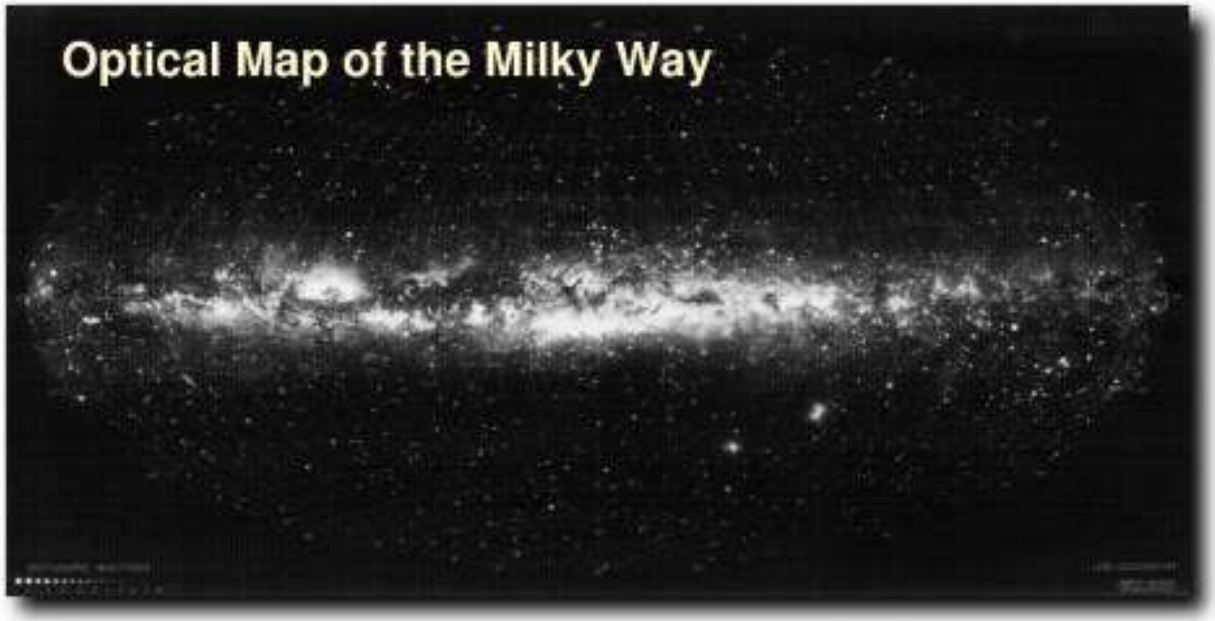
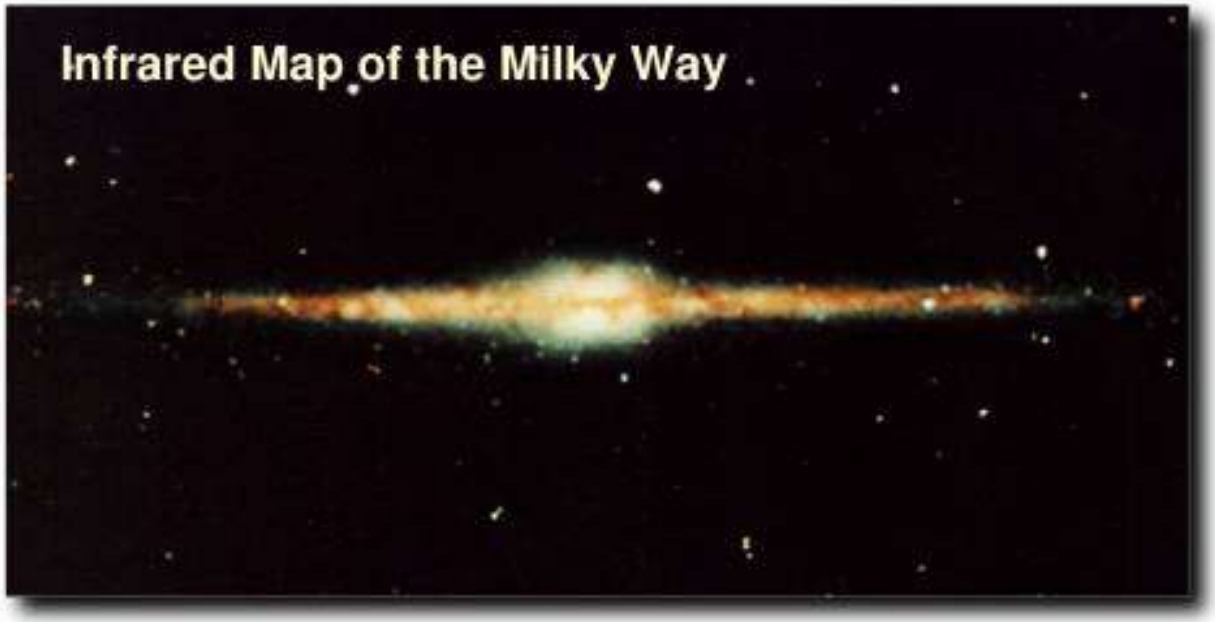
Chapter 15: **The Milky Way Galaxy**





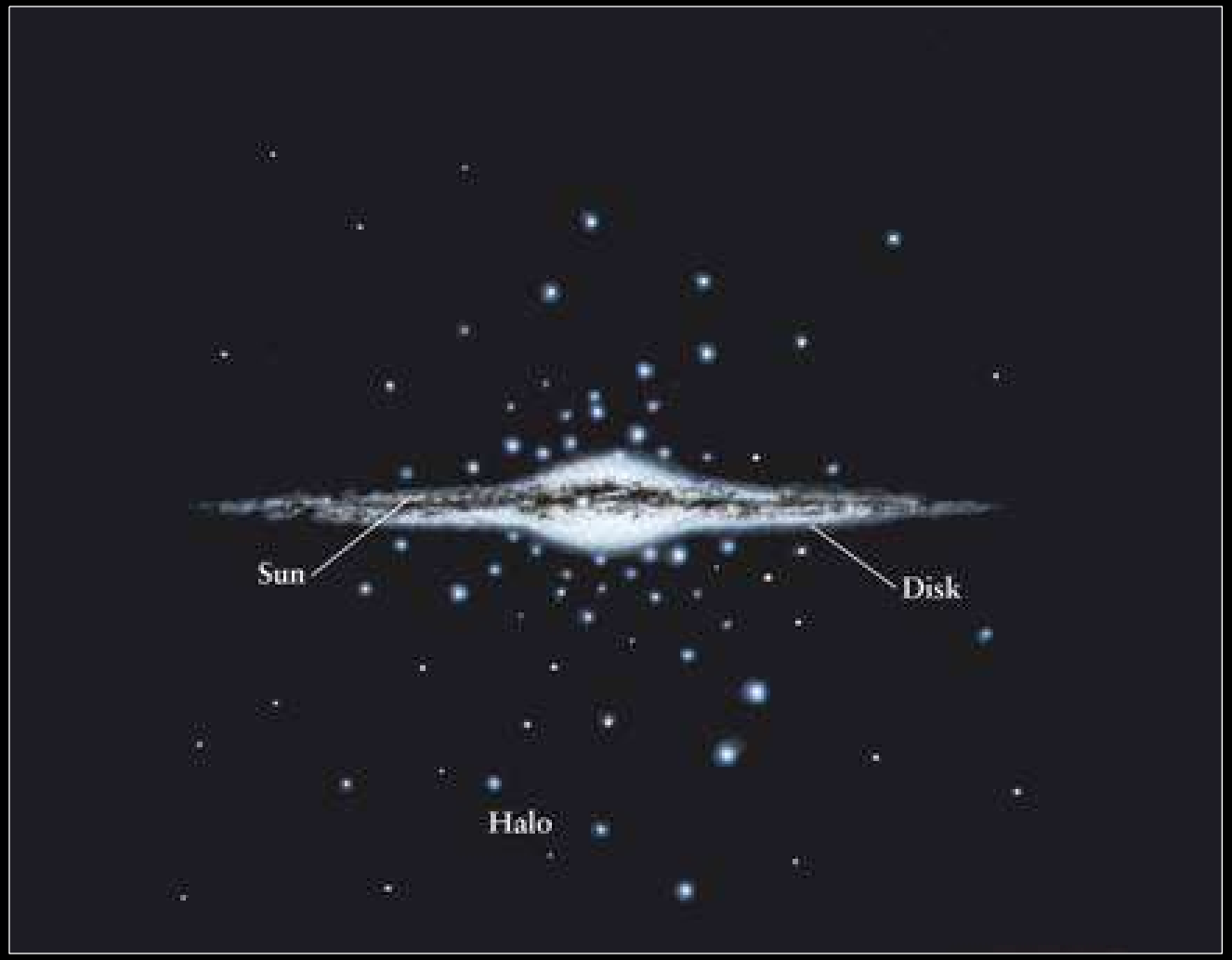
WHAT DO YOU THINK?

