Welcome to Phys333-20S

Fundamentals of Astrophysics

Instructor:

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Course Theme

• The physical laws and forces that govern our lives...
  – e.g. gravity, electricity & magnetism, nuclear binding

• Also govern the cosmos...
  – planets, stars, galaxies, even the universe itself

• Use geometry, logic, physics, & math to:
  – quantitatively determine the physical properties of astrophysical objects, e.g.
  – Stars, Clusters, ISM, Galaxies, Gal. Clusters, and ultimately, the Universe and “Big Bang”!
"The most incomprehensible thing about the universe is that it is comprehensible."

- Albert Einstein (1879-1955)
Based on a triad...

1. observations (mostly of light)
2. theory (physical laws)
3. computation (by hand and computer)
• This is a **Quantitative Science** course

• Language of Science is **Math**

• Science of Astronomy is **Astrophysics**
  - **Not** just “Descriptive” Astronomy”

• Mostly use “freshman physics” (Phys207/208) and **calculus**

• But also some (basic) Quantum and Relativity

• **LOTS OF COMPUTATION**, 
  - e.g. HW, Class, Exams
Chinese Proverb

I hear
and I forget

I see
and I remember

I do
and I understand
So to learn by doing...

- HW problems
  - Work with others ok
  - But must be open, acknowledge
- i-clicker quizzes, in class exercises
- Class participation
  - Ask questions. Engage!
Course web page

http://www.bartol.udel.edu/~owocki/phys333
Syallabus

• 2 mid-terms (25%) + no final
• HW 20%: about one set due every 4th class,
  – due classtime on date; NO LATE
  – drop lowest HW in final grade
• class participation 15% (i-clicker ~ 10%)
• term paper/project 15% (details later)
• Any questions??
3 basic observables for stars

1. position on the sky
2. apparent brightness
3. color or spectrum

From this, we can infer physical properties:
  distance, size, temperature, mass, age, luminosity, etc.
An astronomer living on the equator watches two stars pass directly overhead (i.e. through the local "zenith"), with a clock time difference of 1 minute.

What is the angular separation (in degrees) of the two stars on the sky (a.k.a. celestial sphere).

A. 1 degree
B. 4 degrees
C. ¼ degree
D. ½ degree
E. There is insufficient information to answer
An astronomer living on the equator watches two stars pass directly overhead (i.e. through the local "zenith"), with a clock time difference of 1 minute.

What is the **angular separation** (in degrees) of the two stars on the sky (a.k.a. celestial sphere).

A. 1 degree

B. 4 degrees

C. ¼ degree

D. ½ degree

E. There is insufficient information to answer
Stars actually lie at different distances; arrows indicate where they *appear* to be located on the celestial sphere.
Stretch out your arm as shown here.
How to infer distance

- In every day world, we use two methods:
  - **angular size** assuming physical size
  - stereoscopic vision
Size Illusion
Angular size, distance, & parallax

- How do we infer distance?
  1. Decline of angular size for a given fixed size
  2. Stereoscopic eyes -- bending angle
Angular size

\[ a = 360^\circ \frac{s}{2\pi D} \]
Class Example

Person of size \( s = 2 \text{ m} \)

At distance \( D = 6 \text{ paces} \approx 4 \text{ m} \)

Angle \( a = \frac{360}{2} \left(\frac{2}{\pi \cdot 4}\right) = \frac{90}{\pi} = 30^\circ \)
\[
\sin\left(\frac{\alpha}{2}\right) = \frac{R}{d}
\]

for \( \alpha \ll 1 \), \( \alpha \approx \frac{2R}{d} \)
Parallax

\[
\frac{d}{pc} = \frac{1}{p/\text{arcsec}}
\]

For earth’s orbit with size/radius \( s = 1 \) au, then \( p \) (in arcsec) represents the parallax angle to a star/object at distance \( d \) in parsec (pc).
Assignment for Thursday

– Review the course Syllabus
– Be prepared to answer Quick Questions for sec. 2
– Look over website: http://htwins.net/scale/
  – play with “scale of the universe” app
– View video UPhoneLecture.m4v
Universe’s Phone Number
From the scale of the nucleus to the universe in 10 key steps of powers of ten

-711-2555

bigger than us

1 meter

Earth 10⁷ m

Jupiter 10⁸ m

Sun 10⁹ m

AU 10¹¹ m

ly 10¹ⁱ m

galaxy 10⁵ ly

pc 3 x 10¹⁰ m

d = 4 x 10¹⁶ m

10¹⁰ ly 10²⁶ m

Universe