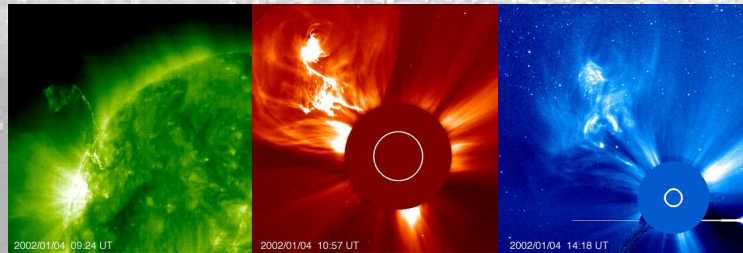
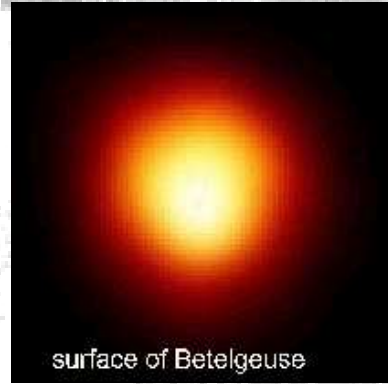
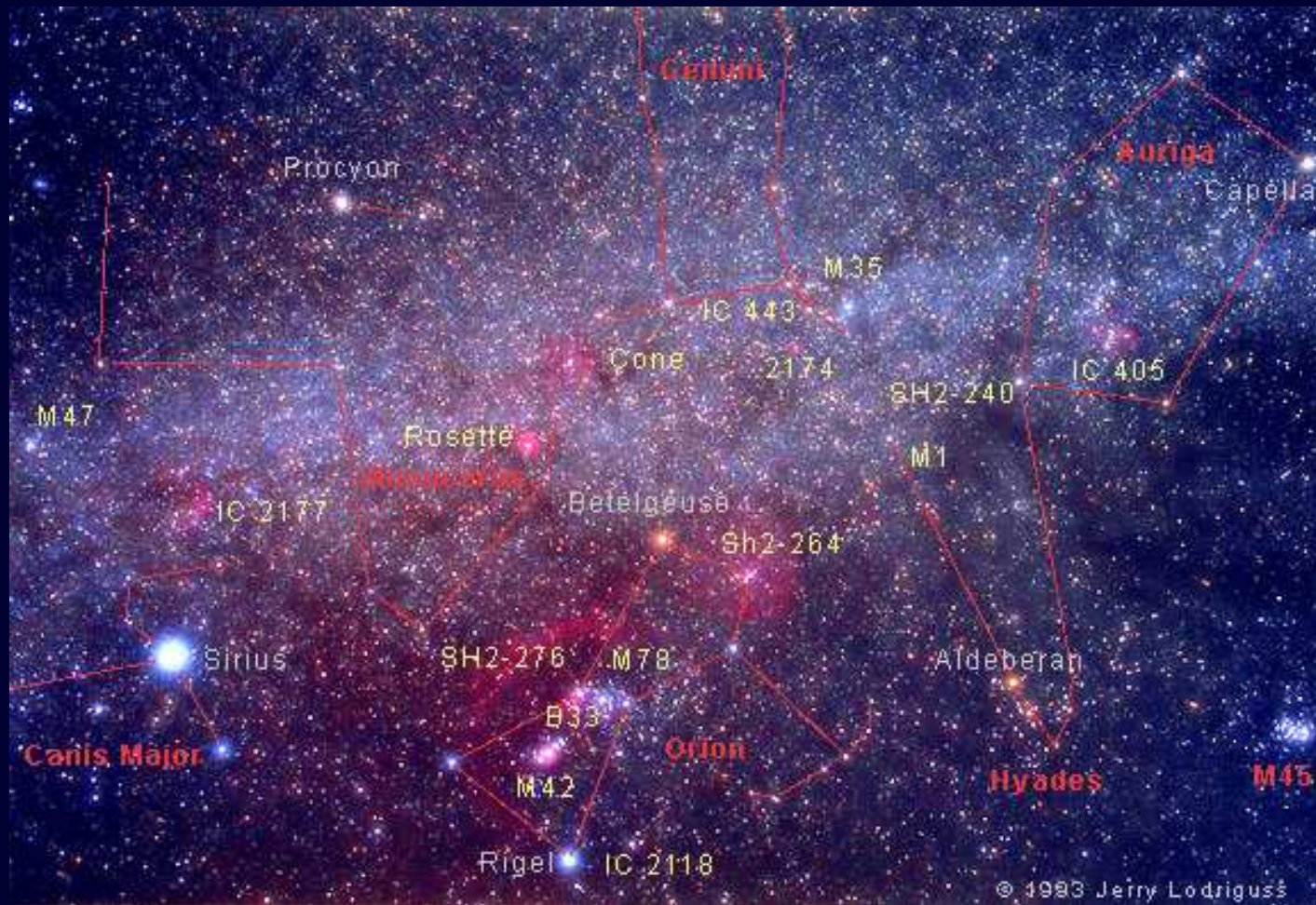


