The Milky Way

- Scattering of light, or why is the sky blue?
- Milky Way in infrared, radio
- The 21 cm line of Hydrogen
- Spiral arms
- Density waves

It is possible to measure the distances to a Cepheid variable star because

A) All Cepheids have the same luminosity

B) Cepheids pulsate

C) Cepheids are found in globular clusters

D) The luminosity of a Cepheid can be determined from its period of pulsation

What is the diameter of the disk of the Milky Way?

A) 4.3 light years
B) 8,000 parsecs
C) 50,000 parsecs
D) 750,000 parsecs

Scattering of light

- Light is completely absorbed by very dense clouds of dust
- For less dense clouds, some light is transmitted
- Does the transmitted light have the same color as the scattered light?

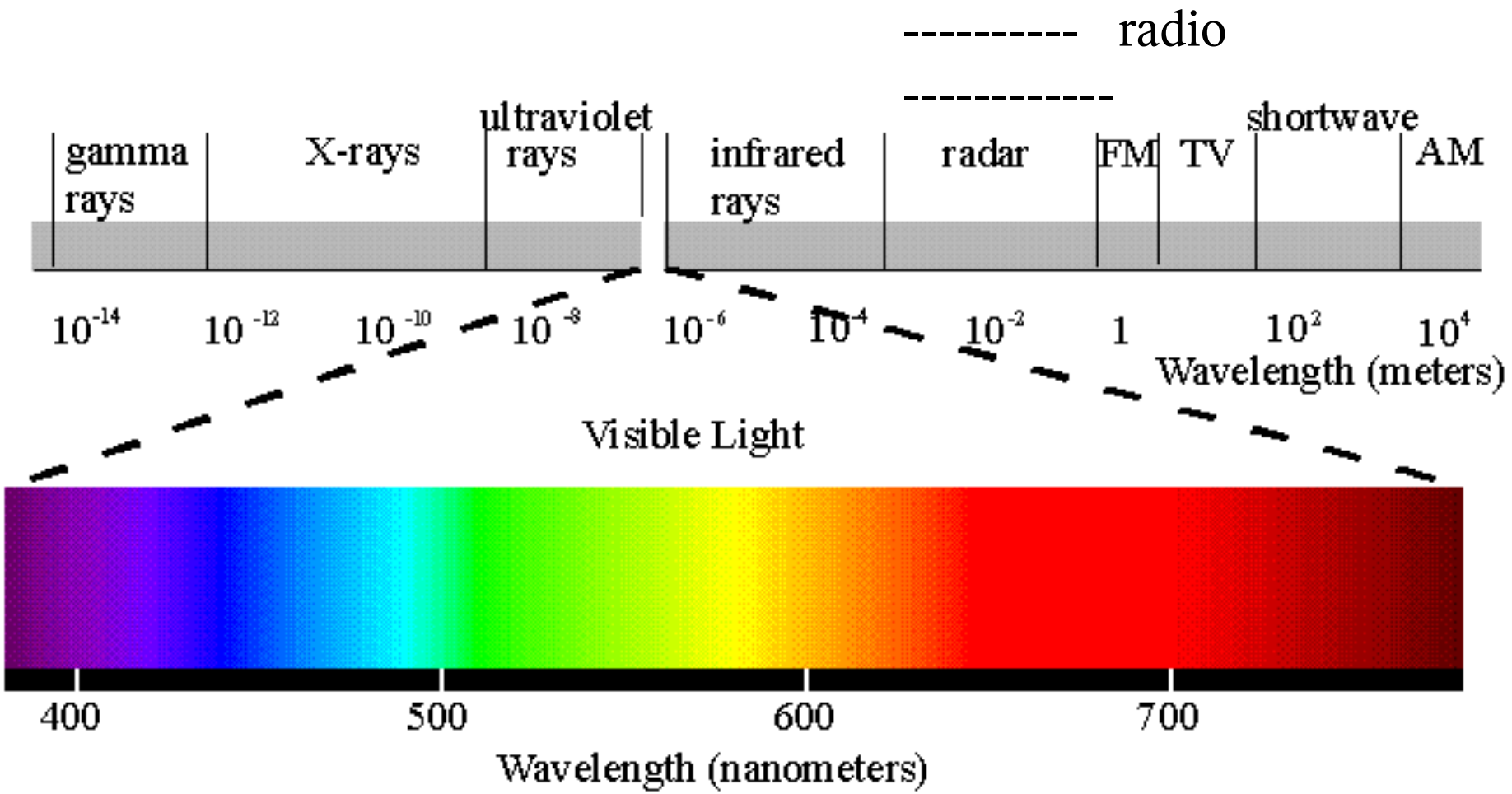
Do demo 6F40.10

Scattering light

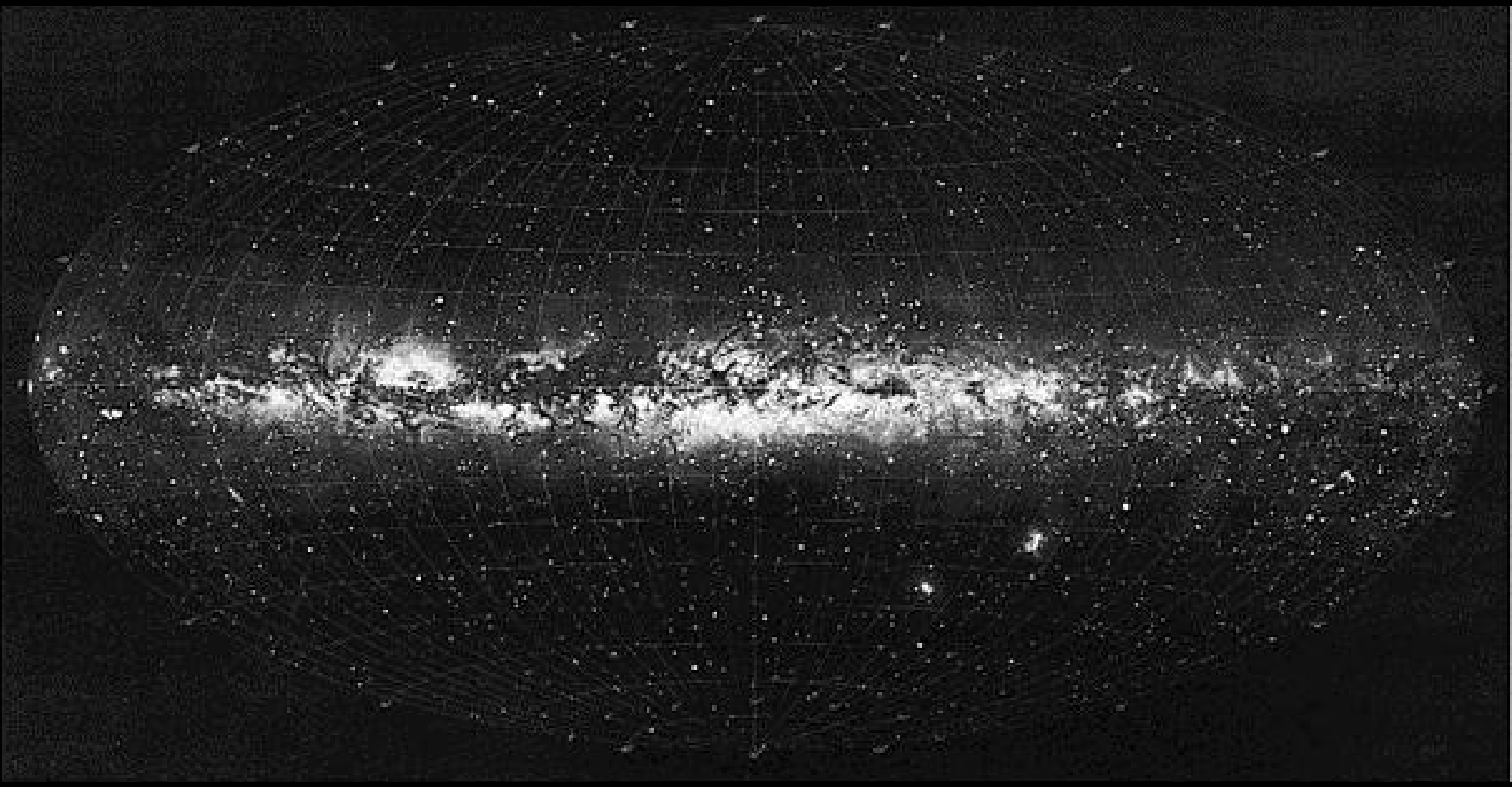
- Blue light is scattered more
- Red light is transmitted more

- This is why the sky is blue
- Stars seen through dust appear redder than they really are
- If we want to try to see through dust, what kind of light should we use?

