

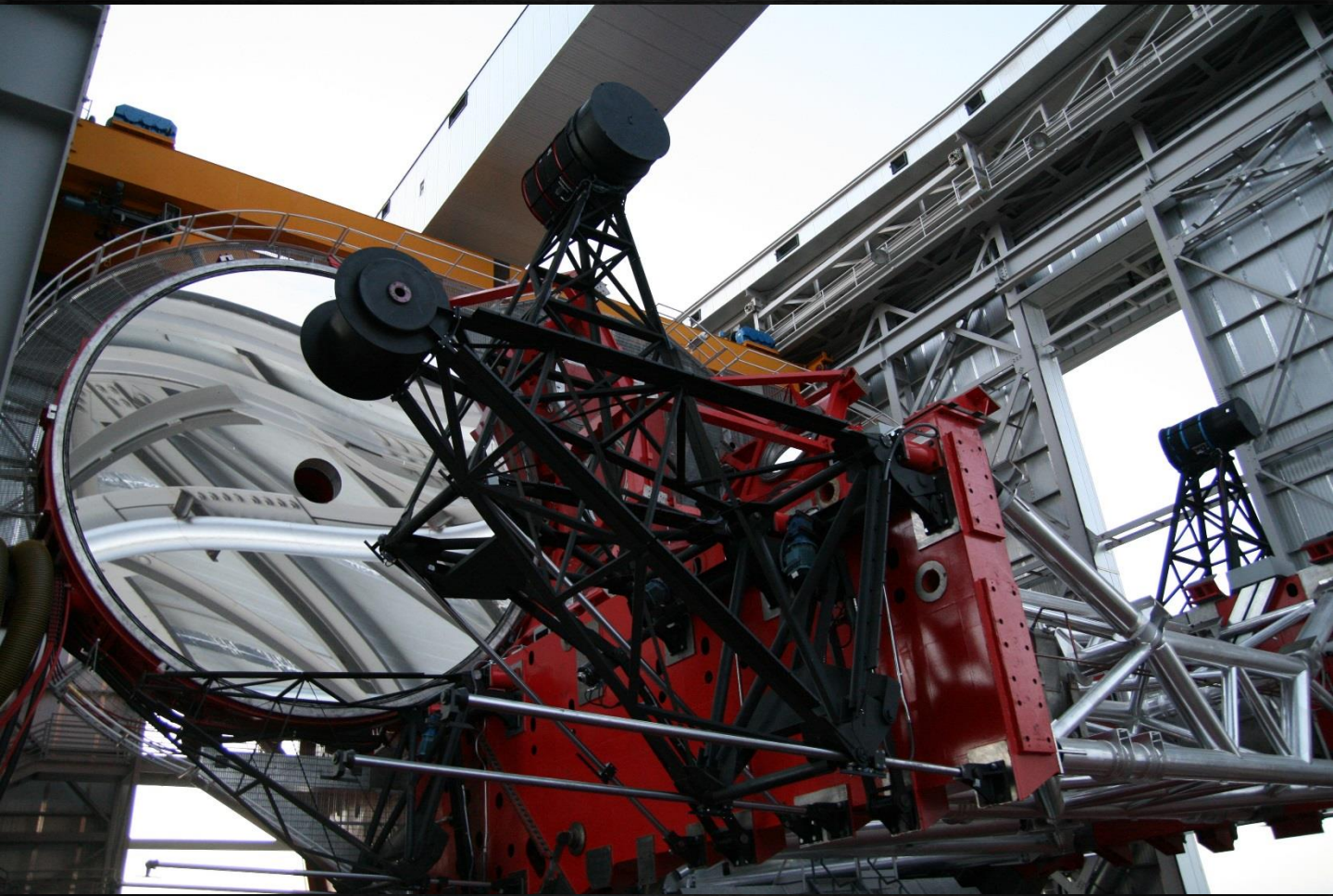


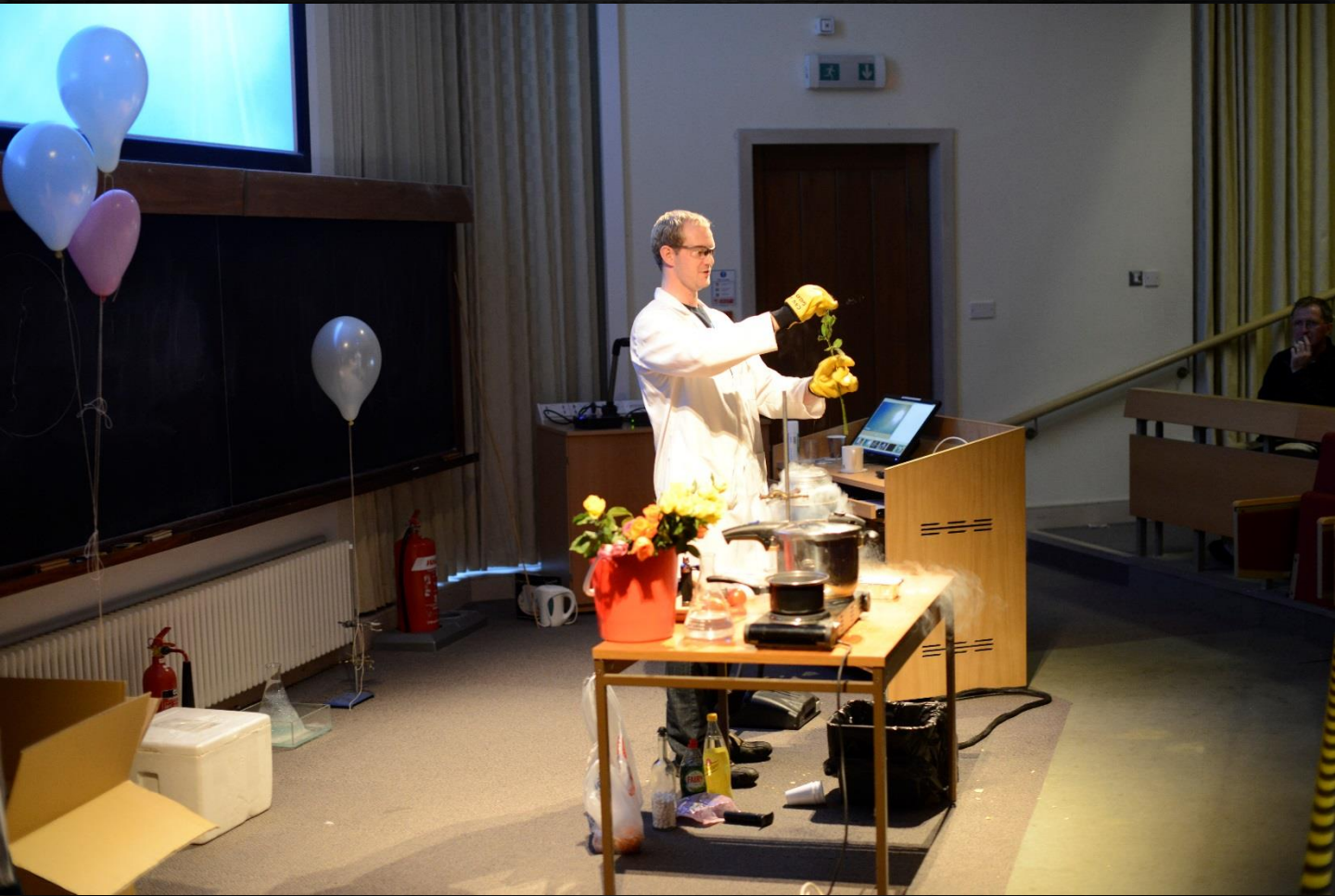
Our Place in the Universe

From Earth to the Stars

Jonathan Crass







Our Place in the Universe

- So just where are we in the Universe?
 - What makes up the Universe?
 - The distance scale
- The changing and evolving Universe
 - The Big Bang
 - The birth, life and death of stars
 - Making the galaxies we see

