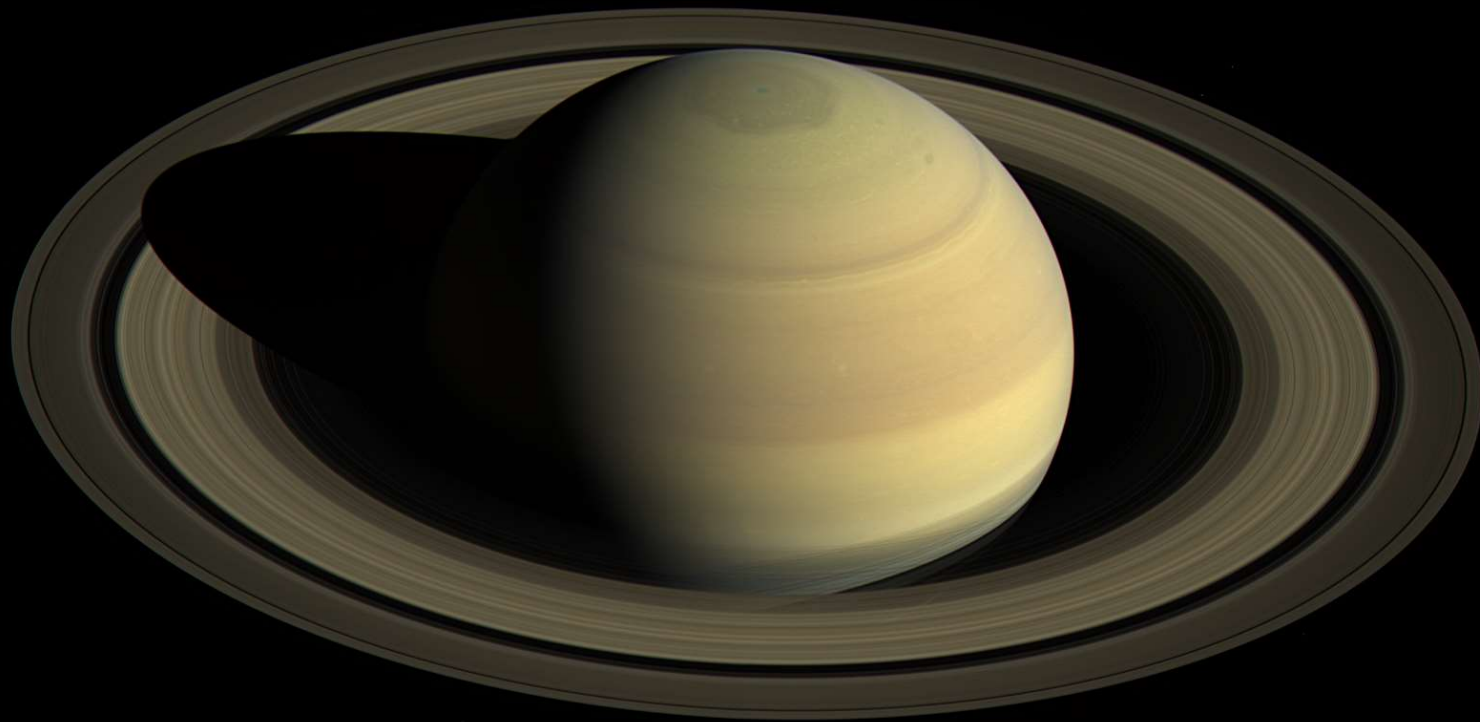


AST 2002

Introduction to Astronomy



iClicker2

**Available at the bookstore.
At the beginning of every class
will sync with iClicker base
(code will be BC).**



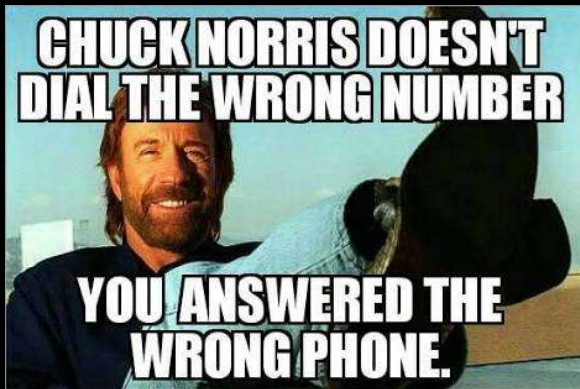
**Must register on Webcourses using knights email
address within first week of class**

Participation counts for 5%

Correct answers for 5%

We will use the 1st week to practice taking polls

**Material may be based on reading material to be
covered that lecture**



A.

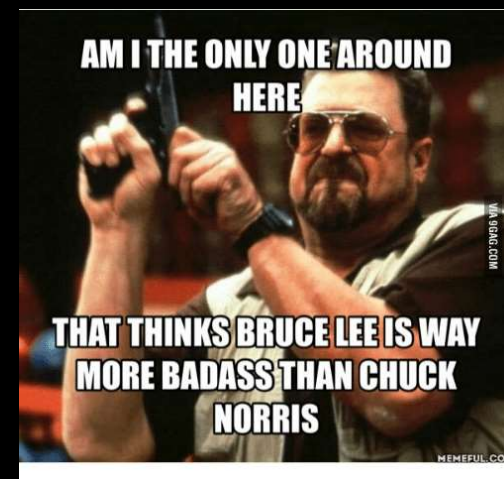
B.



C.



D.



Which is the best Chuck Norris theme?

