Killer Skies

- **Homework 9** due Monday
- Asteroid Lab and Night Obs due Friday
- Solar Observing still ongoing-- stay tuned
- Last time: Earth v. Black Hole
- Today: Center of the Milky Way

Music: *Supermassive Black Hole*– Muse

Solar Observing This Week

Last Day now!

W, 10:30am-1:30pm, weather permitting (extending)

At Campus Observatory

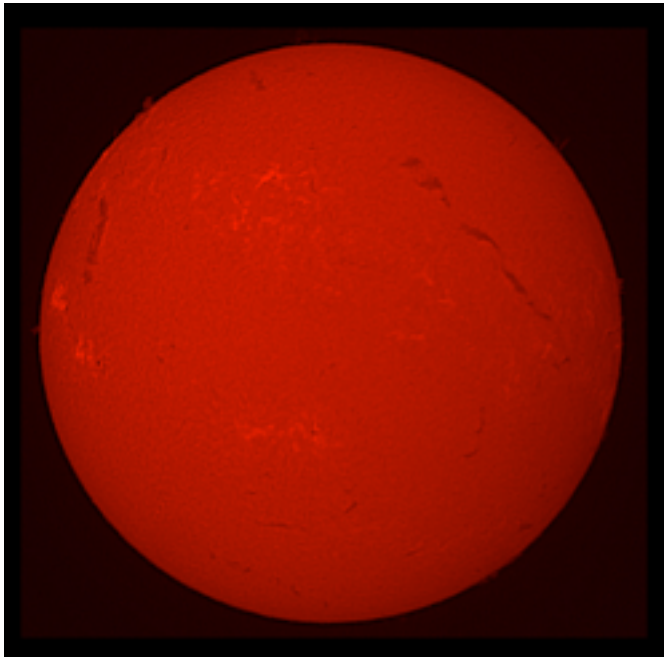
(behind building)

Assignment details and report form on class website

Report due Nov 22nd

Subscribe to Solar Observing Status Blog for weather-related notices

http://illinois.edu/blog/view/414



What About Supermassive Black Holes?

I can hear you thinking… sure micro-black holes and the cores of dead stars can be deadly.

But all very unlikely…

Is there a more massive black hole? Something like a supermassive black hole?

Yeah, they're out there… and more of them than you think…one per galaxy.

Imagine

Radio and X-ray astronomers notice something odd

Sagittarius A* is getting brighter

And bigger: appears as an expanding blob

High-energy gamma rays turn on next, along with high-energy neutrinos

The blob starts to appear in visible light

Doppler shifts show that it is made of matter traveling at huge speeds >99% c

Eventually it fills half of the night sky

Sagittarius A* = center of galaxy!

Imagine

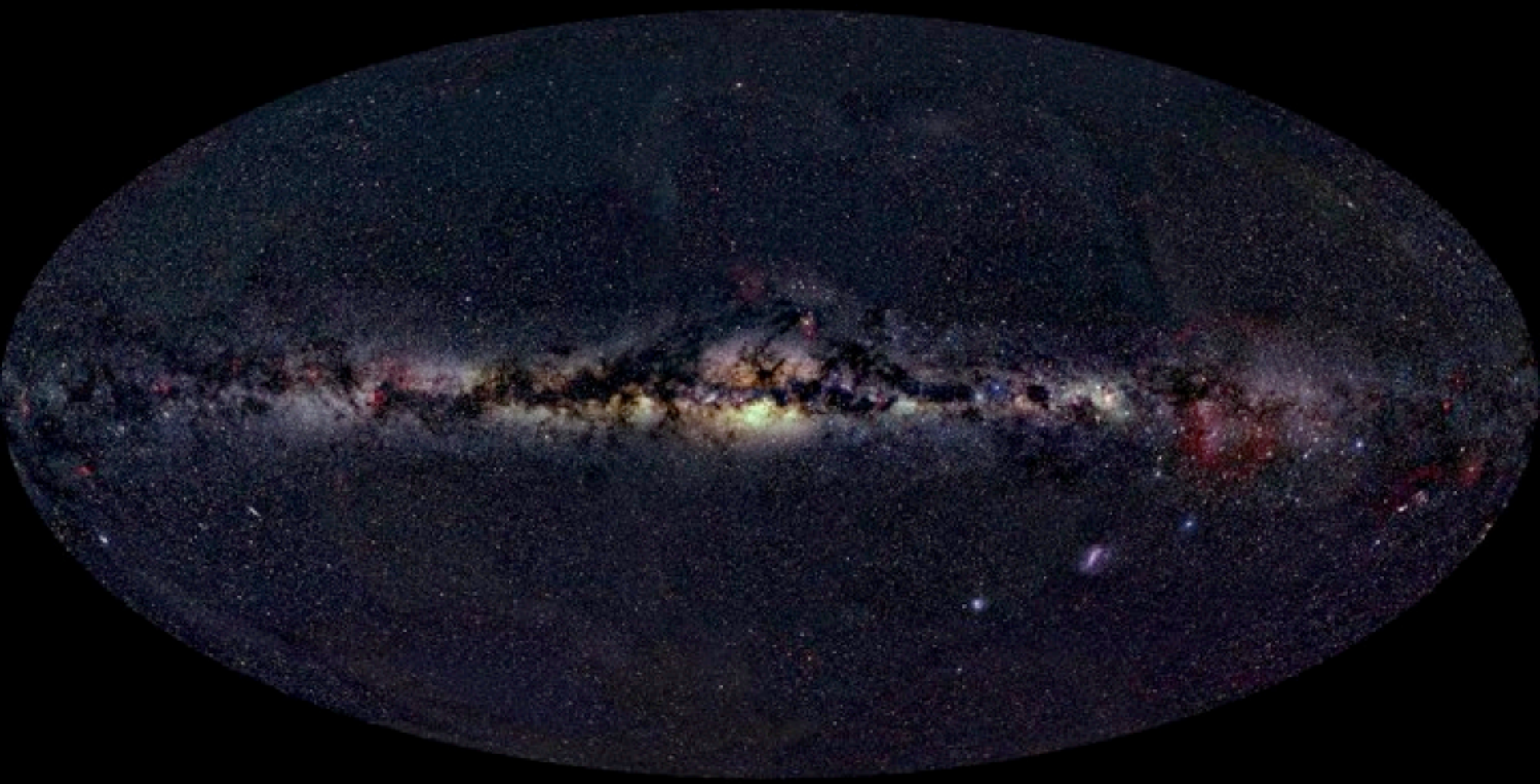
- The UV, X-rays and gamma-rays become ever more intense
- The Earth's ozone layer is totally stripped clean
- The Sun's UV rays destroy the food chain and initiate a mass extinction
- Finally, the solar system is engulfed in the blast of a plasma filled with positrons
- The blast pushes back the solar wind, possibly inside 1 AU
- The Earth will be bathed by intense cosmic rays for thousands of years
- As you die in pain, you wonder if this is what Leslie meant by a relativistic jet.

Death by Relativistic Jet

The center of the Galaxy likely used to have a dangerous beam of death, but it has been quite for a very long time...

Perhaps it is time to get dangerous again?

The Milky Way



http://home.arcor-online.de/axel.mellinger/mwpan_aitoff.html

iClicker Poll: Our Milky Way Galaxy

Milky Way to eye: irregular band of light

go see it!

need to drive a few miles out of town on a clear night

Vote your conscience!

What is the dominant Milky Way light source?