Electromagnetic spectrum

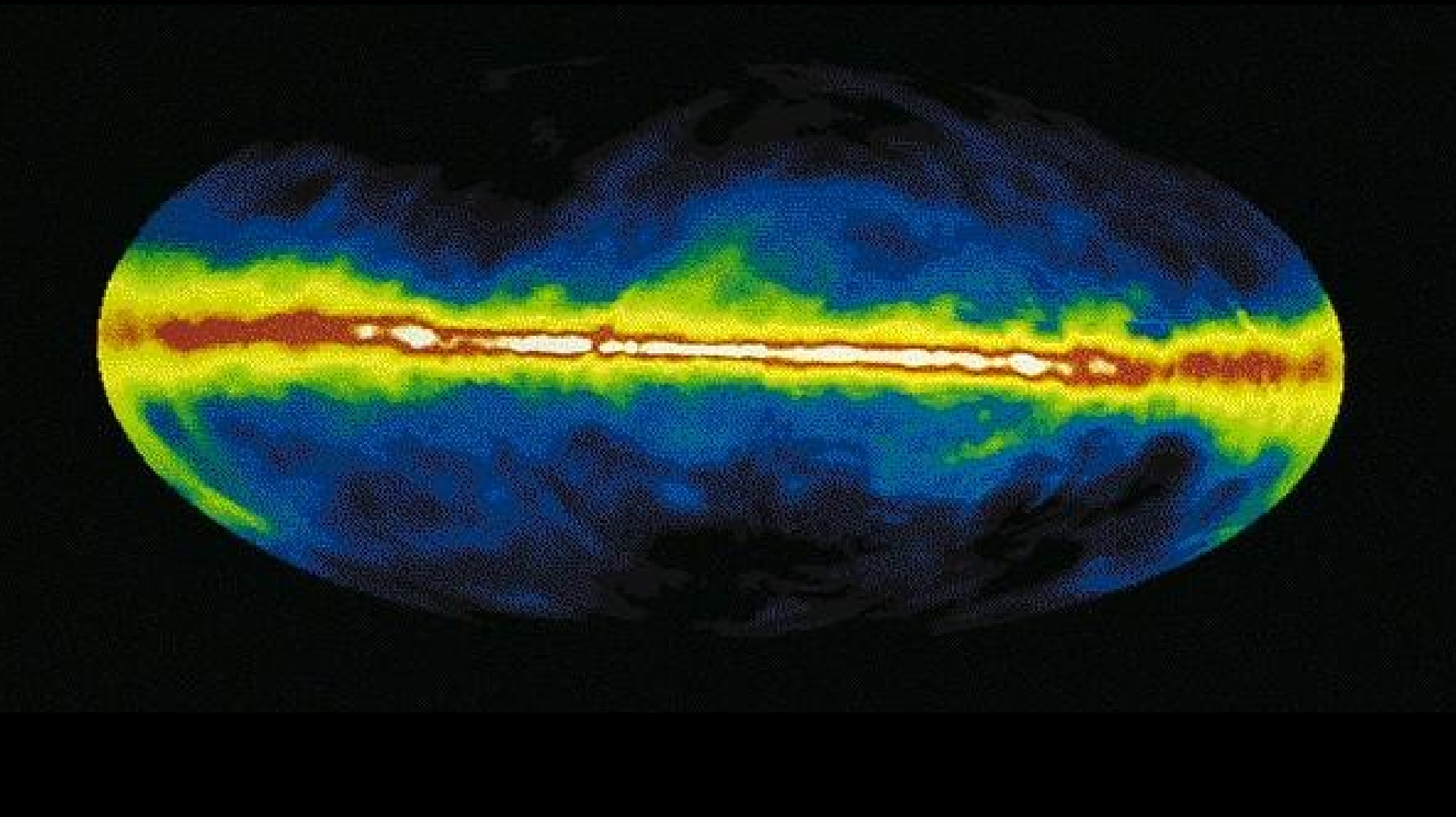


Milky Way in optical light

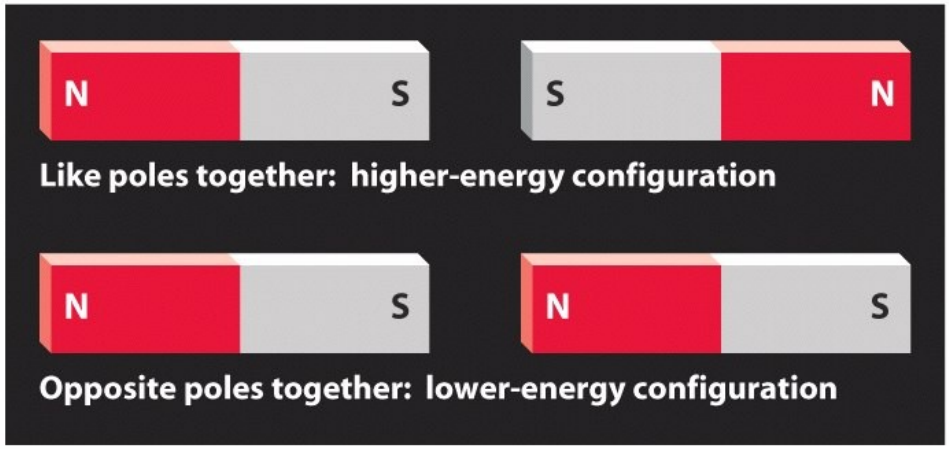


Milky Way in infrared light

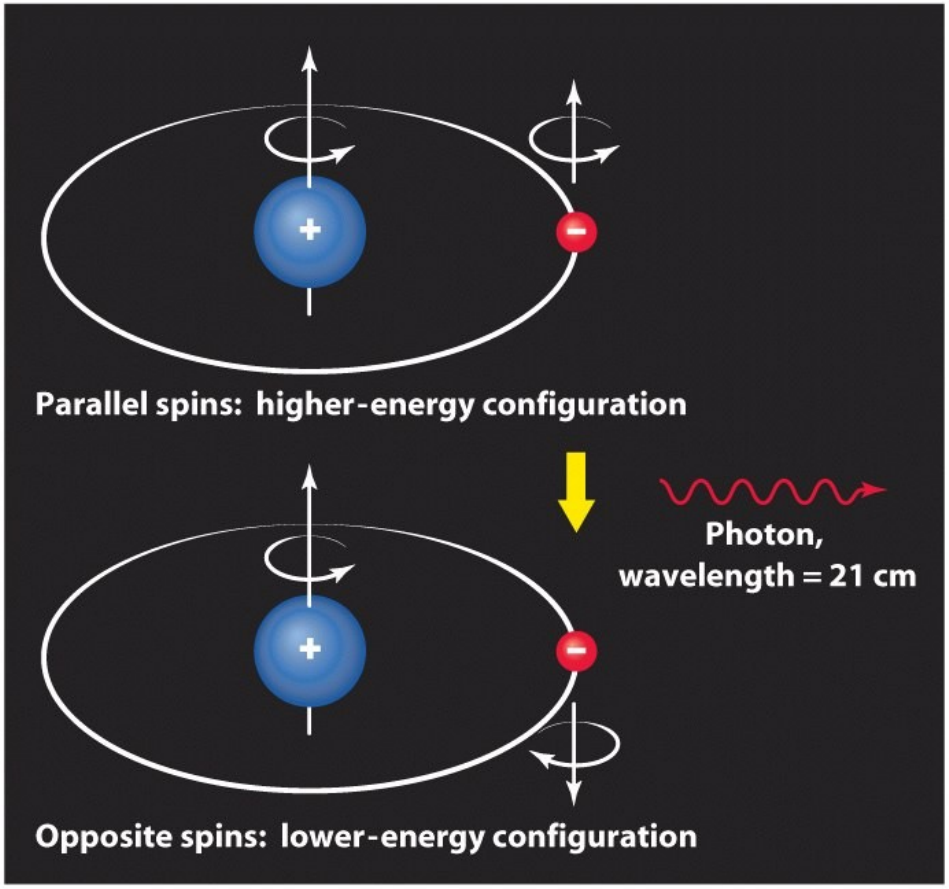
Milky Way in radio waves