- How many stars does the Milky Way Galaxy contain?
- Where is our Solar System located in the Milky Way Galaxy?
- Is the Sun moving through the Milky Way Galaxy and, if so, about how fast?

You will discover…

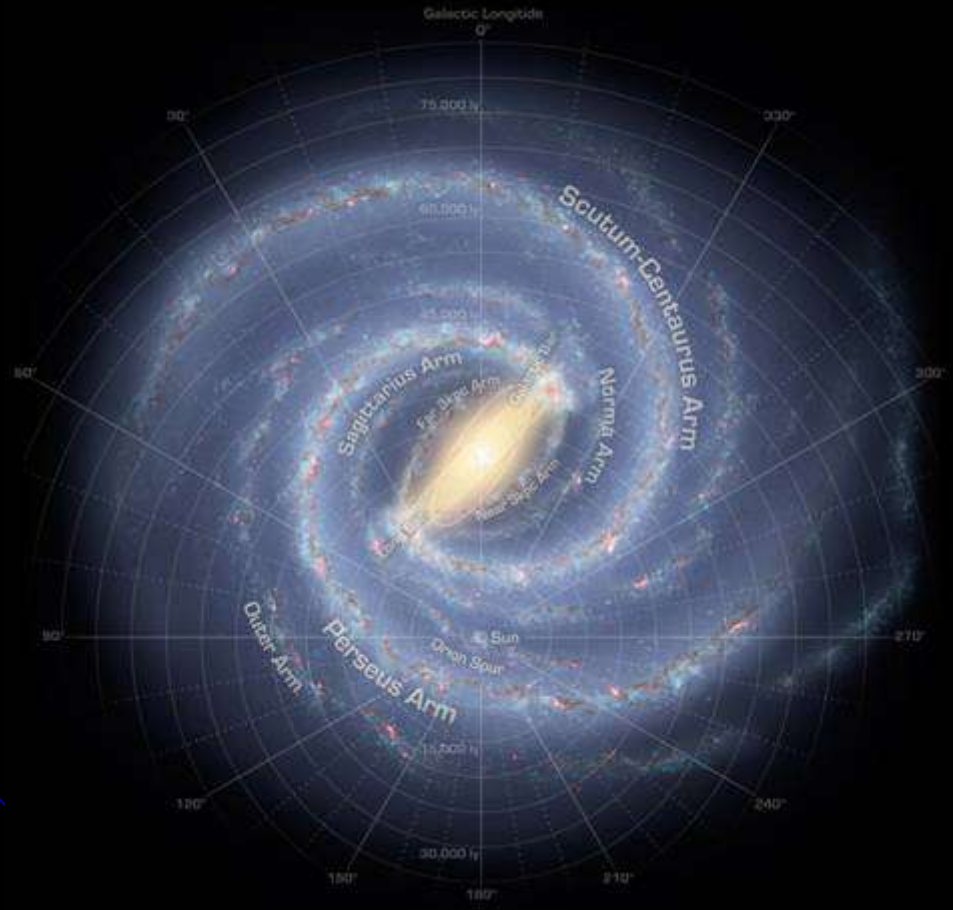
- The Milky Way Galaxy is made of billions of stars, and gas and dust, all bound together by mutual gravitational attraction.
- The properties of our Milky Way Galaxy.
- Earth's location in the Milky Way.
- That there is a huge Black Hole at the center of our Galaxy.
- That observations reveal the presence of significant hidden mass in the Milky Way – but we don't know what it is.

The Milky Way – Side View



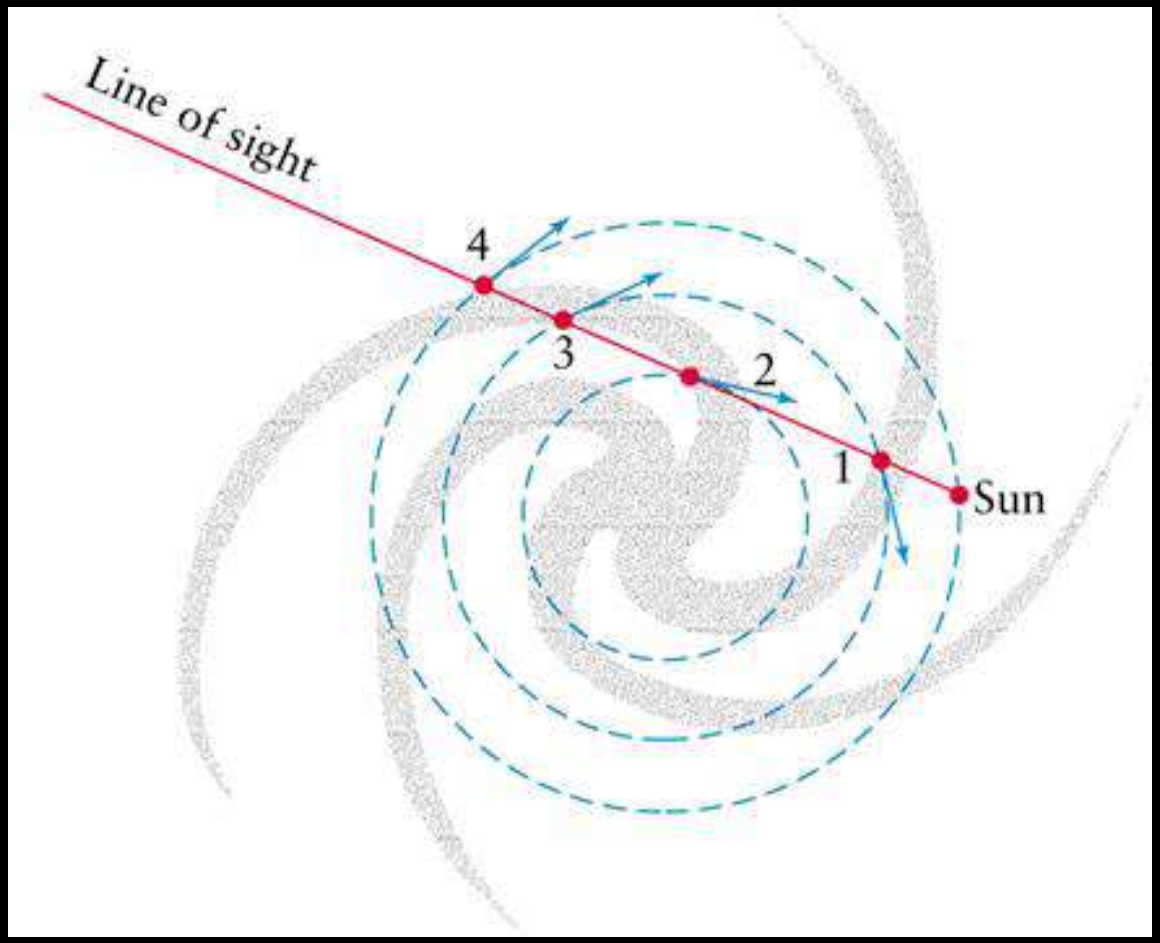
Edge-on view showing the Milky Way's disk, nuclear bulge, and halo.

