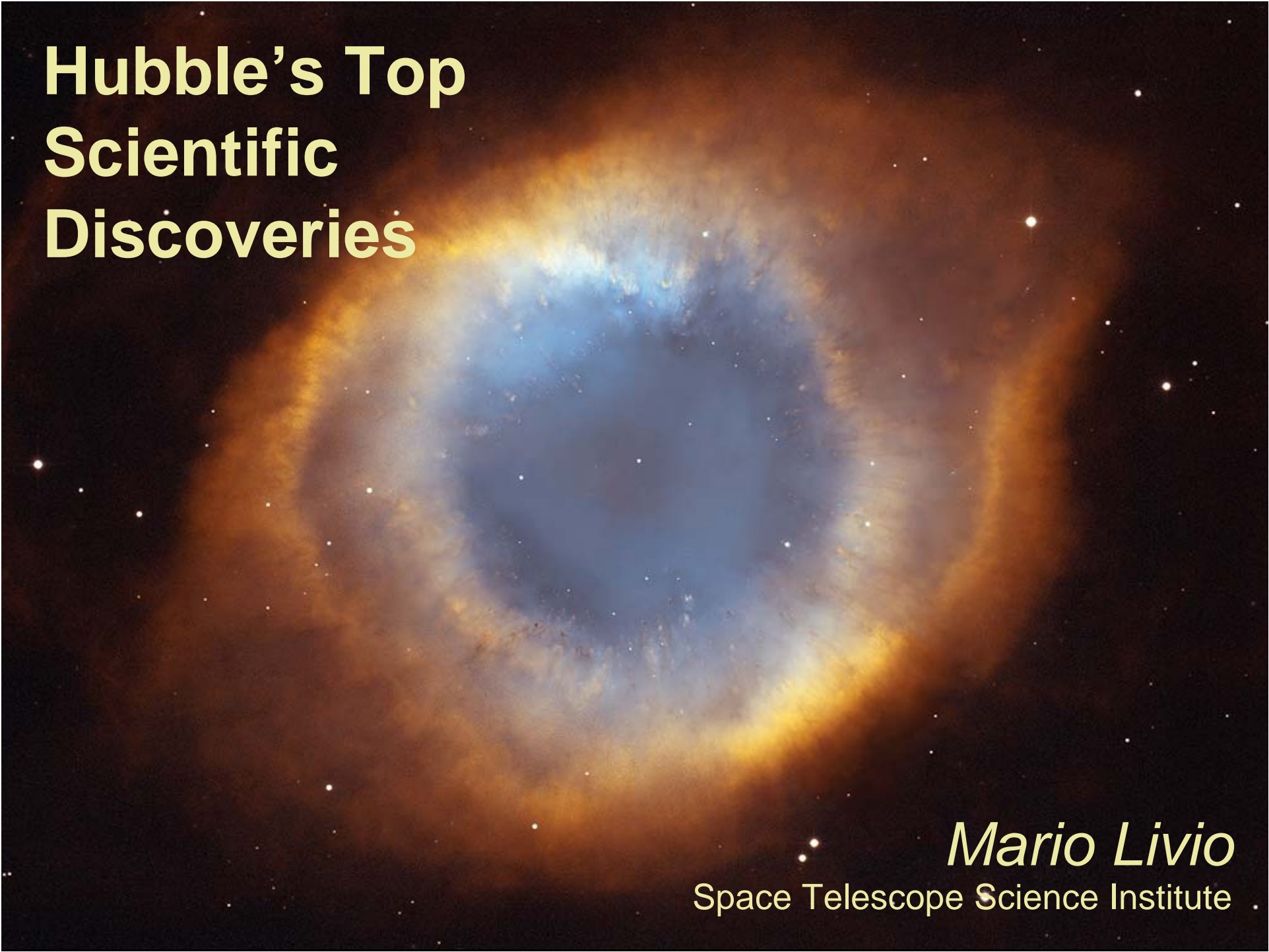


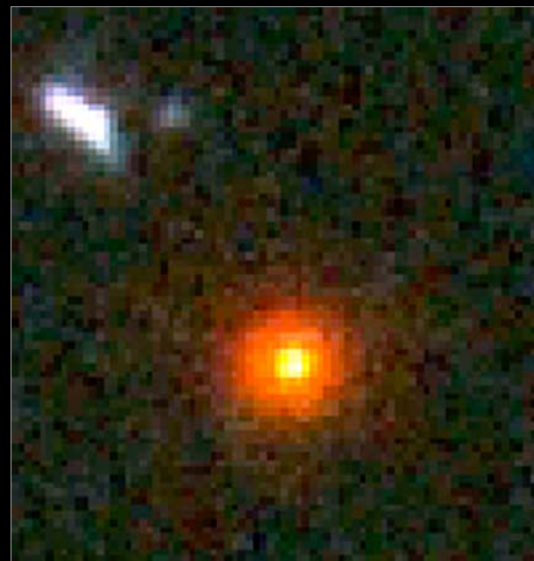
Hubble's Top Scientific Discoveries



Mario Livio
Space Telescope Science Institute

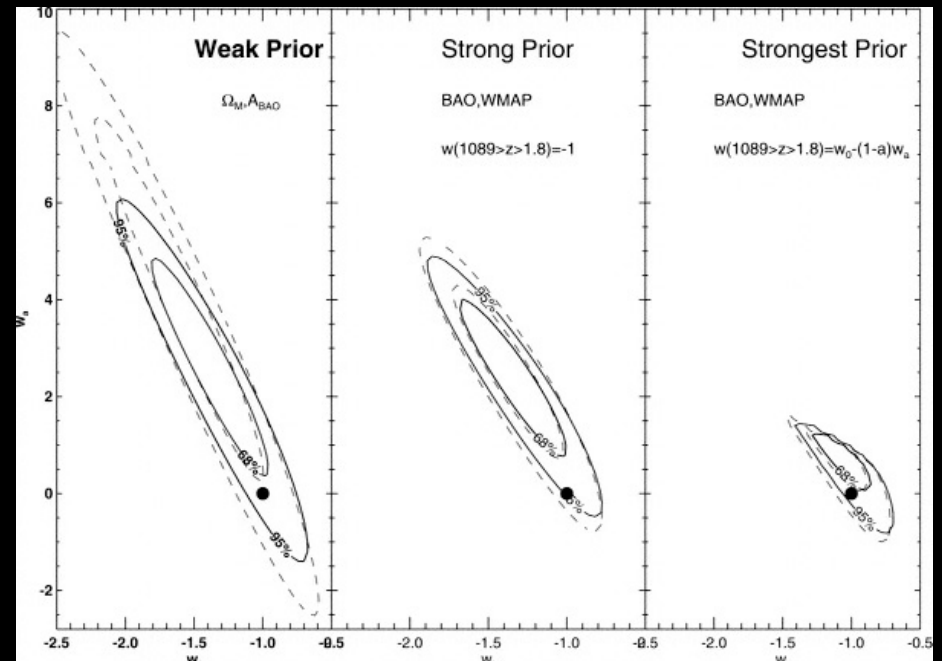
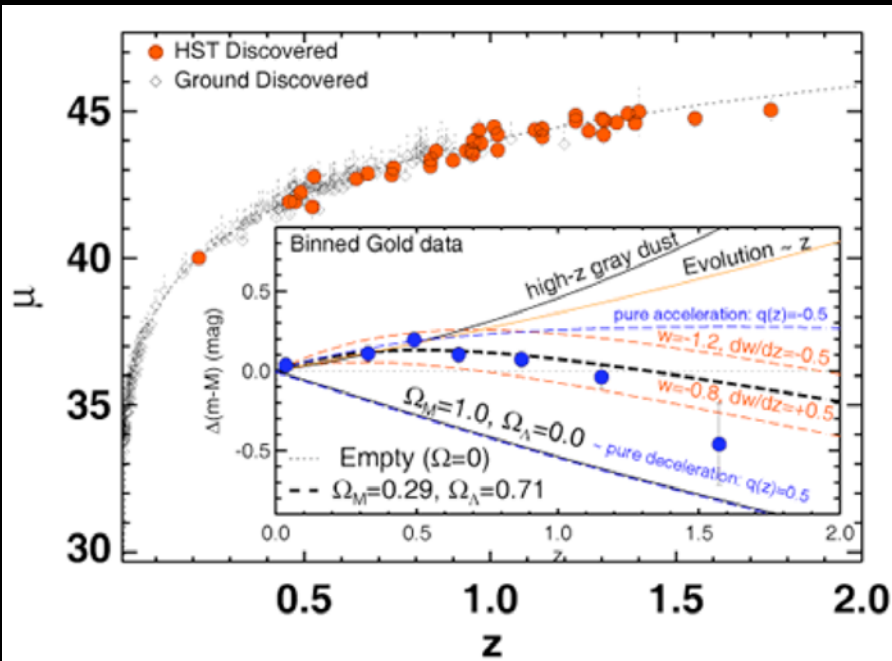
1: The Accelerating Universe and Dark Energy