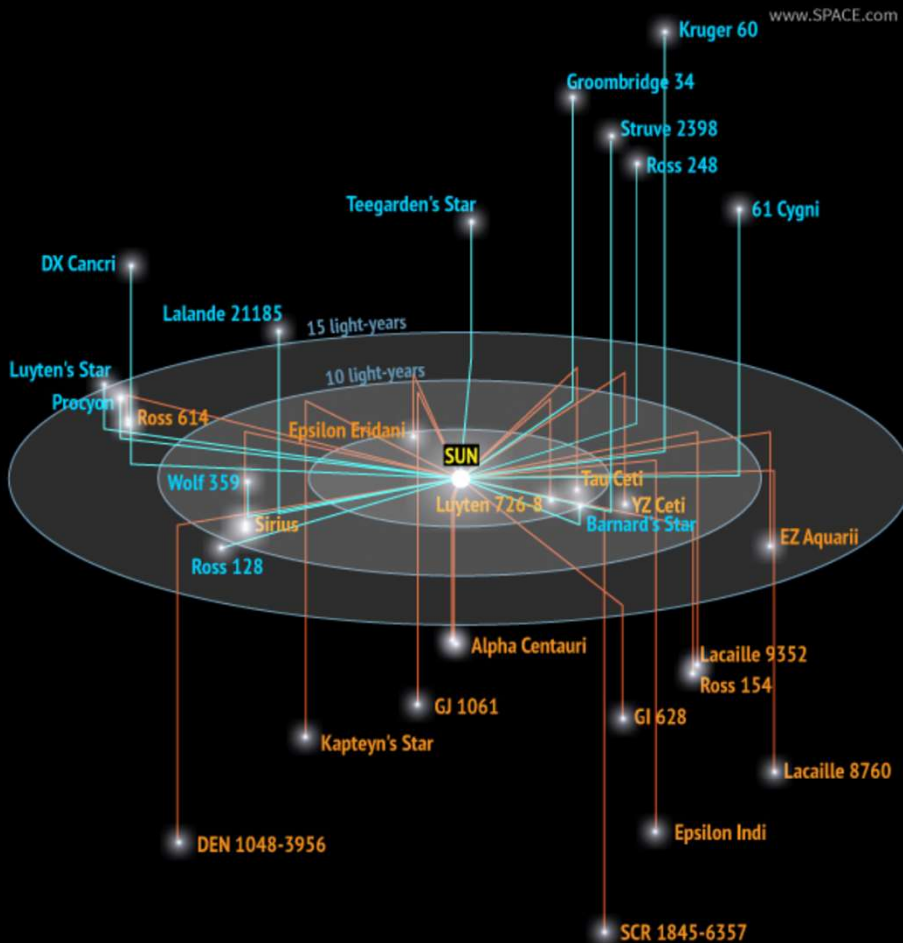
♦ A: A

♦ B: B

♦ C: C

♦ D: D

Other Nearby Stars



	Star system	Distance in light-years	Stellar type (s)	Observed planets
1	Alpha Centauri	4.24-4.37	M, G, K	1
2	Barnard's Star	5.96	M	
3	Wolf 359	7.78	M	
4	Lalande 21185	8.29	M	
5	Sirius	8.58	A, D	
6	Luyten 726-8	8.73	M, M	
7	Ross 154	9.68	M	
8	Ross 248	10.32	M	
9	Epsilon Eridani	10.52	K	2
10	Lacaille 9352	10.74	M	
11	Ross 128	10.92	M	
12	EZ Aquarii	11.27	M, M, M	
13	Procyon	11.40	F, D	
14	61 Cygni	11.40	K, K	
15	Struve 2398	11.53	M, M	
16	Groombridge 34	11.62	M, M	
17	Epsilon Indi	11.82	K, T, T	
18	DX Cancri	11.83	M	
19	Tau Ceti	11.89	G	5
20	GJ 1061	11.99	M	
21	YZ Ceti	12.13	M	
22	Luyten's Star	12.37	M	
23	Teegarden's Star	12.51	M	
24	SCR 1845-6357	12.57	M, T	
25	Kapteyn's Star	12.78	M	
26	Lacaille 8760	12.87	M	
27	Kruger 60	13.15	M, M	
28	DEN 1048-3956	13.17	M	
29	UGPS 0722-05	13.26	T	
30	Ross 614	13.35	M, M	

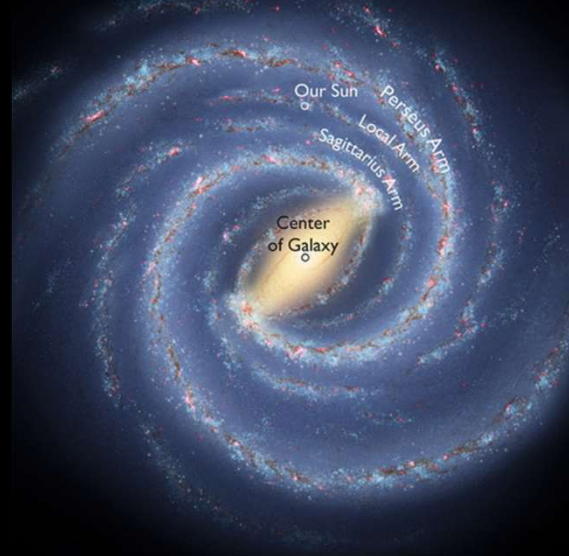
Star classifications: Spectral types



Colors do not represent the actual visual color of the star.

<https://www.space.com/18964-the-nearest-stars-to-earth-infographic.html>

How Many Stars Are There?



(Both are artistic impressions)