(A) predominantly gas

(B) predominantly stars

(C) roughly equal mix

Answer: A It is made out of stars!

The Milky Way Revealed

Galileo's telescope showed:

- Milky Way made (mostly) of stars
- so numerous and distant their light smeared together to your eye

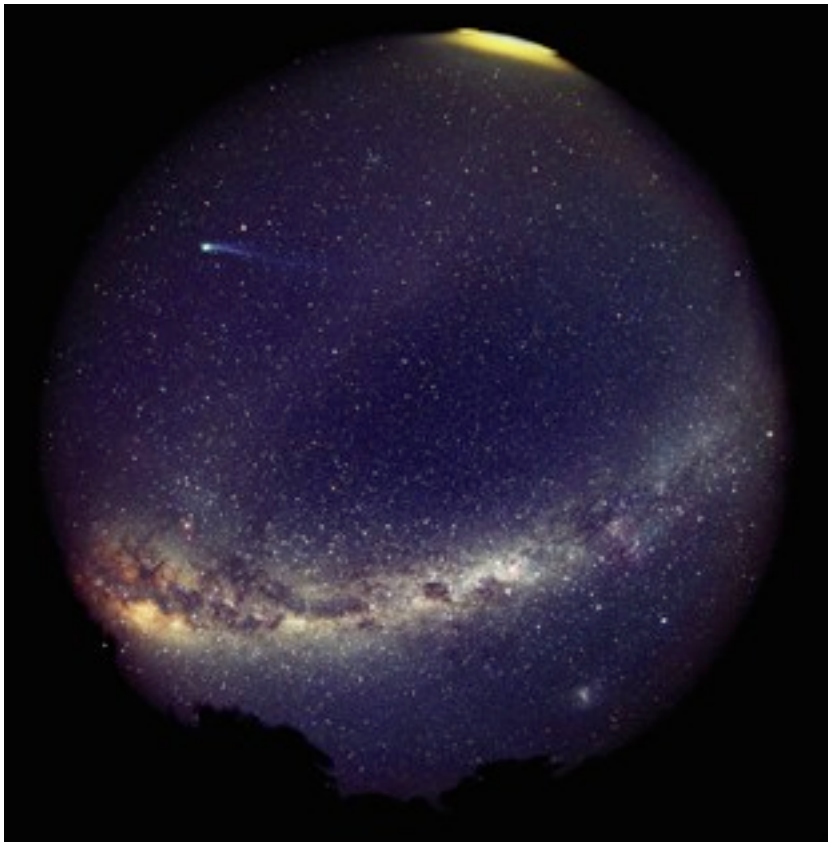
But indeed, there are also gas clouds

and dark splotches

and -- as well will see -- much more stuff than what meets the eye

What is the shape of the galaxy?

- Nearby stars are all over the sky
- Distant stars make a faint band of light circling the entire sky
  - **The Milky Way**
- *Q: if MW is circle on 2-D sky, how are stars arranged in 3-D space?*
- Suggests the overall population of stars is *disk-shaped*
  - *note similarity with Solar System planets lying in a plane*
- Population of stars called the **Galaxy**

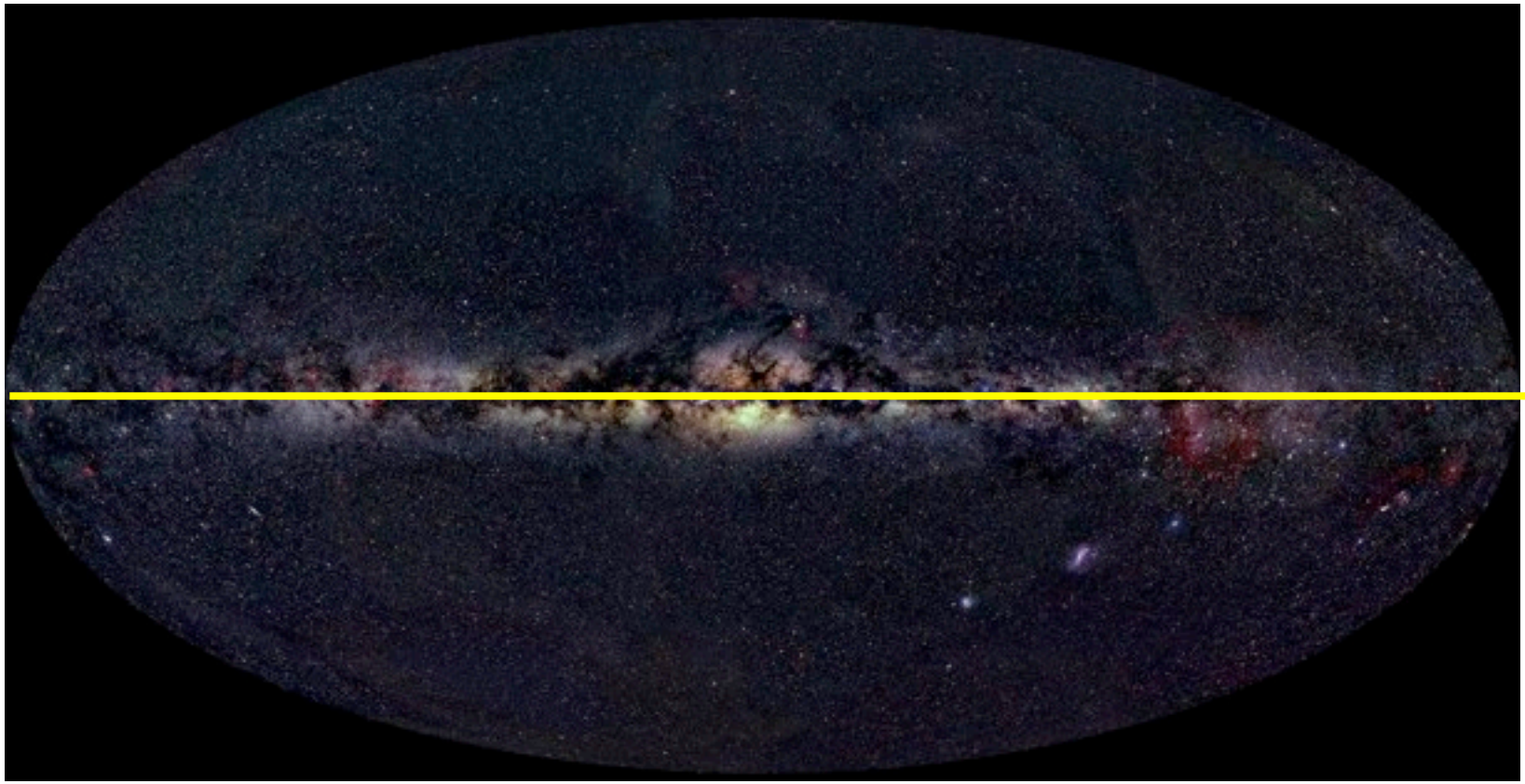


The ancient Greeks named the band of light '*galaxies kuklos*' - the '*milky circle*'

We are inside - can't see the forest for the trees.
The Romans changed the name to 'via lactea'—'milky road' or 'milky way.'
Galileo's telescope revealed that the glowing Milky Way was made up of stars.
Only a wheel or disk shape would look, from the inside, like the Milky Way band encircling the sky.