The Milky Way – Top View



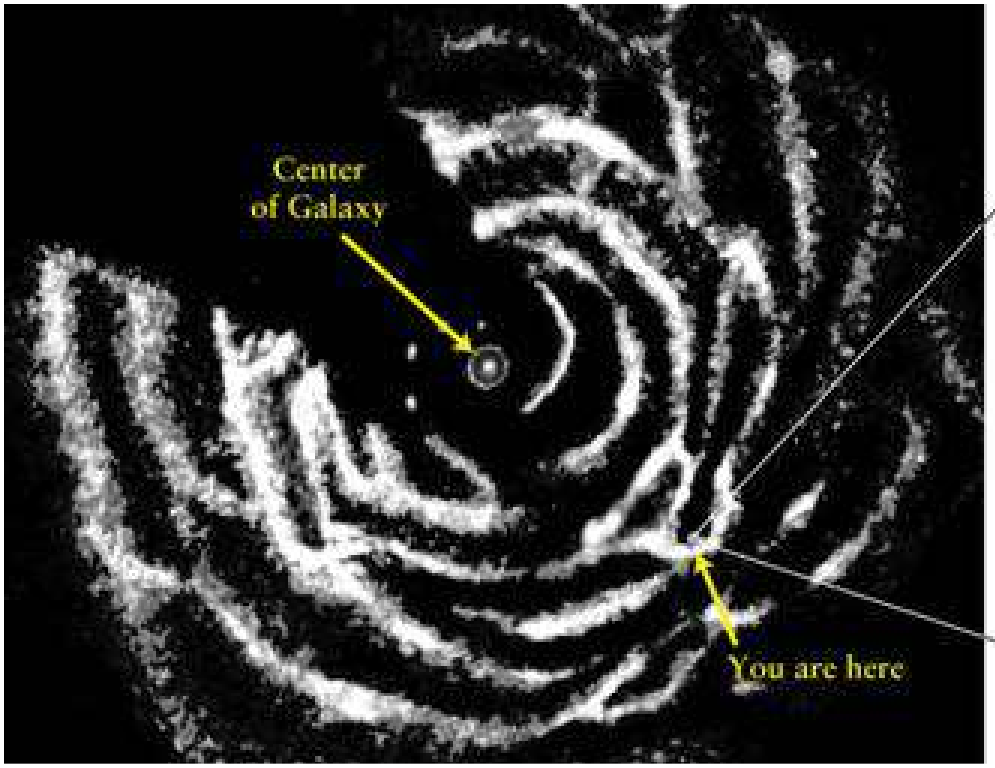
Top view showing spiral arms. Latest research shows that the Milky Way also has a bar in the center.

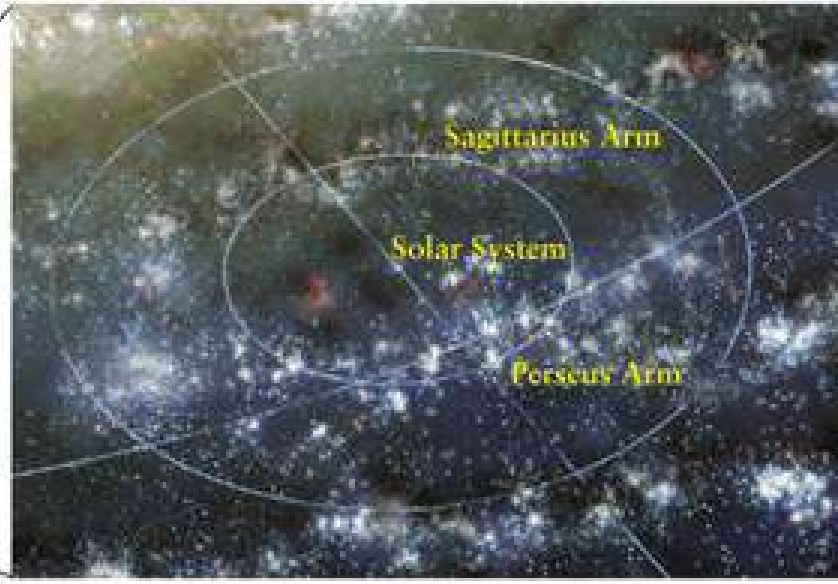
How We Map the Galaxy



Radio waves from different gas clouds show slightly different Doppler shifts, permitting astronomers to sort out the gas clouds and map the Galaxy.

Map of the Galaxy

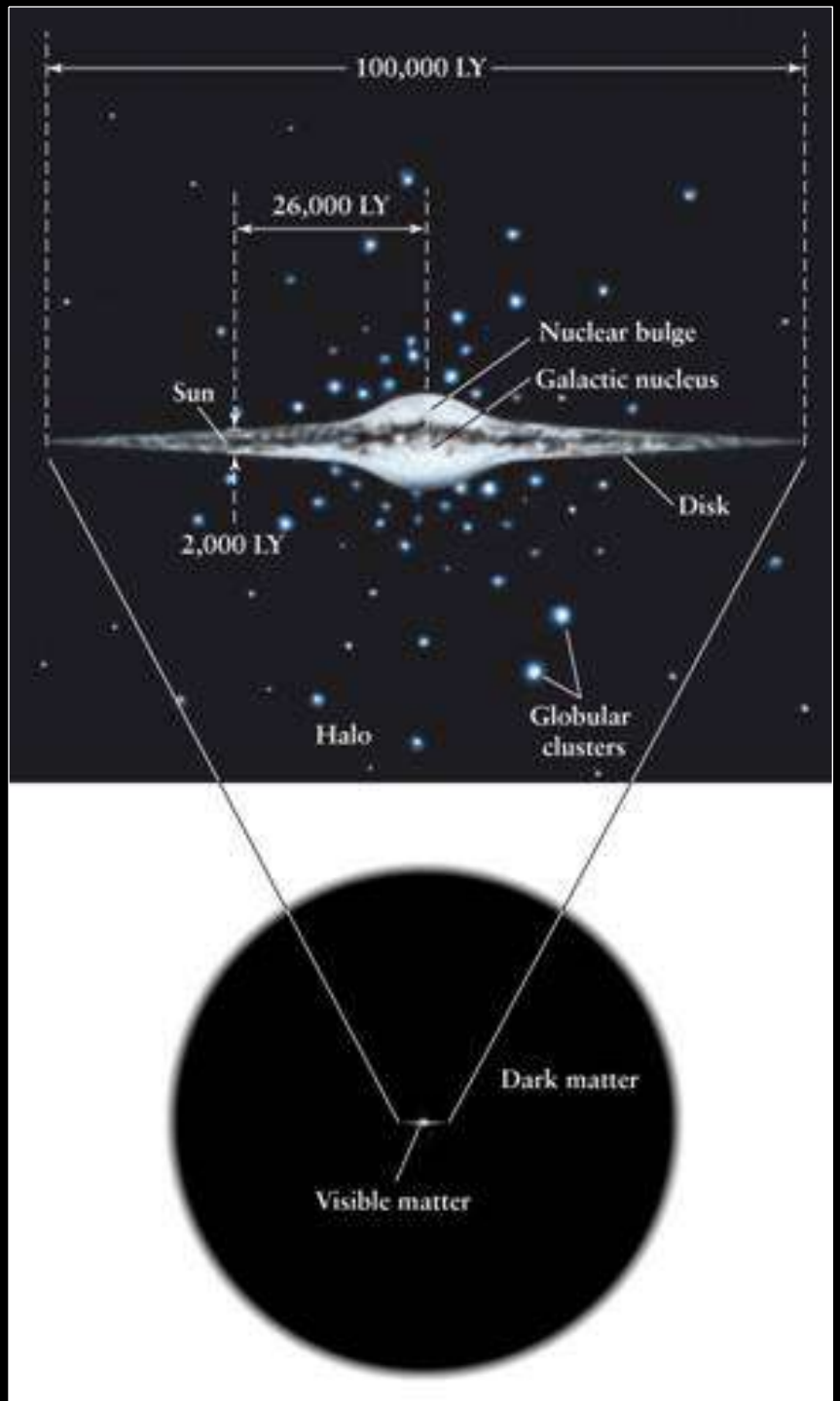




This map (left), based on radio telescope surveys of 21-cm radiation, shows the distribution of hydrogen gas in the Milky Way.