Galactic Inventory

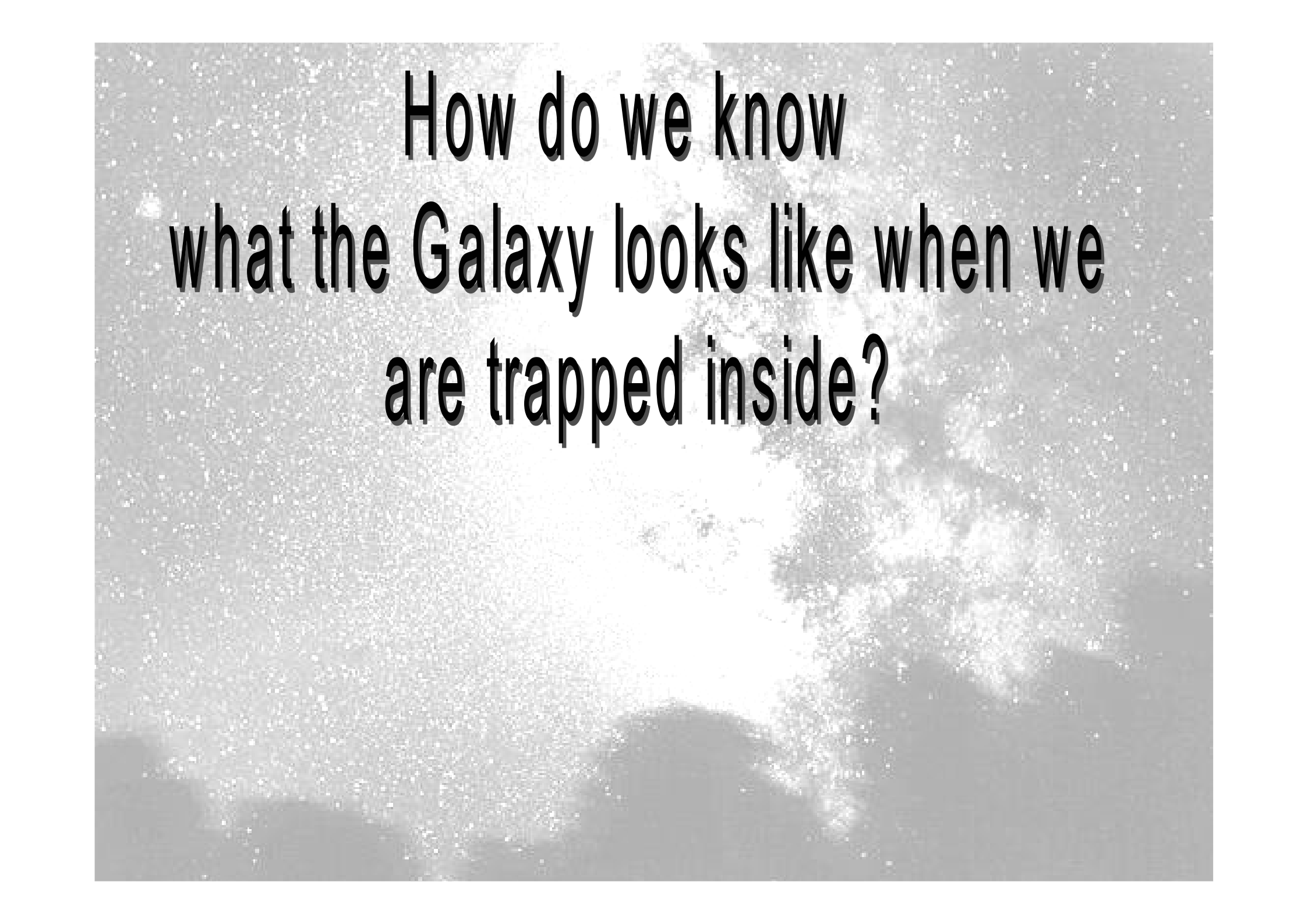
- Stars
 - Low-mass
 - Protostars
 - High Mass
 - Supernova
 - White dwarfs
 - Neutron stars
 - Black holes
- Star clusters
- Interstellar medium
 - Gas
 - Dust
 - Dark matter
- Planetary systems
 - Planets
 - Debris
- Light
- Life
- Astro classes
- Consciousness
- Love





Objectives

- summarize how the variable stars, RR Lyrae, are used to determine distances; find the distance to a globular cluster using the characteristics of an RR Lyrae variable [LAB]
- summarize how our view of the Galaxy has changed with the measurements of the distances to globular clusters
- explain the different kinds of information derived from different regions of the electromagnetic spectrum and what it tells us about the structure of the Galaxy



How do we know
what the Galaxy looks like when we
are trapped inside?



You learned how to open the door to the outside!

