The Milky Way

- Shape
- Globular cluster system
- Galactic coordinates
- Pulsating stars
- Size of the Milky Way

Accretion disks around stellar-mass black holes emit most of their light as

A) Radio waves

B) Infrared light

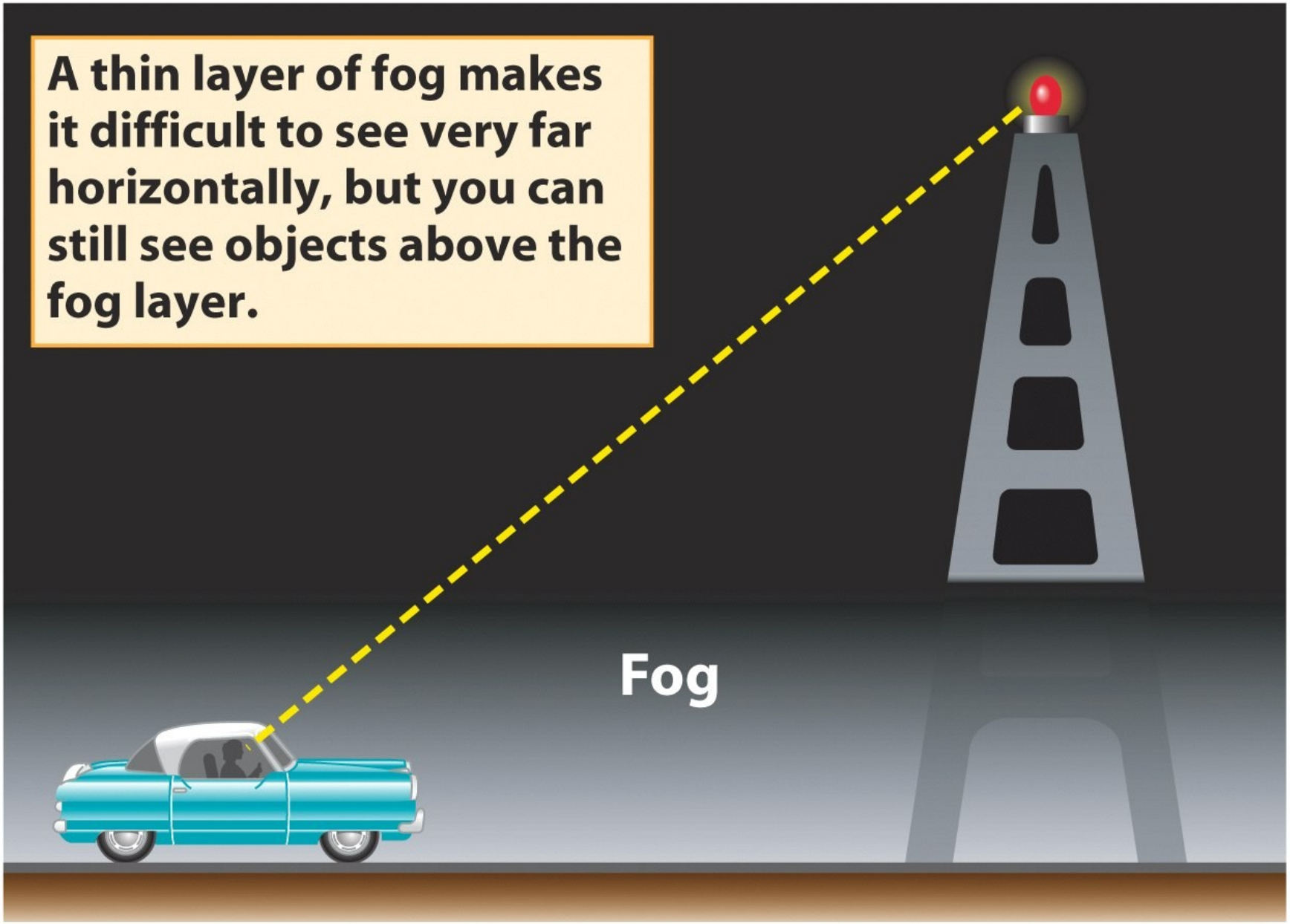
C) Visible light

D) X-ray

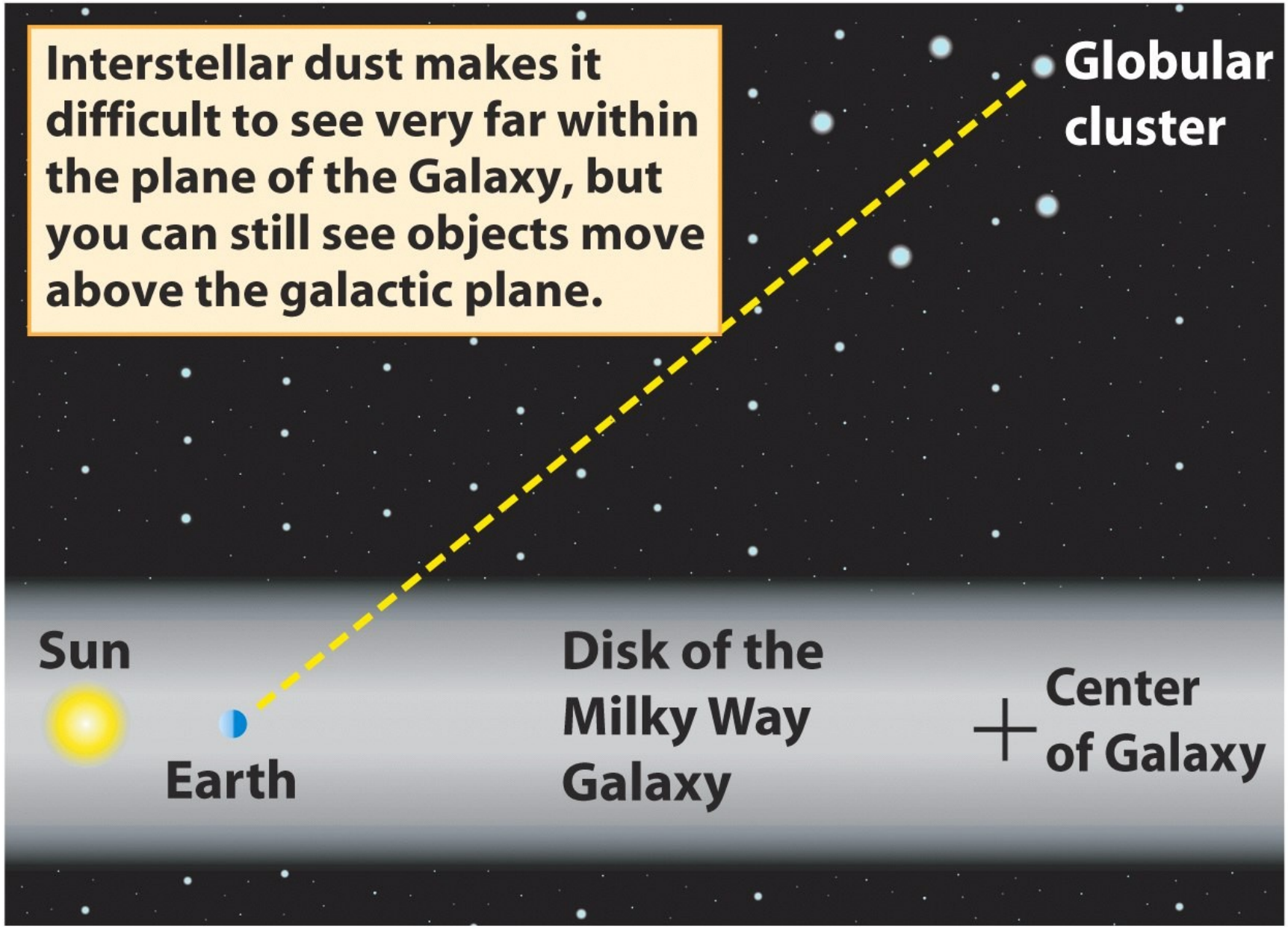
How do we locate the center of the Milky Way?

- Can’t see center directly with visible light because of obscuring clouds in the plane of the Galaxy