Milky Way Galaxy

~ 26,000 light-years from center

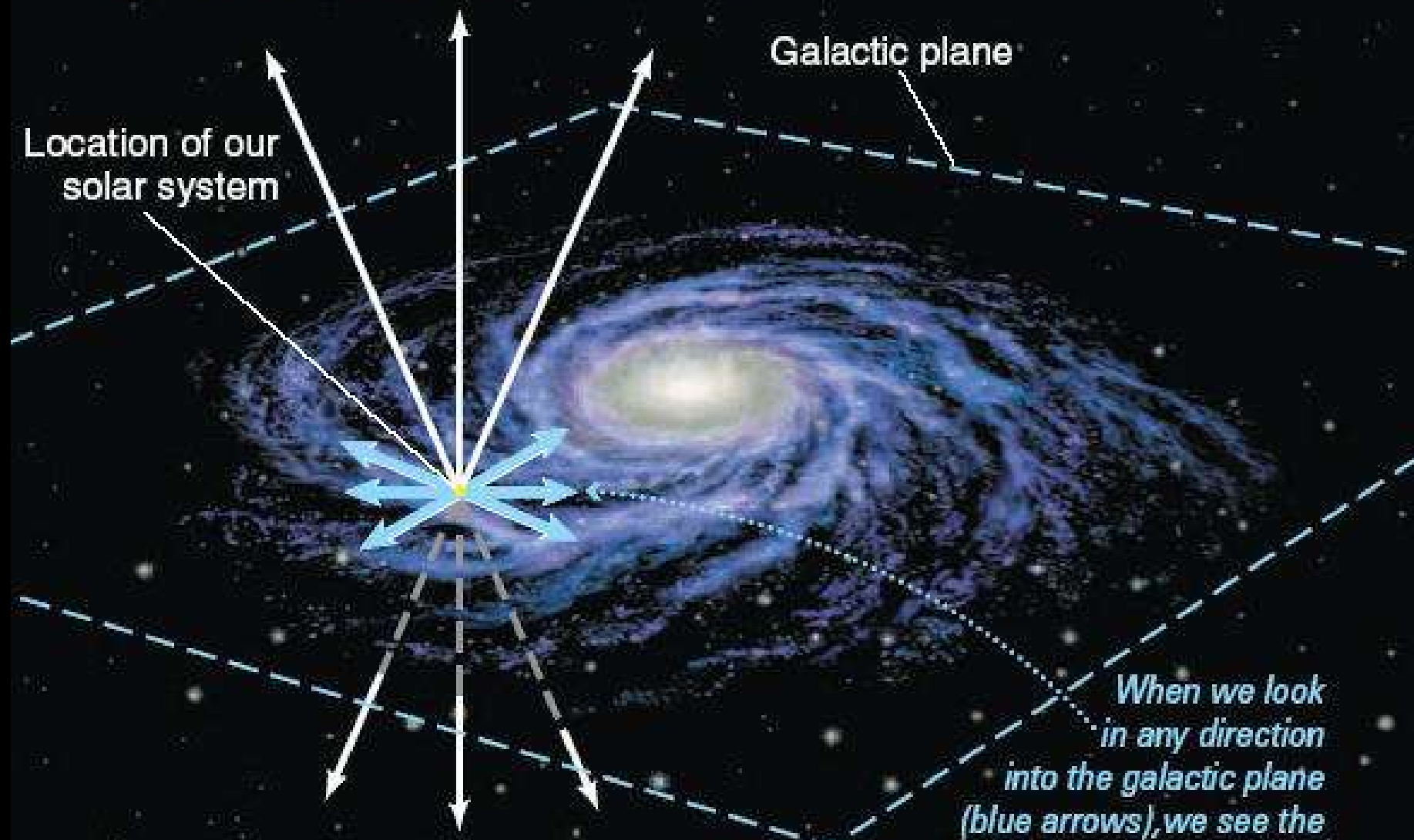
~ 100,000 light-years across

100 – 400 billion stars (maybe as many as 1 trillion)

Sun

Region of Individual Stars We See

When we look out of the galactic plane (white arrows), we have a clear view to the distant universe.

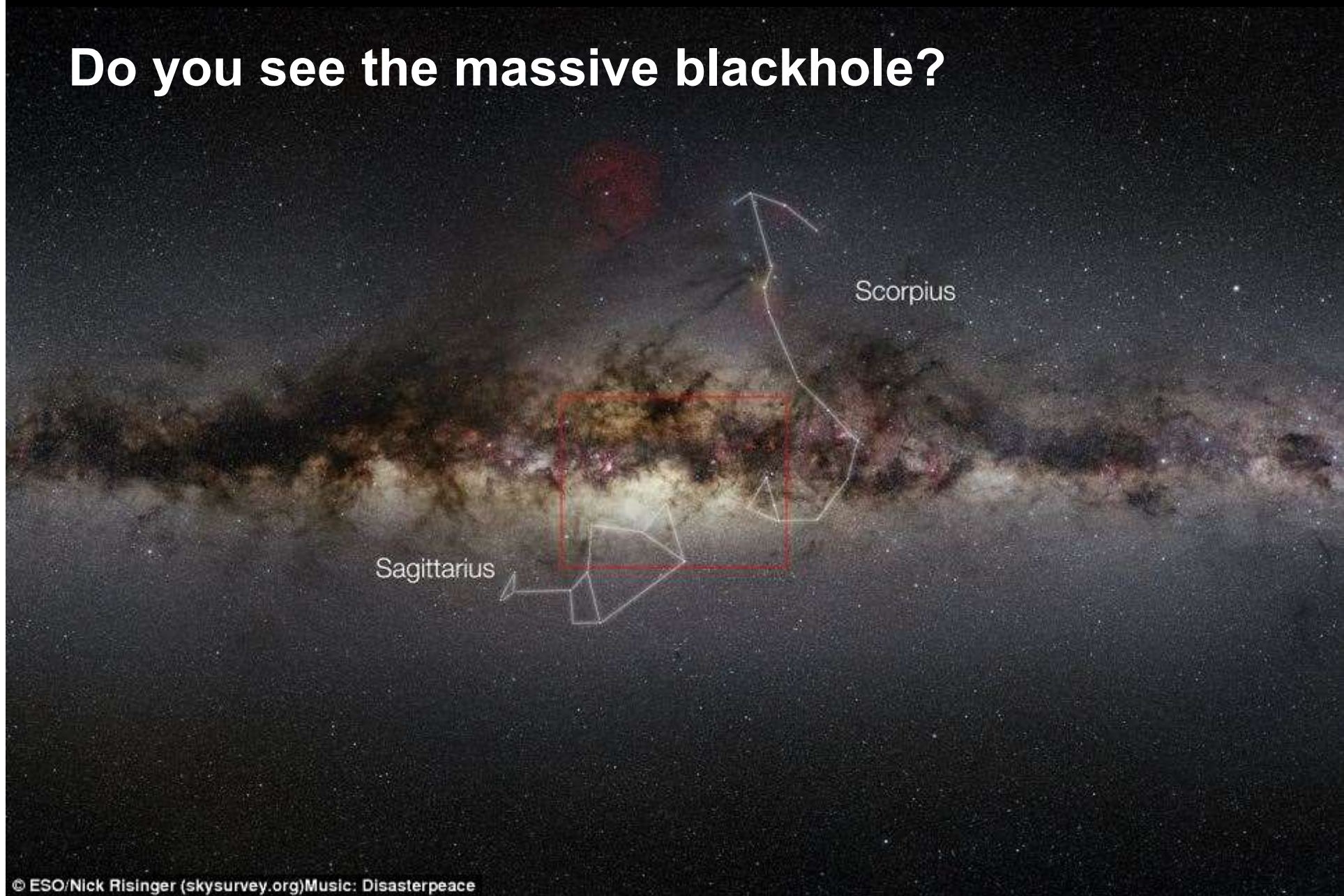


Galactic plane

Location of our solar system

When we look in any direction into the galactic plane (blue arrows), we see the stars and interstellar clouds that make up the Milky Way in the night sky.