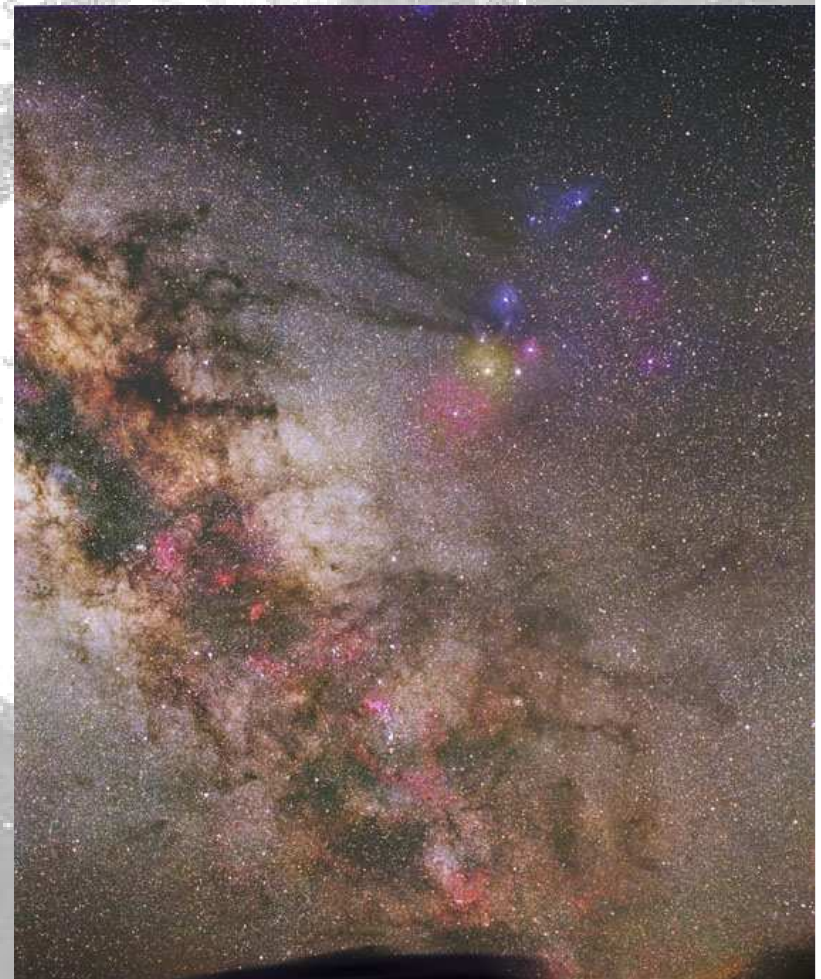
Seeing all this, wouldn't you find every means possible to find out more? What questions does this "new" universe inspire? How will you answer these questions?

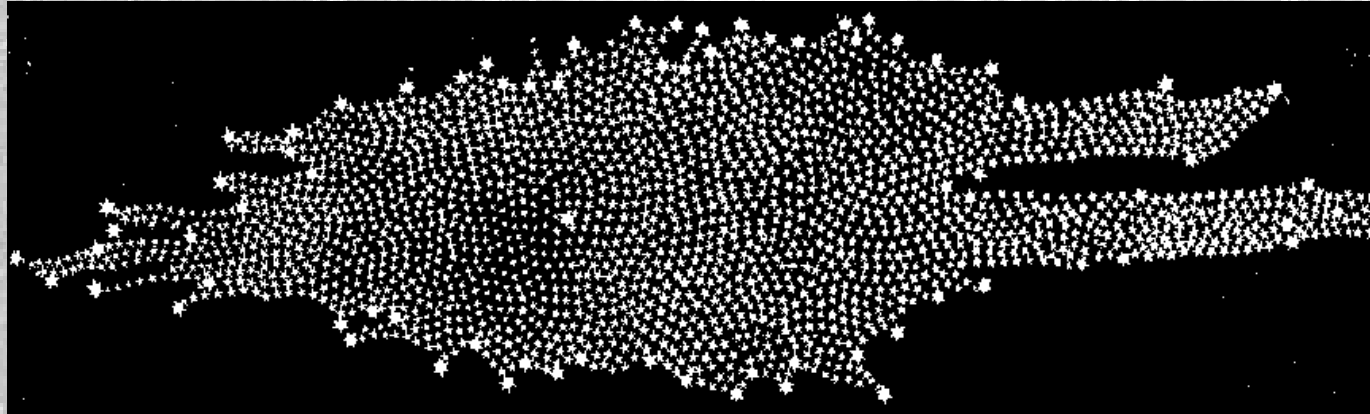
Akira Fujii/DMI



Winter Milky Way

Summer Milky Way





1785

The entire
Universe!

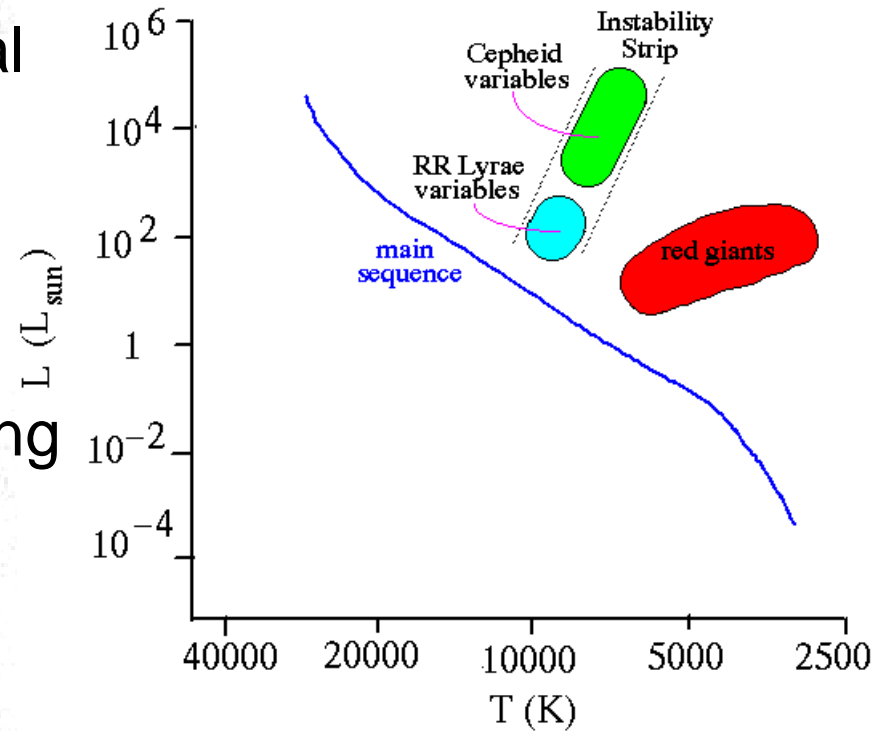
c. 1920, our view of the Universe changed dramatically!
Harlow Shapley measured distances to globular clusters
Got estimate of size of Galaxy
Got approximate location of Sun in Galaxy