- Look above the plane of the galaxy



Determining your position in the fog



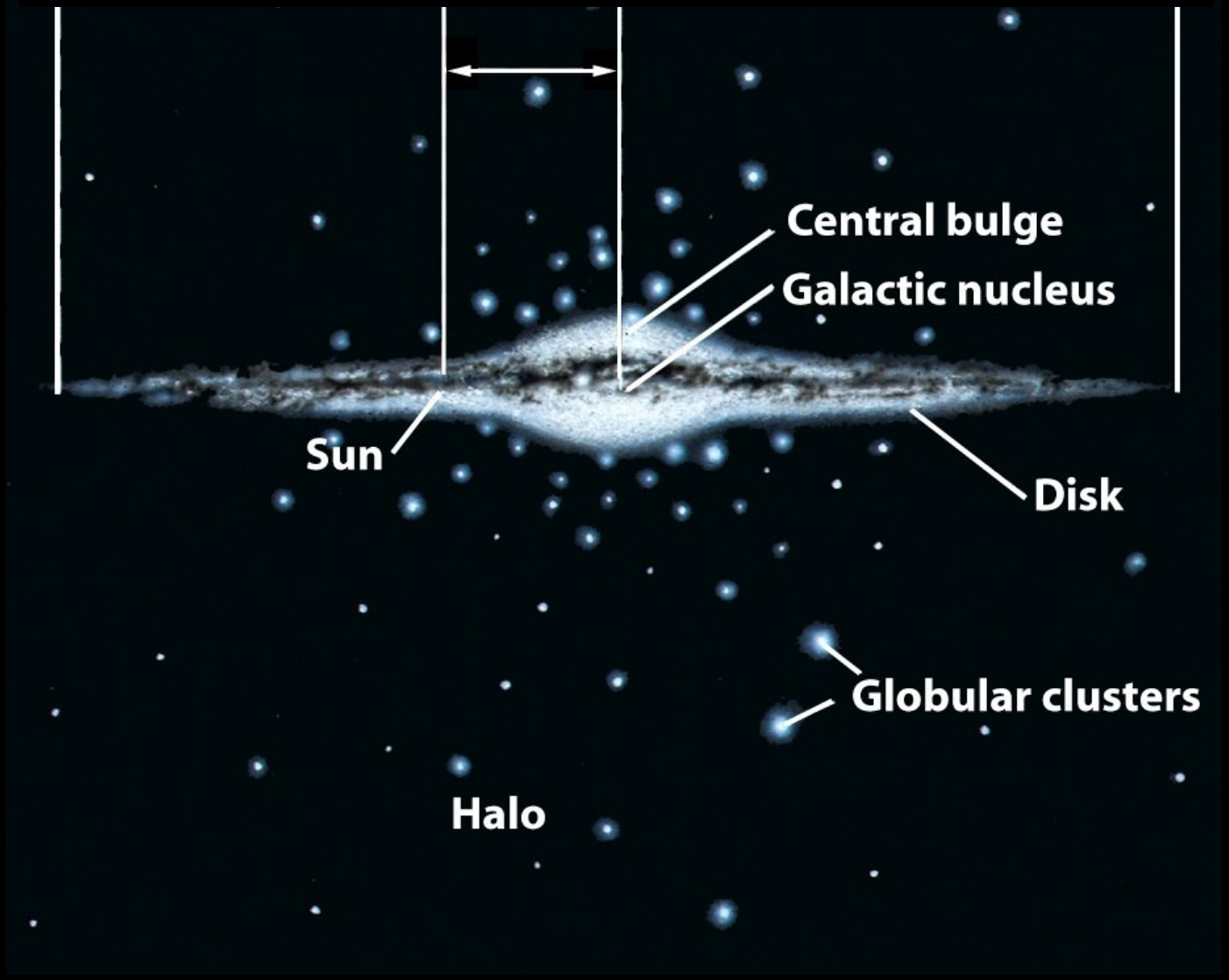
Determining your position in the Galaxy

M15

M13

Globular clusters

- Compact, spherical group of stars
- Up to several 100,000 stars
- All stars formed together, same age
- Form a halo around the Milky Way


Central bulge
Galactic nucleus
Sun
Disk
Globular clusters
Halo

Globular cluster system

- Centered on the center of the Milky Way
- Extends far above and below the plane

- By observing globular clusters, we can determine the direction to the center of the Milky Way and our distance from the center