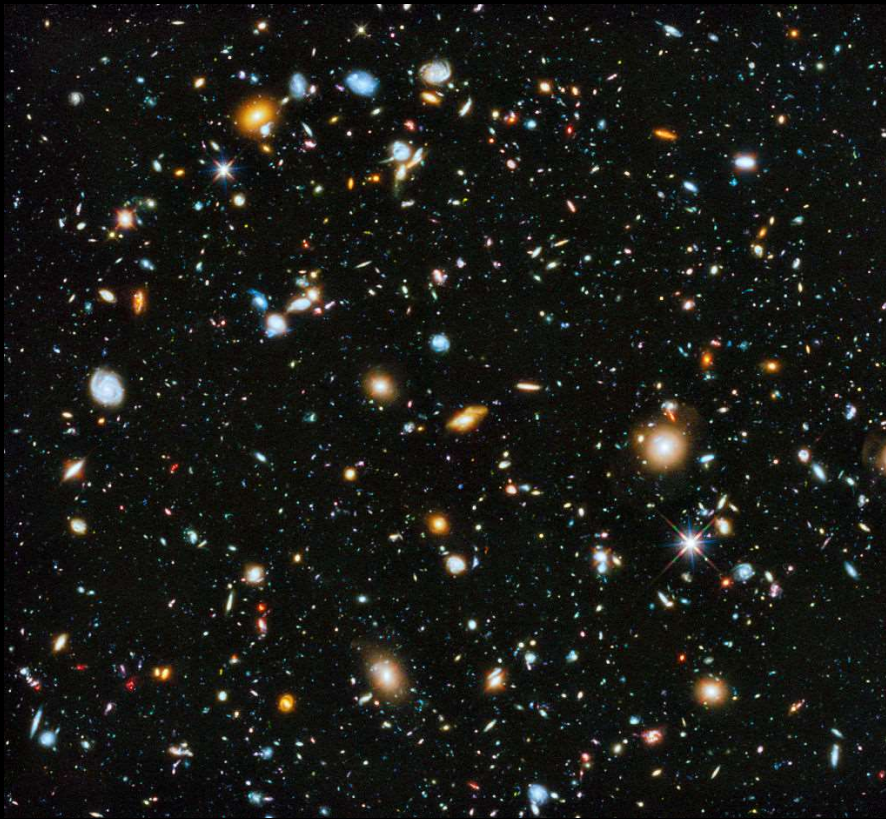
Do you see the massive blackhole?





Hubble Ultra-Deep Field (2012)

Original Deep Field taken in 1995 ~ 10 day exposure each wavelength used



This image contains over 10,000 galaxies

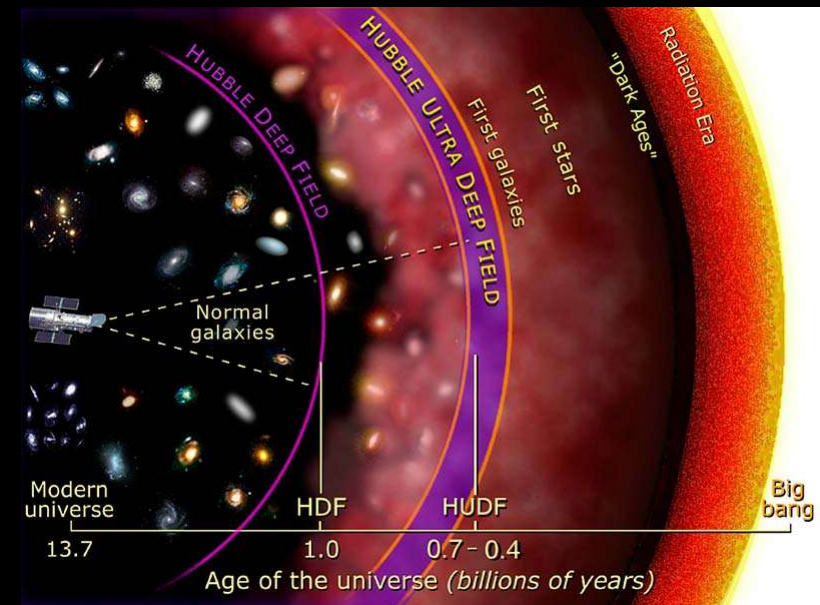
*“This is approximately one tenth of the angular diameter of a full moon viewed from Earth - smaller than a 1 mm by 1 mm square of paper held at 1 meter away, and equal to roughly **one thirteen-millionth** of the total area of the sky” - Wikipedia (cf., sand in the book)*

Estimated 200 billion – 1 trillion galaxies in the Universe, each containing >100 billion stars...

If there are 1×10^{11} galaxies, each with 10^{11} stars, there are $\sim 10^{22}$ stars

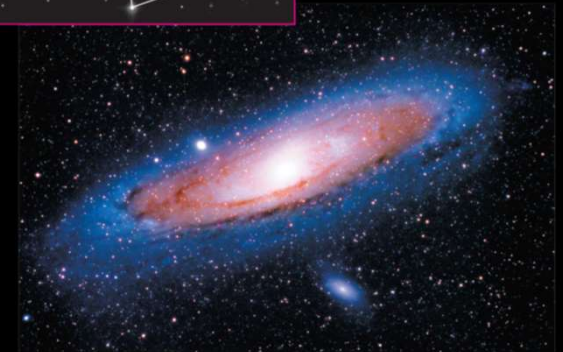
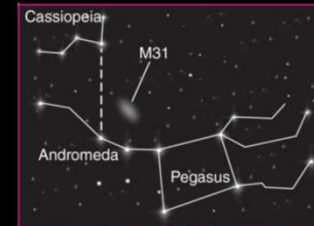
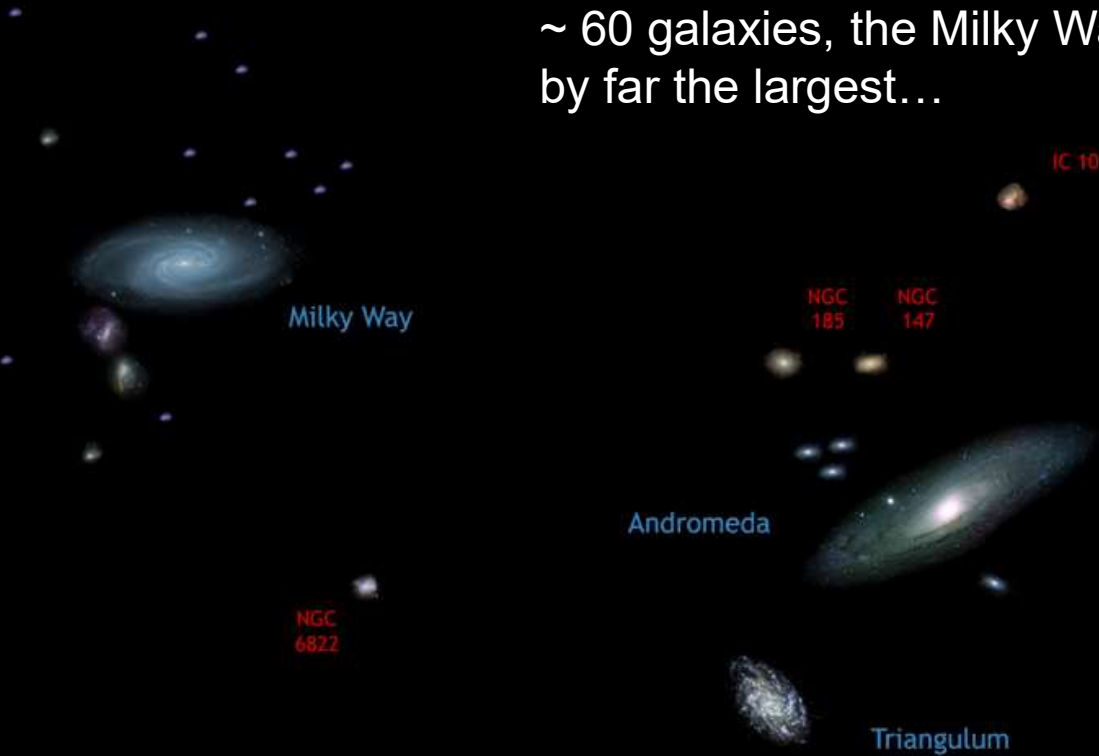
$\sim 10,000,000,000,000,000,000,000$