Ways of determining distances:

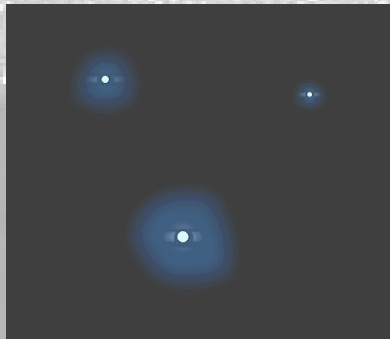
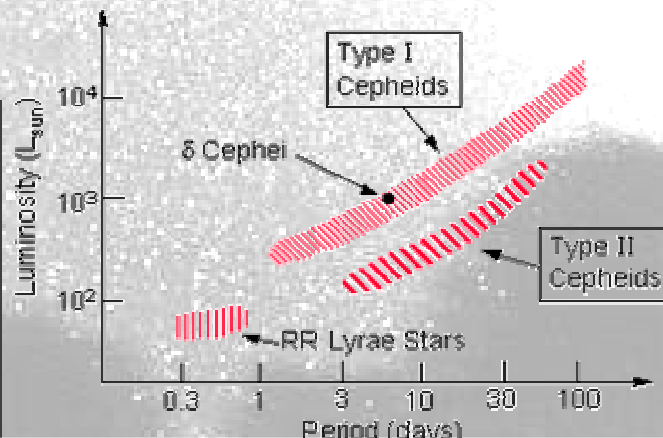
- Measured parallax
- Spectroscopic parallax
- Main sequence fitting
- Variable Stars

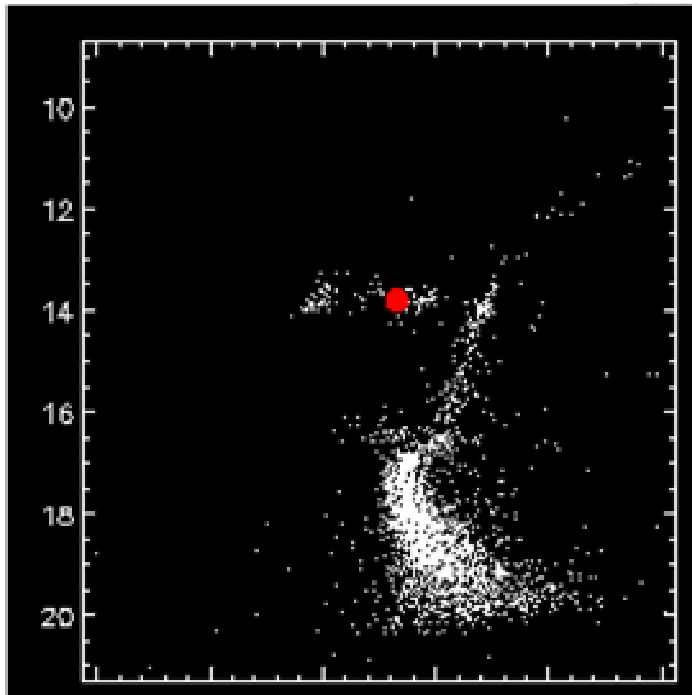
Understanding RR Lyrae Stars: Standard Candles for Distance Determination

- Stars on or near the horizontal branch
- Fusing $\text{He} \rightarrow \text{C}$ in core
- May have shell fusion occurring
- Temperature range where ionization of H and He occurs



