

The Cosmic Distance Ladder

(Incomplete)

Distance Method

Used For

Good To

*Thermonuclear
Supernovae*

Nearby and
Distant Galaxies

10 Gpc

(Tully Fisher)

Spiral Galaxies

<100 Mpc

(Surface Brightness
Fluctuations)

Elliptical Galaxies
Spiral Bluges

10¹ Mpc

Cepheid Variables

Close Spiral
Galaxies

10-20 Mpc

RR Lyrae Variables

Globbies,
Very Near Galaxies

100 kpc,
few Mpc

Main-Sequence
Fitting

Clusters in
the Milky Way

10¹ kpc

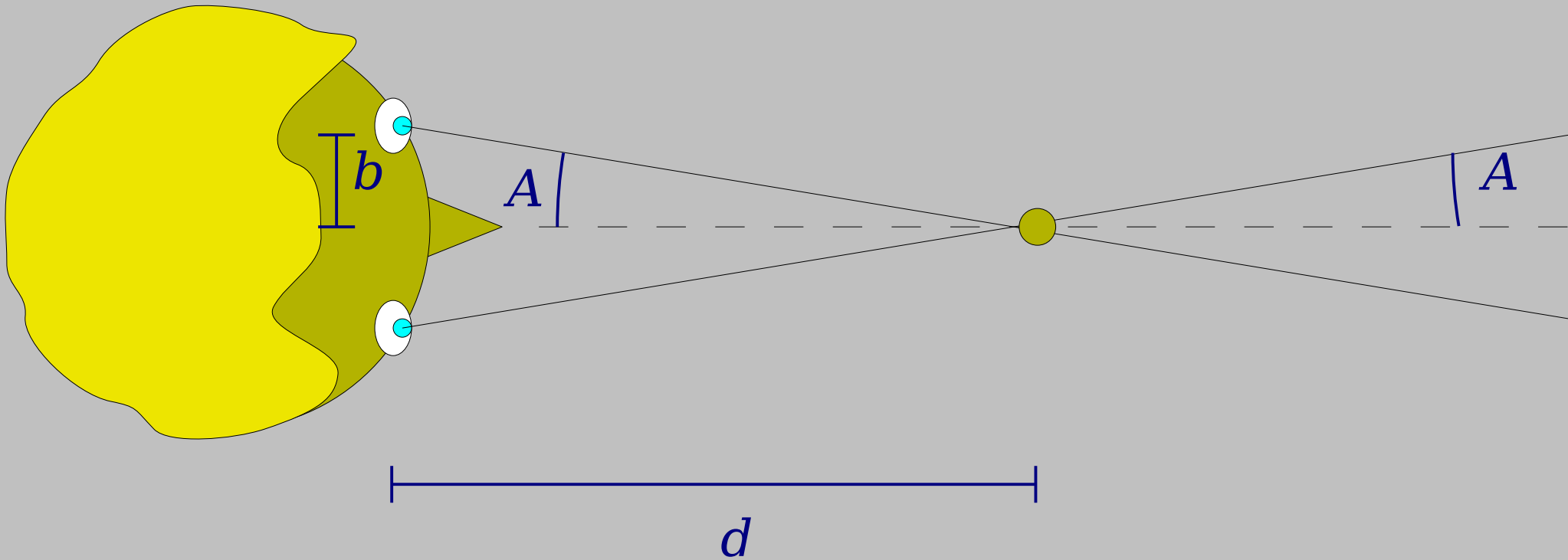
Parallax

Close Stars in the
Milky Way

10⁰ kpc



b = baseline
 A = angle
 d = distance



Small-Angle Formula:

$$A = \frac{b}{d} \quad (\text{if } A \ll 1)$$

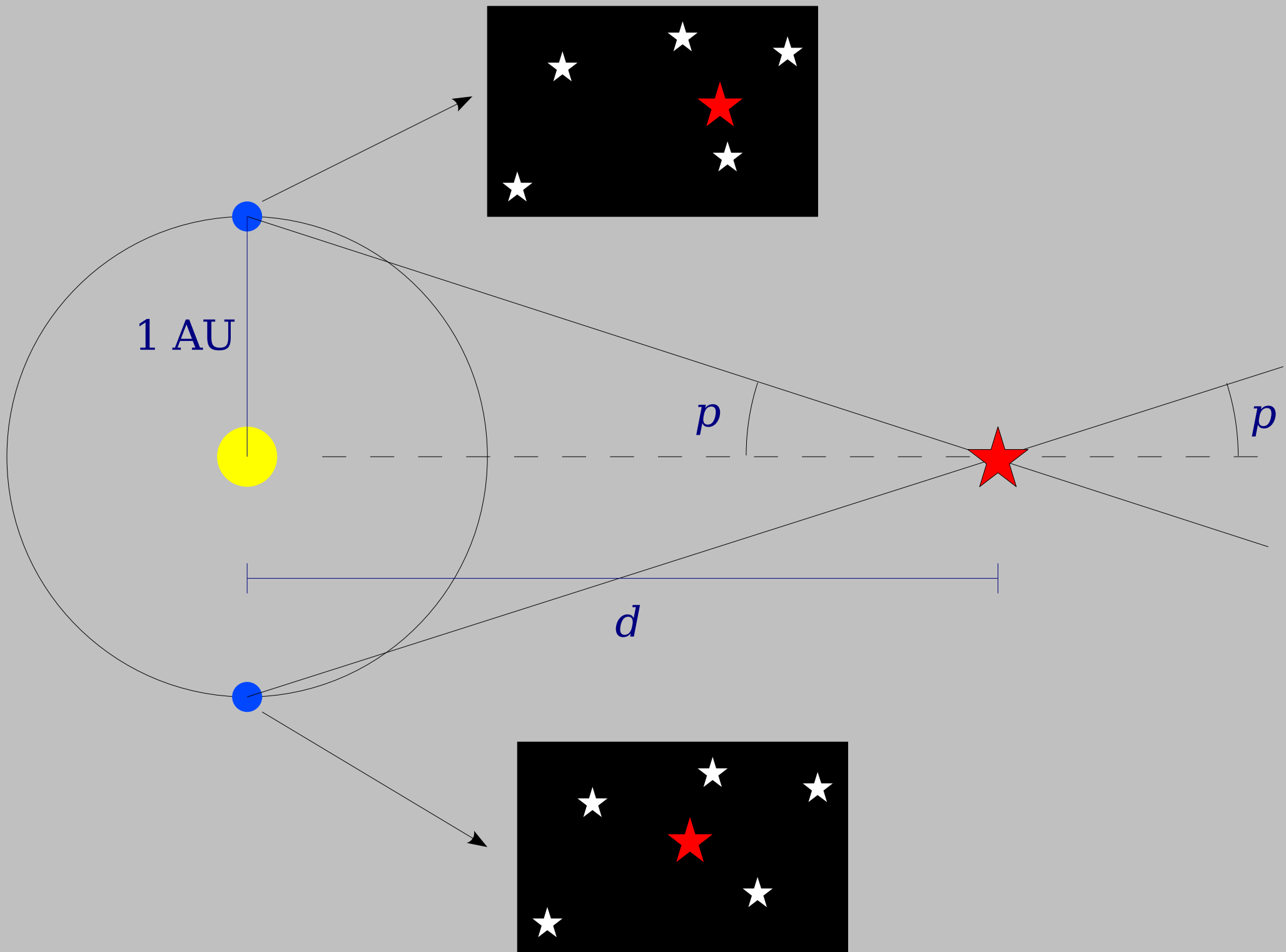
A is in radians (π radians = 180°)

b and d are in the same units

For those of you who know trig....

$$\sin A \simeq \tan A \simeq A \quad \text{for } A \ll 1, A \text{ in radians}$$

