ASTR 469
HW #5

1) $S/N = 5 = \frac{100 \cdot t}{(100 \cdot t)^{1/2}} = 10 t^{1/2} \Rightarrow t = 0.5^2 s$

b) $1 = t^{1/2} \Rightarrow t = 1s$

c) Reduces chance of saturation or spurious events. Also reduces dark current ($\propto t^2$)

2) a) $m_V = 5.72$ $\quad m_B = 6.27$

b) $B-V = +0.55$

c) G/K, much like the Sun!

d) Source: 25 e⁻/s
BG: 1 e⁻/s (@ 50% efficiency)

e) S/N should increase as $t^{1/2}$, roughly

f) Since they are close to $S/N \propto t^{1/2}$, integrating longer helps! But, as source counts decrease, help is less.

g) 1 s, 3.5 s, 0.15 s

h) $$S/N = \frac{F \cdot t}{(F \cdot t + F_{sky} \cdot t + n_{pix} \sigma_d^2 t^2 + n_{pix} \sigma_r^2)^{1/2}}$$

$5t$ ↑ $\quad 2t$ ↑ $\quad 0.0001t^2$ ↑ $\quad 10.49$ ↑

When is $\sigma_r^2 > \sigma_d^2 + \sigma_{sky}^2 + \sigma_{sig}^2$

$10.49 > 0.0001t^2 + 5t + 2t$

Solves to $t \lesssim 1.5$ s

3) $n = 92$

$\Delta n = 1$ so $n = 93 \to 92$

$$\nu = R_M c \left[\frac{1}{n^2} - \frac{1}{(n+\Delta n)^2} \right] = R_M c \left[\frac{1}{92^2} - \frac{1}{93^2} \right]$$

$$R_M c = 3.29 \times 10^{15} \left[1 + \frac{m_e}{M} \right]^{-1} \approx 3.29 \times 10^{15} \text{ Hz}$$

$$\Rightarrow \nu = 8.31 \times 10^9 \text{ Hz} = 8.31 \text{ GHz}$$

$$z = 3 = \frac{\lambda_{obs}}{\lambda_{emit}} - 1$$

$$\lambda_{obs} = 4 \lambda_{emit} = 4 \cdot \frac{c}{8.31 \times 10^9 \text{ Hz}} = 144.4 \text{ cm}$$

4) Circular motion $v = \frac{2\pi r}{t}$

a) $t = 23.934 h = 8.616 \times 10^4 s$

$r = 6.371 \times 10^6 m$

$\Rightarrow v = \pm 464.6 m/s$

$z = \frac{v}{c} = 1.5 \times 10^{-6}$

b) In this case, the radius is smaller

$\cos 4 = r/r_E \Rightarrow r = 4.909 \times 10^6 m$

$\Rightarrow v = \pm 358 m/s$

$\Rightarrow z = 1.2 \times 10^{-6}$

c) $t = 1 year = 3.154 \times 10^7 s$

$r = 1.496 \times 10^{11} m$

$\Rightarrow v = 2.98 \times 10^4 m/s$

$\Rightarrow z = 9.9 \times 10^{-5}$

d) $t = 7.3 \times 10^8 yr = 7.26 \times 10^{15} s$

$r = 8.34 kpc = 7.56 \times 10^{20} m$

$v = 7.22 \times 10^5 m/s$ $z = 2.4 \times 10^{-4}$