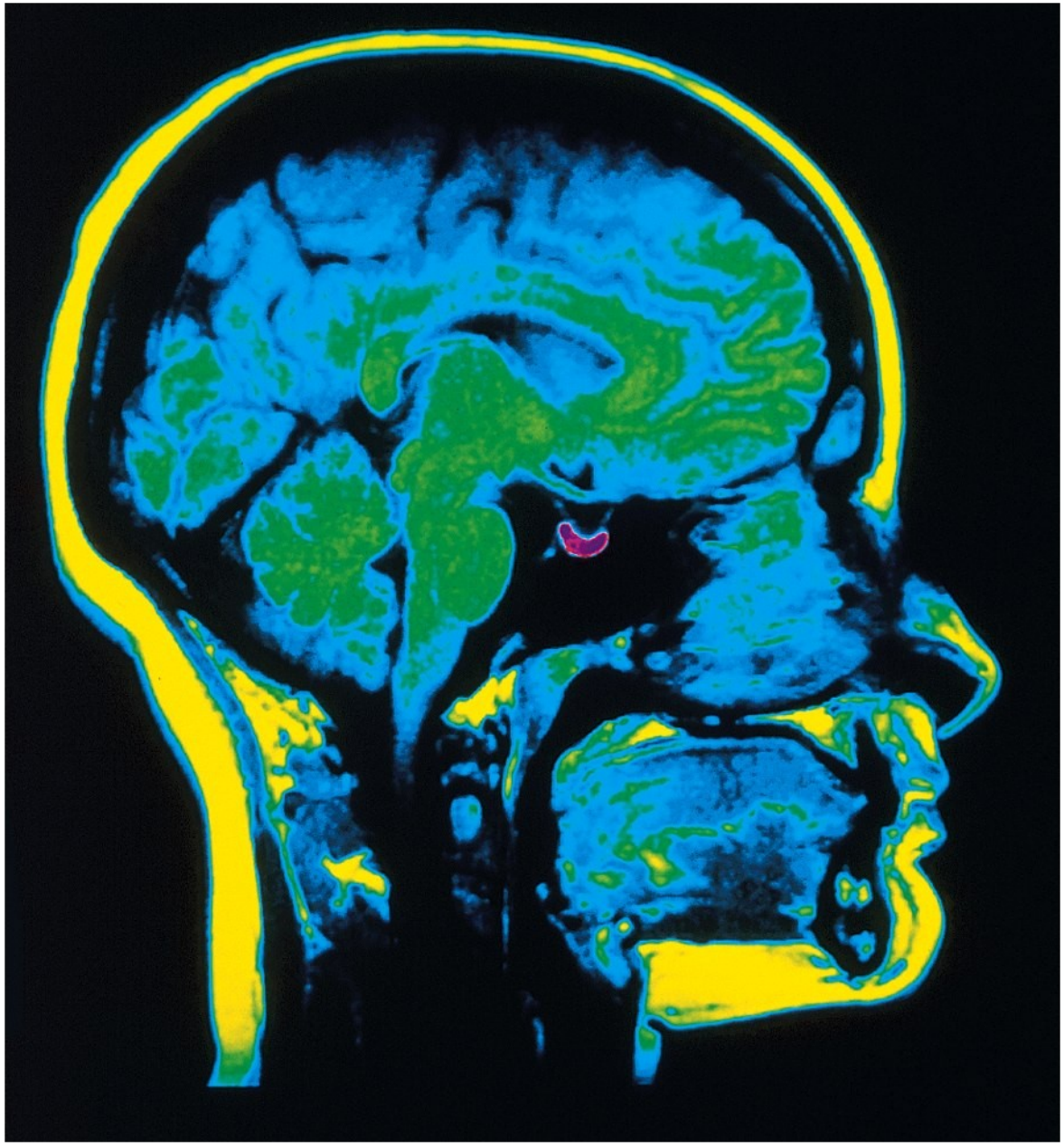
Hydrogen emits 21 cm radio waves



(a) The magnetic energy of two bar magnets depends on their relative orientation



(b) The magnetic energy of a proton and electron depends on their relative spin orientation



