Week 8
Measuring stars 1

Monday, Nov. 7

Today’s learning objectives (Monday Nov. 7)

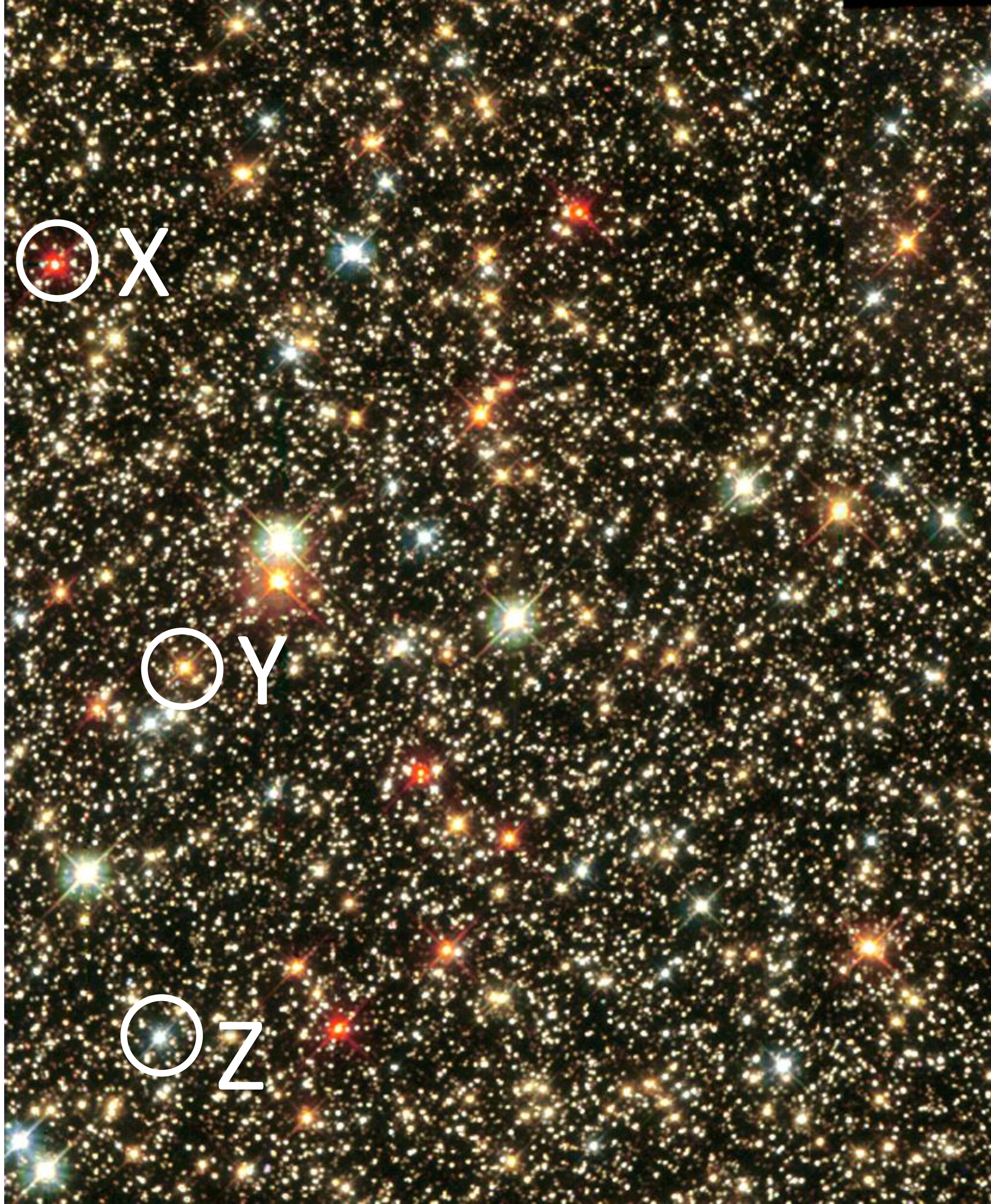
- Describe how star magnitude, flux, luminosity are related and why each is used
- Explain what factors (variables) influence magnitude, flux and luminosity
- Describe the features of the H-R diagram
- Explain how the H-R diagram is used to categorize stars

Tomorrow:

- Activity 17: Spectral Classification of Stars

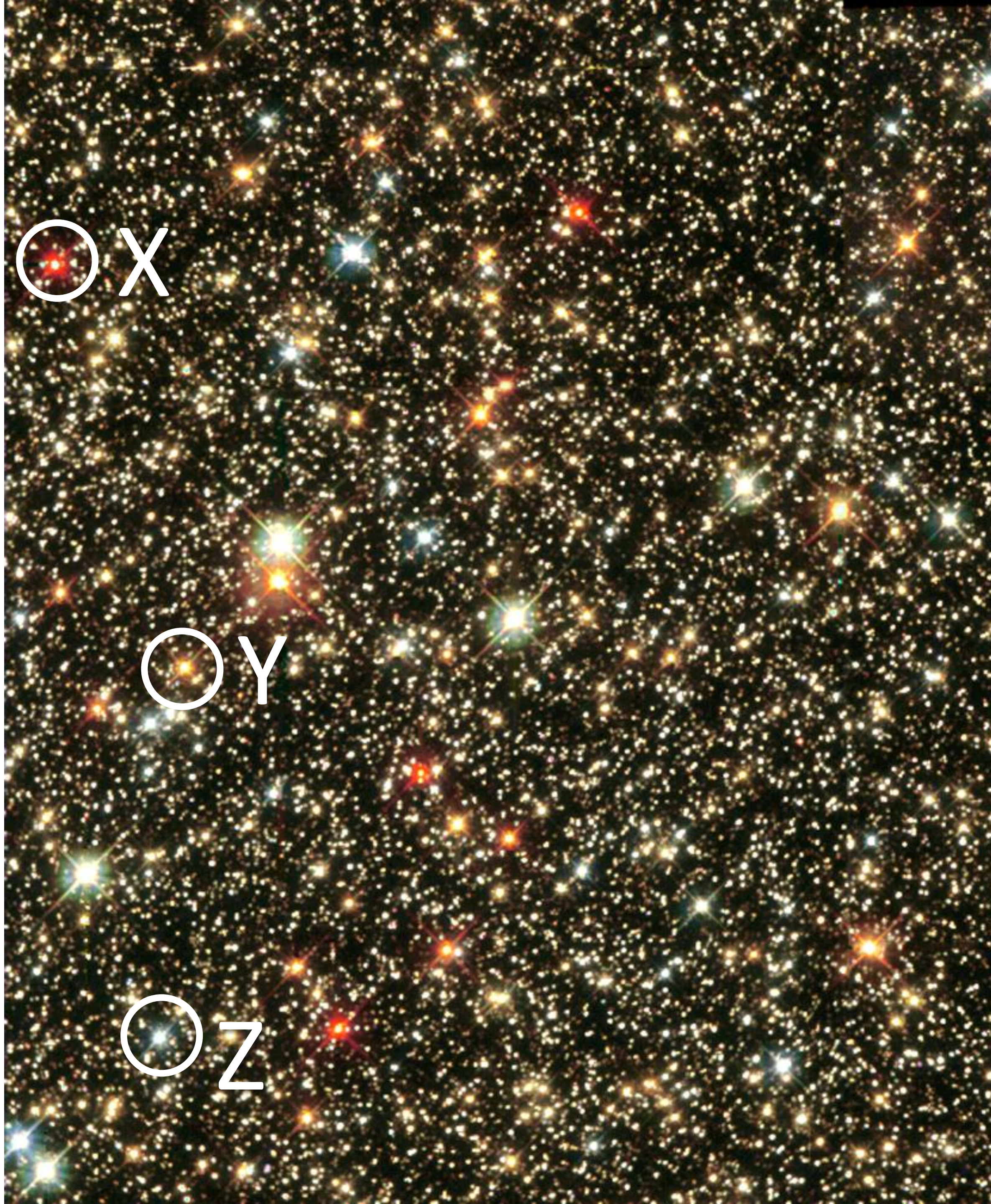
Place stars in order of temperature, coolest to hottest

A. X, Y, Z
B. X, Z, Y
C. Z, Y, X
D. Y, Z, X



Place stars in order of temperature, coolest to hottest

A. **X, Y, Z**
B. X, Z, Y
C. Z, Y, X
D. Y, Z, X



What is a star’s magnitude?

