

Milky Way

- Orbits of stars in the Milky Way
- Rotation curves
- Finding the mass from the orbit
- Center of the Milky Way
- Stars orbiting the black hole
- X-ray flares from the black hole

How do we know that the Milky Way has a spiral structure?

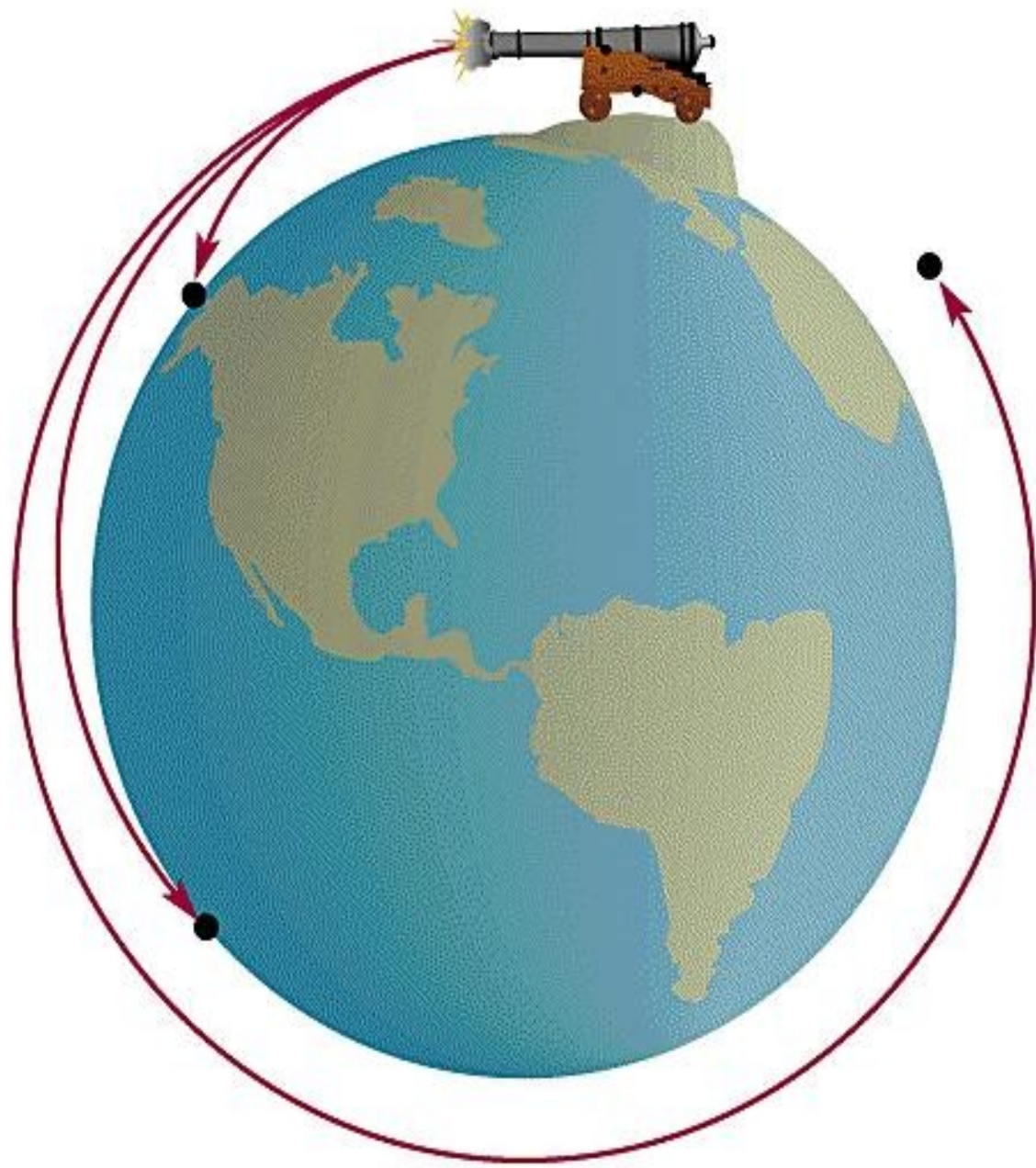
- A) By observing the gravitational influence of the arms on nearby galaxies
- B) By plotting the distances and directions of objects known to be in spiral arms
- C) By observing the changing conditions as the Sun enters and leaves a spiral arm
- D) By viewing the Milky Way from a point well above its plane

Which of the following objects are ***not*** found primarily in the spiral arms of the Galaxy?