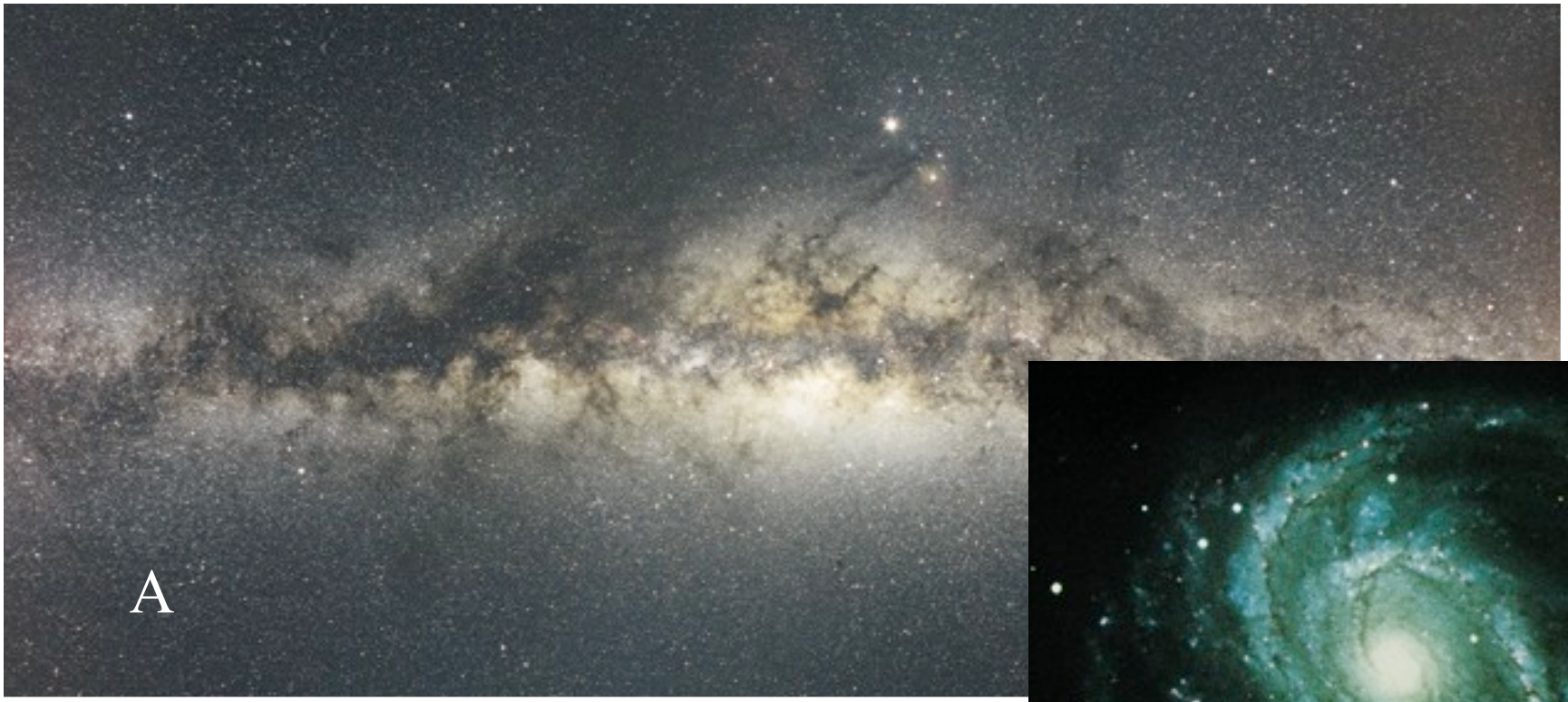
The Milky Way

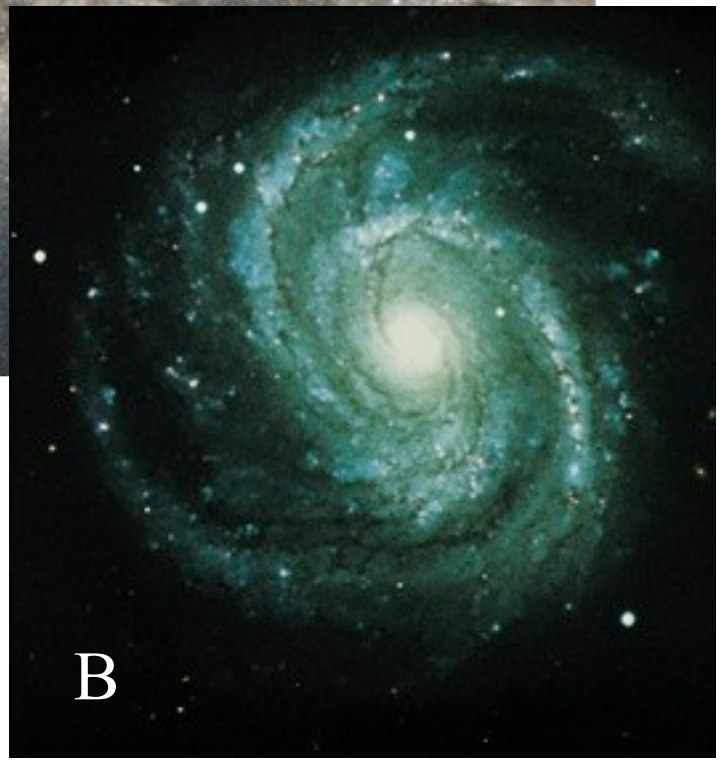
- Our galaxy is a collection of stars, nebulae, molecular clouds, and stellar remnants
  - All bound together by gravity
  - Connected by the stellar evolution cycle



Map of the entire sky in visible light

Which is a picture of the Milky Way?





A is what we see from Earth inside the Milky Way.

B is what the Milky Way "might" look like if we were far away looking back at our own galaxy from some other galaxy

The Milky Way is made of all the stars in our galaxy– about 100 billion. All the stars you can see in the sky are in our Galaxy.