**Advantages to using
RR Lyrae variables?**

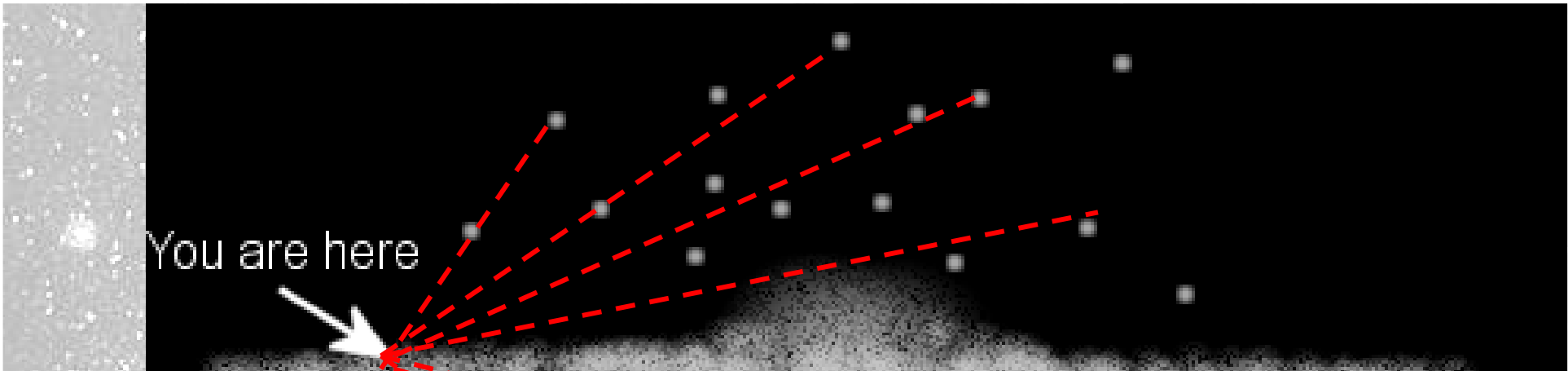




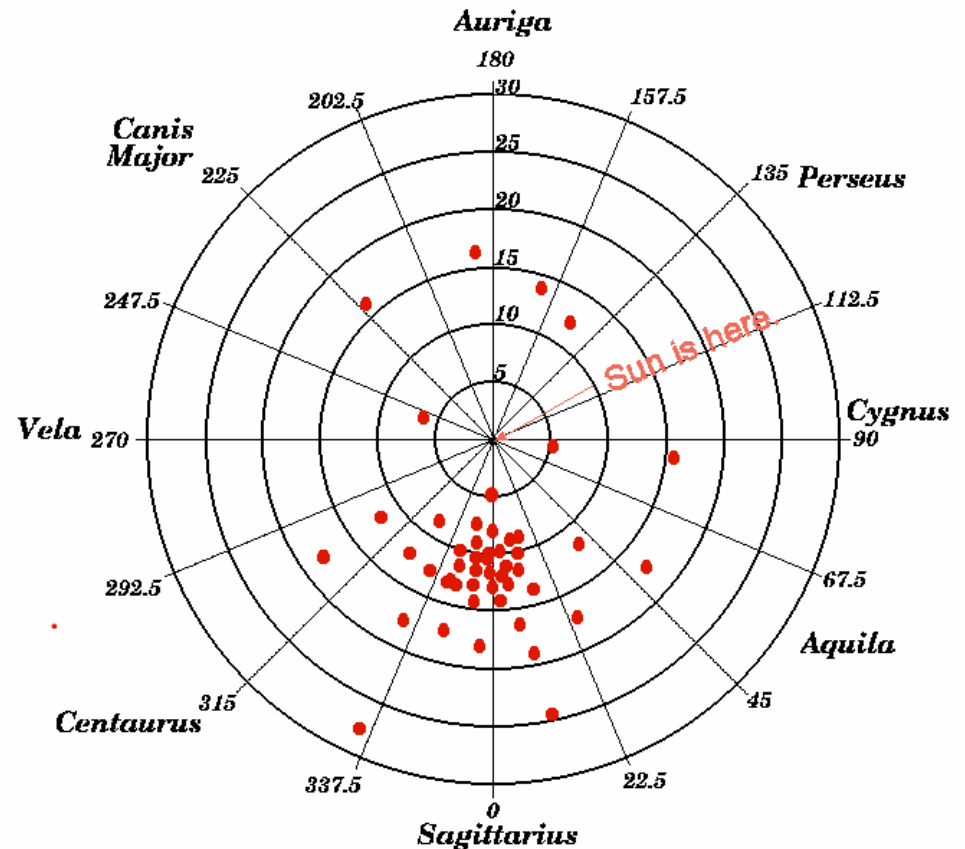
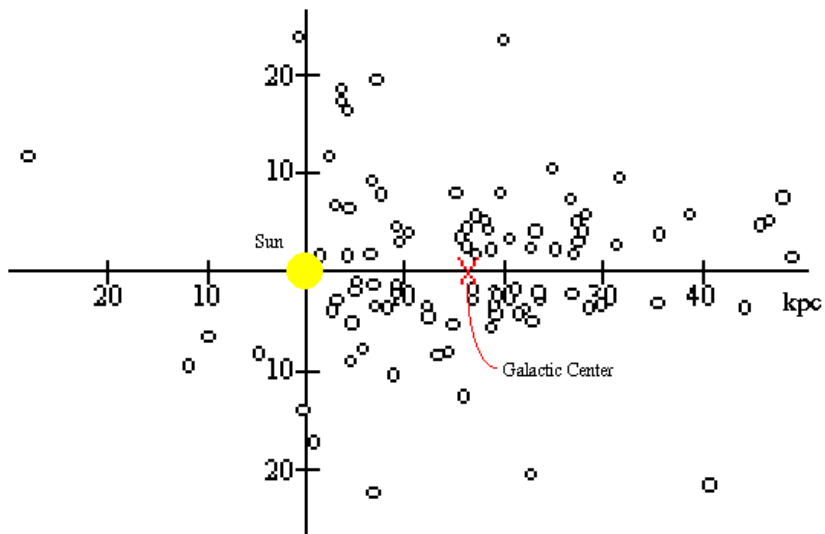
QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.