A. Its size
B. Its brightness
C. Its distance
D. Its magnetic field

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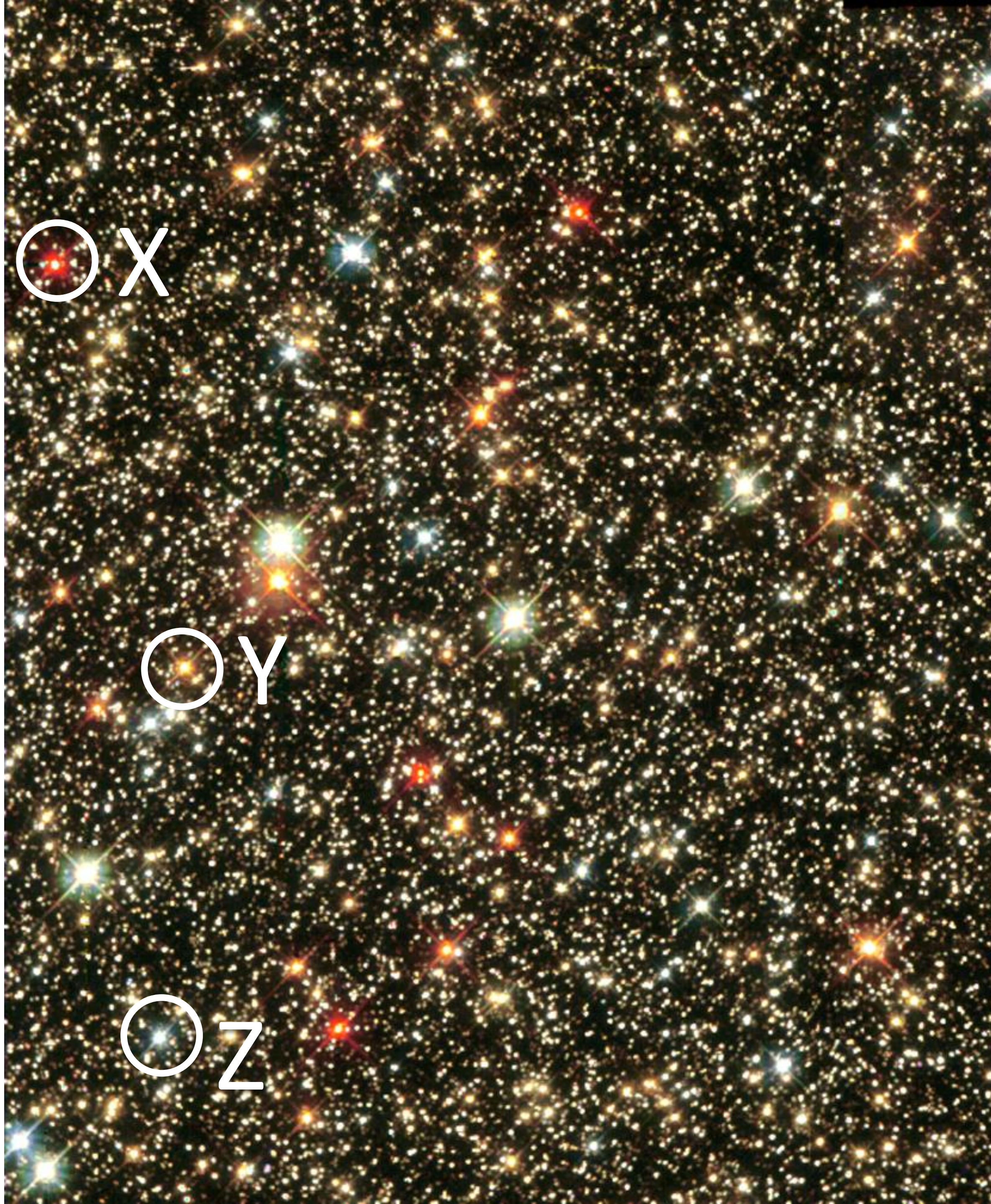
Magnitude provides a way to compare the brightness of different stars

Which star is brightest?

A. X
B. Y
C. Z
D. Depends, dude.



Which star is brightest?

