Physics 431
Galactic Astrophysics

Prof. Steve McMillan

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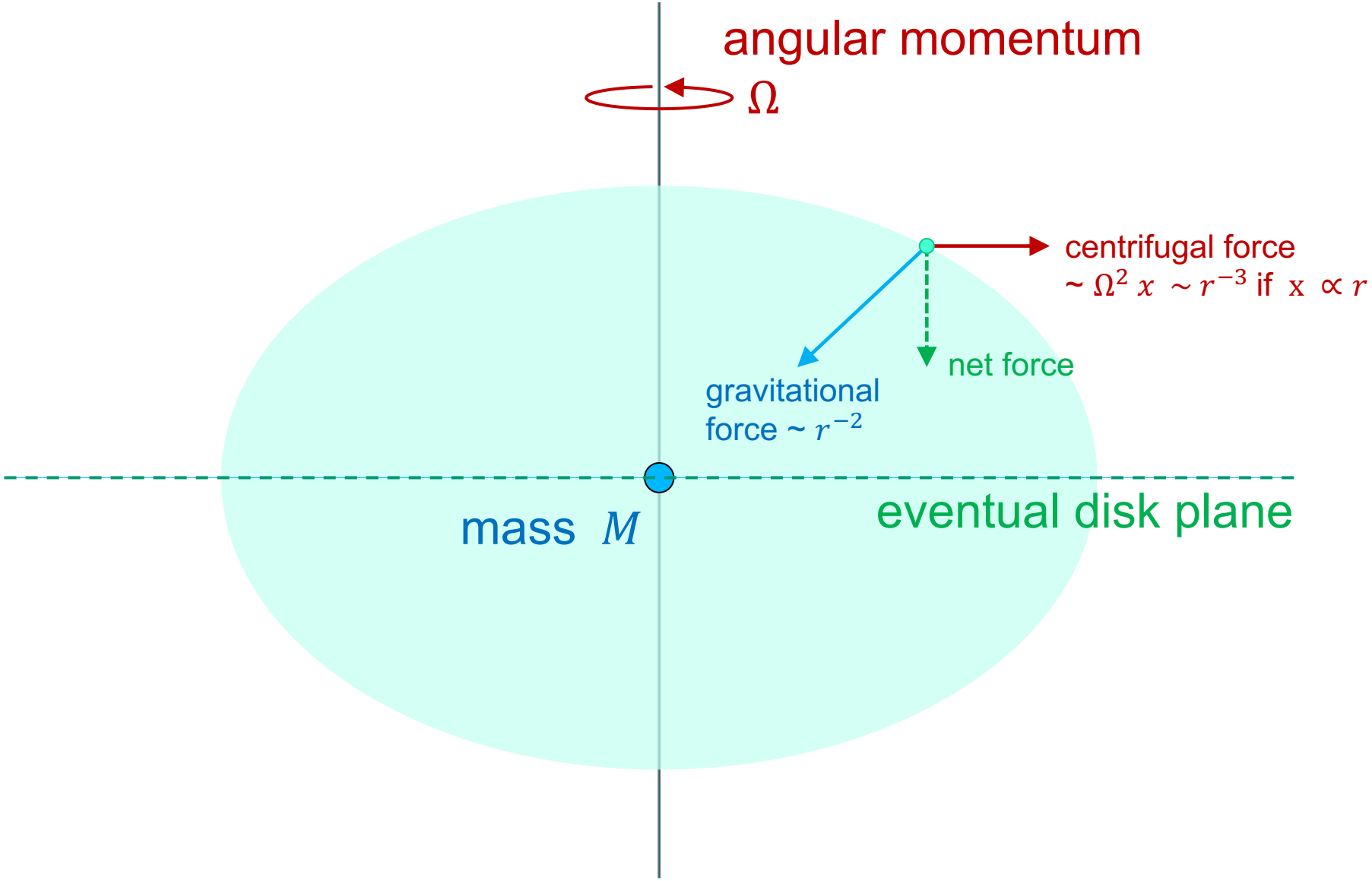
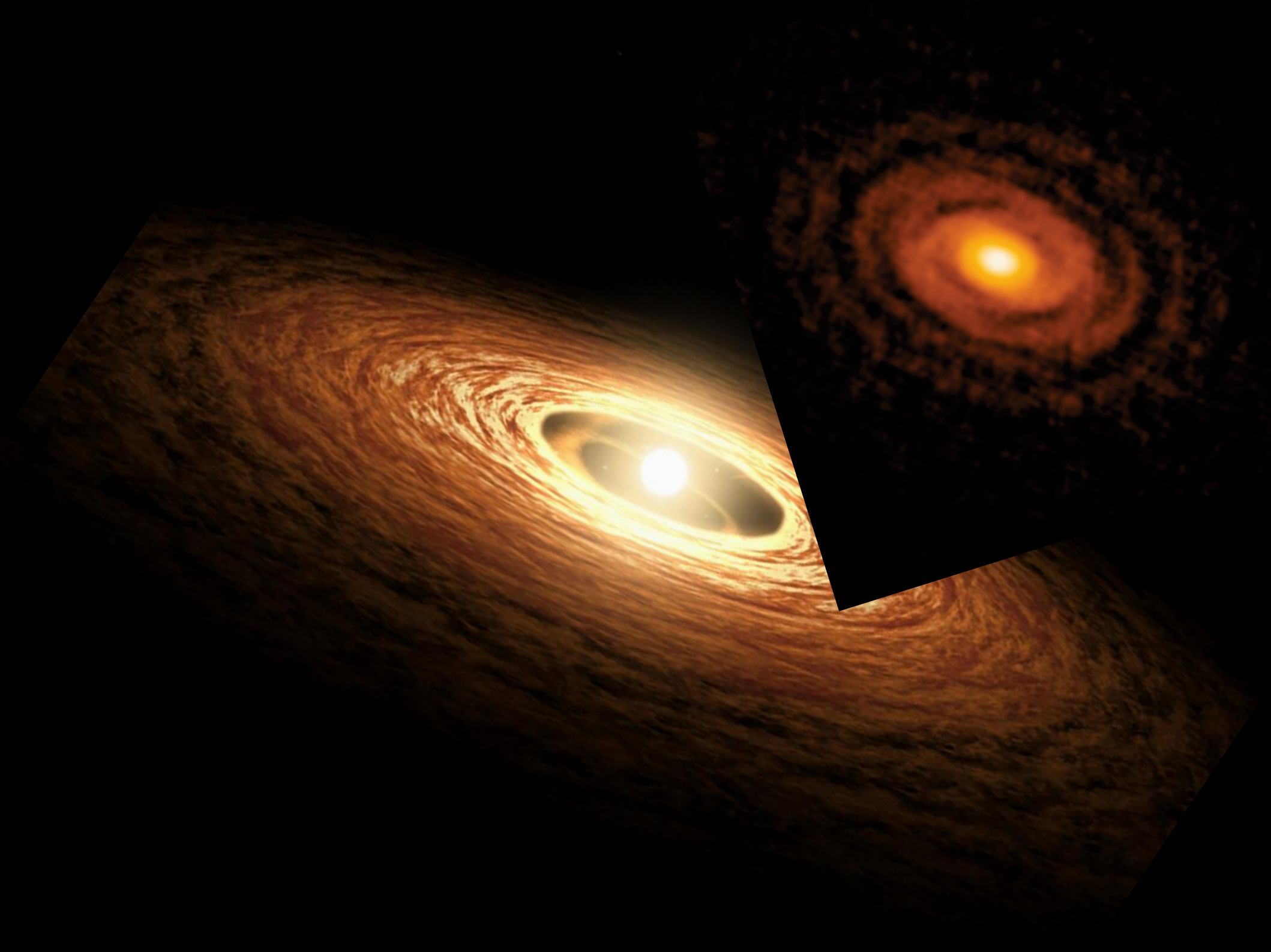
$\Omega \sim r^{-2}$ (conservation of angular momentum)