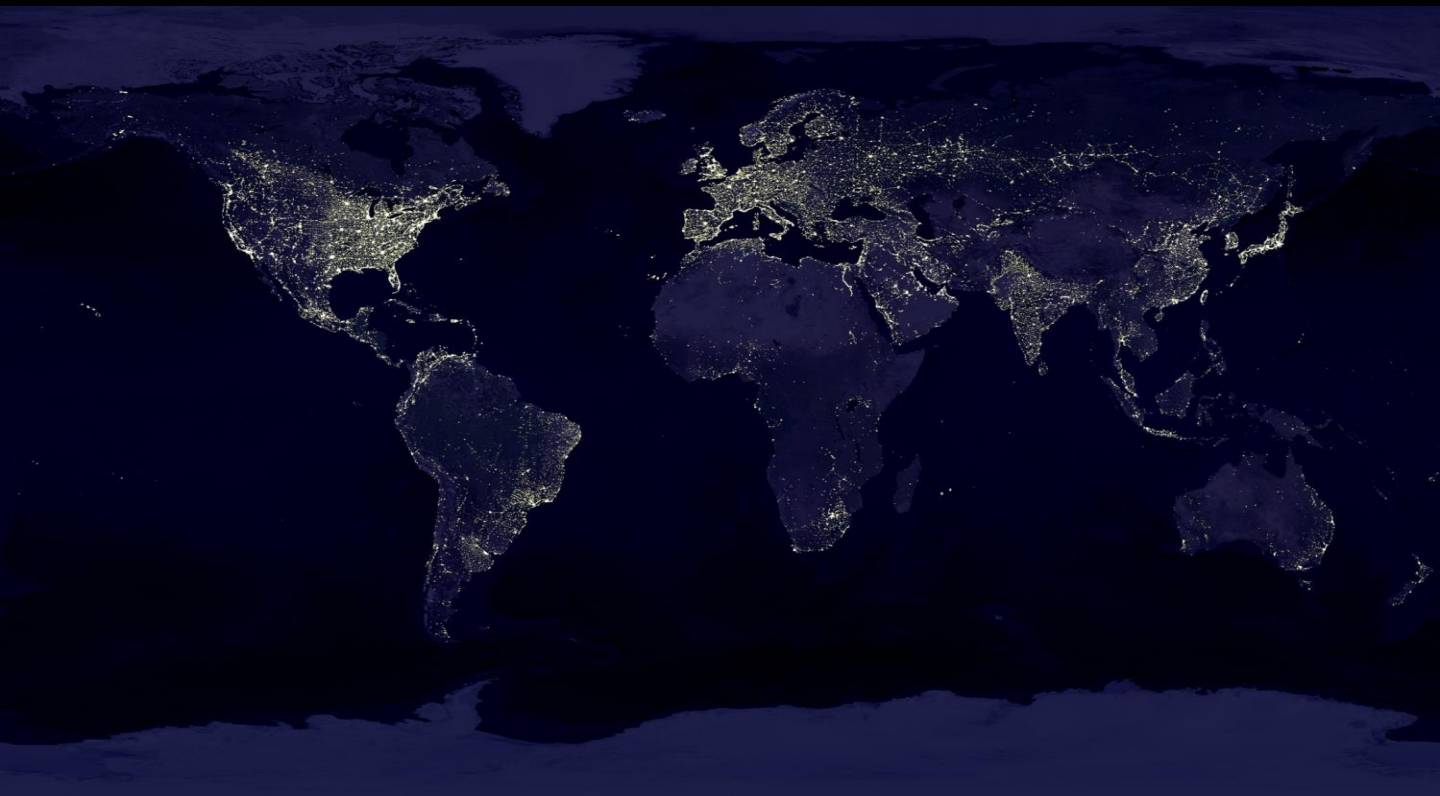




The United Kingdom

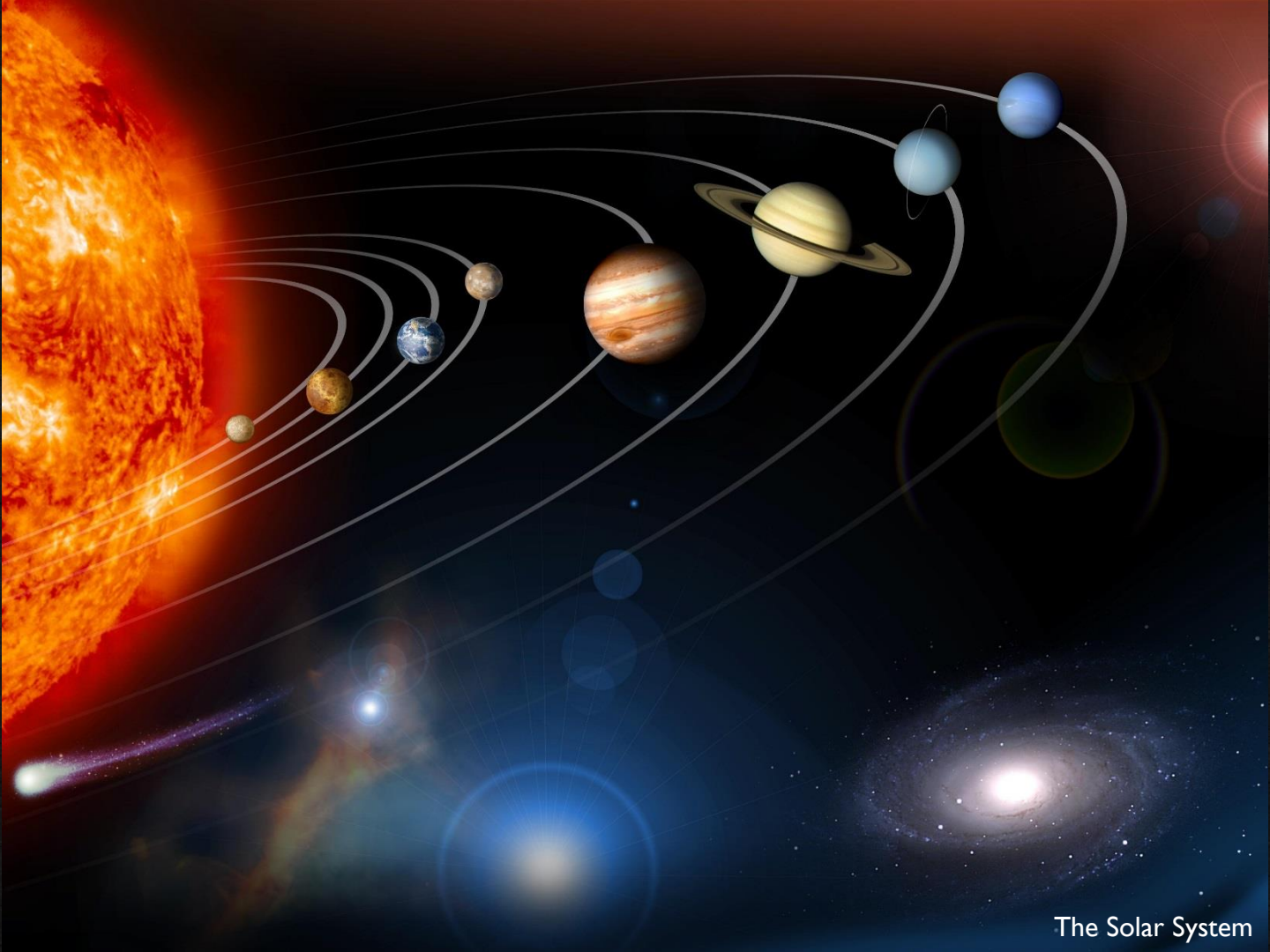


Europe

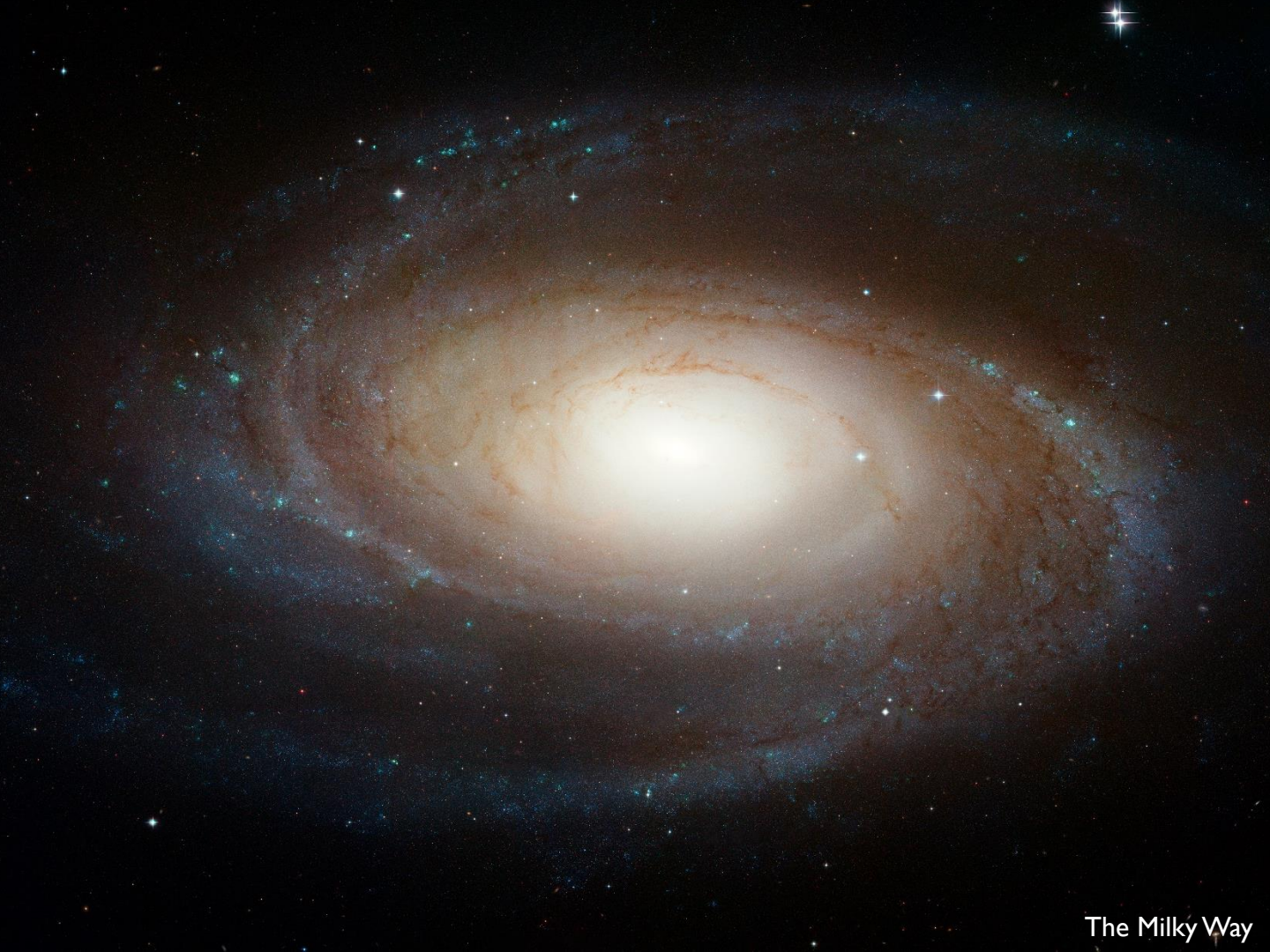




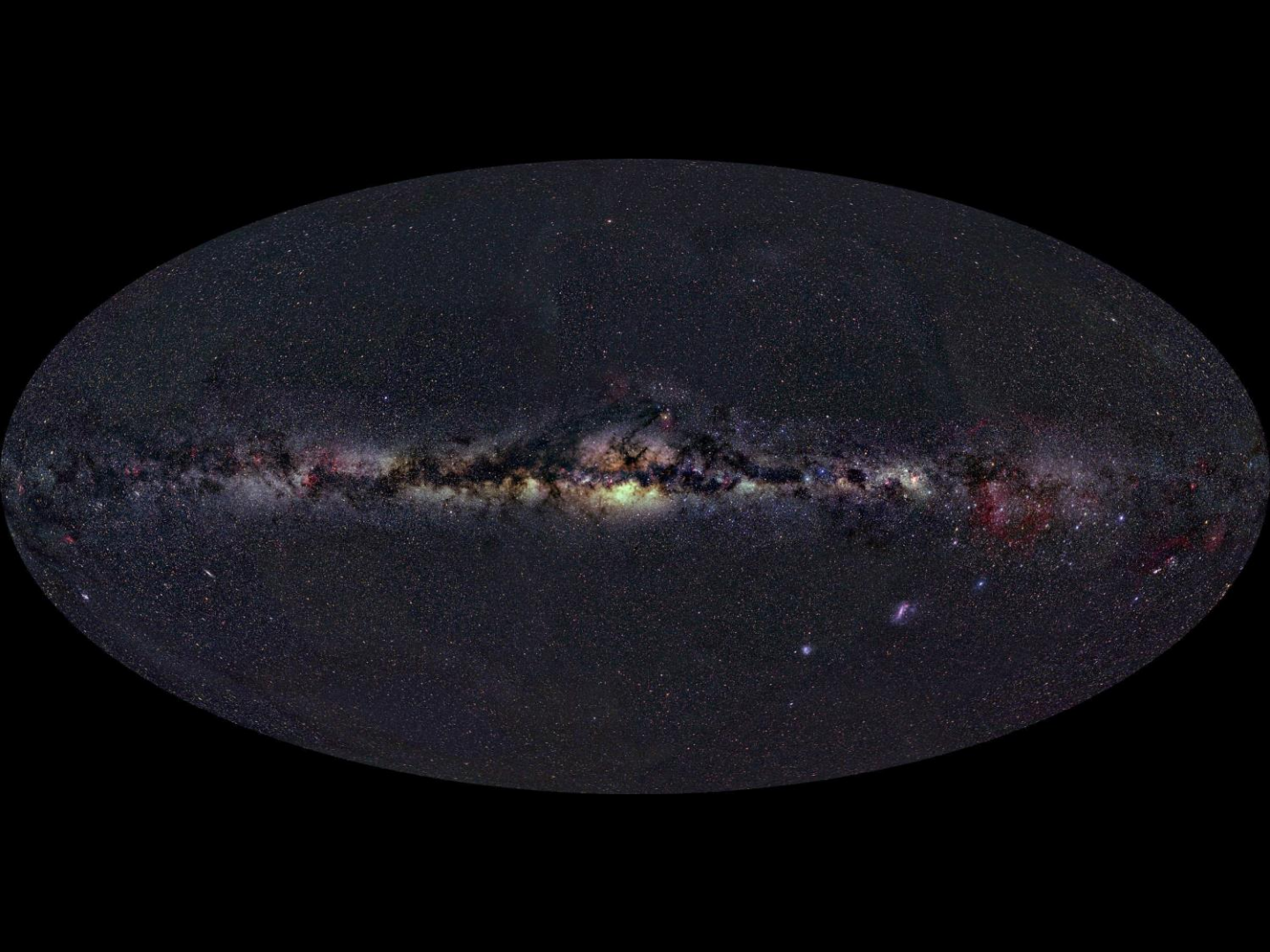
The Earth

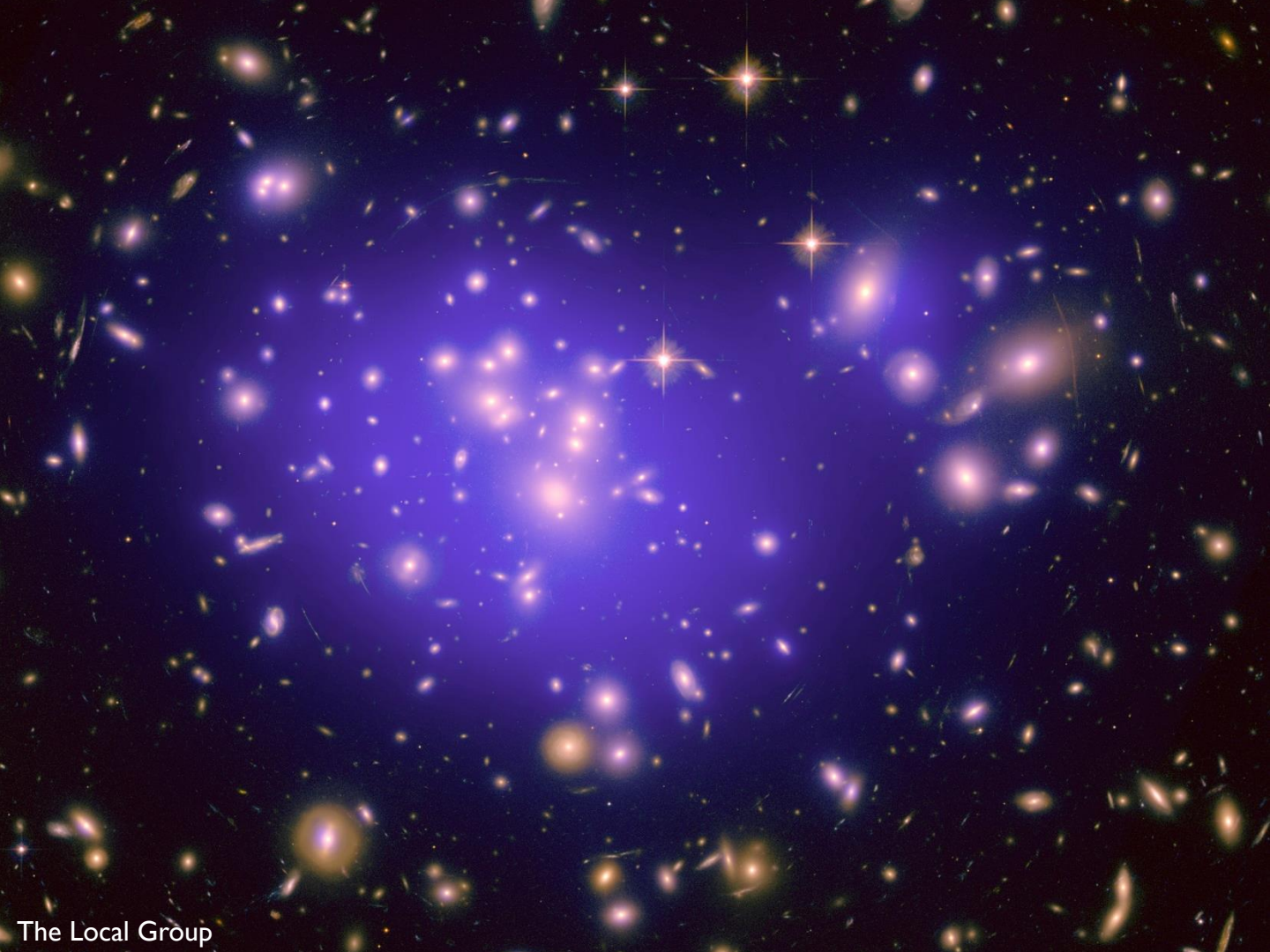


The Solar System

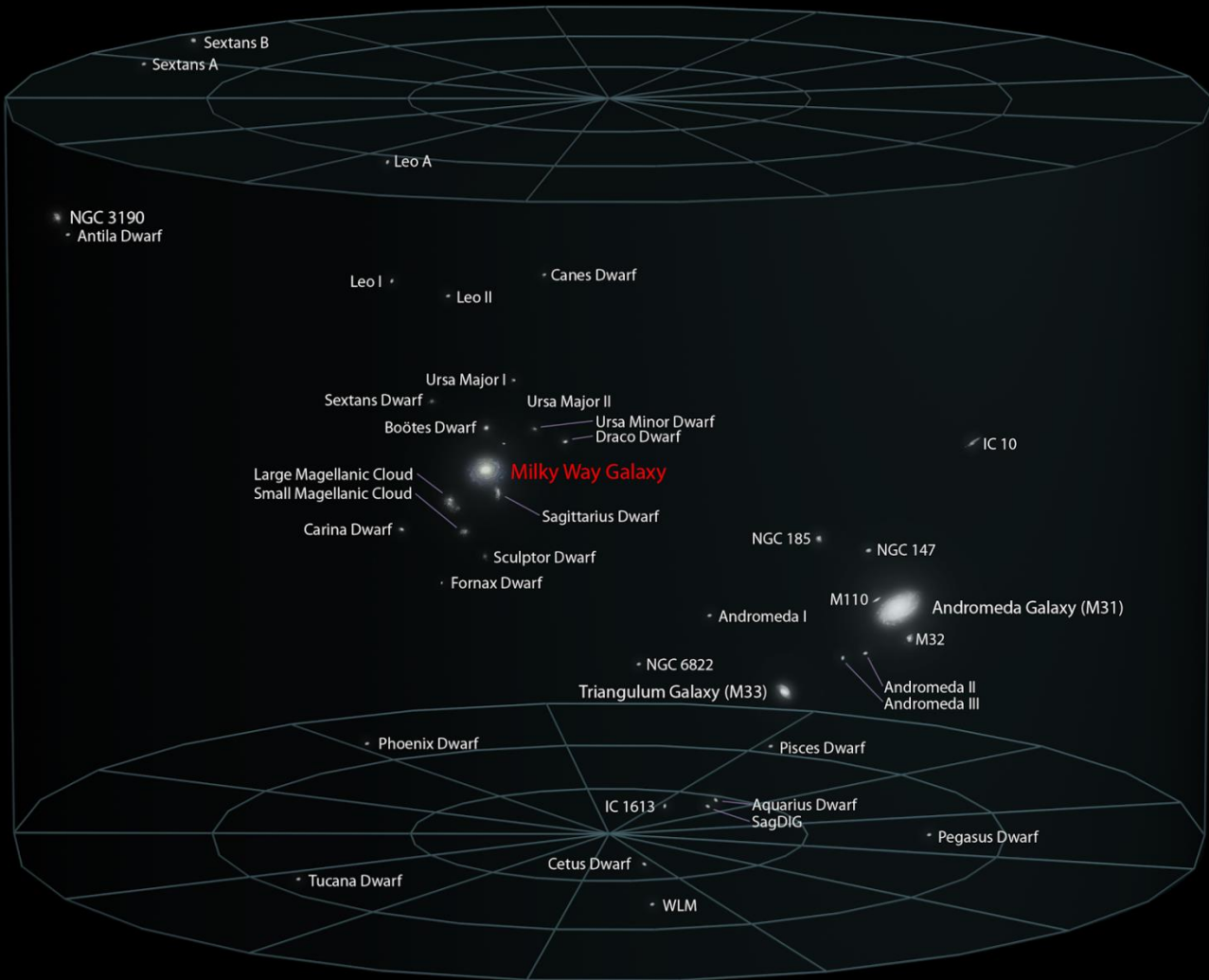


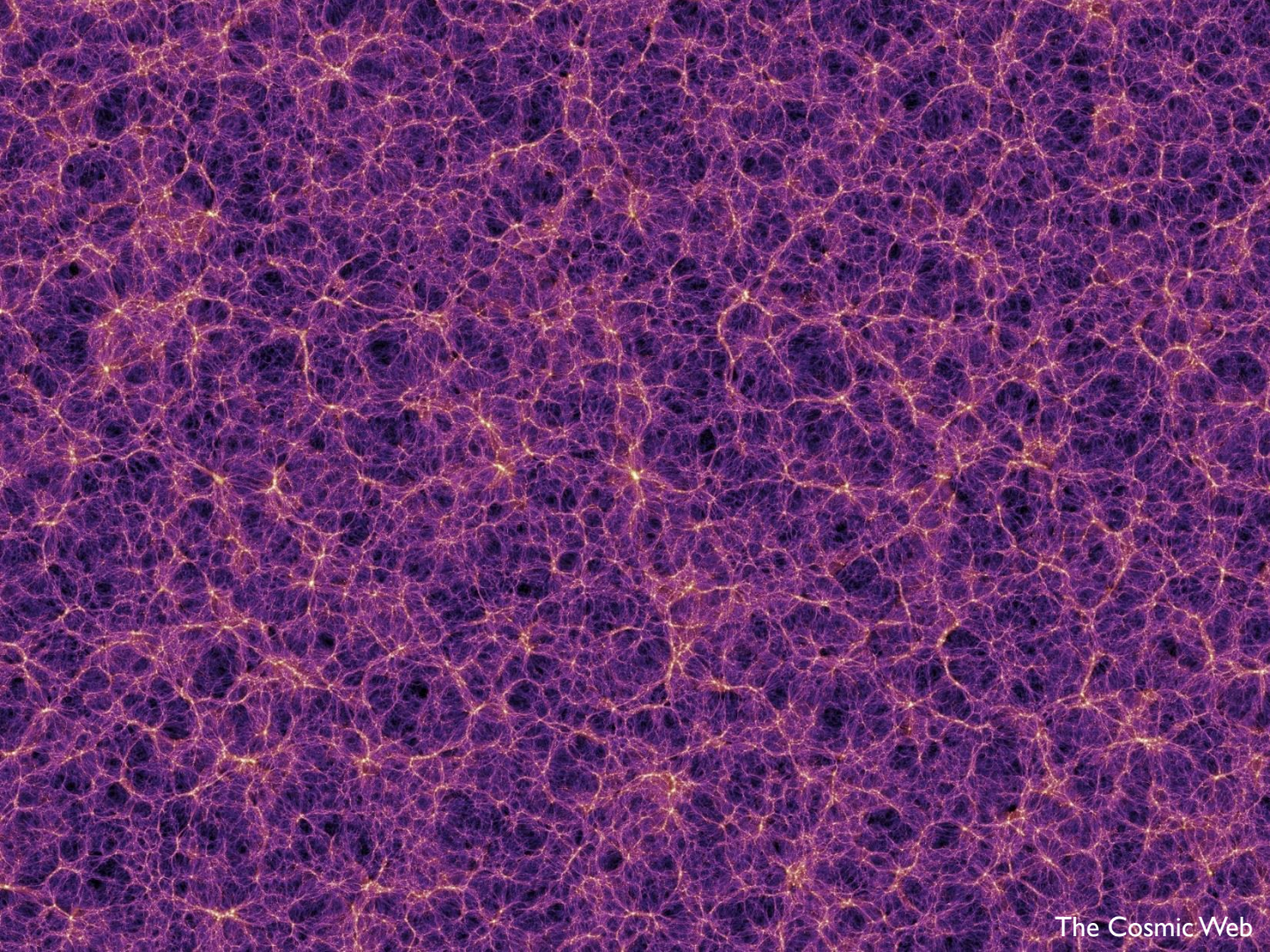
The Milky Way



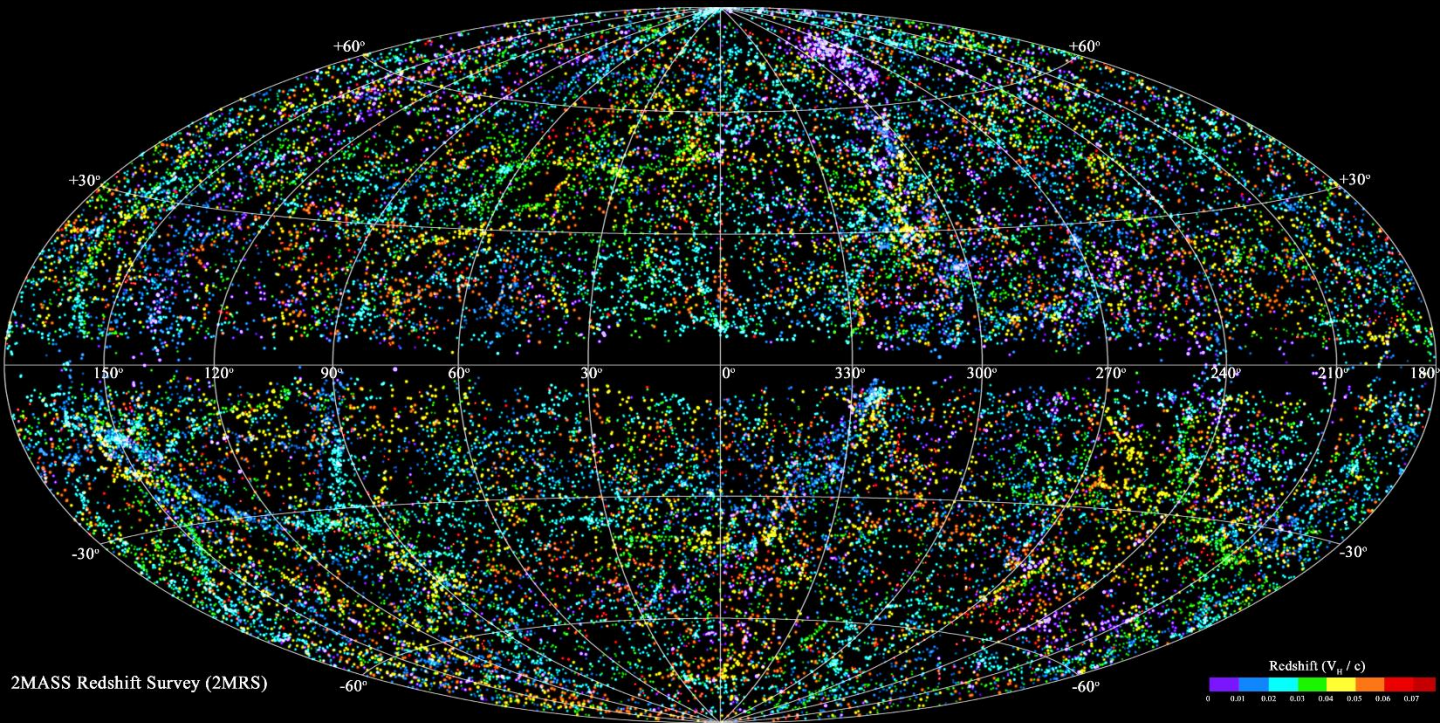


The Local Group



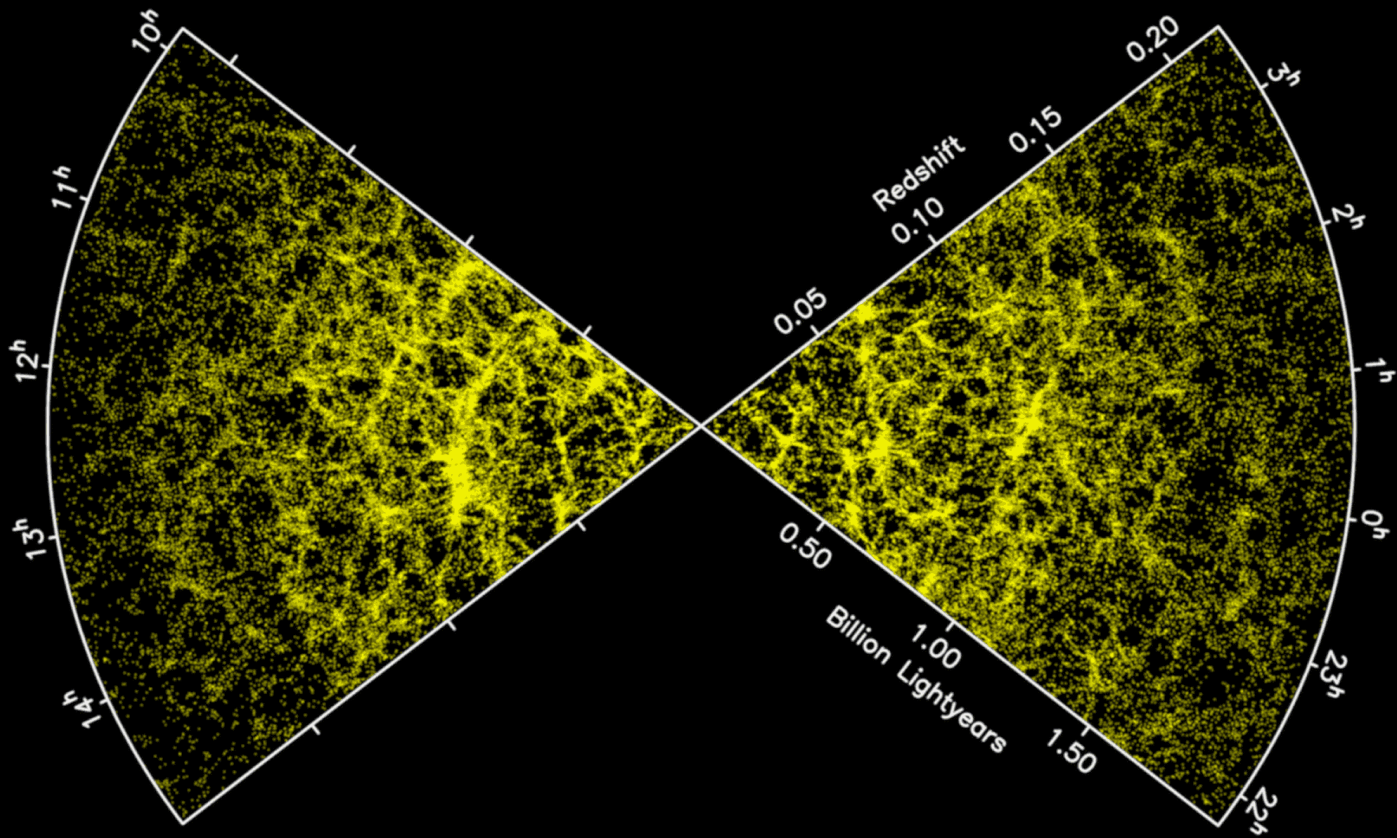


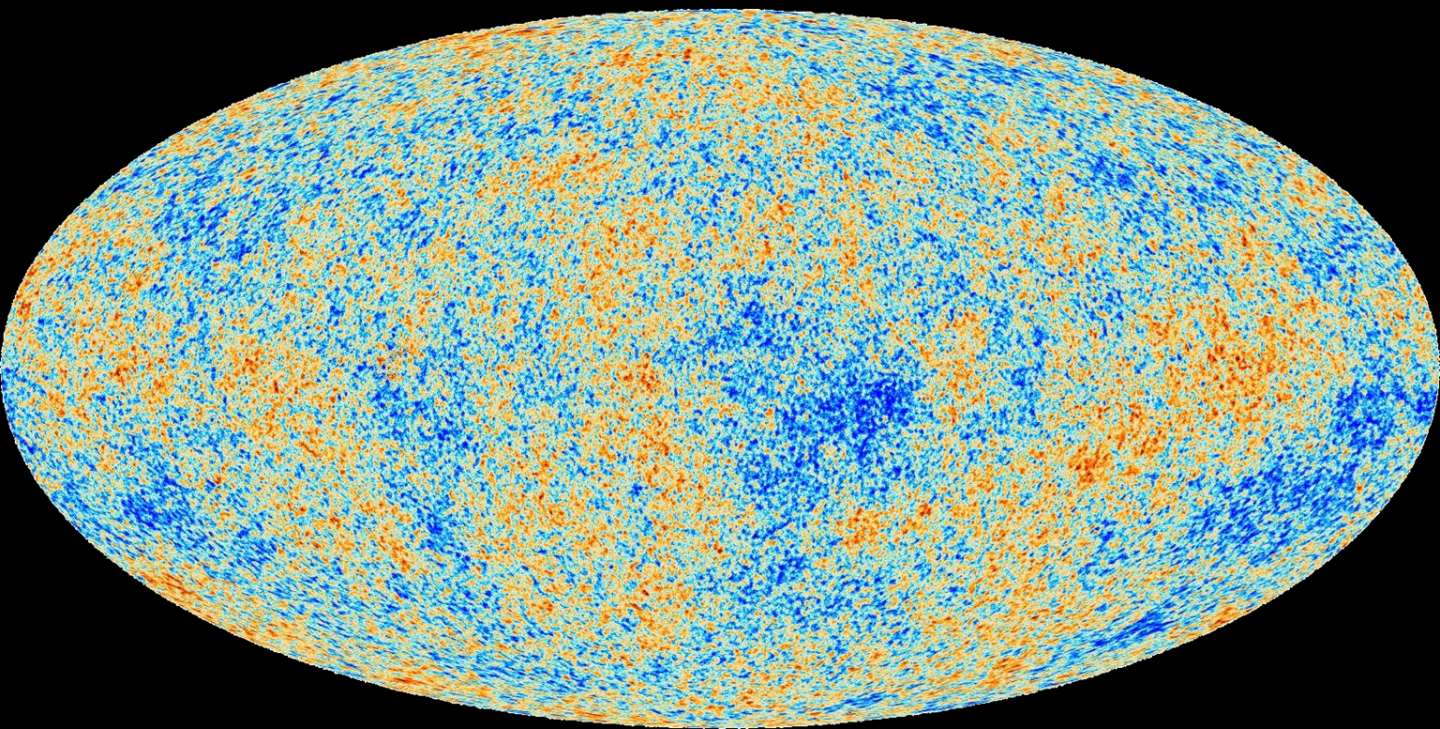
The Cosmic Web