A. X
B. Y
C. Z
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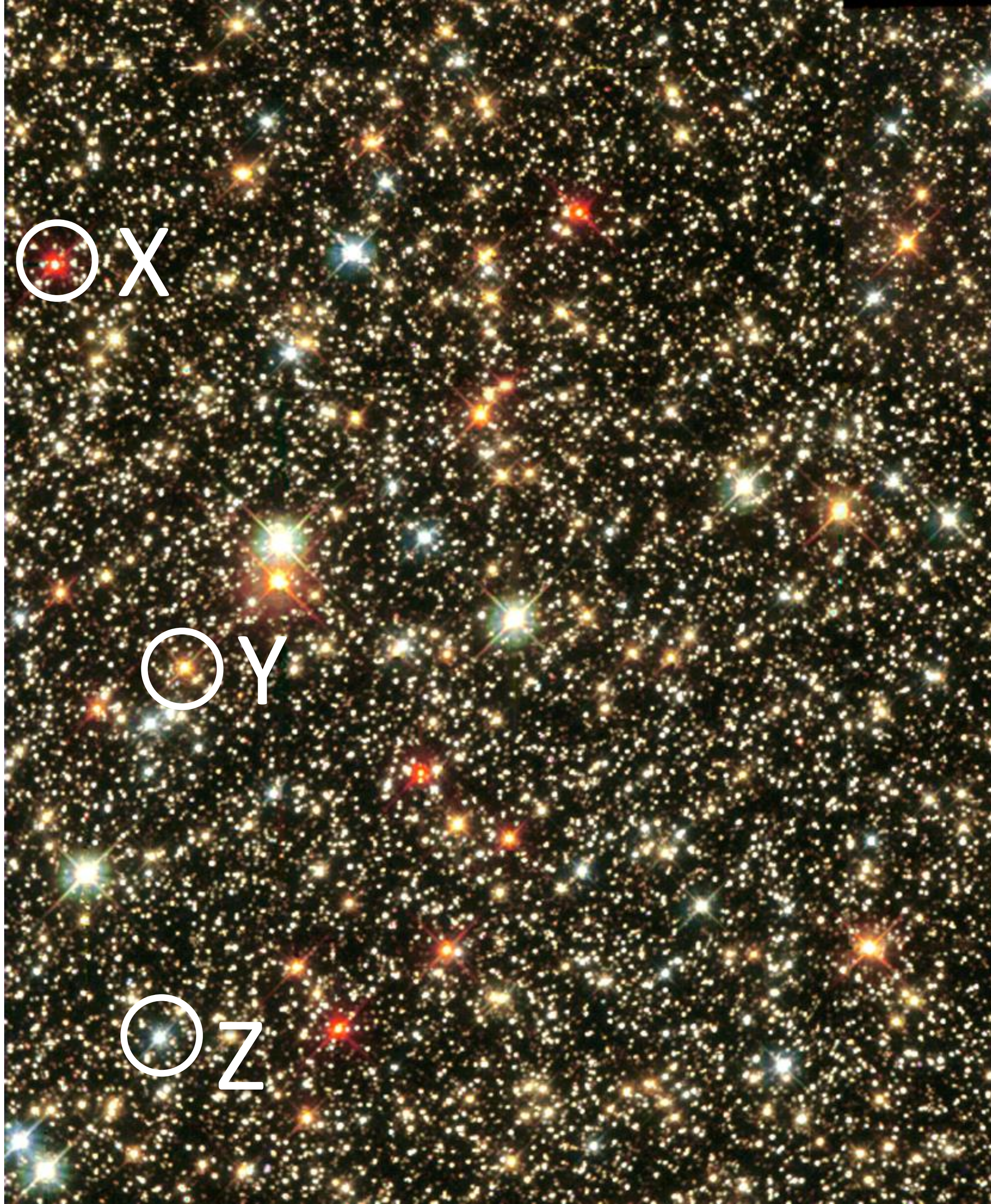
Have to consider:

- *How well we can distinguish (measure) brightness?*
- *How far away is each star?*



