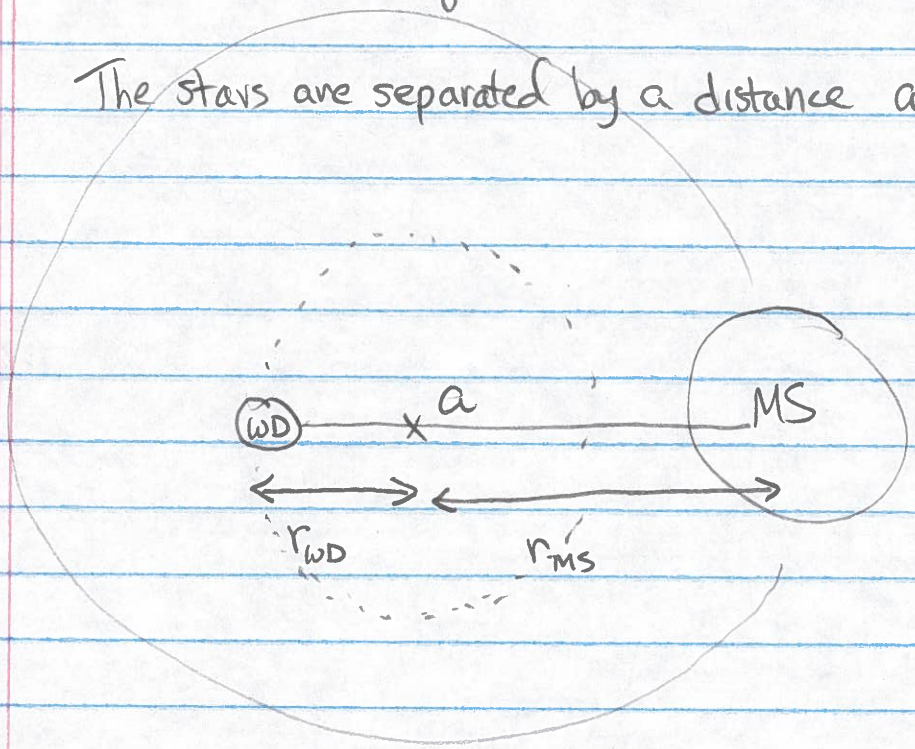
HW 6 #3

Two stars orbit each other in circular paths:

- white dwarf $m_{WD} = 1.44\ M_\odot$
- main sequence $m_{MS} = 1.08\ M_\odot$

The stars are separated by a distance $a = 4.45 \times 10^9$ m



To find the period of the orbit, we can use several methods

a) Kepler's Third Law

$$P^2 = \frac{4\pi^2}{G(m_{WD} + m_{MS})} a^3$$

b) Newton's Laws: gravity + centripetal force

Pick one star - MS

$$m_{MS} \frac{V_{MS}^2}{r_{MS}} = \frac{G m_{MS} m_{WD}}{a^2}$$

#3 continued

The distance of the main sequence star from the center of mass — which is the radius of its orbit — is

$$r_{MS} = a\left(\frac{M_{WD}}{M_{WD}+M_{MS}}\right)$$

Then one can find the speed of the star in its orbit

$$V_{MS}^2 = \left[\frac{G M_{WD}}{a^2}\cdot a\,\frac{M_{WD}}{M_{WD}+M_{MS}}\right]$$

$$\Rightarrow \quad V_{MS} = \sqrt{\frac{G M_{WD}^2}{a(M_{WD}+M_{MS})}}$$

And with the speed V_{MS} and orbital radius r_{MS}, one can compute the period

$$P = \frac{2\pi r_{MS}}{V_{MS}}$$

In this case, both methods yield

$$P = 1.02\times10^5\,s = 1.18 \text{ days}$$

The velocity of main sequence star is

$$V_{MS} = \frac{2\pi r_{ms}}{P} = 157\ ^{km}/_{s}$$

And this ↗ is the speed with which star would fly away.