Comparable to number of grains of (dry) sand on every beach on Earth...



Our Local Galaxy Cluster

~ 60 galaxies, the Milky Way and Andromeda are by far the largest...



Andromeda (M31) can be seen with the naked eye

Andromeda is ~ 2.5 million light-years away

The Universe is expanding. Therefore, all galaxies are moving away from us.

♦A: True

♦B: False

Collision Scenario for Milky Way and Andromeda Galaxy Encounter

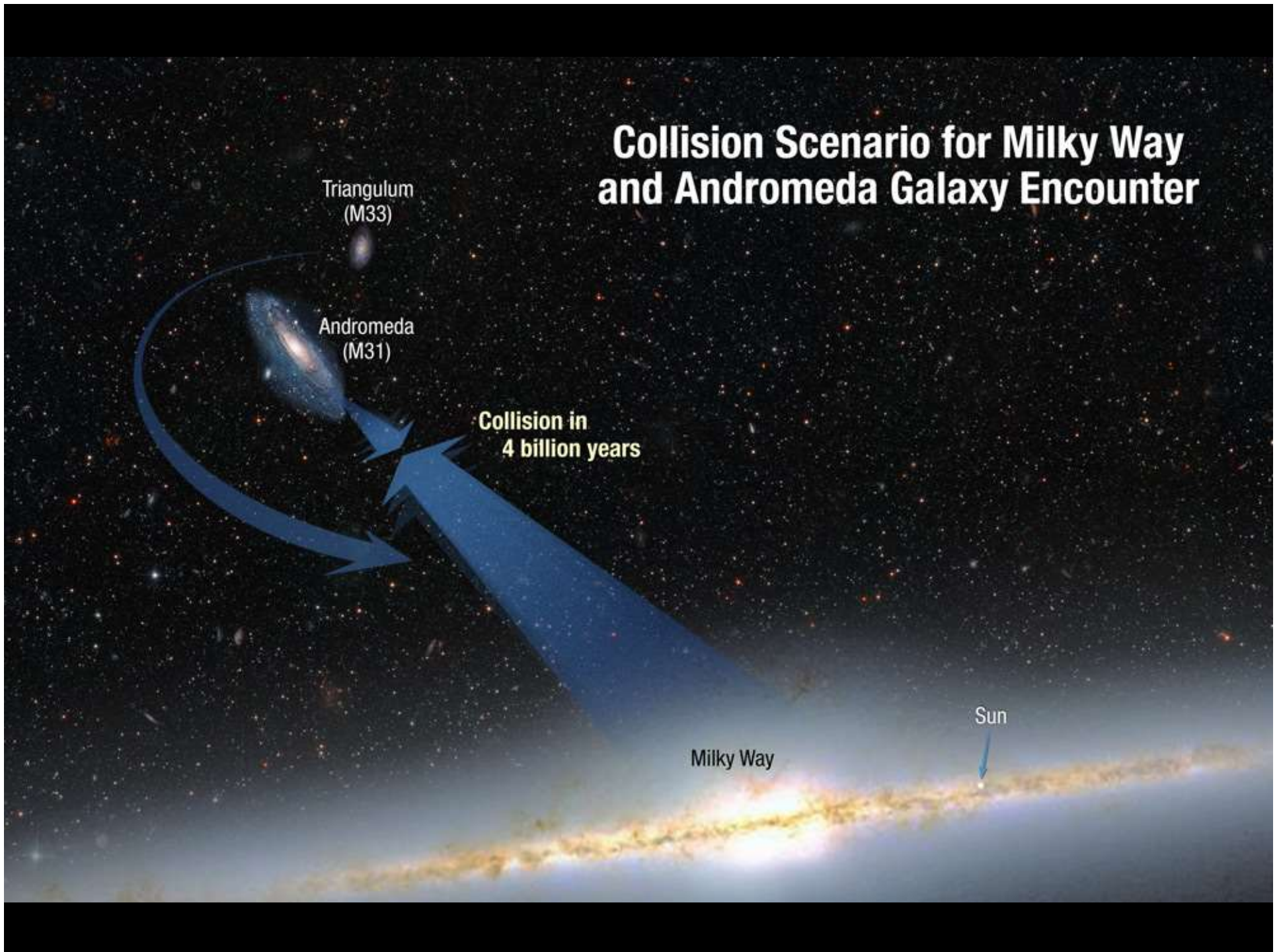
Triangulum
(M33)

Andromeda
(M31)