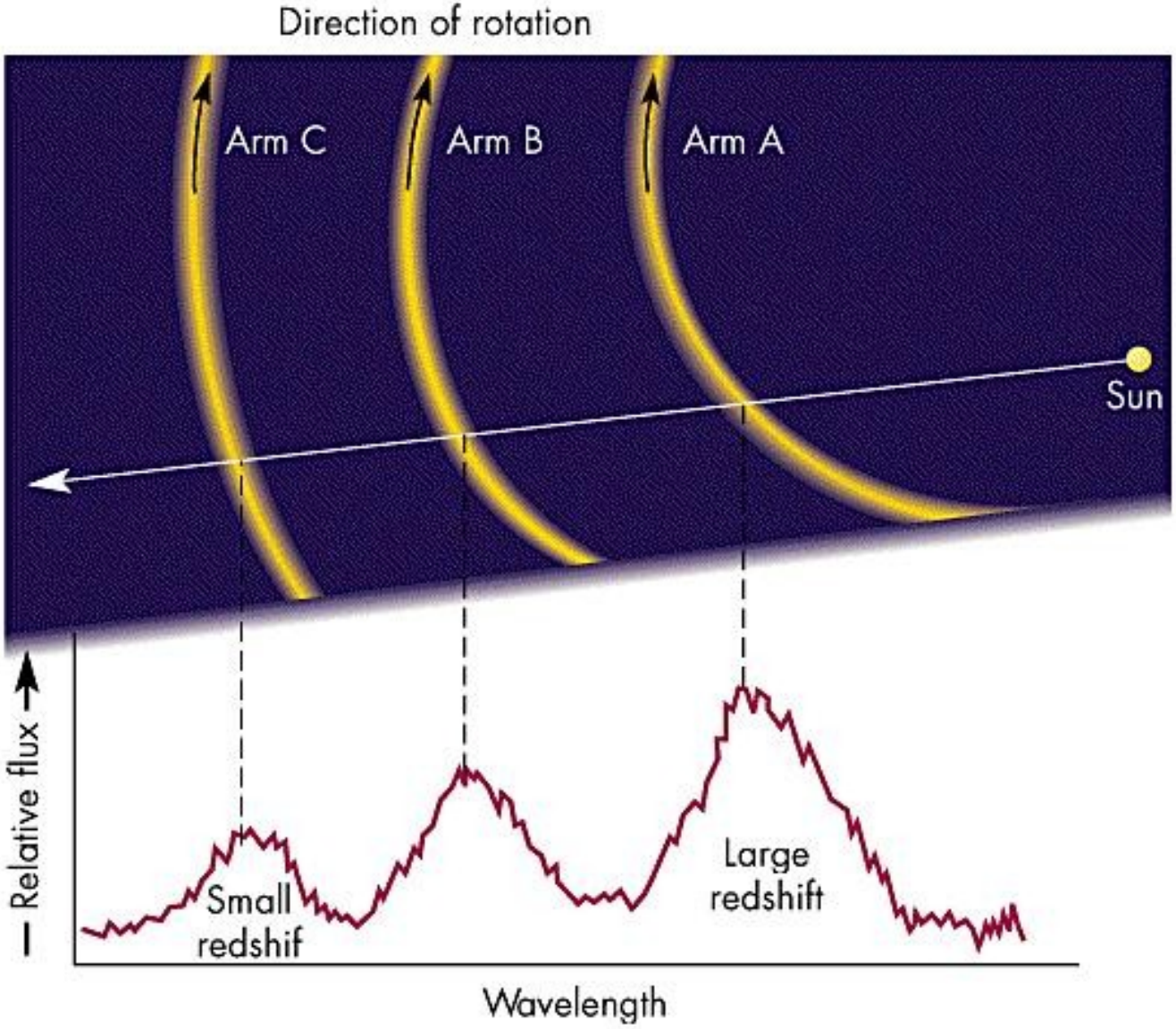
Same effect in other atoms is used to do magnetic resonance imaging (MRI)

What effect do interstellar dust particles have on the appearance of a distant star?