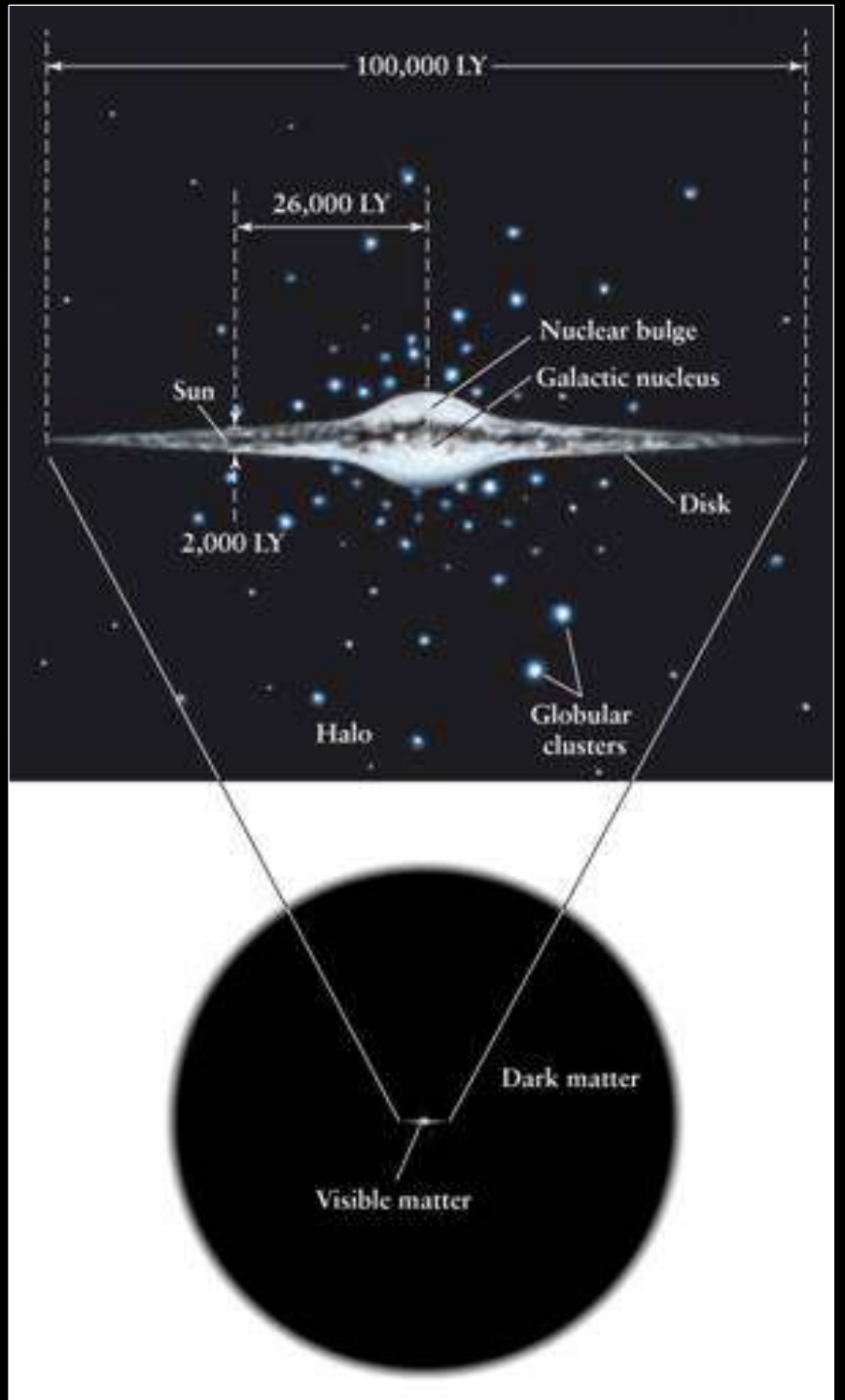
How Big? How Many Stars?

- Diameter 100,000 light years (only the visible stuff – dark matter area is much larger).
- 2,000 light years thick where we are.
- 200 billion stars.
- Sun is 26,000 light years from the galactic center.

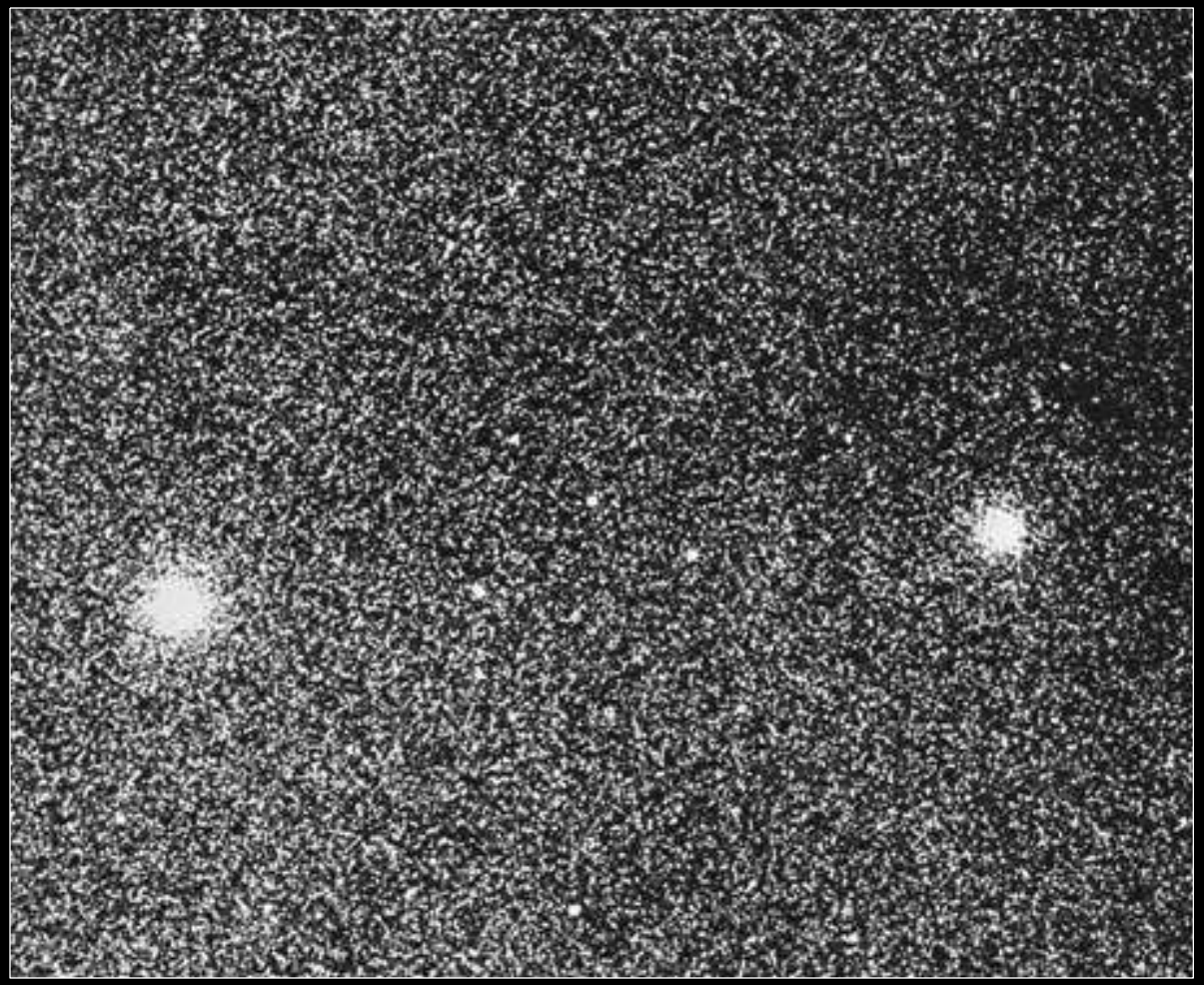


What Kinds of Stars?

- Nuclear bulge about 20,000 light years diameter.
- Disk contains gas, dust, and Population I stars (young, metal-rich stars).
- Halo is composed mostly of Population II stars (old, metal-poor stars).

