Our Galaxy

MILKY WAY

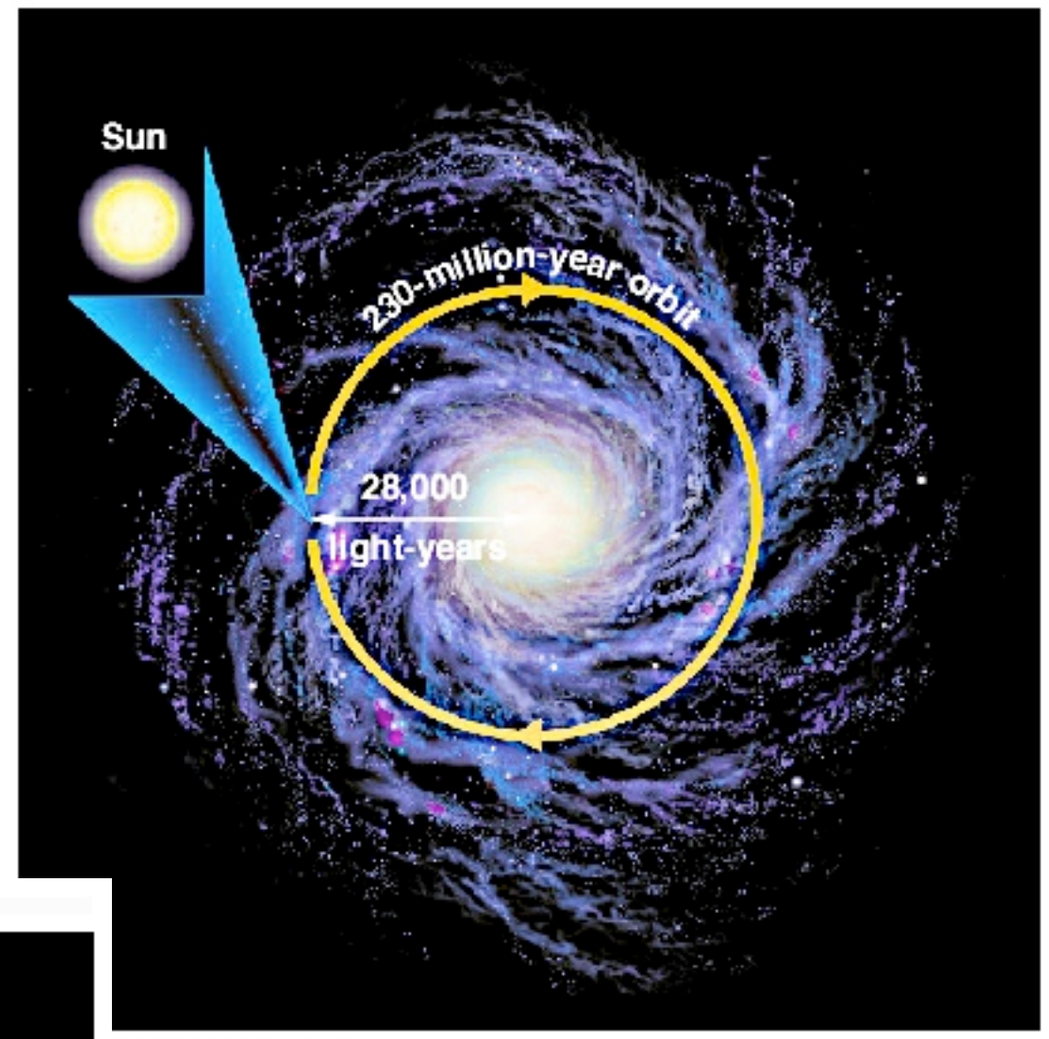
Other nebulae

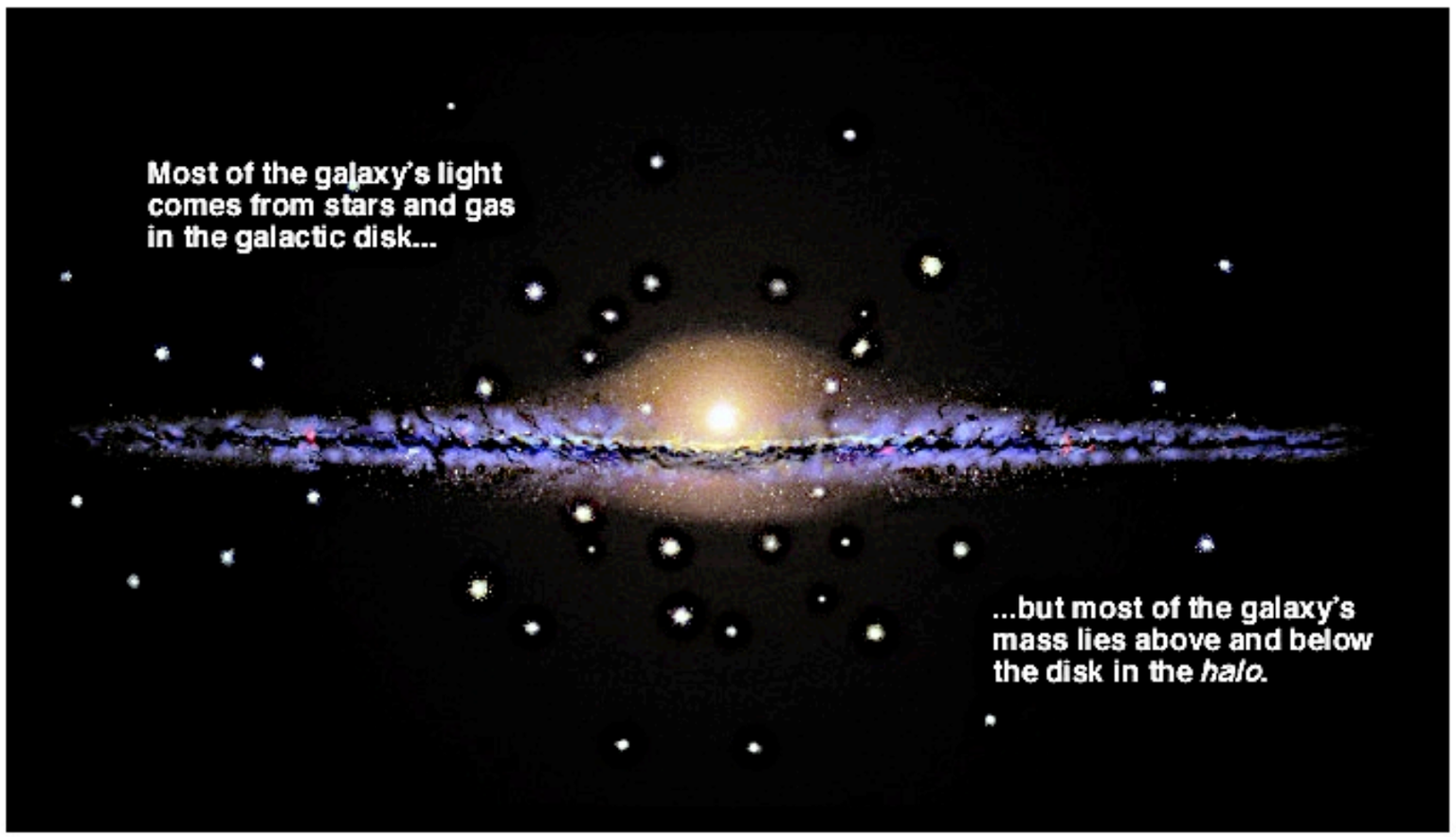
Carina Nebula

Hubble Heritage

Main Components

Disk, Bulge, Halo



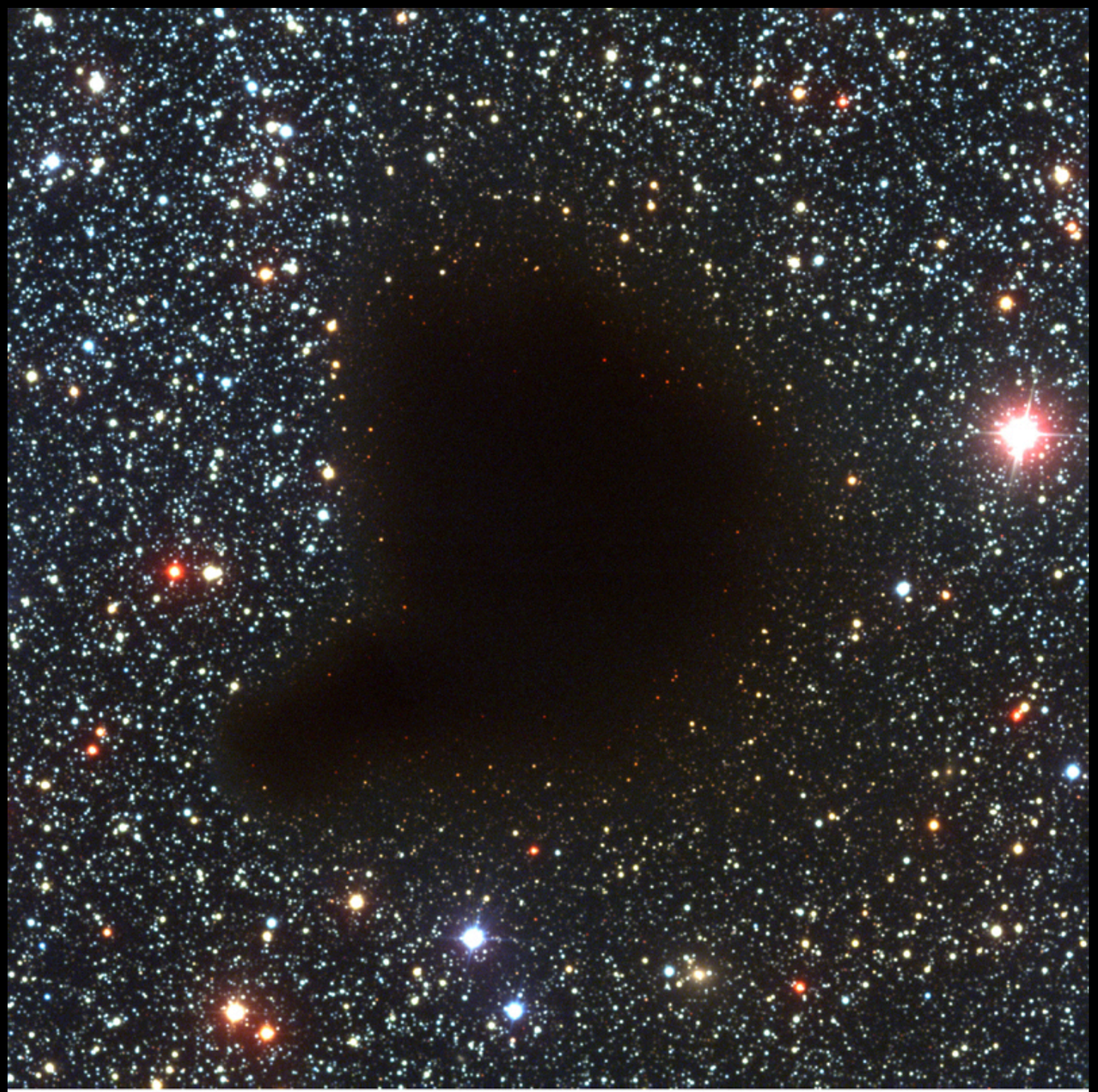


Distances:

1pc - typical distance between stars.