Distance Measurement

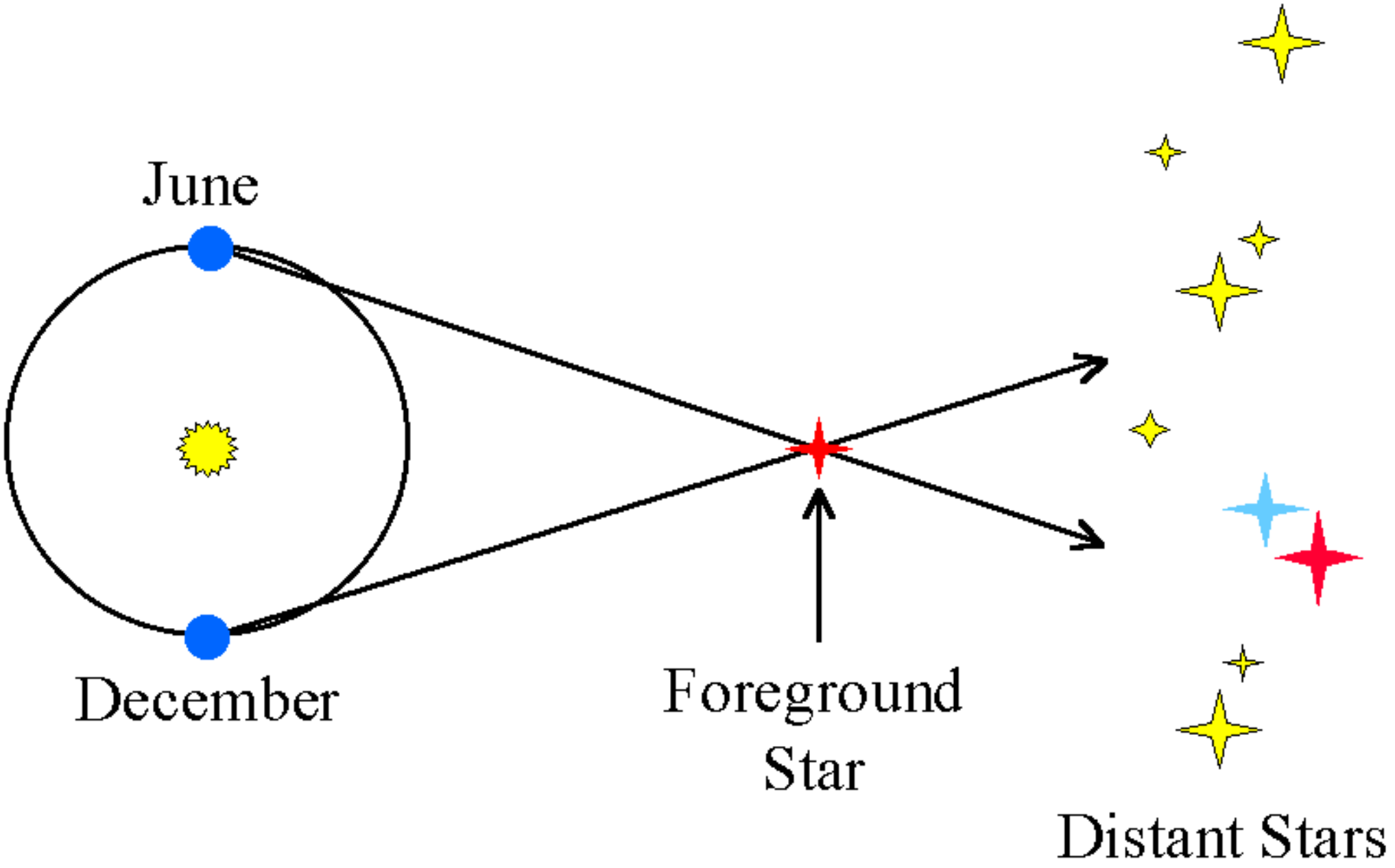
- Light echo

$$D = c\,\Delta t$$

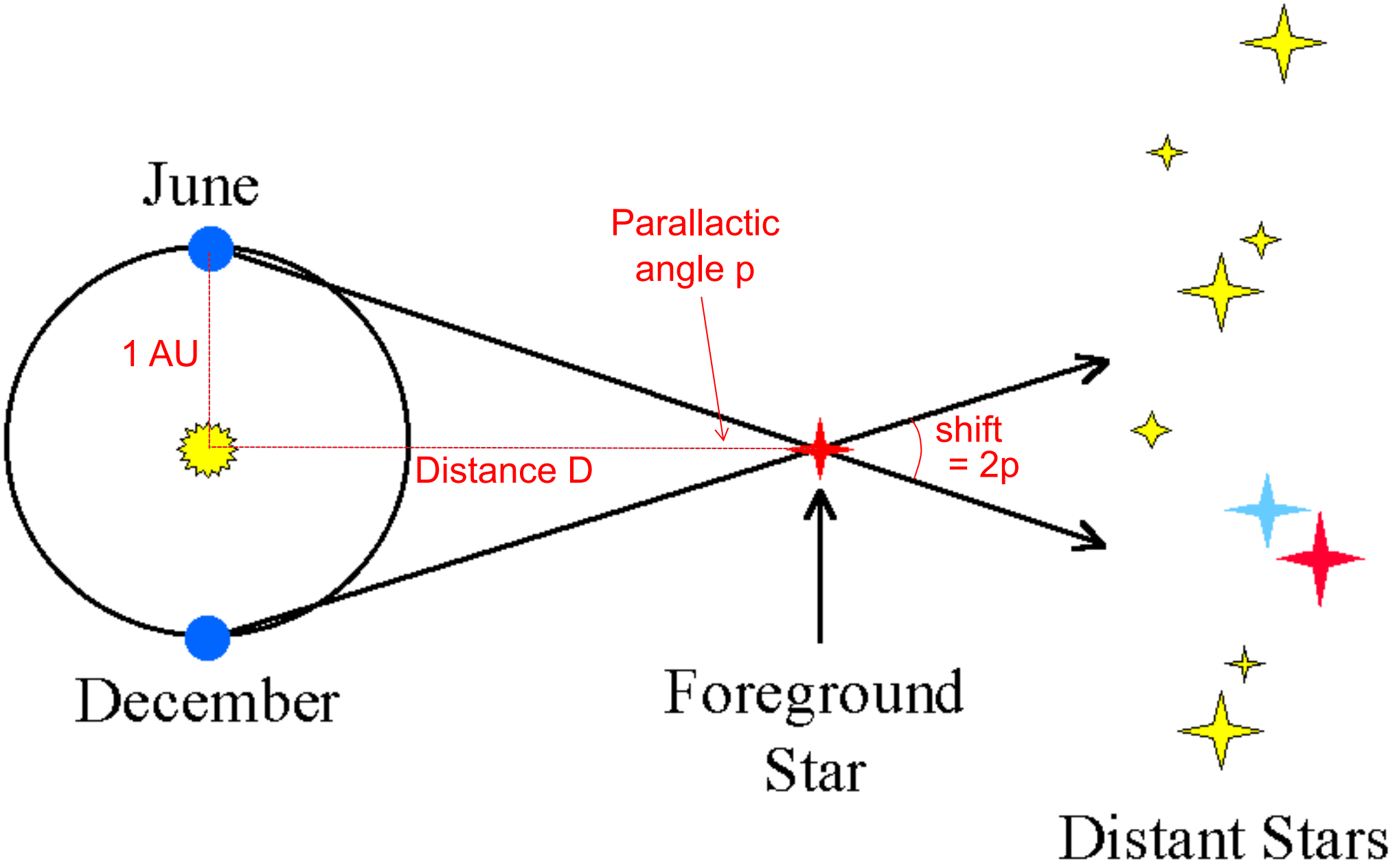
- Standard ruler

$$D = L / \theta$$

Parallax



Parallax

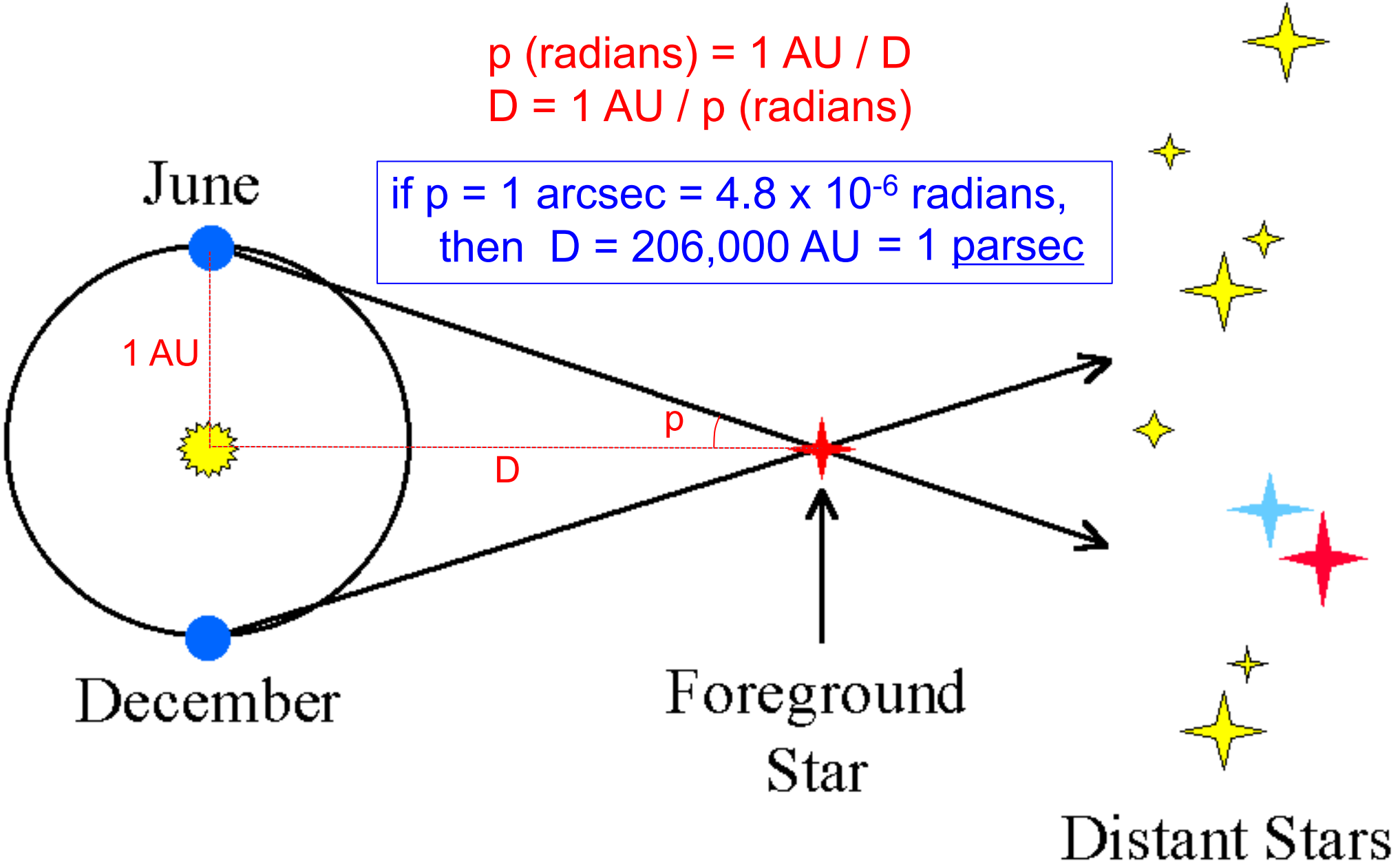

June
Parallactic
angle p
1 AU
shift
= 2p
Distance D
December
Foreground
Star
Distant Stars

Parallax

p (radians) = 1 AU / D

D = 1 AU / p (radians)