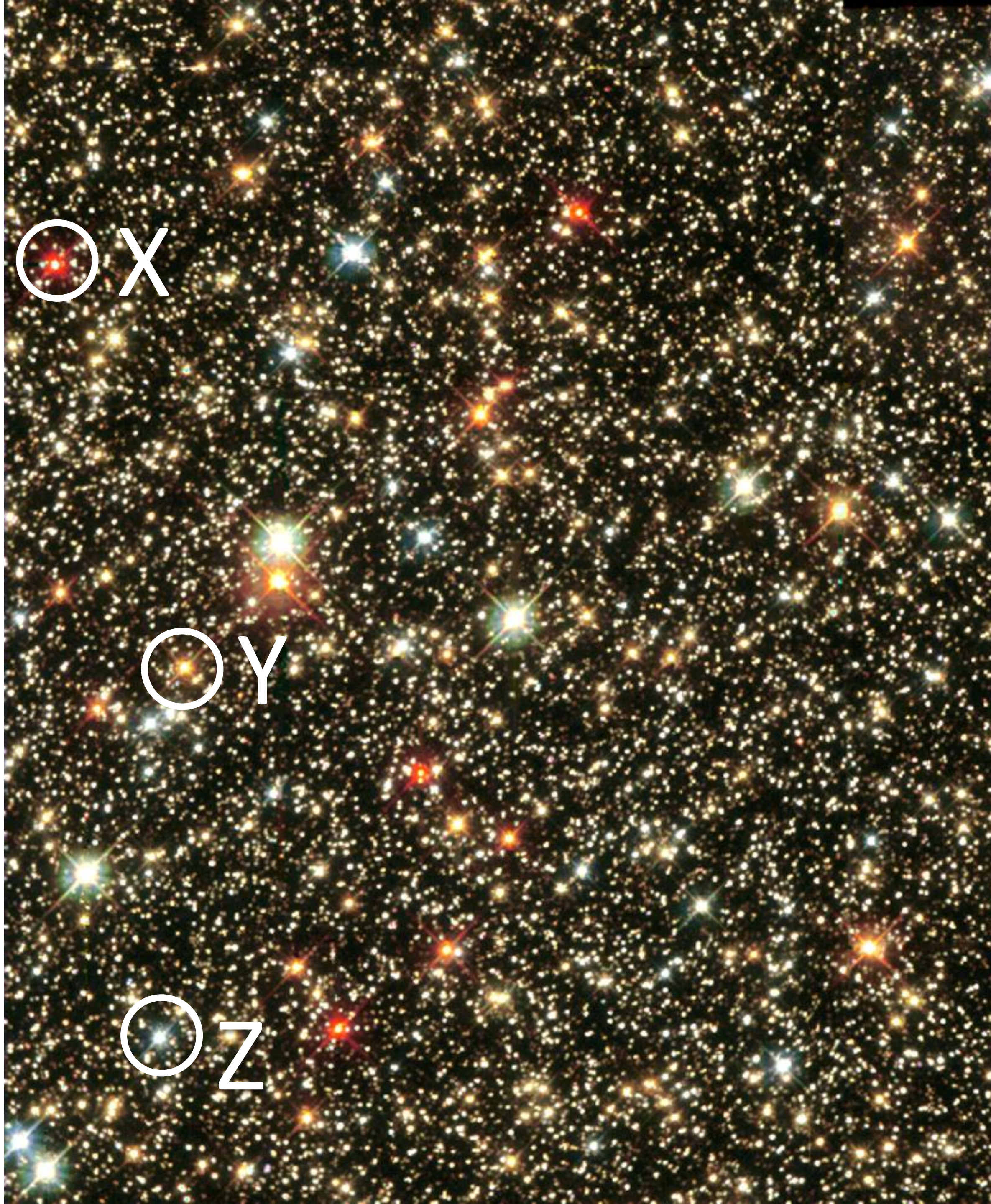
X, Y, Z all appear to have the same brightness at visible wavelengths

= same **apparent magnitude**

If we consider effect of ***distance*** *from Earth, we can adjust for direct comparison:*

= Absolute magnitude

$$M_v = m_v - 5\,log d + 5$$



Need a way to measure distance

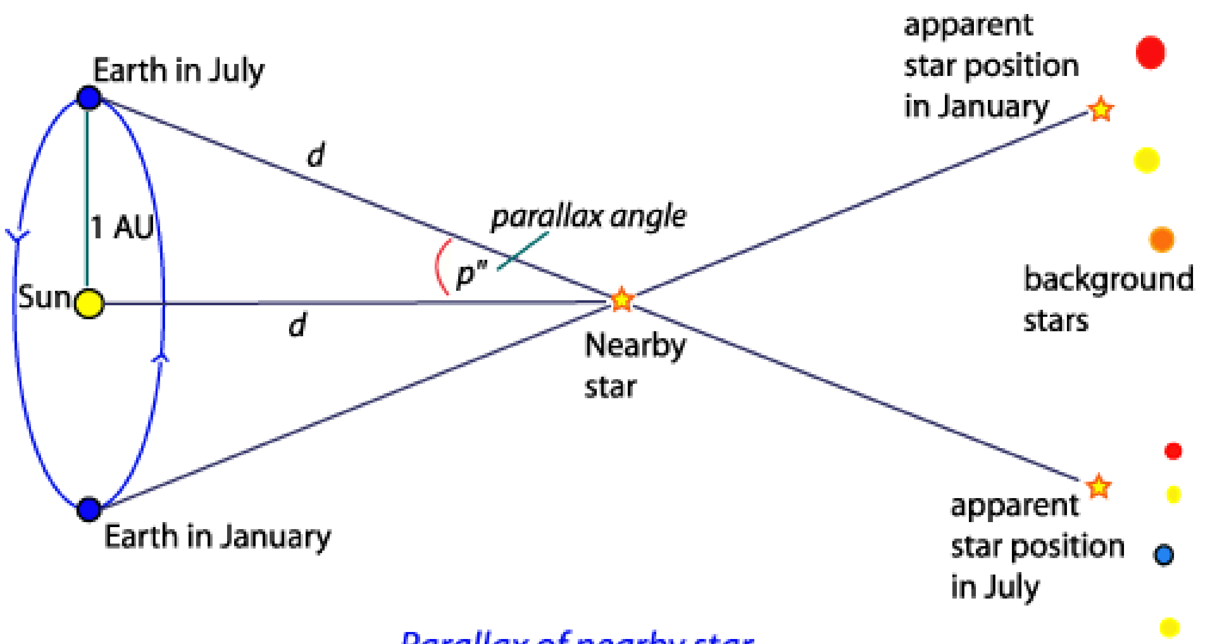
- We'll find there are different ways to measure astronomical distance
- On Friday, we calculated distance according to **parallax**