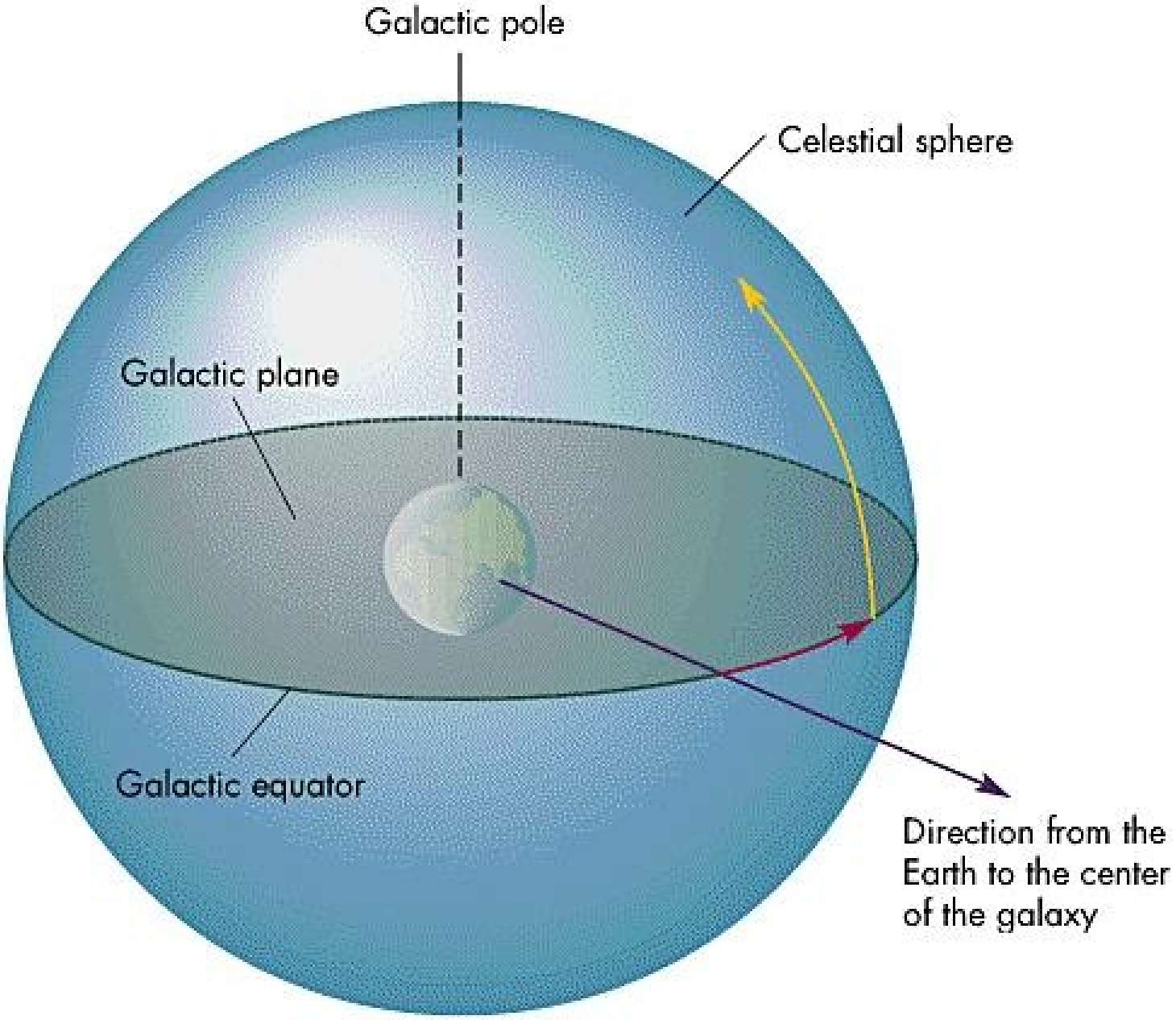
What about globular clusters allows us to determine the Sun's distance from the center of the Galaxy?

A)The clusters are confined to a thin plane.

B)The clusters are all located at the same distance from the Sun.

C)The center of the distribution of clusters is far from the Sun.

D)All of the clusters are located in a region a few parsecs across.