Enormous clouds of dust obscure our view of most of the stars in our Galaxy

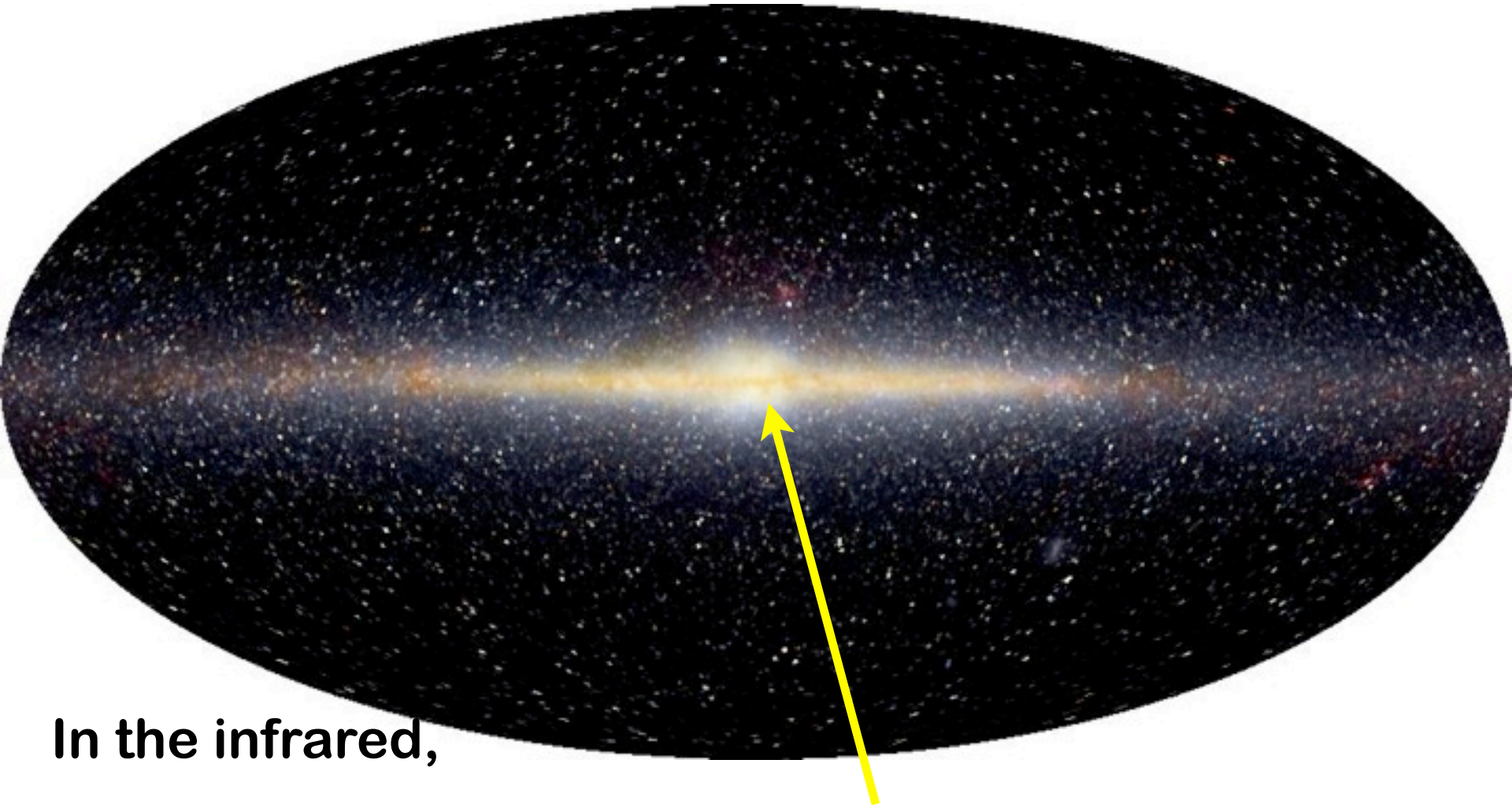
Question

The Milky Way is

a) effectively the observable Universe
b) a galaxy made up of stars, stellar remnants, dust, and gas.
c) a tasty treat.
d) the beautiful band of light seen in the night sky with an unknown origin.
e) all of the stars you can see with a telescope.

Answer: B

Our Home



In the infrared,

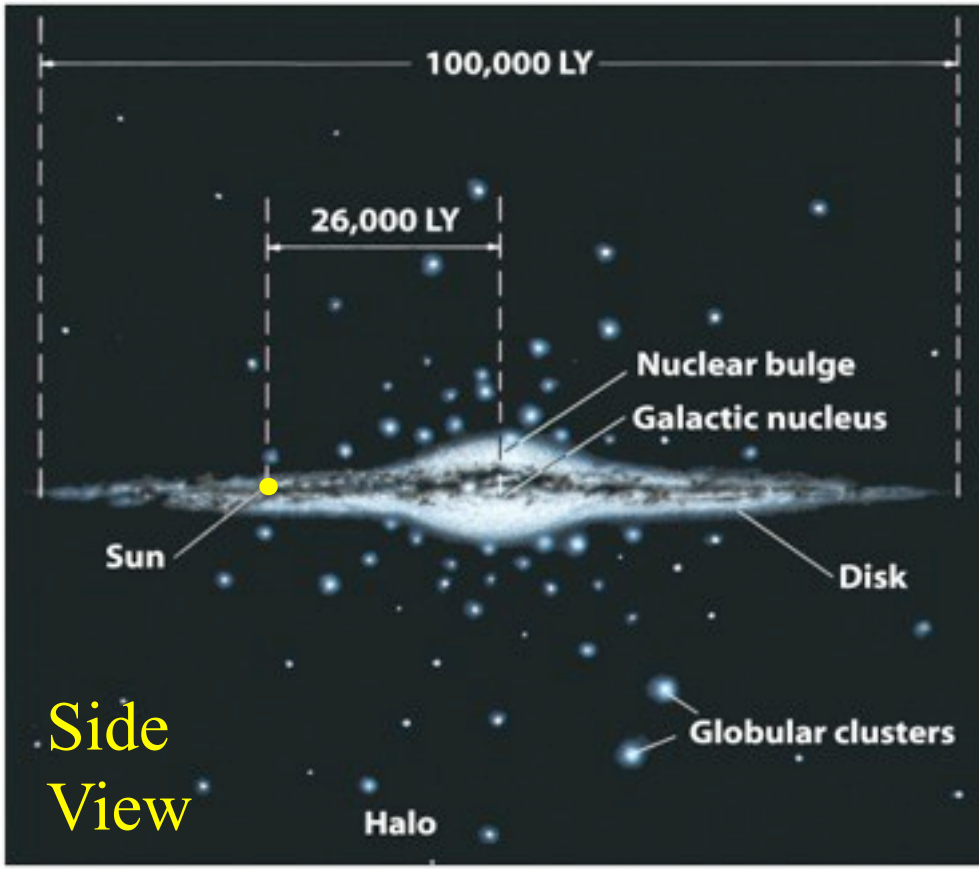
can see through dust

Center of the Galaxy

http://antwrp.gsfc.nasa.gov/apod/image/0001/milkyway_cobe_big.jpg

Our Galaxy

- Globular clusters– halo of oldest stars
- Galactic nucleus– dense collection of stars (center of Galaxy)
- Nuclear bulge– mostly old stars, but very densely packed
- Spiral arms and the disk– mostly young stars and lots of dust
- Note position of the Sun, just over half way out.



Parts of the Milky Way:

Halo, Bulge, disk, nucleus.

The Disk

- The disk of our Galaxy contains most of its visible mass
  - 90% of the Galaxy's stars

- It's where "the action" occurs
  - Star formation, nebulae, etc..
- Relatively thin
  - 1,000 lyrs thick vs. 100,000 lyrs across

Spiral Arms?

Other disk galaxies show spiral arms

- Made of O- & B-type stars, diffuse nebulae, and most of the giant molecular clouds

How do we know our Galaxy has them?