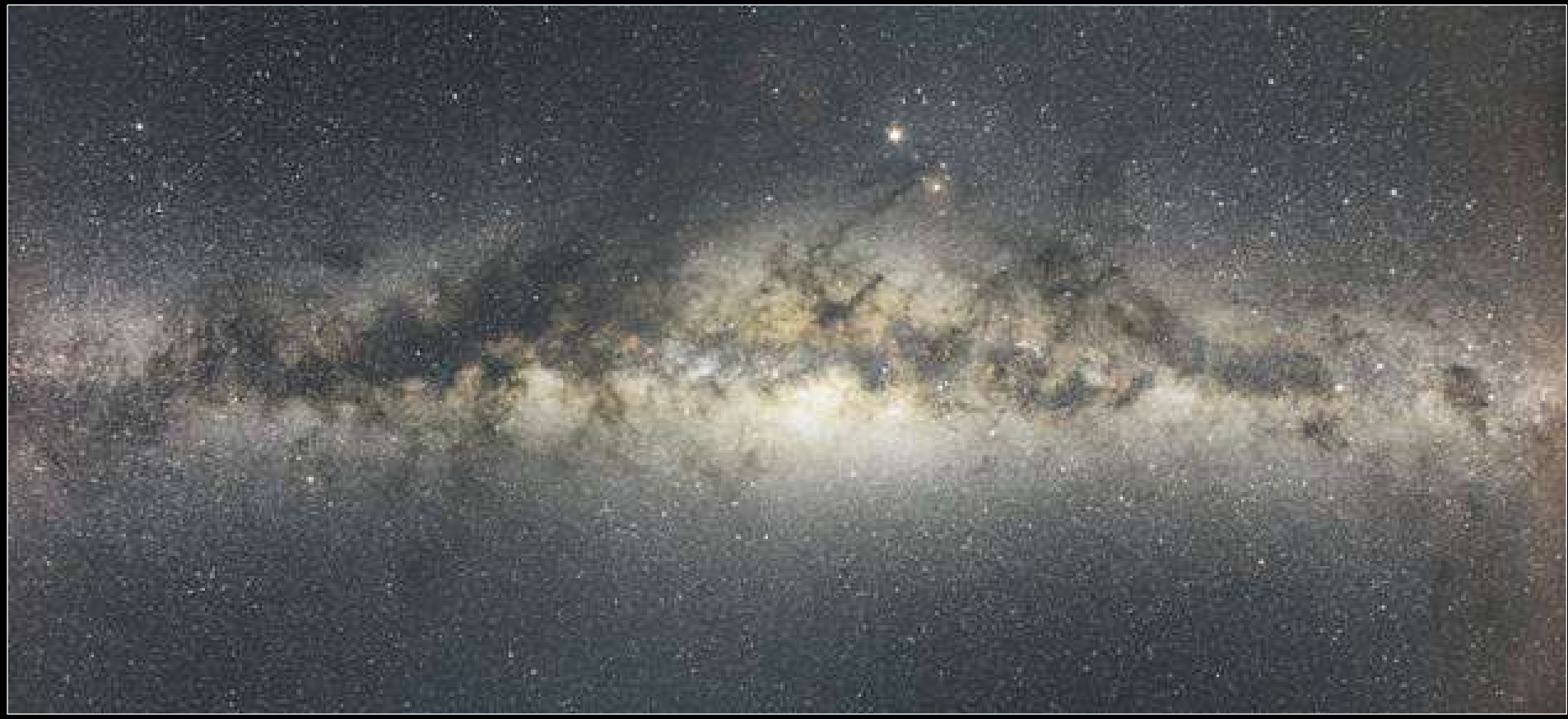


View Toward the Galactic Center

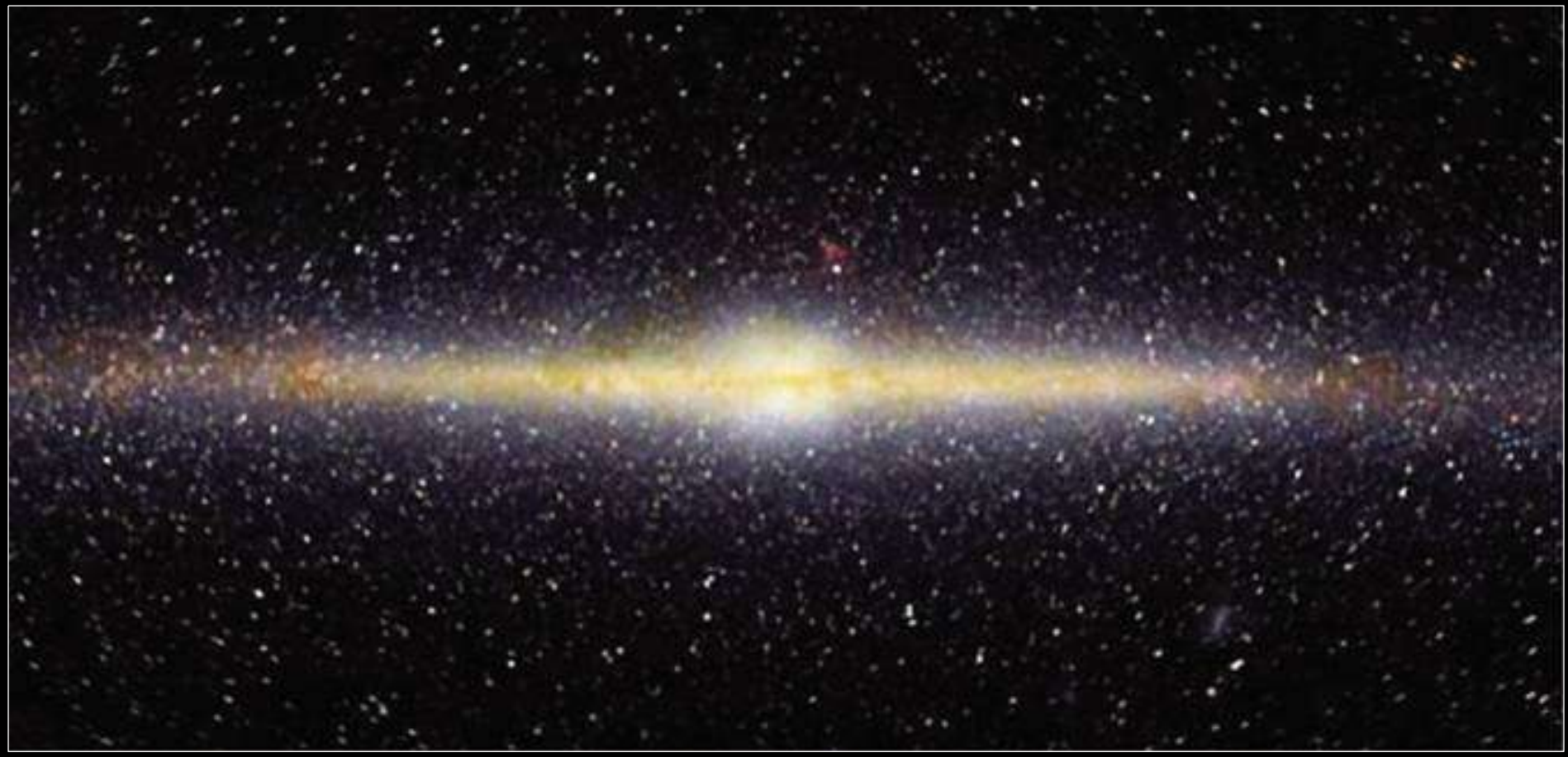


More than a million stars in the disk of our Galaxy fill this view, looking toward the galactic nucleus in Sagittarius.