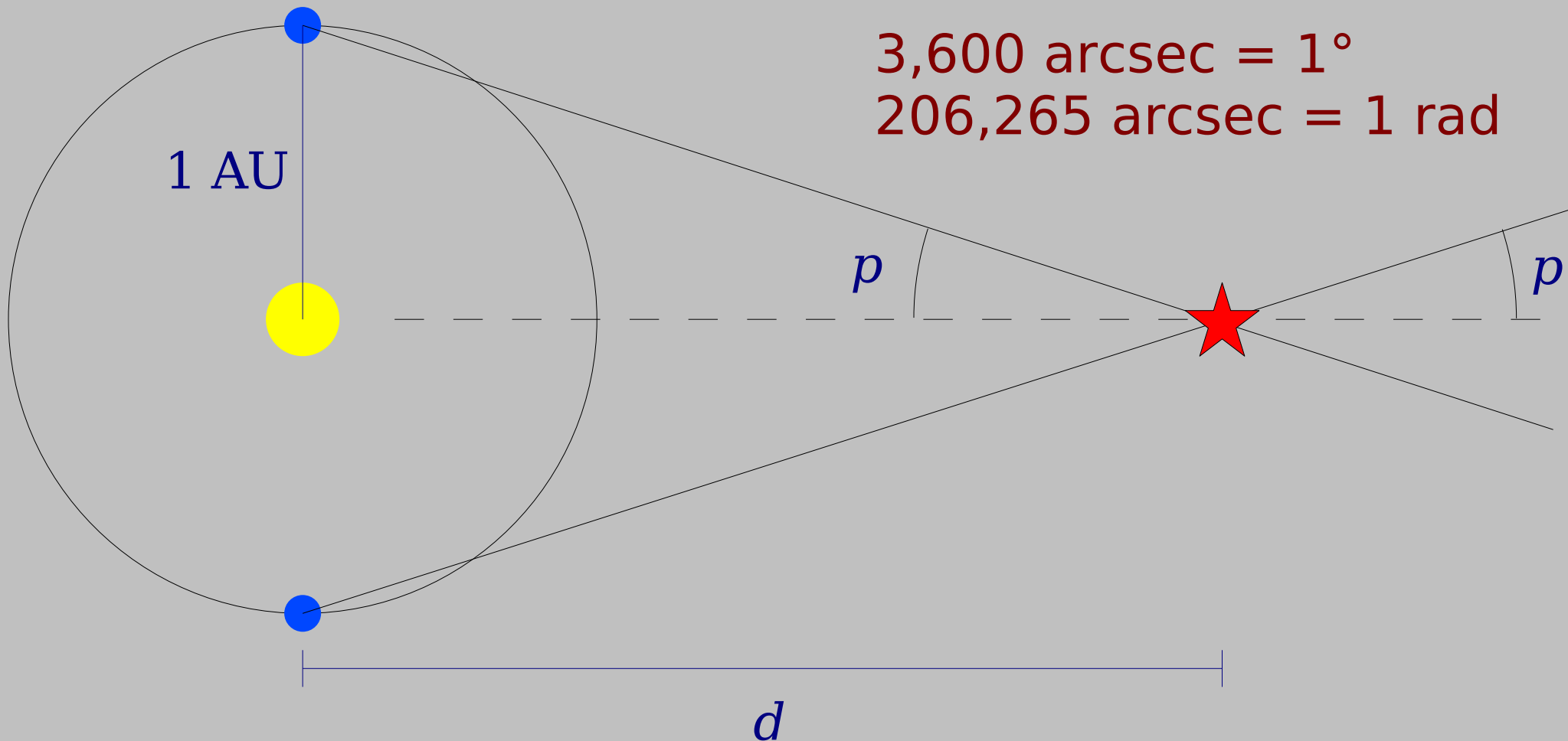
...the rest of you, don't worry about it;
take the small angle formula as given.