- A) white dwarf stars
- B) HII regions
- C) supernovas
- D) O and B stars

What keeps the planets in orbit around the Sun?

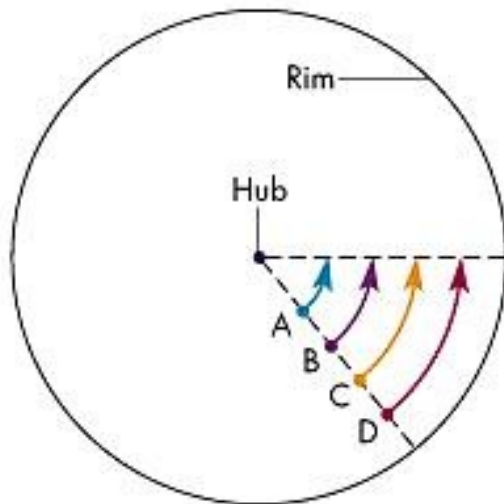
- The force of gravity from the Sun
- To orbit, a planet at a particular distance from the Sun must have a particular orbital speed.



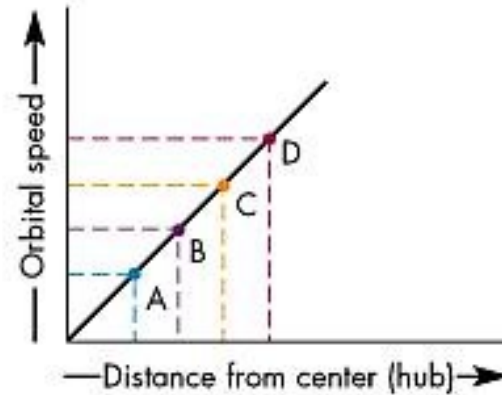
Orbits of stars in the Milky Way

- The orbit of a star is determined by the total mass lying inside the orbit
- By measuring the speed of the star's orbit and its distance from the center, we can figure out the total mass lying inside the orbit of the star