Looking toward the Galaxy Center in Sagittarius – Visible Light



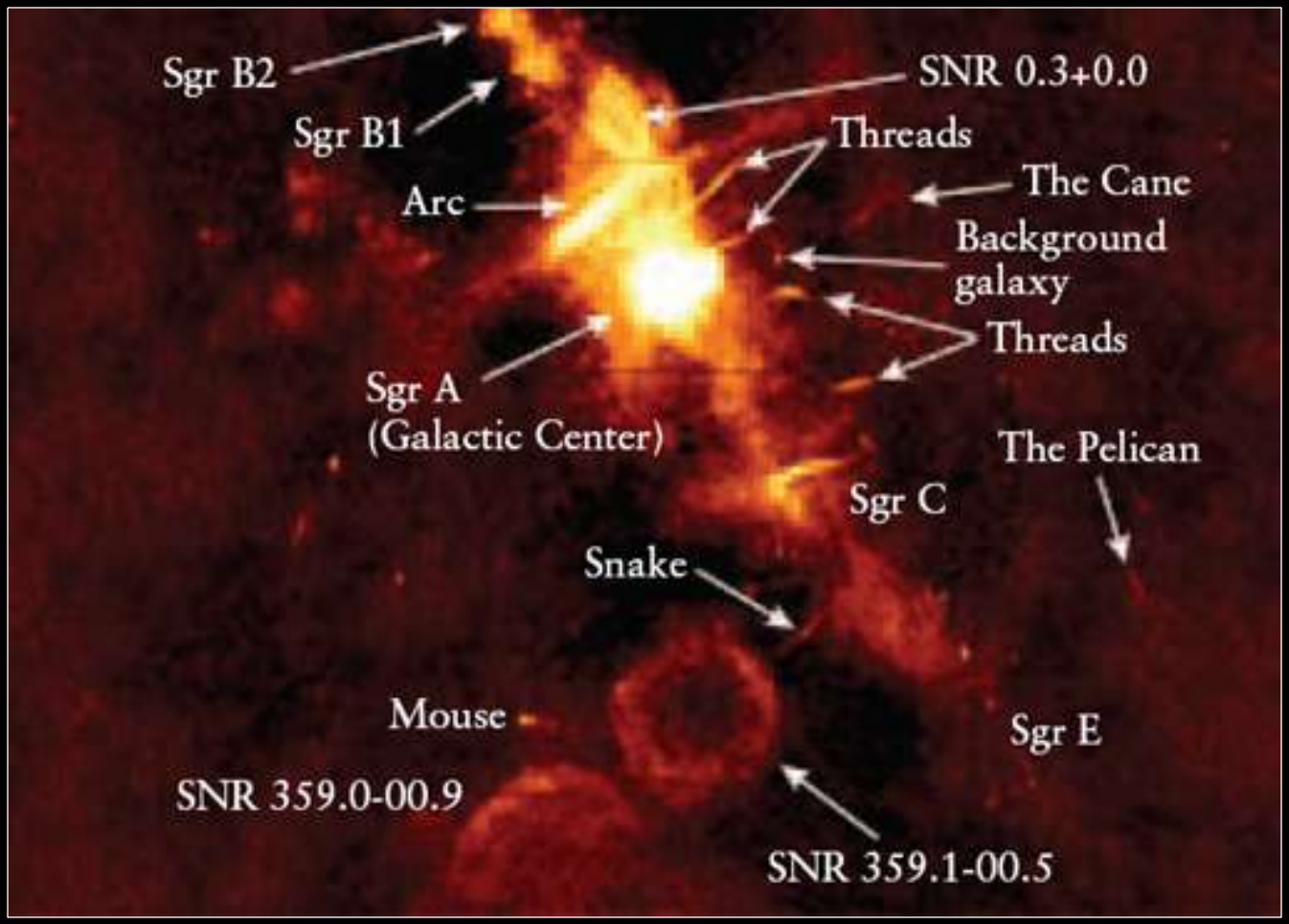
Looking toward the Galaxy Center in Sagittarius – Infrared Light



The Galactic Center – Zooming in, in Infrared Light

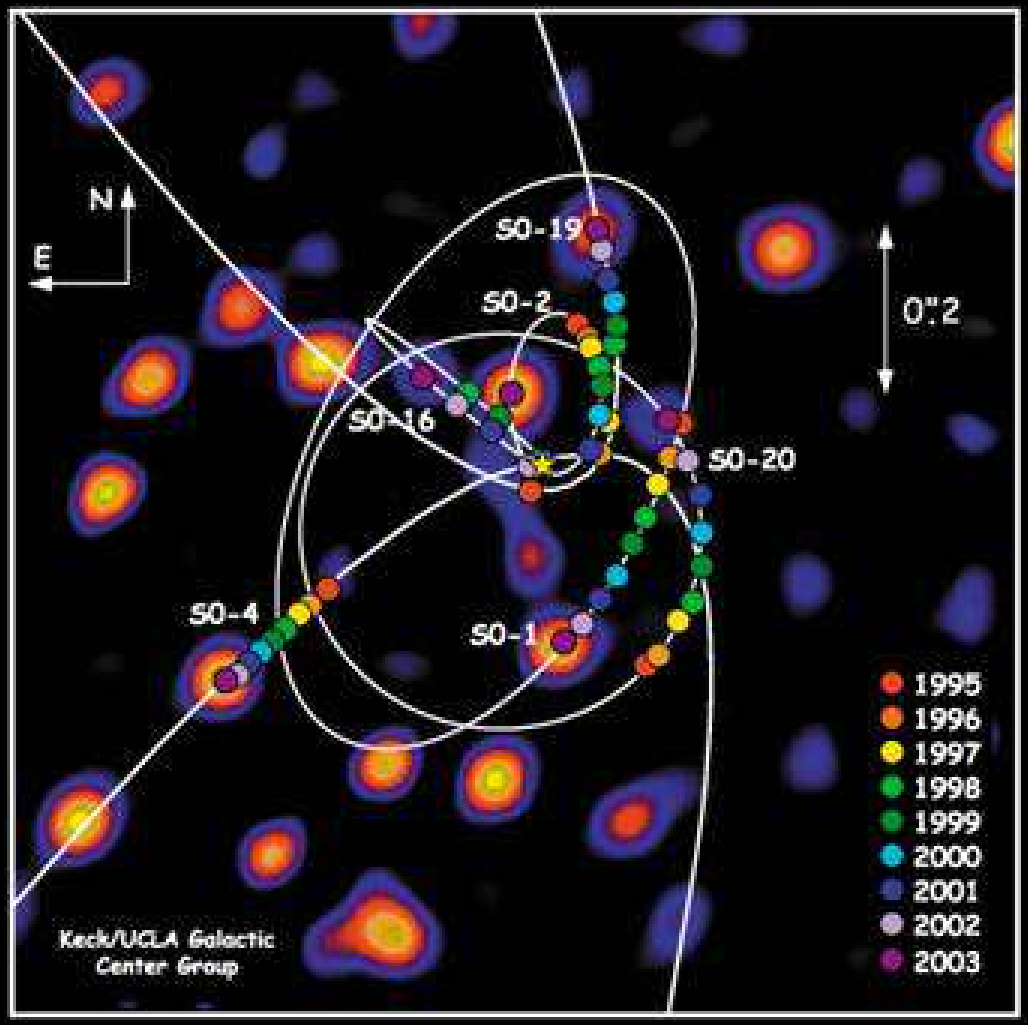
Shows very high density at the Center.

