welcome back to

ASTR 160

NO SCIENCE MAJORS

FRESH / SOPH
section sign-up MONDAY

JR / SR
course & sections TUESDAY
not is, noonish

1st problem set (now) available on classes V2

due Thursday (START of class)

PLEASE READ P.S. POLICIES

PLEASE START EARLY

GROUPS STRONGLY ENCOURAGED

but SUBMITTED WORK SHOULD BE YOUR OWN

HELP: sections (not this week)

office hours (CB STARBUCKS M 9:30 - 11 am
TFs Weds TBA)

classes forum (works well)
cutoff: 8pm Weds

+ on-line help sheets

NEED MORE? COME TALK!

EXOPLANETS

problem: planets are too close to star

how close is it?
→ planetary orbits

$a^3 = P^2 M$

- a → semi-major axis (in A.U.) → distance from Earth-Sun
- P → orbital period (years)
- M → mass (solar masses)

$$a^3 = \frac{P^2 G M}{4\pi^2}$$

G → constant depends on units

if units are
solar mass
yrs
A.U

then $G = 4\pi^2$

$a^3 = P^2 M$

$a, M \Rightarrow P \Rightarrow$ (like Jupiter)

→ $a, P \Rightarrow M$

$P, M \Rightarrow a$

<u>example</u>: what is mass of Sun?

use Earth's → mass of Sun

$a = 1$ A.U. $P = 1$ yr

$1^3 = 1^2 \times M$ $M = 1$

→ solar masses

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mks units

m → meter

k → kilogram

s → seconds

A.U.: 150,000,000,000

1 year = 365.24 × 24 × 60 × 60

$N \times 10^{m}$ → integer

↓ decimal

$10^{m} = 1\underbrace{00000}_{m \text{ zeros}}$

$$N \times 10^{m} \times A \times 10^{B} = A \times N \, 10^{m+B}$$

$$(N \times 10^{m})^{k} = N^{k} \times 10^{m \cdot k}$$

$$(N \times 10^{m})^{1/2} = N^{1/2} \times 10^{m/2}$$

$$(N \times 10^{m})^{1/2} = (10 \times N \times 10^{m-1})^{1/2}$$
$$= (10 \times N)^{1/2} \times 10^{(m-1)/2}$$

$$1 \text{ AU} = 1.5 \times 10^{11} \text{ m}$$

$$1 \text{ yr} = 2.4 \times 10^{1} \times 6 \times 10^{1} \times 6 \times 10^{1} \times 3.6524 \times 10^{2} \text{ s}$$

$$2.4 \times 6 \times 6 \times 3.6 \ldots \times 10^{5}$$

15

90

300

$$\boxed{1\ yr = 3\times 10^{7}\ s}$$

in mks $G = 7\times 10^{-11}$

$$a^3 = \frac{GMP^2}{4\pi^2}$$

$$(1.5\times 10^{11})^3 = \frac{(3\times 10^{7})^2\ 7\times 10^{-11} M}{4\pi^2}$$

$$\begin{matrix}(1.5\times 1.5\times 1.5) \\ \times 10^{33}\end{matrix} = \frac{3^2 \times 10^{14} \times 7\times 10^{-11} M}{4\times\pi\times\pi}$$

$$= \frac{7\times 10^{4} M}{4\times 10^{1}}$$

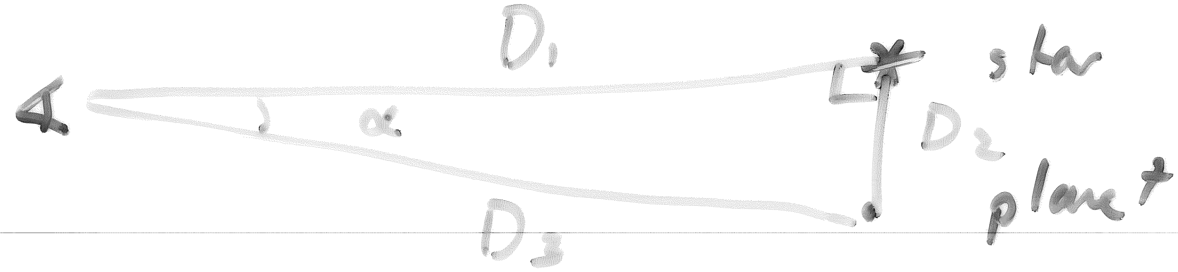
$$4\times 10^{33} = 2\times 10^{3} M$$

$$\frac{4}{2}\times\frac{10^{33}}{10^{3}} = M = 2\times 10^{30}\ kg.$$

$3 = \pi = \sqrt{10}$

NO ANDROIDS

"how close are planets to stars"



$\sin\alpha = \frac{D_2}{D_3}$

small angles

$\sin\alpha = \alpha$ → radians

SMALL ANGLE FORMULA

$$\frac{D_2}{D_1} = \alpha$$

$$\frac{D_2}{D_1} = \alpha$$

D_2, D_1 same unity

α in radians

2π radians in circle

360° in a circles

→ A.U.

$$\frac{D_2}{D_1} = \alpha$$ → arc seconds

↓

parsecs = 3×10^{16} m = 3 light years

60 arcsecs = arc minute

60 arcminutes = 1 degree

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PROBLEM:

a planet with a 40 yr period

around a star 3 pc away

what is angular separation

$T_* = 10{,}000\ °K$

HARD: plug & chug fails because no one equation

: missing information

(too much information)

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$P = 40$ yrs $= 40 \times 3 \times 10^7 \ldots$

$D = 3$ pc

$a^3 = P^2 M$

$M \to 1$

$P \to 40$

$a^3 = 1600 = 1.6 \times 10^3$

$a = (1.6)^{1/3} \times (10^3)^{1/3}$

1×10^1 AU.

$\alpha = \frac{D_2}{D_1} = \frac{10}{3} = 3.$

$\alpha = 3$ arc seconds

light from observations of stars is scattered over angular sizes of arcseconds

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how to think about such problems

1) have P $\Rightarrow$ want α
have D

2) suppose $M \sim M_\odot$

3) Ah ha $M, P \Rightarrow a$

4) distance between star-planet is $a = D_2$

$$D = D_1$$

5) compute α

$$\alpha = D_2 / D_1$$