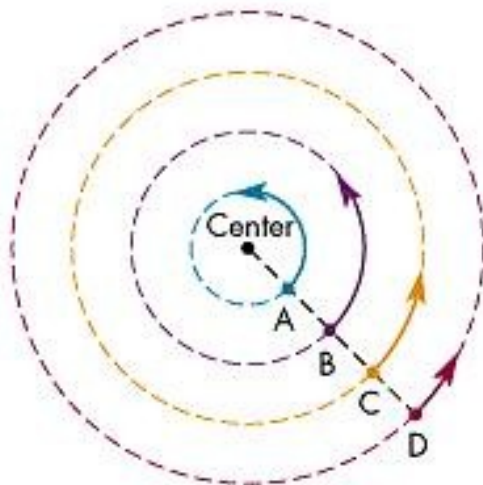
Rotation curves



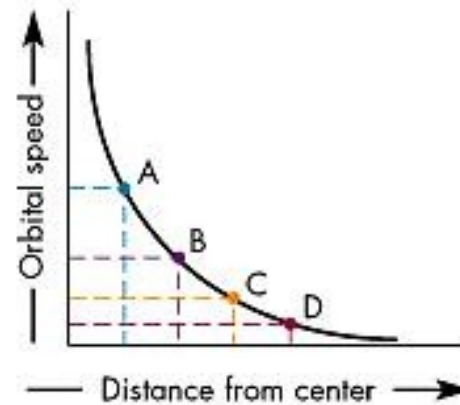
A Wheel-like rotation



Rotation curve for wheel-like rotation

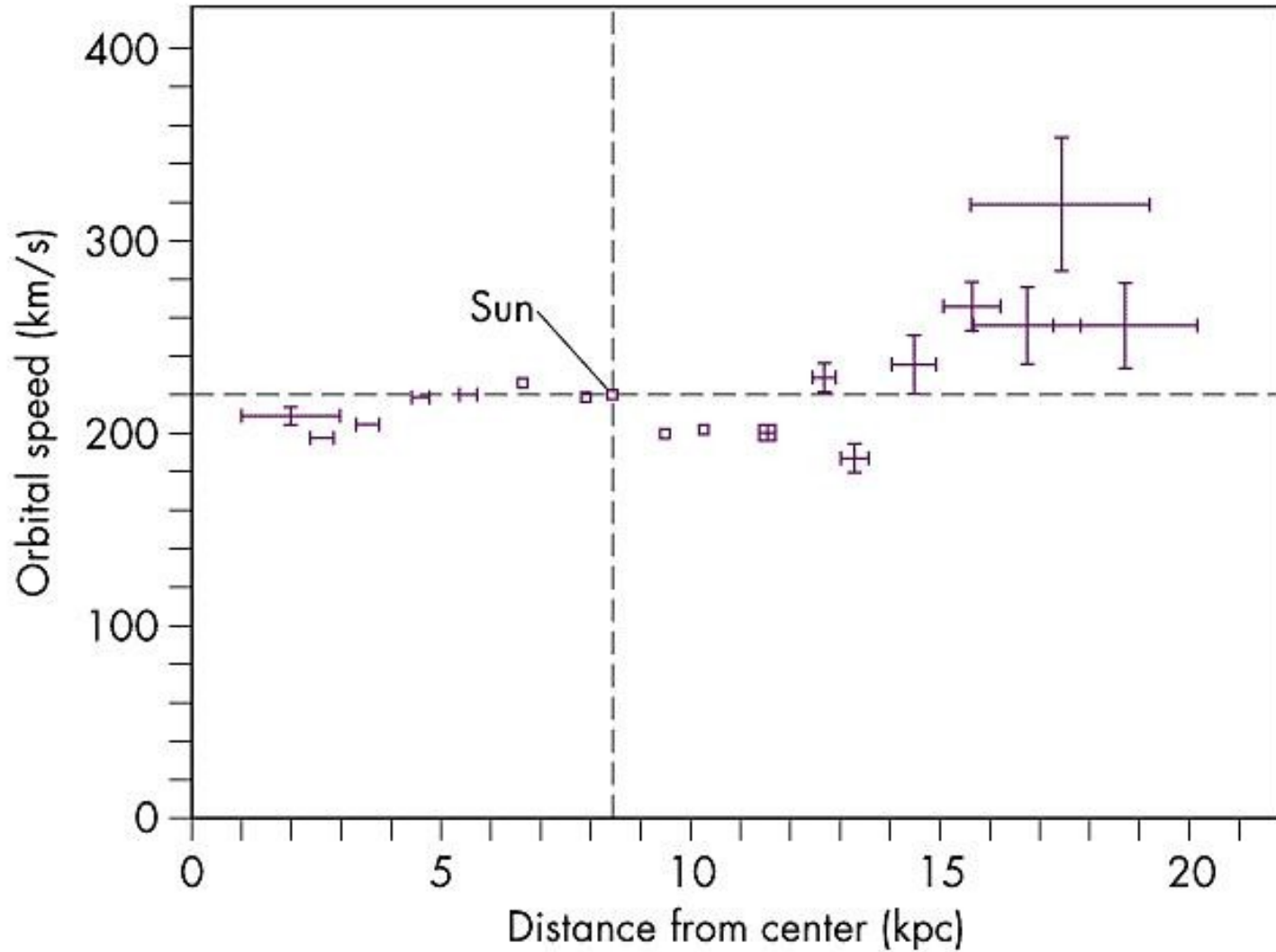


B Planet-like rotation

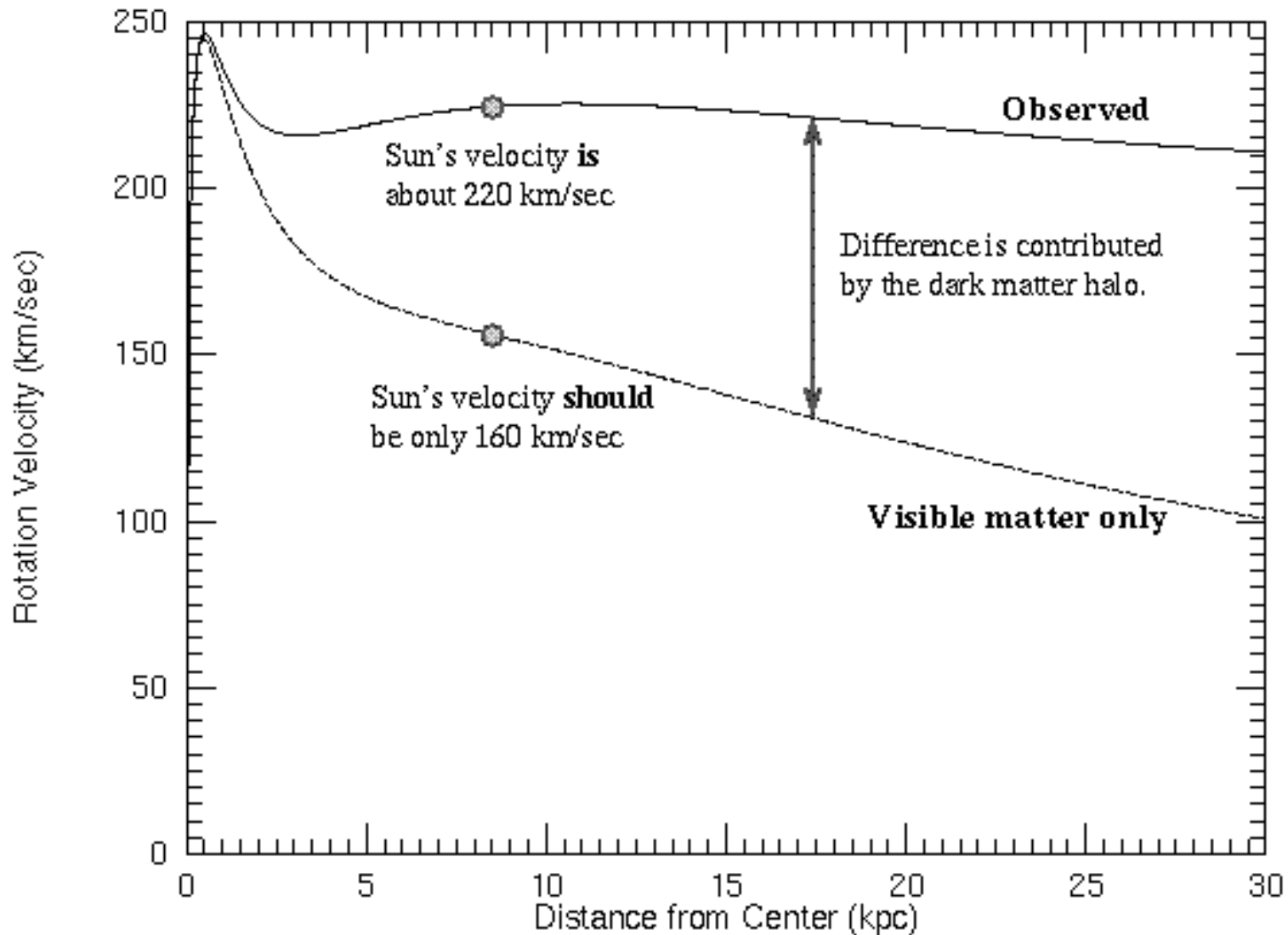


Rotation curve for planet-like rotation

Rotation curve of the Milky Way



Rotation curve of Milky Way



Dark Matter

- Dark – it doesn't produce light (any kind)
- Does have mass, produces gravity
- Nature is unknown
- Might be normal matter in a form that doesn't emit much light – very small and dim star, little black holes
- More likely it is elementary particles other than normal matter