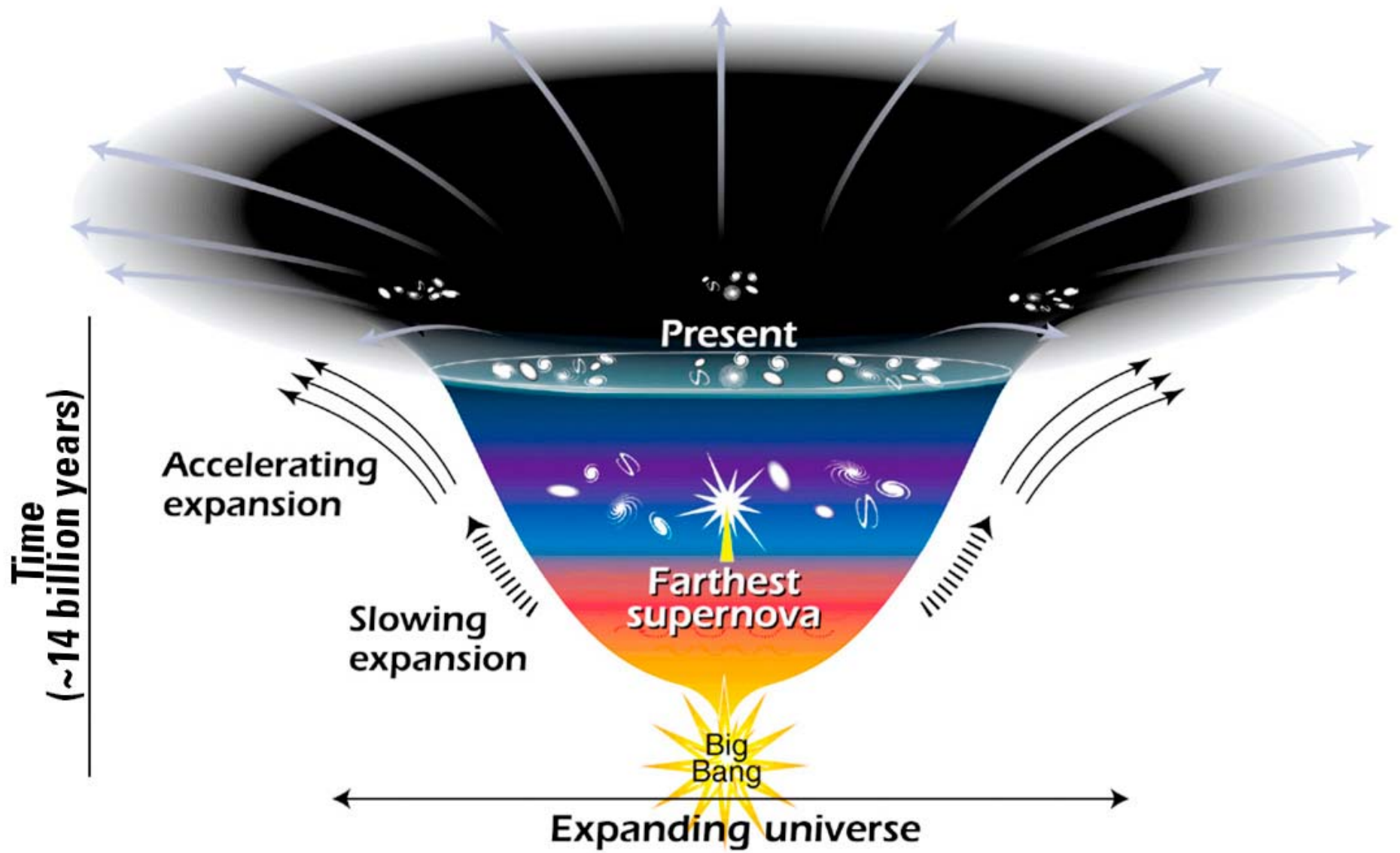
High Redshift Type Ia Supernovae



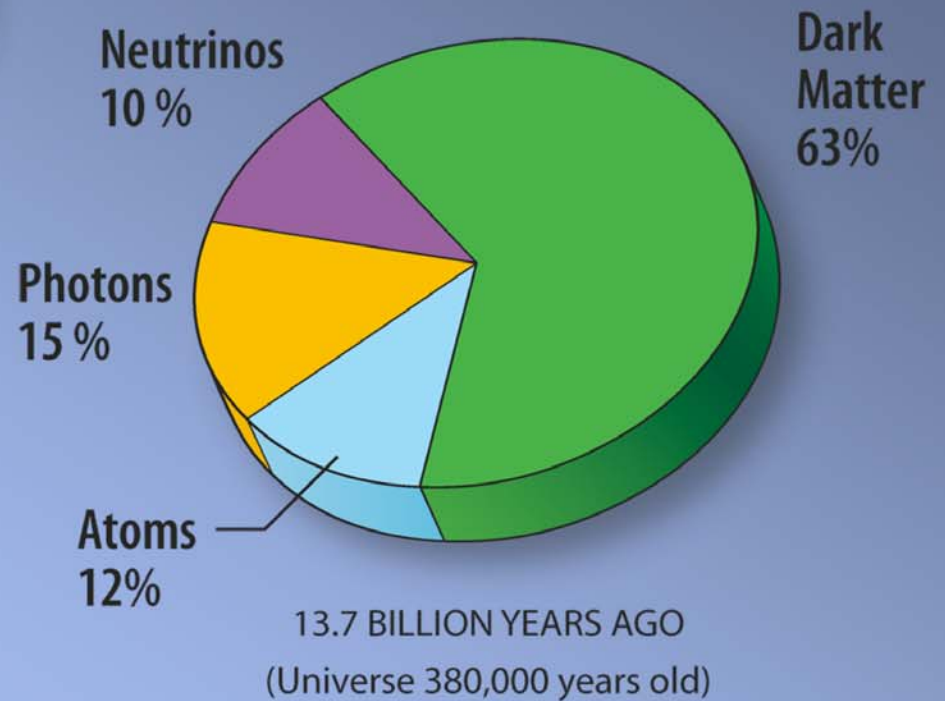
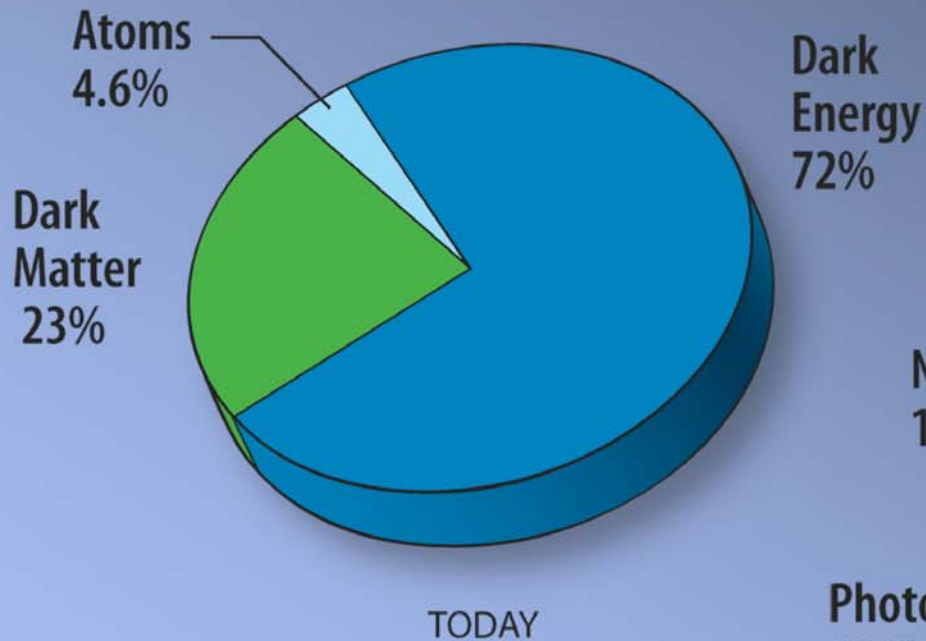
The Evidence from Type Ia Supernovae

Constraints on equation of state



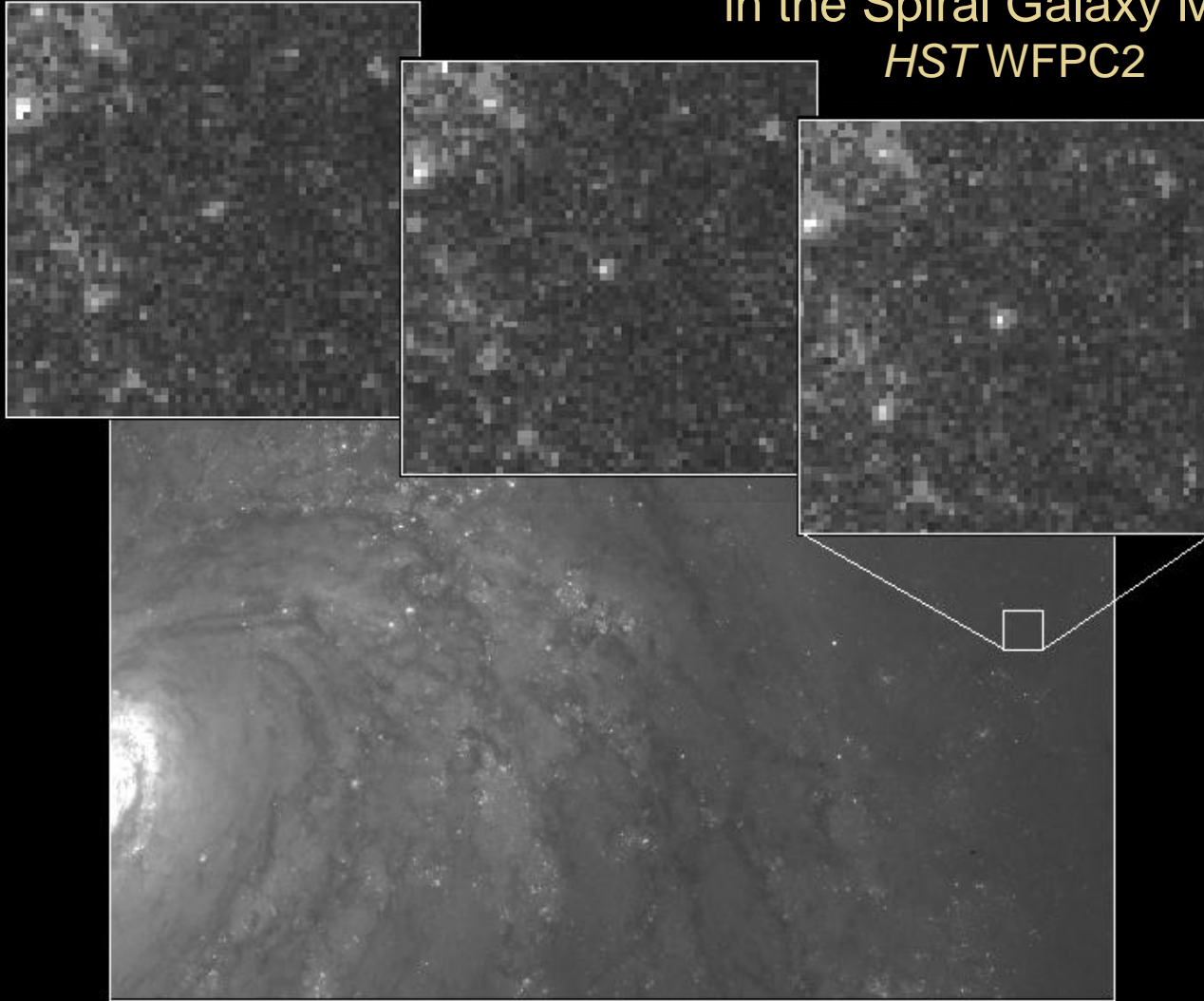


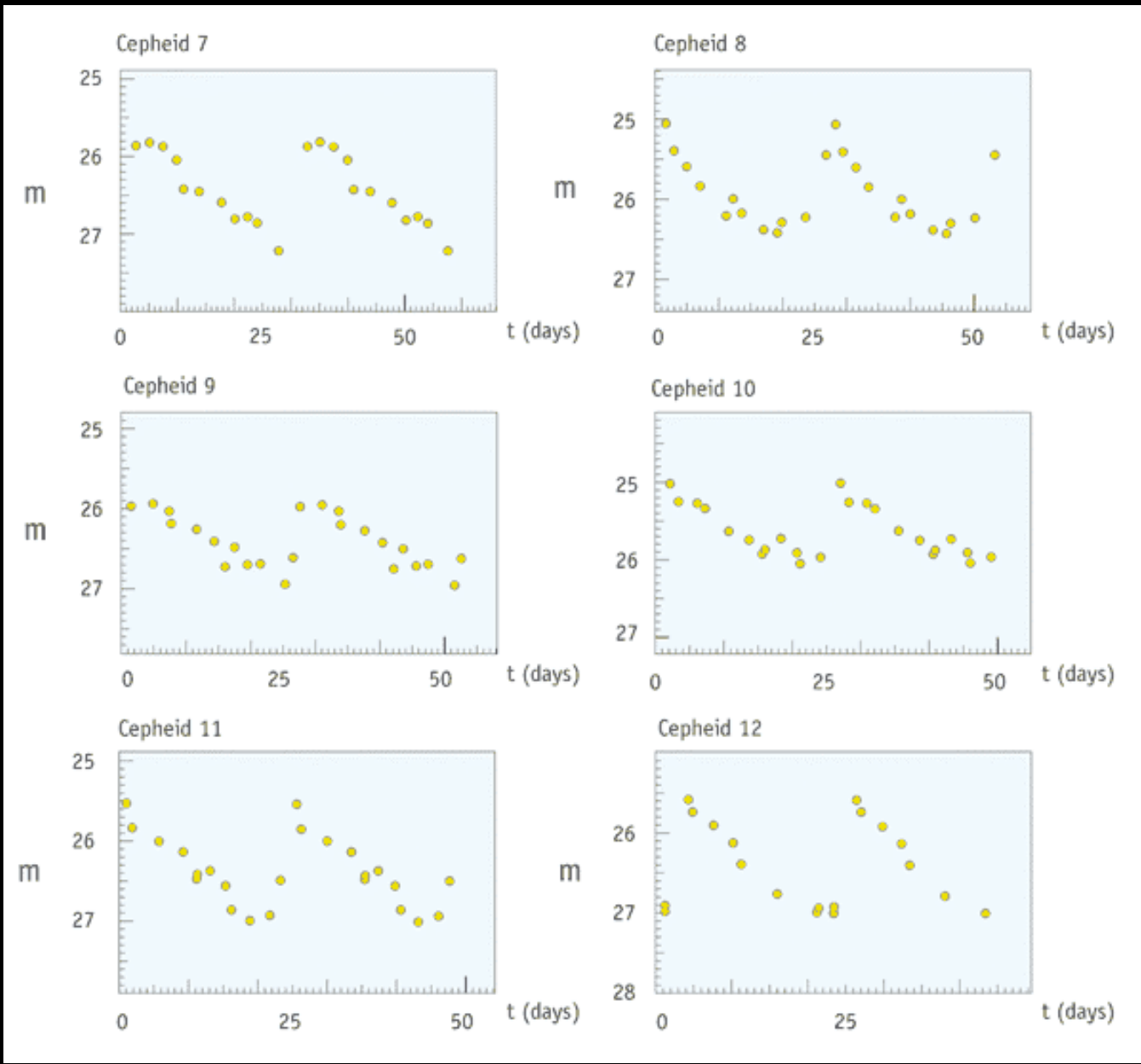
Composition of the Cosmos



2: The Distance Scale and the Value of H_0

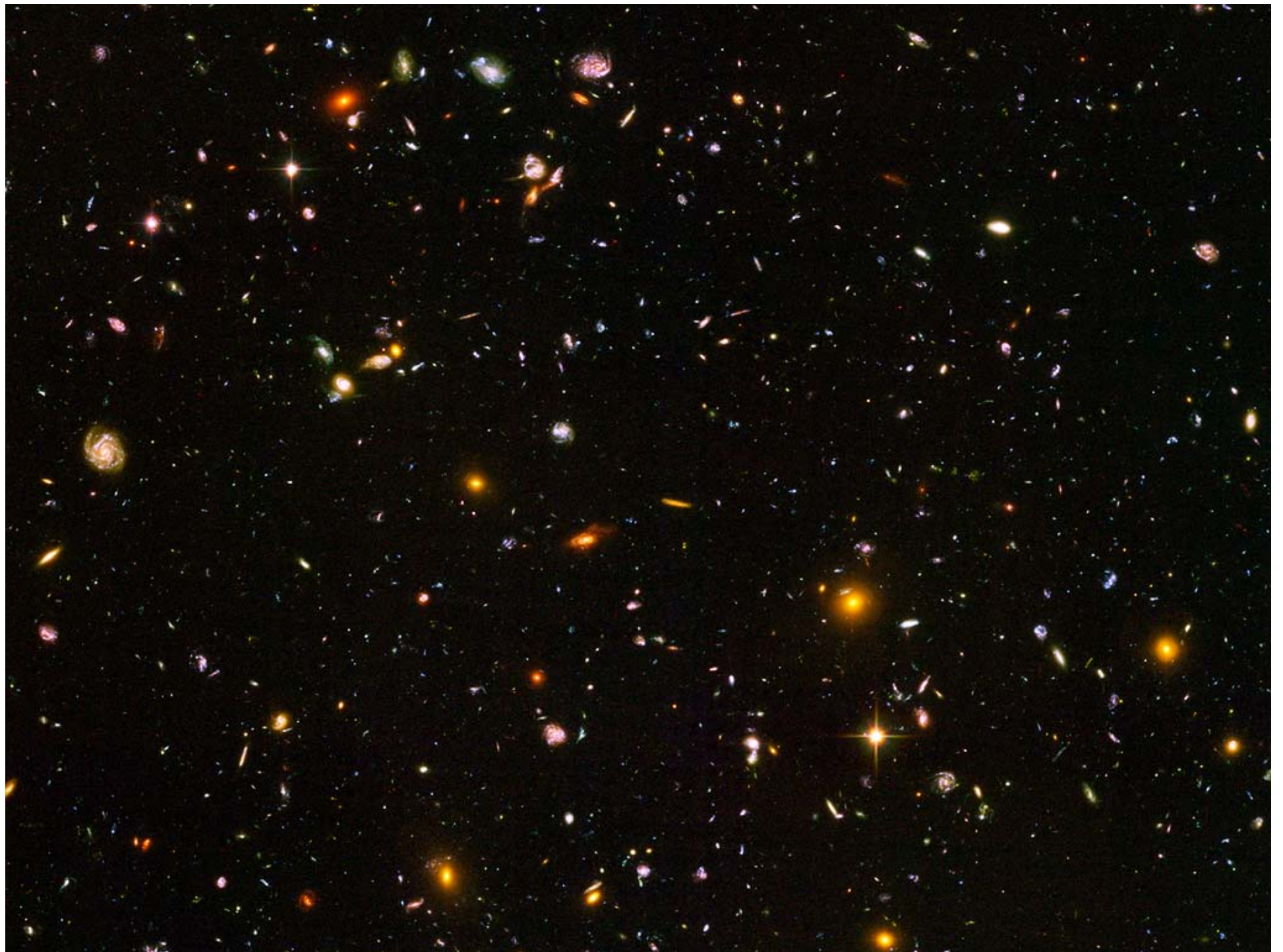
Cepheid Variable Star
in the Spiral Galaxy M100
HST WFPC2