Measuring by parallax

- Close your left eye
- Hold up your thumb to cover the blue star
- Close your right eye and open your left
- Adjust your thumb so the orange star is covered

- Now do the same, and adjust your thumb so the yellow star is covered
- *Did you move your thumb closer or further from you?*

Measure parallax of stars by observing them as Earth moves around the Sun

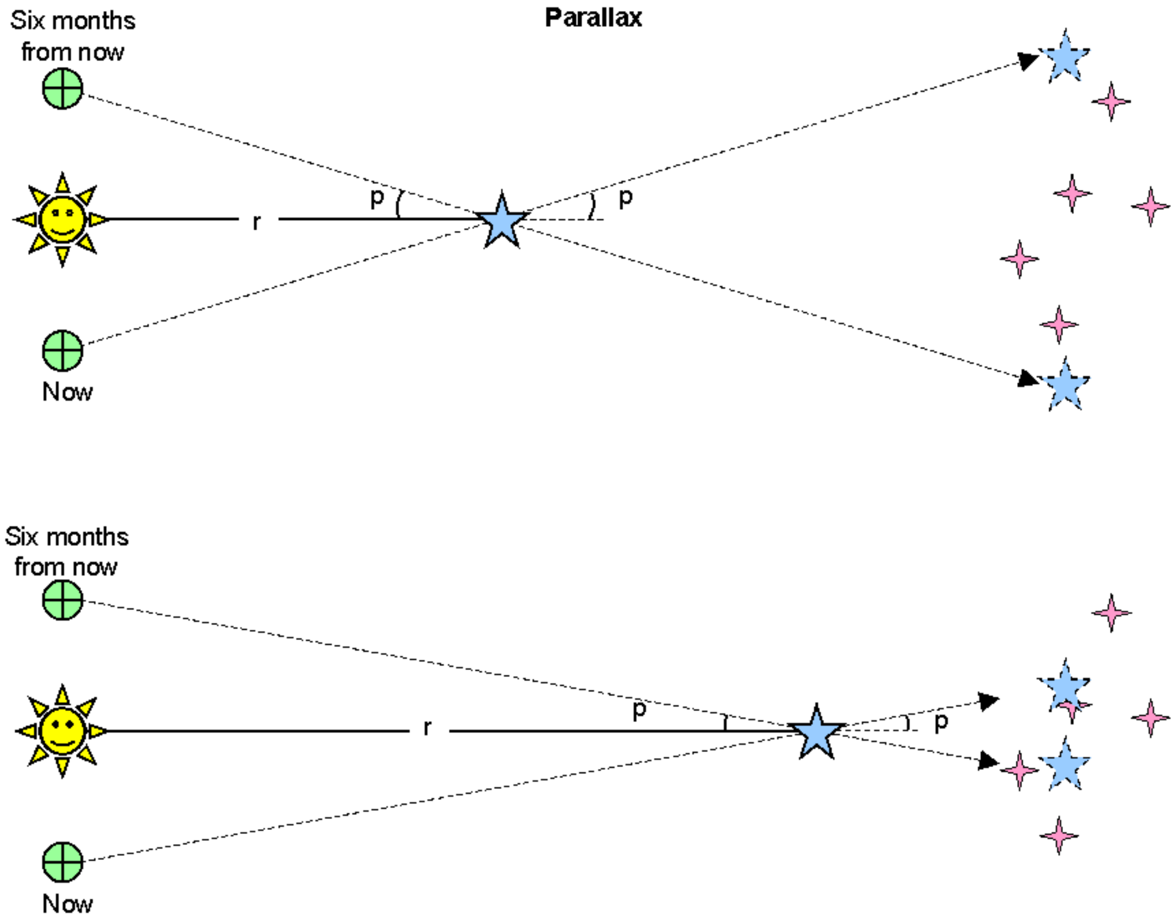


Parallax of nearby star

The smaller the parallax angle, p”:

A. The closer the star
B. The further the star
C. The bigger the star
D. The smaller the star

Measure parallax of stars by observing them as Earth moves around the Sun



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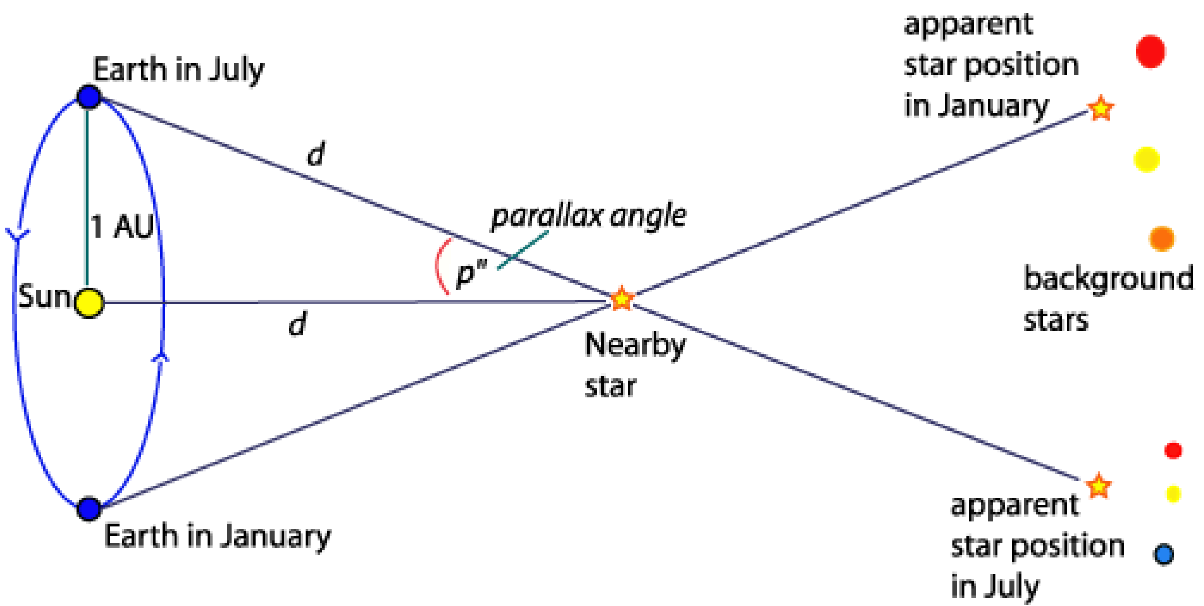
Parsec

Distance expressed in terms of the angle of parallax

- Parallax arcsecond = ***parsec*** (abbreviated 'pc')