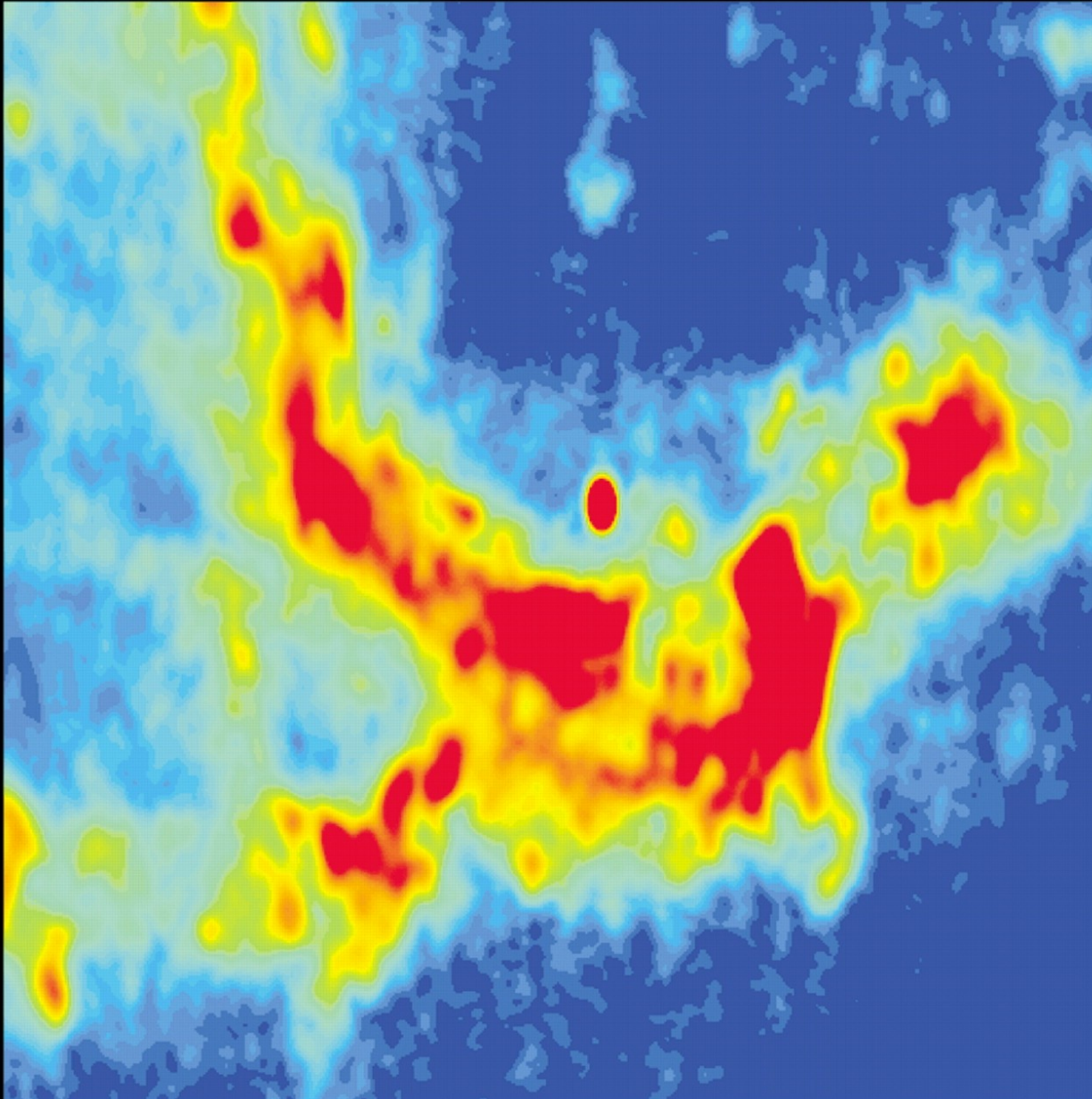
What properties of the sun could be used to measure the total mass enclosed within the sun's orbit?