if p = 1 arcsec = 4.8 x 10^{-6} radians,
then D = 206,000 AU = 1 parsec

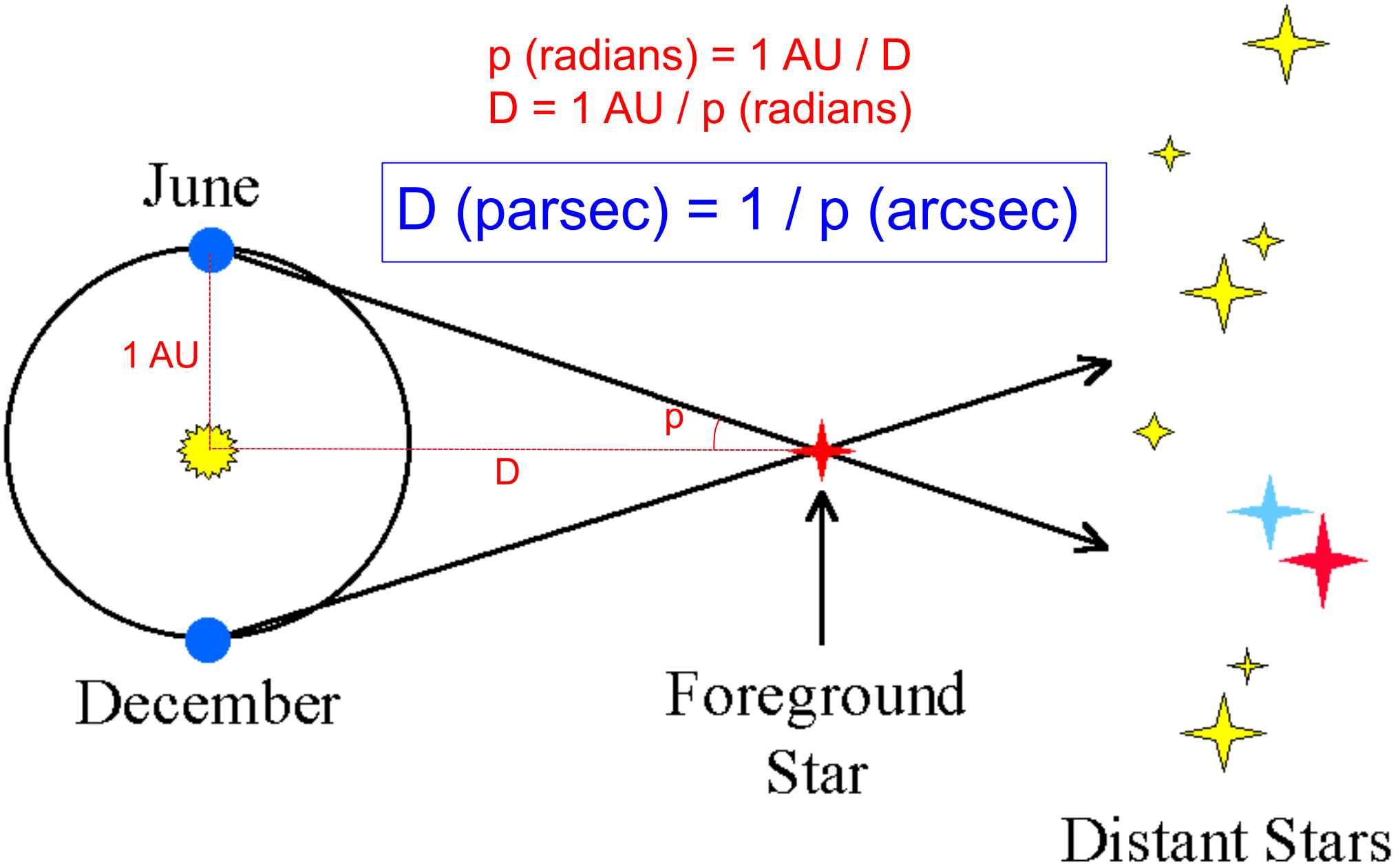


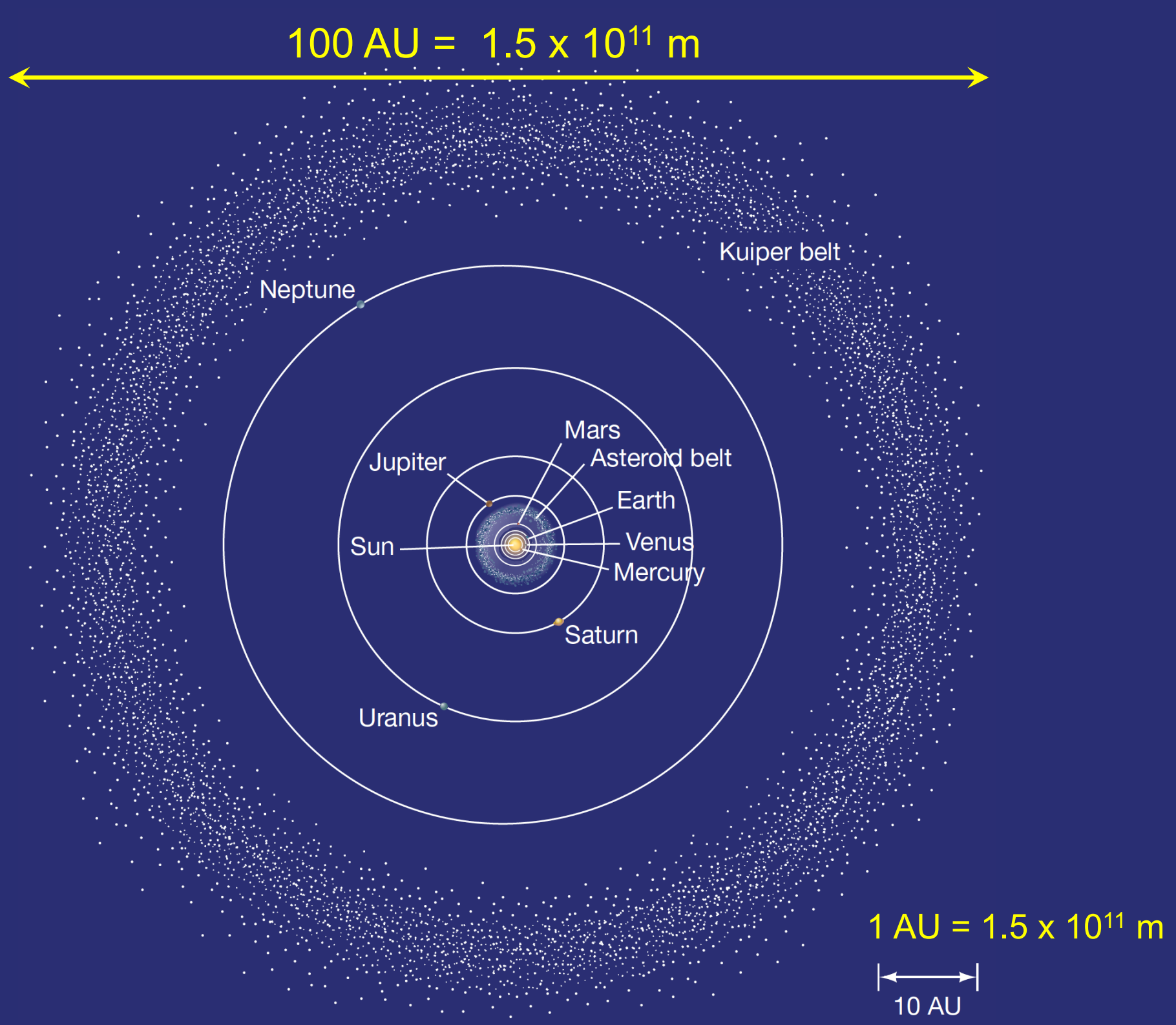
Parallax

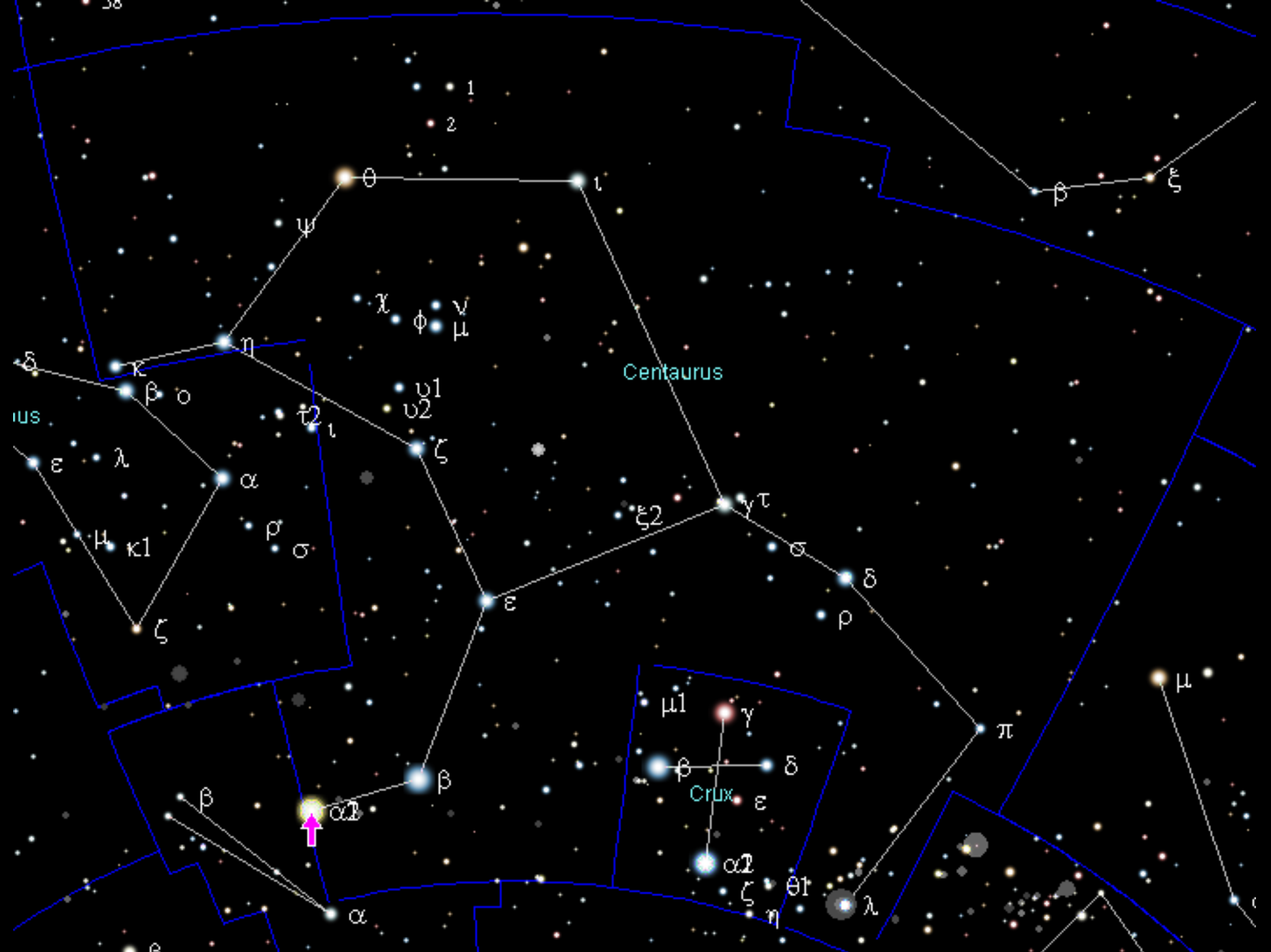
p (radians) = 1 AU / D

D = 1 AU / p (radians)

D (parsec) = 1 / p (arcsec)




100 AU = 1.5 x 10^11 m
Kuiper belt
Neptune
Mars
Asteroid belt
Jupiter
Earth
Sun
Venus
Mercury
Saturn
Uranus
1 AU = 1.5 x 10^11 m
10 AU