Parallax formula: $d = \frac{1}{p}$

d = distance to star in parsecs

p = parallax angle in arcseconds



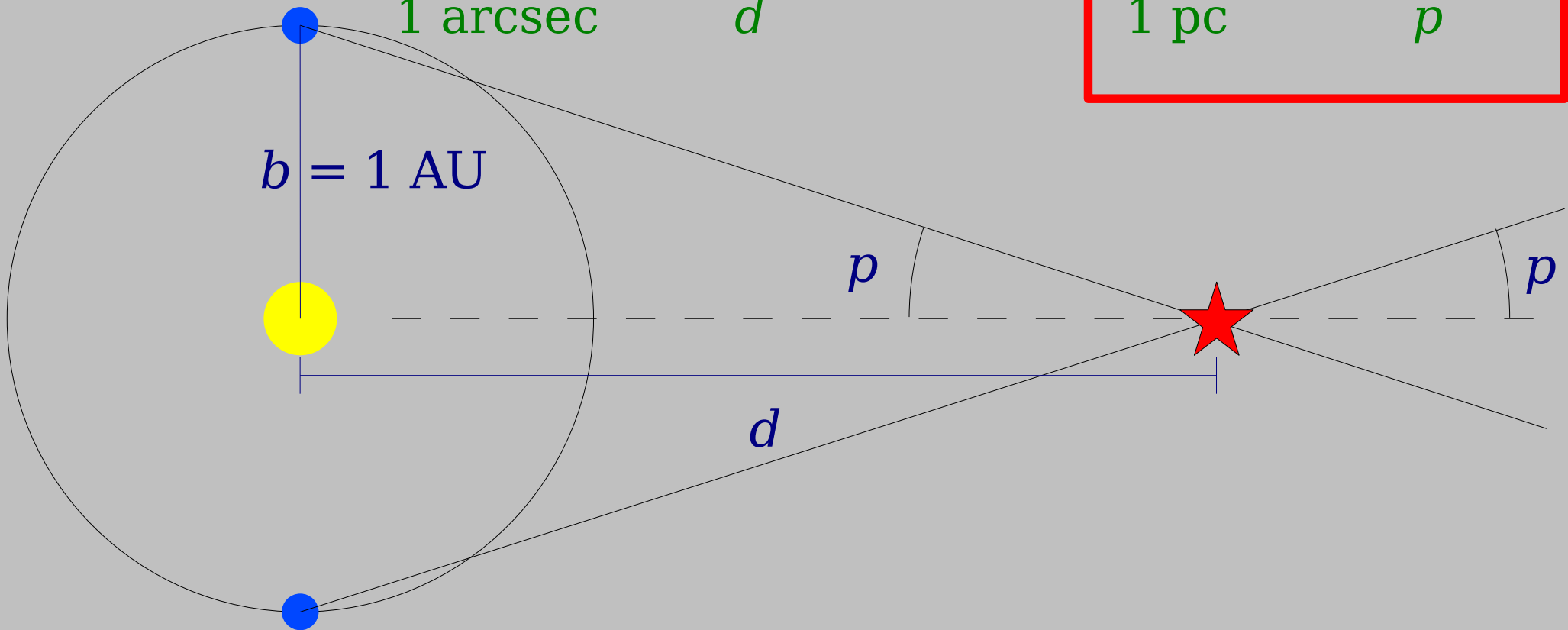
From the small angle formula to the parallax formula....

$$\frac{p}{1 \text{ rad}} = \frac{b}{d} = \frac{1 \text{ AU}}{d}$$

$$\left(\frac{1 \text{ rad}}{206265 \text{ arcsec}} \right) \left(\frac{p}{1 \text{ rad}} \right) = \left(\frac{1 \text{ AU}}{d} \right) \left(\frac{1 \text{ pc}}{206265 \text{ AU}} \right)$$

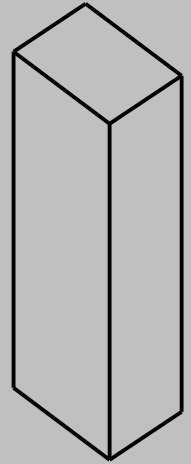
$$\frac{p}{1 \text{ arcsec}} = \frac{1 \text{ pc}}{d}$$

$$\frac{d}{1 \text{ pc}} = \frac{1 \text{ arcsec}}{p}$$





Building 1



Building 2

You are looking at two buildings; Building 2 is farther from you than Building 1. You measure the distance to them by measuring a parallax angle standing in two different positions as shown.

- A Building 1 has greater parallax than Building 2
- B Building 2 has greater parallax than Building 1
- C Buildings 1 and 2 have the same parallax.
- D You must wait 6 months before measuring the buildings' parallax

Vega has a parallax of $0.129''$. How far away is it?

A 0.78 pc

B 7.8 pc

C 78 pc

D 780 pc

E 7.8 kpc

Alpha Centauri has a parallax of $0.75''$.
How far away is it?