2MASS Redshift Survey (2MRS)







The Cosmic Microwave Background

So where are we?

Our Earth Address

Cunard Line,
Southampton,
Hampshire,
United Kingdom,
Europe,
The Earth

Our Universal Address

Cunard Line,
The Earth,
The Solar System,
The Milky Way,
The Local Group,
The Universe

Cosmic Distances

Distances in Astronomy



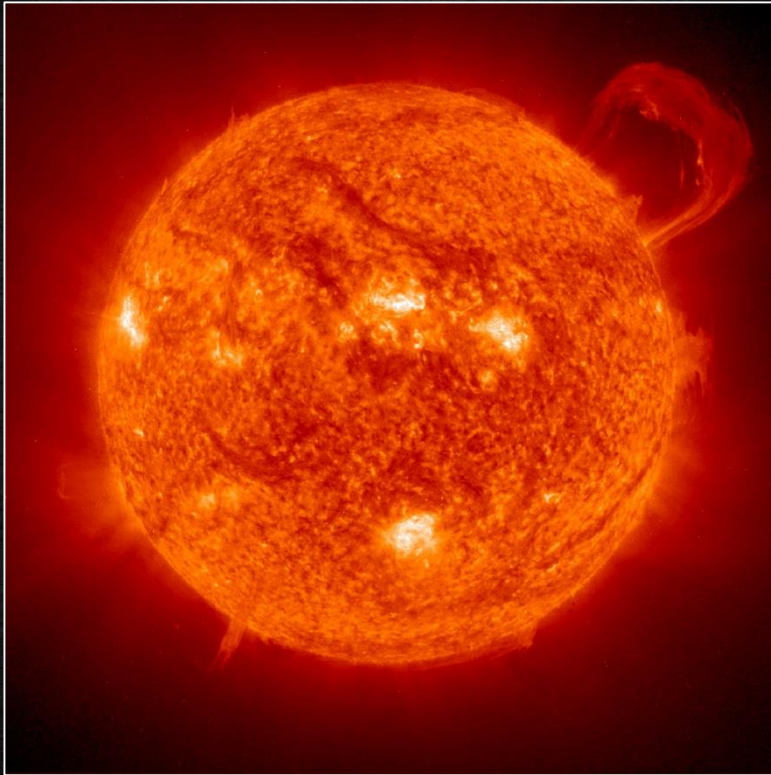
New York to Rio de Janeiro: 4,800 miles / 7,750 km

Distances in Astronomy



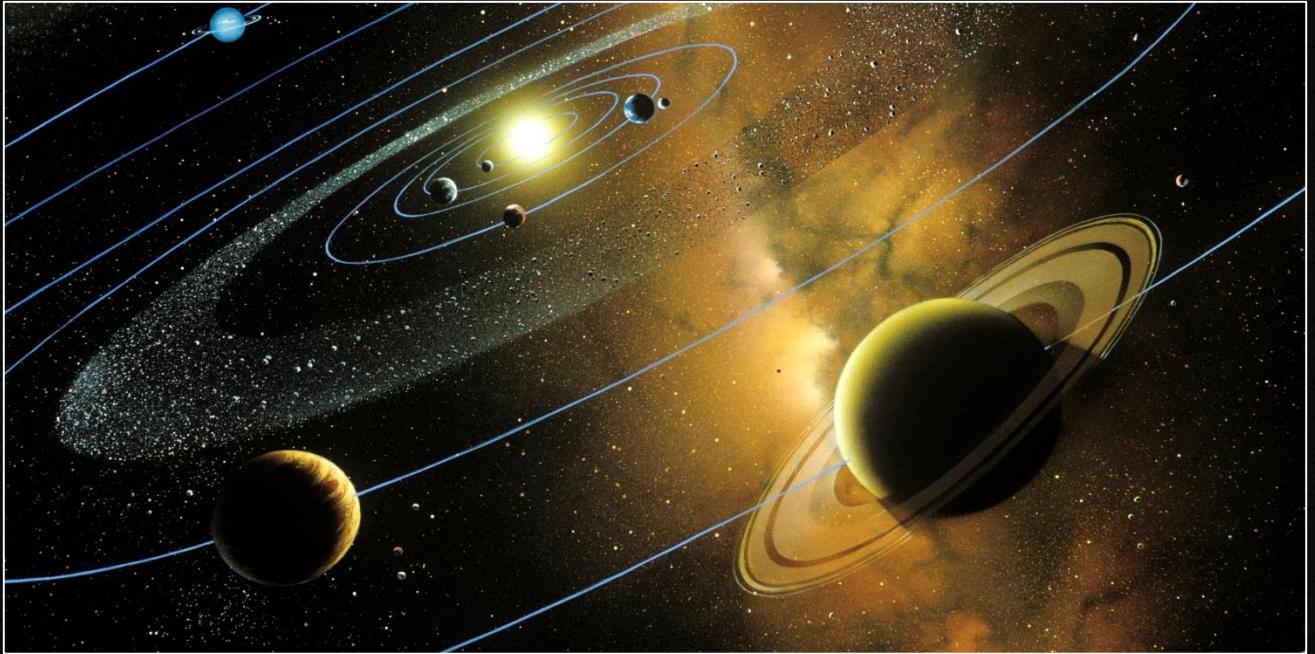
Earth to the Moon: 238,900 miles / 384,400 km