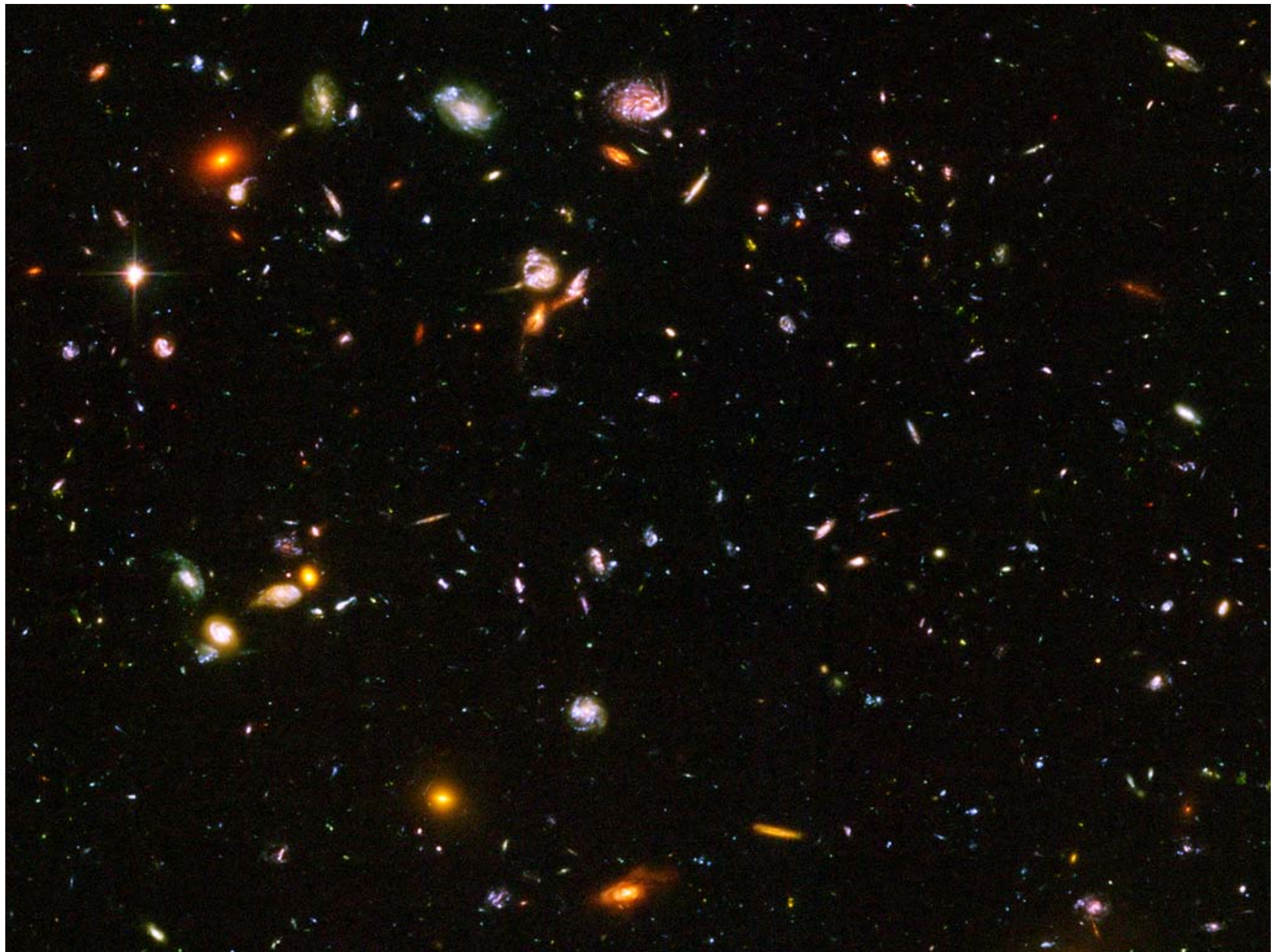


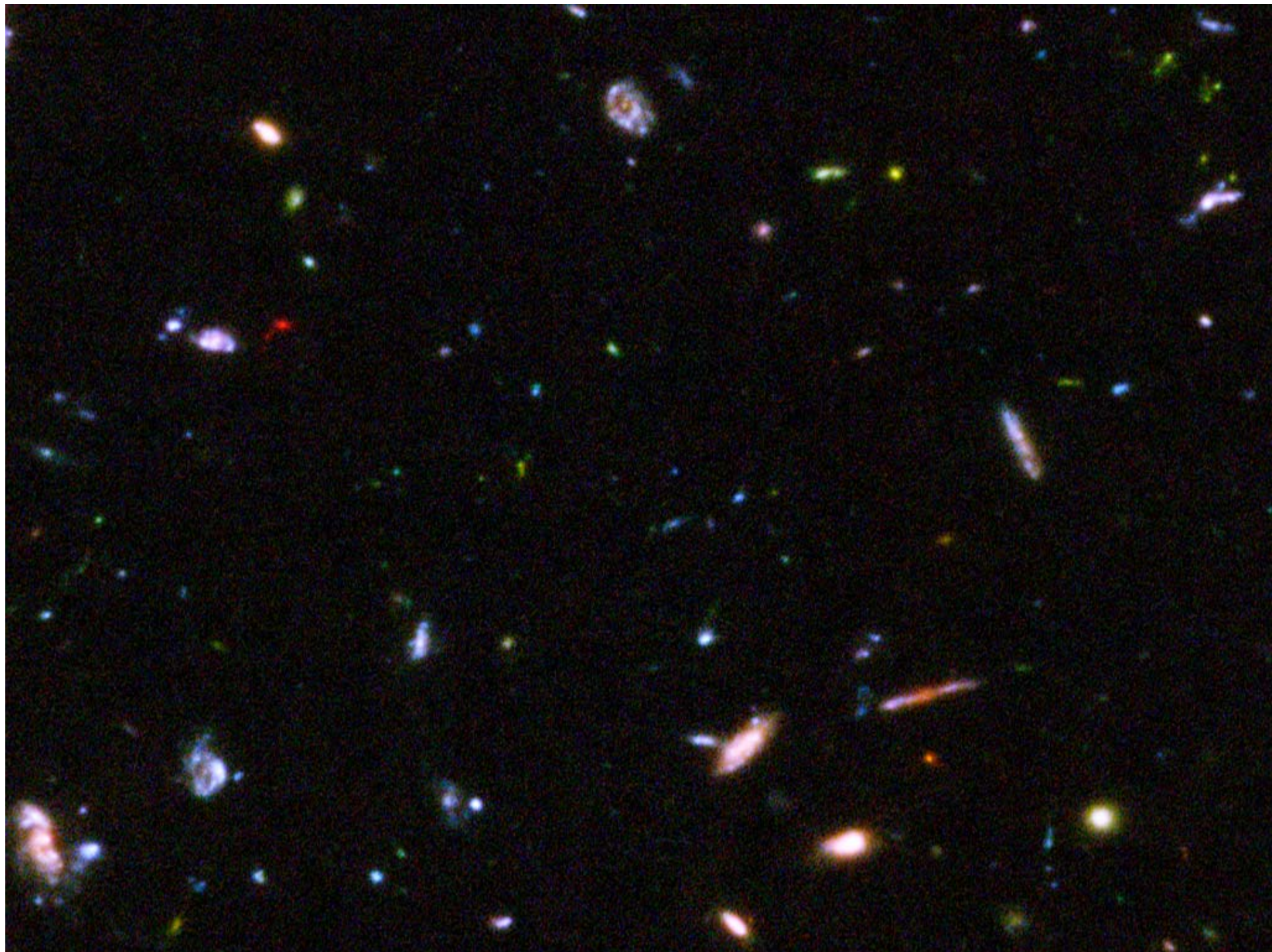


$$H_0 = 72 \pm 8 \text{ km/s/Mpc}$$

3: The Evolution of Galaxies and the Cosmic Star Formation Rate

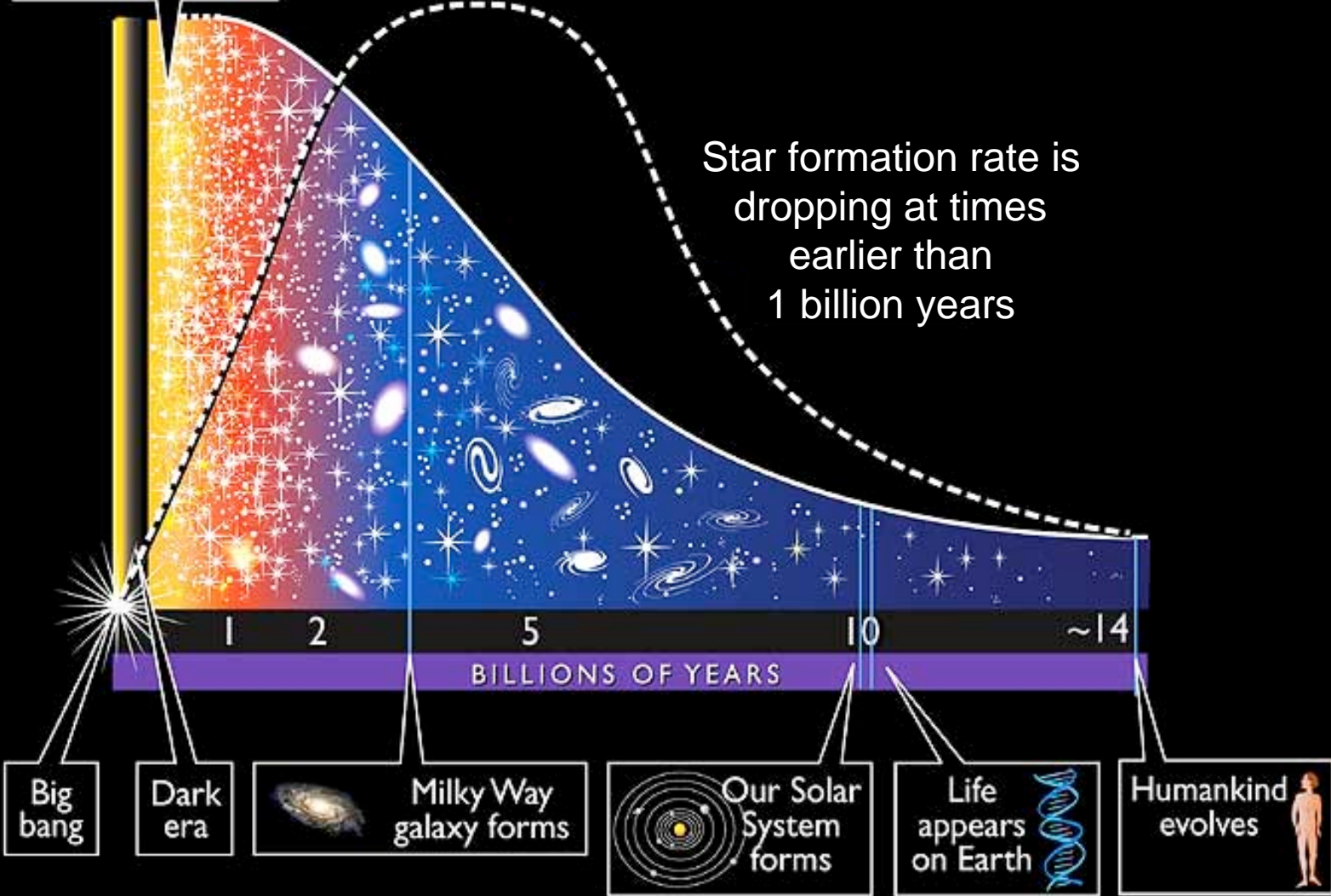




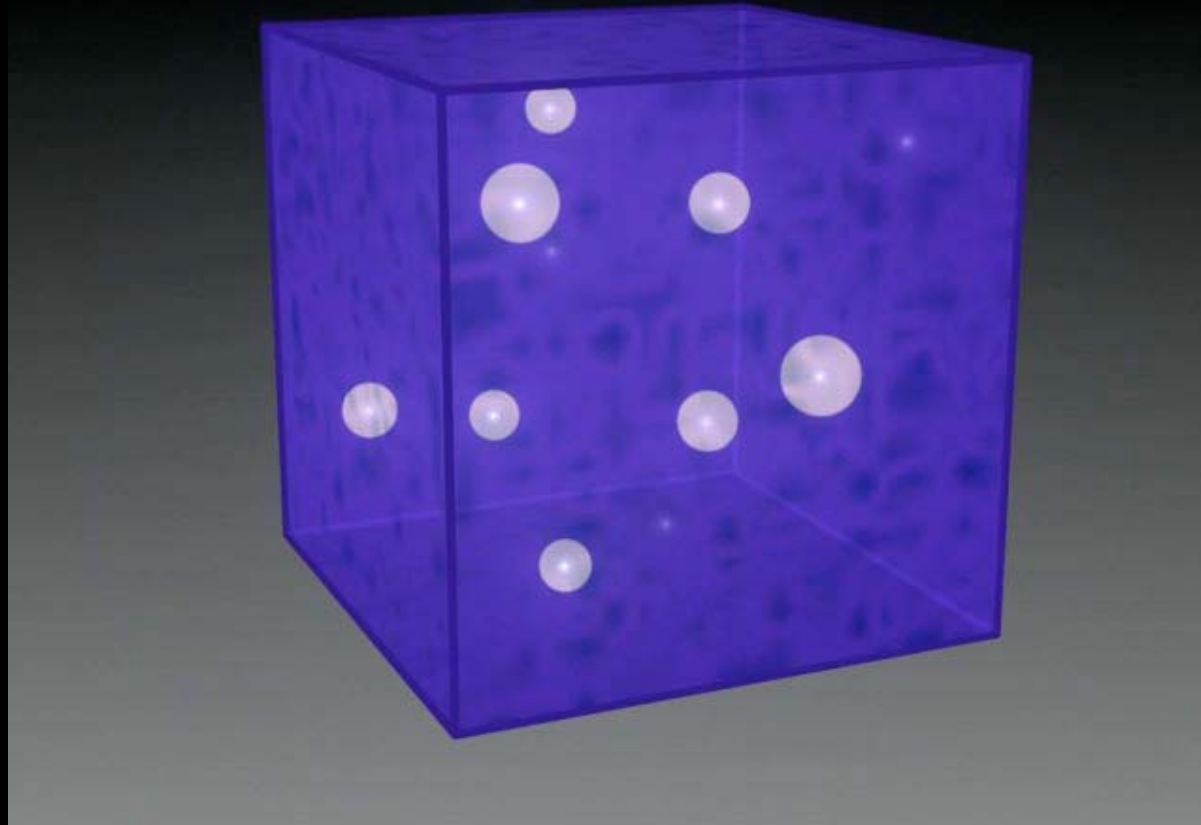


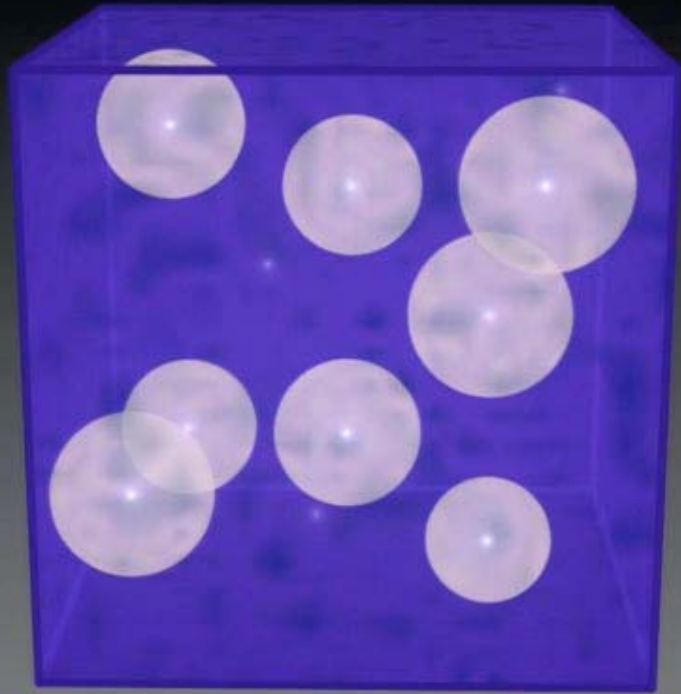