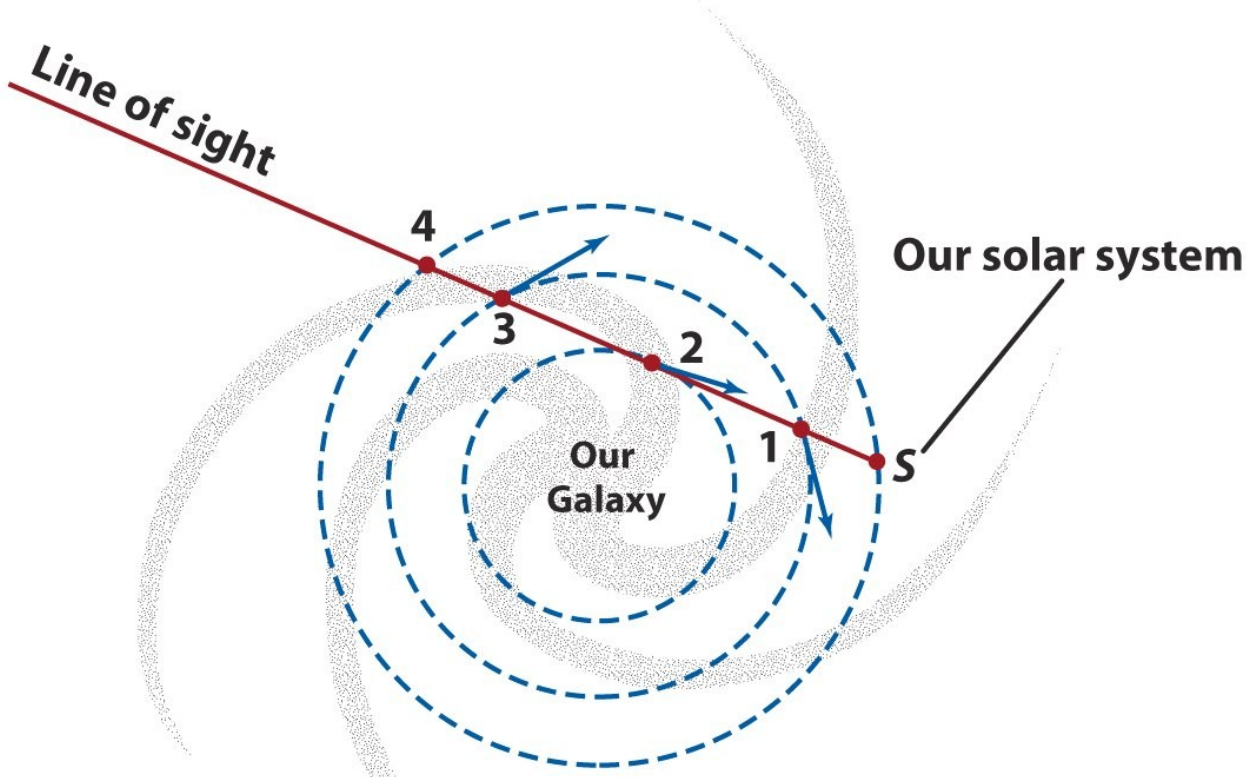
A) They make it look bluer and brighter
B) They make it look redder and brighter
C) They make it look bluer and dimmer
D) They make it look redder and dimmer