8,500pc - distance to the center

Dark clouds: beginning of star formation



Nebulae: star formation

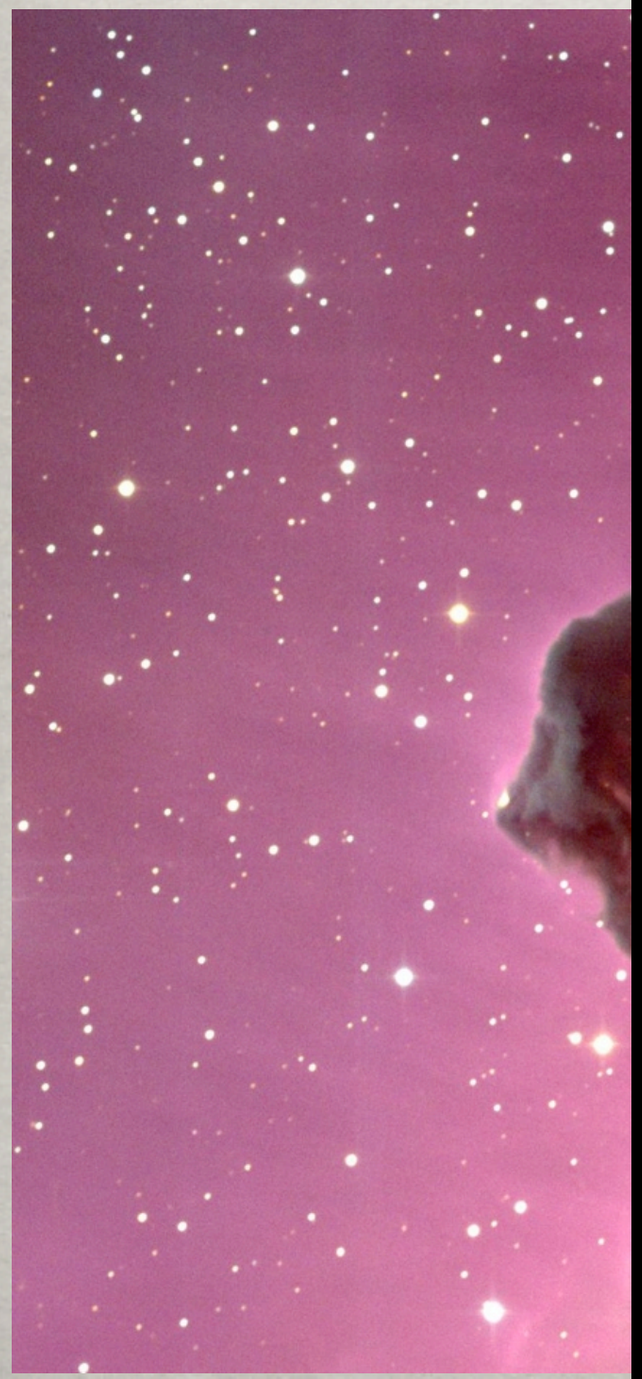
10-100pc

Nebulae: star formation

10-100pc

Nebulae: star formation

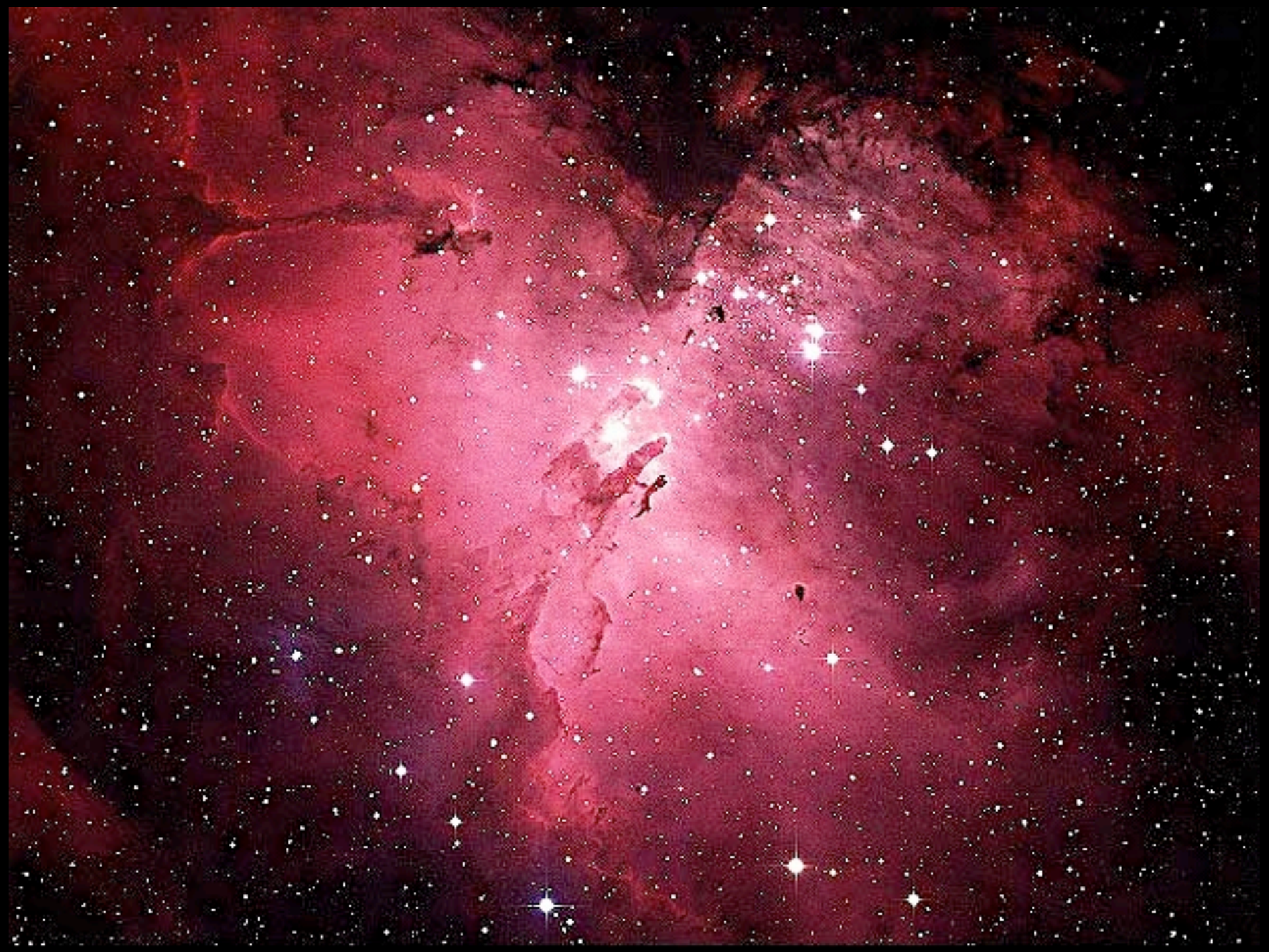
10-100pc



Horsehead Nebula

Hubble Heritage

Eagle Nebula: M16