Galactic pole
Celestial sphere
Galactic plane
Galactic equator
Direction from the Earth to the center of the galaxy
Longitude
Latitude

But how do we find the distance to the Galactic center?

- We need the distances to the globular clusters

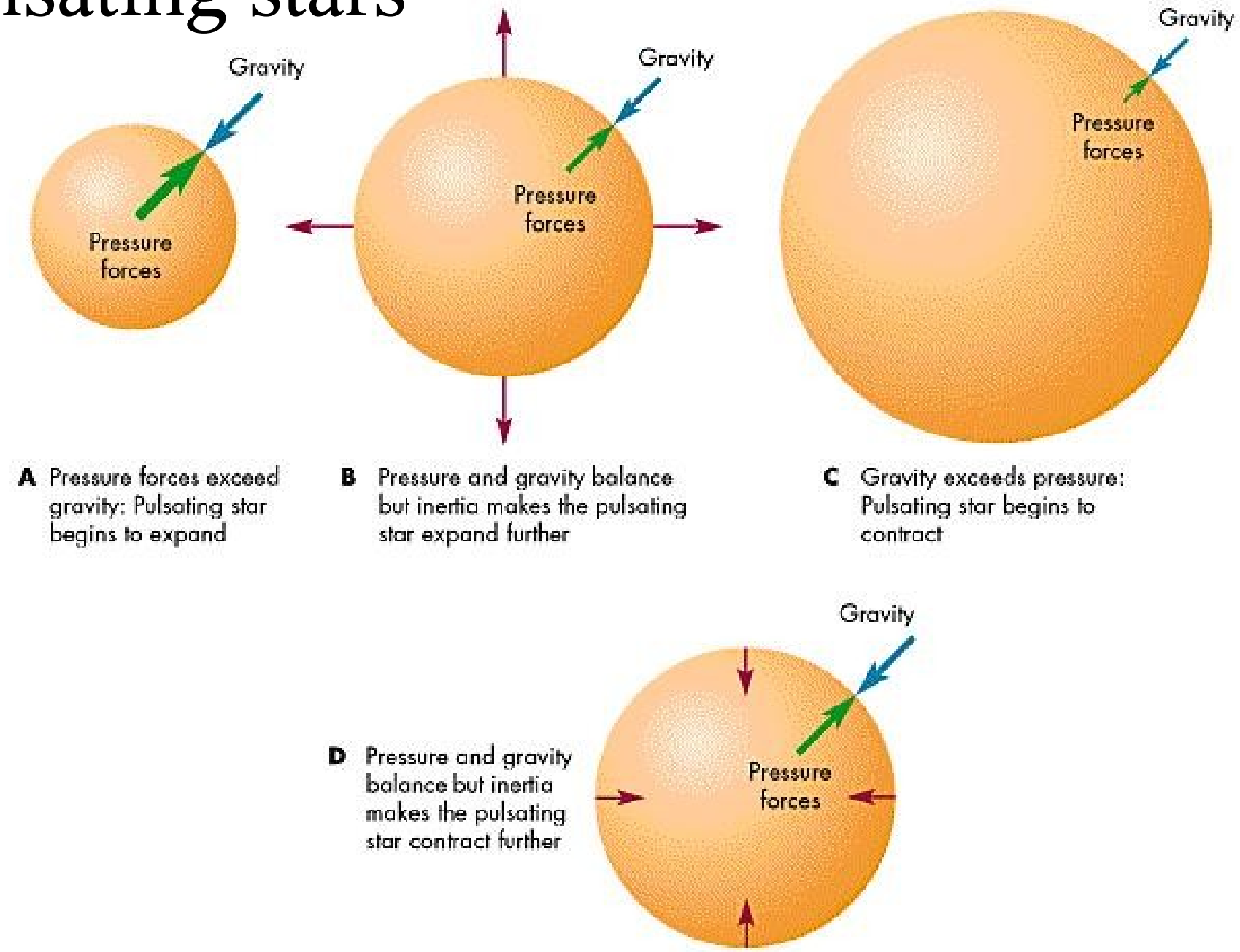
- Use pulsating stars in the clusters
- Animation