Globular Cluster Messier 4 (M4)



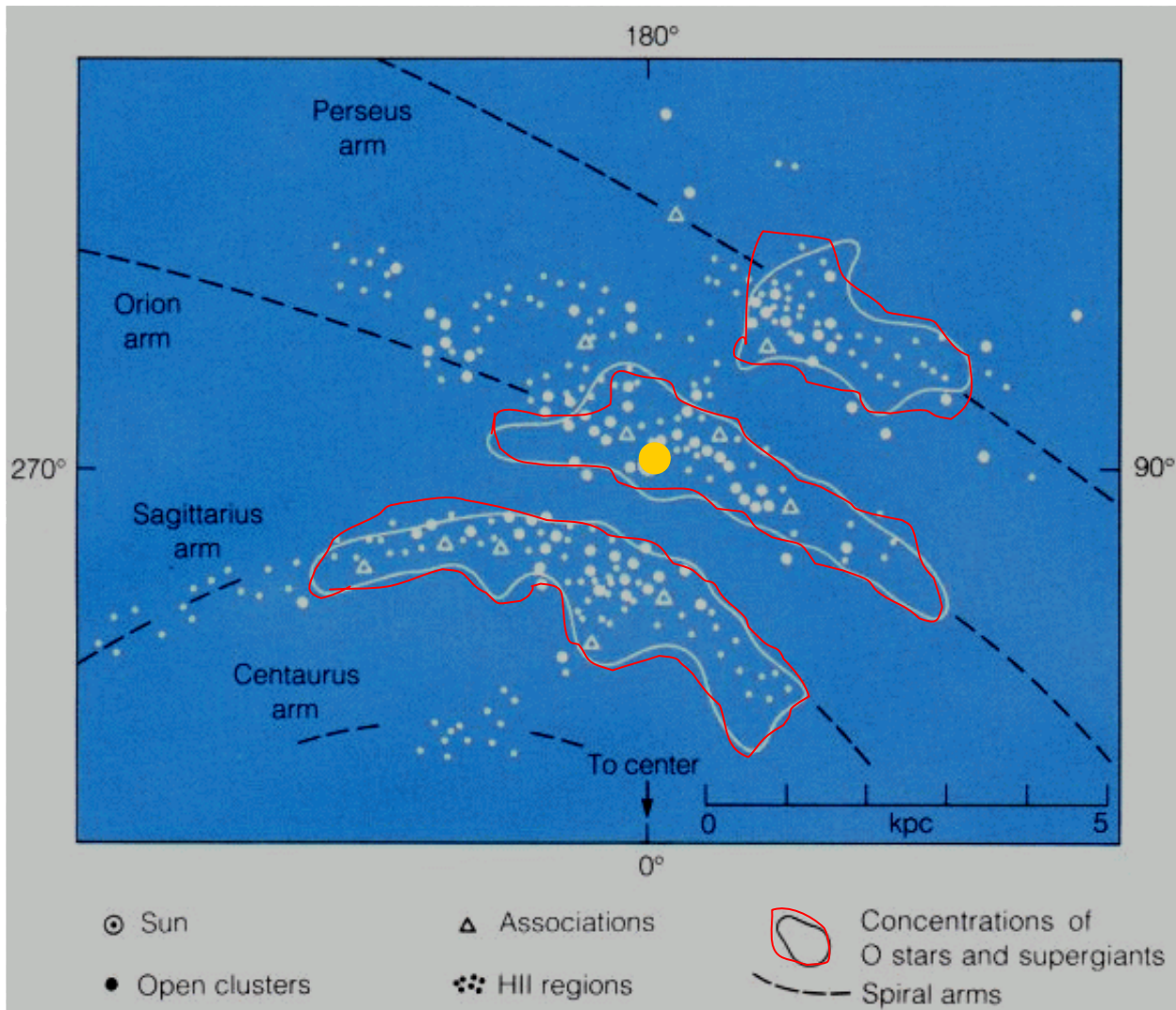
What if you had an accurate
globular clusters in our Galax



Assuming the globular cluster system orbits the center
of the Milky Way, are we at the center?



We're back to the front steps of Architecture. We cannot go any farther and thus cannot look back at ourselves, nor move around to the back, etc. What can we deduce just from what we see here?



Obvious targets from our studies so far (why?):