Collision in
4 billion years

Milky Way

Sun

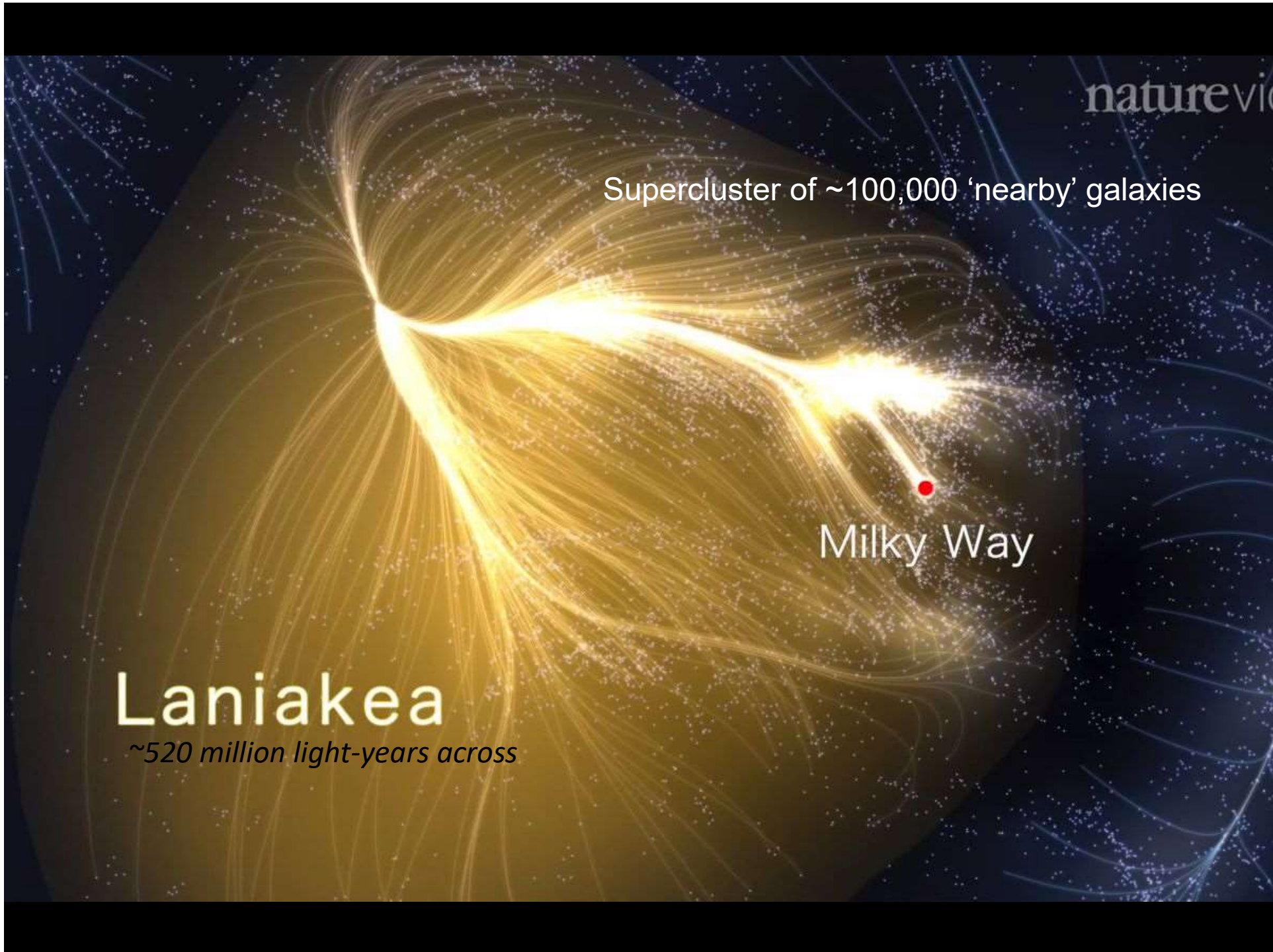


Supercluster of ~100,000 'nearby' galaxies

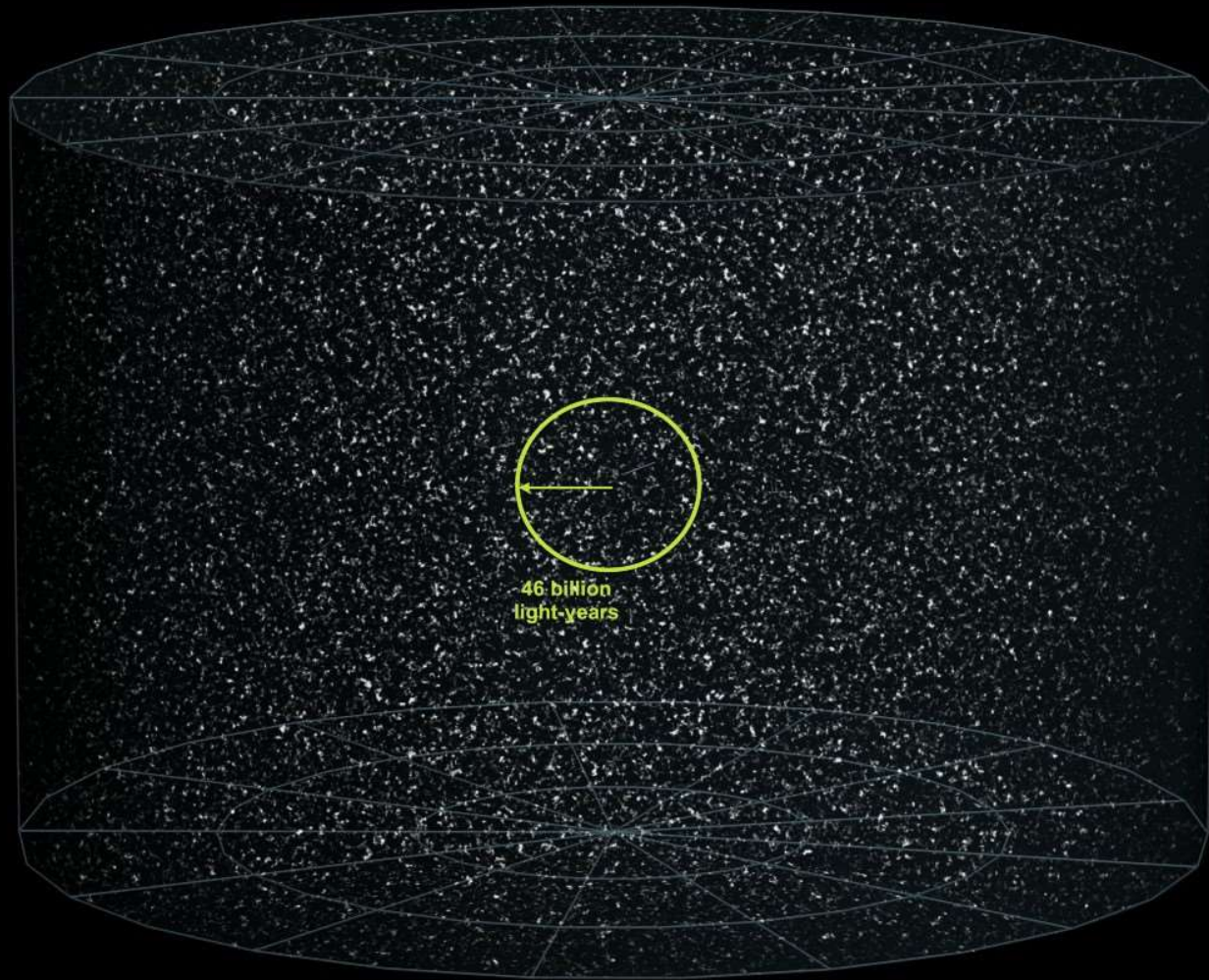
Milky Way

Laniakea

~520 million light-years across



How Big is the Known Universe?



Looking back in time

Light, although fast, travels at a finite speed and the Universe is very large

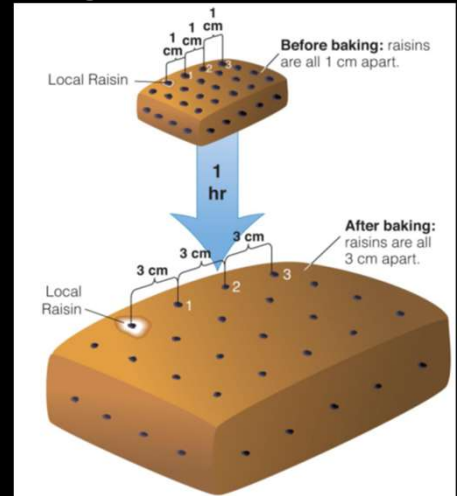
It takes: 8 minutes to reach us from the Sun
8 years to reach us from the star Sirius (8 light-years away)
1,500 years to reach us from the Orion Nebula

The farther out we look into the Universe, the farther back in time we see!