Star birth begins

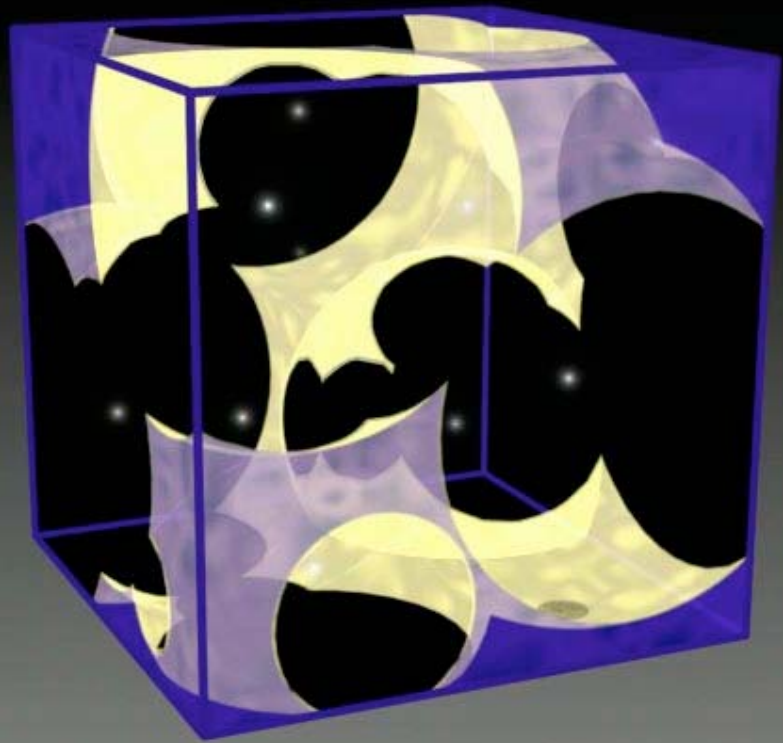
Star formation rate is dropping at times earlier than 1 billion years

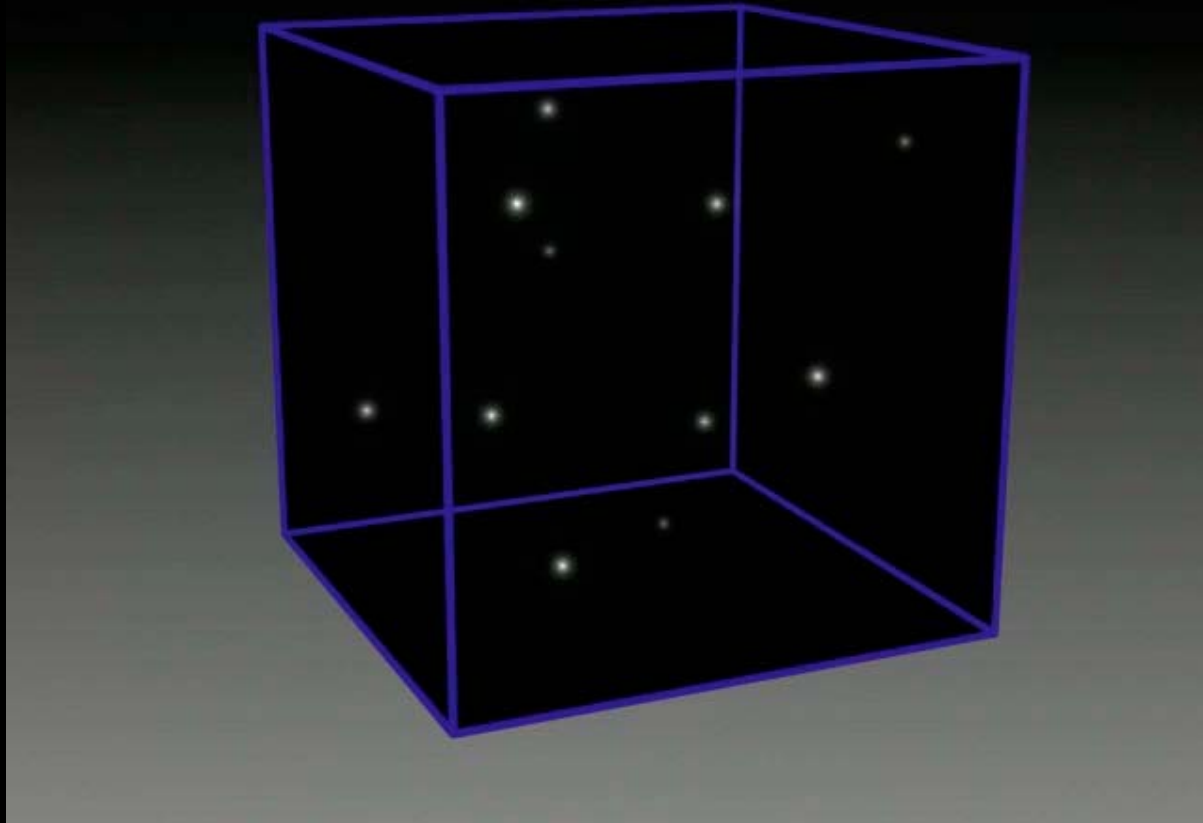


Cosmic Reionization



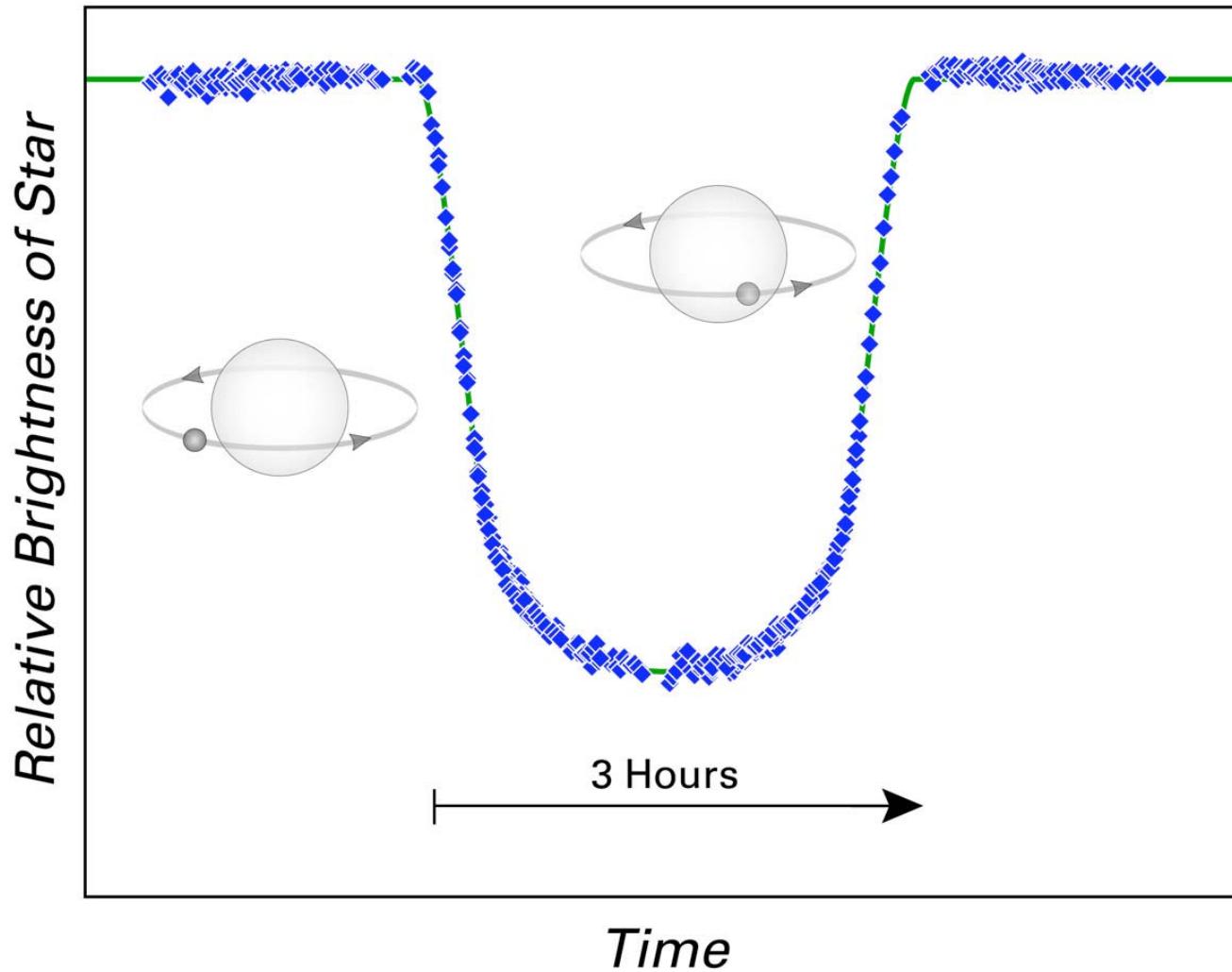




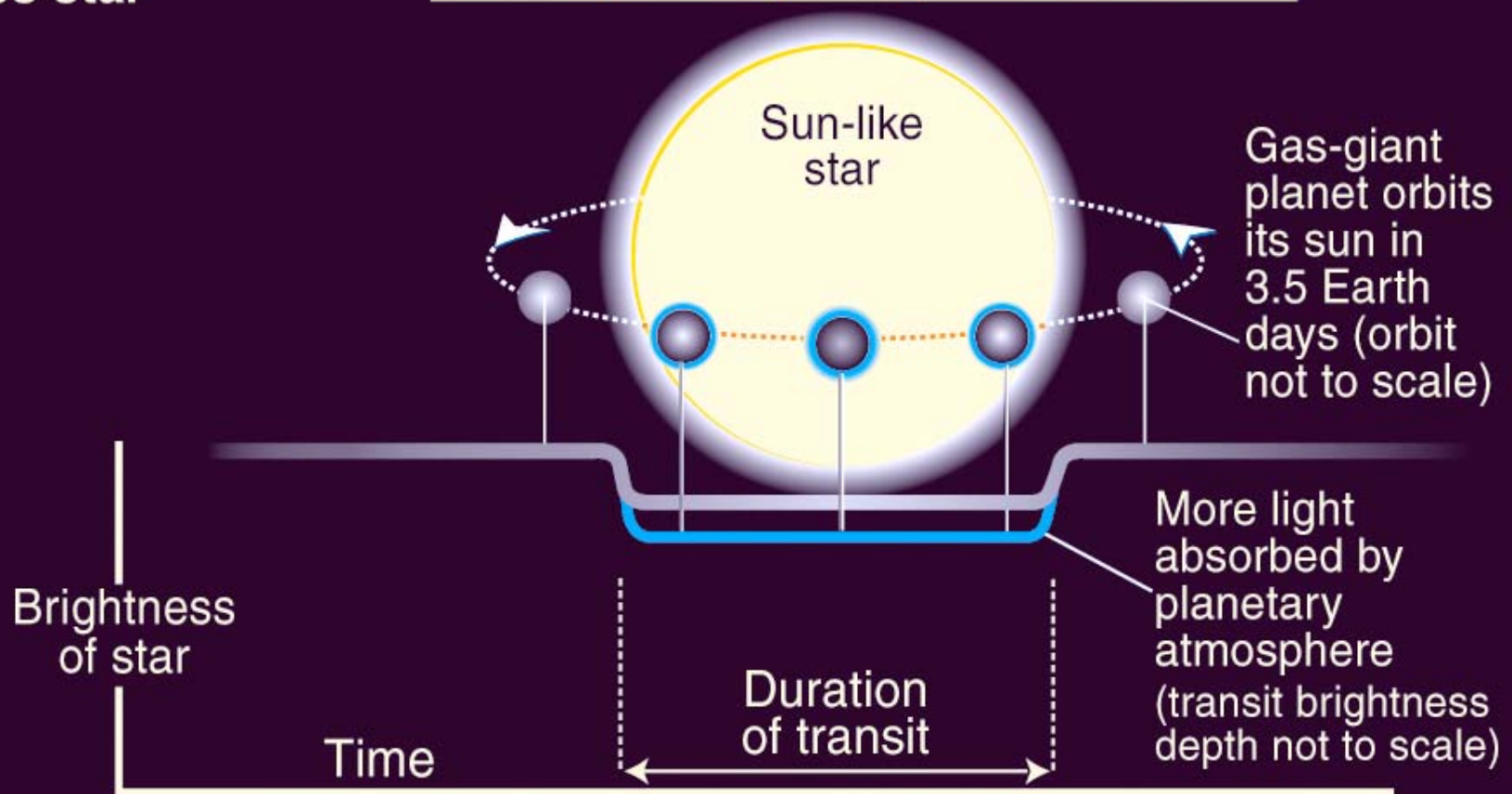
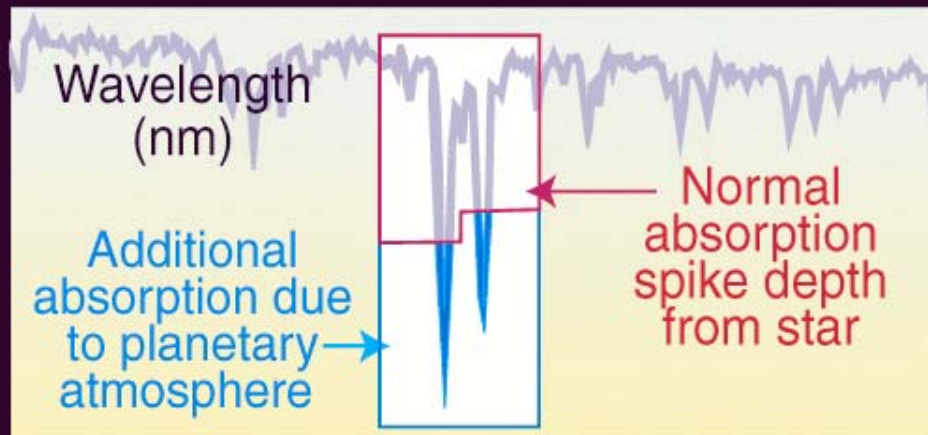