Spiral arms

Tracing spiral arms



Spiral arms can be traced from the positions of clouds of atomic hydrogen



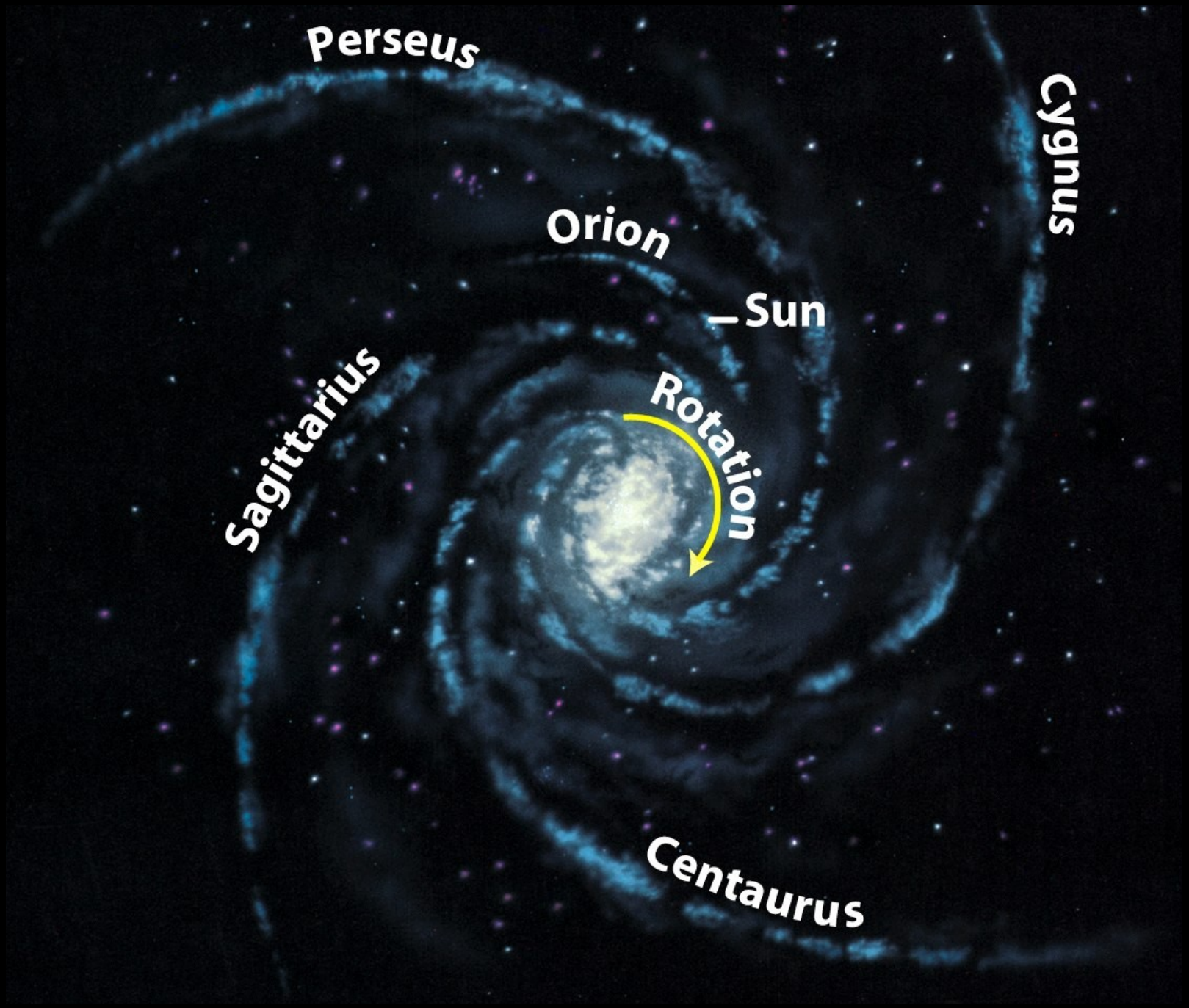
- Hydrogen clouds 1 and 3 are approaching us: They have a moderate blueshift.
- Hydrogen cloud 2 is approaching us at a faster speed: It has a larger blueshift.
- Hydrogen cloud 4 is neither approaching nor receding: It has no redshift or blueshift.


You are here
Center
of Galaxy

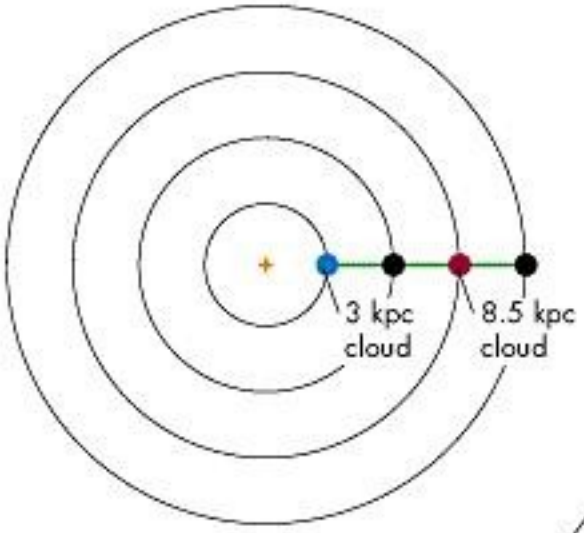
Tracers of spiral arms

- Young stars and related objects also trace spiral arms

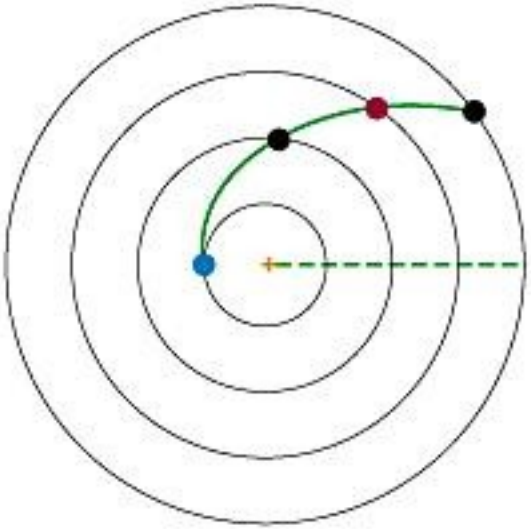
- Emission nebulae = H II regions
- Molecular clouds
- Clusters of young (O and B) stars


Perseus
Cygnus
Orion
Sun
Sagittarius
Rotation
Centaurus

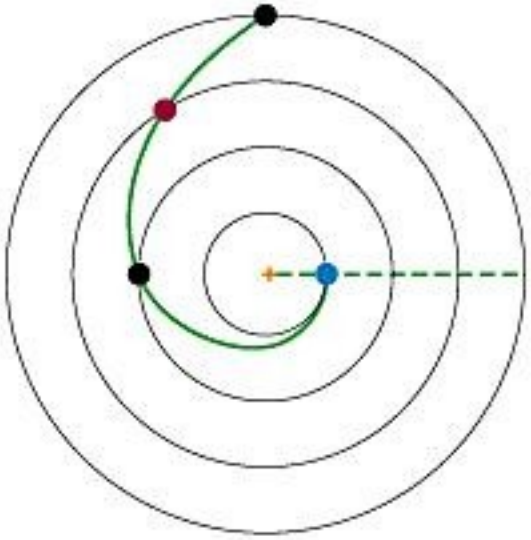
So what causes spiral arms?