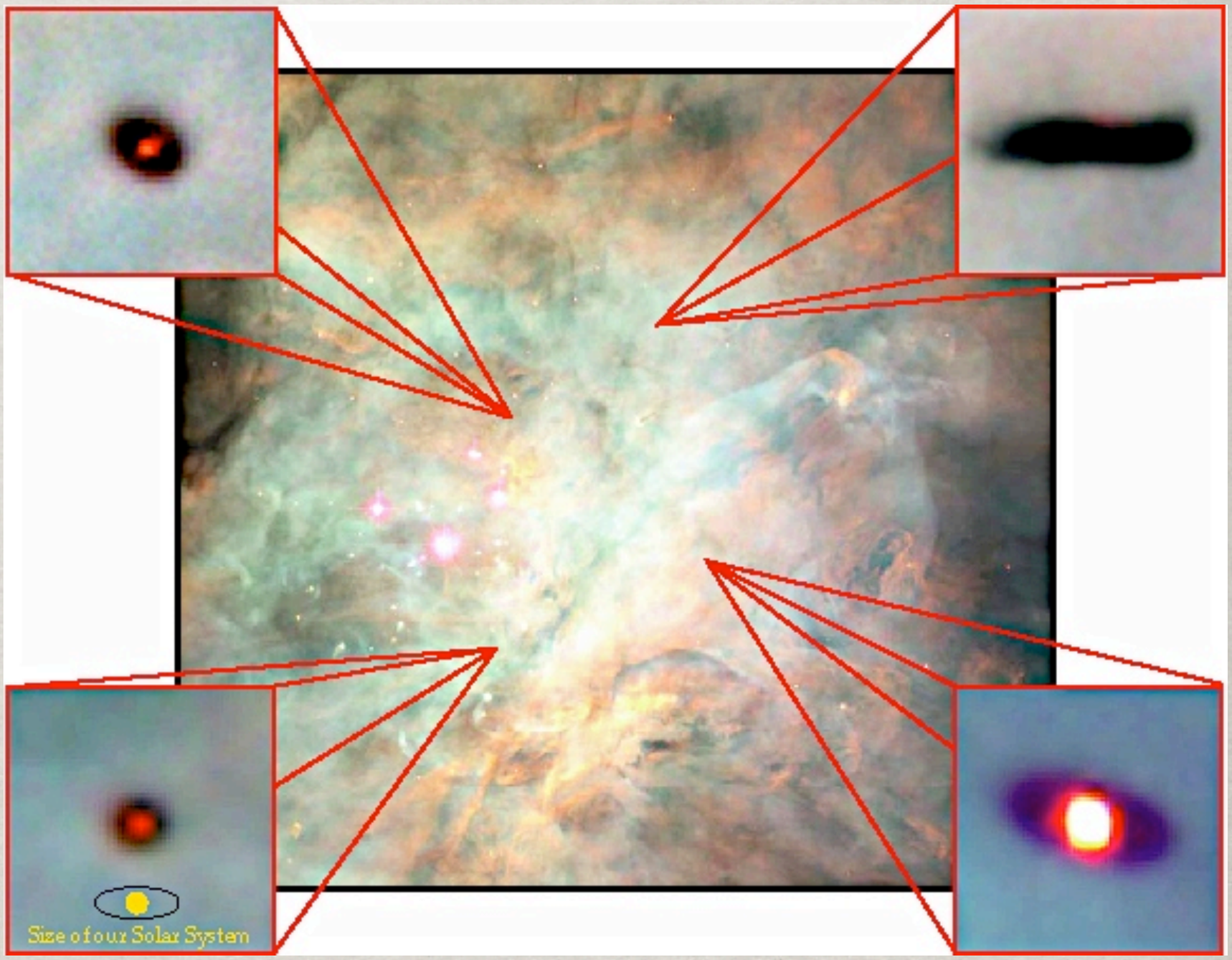
M16 © Anglo-Australian Observatory Photo by David Malin

Eagle Nebula
M16

Hubble Heritage

Orion Nebula

Orion Nebula: forming stars



Orion Nebula: forming stars

Rosette Nebula

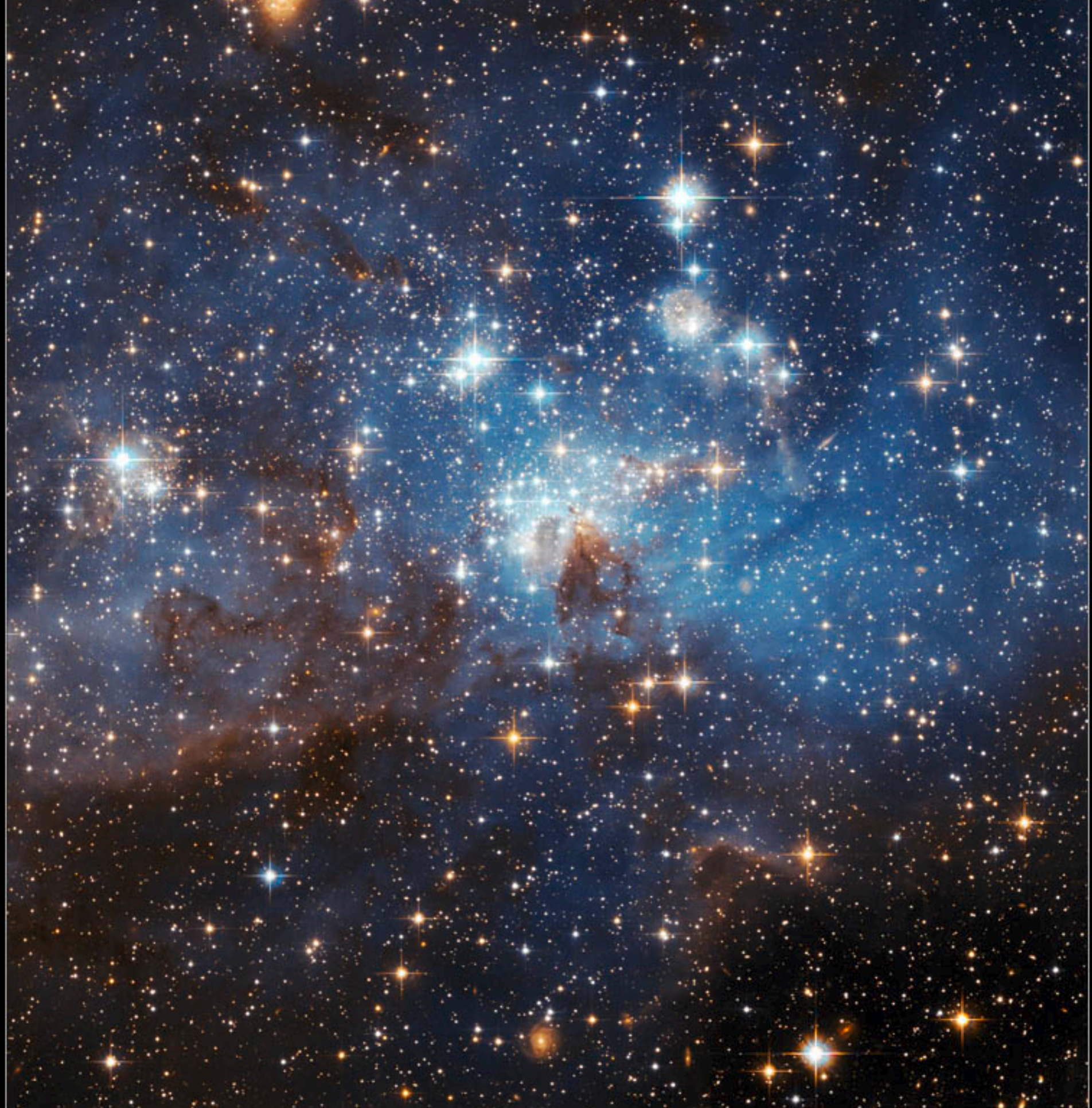
Rosette Nebula

Hubble Heritage

Next Step:

stellar cluster

10-20 pc



Next Step:

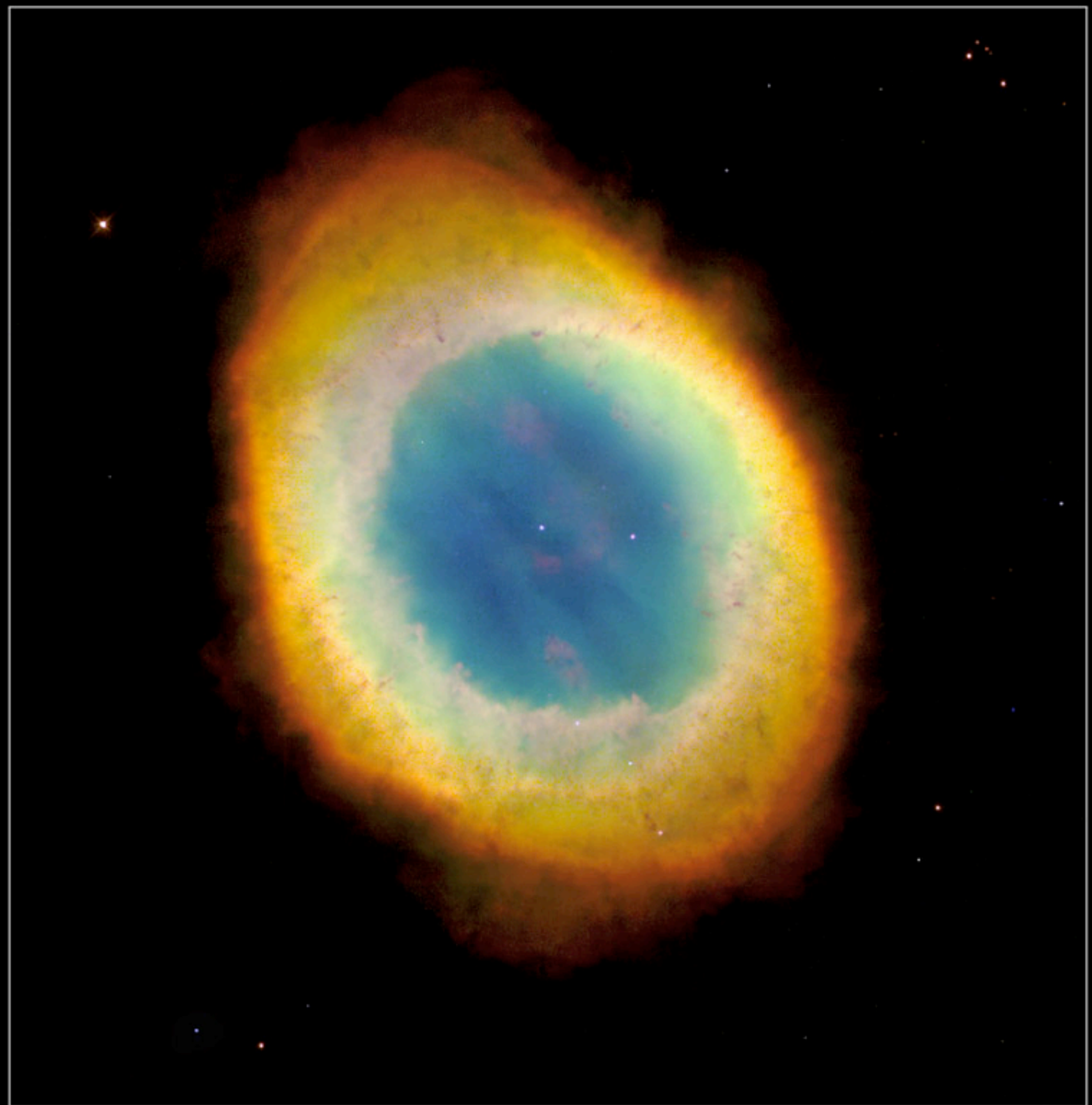
stellar cluster

10-20 pc

Planetary Nebulae:

Late stages of STELLAR EVOLUTION

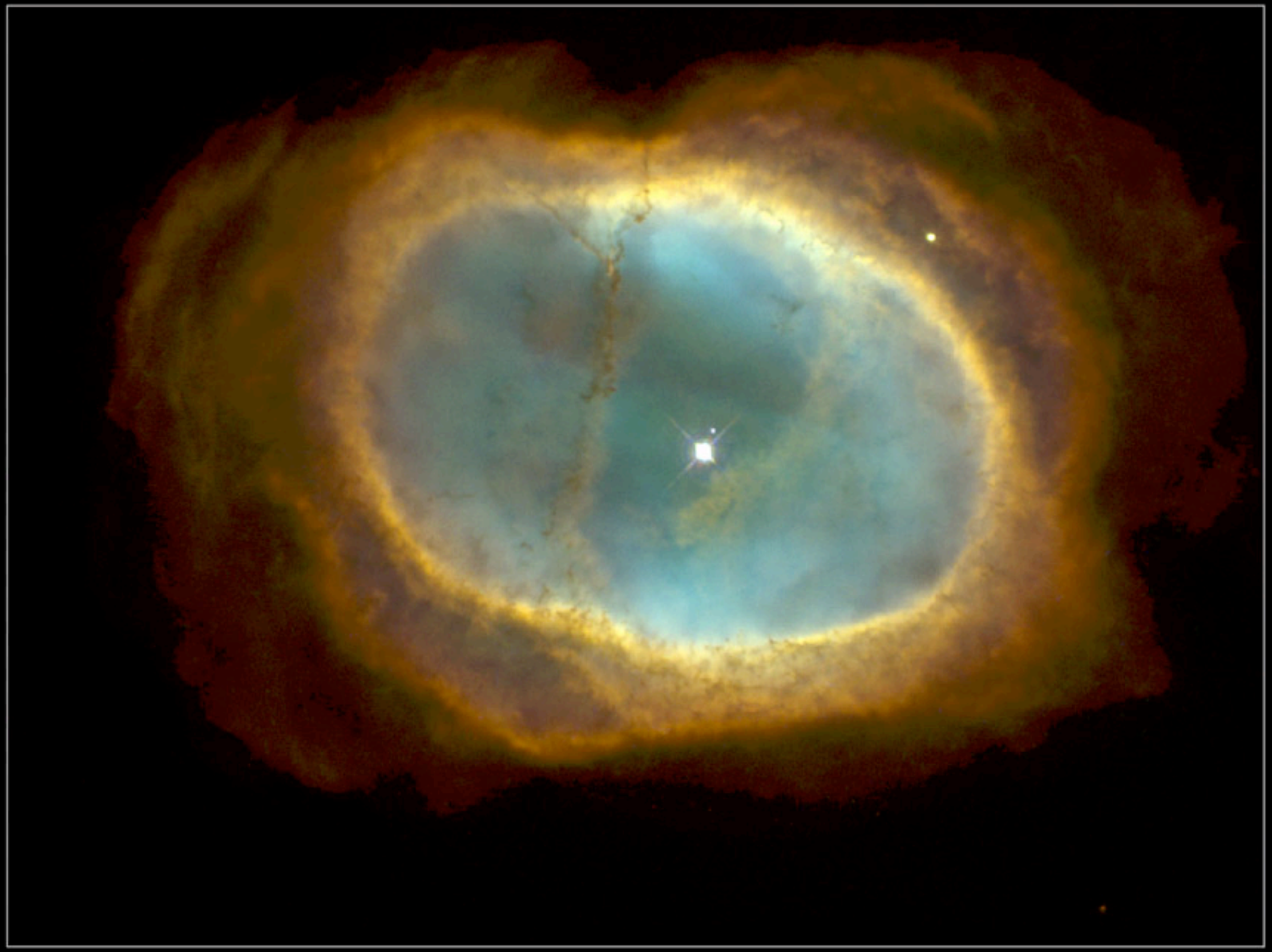
Ring Nebula



Cat's Eye Nebula • NGC 6543

Planetary Nebula IC 418

Planetary Nebula NGC 3132



Hubble Heritage

When Stars Die

Supernova Remnant Cassiopeia A

Hubble Heritage

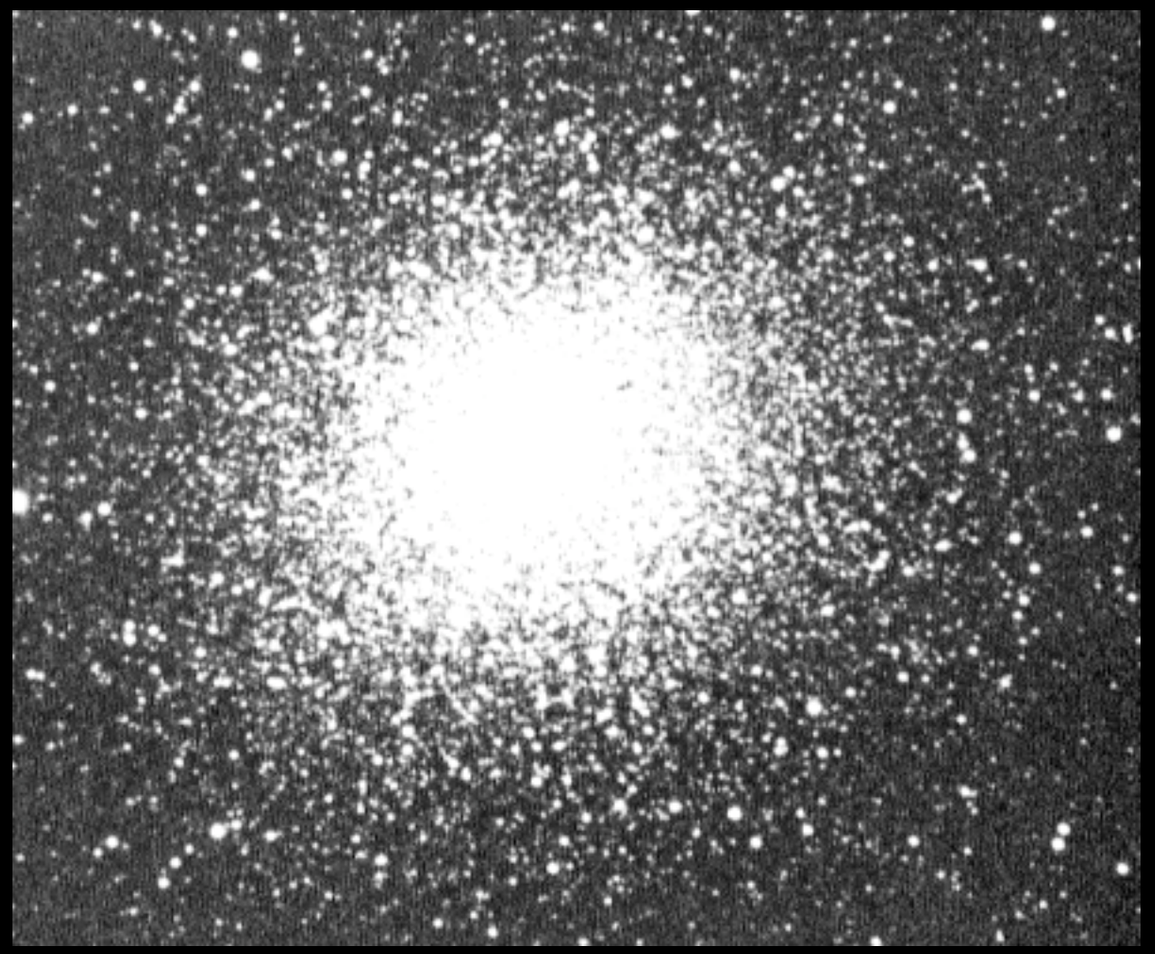
Kepler's Supernova Remnant • SN 1604

Veil Nebula Details

Hubble Heritage