However, we see them at them "as they were" this far back in time.

A galaxy 12 billion light-years away may have traveled 12 billion light years

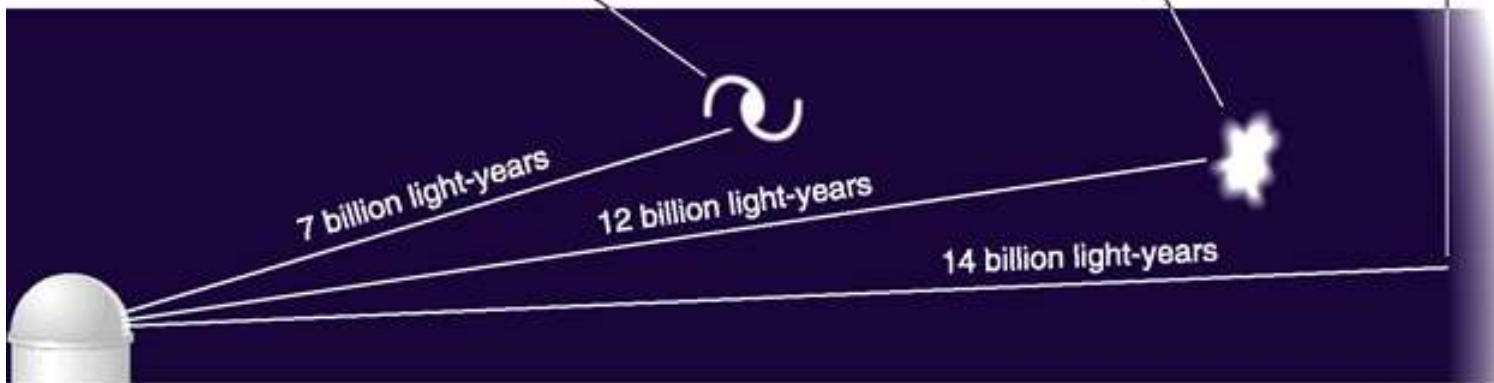
The Universe is also expanding (which we will get to later)!



We see this galaxy as it was 7 billion years ago, when the universe was only about half its current age.

We see this galaxy as it was 12 billion years ago—so if the universe is 14 billion years old today, we are seeing this galaxy as it looked when the universe was only 2 billion years old.

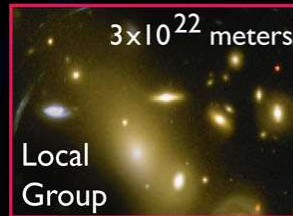
Light from this distance shows us how the universe looked very shortly after the Big Bang.