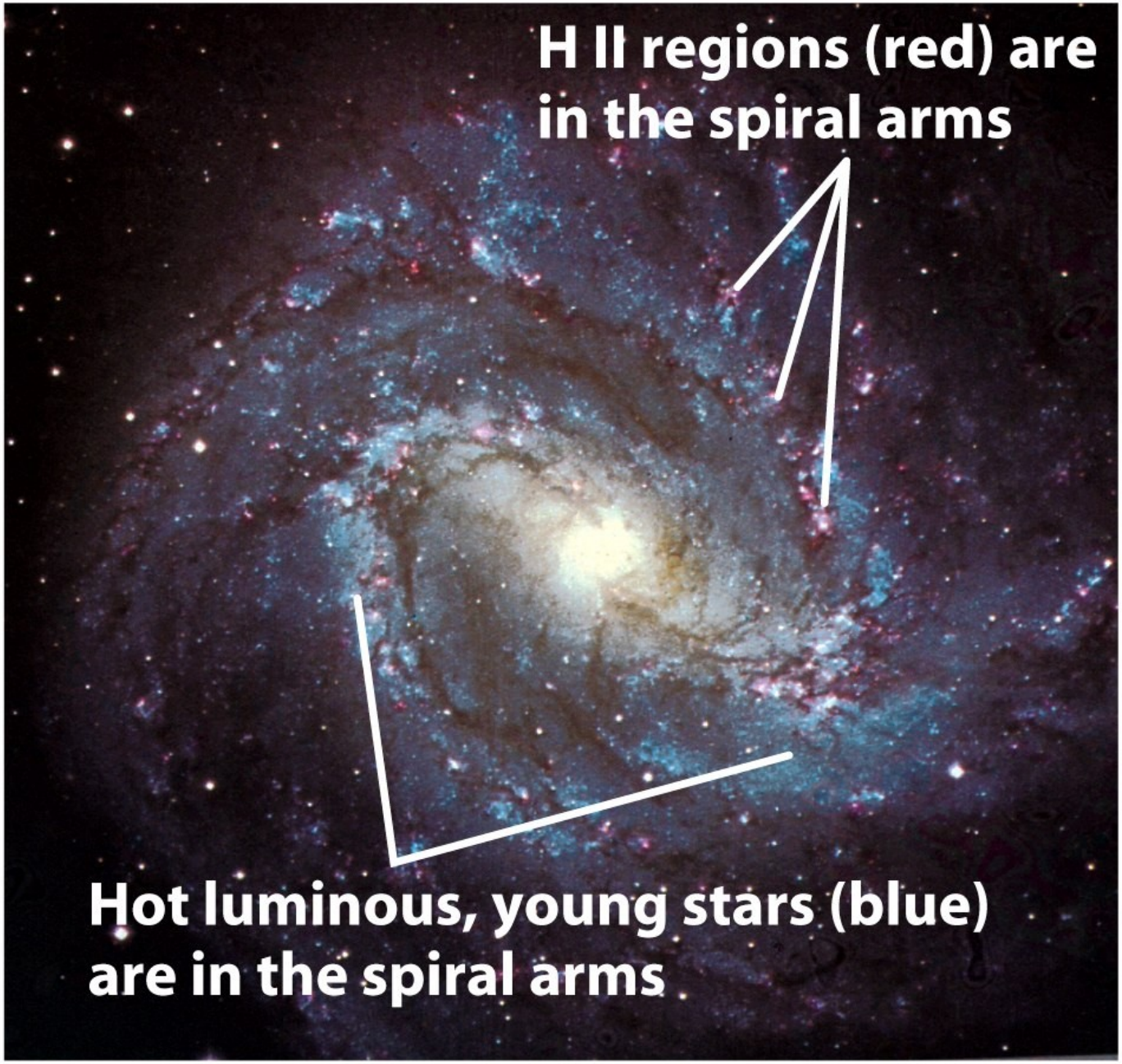
A A string of gas clouds lines up radially



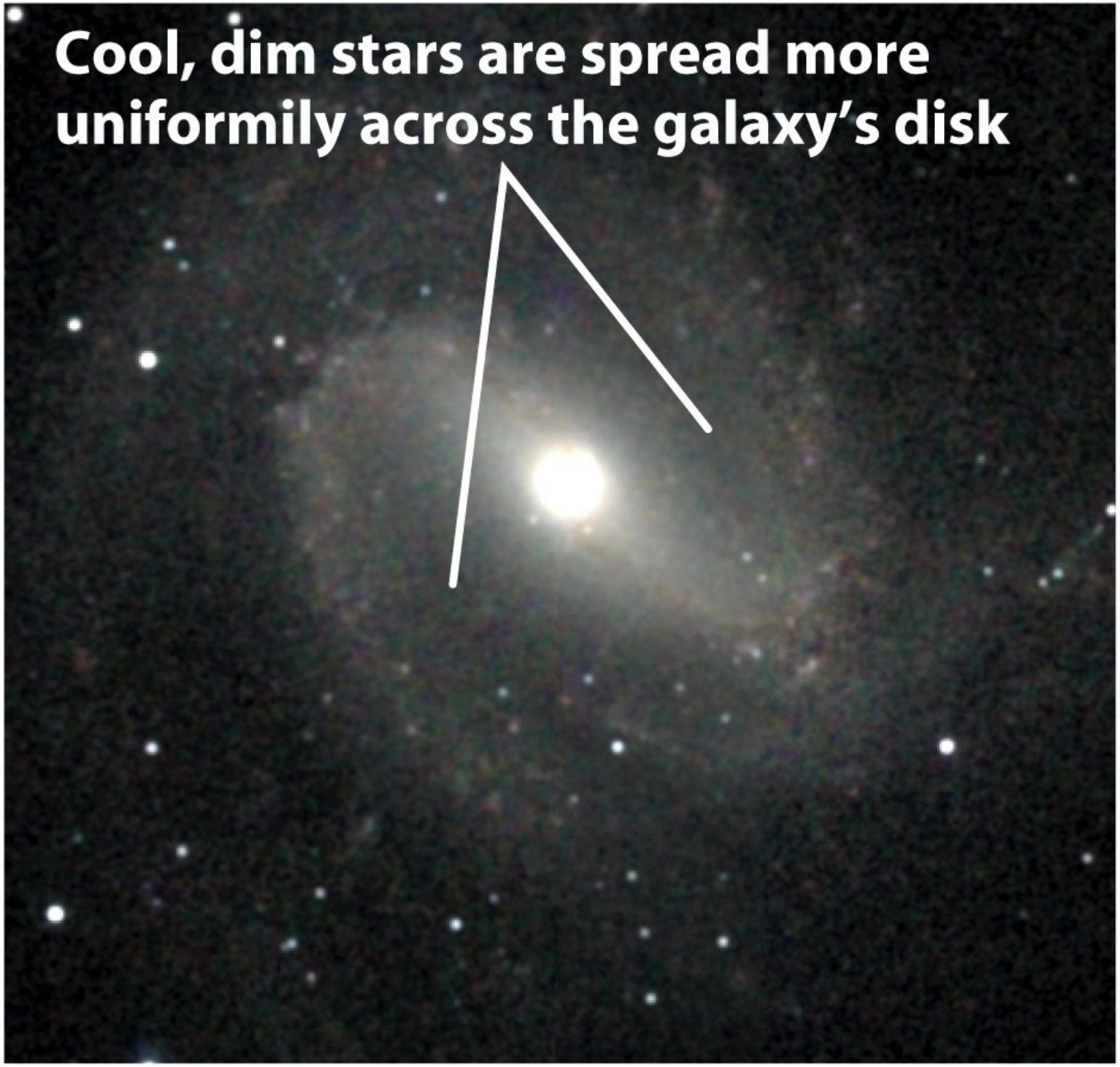
B The 3 kpc cloud completes half of a revolution in the time the 8.5 kpc cloud completes $\frac{1}{6}$ of a revolution