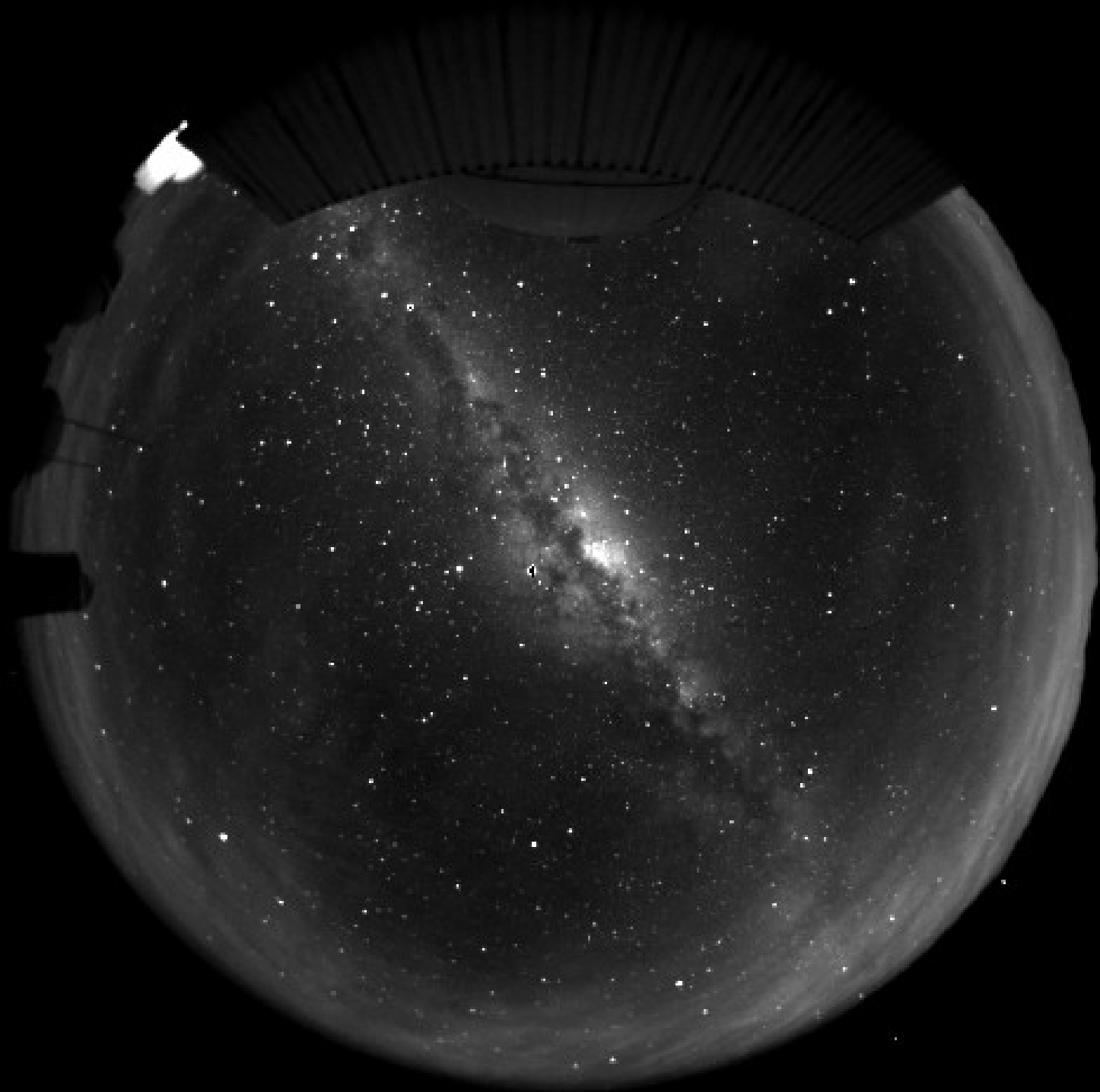
A 0.13 pc

B 0.45 pc

C 1.3 pc

D 13 pc

E 45 pc



In the late 1990's, the European Space Agency satellite *Hipparcos* measured the parallax of stars with a precision of 0.002". The farthest star whose distance was measured by this satellite is:

- A Within 30 light-years of the Sun (i.e. in the Solar Neighborhood)
- B In the same general region of the Milky Way as the Sun
- C On the far side of the Milky Way
- D In the Large Magellanic Cloud
- E In the Andromeda Galaxy.

$$d = 1/p = 1/0.002'' = 500\text{pc} = 0.5 \text{ kpc} :$$

well within the Milky Way