7. (12 points) What is the Doppler effect? How does an astronomer make use of it?

The Doppler effect is a wave phenomenon where the wavelength of waves emanating from a moving source are redshifted if the source is moving radially away from the observer and blueshifted if the source is moving radially toward the observer.

Astronomers use the Doppler effect to determine the radial velocity of a source.

8. (13 points) Suppose a planet with a mass of 6×10^{25} kg is orbiting in a circular orbit about a star with a mass of 3.77×10^{31} kg. If it takes 20.5 years to go around the star, what is the radius of the orbit? Give your answer in both meters and AU.

$$p^2 = \frac{4\pi^2 a^3}{GM} \qquad \text{(ignore mass of planet)}$$

$$20.5 \text{ yrs} = 6.48 \times 10^8 \text{ s}$$

$$a^3 = \frac{GMp^2}{4\pi^2} \Rightarrow \quad a = \left(\frac{GMp^2}{4\pi^2}\right)^{1/3}$$

$$a = \left[\frac{(6.67\times10^{-11})(3.77\times10^{31})(6.48\times10^8)^2}{4\pi^2}\right]^{1/3}$$

$$a = 2.99 \times 10^{12} \text{ m}$$

$$a = 19.9 \text{ AU}$$