1
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υ1
υ2
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κ1
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ζ
Centaurus
ξ2
γ
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σ
δ
ρ
ε
β
α2
α1
β
α
μ1
γ
β
δ
Crux
ε
α2
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θ1
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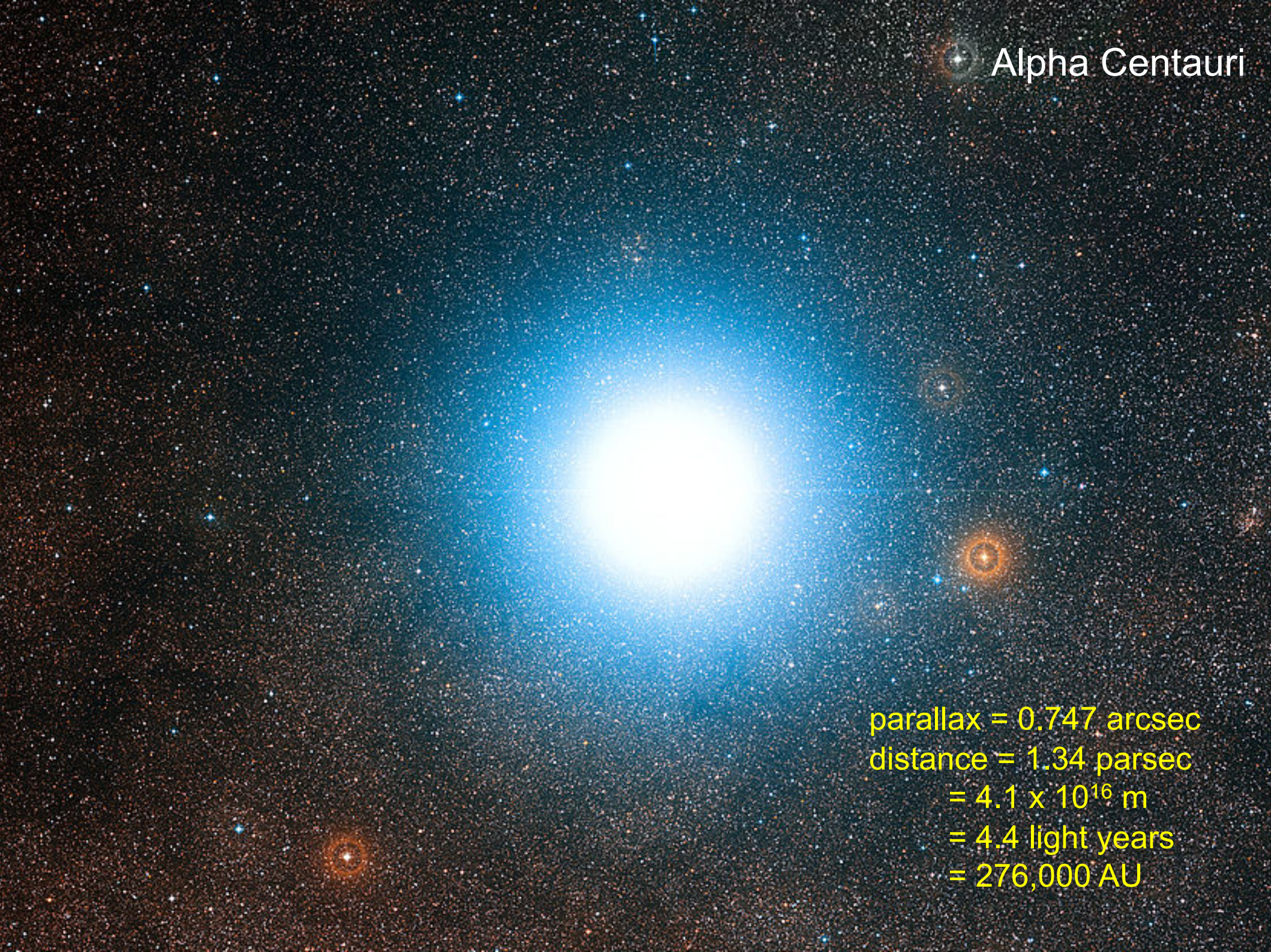

Alpha Centauri
parallax = 0.747 arcsec
distance = 1.34 parsec
= 4.1 x 10^16 m
= 4.4 light years
= 276,000 AU