Distances in Astronomy

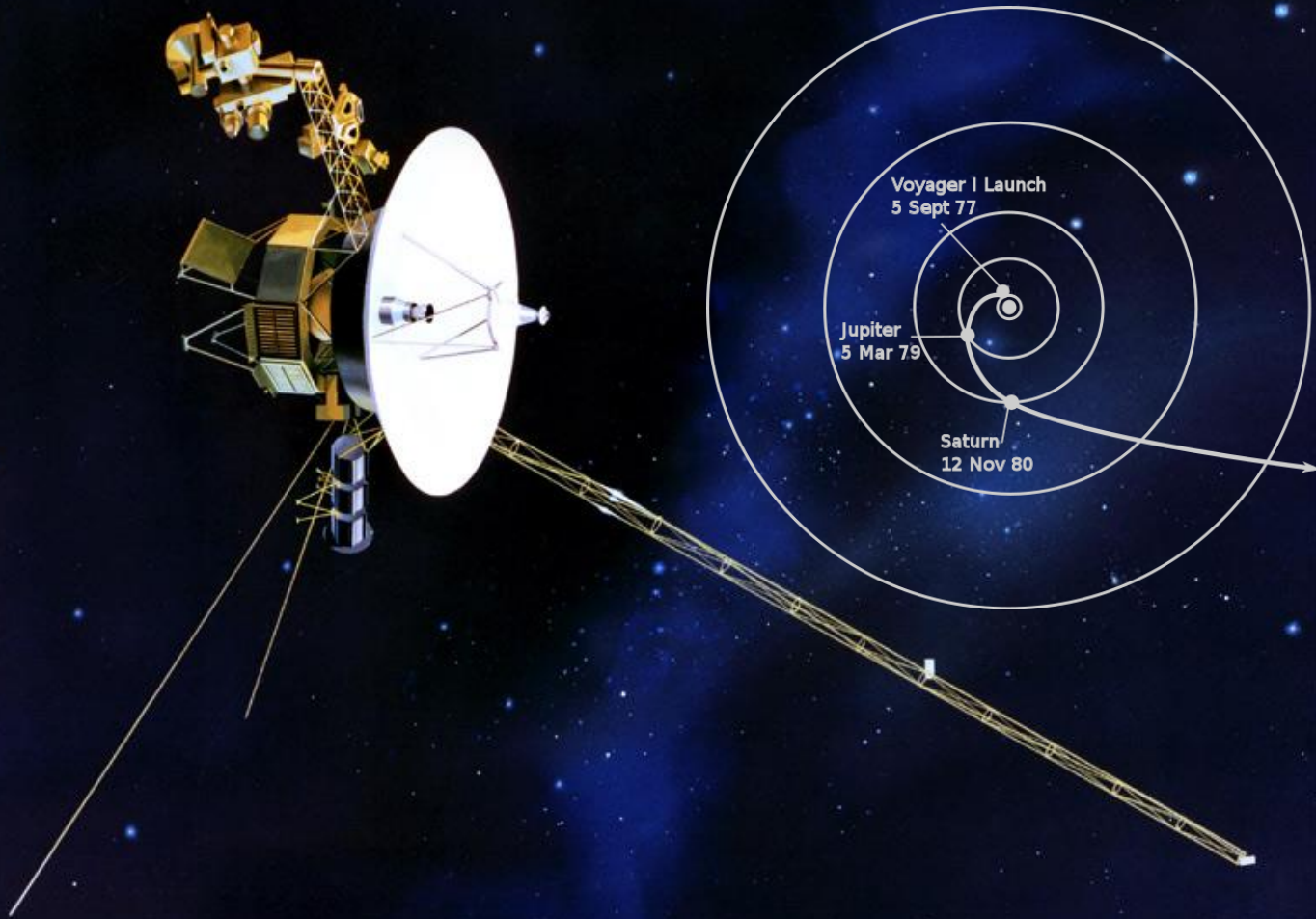


Earth to the Sun: 92,960,000 miles / 149,600,000 km

Distances in Astronomy



The edge of the Solar System: 9,000,000,000 miles / 14,484,096,000 km



Voyager I Launch
5 Sept 77

Jupiter
5 Mar 79

Saturn
12 Nov 80



Queen Mary 2

Q

QUEEN MARY 2

Distances in Astronomy

- At the maximum speed of Queen Mary 2 (35mph)
 - New York to Rio de Janeiro:
6 days
 - Earth to the Moon:
284 days
 - Earth to the Sun:
302 years
 - To the edge of the Solar System:
29,334 years