4: Extrasolar Planets

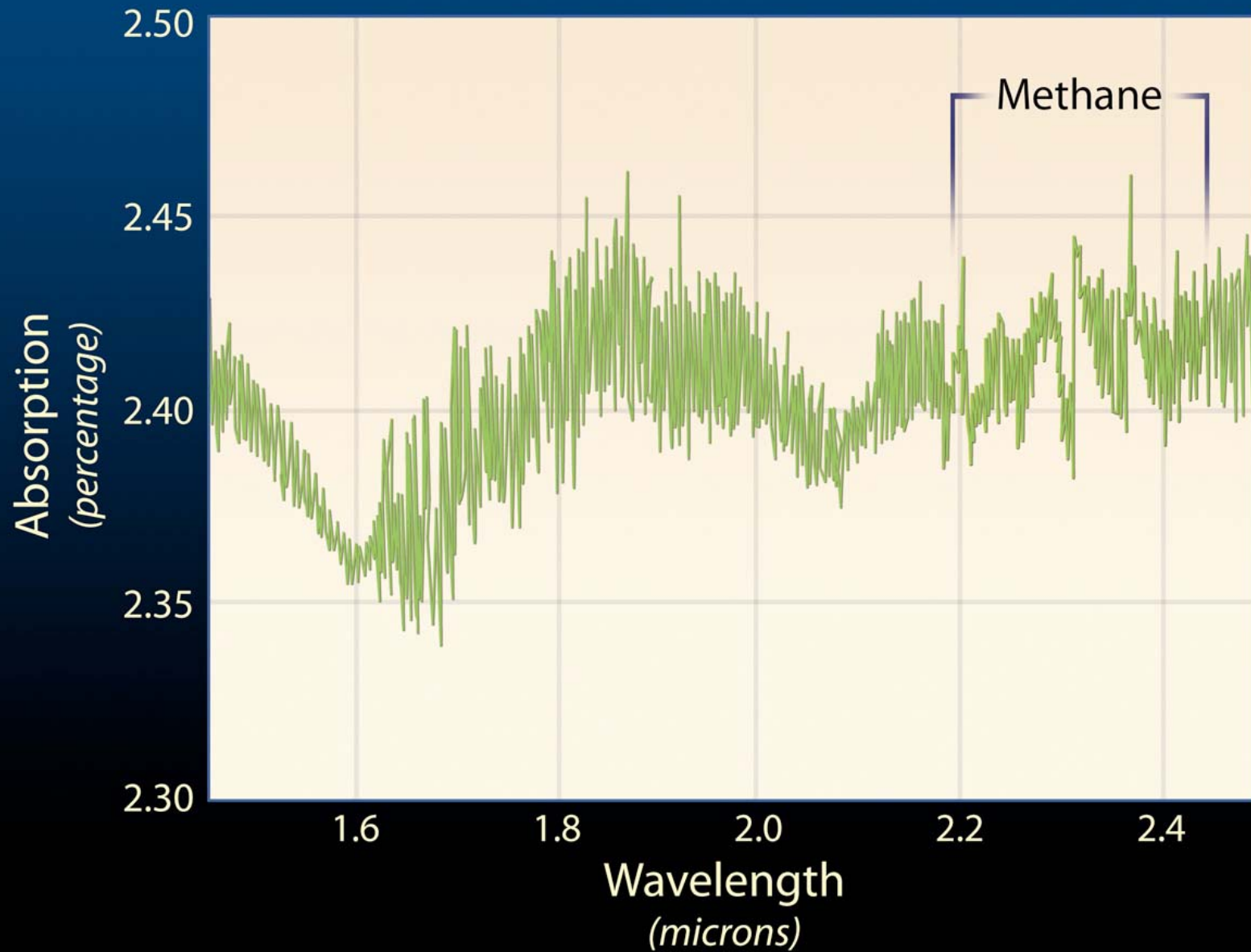
Planet Eclipsing Star HD 209458



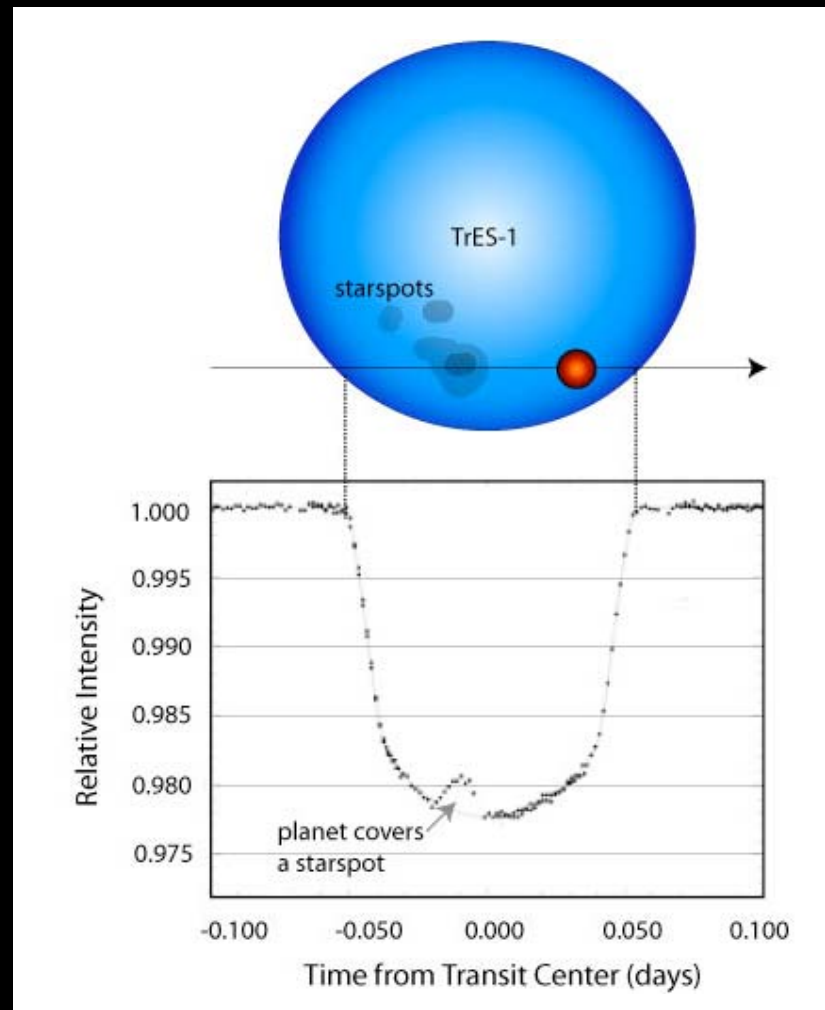
HST detects additional sodium absorption due to light passing through planetary atmosphere as planet transits across star