Alpha
Centauri
A+B
Beta
Centauri
Proxima
Centauri
= Alpha
Centauri C

Distance Measurement

- Light echo

$$D = c\,\Delta t$$

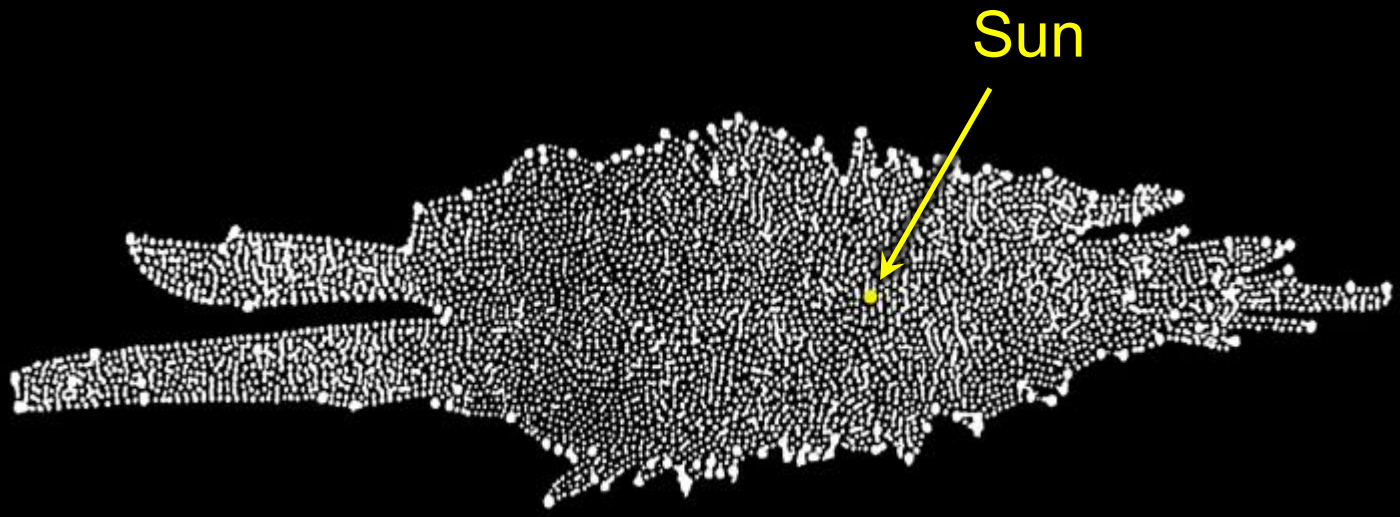
- Standard ruler

$$D = L / \theta$$

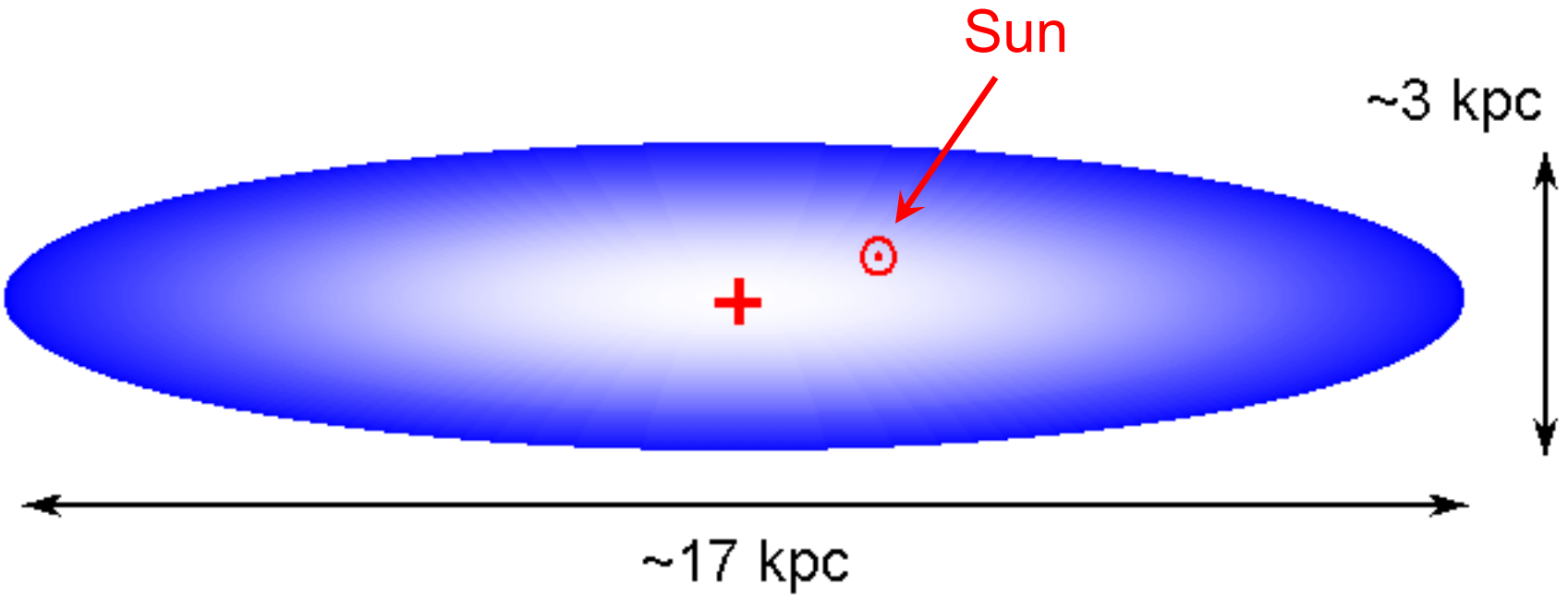
- Standard candle

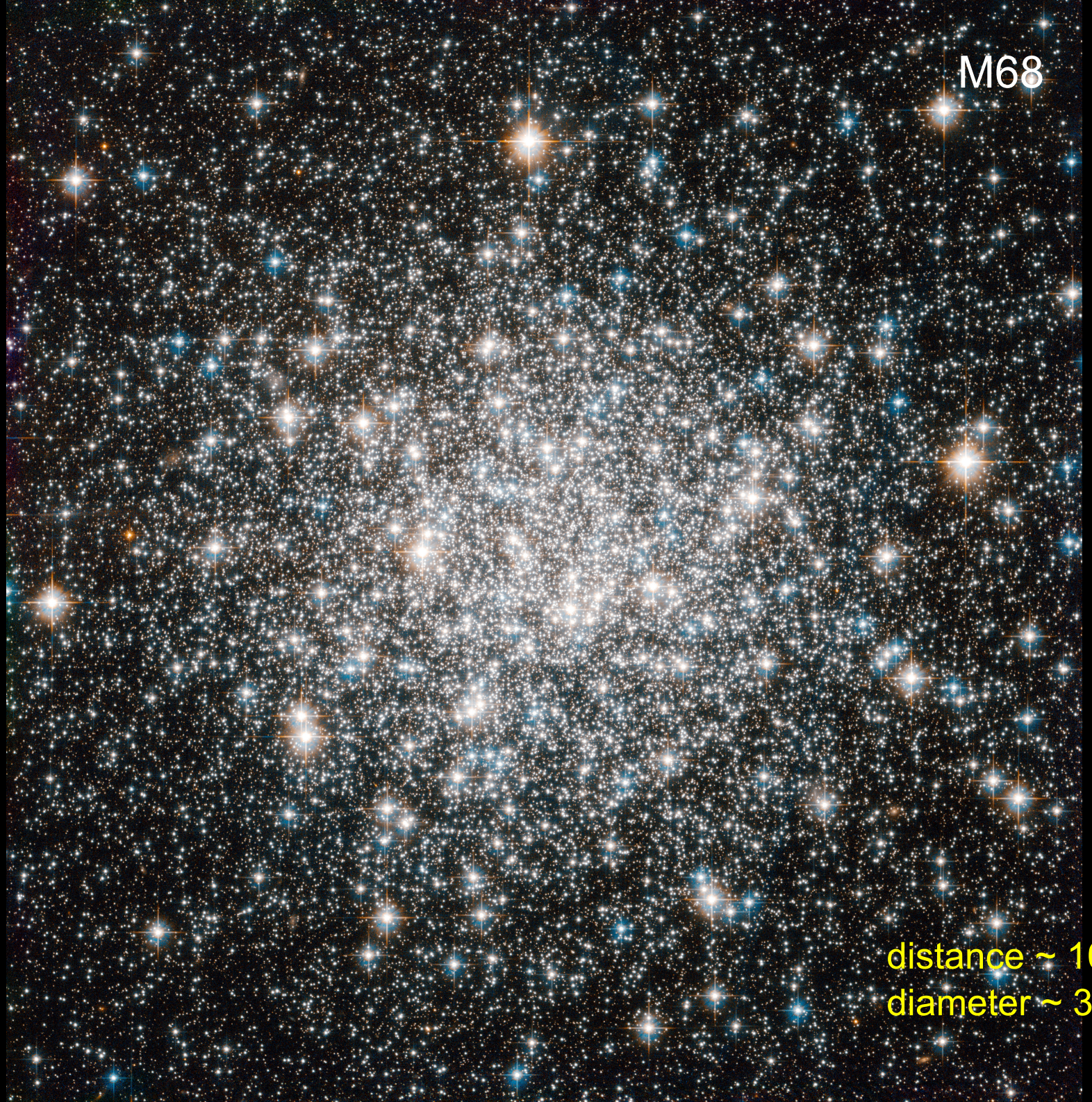
$$D = \sqrt{\frac{L}{4\pi f}}$$

Herschel model (1785)

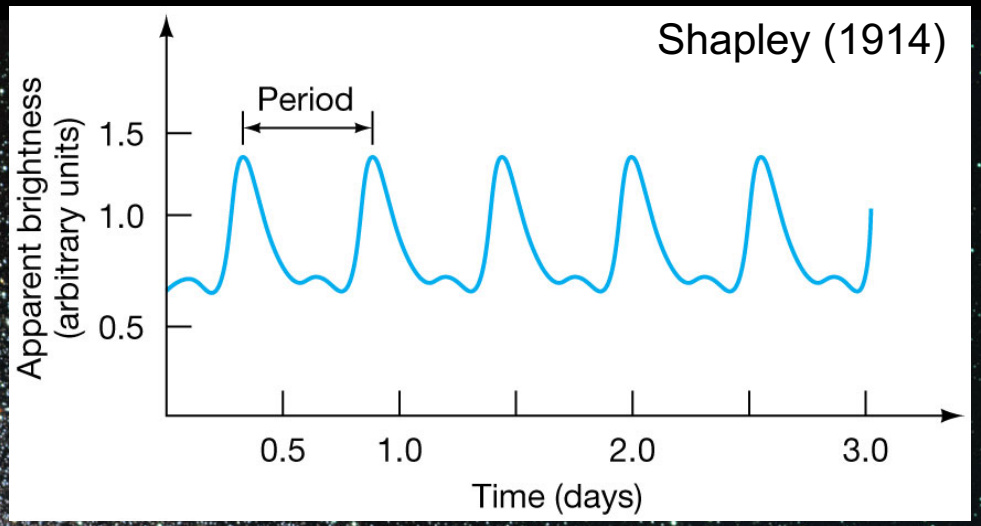


Kapteyn Model (1922)

