

ASTR 2500 - Ch.2

Kepler's 3rd law $P^2 = a^3$

Is this a proper equation?

Nope: MUST include units

$$\left(\frac{P}{1\text{yr}}\right)^2 = \left(\frac{a}{1\text{AU}}\right)^3$$

What is an AU? a_E

Can make the units

$$P^2 = \frac{(1\text{yr})^2}{(1\text{AU})^3} a^3$$

define to be a const k

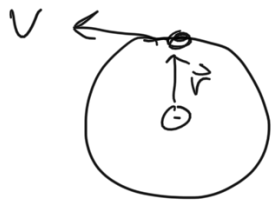
$$K = 1 \text{ yr}^2/\text{AU}^3 \rightarrow P^2 = K a^3$$

Works outside the solar system, but
the value of K will be different

... .. L. H.

Why don't we notice the centripetal accel. of Earth's rotation?

$$\vec{a}_{\text{cen}} = \vec{\omega} \times (\vec{\omega} \times \vec{r})$$



same dir.
as \vec{v}
same dir.
as \vec{r}

$$|\vec{a}| = \omega^2 r, \quad r = R_E \quad \omega = \frac{2\pi}{1d}$$

$$R_E = 6400 \text{ km}, \quad 1 \text{ yr} \approx \pi \times 10^7 \text{ s}$$

$$\omega = \frac{2\pi}{1d} \left(\frac{365.25d}{\text{yr}} \right) \left(\pi \times 10^7 \frac{\text{s}}{\text{yr}} \right)^{-1}$$

$$= 2 \times 10^{-7} \cdot 365.25 \text{ s}^{-1} = \underline{7.3 \times 10^{-5}}$$

$$|\vec{a}| = \omega^2 r = (7.3 \times 10^{-5} \text{ s}^{-1})^2 (6.4 \times 10^6 \text{ m})$$

$$= 7.3^2 \cdot 6.4 \cdot 10^{-4} \text{ m s}^{-2}$$

$$= 3.4 \times 10^{-2} \text{ m s}^{-2} = 0.034 \text{ m s}^{-2}$$

$$|\vec{a}_g| = 9.8 \text{ m s}^{-2}$$

$$\frac{|\vec{a}_{\text{cen}}|}{|\vec{a}_g|} \approx 0.3\%$$

↳ 1

Dart, easy to detect with accurate telescope,
pointing: aberration of starlight



$$\tan \theta = \frac{v}{c} = \frac{30 \text{ km/s}}{3 \times 10^5 \text{ km/s}} = 10^{-4} \text{ rad}$$

$$\theta \ll 1, \quad \tan \theta \approx \theta$$

$$\theta = 10^{-4} \text{ rad} \cdot \frac{180^\circ}{\pi \text{ rad}} \cdot \frac{60'}{1^\circ} \cdot \frac{60''}{1'}$$

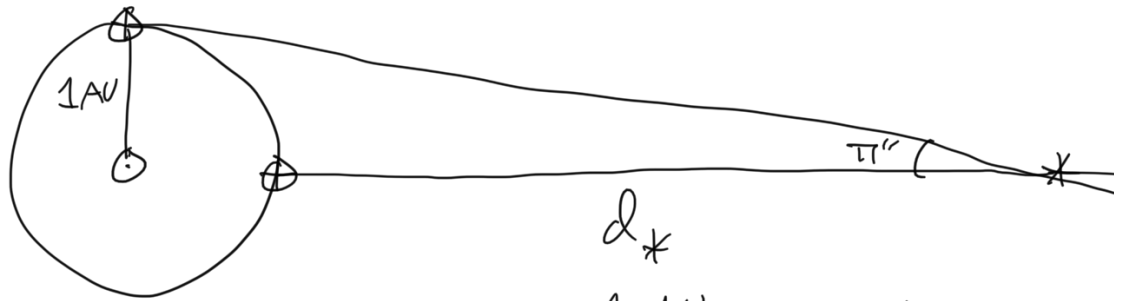
206265 arcsec/rad

$\theta \approx 20''$, eye is $\sim 1'$, so need telesc

1st measured in 1680 by Jean (Luc?)
Picard

Many 1m class telescopes have 1" resoluti
(ble on Earth) & a few arcmin FOVs,
so effect often not important in practice.

One reason Tycho + others didn't think the Earth revolved around the Sun was the lack of parallax



$$\tan \pi'' = \frac{1 \text{ AU}}{d_*} \approx \pi''$$

$$d_* = \frac{1 \text{ AU}}{\pi'' (\text{rad})} = \frac{206265}{(\pi'' / \text{arcsec})} \text{ AU}$$

If $2'$ is needed to measure parallax by eye, stars must be further

$$\text{than } d_* = \frac{206265 \text{ AU}}{120''} \sim 2000\times \text{ farther than the sun}$$

Nearest star Proxima Cen has $\pi'' = 0.76$ way smaller than aberration!

If this had astronomers measure distance why not use it as a new unit?

Define $1 \text{ pc} = d(\pi'' = 1'')$

parsec \equiv parallax - arcsec

$$1 \text{ pc} = 206265 \text{ AU} = 3.086 \times 10^{16} \text{ m}$$

$$= 3.26 \text{ light-years}$$