

AST 301  
Homework #1  
Due Friday Sep. 3

1. I want you to do one of the calculations I did in class a bit more carefully than I did it. The Earth orbits around the Sun in a nearly circular orbit with a radius of  $1 \text{ AU} = 1.5 \times 10^8 \text{ km}$ . It takes one year to go around its orbit.

a) What distance does it travel in one year? (Give the answer in km.)

It travels the circumference of its orbit:  $C = 2 \pi R = 9.4 \times 10^8 \text{ km}$ .

b) How long does it take it? (Give the answer in seconds.)

$1 \text{ year} = 365 \times 24 \times 60 \times 60 = 3.15 \times 10^7 \text{ sec}$ .

c) What is its speed (in km/s)?

$\text{speed} = \text{distance} / \text{time} = 9.4 \times 10^8 \text{ km} / 3.15 \times 10^7 \text{ s} = 30 \text{ km/s}$

d) How many times faster than your walking pace is that?

I can walk about  $2 \text{ m/s} = .002 \text{ km/s}$ . The Earth goes  $30/.002 = 15,000$  times faster.

2. Let's do almost the same question for the Sun orbiting around the center of the Milky Way galaxy. The radius of the Sun's orbit is about 25,000 light-years, and it moves with a speed of about 200 km/s.

a) How far (in km) does the Sun go around its orbit?

$1 \text{ ly} = 9.46 \times 10^{12} \text{ km}$ , so  $C = 2 \pi R = 2 \pi \times 25,000 \times 9.4 \times 10^{12} \text{ km} = 1.48 \times 10^{18} \text{ km}$ .

b) How long does it take it to go around (in seconds)?

$\text{time} = \text{distance} / \text{speed} = 1.48 \times 10^{18} \text{ km} / 200 \text{ km/s} = 7.4 \times 10^{15} \text{ s}$ .

c) How long does it take it to go around (in years)?

$7.4 \times 10^{15} \text{ s} / 3.15 \times 10^7 \text{ s/yr} = 2.34 \times 10^8 \text{ yr}$ .

d) The Sun is about 5 Gyr old. How many times has it been around the Milky Way?

$5 \times 10^9 \text{ yr} / 2.34 \times 10^8 \text{ yr} = 21 \text{ times around}$