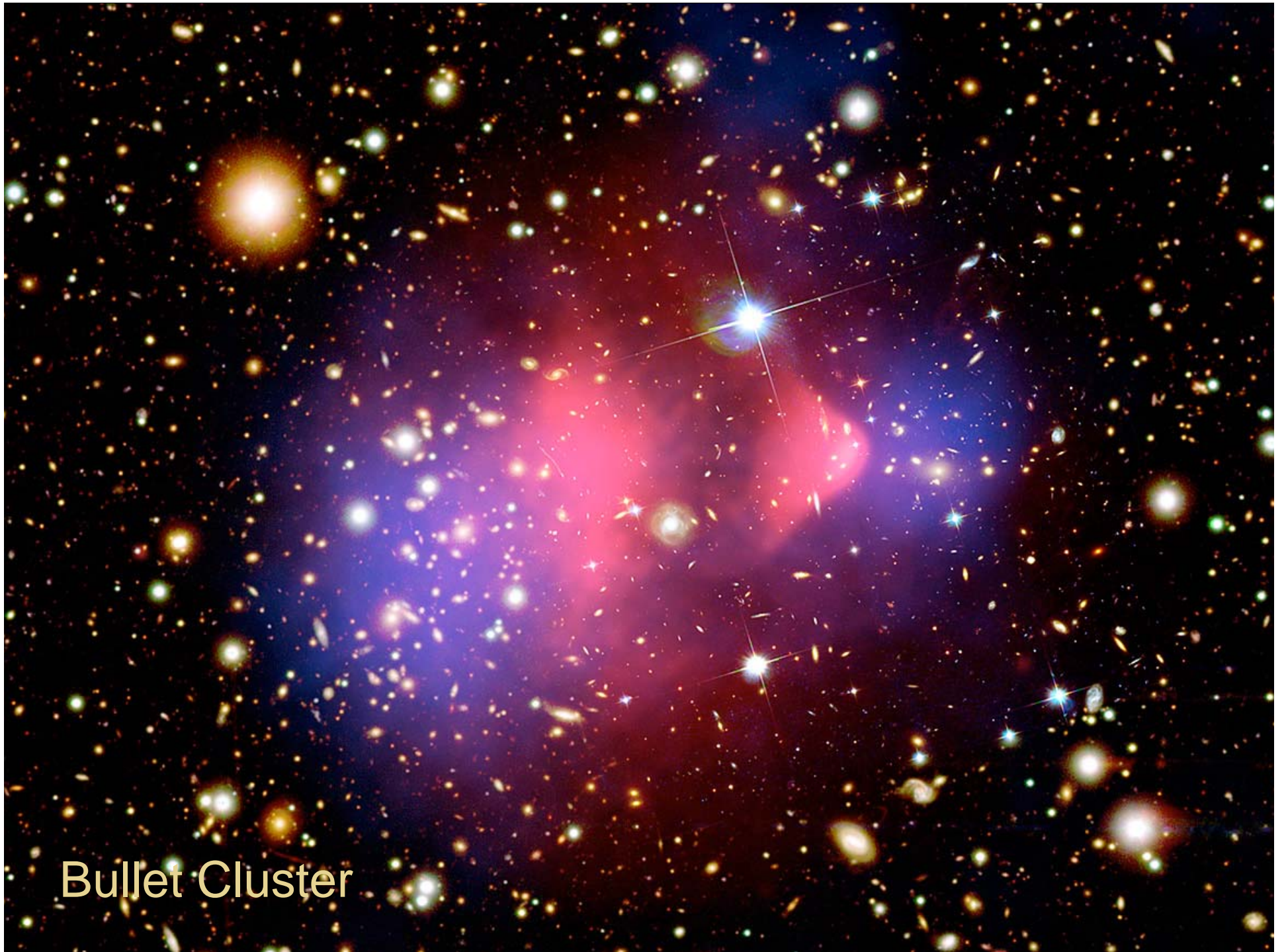
Exoplanet HD 189733b



Detection of Starspot on TrES-1



5: Dark Matter

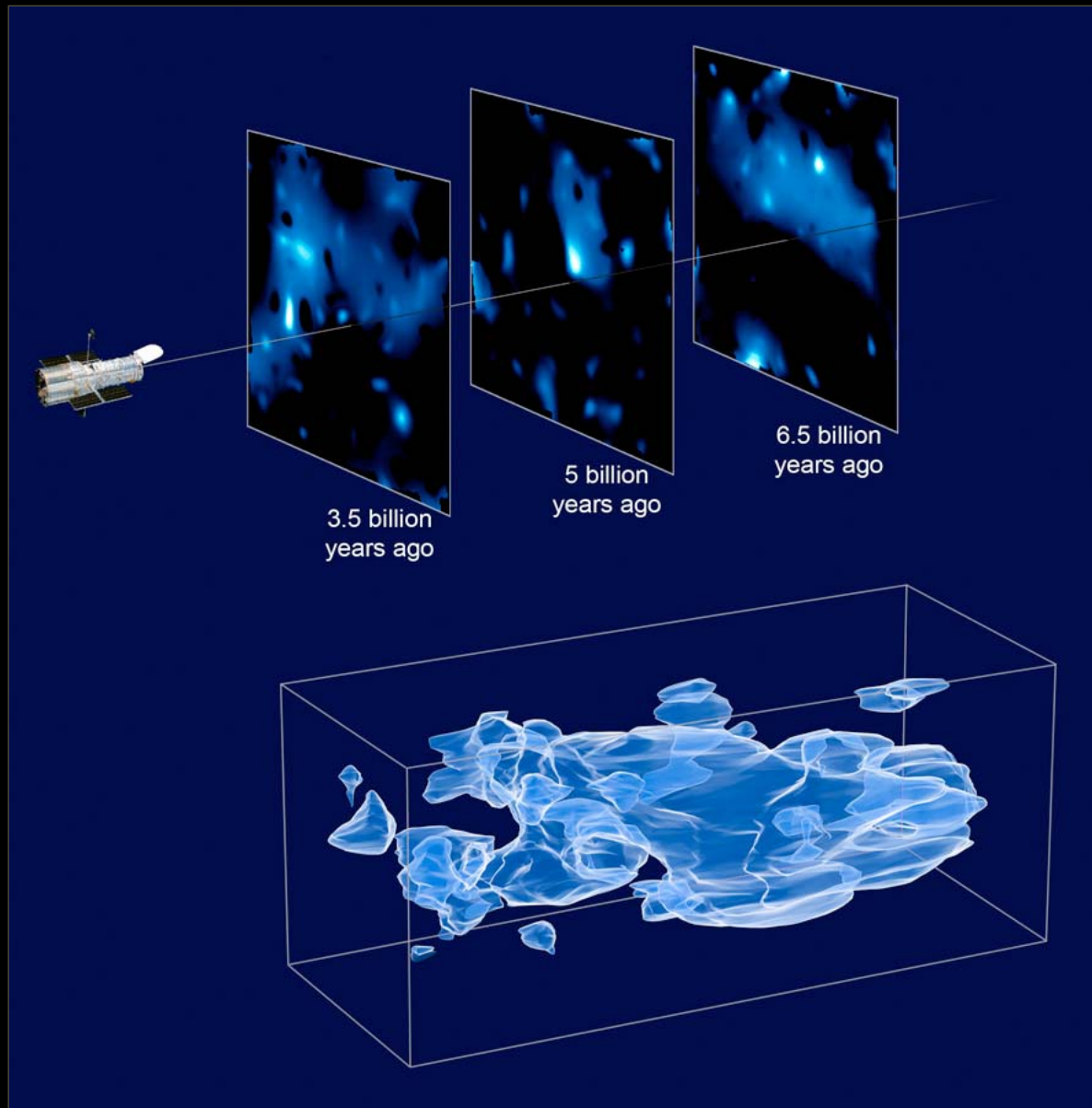


Bullet Cluster



Dark matter ring in CI 0024+17

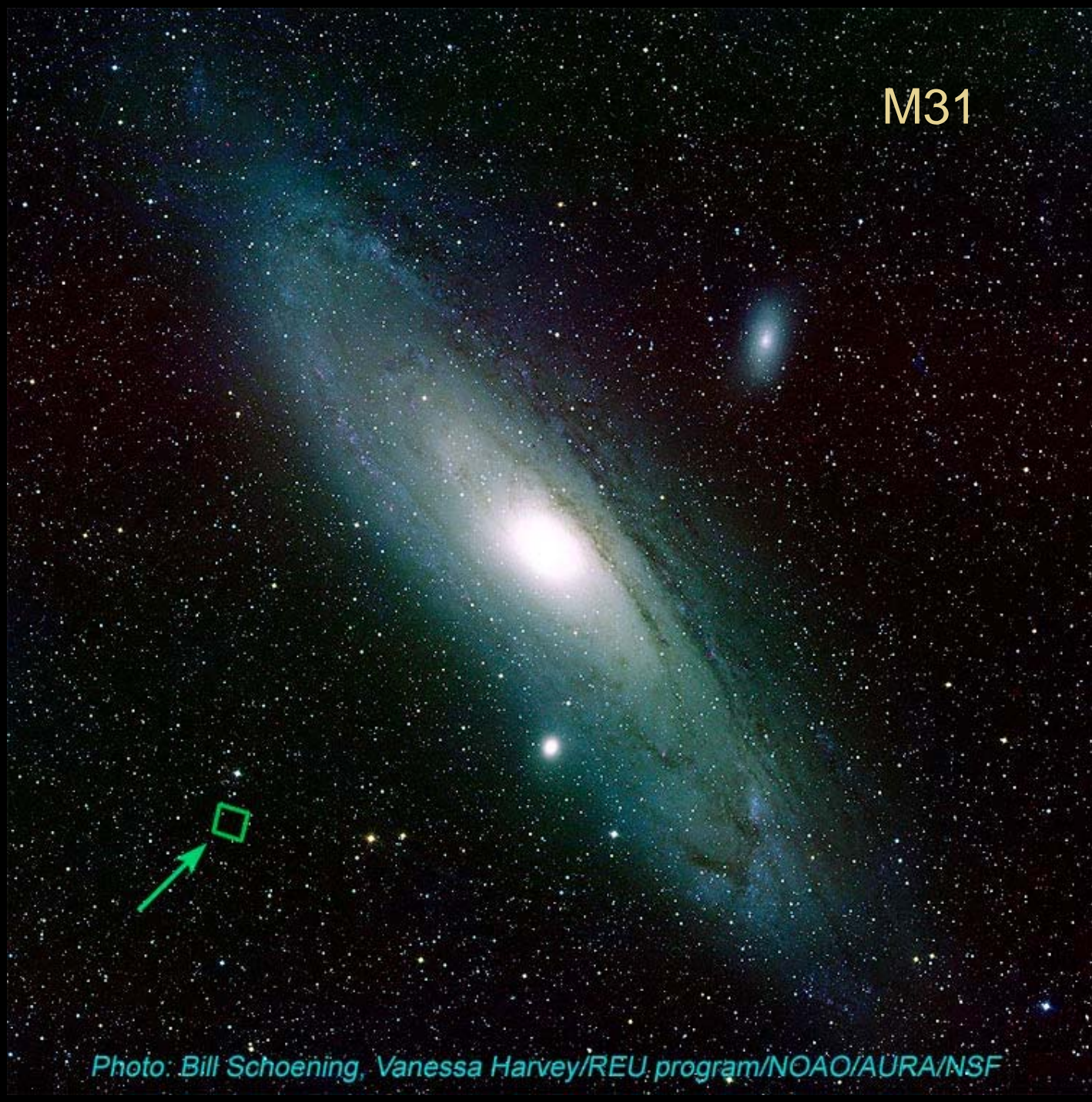
3-D Distribution of Dark Matter



6: Stellar Populations in Nearby Galaxies

M31

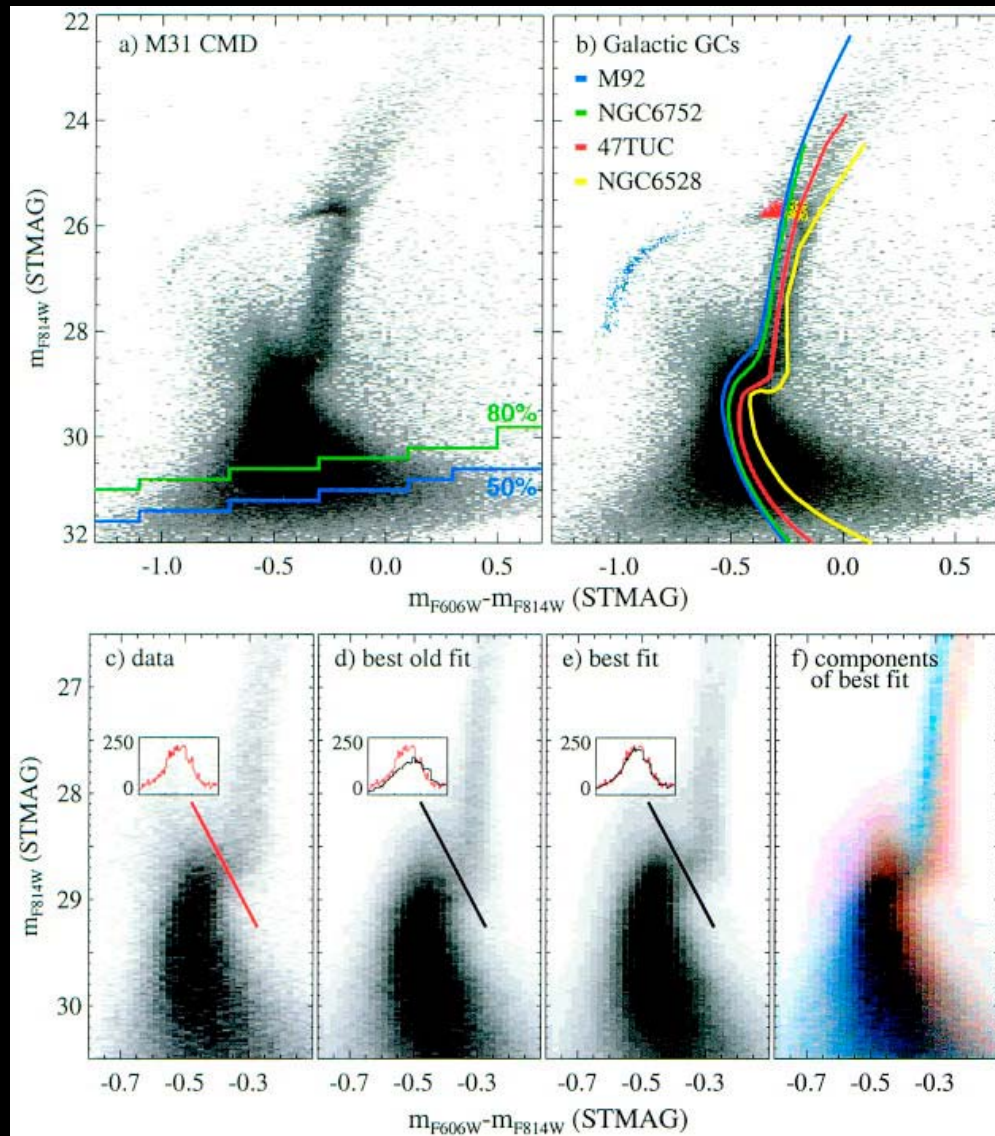
Photo: Bill Schoening, Vanessa Harvey/REU program/NOAO/AURA/NSF



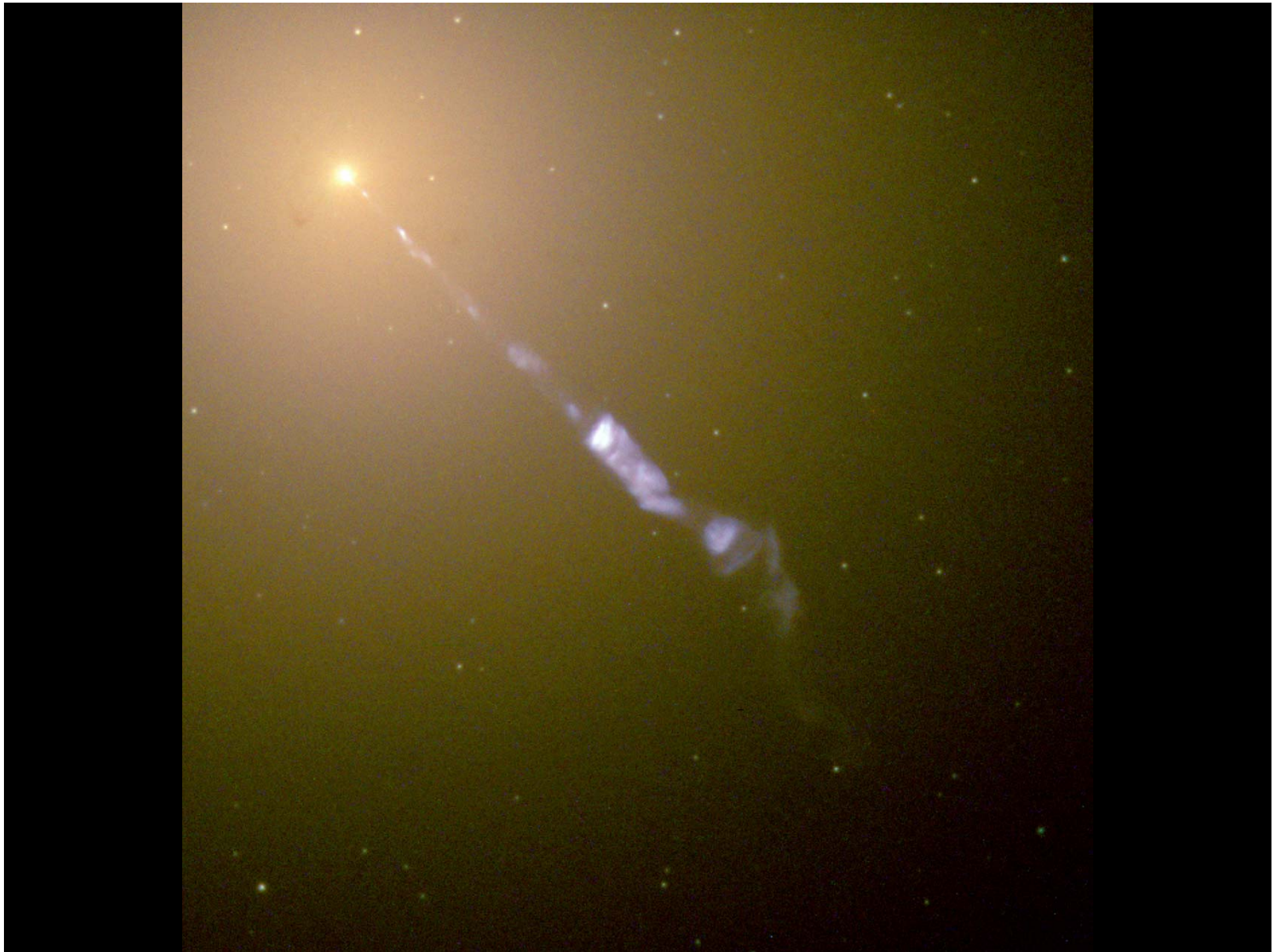


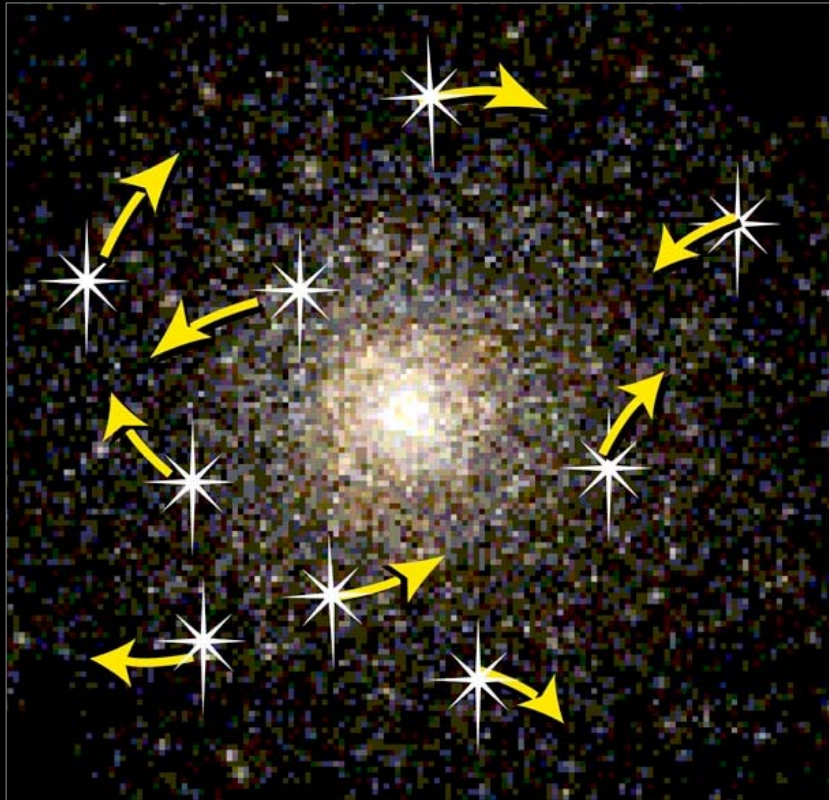
M31 Halo
HST ACS

Color-magnitude diagram reveals two populations: one of 6-11 Gyr, and one of 10-13.5 Gyr.