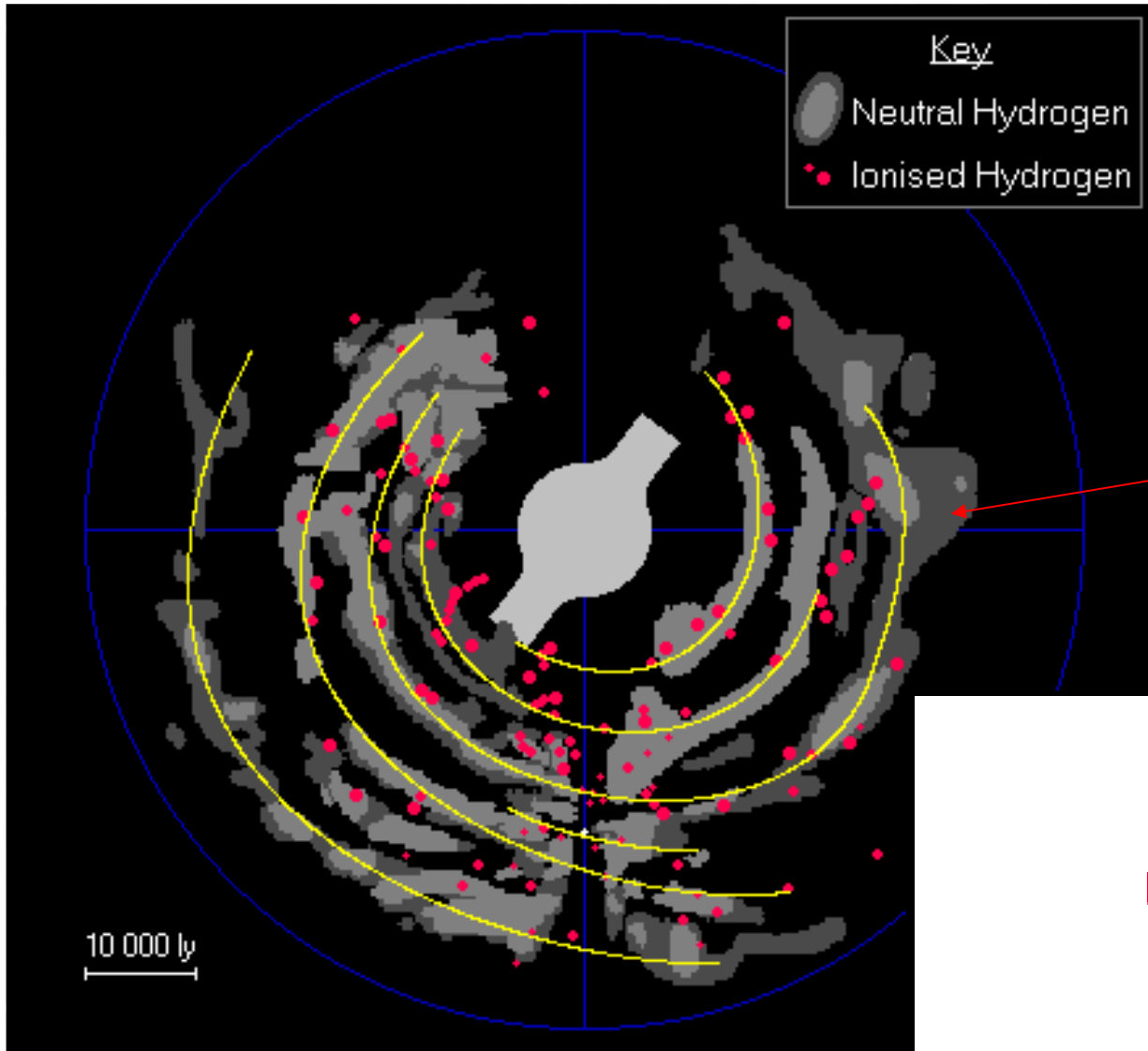
Open clusters; luminous stars (OB associations); ISM (HII regions, H_2 , H)

BACK TO THE ISM!!!