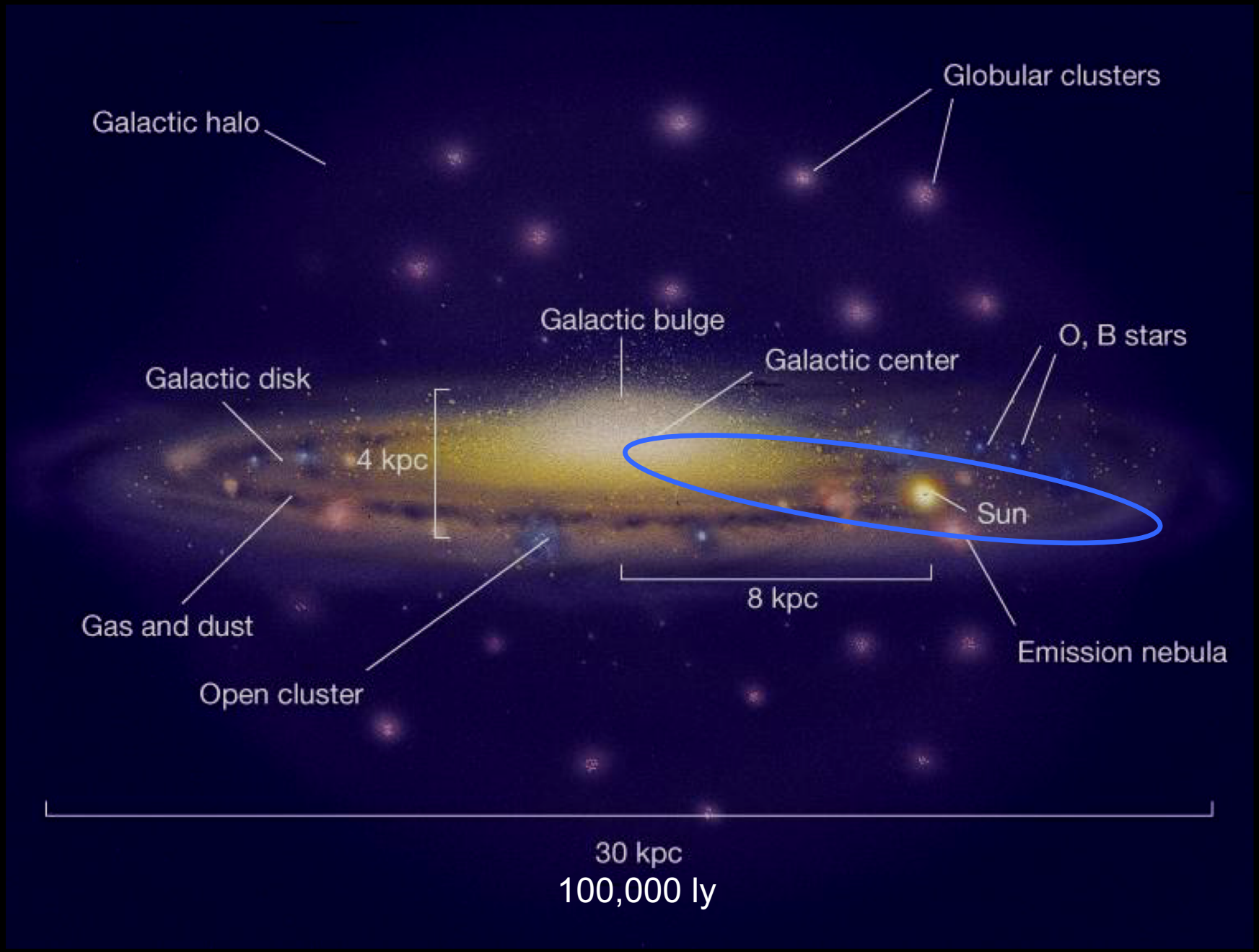


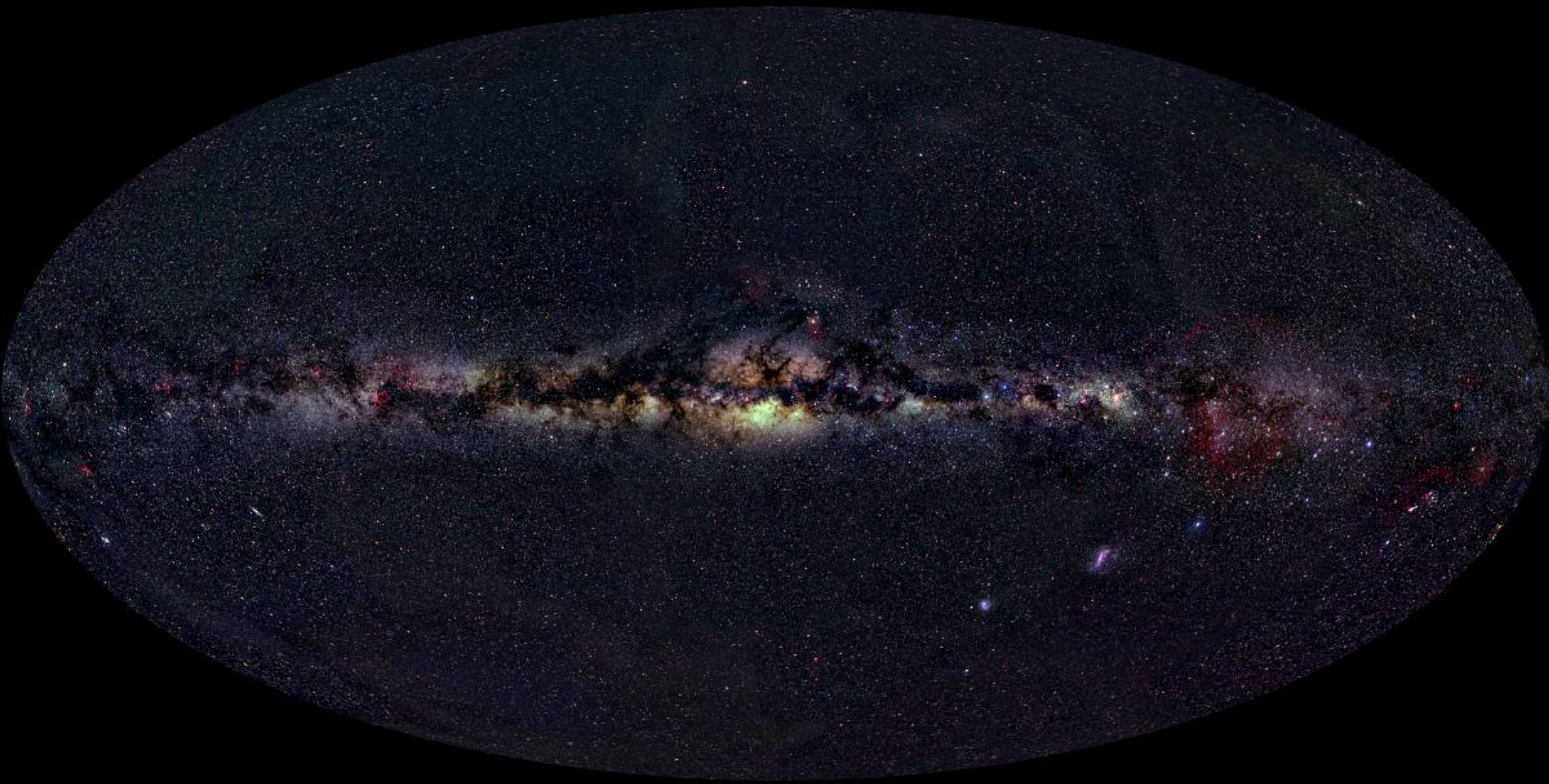

M68
distance ~ 10 kpc
diameter ~ 30 pc

47 Tucanae



distance ~ 4 kpc
diameter ~ 40 pc


Globular clusters
Galactic halo
Galactic bulge
O, B stars
Galactic center
Galactic disk
4 kpc
Sun
8 kpc
Gas and dust
Emission nebula
Open cluster
30 kpc
100,000 ly