If a star is neither expanding nor contracting, we may assume that throughout the star there is a balance between pressure and

A) temperature
B) density
C) luminosity
D) gravity

Do mass on spring demo

Pulsating stars



A Pressure forces exceed gravity: Pulsating star begins to expand

B Pressure and gravity balance but inertia makes the pulsating star expand further

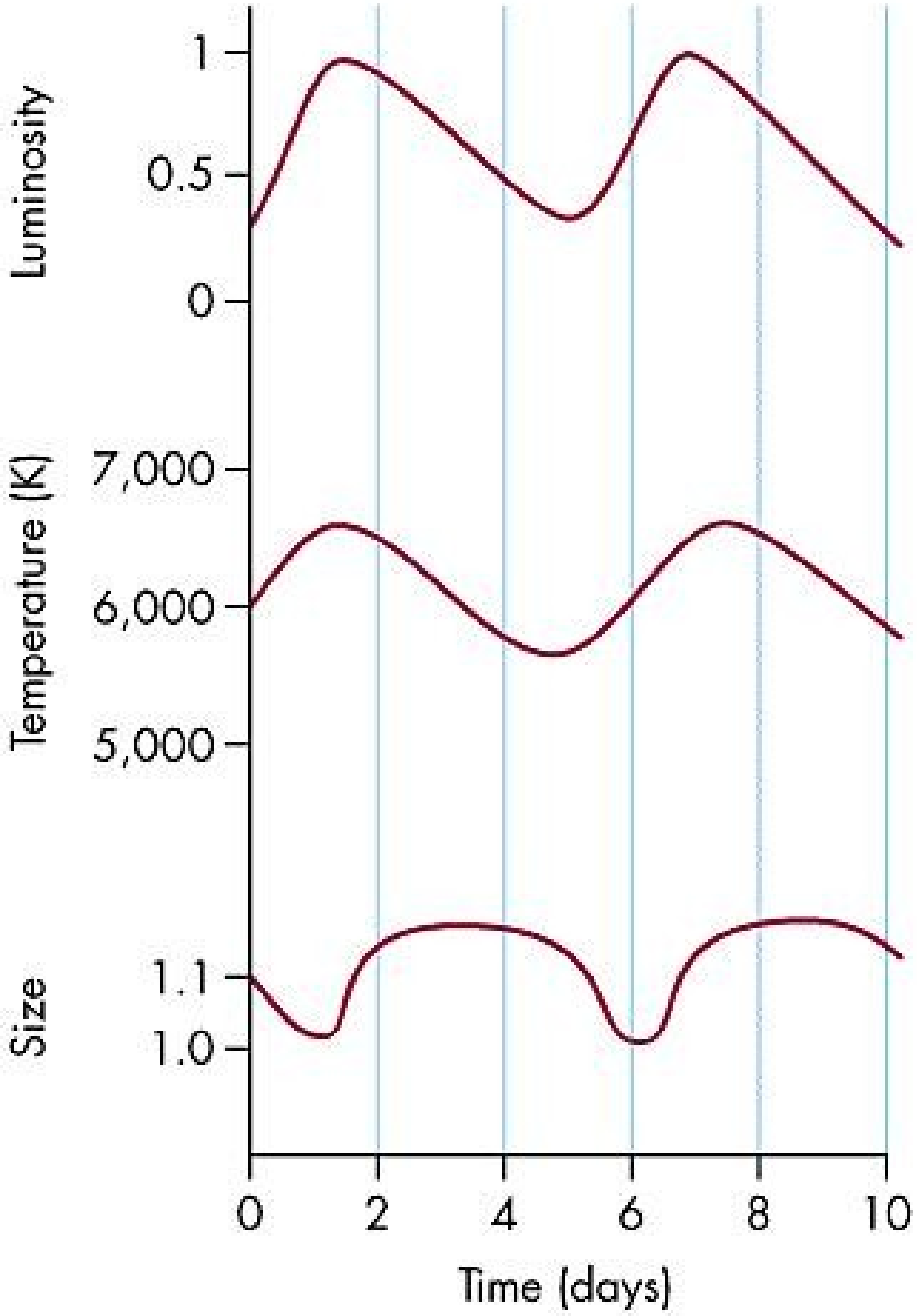
C Gravity exceeds pressure: Pulsating star begins to contract