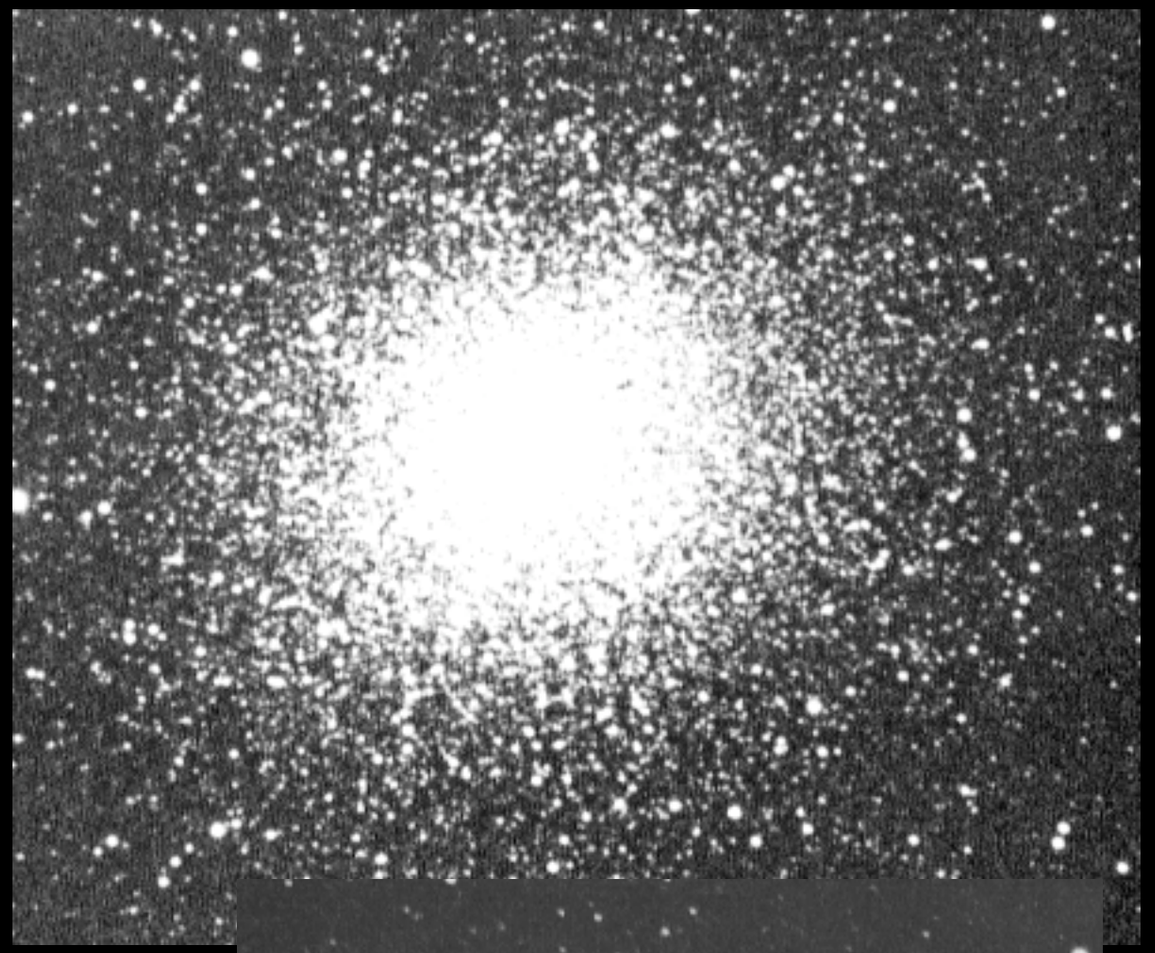
Globular clusters: Halo population

10 pc. Mass =1Million Solar Mass



Globular clusters: Halo population

10 pc. Mass =1Million Solar Mass



Globular clusters: Halo population

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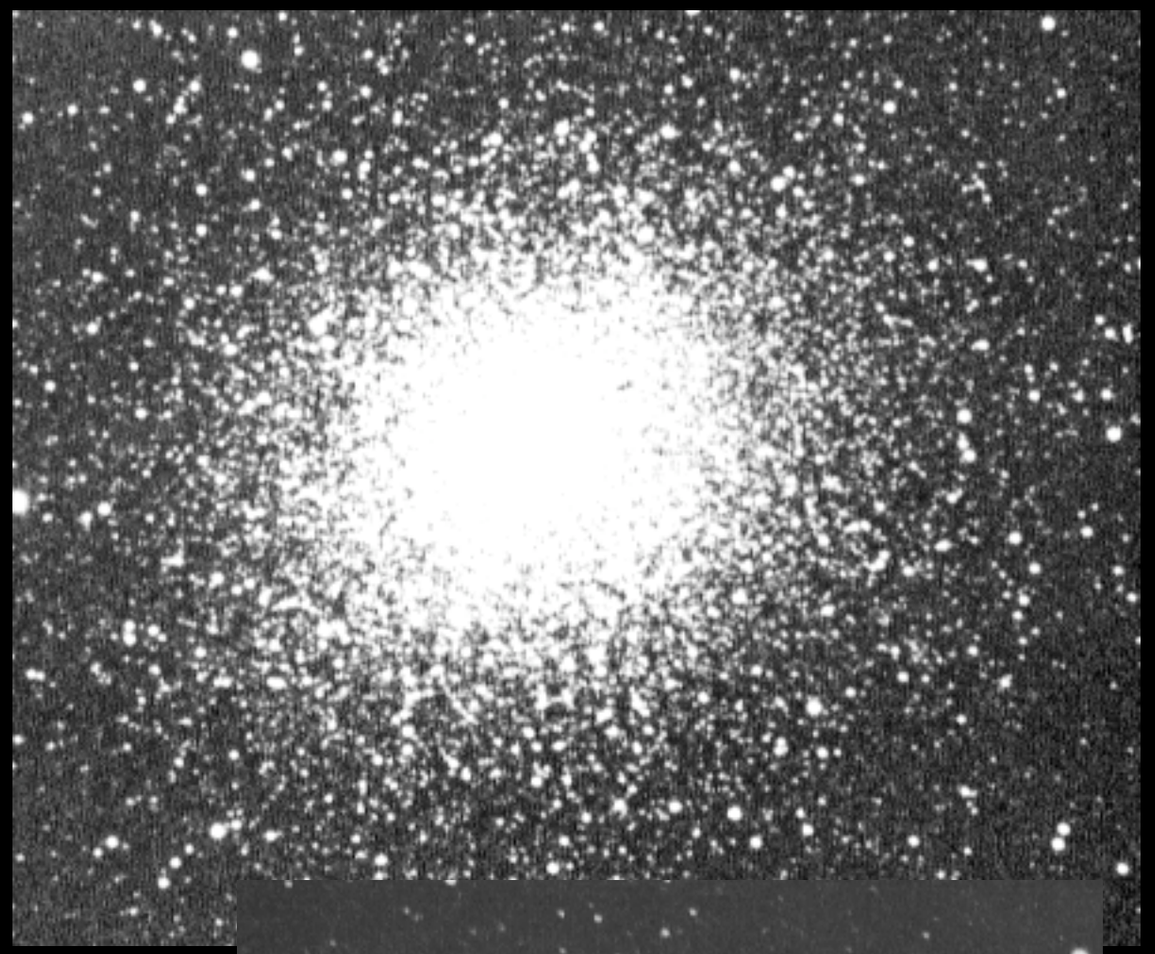
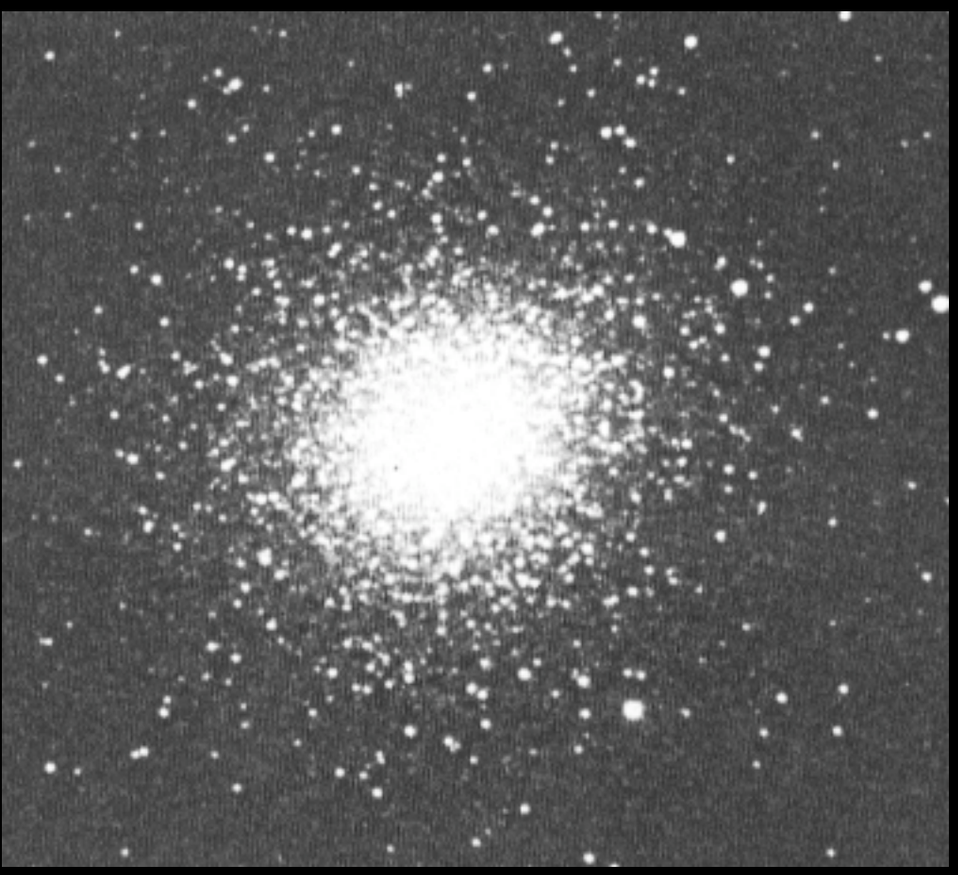
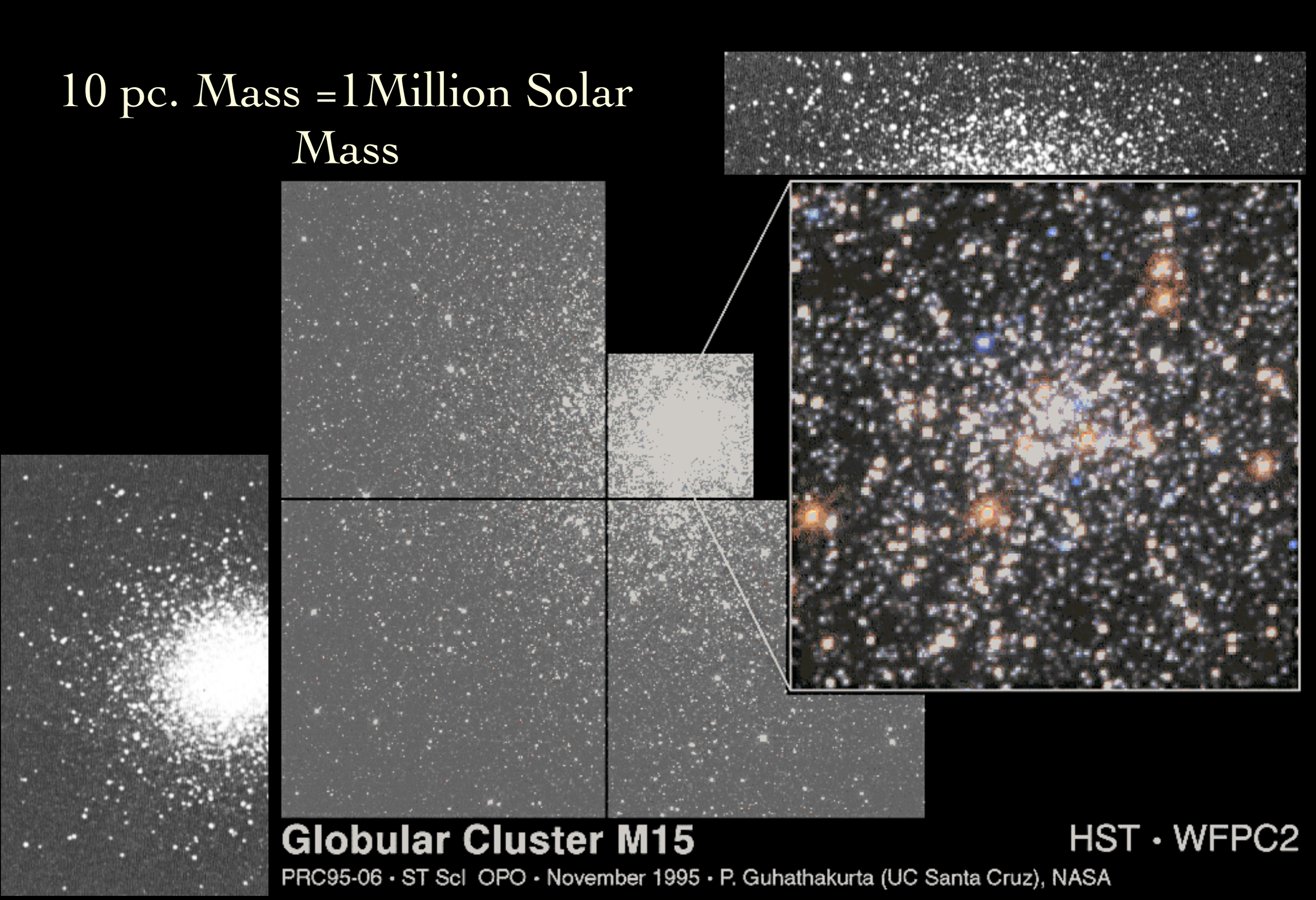