Distances in Astronomy

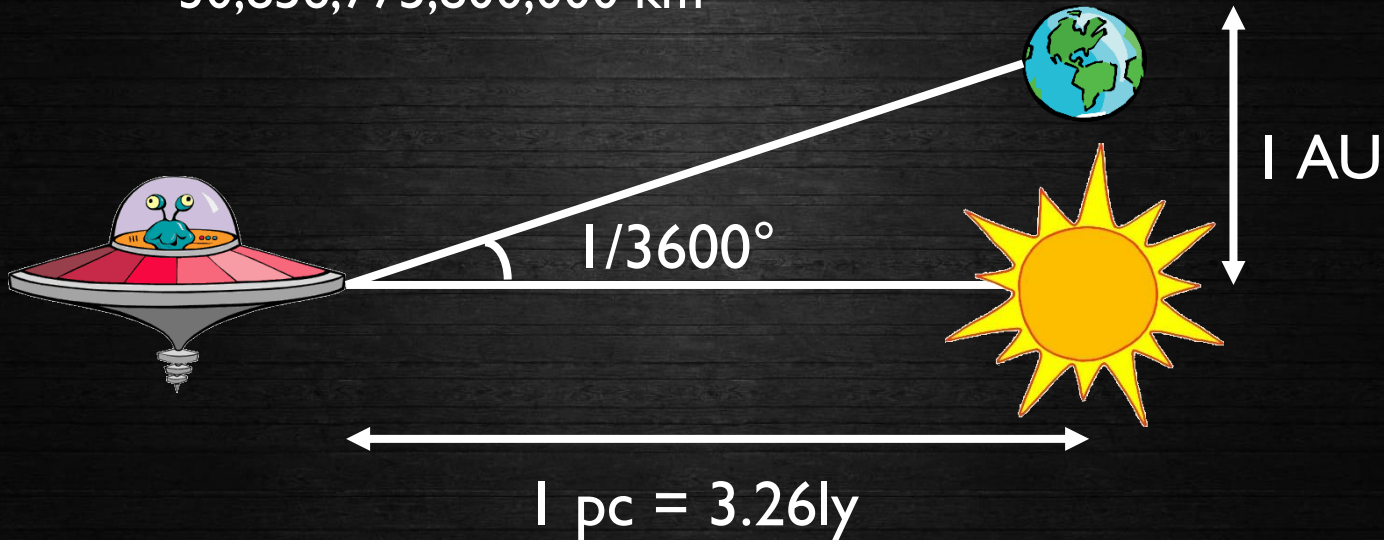
- At the speed of light
 - Southampton to New York:
0.0183 seconds
 - Earth to the Moon:
1.28 seconds
 - Earth to the Sun:
8.3 minutes
 - To the edge of the Solar System:
13.4 hours

Units of Distance

- 1 Astronomical Unit (AU)
 - The average distance between the Sun and the Earth
 - 149,597,871 km
- 1 Light Year (ly)
 - The distance light would travel in 1 year
 - 9,460,528,410,000 km

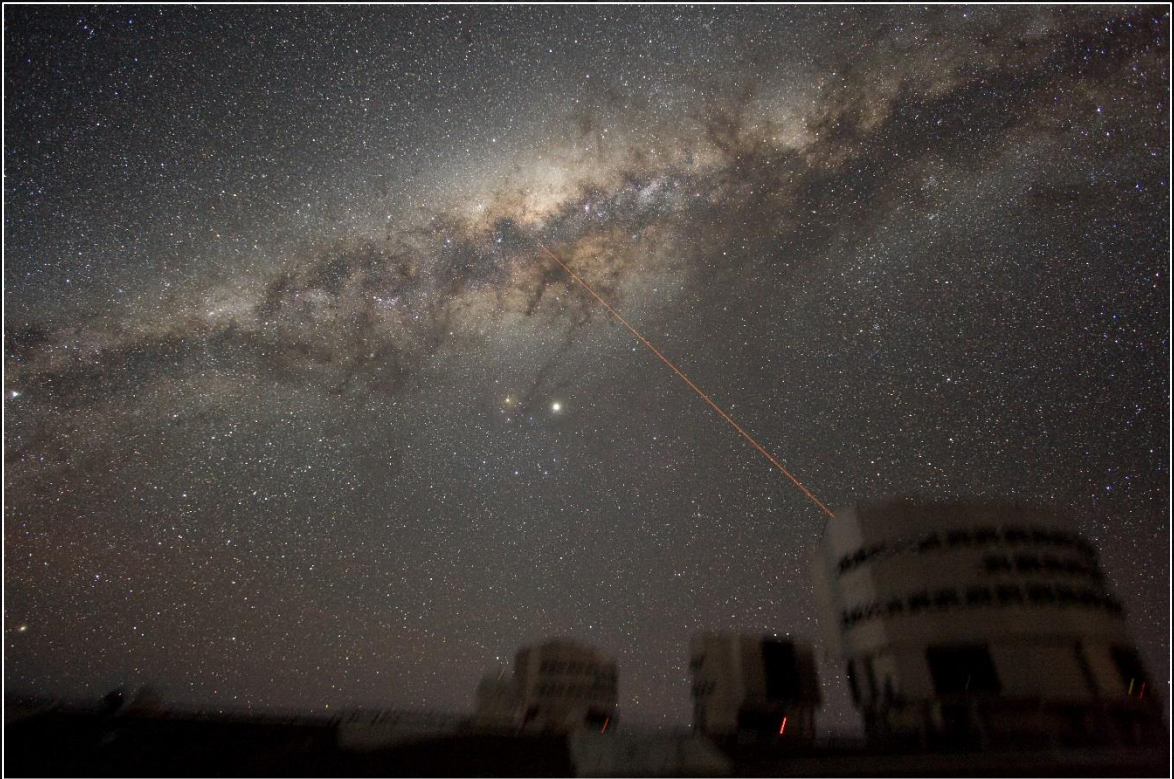
Units of Distance

- 1 Parsec (pc)
 - Based upon the Earth's rotation around the Sun
 - 30,856,775,800,000 km





Distances in Astronomy



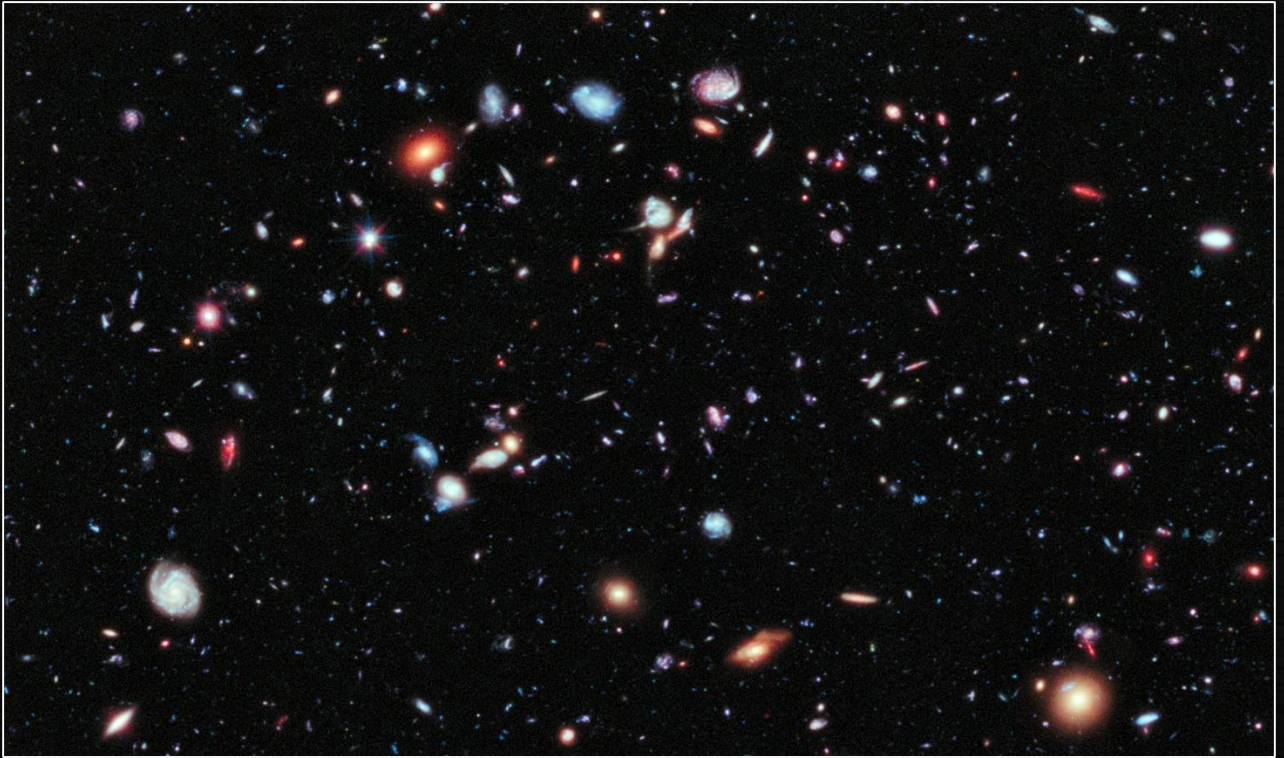
To the centre of the Galaxy: 25,900 light years

Distances in Astronomy



To the Andromeda Galaxy: 2,538,000 light years

Distances in Astronomy



To the most distant Galaxy known: 13,000,000,000 light years

Our Location – a Summary

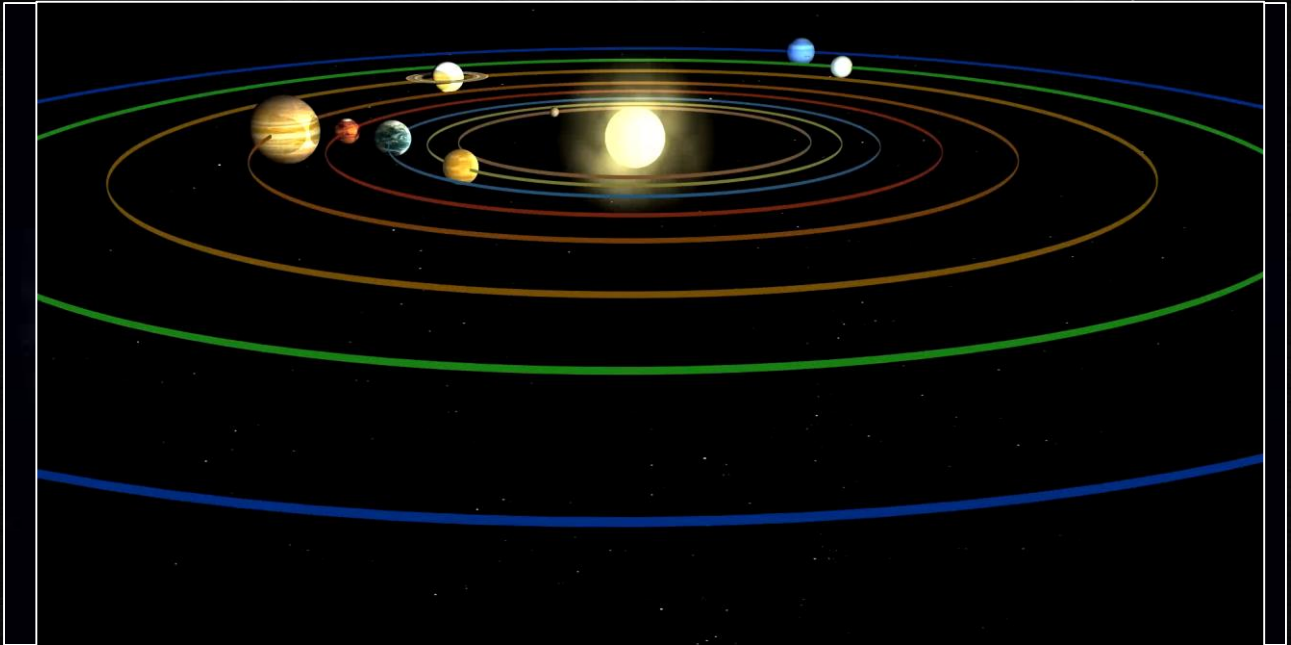
- We are:

On Earth	km/miles
Which is in the Solar System	50-100 AU
Which is in the Milky Way	50 thousand ly/pc
Which is in the Local Group	10 million ly/pc
Which is in the Cosmic Web	Billion ly/pc
Which is in the Universe	13.7 Billion ly/pc