It's the problem of not seeing the forest for the trees

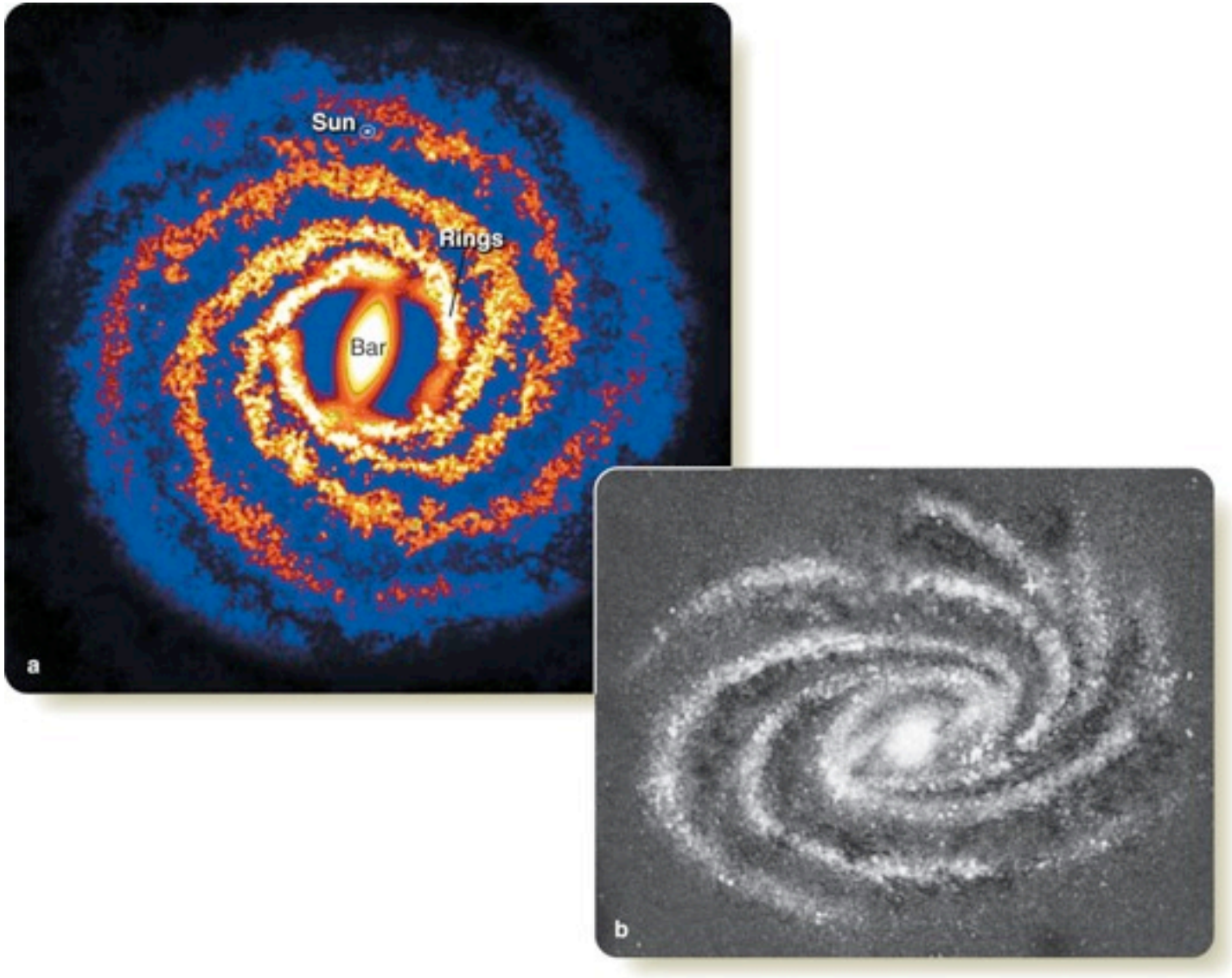
Hints of Spiral Arms

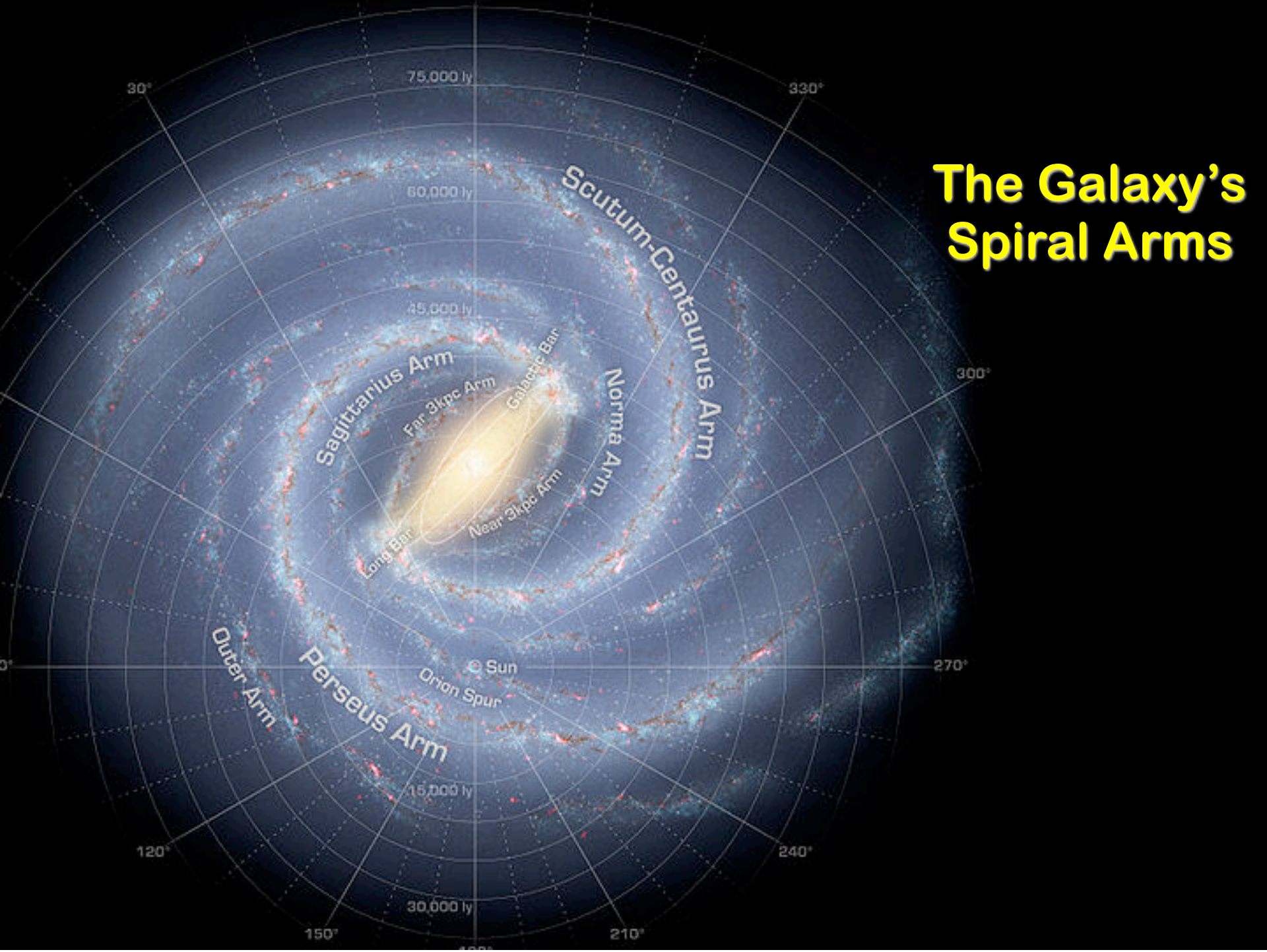
We plot the locations of nearby massive, bright stars in our Galaxy

