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)

+ on-line
help
sheets

classes forum (works well)
cutoff: 8pm Weds

NEED MORE? COME TALK!

EXOPLANETS

problem: planets are too close to star

how close is it?

→ planetary orbits

$a^3 = P^2 M$

P → orbital period (years)

M → mass (solar masses)

a ← semi-major axis (in A.U.)

A.U. → distance from Earth-Sun

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

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)

$\rightarrow a, P \Rightarrow M$

$P, M \Rightarrow a$

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

use Earth's $\rightarrow$ mass of Sun

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

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

$\rightarrow$ solar masses

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mks units

m $\rightarrow$ meter

k $\rightarrow$ kilogram

s $\rightarrow$ seconds

A.U. = 150,000,000,000

1 year = $365.24 \times 24 \times 60 \times 60$

$N \times 10^{m}$ → integer

↓

decimal

$$10^{m} = \underbrace{100000}_{m \text{ zeros}}$$

$$N \times 10^{m} \times A \times 10^{B} = A \cdot N \; 10^{M+B}$$

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

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

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

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

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

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

$$= \underbrace{\underbrace{\underbrace{2.4 \times 6}_{15} \times 6}_{90} \times 3.6 \ldots}_{300} \times 10^{5}$$

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

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

~~P.S~~ $\quad a^3 = \frac{G M P^2}{4\pi^2}$

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

$$\begin{matrix}(1.5 \times 1.5 \times 1.5) \\ \times 10^{33}\end{matrix} = \frac{\cancel{3^2}^{\,10} \times \cancel{10^{14}}^{\,10^{15}} \times 7 \times 10^{-11} M}{\cancel{4} \times \cancel{\pi} \times \cancel{\pi}}$$

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

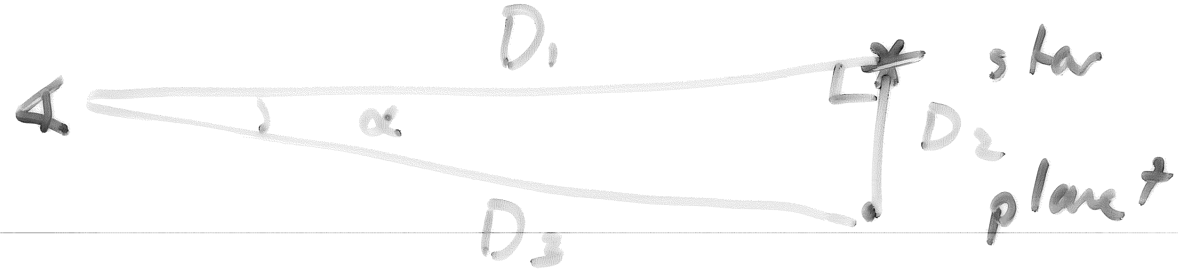
$$4 \times 10^{33} = 2 \times 10^3 M$$

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

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

NO ANDROIDS

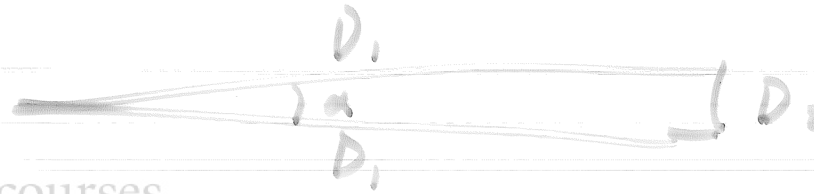
"how close are planets to stars"



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

small angles

$\sin\alpha = \alpha \rightarrow$ radians



SMALL ANGLE FORMULA

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

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

D_2, D_1 same unity

α in radians

2π radians in circle

$360°$ in a circles

$$\frac{D_2 \rightarrow \text{AU.}}{D_1} = \alpha \rightarrow \text{arc seconds}$$

parsecs = 3×10^{16} m = 3 light years

60 arcsecs = arc minute

60 arcminuts = 1 degree

PROBLEM:

a planet with a 40 yr period

around a star 3 pc away

what is angular separation

$T_* = 10{,}000\ ^\circ K$

HARD: plug & chug fails because no one equation

: missing information

(too much information)

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

$D = 3$ pc

$a^3 = P^2 M$

$M \to 1$

$P \to 40$

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

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

$\;\;\;\; 1 \times 10^1$ A.U.

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

$\alpha = 3$ arc seconds

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

Open Yale courses

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

$\alpha = D_2/D_1$