

- Pickup up your Homework #1 and Doodle Sheets
- Wednesday: TIMESTEP (5 pm), PHYS 218
 ATOMM (3-5 pm), Parker Room
- Thursday: Study session (2-4 pm), Bookstore 304A
 ATOMM (1:30-3:30 pm),
- Friday: Astronomy Club Friday (4 pm), N210

Homework #1 in Hindsight

- Remember Polya's 4-step method
 - 1. Understand the problem. More than one part?
 - 2.
 - 3.
 - 4. Reflect back.
 - Did I answer all parts?
 - Do my answers make sense?
- Final question related to the reading and classwork, not "time zones."
 - If you feel the need to "Google" don't !
 - Ask us a question instead.
- Did you also email us as required?

In a single sentence, define the scientific term 'acceleration."

If you are an astronaut in the Space Shuttle as it brakes during landing, the Shuttle ... (Circle all possible answers.)



- A. exerts a force on you.
- **B.** decreases your kinetic energy.
- C. accelerates you.
- D. slows down.



Work together!

Review: Angles First Proof of Earth's Motion 1728 – two centuries after Copernicus!

"Aberration of Starlight"

- Earth is traveling through a "wind" of starlight.
- The apparent direction of starlight shifts because of our motion.
- Earth moves 18.5 miles/sec.
- <u>How</u> determine the magnitude of this effect?



Measuring Distances to Stars "parallax"

Easiest way of measuring distance: A surveying method

An object seems to change position if we change our viewpoint.

The Earth gives different viewpoints as it revolves in its orbit.

The angle a star appears to move is its "parallax" (p).



Definitely NOT to scale!

WHY?

Why obtain the observations six months apart?

Necessary?



tan (p) = 1 AU / dFor small angles in radians, tan (p) $\approx p = 1/d$

Parallax What is a "parsec" (pc)?

- p (radians) must be dimensionless
 so d must be in AU
- p is actually measured in arcseconds, so
 p (arcsec) = p (rad) x 206265 arcsec/rad
- p (arcsec) = 206265/d, where d (AU)
- p (arcsec) = 1/d where d is in "parsecs"
 1 pc = 206265 AU = one parsec
- Parsec: <u>Parallax of one arcsecond</u>

A **"Parsec"** corresponds to a <u>par</u>allax angle of one arc<u>sec</u>ond



distance (parsecs) =

parallax (arcsec)

Problem:

<u>How</u> estimate how much bigger stellar parallax angles would be from Mars vs. Earth?



Today's Homework an alternative approach

The black hole (Sgr A*) at the center of our Milky Way galaxy is predicted to have an event horizon of diameter 0.16 AU. What is the corresponding angular diameter as seen from Earth at a distance of ~8 kpc?

> 1 AU at 1 pc distance subtends angle of 1 arcsec 0.16 AU at 1 pc → 0.16 arcsec

at a distance of 8000 pc \rightarrow 0.16/8000 = 2 x 10⁻⁵ arcsec 20 microarcsec or 20 µarcsec

Estimate 'parallax' angles to the following objects

• Given:

Across Earth's diameter, the Moon's parallax = ~1 deg

- Estimate:
 - Mars
 - Sun

Parallax angles to ...

Across the diameter of Earth: Moon (~1°) Mars (~20") Sun (8.8")

From Earth, how many times farther is the Sun than Moon?

Across the diameter of Earth's orbit: stars (<1")

Review: AZ-EL Coordinates elevation = altitude What units?



Coordinates on Earth's Surface latitude and longitude







Equatorial Coordinates the "Celestial Sphere" concept

Earth was imagined to be inside at center.

Stars & constellations are fixed on a rotating sphere surrounding the Earth.

Earth's poles and equator are "projected out" onto the celestial sphere.

Sun moves along the yellow path ("ecliptic").



Angle of Polaris Above the Horizon Solve these problems in different rows.



From Tucson (lat ≈ 32 deg) What is the altitude of Polaris?

What DEC is overhead?

http://homepage.mac.com/kvmagruder/images/polarislat.gif

The angle of Polaris above horizon (altitude) equals your latitude.

Problem #1: What information do you need?

- Could the famous navigational star "Canopus" be observed from Tucson?
 - RA: 6:23:57
 - DEC: -52:41:44
- What is the lowest DEC observable from Tucson?

Equatorial Coordinates right ascension and declination do not change with time (sort of)



- DEC: deg: arcmin: arcsec
- RA: hours: min: sec
- increases towards East
- <u>How</u> convert between time and angle?

Note how "zero-point" of RA is defined.

Equatorial Coordinates "right ascension" and "declination"





FIGURE 1.5 The right ascension (α) and declination (δ) of a point on the celestial sphere.

Equatorial Coordinates <u>More Terms</u>: sidereal time, hour angle, transit



Problem #2: What information do you need?

- If a Near-Earth Object (aka, NEO) were discovered at midnight tonight at the following coordinates from Mt. Lemmon near Tucson, could it be observed simultaneously at Mauna Kea Observatory in Hawaii?
 - RA: 22:30:00
 - DEC: +20:00:00
 - Mauna Kea:
 - Longitude (155.4681 deg)
 - Latitude (19.8208 deg)