Galactic Nucleus – in Radio Waves



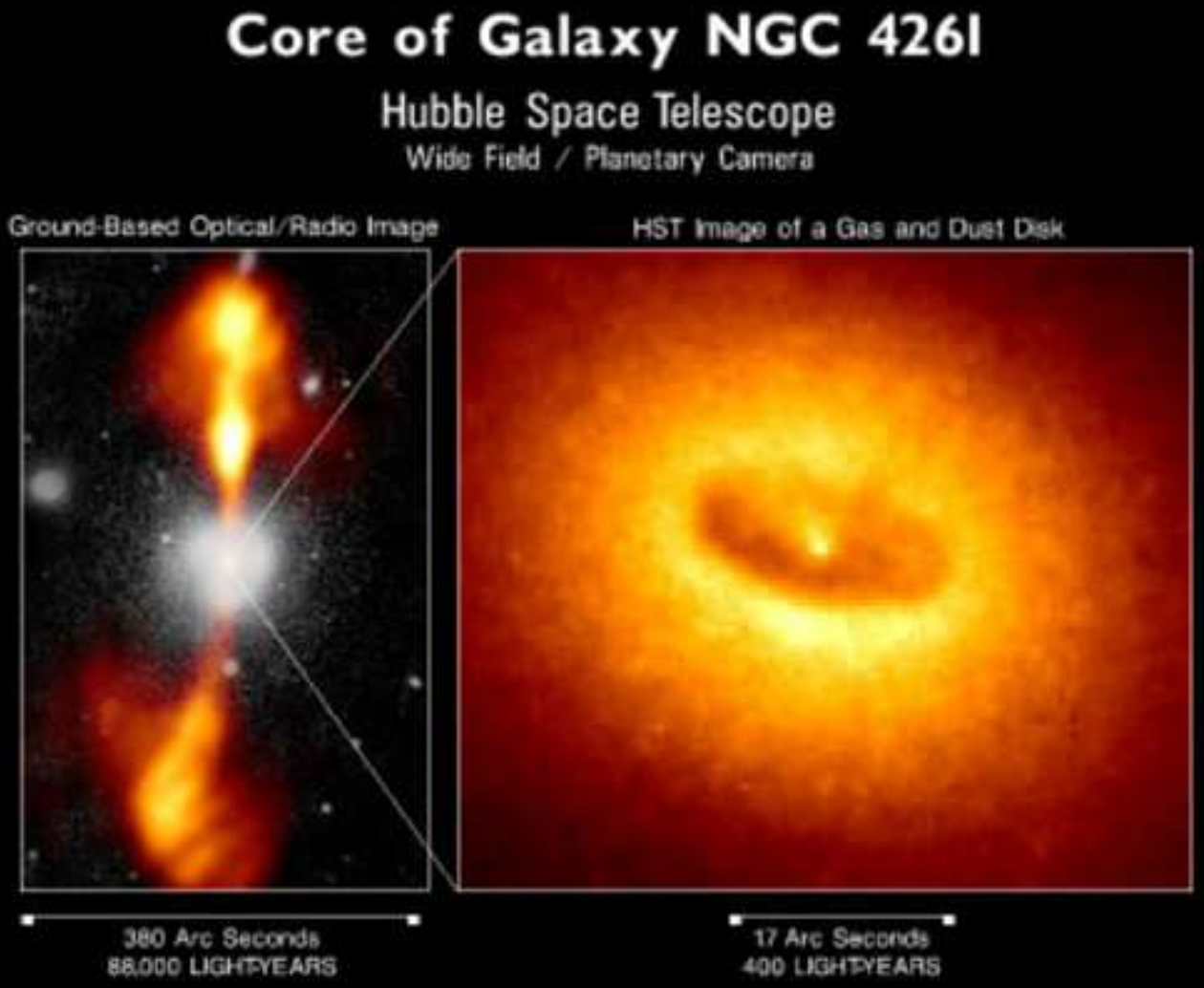
Sagittarius A (Sgr A) is at the Galaxy Center, and is very bright in Radio Waves. SNR = Supernova Remnant.

Galactic Nucleus – in Infrared

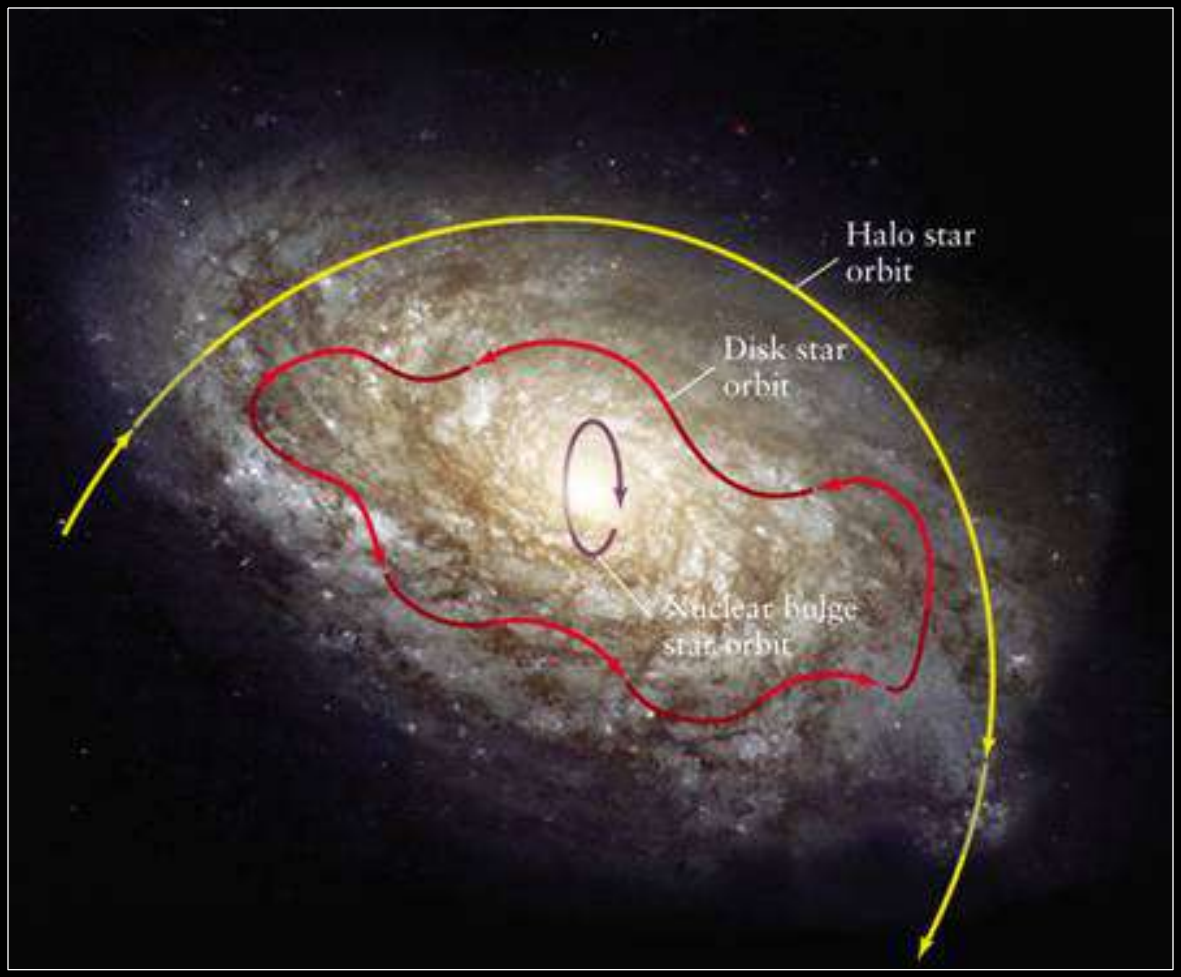


Stars orbiting a MASSIVE object that cannot be seen – a 4 million solar mass BLACK HOLE – where the Sgr A radio source is located.

The Black Hole Area at the Center of our Galaxy might look something like this.