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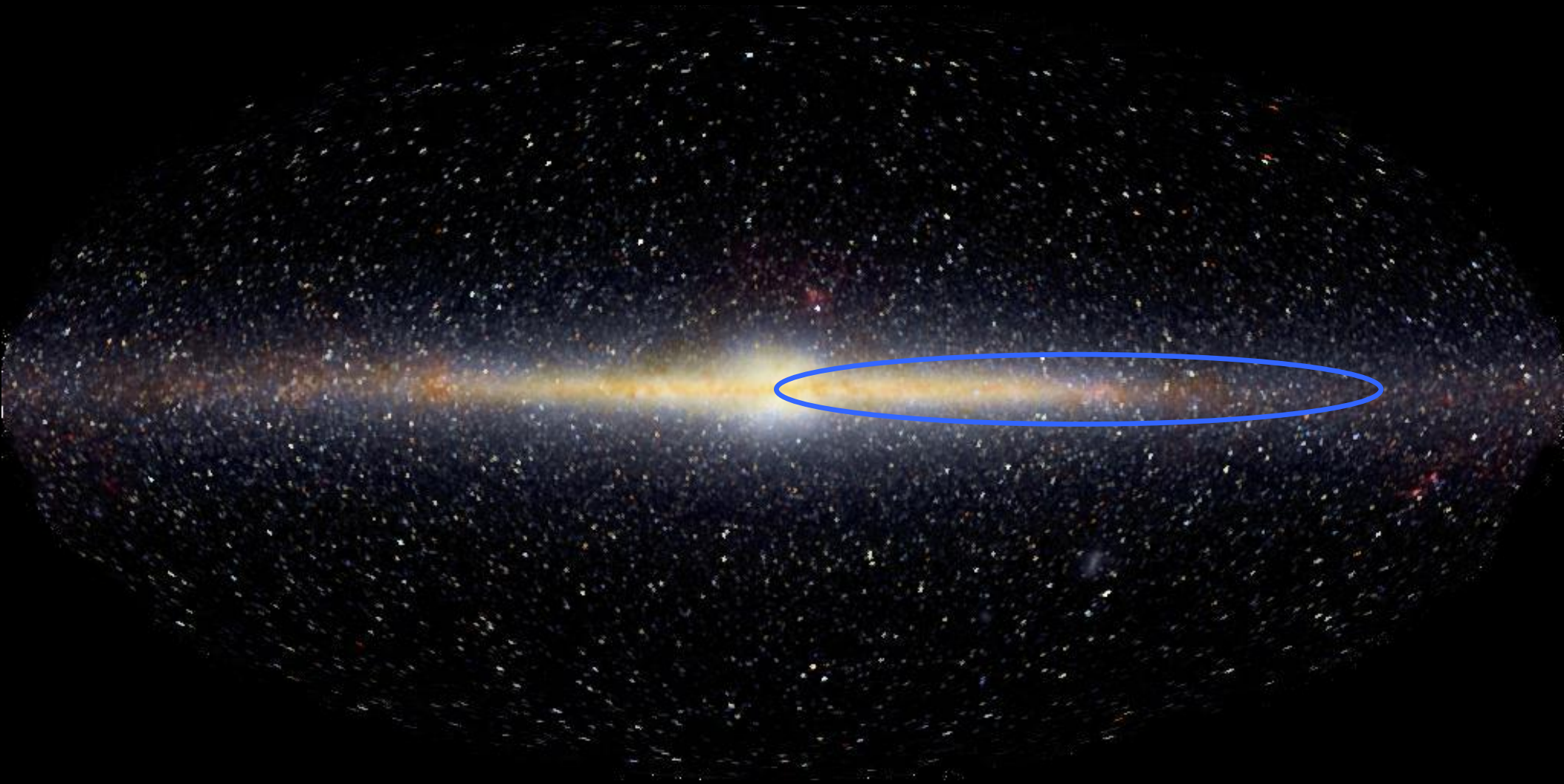

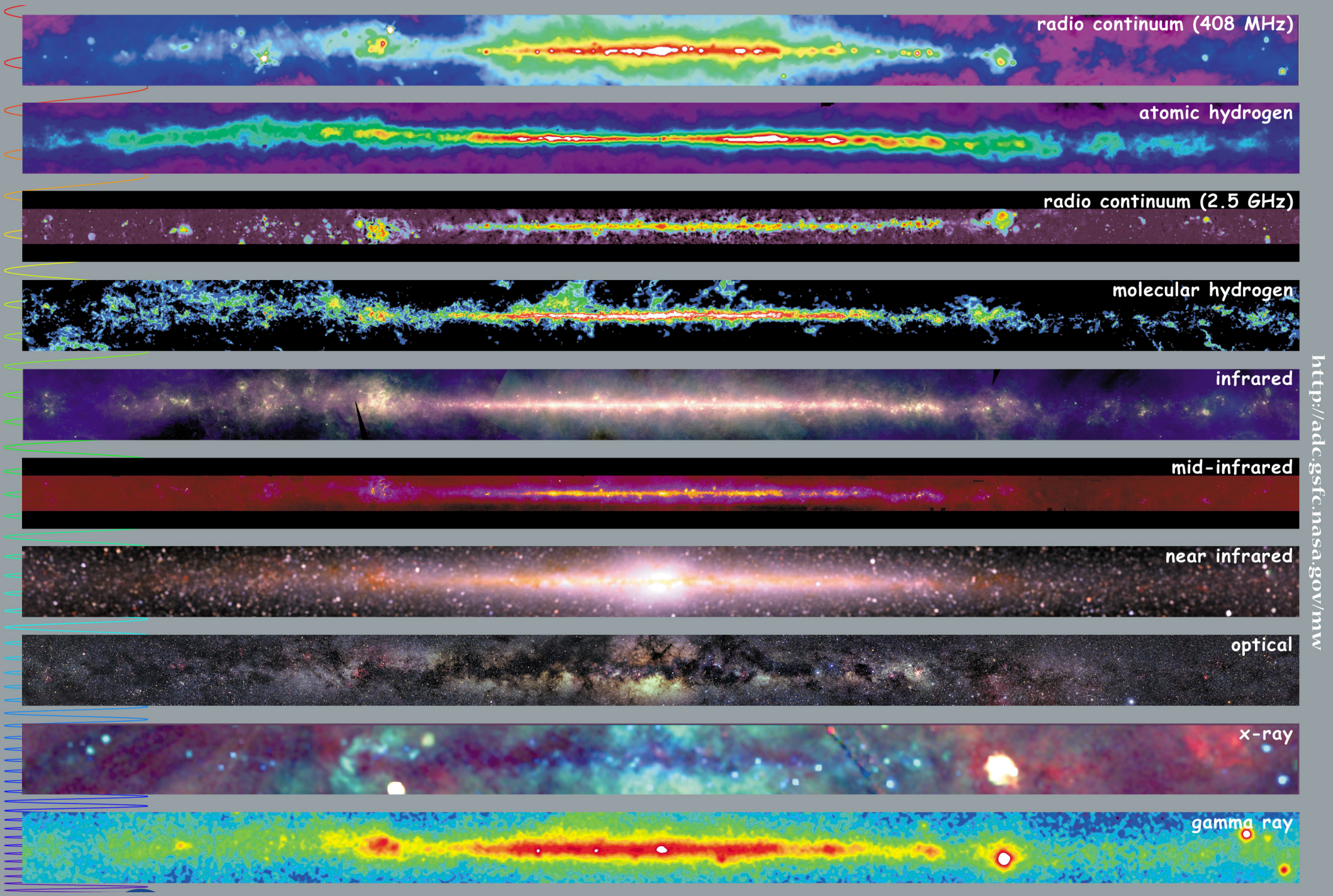
radio continuum (408 MHz)
atomic hydrogen
radio continuum (2.5 GHz)
molecular hydrogen
infrared
mid-infrared
near infrared
optical
x-ray
gamma ray
http://adc.gsfc.nasa.gov/mw

Distance Measurement

- Light echo

$$D = c\,\Delta t$$

- Standard ruler

$$D = L / \theta$$

- Standard candle

$$D = \sqrt{\frac{L}{4\pi f}}$$

- Hubble expansion

$$D = \Delta v / H_0$$