D Pressure and gravity balance but inertia makes the pulsating star contract further

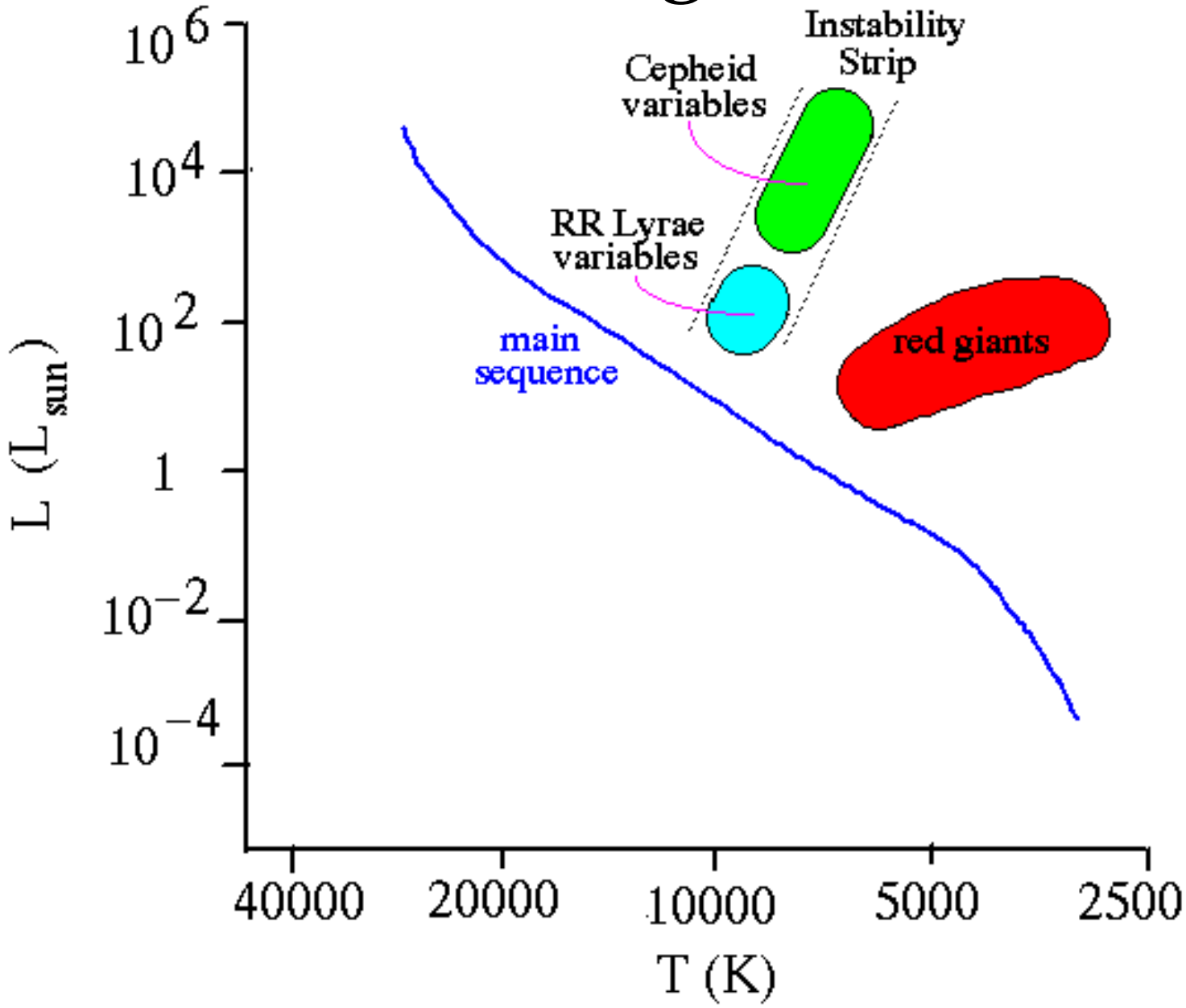
Pulsation cycle

Rate of fusion in the core stays constant.

