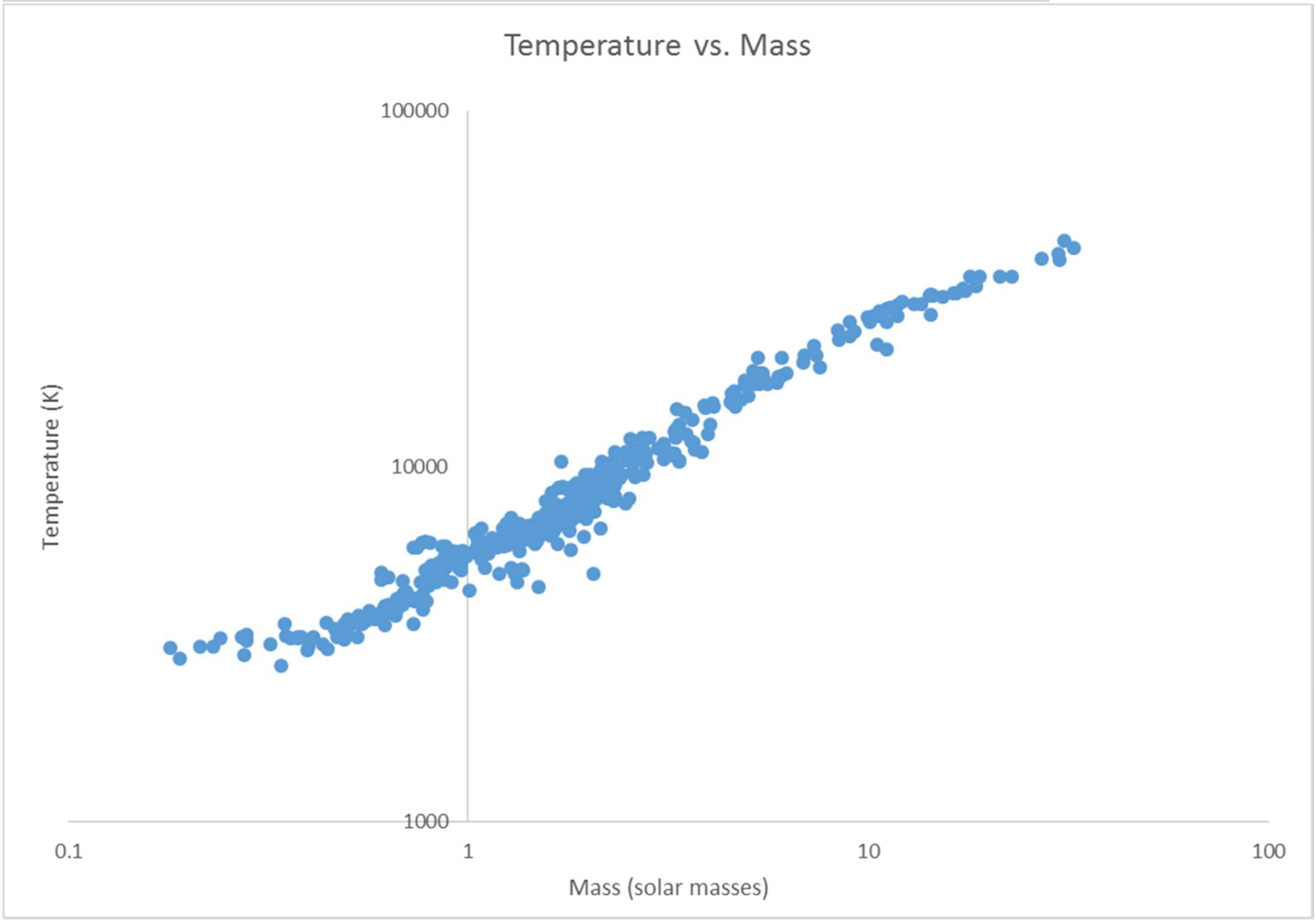
b) The slope is approximately .1 and there appears to be a smaller standard deviation