- A) mass and orbital speed
- B) mass and distance from the center
- C) mass and age
- D) orbital speed and distance from the center

If the orbital velocities of stars in the Milky Way were found to be half of what they are now measured to be

- A) Our estimate of the mass of the Milky Way would decrease
- B) Our estimate of the diameter of the Milky Way would decrease
- C) Our estimate of the mass of the Milky Way would increase
- D) Our estimate of the diameter of the Milky Way would increase

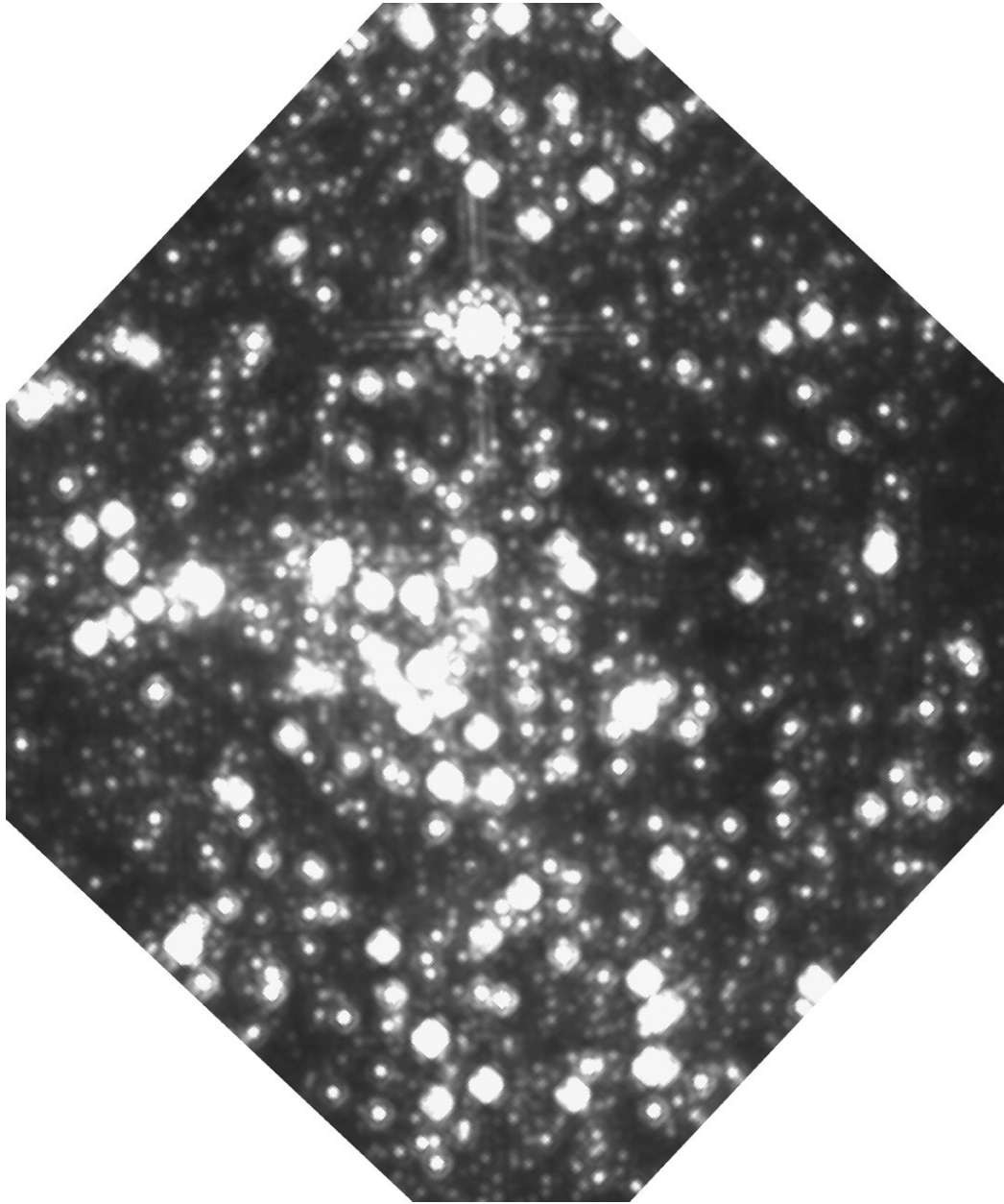




Radio image, central 3 ly

Center is the
red ellipse at
the center

Called Sgr A*



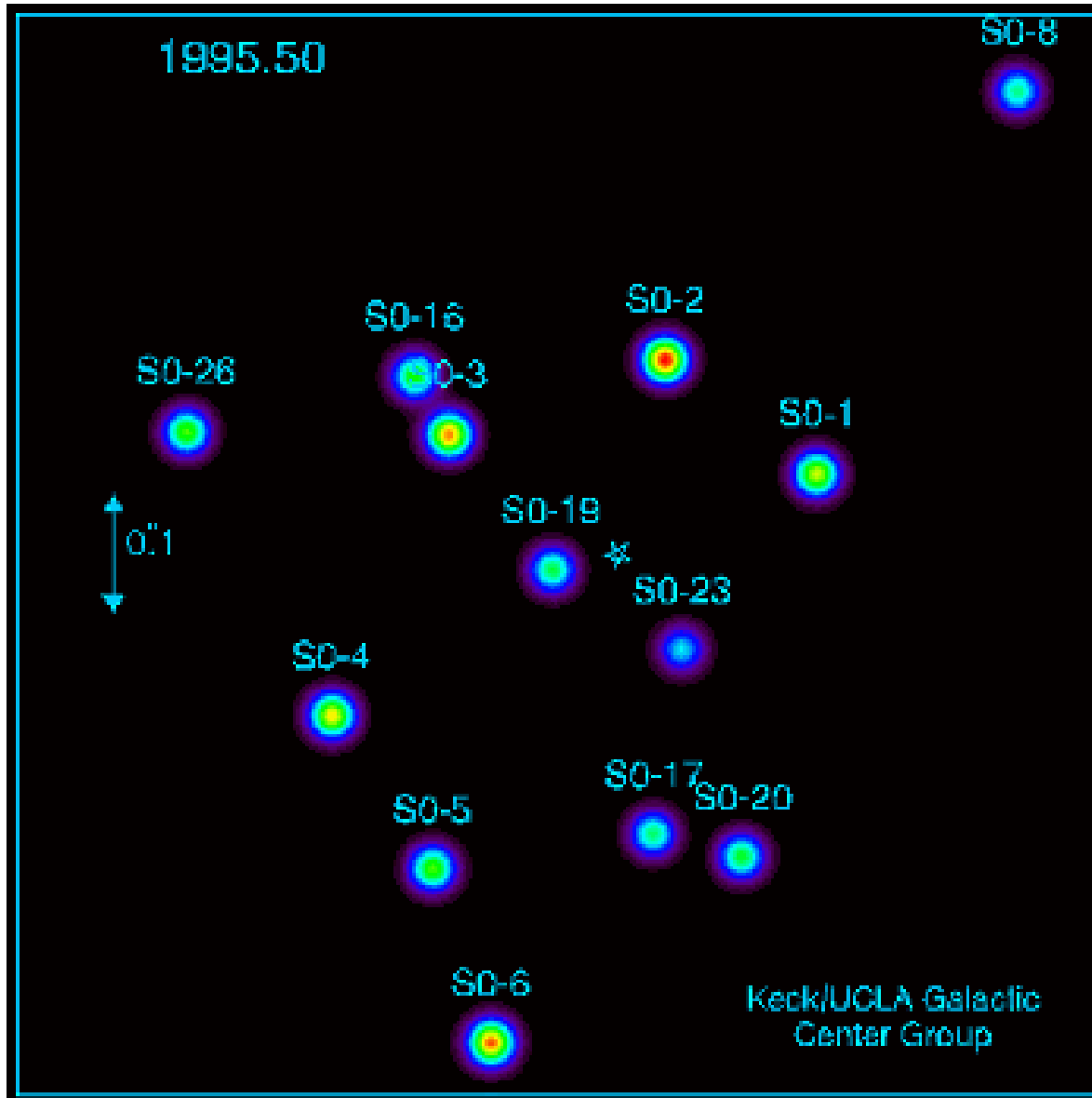
Infrared image, central 3 ly

Sgr A* does not
appear.

There are about
1,000,000 stars in
the area covered by
this image.