Find the stars are arranged in arms

Our Sun is in-between spiral arms

The Galaxy's Spiral Arms





The Galaxy's Spiral Arms

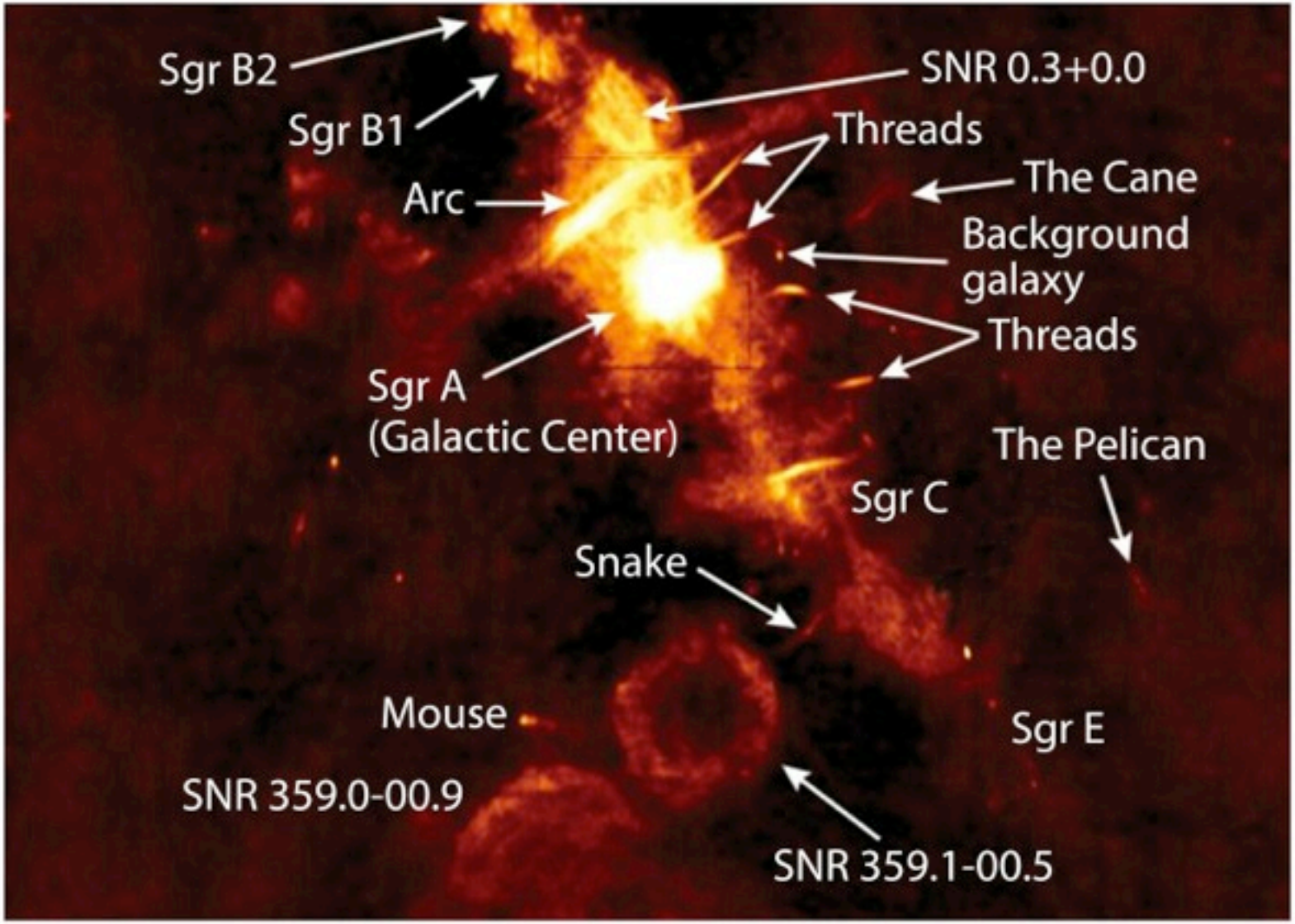
The Galactic Halo

- Our Galaxy's disk is surrounded by a spherical halo of old stars & globular clusters
  - Red dwarfs and red giants – old stars
  - Only about 2% the number of stars in the disk

The Bulge

- The region where the disk and the halo merge
  - About 2,000 pc across
  - Contains about 10% of the Galaxy's stars
- Mix of primarily old stars, but also contains some young stars and gas & dust
- Like an extension of both the disk and halo

The Center of Our Galaxy

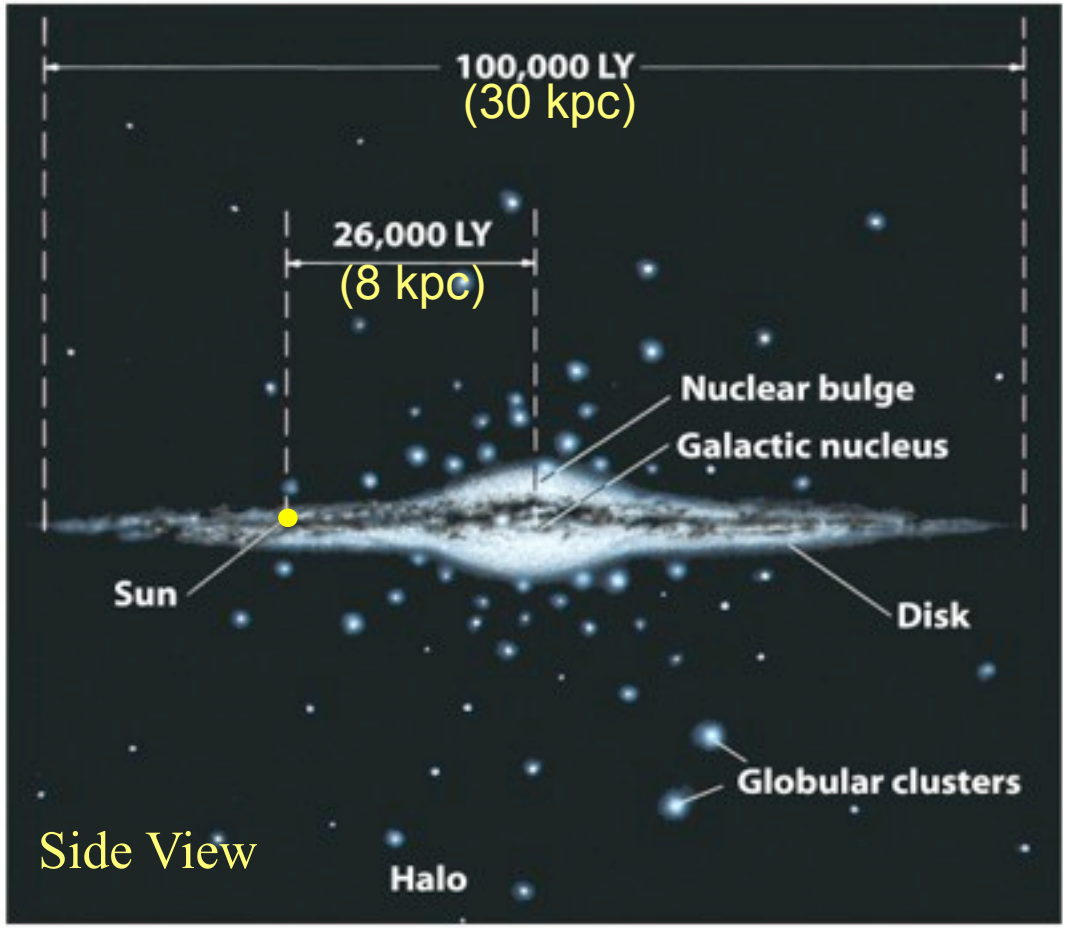


The Galactic Nucleus

- Buried in the center of the bulge
- 21,000 lys away
- Incredibly dense region of stars and gas