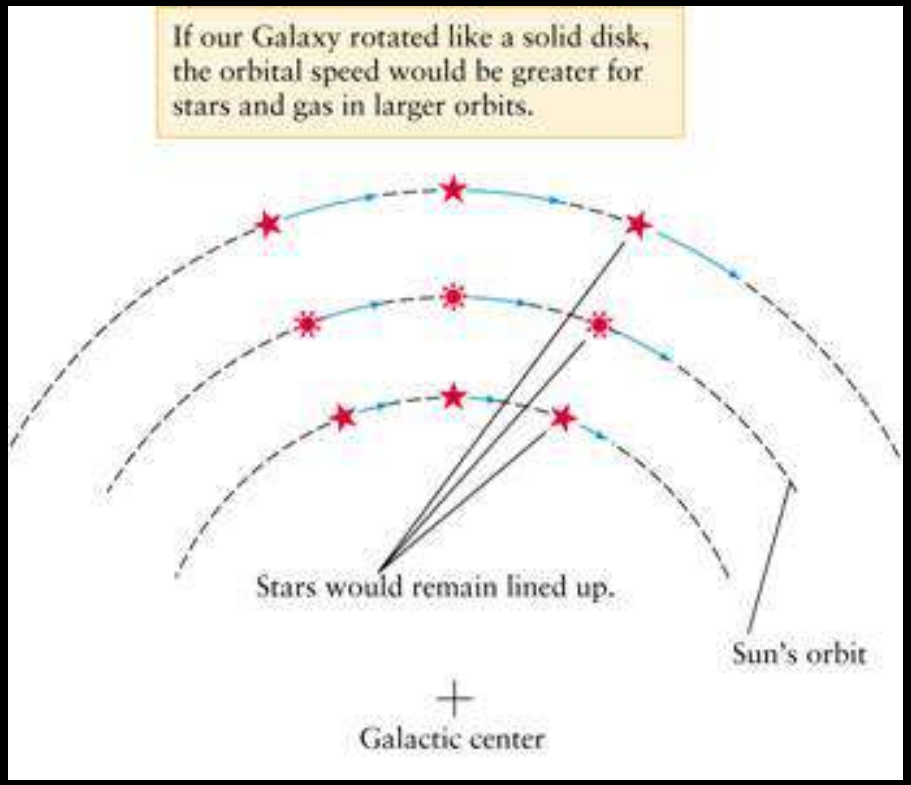


Orbits of Stars in Different Parts of Our Galaxy

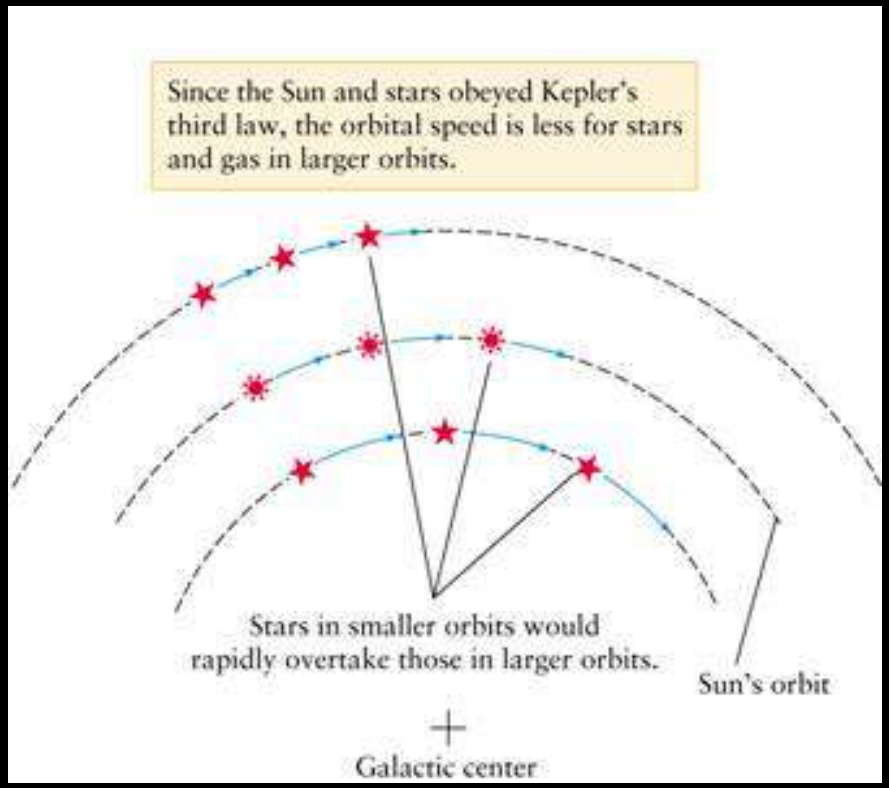


NGC 4144, very similar to the Milky Way.

Our Galaxy rotates, and the center rotates faster than the outer parts do – Kepler's 3rd Law !

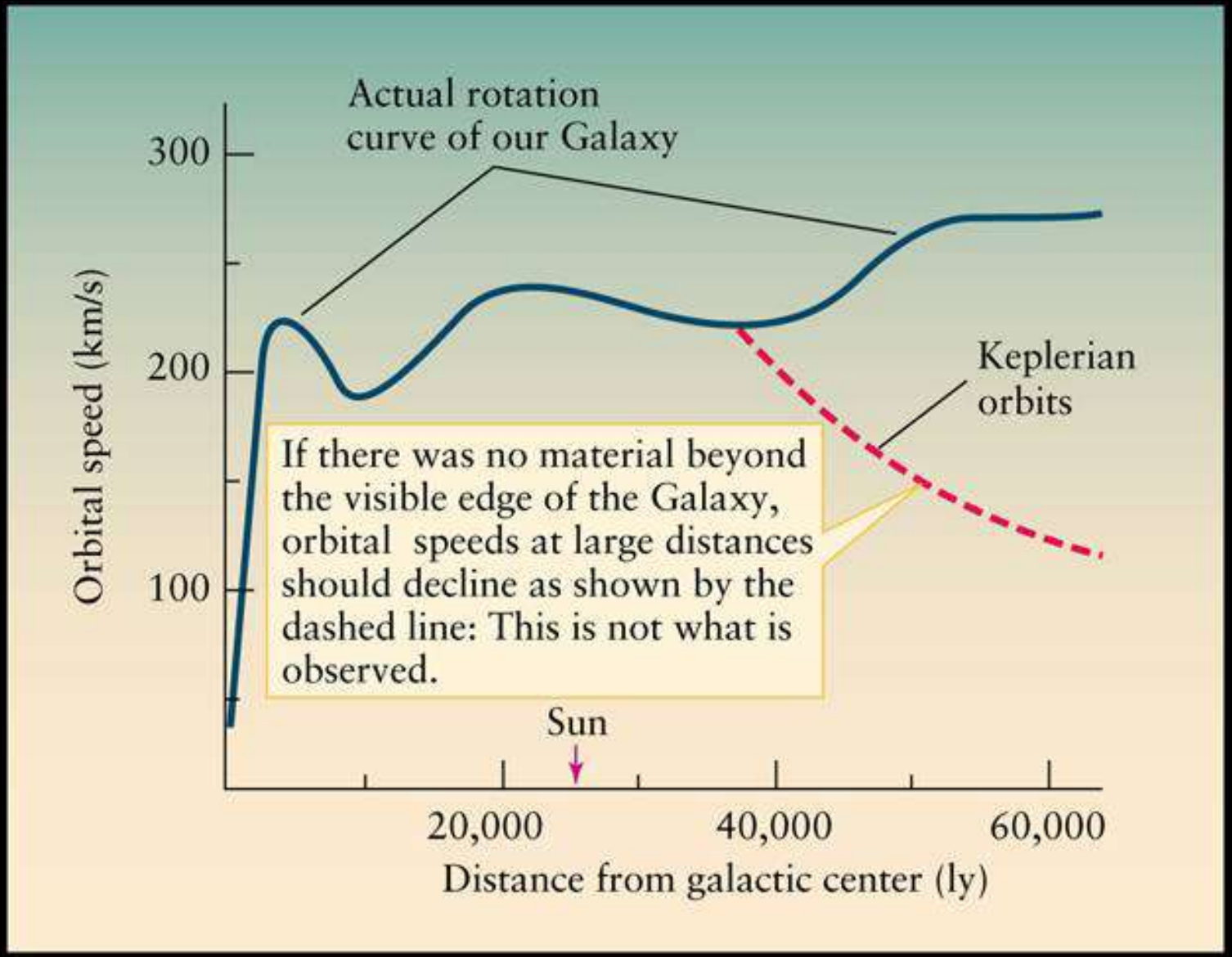


NOT like this.



Like THIS.

The Galaxy's Rotation Curve – shows there's Dark Matter beyond the visible edge of the Galaxy.



How Much Dark Matter Does Our Galaxy Have?

- The stars and other objects that give off radiation account for only 10% of the Galaxy's total mass.
- The other 90% of our Galaxy is made of stuff that we can't see at any wavelength of radiation – so we call it "Dark Matter."
- Dark Matter forms a sphere around the Galaxy, at least 12 times farther from the center than we are.
- We don't know what this Dark Matter is, but it does have gravity.

WHAT DID YOU THINK?

- *How many stars does the Milky Way Galaxy contain?*
- The Milky Way has about 200 billion stars.
- *Where is our Solar System located in the Milky Way Galaxy?*
- The Solar System is in the Orion Arm, about 26,000 light years from the center of the Galaxy.
- *Is the Sun moving through the Milky Way Galaxy and, if so, how fast?*
- The Sun orbits the center of the Milky Way Galaxy at a speed of 828,000 km per hour. How many miles per hour is that?