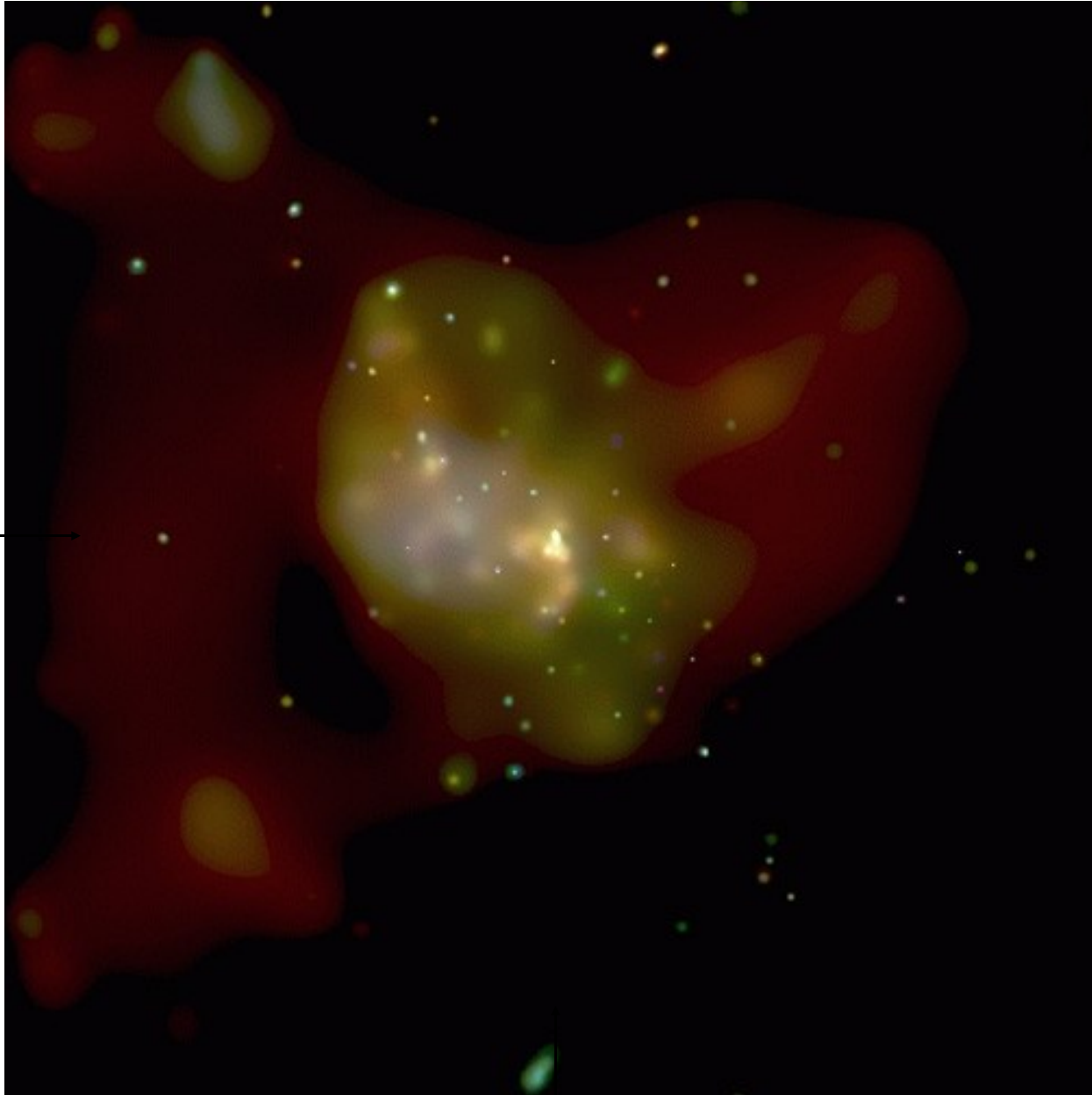
Stars are only 1000
AU apart.

Stellar Orbits in the Galactic Center



Mass of Sgr A* can be measured using stellar orbits

- Fastest moving star moves at 2% of the speed of light, 5000 km/s
- Mass is about 3 million solar masses
- Emits radio and X-rays
- Almost certainly a black hole



X-ray image,
central 3 ly

Sgr A* is the
bright object in
the center of
the image.

Makes flares
in X-rays.

[Movie.](#)

Review Questions

- What properties of a star's orbit around the Galaxy enable one to measure the mass inside its orbit?
- What is the shape of the rotation curve of the Milky Way and why is it unexpected?
- What lies at the center of the Milky Way?