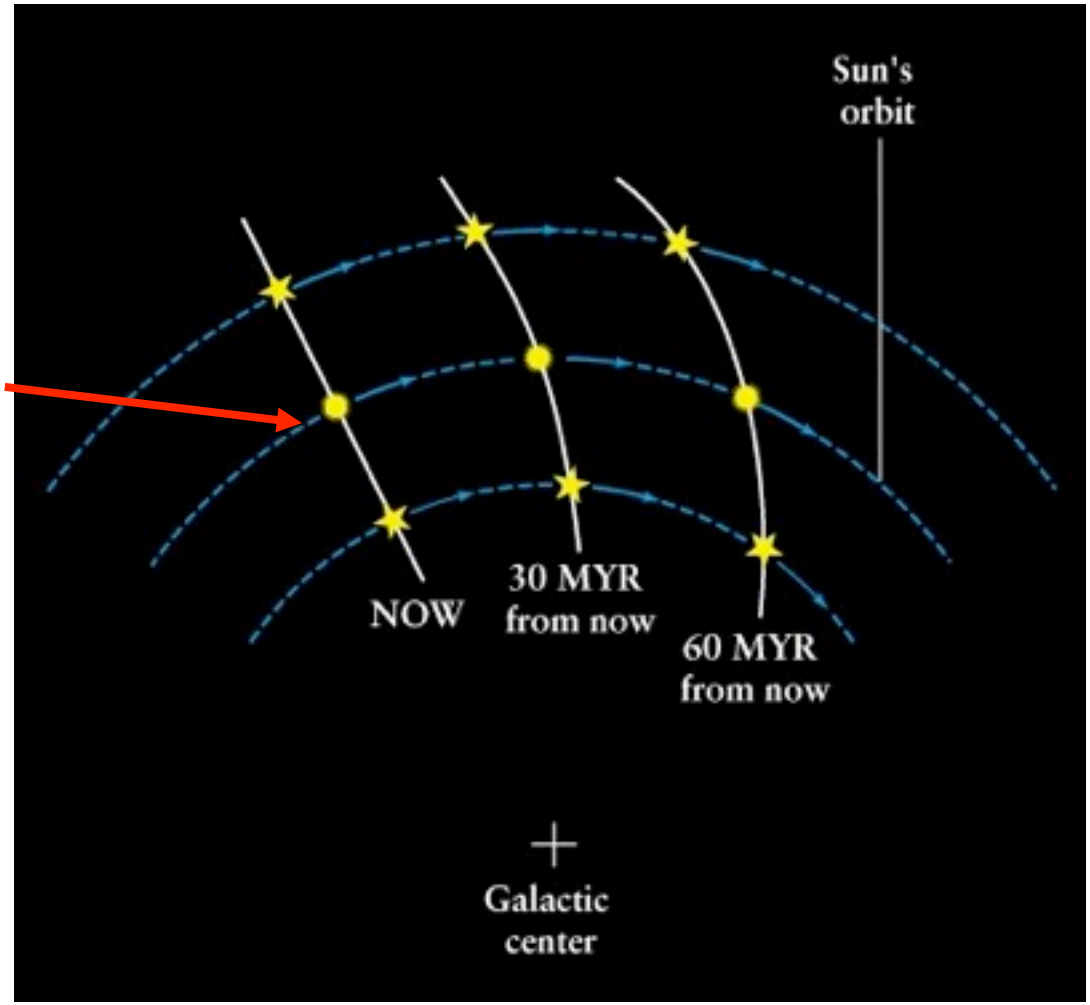
The Structure of Our Galaxy

- Disk
  - All kinds of stars, many younger
  - Open clusters
  - Gas and dust
- Halo
  - Old, red dwarfs and giants
  - Little gas and dust
  - Globular clusters
- Bulge
  - Mixture of halo and disk



We Orbit the Center

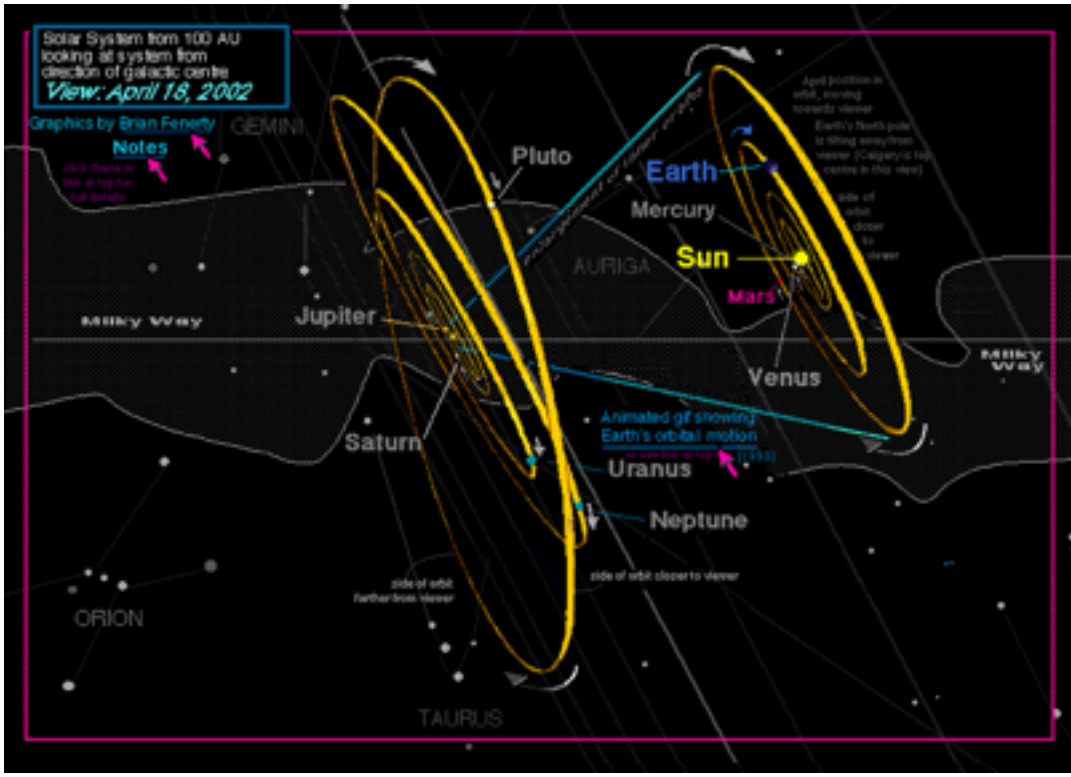
The Sun orbits at 220 km/s or about 500,000 mph– 230 million years per orbit!



