Computing earth sun distance

\[ AU = \frac{\text{Dev}}{\cos(48 \, \text{deg})} \]

\[ \text{Dev} = c \frac{\text{tev}}{2} \]

\[ \text{tev} = 669 \, \text{sec} \]
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 $a = \frac{360}{2/(2\pi \cdot 4)} = \frac{90}{\pi} = 30^\circ$
A balloon of diameter 20 cm is viewed from a distance of 2 m. About what is its angular diameter?

A. 20 degrees
B. 16 degrees
C. 6 degrees
D. 10 degrees
E. 3 degrees
A balloon of diameter 20 cm is viewed from a distance of 2 m. About what is its solid angle?

A. $\pi/300$ steradians
B. $\pi/100$ steradians
C. $\pi/400$ steradians
D. $\pi/600$ steradians
E. $\pi/50$ steradians
Solid angle $\Omega$

\[ \delta \Omega = \sin \theta \, \delta \theta \, \delta \phi \]
Angular size, distance, & parallax

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

\[ 1 \text{ arcsec} = 1 \text{ arcsec} \times \left( \frac{1^\circ}{3600 \text{ arcsec}} \right) \left( \frac{\pi \text{ rad}}{180^\circ} \right) \]

\[ = \frac{1}{206265} \text{ rad}. \]

So 1 pc \equiv 206265 \text{ AU} (= 3.26 \text{ ly}).
For earth’s orbit with size/radius $s = 1$ au, then $a$ (in arcsec) represents the parallax angle to an star/object at distance $D$ in parsec (pc).
A star with parallax of 0.1 arcsec is at a distance:

A. 0.1 light year
B. 10 pc
C. 10 light year
D. 0.1 pc
E. 10 light year
Angle, distance, parallax

\[ a = \frac{360^\circ \cdot s}{2\pi D} \]
\[ = \frac{s}{d} \text{ (radian)} \]
\[ a_{\text{arcsec}} = \frac{s_{\text{au}}}{d_{\text{pc}}} \]

- \( a \) = angular size
- \( s \) = linear size
- \( d \) = distance
- \( a_{\text{arcsec}} \) = parallax angle in arcsec
- \( s_{\text{au}} \) = separation/size in au
- \( d_{\text{pc}} \) = distance in parsec (pc)
What angle would the earth-sun distance subtend from a distance of 10 pc?

A. 1 radian

B. 0.1 radian

C. 1 arcsec

D. 0.1 arcsec

E. 0.1 degree
• Ex. #1: Alpha Centauri is nearest star
  - parallax angle $a = 0.7$ arcsec
  - distance $d = 1/0.7 = 1.3 \text{ pc}$

• Ex. #2: Star at $d = 10 \text{ pc}$
  - parallax angle $a = 1/10 = 0.1$ arcsec
Example: Galactic Center

Galactic center is at distance $D = 8000$ pc.

For an angle size of $a = 0.1$ arcsec, what is the physical size $s$?

$$\frac{s}{\text{au}} = \frac{a}{\text{arcsec}} \frac{D}{\text{pc}} = 0.1 \times 8000 = 800 \text{ au}$$
The amount of luminosity passing through each sphere is the same.

Area of sphere:

$$4\pi (\text{radius})^2$$

Divide luminosity by area to get Flux, or “apparent brightness”.
The relationship between apparent brightness (a.k.a. “flux”) and luminosity depends on distance:

\[ \text{Flux} = \frac{\text{Luminosity}}{4\pi (\text{distance})^2} \]

\[ F = \frac{L}{4\pi d^2} \]

We can determine a star’s luminosity if we can measure its distance and apparent brightness:

\[ \text{Luminosity} = 4\pi(\text{distance})^2 \times (\text{flux}) \]

\[ L = 4\pi d^2 F \]
How would the apparent brightness of Alpha Centauri change if it were three times farther away?

A. It would be only 1/3 as bright.
B. It would be only 1/6 as bright.
C. It would be only 1/9 as bright.
D. It would be 3 times brighter.
Two stars have a luminosity ratio $L_2/L_1 = 100$. At what distance ratio $d_2/d_1$ would they have the same apparent brightness?

A. $1/100$

B. $1/10$

C. 1

D. 10

E. 100
Challenge problem

a. In terms of the moon’s distance $d_{em}$ and diameter $D_m$, derive the fraction of the sky covered by the full moon, i.e. compute $\Omega_m/4\pi$, where $\Omega_m$ is the moon’s solid angle.

b. Next, if the moon were to reflect all light hitting it (albedo=1), derive an expression for the apparent brightness ratio of full moon to sun, $F_m/F_{sun}$.

c. Compare answers to a and b, and explain.
Assignments for Tues. 16 Feb

• Read secs. 3, 4, 5 of DocOnotes-stars1
  – practice Quick Questions at end of sections

• Start HW1 - due Thurs. 18Feb