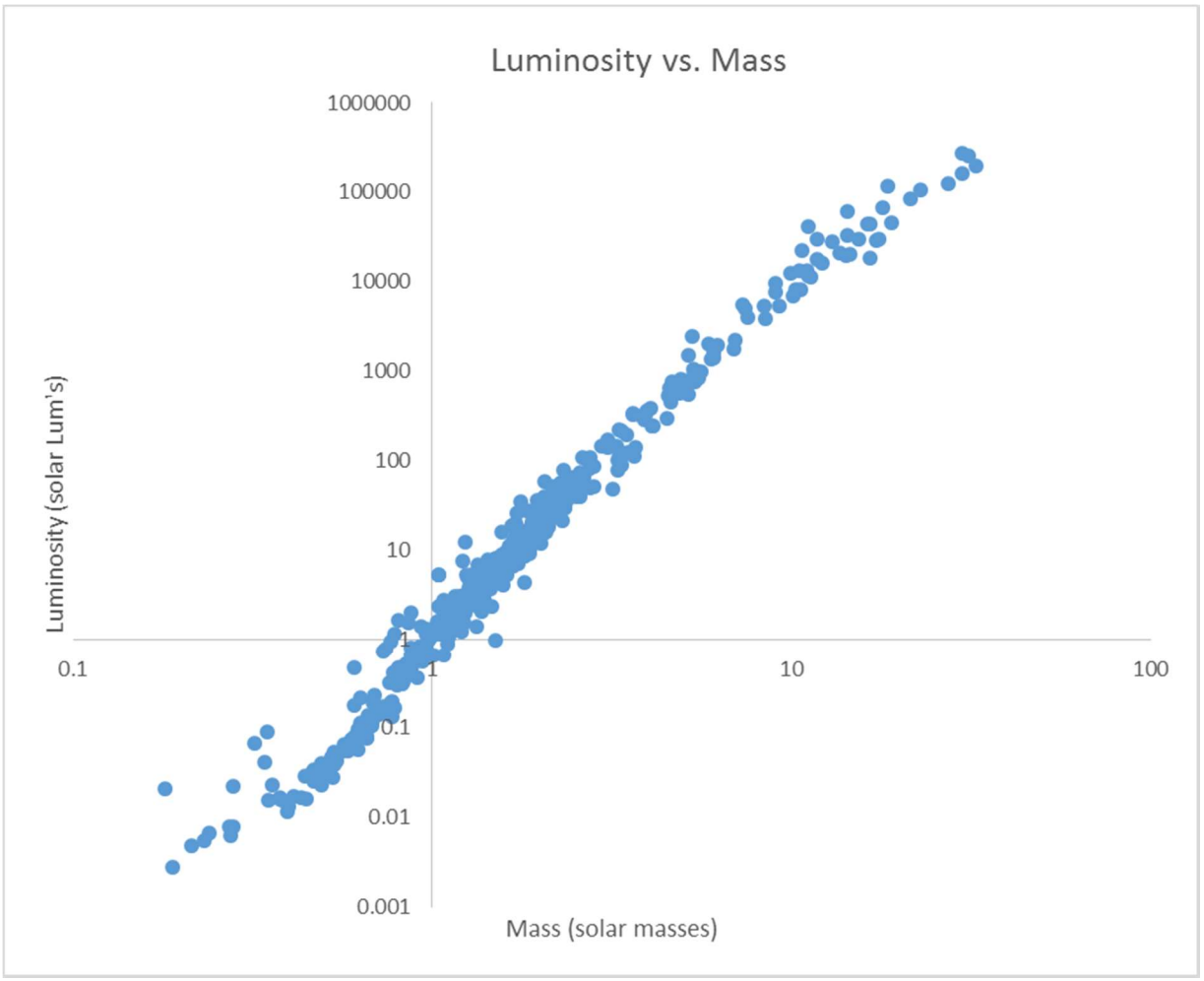
c) There is an approx. slope of 3.5. There appears to be a power law of about 3 or 4.

Graphs Attached

a) Radius vs Mass
b) Temperature vs Mass
c) Luminosity vs. Mass


Radius Vs. Mass
100
10
1
0.1
0.1
1
10
100
Radius (solar radii)
Mass (solar masses)


Temperature vs. Mass
100000
10000
1000
0.1
1
10
100
Temperature (K)
Mass (solar masses)


Luminosity vs. Mass
1000000
100000
10000
1000
100
10
1
0.1
0.01
0.001
0.1
1
10
100
Luminosity (solar Lum's)
Mass (solar masses)