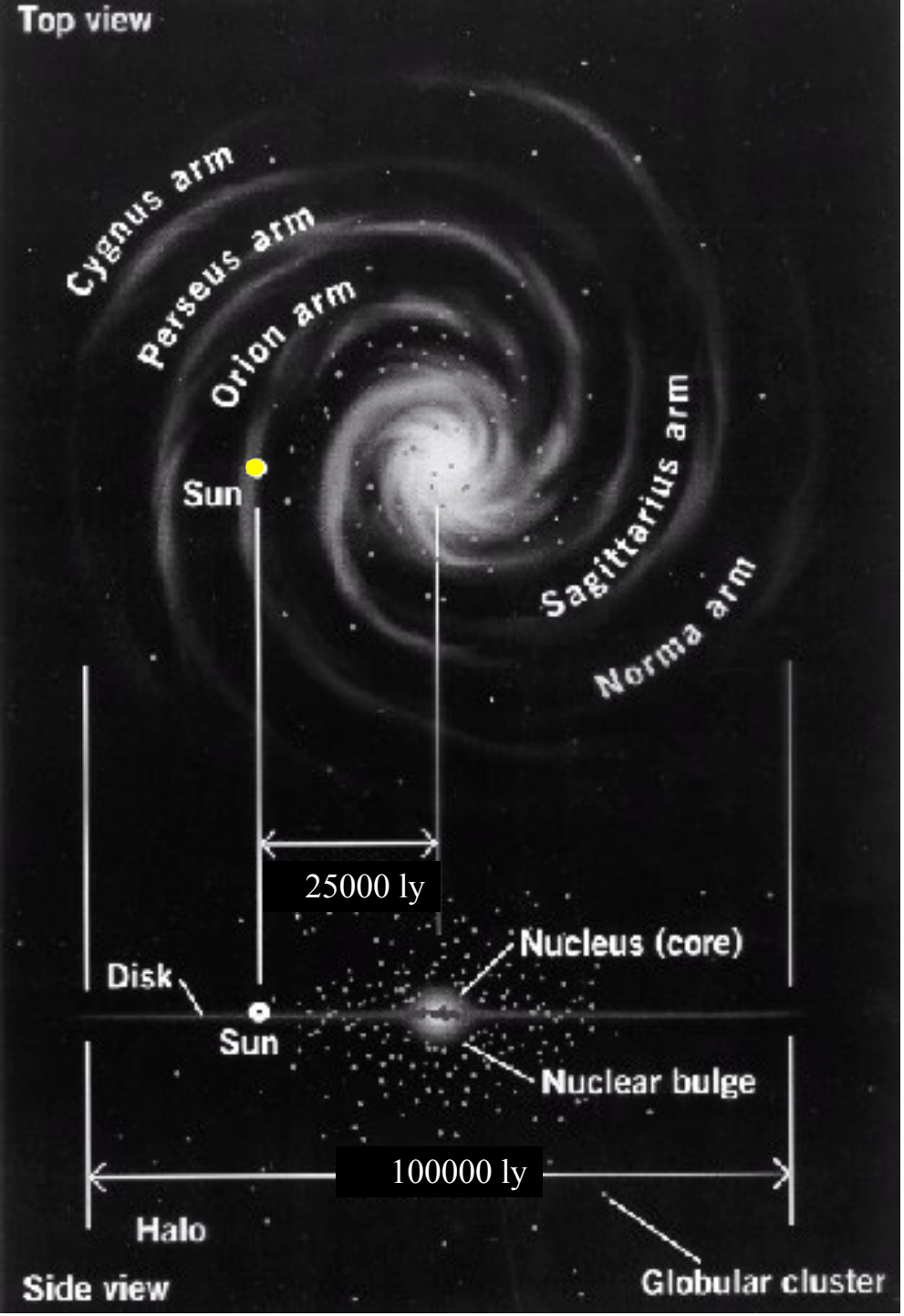
Wow! That's fast!

Stop and think about it.

- **That's traveling to Chicago in 1 second!**
- But Milky Way is big!
- Earth has **only** orbited 50 times!
- Last time the Sun was here, the dinosaurs were just starting out.
- ¼ way around, they were extinct!



View of Solar System from Galactic center. We are not aligned!


Top view
Cygnus arm
Perseus arm
Orion arm
Sagittarius arm
Norma arm
Sun
25000 ly
Nucleus (core)
Disk
Sun
Nuclear bulge
100000 ly
Halo
Side view
Globular cluster

Our Galaxy

Galaxy Song

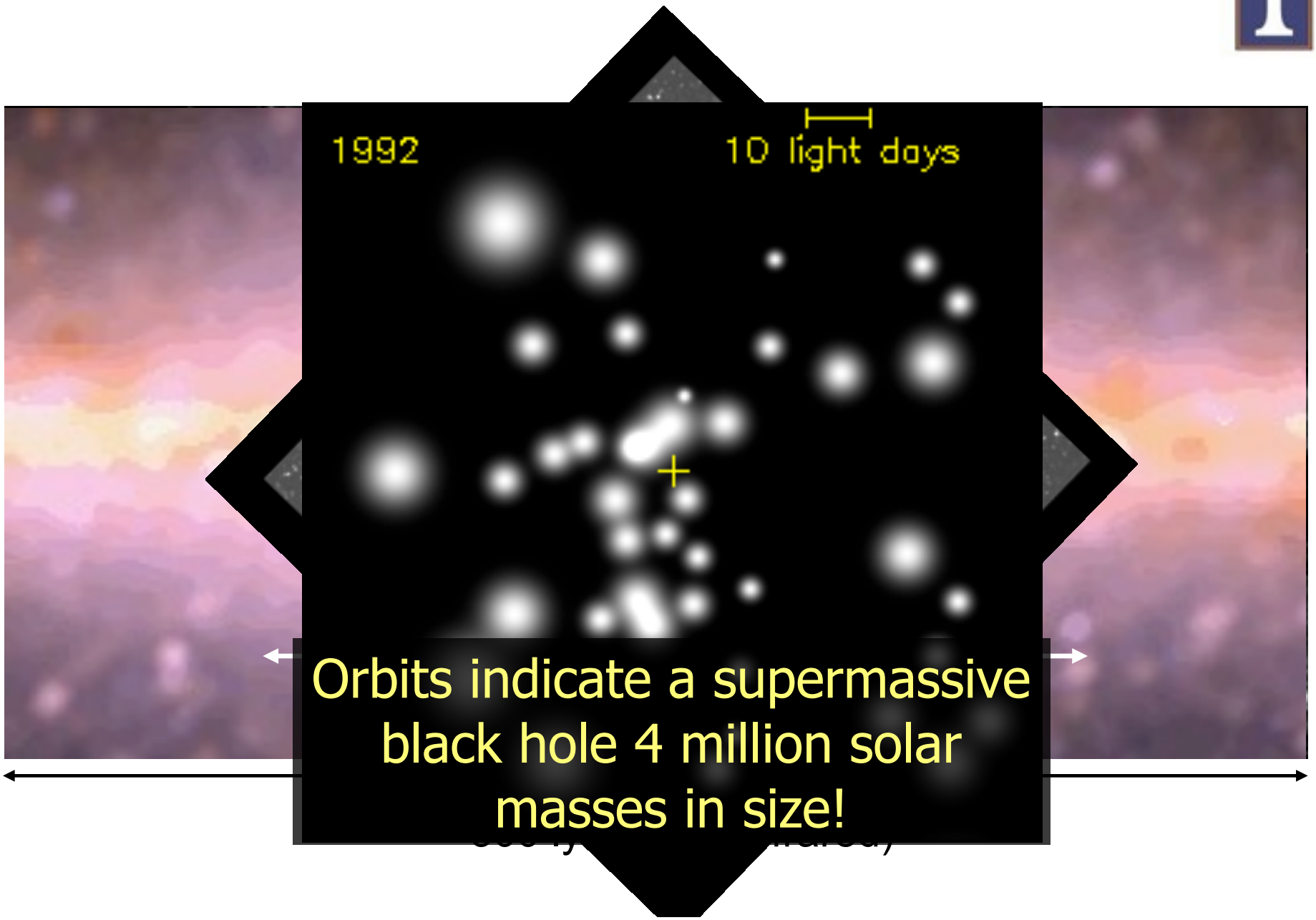
Monty Python's The Meaning of Life (1983)

The Center of the Galaxy

Ever wondered what is at the center of our galaxy? What do you expect?

A. Nothing
B. A large very massive star
C. There is no way to know
D. A massive black hole
E. A regular sized black hole

The Monster at the Center of the Galaxy



From optical image, to infrared, to zoomed infrared

The Center of Our Galaxy

http://www.youtube.com/watch?v=duoHtJpo4GY