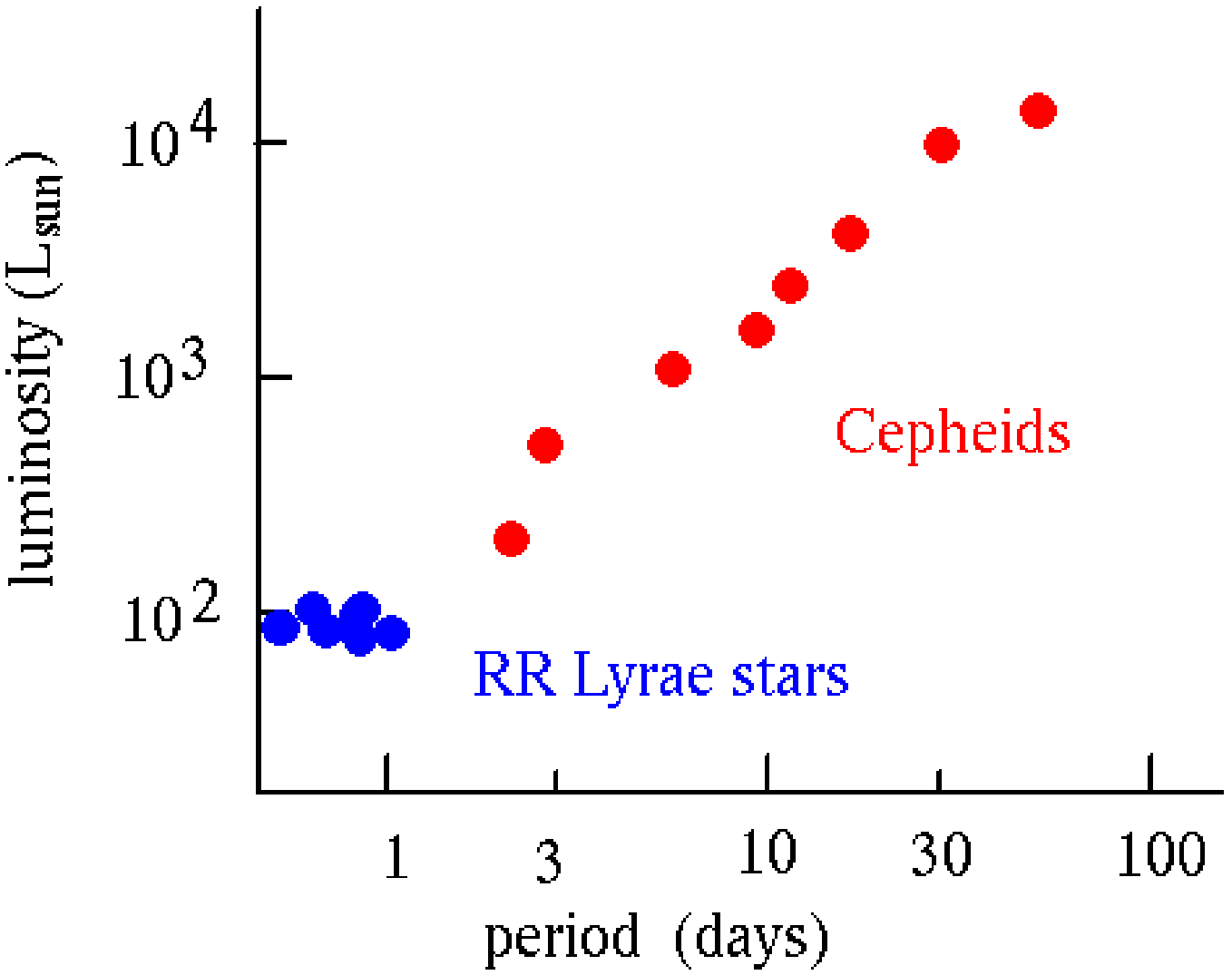
Transport of energy through outer layers of star oscillates.



Pulsating stars



Pulsating stars



What causes Cepheid variables to vary in brightness?