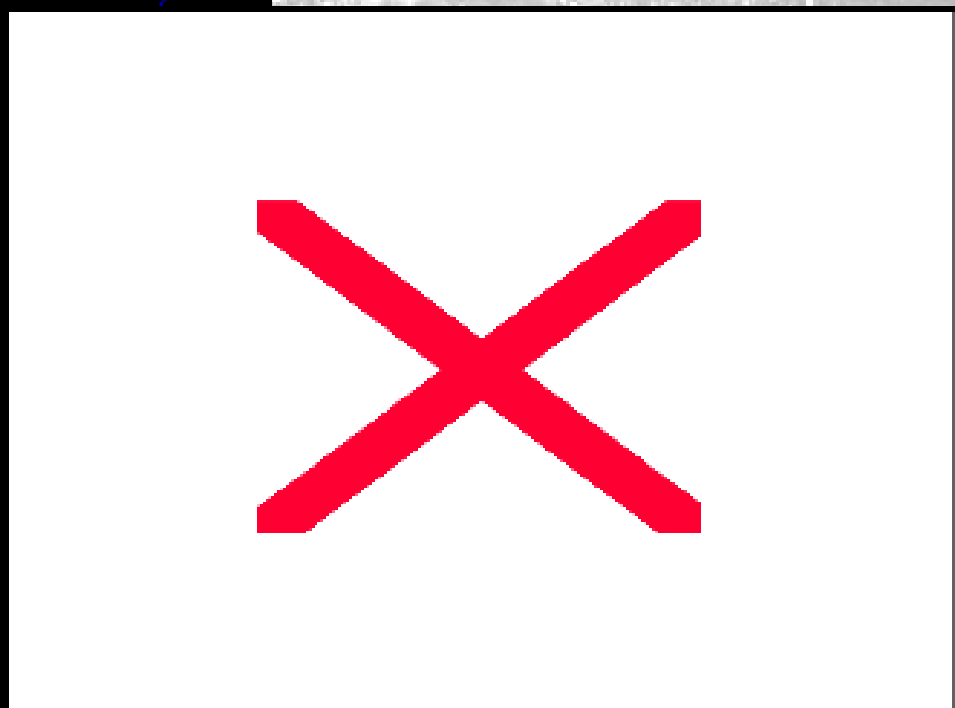
Detecting hydrogen in the Milky Way

radio wavelengths

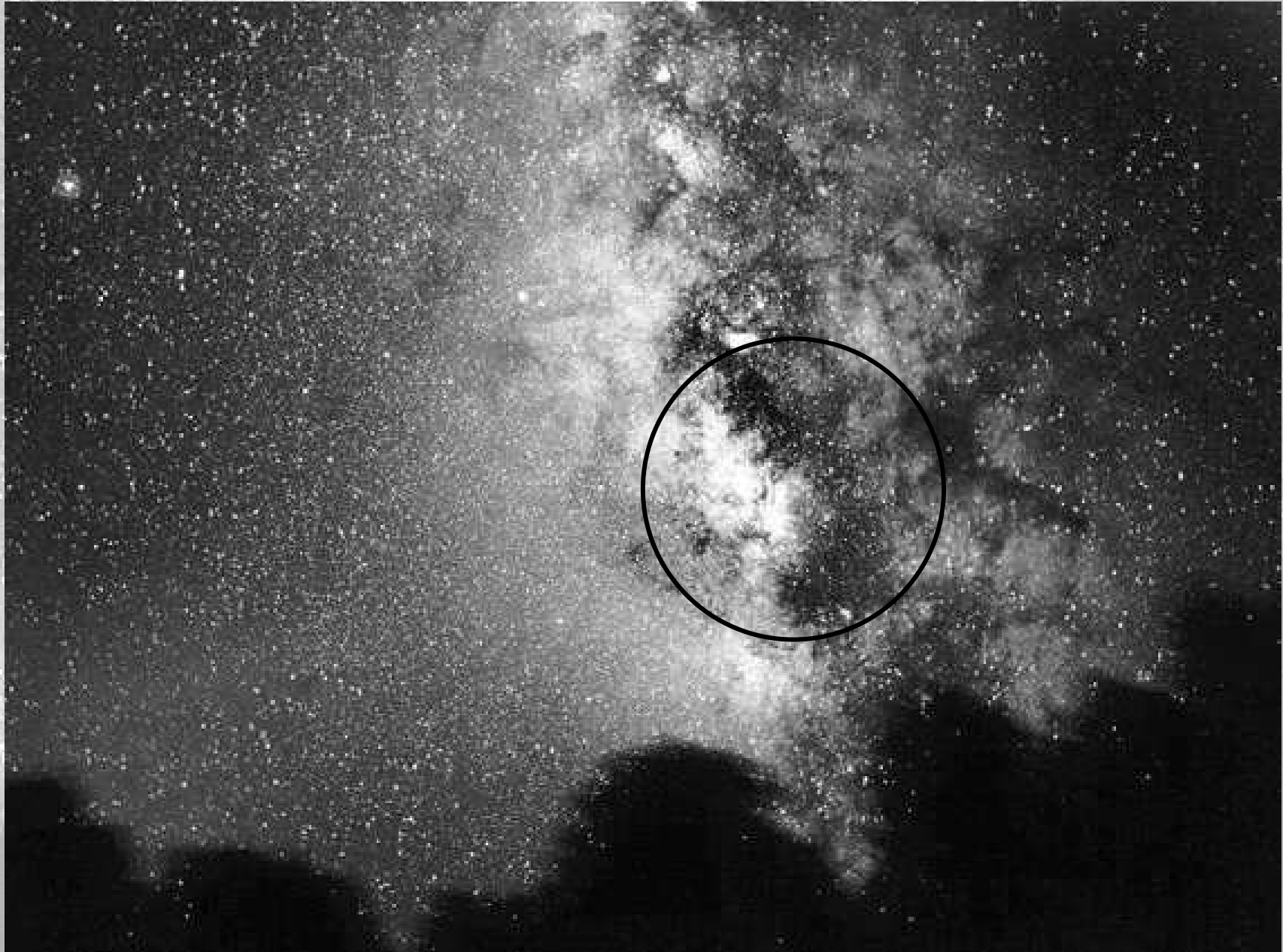
- ☐ Atomic hydrogen
 - ☐ 21-cm line of “electron flip”
- ☐ Molecular hydrogen -- must trace CO emission
- ☐ Ionized hydrogen -- radio continuum
 - Free electron and free proton interacting



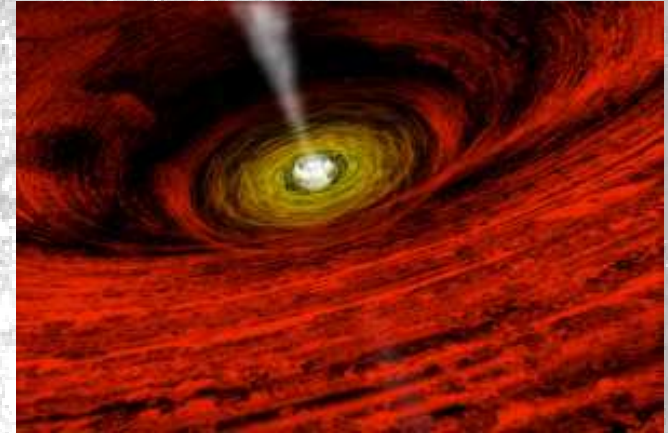
Tracing molecular hydrogen H_2
(actually carbon monoxide, CO)



Portal to the Galactic Center



Evidence for a SMBH
Stellar Populations
Galaxy Formation
Evidence for Dark Matter



Old star, new star

Red star, blue star