7: Supermassive Black Holes in Centers of Galaxies

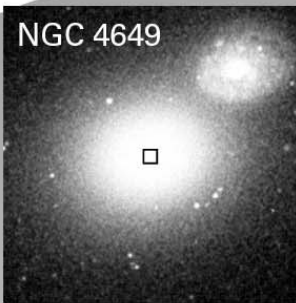




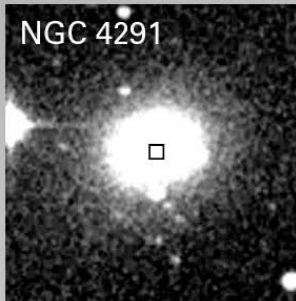
Ground

HST

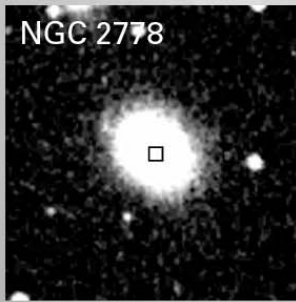
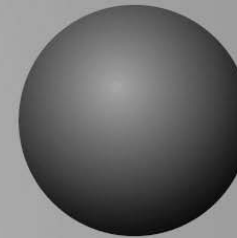
Black Hole Mass



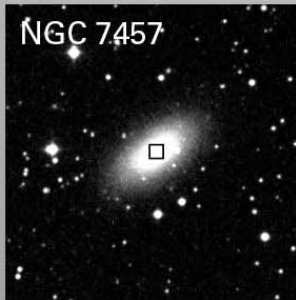
2 billion suns



200 million suns



20 million suns



3 million suns



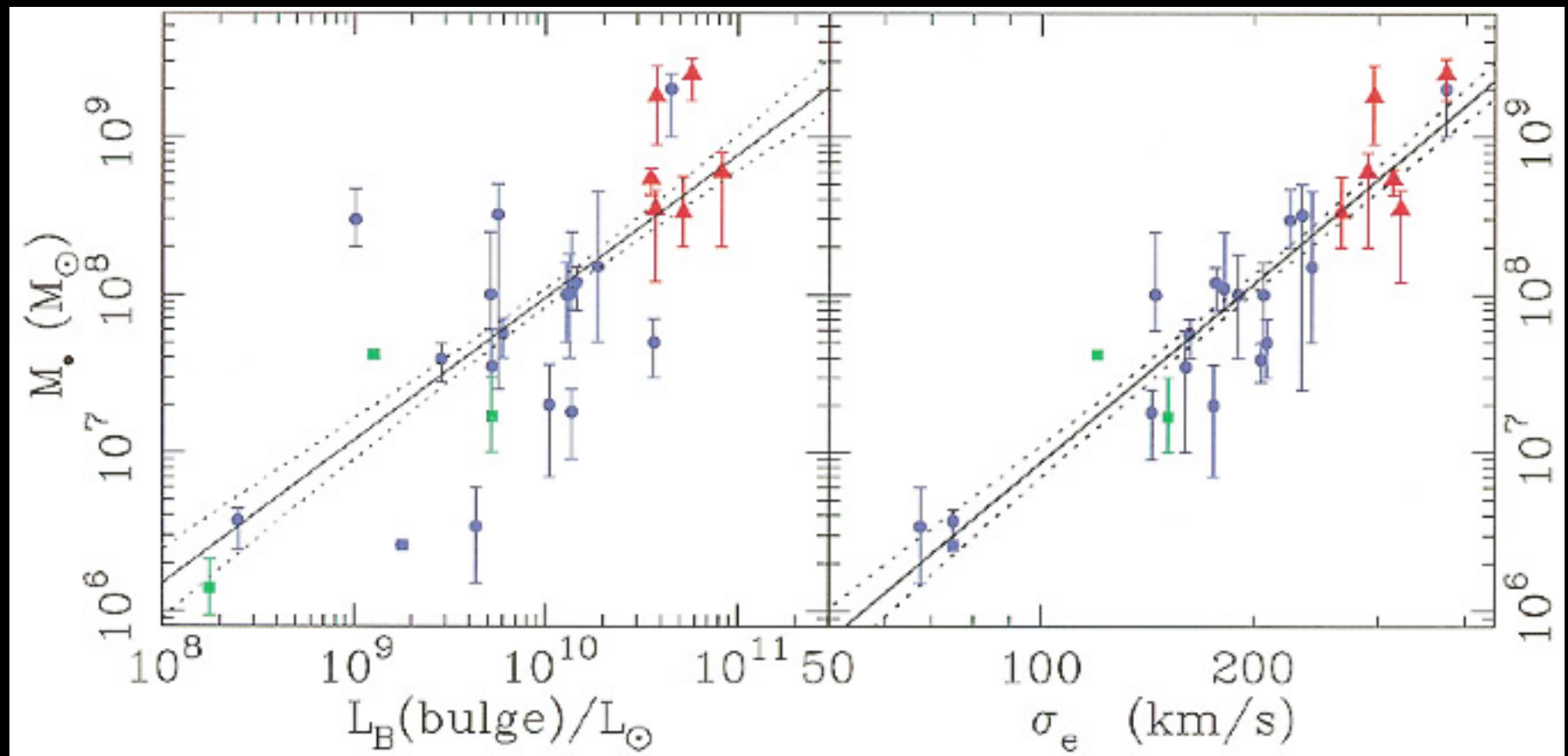
Black hole event horizons

75000 light-years

3000 light-years

Diameter of Earth's Orbit
(186 million miles)

Correlation Between Black Hole Mass and Velocity Dispersion



Penetration into Culture

THE NEW YORK TIMES **EDITORIALS/LETTERS** FRIDAY, MAY 3, 2002

The Hubble Achievement

It seems hard to believe that we have already grown used to seeing images from the Hubble Space Telescope in the dozen years since it was first launched. But the startling pictures released this week from a newly restored Hubble are a reminder that we had, in fact, begun to take for granted our ability to peer into deep space, an ability no generation of humans has ever possessed before. In a sense, these new images, produced with cameras and power sources that were added or rejuvenated during a space shuttle flight in March, feel something like learning to see all over again. They

the real wonder appears. Beyond the uniformity of the naked-eye universe, there is this other universe, the one Hubble discovers with astonishing clarity. This is a place full of discordant objects, of cataclysmic disturbances. Galaxies devour each other. Stars form in infernos of gas and dust and light. And they do so against the backdrop of a sky that is almost unimaginably deep.

For what the Hubble cameras show us, especially in their new incarnation, is time itself. The distance of the distant objects in these images is measured as much by their relative youth, by how

It has taught us to see the properties of a universe humans have been able, for most of their history, to probe only with their thoughts.

when you begin to realize what these forms are that

with their thoughts.