A) Eclipses

B) Changes in nuclear energy generation rate

C) Periodic changes in radius

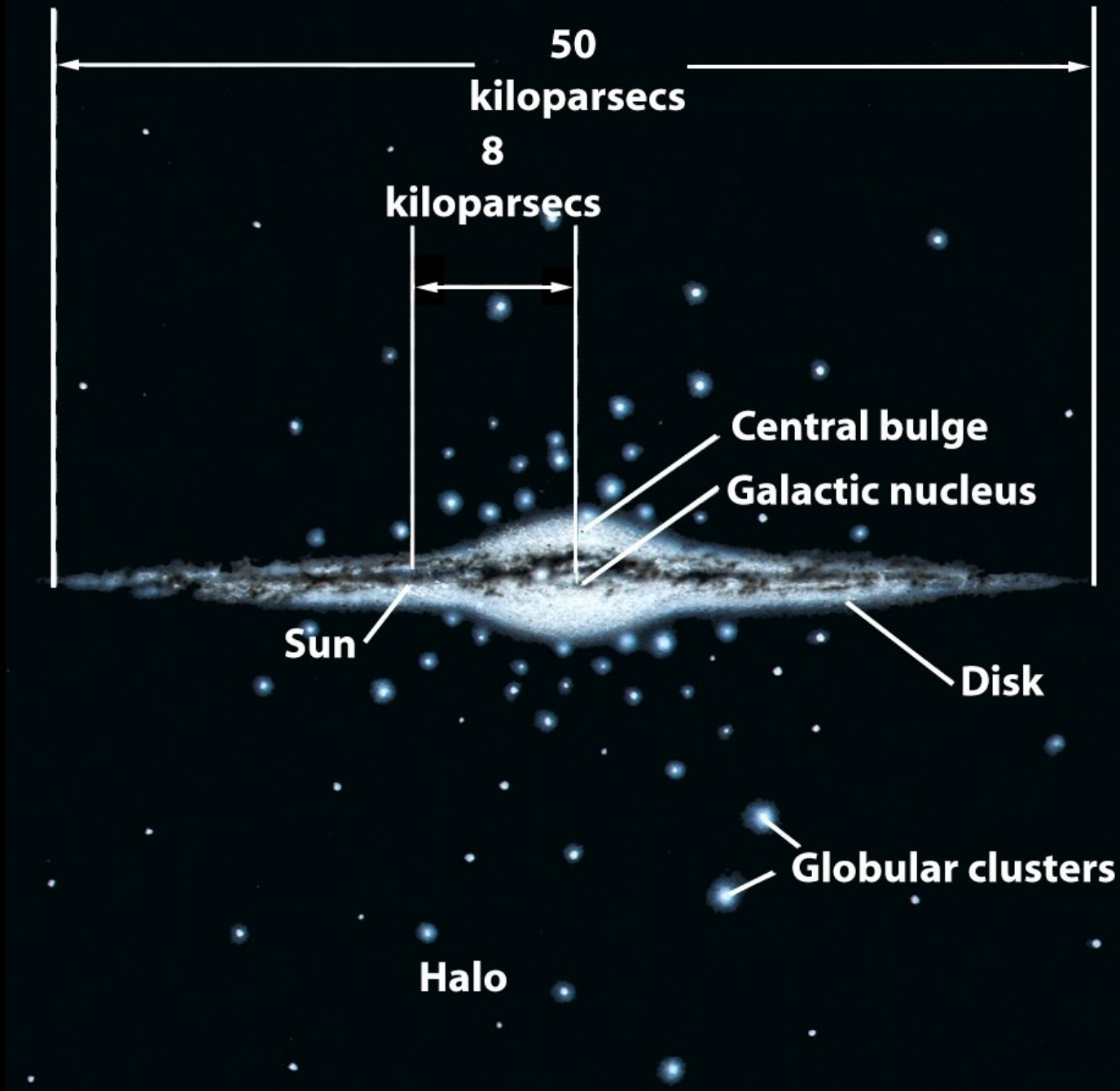
D) Obscuration by clouds of dust

Why is this useful?

Flux versus luminosity relation

$$\frac{\text{Flux}_A}{\text{Flux}_B} = \frac{\text{Luminosity}_A}{\text{Luminosity}_B}\left(\frac{\text{Distance}_B}{\text{Distance}_A}\right)^2$$

We can figure out the luminosity of a pulsating star by timing the pulsations. Since, we can measure its flux, we can then find the distance to the star.


50
kiloparsecs
8
kiloparsecs
Central bulge
Galactic nucleus
Sun
Disk
Globular clusters
Halo

Review Questions

- What are globular clusters? How are they distributed in the Galaxy?
- What are Galactic coordinates?
- Why do some stars pulsate? Why are pulsating stars useful in measuring distances?
- What is the size and shape of the Milky Way?