Globular clusters: Halo population

10 pc. Mass =1Million Solar Mass

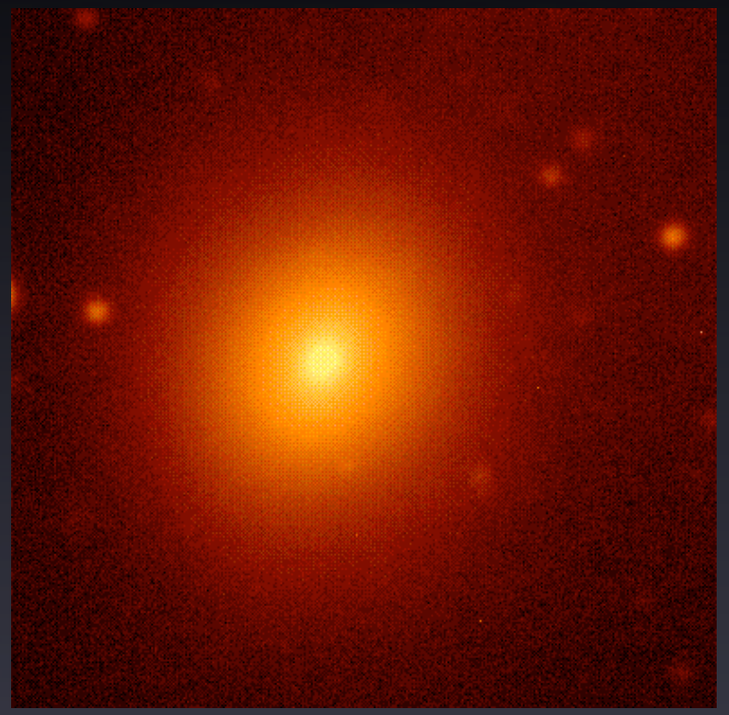


Globular Cluster M15 HST • WFPC2

PRC95-06 • ST ScI OPO • November 1995 • P. Guhathakurta (UC Santa Cruz), NASA

Other Galaxies

Spiral Galaxies



Elliptical Galaxies

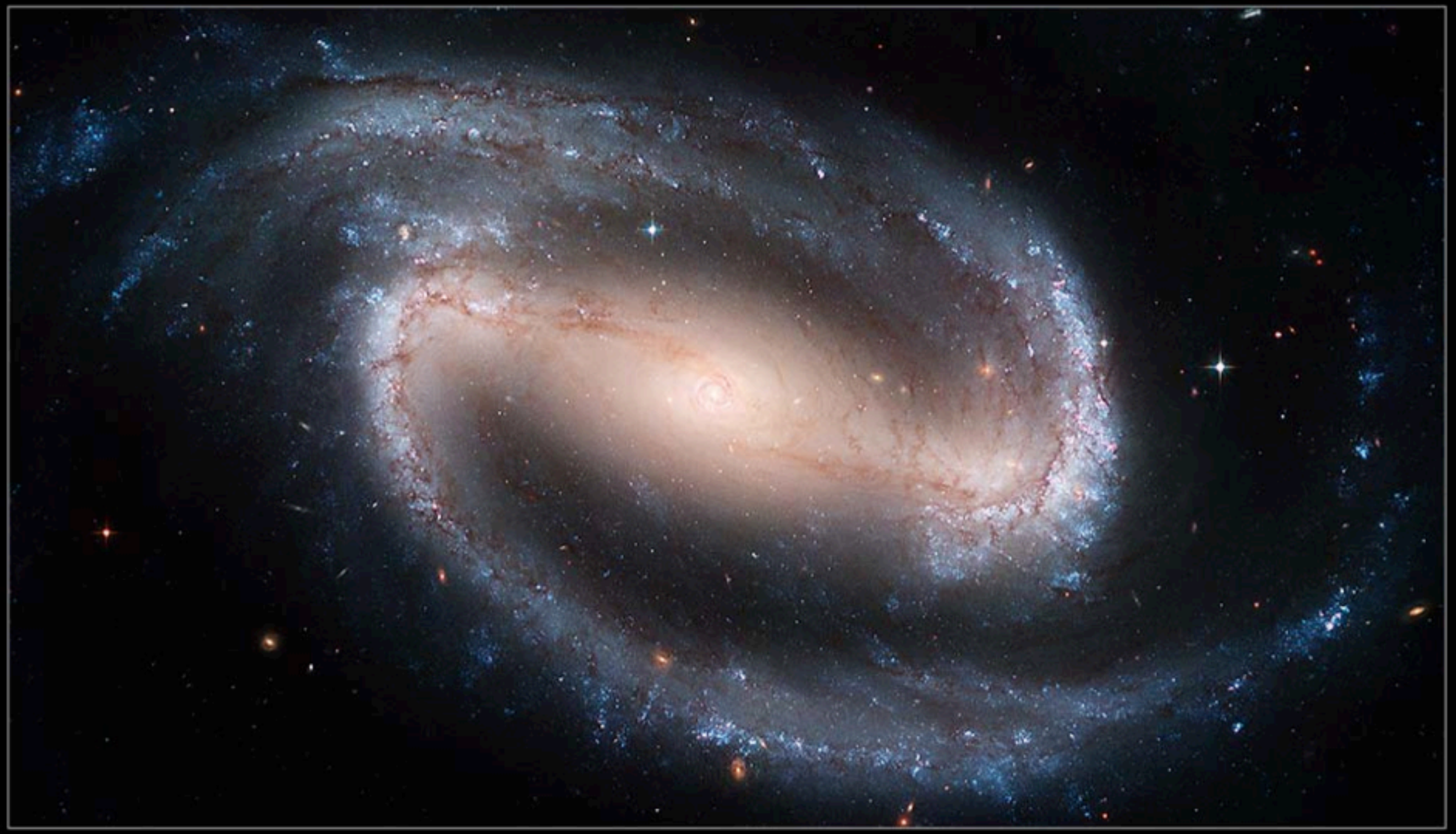
Irregular Galaxies

Spiral Galaxies

Spiral Galaxy M81

Spiral Galaxies

Barred Spiral Galaxy NGC 1300



Hubble Heritage

Spiral Galaxies

Sombrero Galaxy • M104

Hubble Heritage

Spiral Galaxies

Spiral Galaxies

Whirlpool Galaxy • M51

Spiral Galaxies

Galaxies NGC 2207 and IC 2163

Hubble Heritage

Elliptical Galaxies

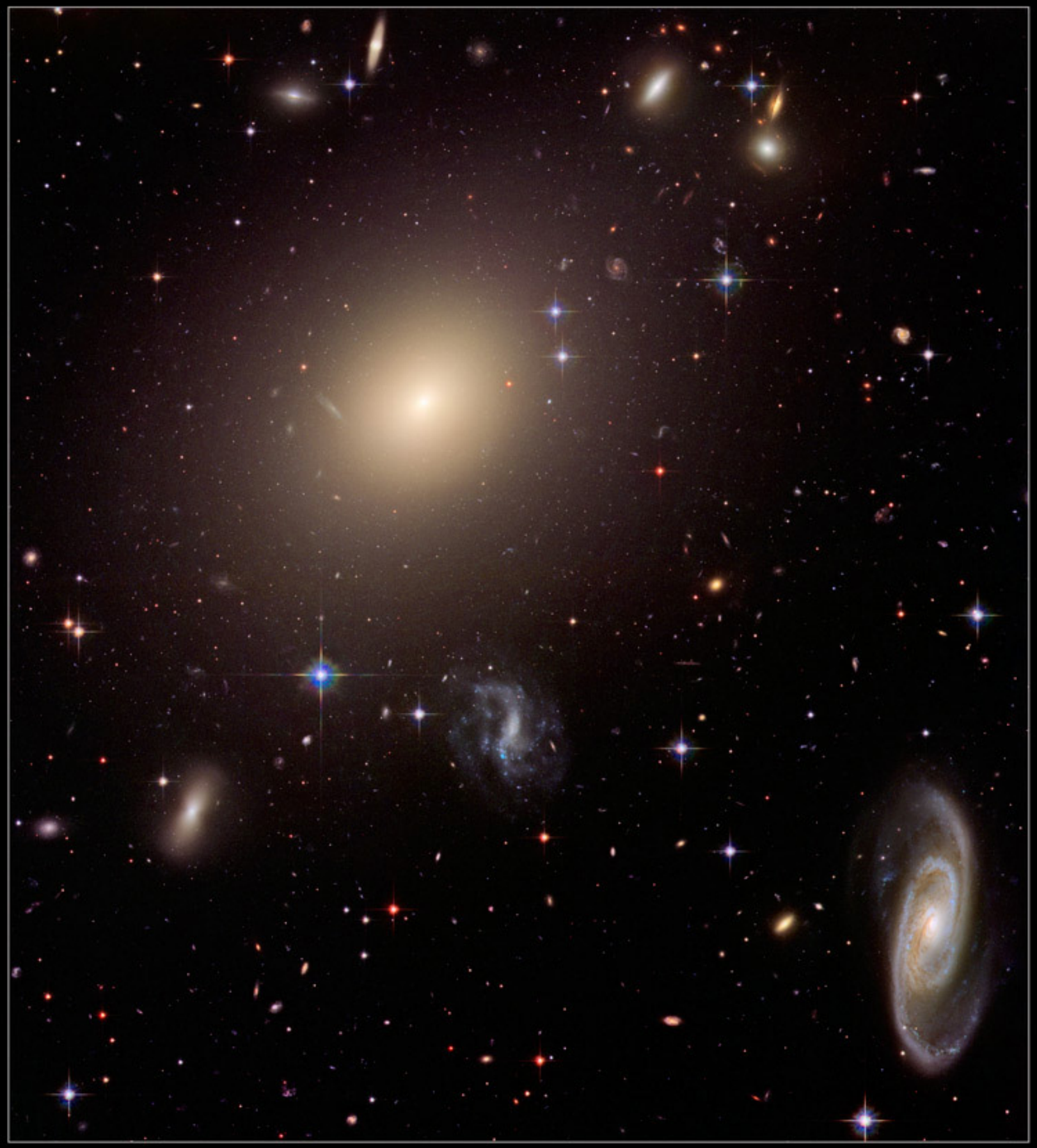
Elliptical Galaxies

Elliptical Galaxy ESO 325-G004 in the Abell Cluster S0740

Hubble Heritage

NASA, ESA, and The Hubble Heritage Team (STScI/AURA) • HST/ACS • STScI-PRC07-08

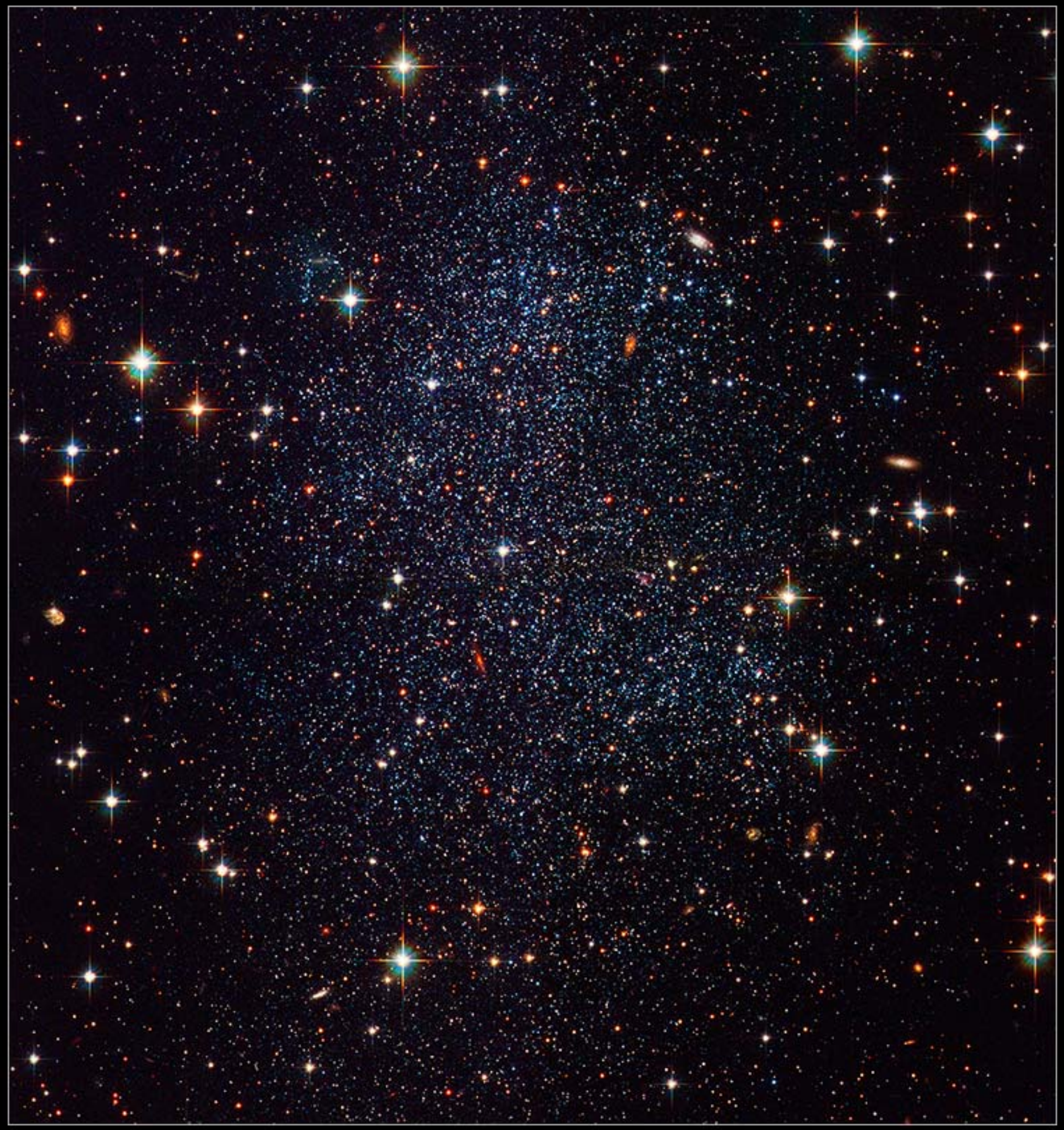
Elliptical Galaxy ESO 325-G004 in the Abell Cluster S0740



Elliptical Galaxy NGC 1132

Irregular galaxies

Sagittarius Dwarf Irregular Galaxy



The Structure of the Milky Way

1. The Milky Way galaxy consists of 3 parts:
   - The ***Bulge*** is the center of our Galaxy. It is densely packed with stars.
   - The ***Disk*** is a flattened plane of stars, gas, and dust which rotates about the center of the Galaxy.
   - The ***Halo*** is a spherical cloud of thinly scattered stars and *Globular (star) Clusters*.
2. The Earth lies about 2/3rds of the way out from the galactic center (8.5 kpc or 28,000 ly).

Stars & Star Clusters

- The Milky Way contains several hundred billion stars. Some are bigger & brighter, and many are smaller & less luminous than the Sun.
- More than half of the stars in our Galaxy are double or *binary* stars. The closest star system, Alpha Centauri, is a triple system.