C The 3 kpc cloud will pass the 8.5 kpc cloud in little more than one orbit

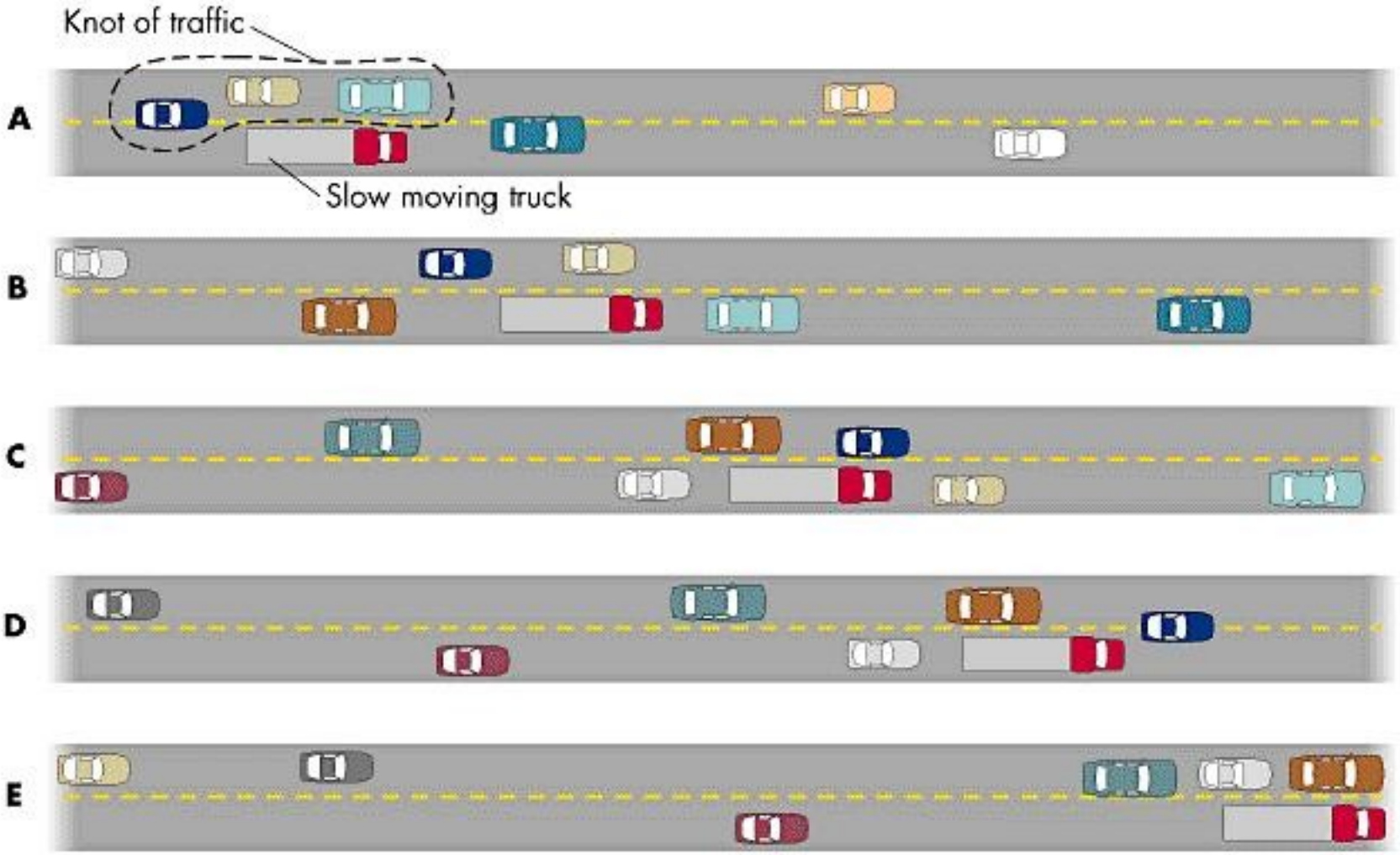


Visible-light view of M83



Near-infrared view of M83

Density waves



Spiral arms are patterns

- According to the density-wave theory, spiral arms are created by density waves that sweep around the Galaxy
- The gravitational field of this spiral pattern causes stars and gas to slow down near the arm
- This compresses the interstellar clouds, triggering the formation of stars
- The entire arm pattern rotates around the Milky Way once every 500 million years

Spiral arm structure is best found by mapping the locations of

A) Globular clusters
B) Young, massive stars
C) RR Lyra variable stars
D) Solar mass and lighter stars

Which is true of spiral arms?

A) Once a star enters a spiral arm it remains there

B) Spiral arms are spun off the core of the galaxy

C) Spiral arms contain a very high density of less than one solar mass stars

D) Stars preferentially form in spiral arms

Review Questions

- Why do stars behind dust clouds appear red?
- Why is the sky blue?
- Why are wavelengths of light outside the visible useful in studying the Milky Way?
- How is the 21 cm line of Hydrogen produced?
- Describe the spiral arms of the Milky Way and what causes them.