The changing and evolving Universe

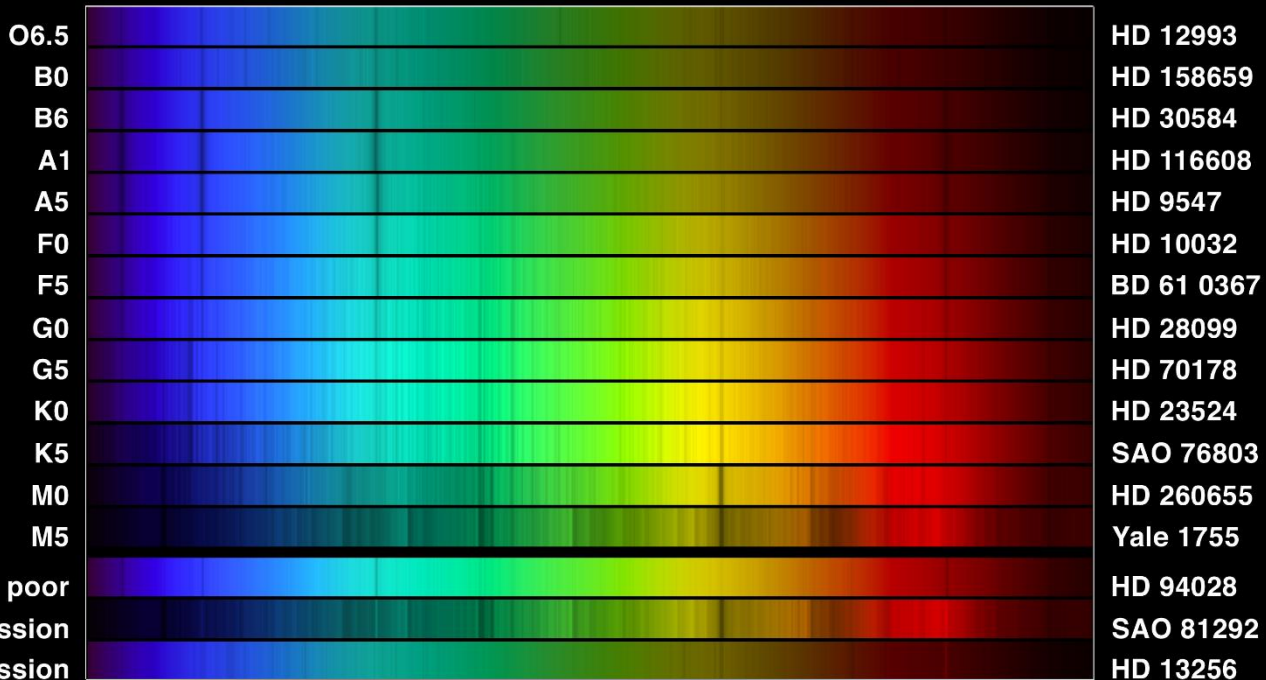
The Universe Today

- The Universe isn't static – it evolves



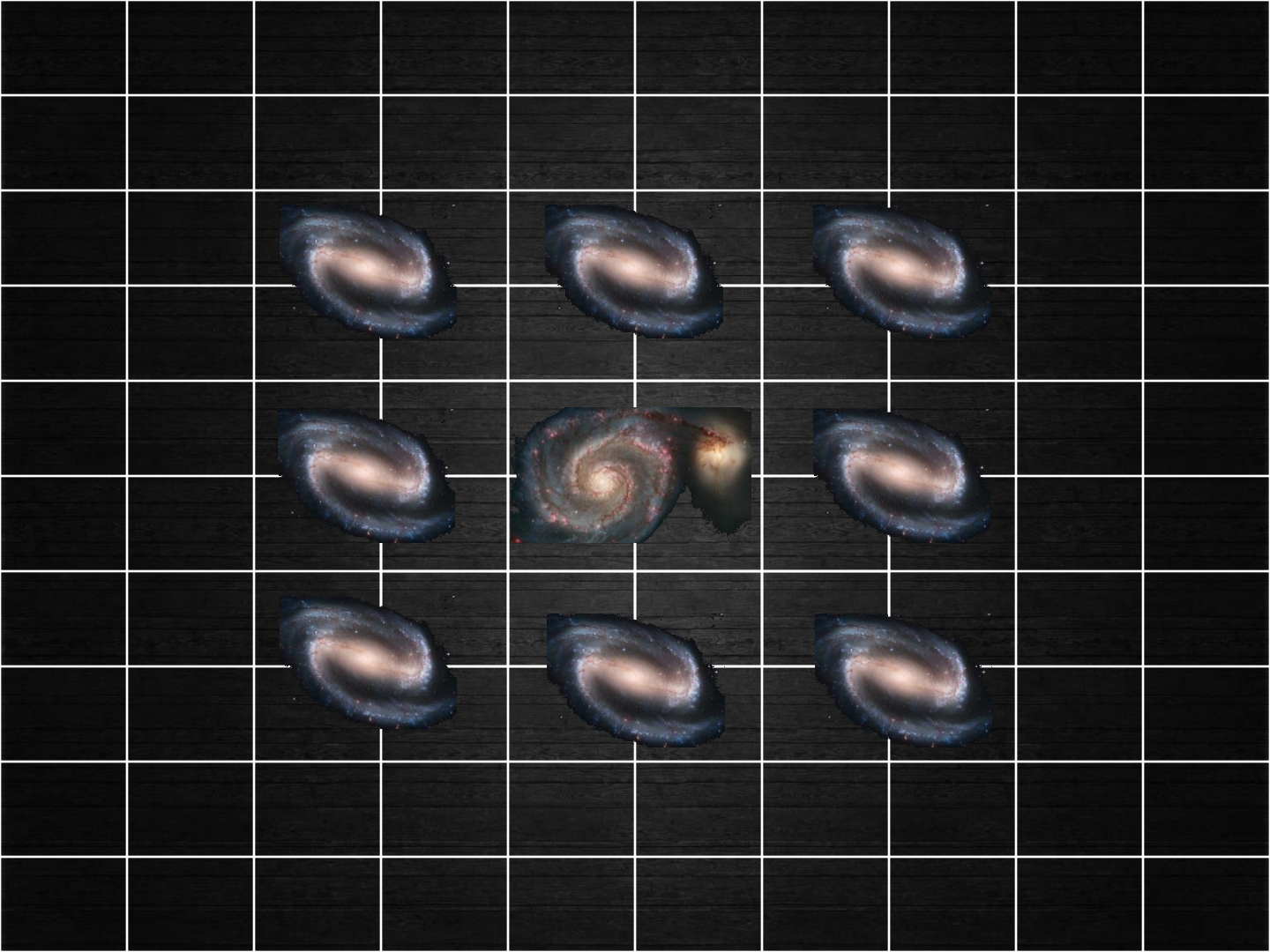
Starting at the beginning



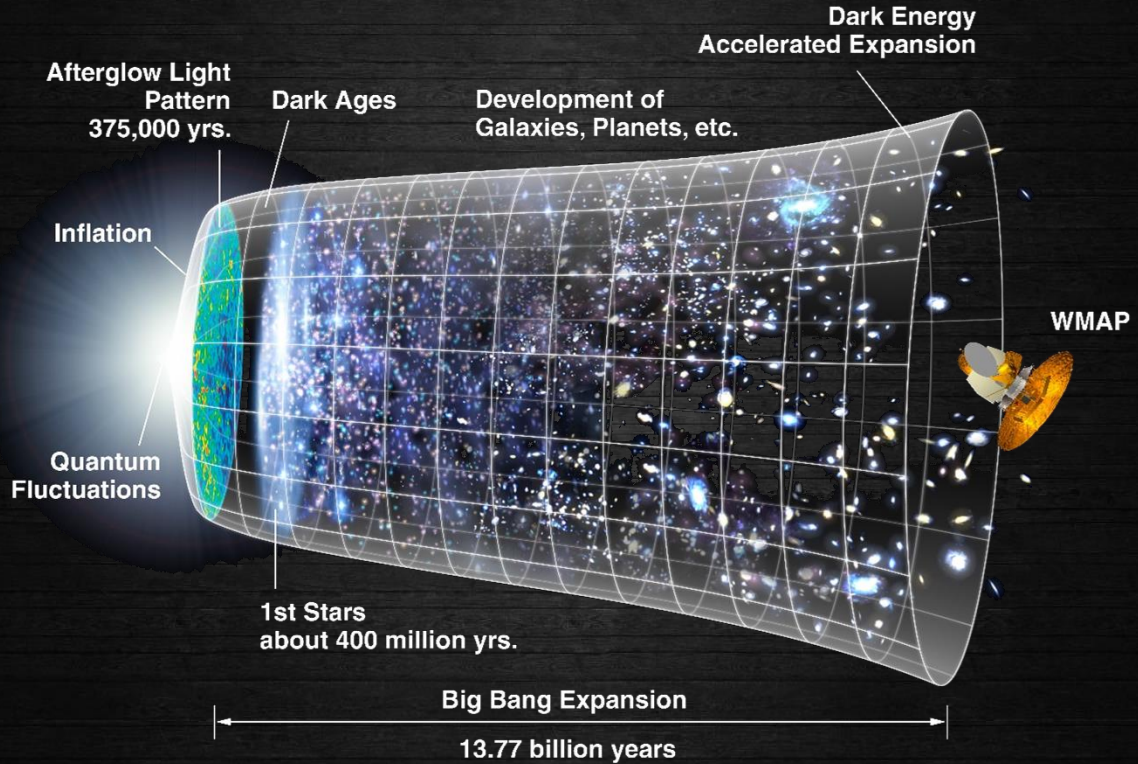


The Expansion of the Universe

- The objects further away are moving away fastest
- Everything appears to be moving away from Earth
- So are we in a “special” place?