$$Distance\ (in\ pc) = \frac{1}{parallax\ (arcseconds)}$$

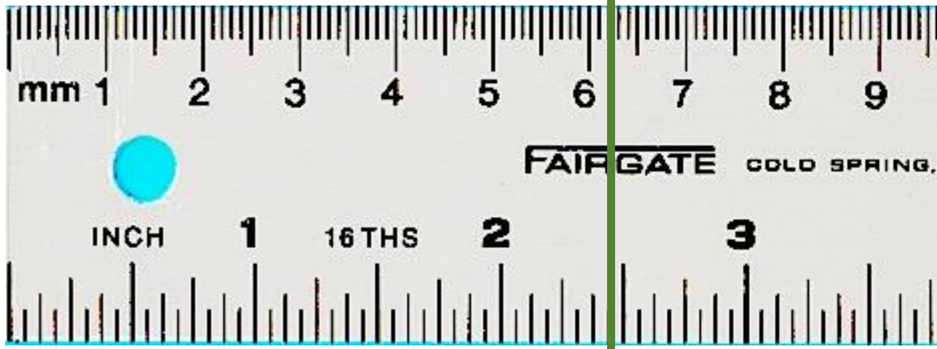
1 pc = 3.26 light years



Arcsecond is an angle

= 1/3600th of 1°

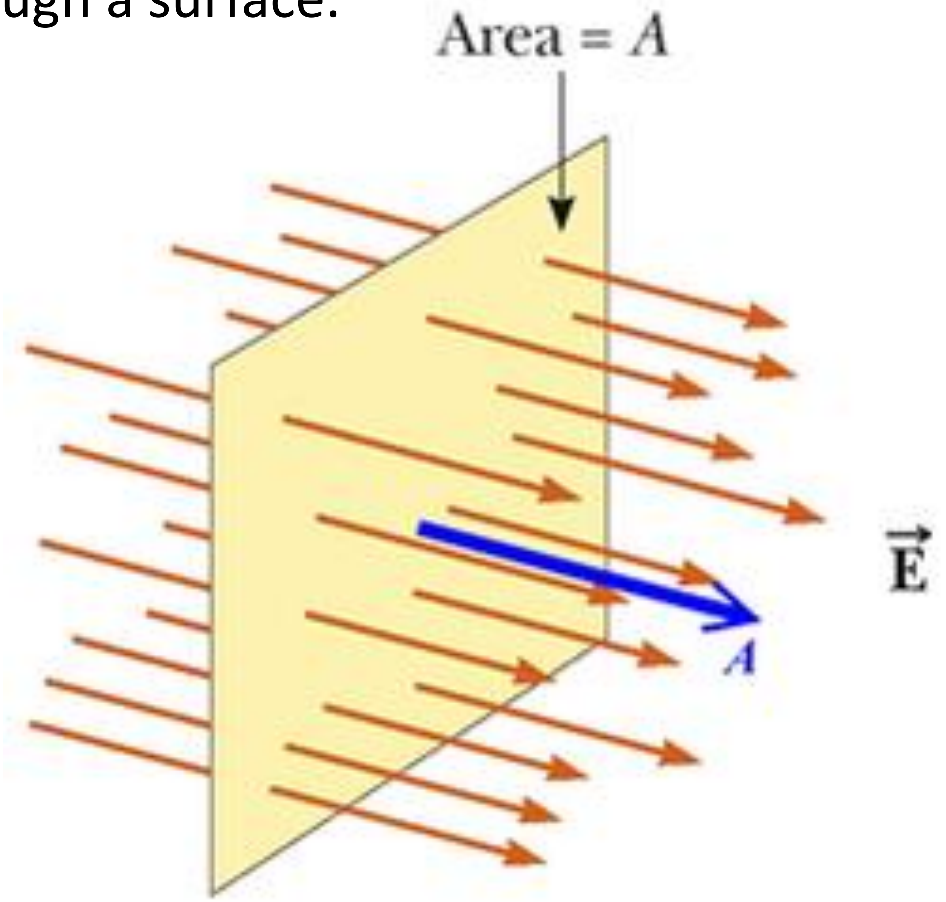
Equal to measuring ~1/20th of 1 mm from across this classroom



Magnitudes are kind of nice, but we can use a better measurement to compare stars

The properties of blackbody radiation let us calculate how **bright** an object is.

- Flux: rate at which energy passes through a surface.
  Units = energy per area per time.



Note:

Energy per unit time is given in the unit of Watts

1 Watt = 1 joule/second

Joule is a unit of energy
Second is a unit of time

The properties of blackbody radiation let us calculate how **bright** an object is.

- **Flux**: rate at which energy passes through a surface.

  Units = energy per area per time (Watts/m^2)

  - Monochromatic flux = flux at a single wavelength
  - Bolometric flux = flux over all wavelengths

    (Mathematically, bolometric flux is the area under a blackbody curve).

- Bolometric flux emitted at the surface of a blackbody is:

  - $F_{emitted} = \sigma T^4$, where $\sigma = 5.67 \times 10^{-8} \frac{Watts}{m^2 K^4}$

Can you calculate the bolometric flux emerging from the Sun's surface?

Quick Quiz: If Star A is twice as hot as Star B, how do their surface fluxes compare? (how much more light is coming off each square foot of Star A's surface?)

A. 2x as much

B. 8x as much

C. 16x as much

D. 32x as much

E. Cannot be determined

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C. **16x as much**

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E. Cannot be determined

Quick Quiz: If Star A is 10x as hot as Star B, how do their surface fluxes compare? (how much more light is coming off each square foot of Star A's surface?)

A. 10x as much

B. 40x as much

C. 4000x as much

D. 10000x as much

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