- Possibly all stars in the galactic Disk are born in galactic star clusters.
- The distance between stars is very large in our stellar neighborhood. Alpha Centauri is 4.2 ly away. The density of stars like the Sun is quite low. The Milky Way galaxy is mainly empty space!
- Stars, like people, go through a life cycle: they are born, live steadily through most of their lives, and then die.

The Interstellar Medium (ISM)

- The space between stars is not totally empty. It contains gas and dust but with a very low density - about 1 atom/ cm (compared to atoms/cm for the Earth's atmosphere). This is the *interstellar medium* (ISM).
- Occasionally, gas gathers into larger & somewhat denser clumps called *nebulae*. These gas clouds are often red in color. These nebulae house stellar nurseries.
- The ISM contains mainly hydrogen gas.
- The ISM also contains significant dust which dims the light of the stars that lie behind the dust clouds.

Individual Galaxies

1. There are a variety of galaxy types in the Universe:
    - *Spiral* galaxies rotate, have a relatively cool ISM, and are like our own Milky Way.
    - *Elliptical* galaxies are somewhat shaped like a football, do not have spiral arms, do not rotate, and have a hot (K) ISM.
    - *Irregular* galaxies have no organized shape, no symmetry, contain young stars and much gas.

Groups and Clusters of Galaxies

- Most, if not all, galaxies are in groups or clusters.
- Our galaxy and about 22 others are part of the *Local Group* of Galaxies. It is about 10 million ly in diameter.
- There are some truly gigantic rich clusters which contain about 1000 galaxies and are more than 20 million ly in diameter.

The Expanding Universe

- In 1929, Edwin Hubble discovered that the Universe is expanding. All galaxies are rushing away from all other galaxies.
- On very large scales the Universe is *homogeneous*