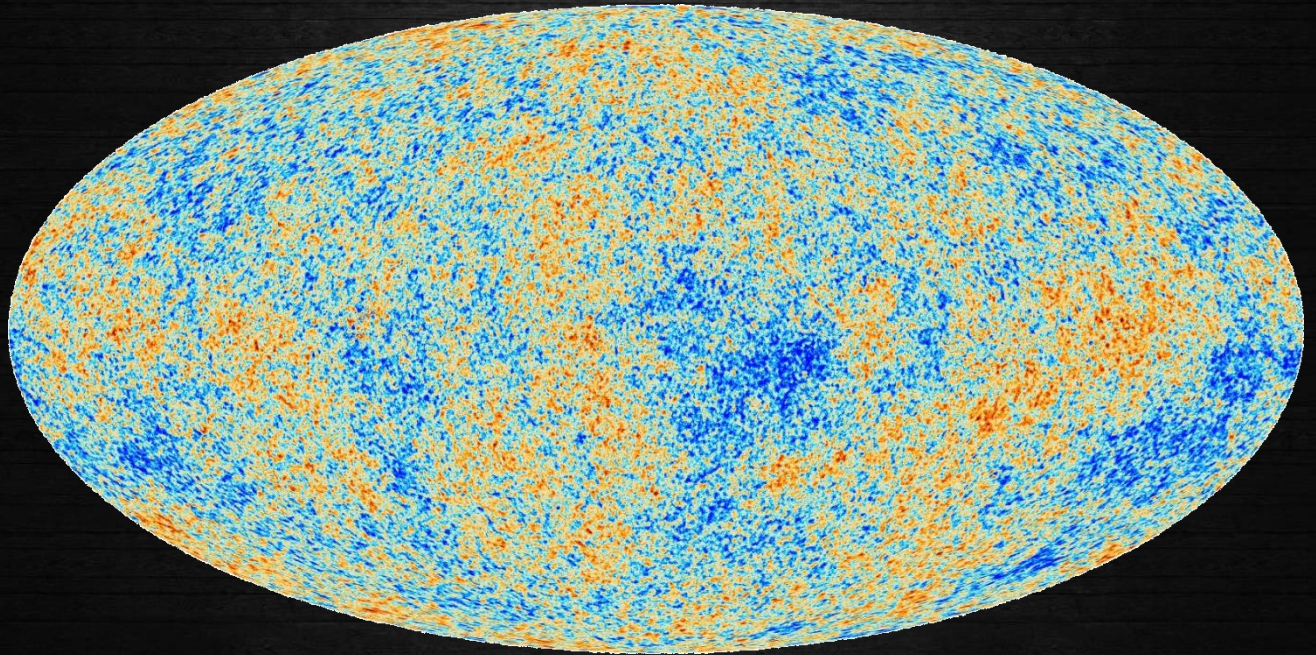


The Big Bang

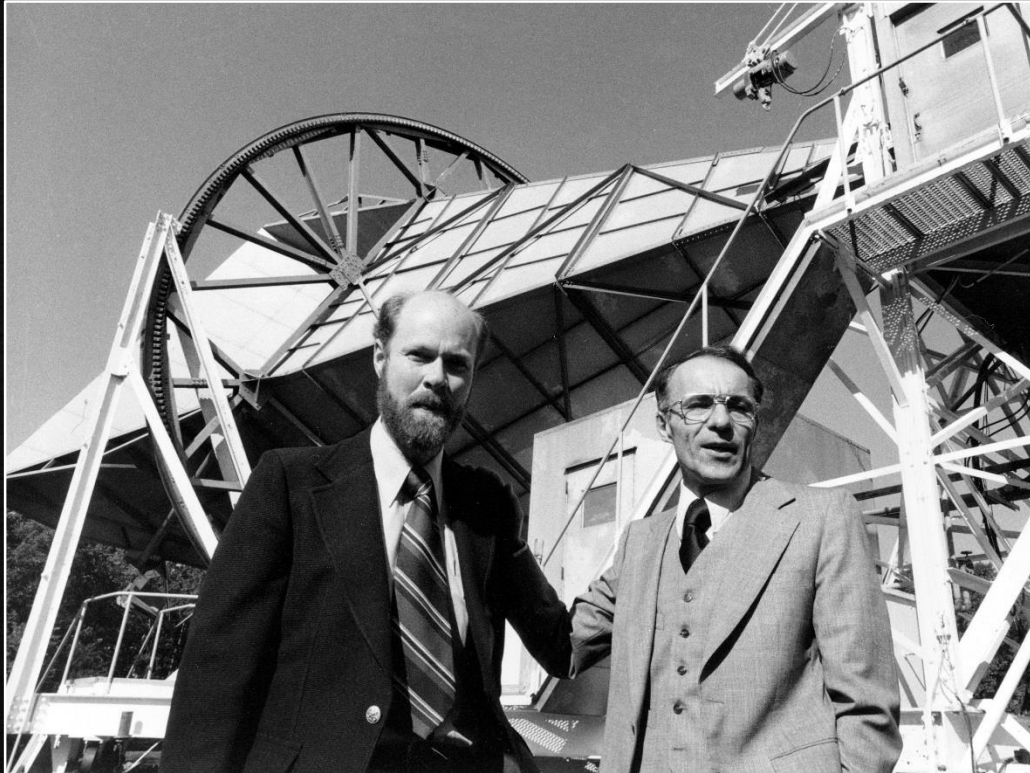


1,000,000,000,000,000,000,000,000,000,000,000°C

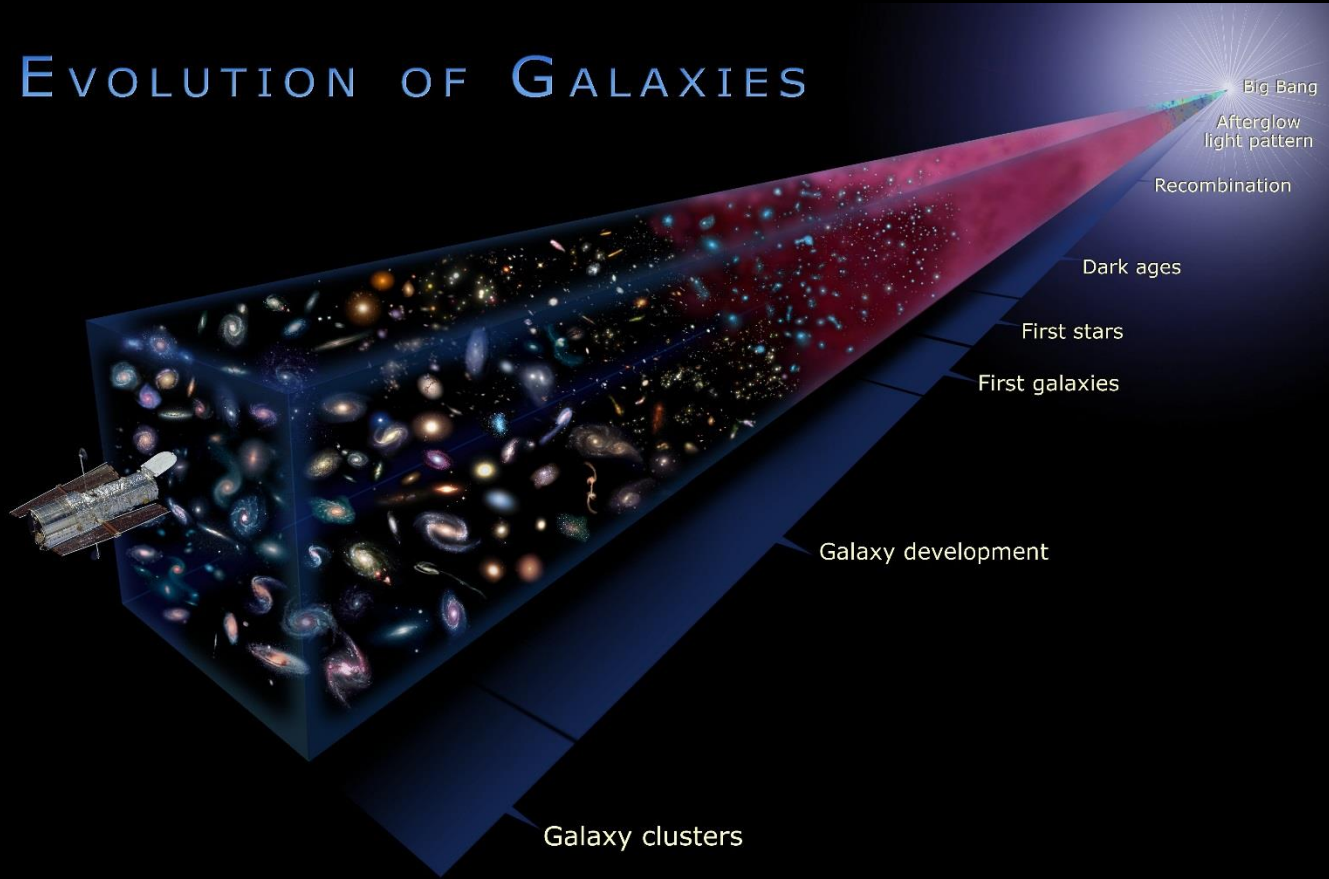
The Cosmic Microwave Background



The Cosmic Microwave Background



EVOLUTION OF GALAXIES



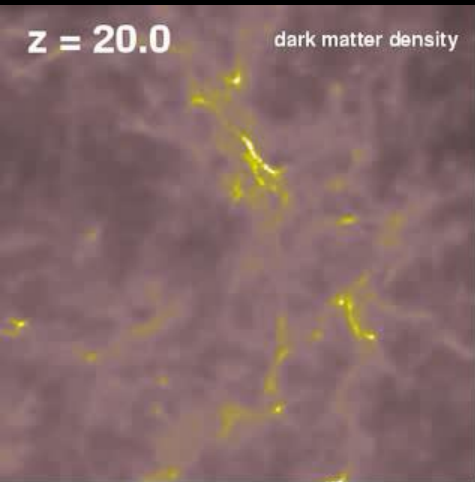
Forming Structure

- The Universe is clumpy

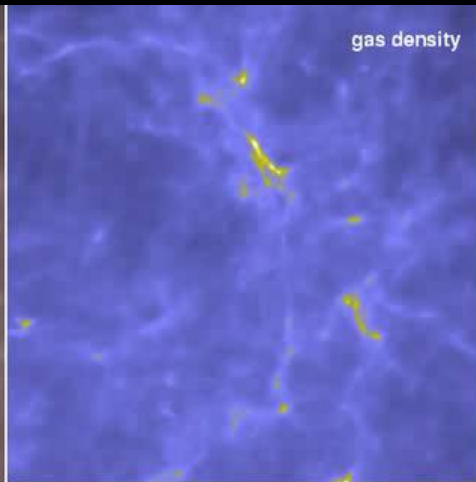
It's all the fault of Gravity!