Sheer Beauty

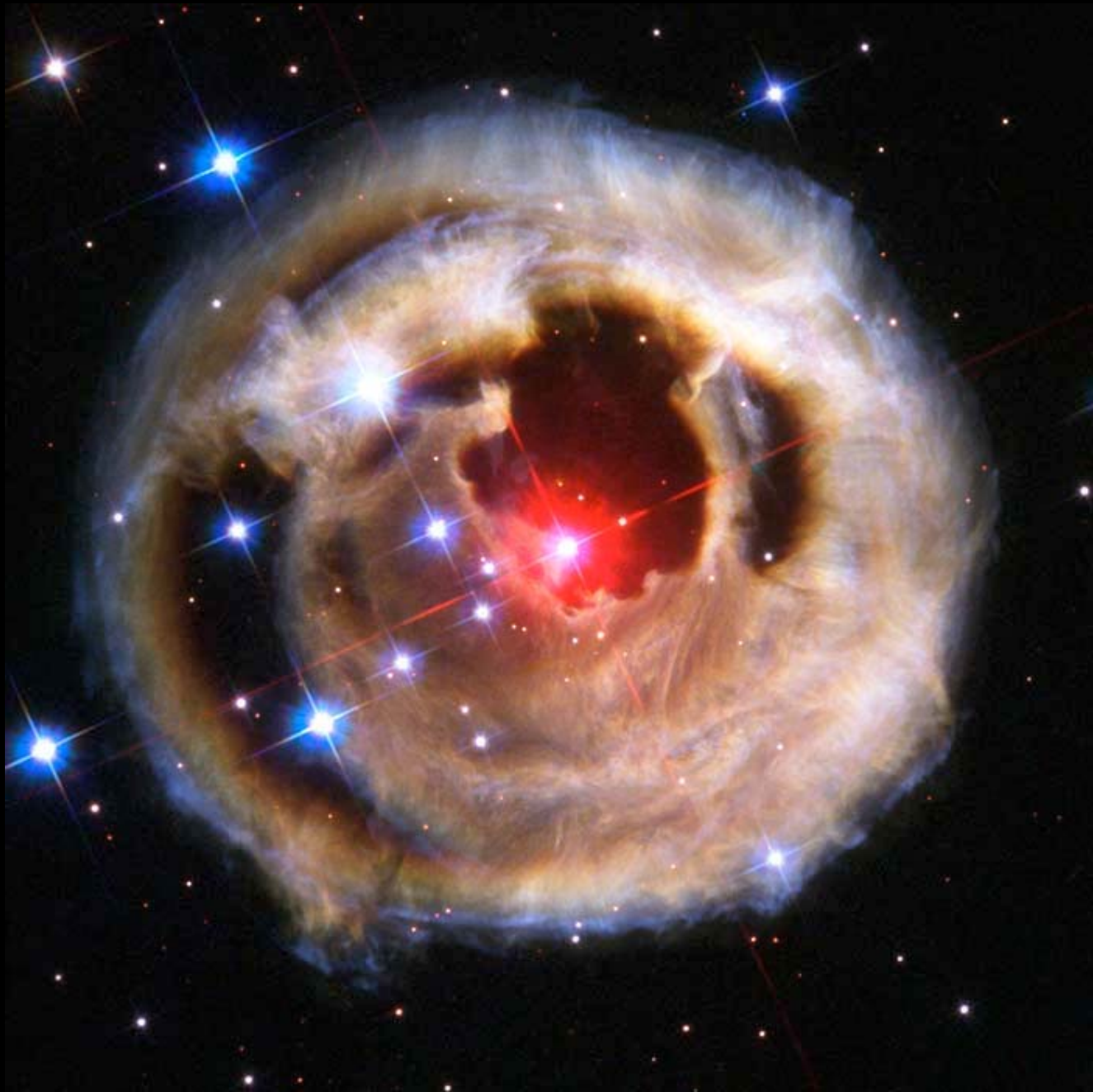




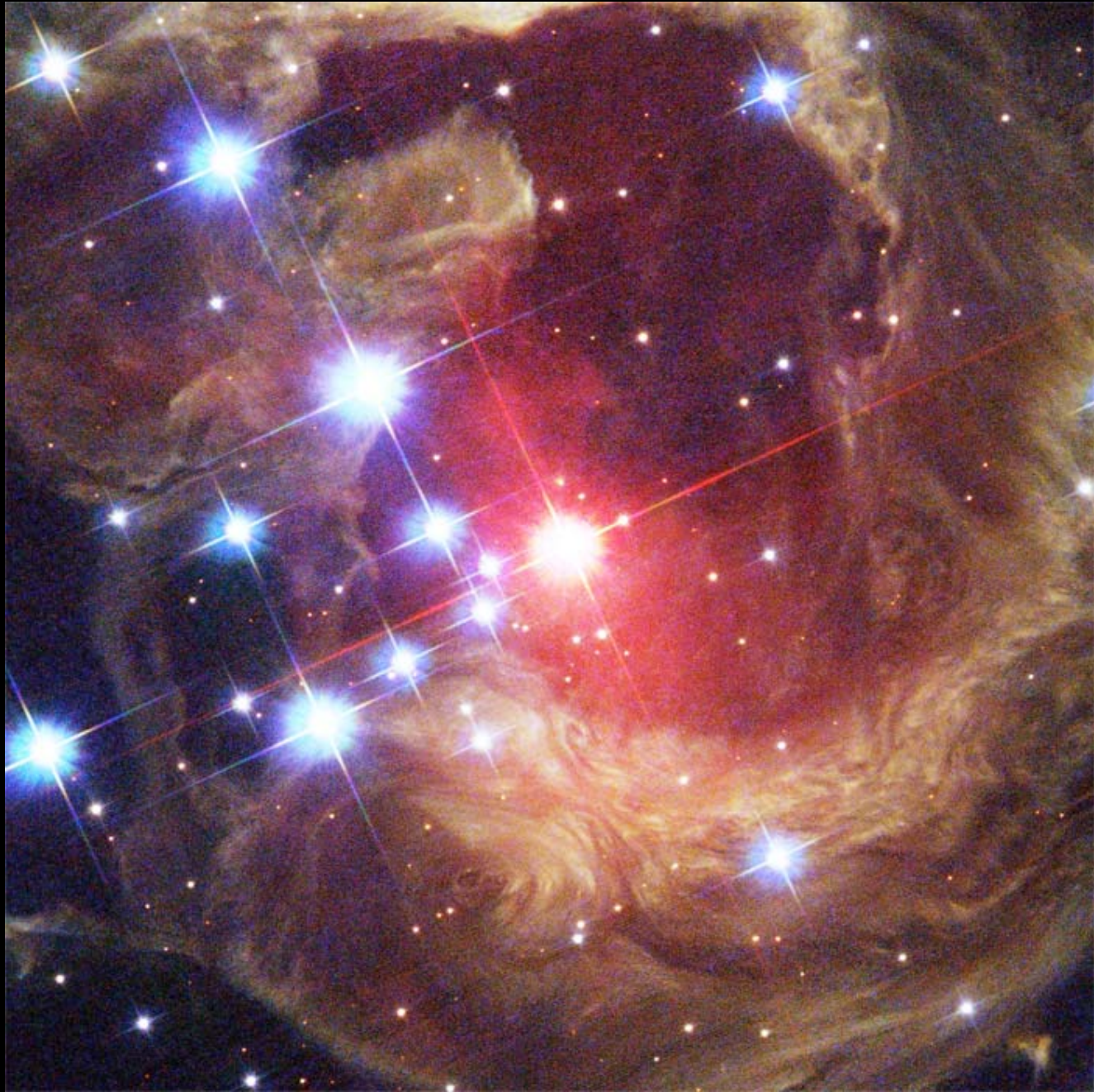






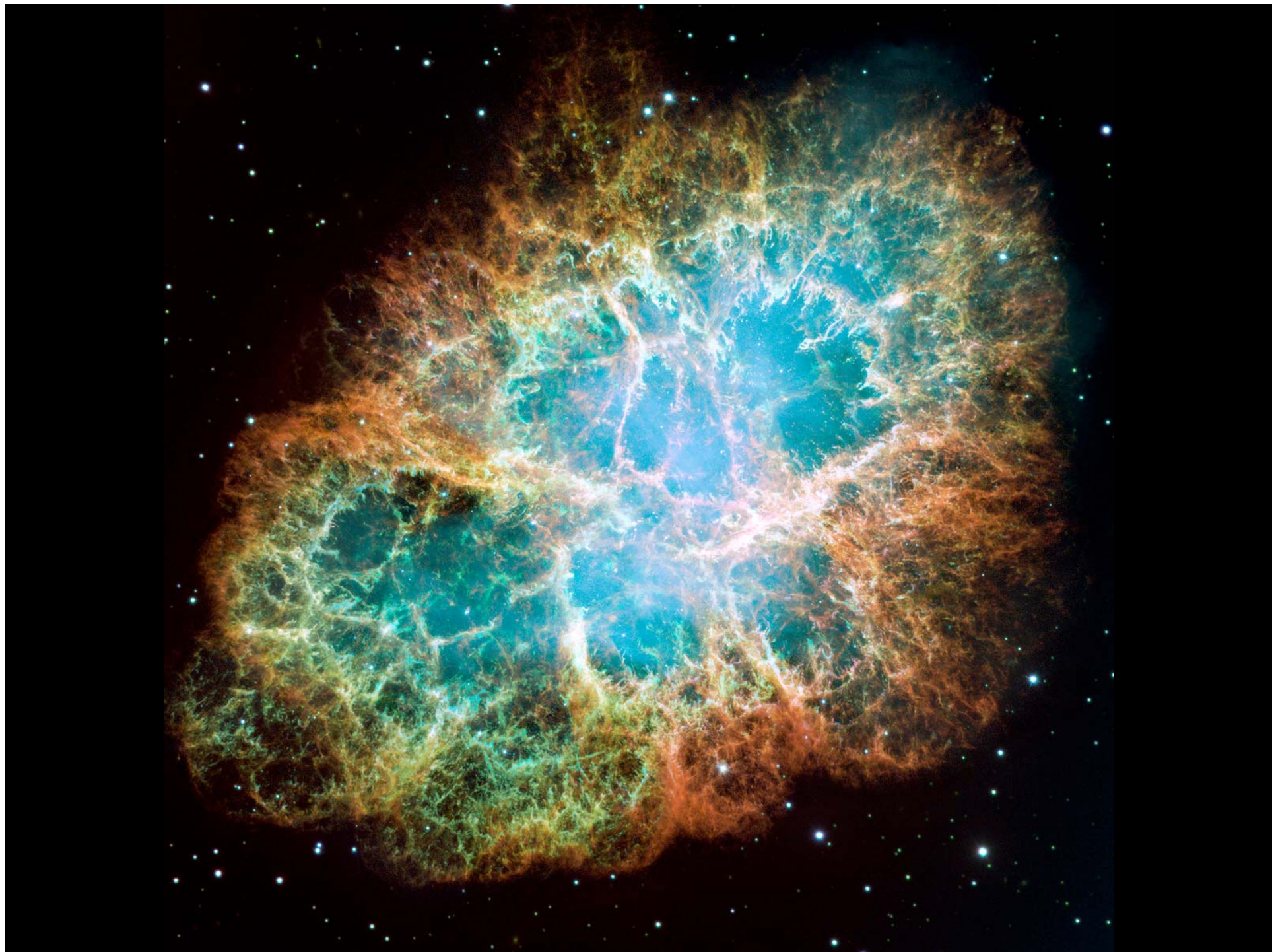


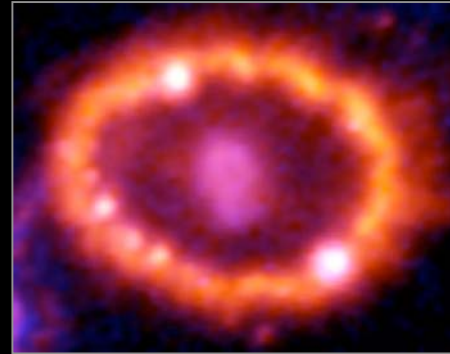
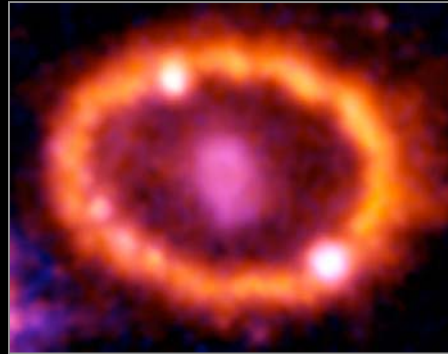
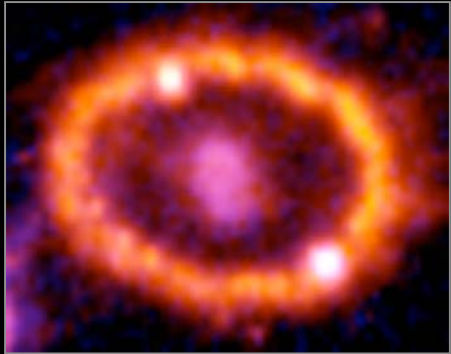






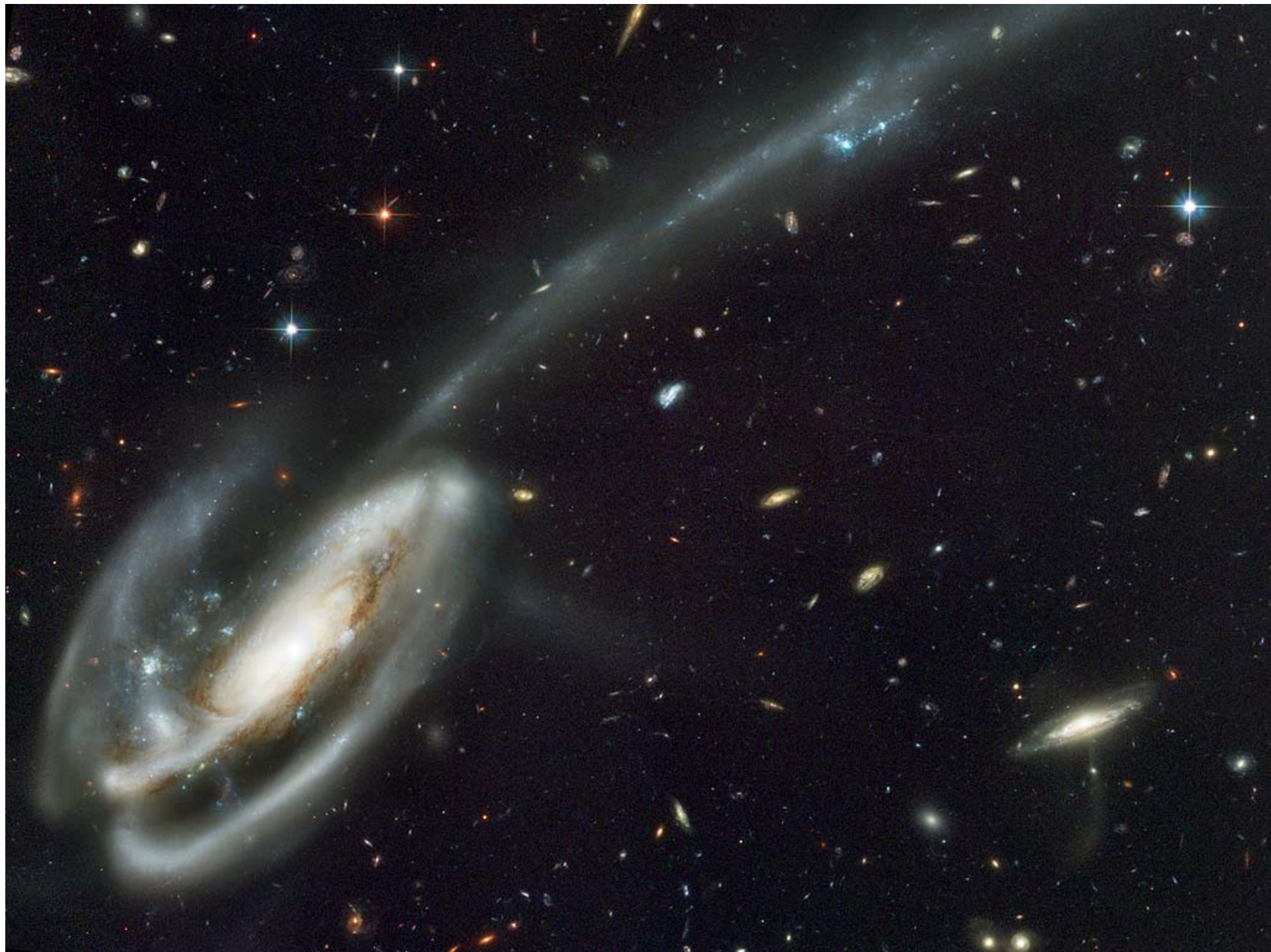




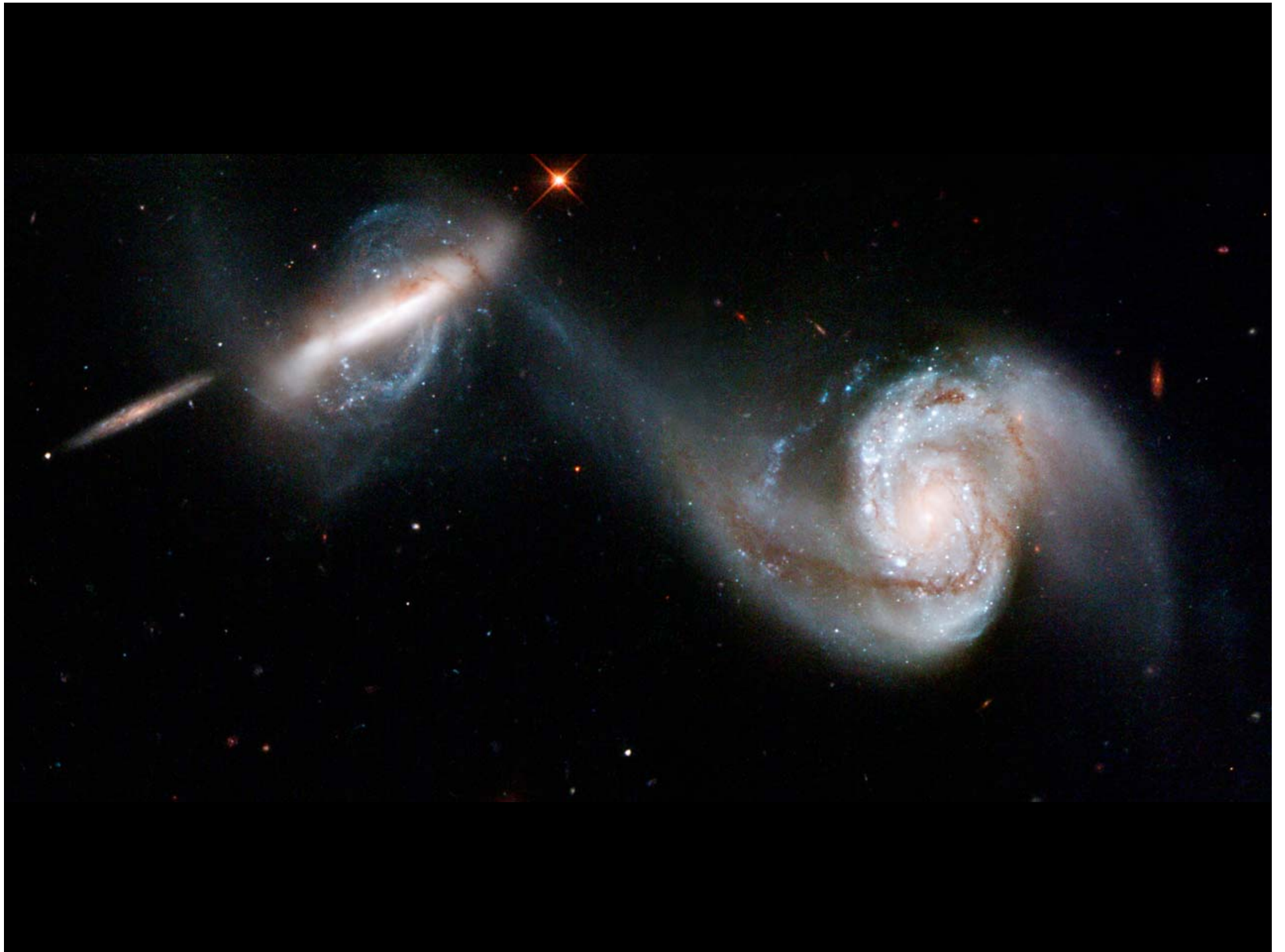












To be continued...