$z = 20.0$

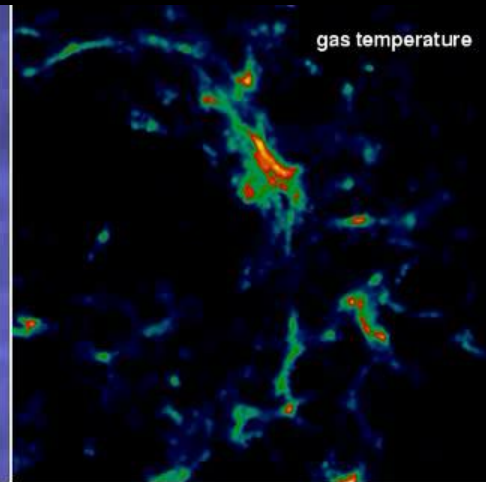
dark matter density



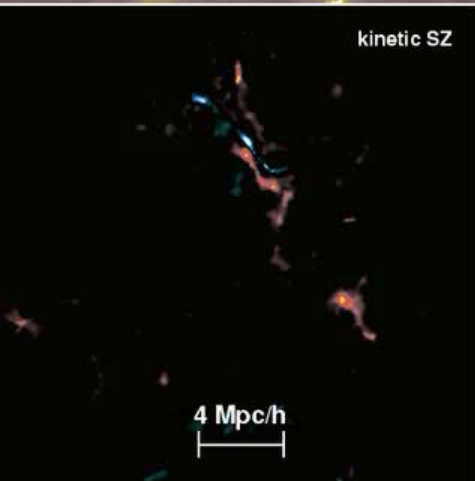
gas density



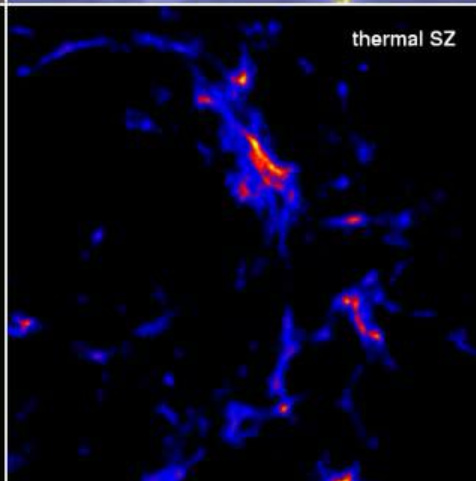
gas temperature



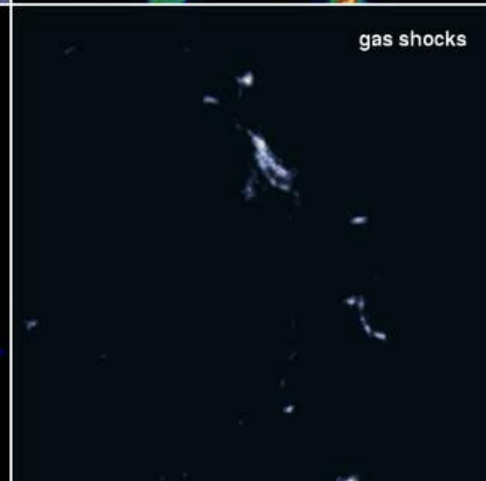
kinetic SZ



thermal SZ



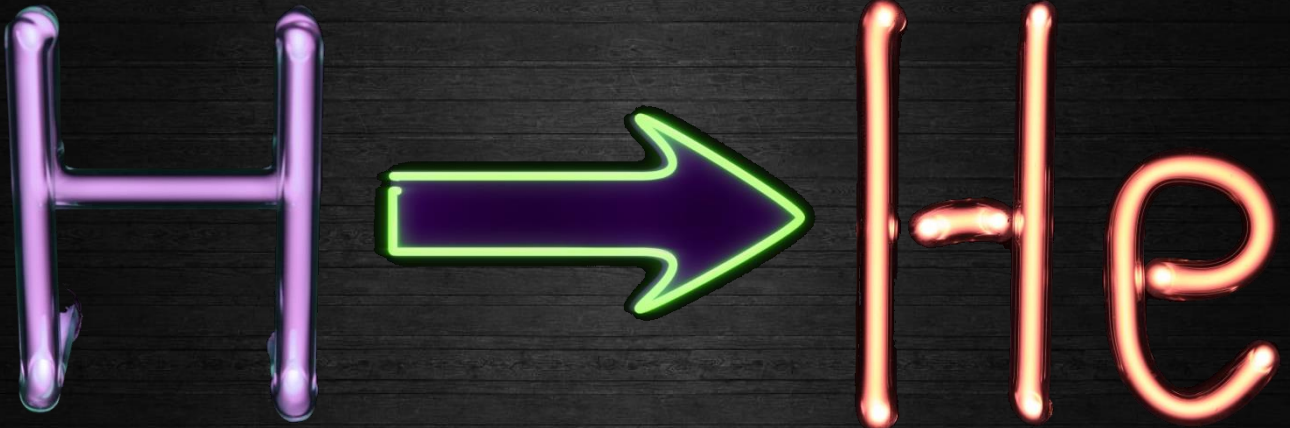
gas shocks



4 Mpc/h
|-----|

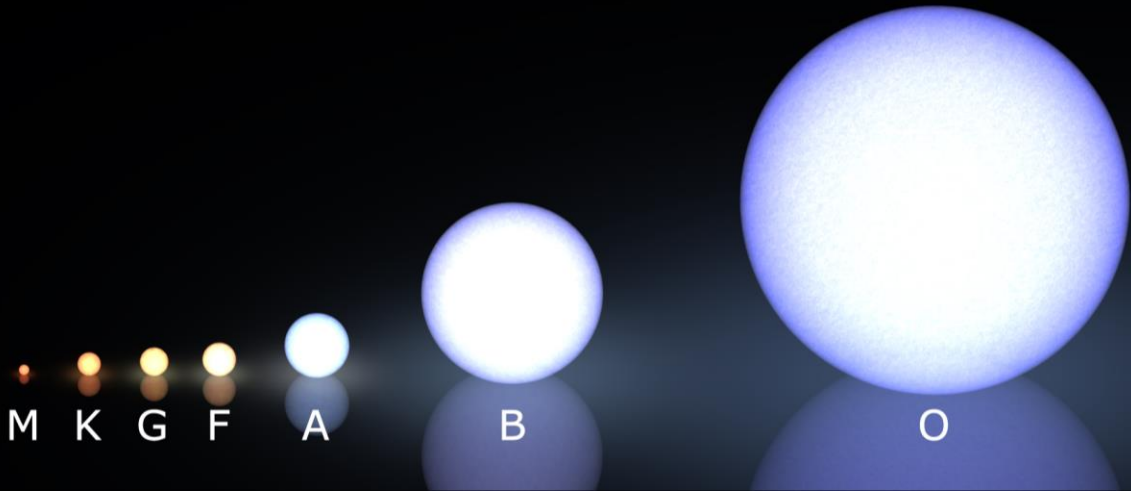


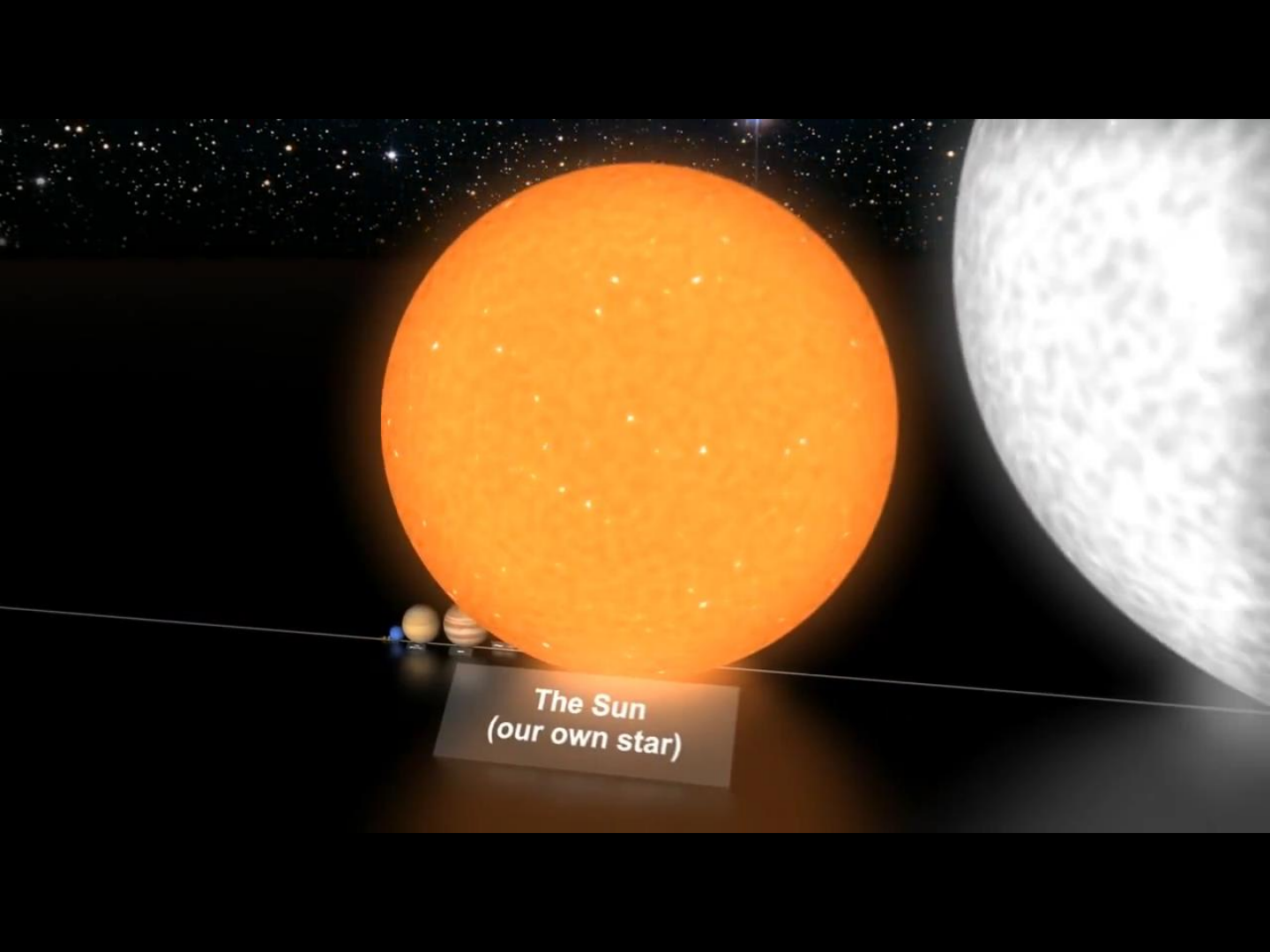
How do stars work?



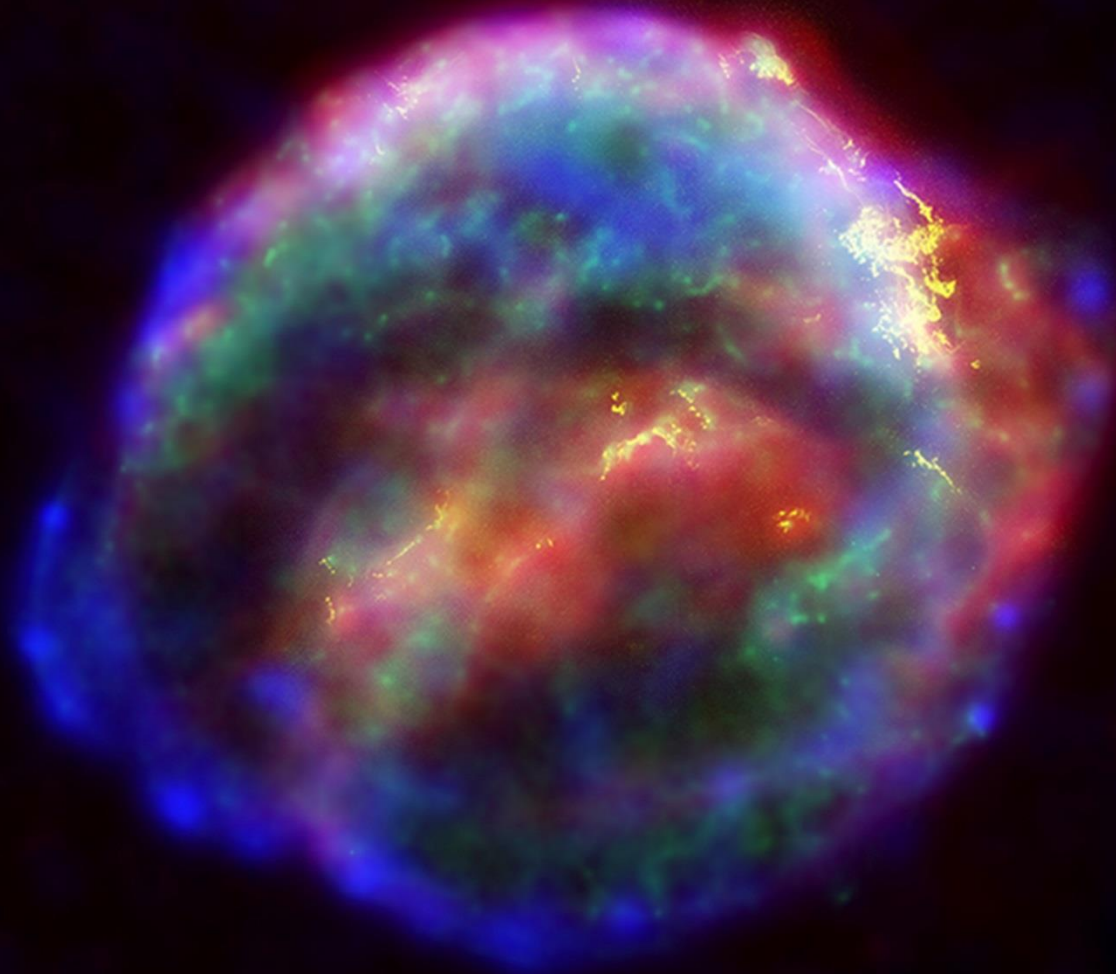
So is the Sun special?

	Minimum	Maximum	The Sun
Size	$0.4 \times$ Radius of Sun	$15 \times$ Radius of Sun	1
Mass	$0.3 \times$ Mass of Sun	$60 \times$ Mass of Sun	1
Temperature	3500 K	25,000+ K	5,500K





The Sun
(our own star)









The Spitzer Infrared Nearby Galaxies Survey (SINGS) Hubble Tuning-Fork

The Spitzer Space Telescope observed 75 galaxies as part of its SINGS (Spitzer Infrared Nearby Galaxies Survey) Legacy Program. The galaxies are presented here in a Hubble Tuning-Fork diagram, which groups galaxies according to the morphology of their nuclei and spiral arms. The designation of these galaxies and their placement in the diagram is based on their visible-light appearance. The main goal of the SINGS program is to characterize the infrared properties of a wide range of galaxy types. The images of the galaxies are composites created from data taken by IRAC (the Infrared Array Camera) at 3.6 and 8.0 μm , and MIPS (the Multiband Imaging Photometer for Spitzer) at 24 μm .

The infrared range probed by these and other observations taken for the SINGS project allows for the detailed study of star formation, dust emission, and the distribution of stars in each galaxy. Light from old stars appears as blue in the images, while the lumpy knots of green and red light are produced by dust clouds surrounding newly born stars. The elliptical galaxies on the left are almost entirely made of old stars, while spiral galaxies like our own Milky Way are rich in young stars and the raw materials for future star formation.

More information can be found at:
<http://sings.stsci.edu/>



Ellipticals

Irregulars

Unbarred Spirals

Weak Bulge

Strong Bulge

Strong Bulge

Weak Bulge

Intermediate Spirals

Barred Spirals

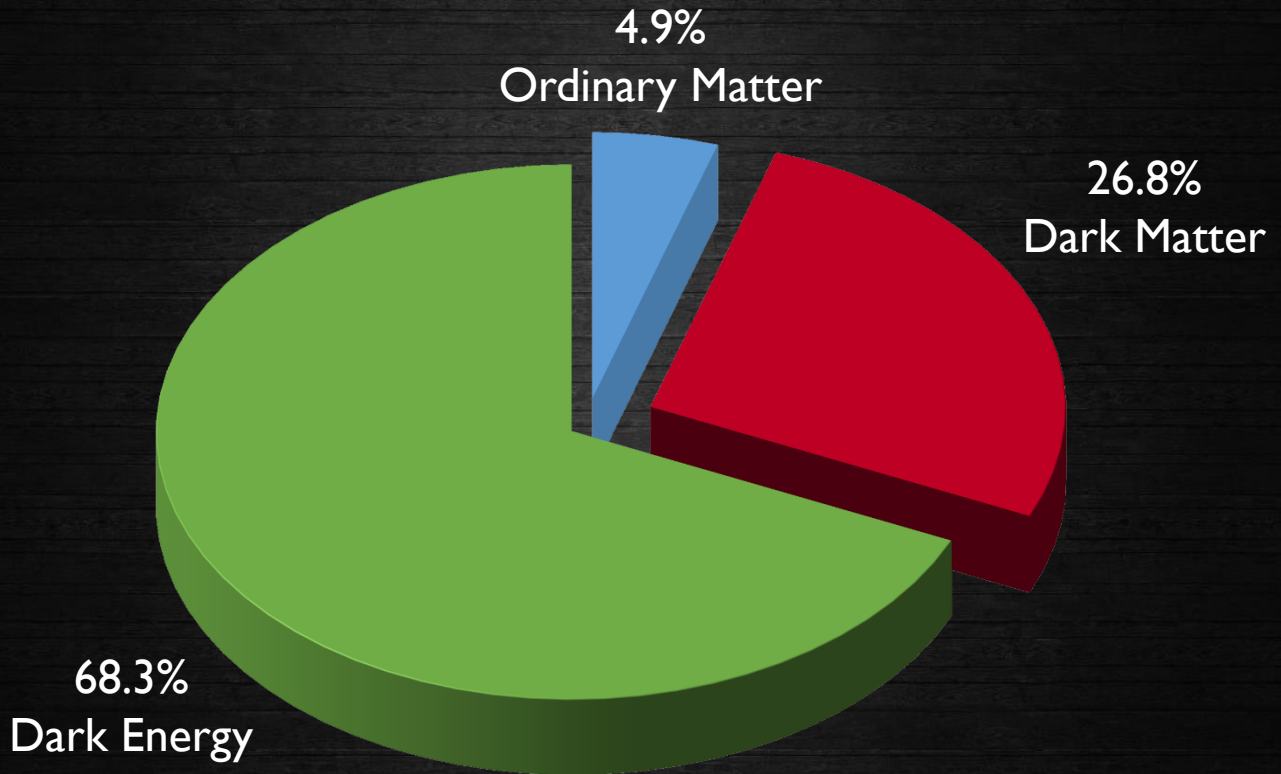
Poster and composite images created from SINGS observations by Karl D. Gordon (cc.2007)
 Based on IRAC 3.6 μm (blue)
 Green = IRAC 8 μm
 (aromatic features from dust grains/molecules)
 Red = MIPS 24 μm (warm dust)

SINGS Team

Robert Kornreich, Jr. (Principal Investigator), Daniela Calzetti (Deputy Principal Investigator), Charles Engelbracht (Technical Contact), Lee Armus, George Rieke, Carolina Bot, Brent Beckwith, John Cannon, Daniel Dale, Bruce Draine, Karl Gordon, Albert Grauer, David Hollenbach, Tom Jarrett, Lisa Kewley, Claus Leitherer, Alan Li, Saugata Malhotra, Martin Meyer, John Moustakas, Eric Murphy, Michael Regan, George Rieke, Maria Rieke, Helene Roussel, Karik Sheth, J.D. Smith, Michele Thorneley, Fabian Walter & George Helou



The Universe of Today





Thank you