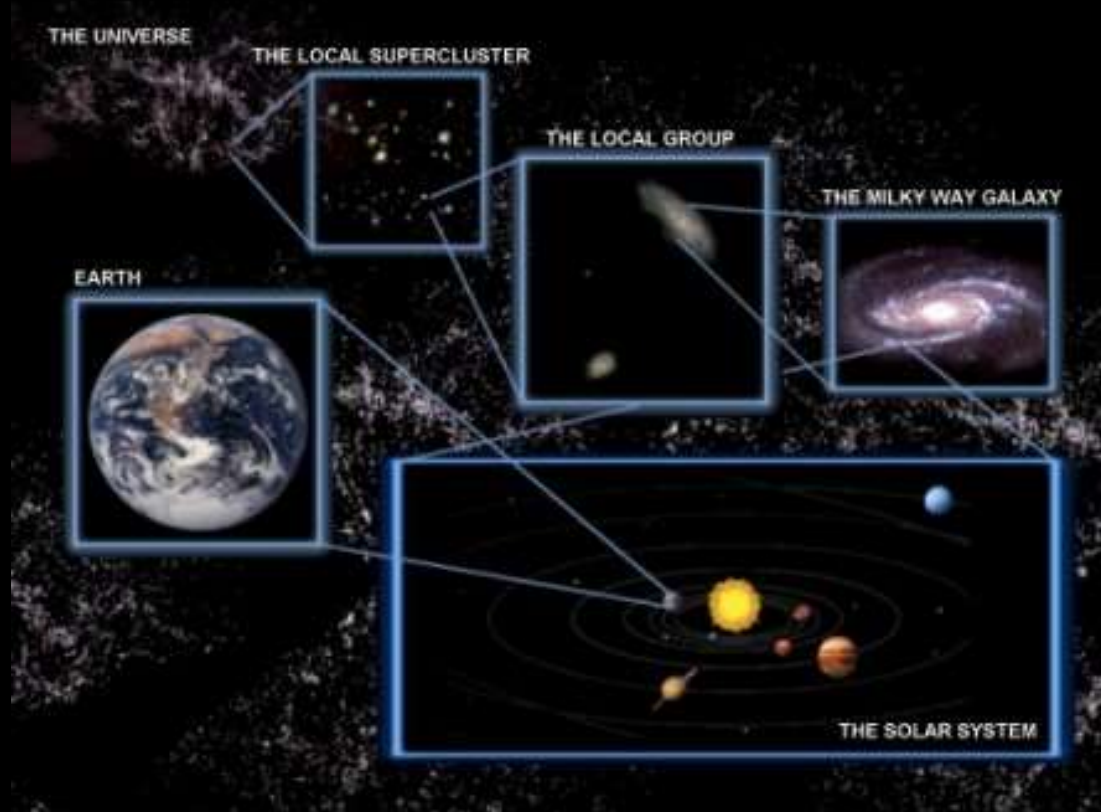
If the universe is 14 billion years old and we try to look to a distance of, say, 15 billion light-years, we are trying to look to a time before the universe existed—which means we cannot see anything at this distance, even in principle.

Our Cosmic Address

Our sun is one of 400 billion stars in the Milky Way galaxy, which is one of more than 100 billion galaxies in the visible universe.



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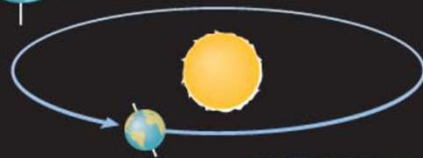


Spaceship Earth

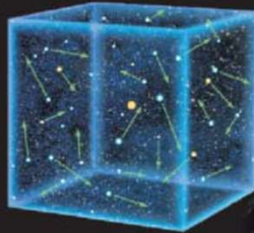
<https://www.youtube.com/watch?v=ucLYUYDhg0s> for a visualization...



Earth rotates around its axis once each day, carrying people in most parts of the world around the axis at more than 1000 km/hr.



Earth orbits the Sun once each year, moving at more than 100,000 km/hr.



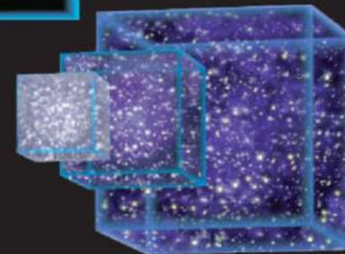
The Solar System moves relative to nearby stars, typically at a speed of 70,000 km/hr.



The Milky Way Galaxy rotates, carrying our Sun around its center once every 230 million years, at a speed of about 800,000 km/hr.



Our galaxy moves relative to others in the Local Group; we are traveling toward the Andromeda Galaxy at about 300,000 km/hr.



The universe expands. The more distant an object, the faster it moves away from us; the most distant galaxies are receding from us at speeds close to the speed of light.

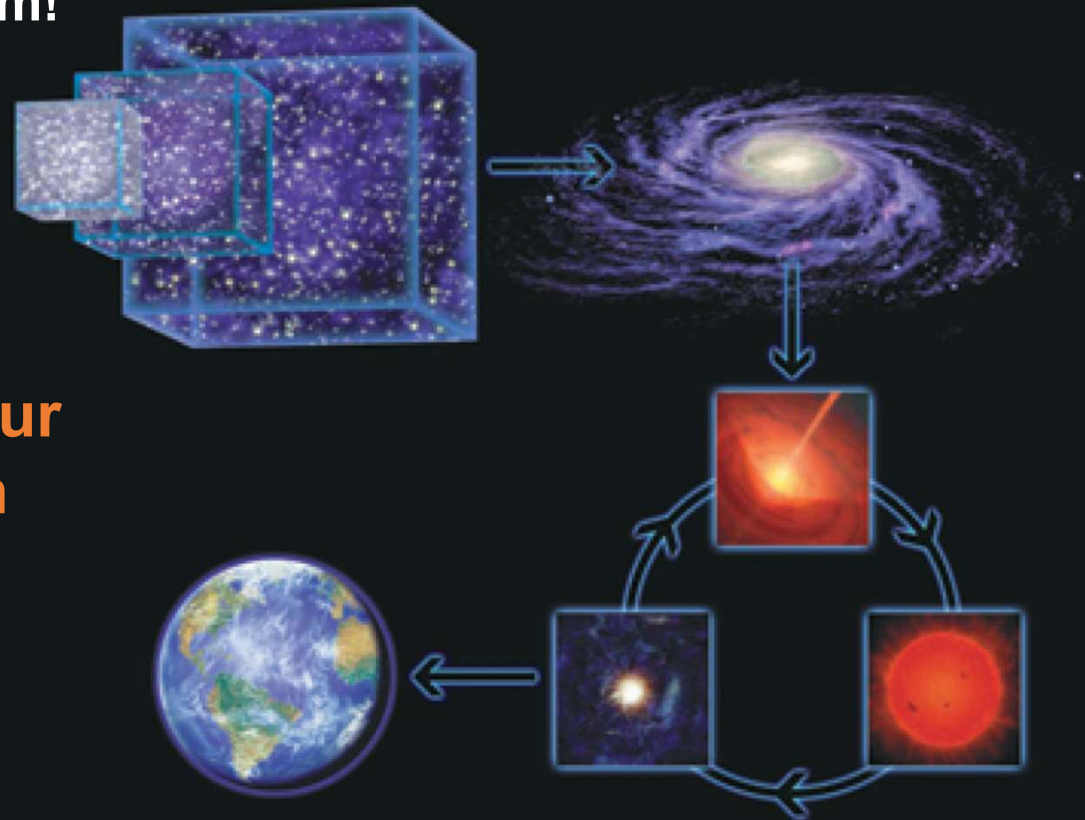
We Are Made of Star-Stuff!

Only the simplest atoms were created during the Big Bang (mostly Hydrogen and Helium)

More complex atoms were created in stars.

When the star dies, they are expelled into space....

new stars and planets form!



Most of the atoms in our bodies were created in the core of a star!

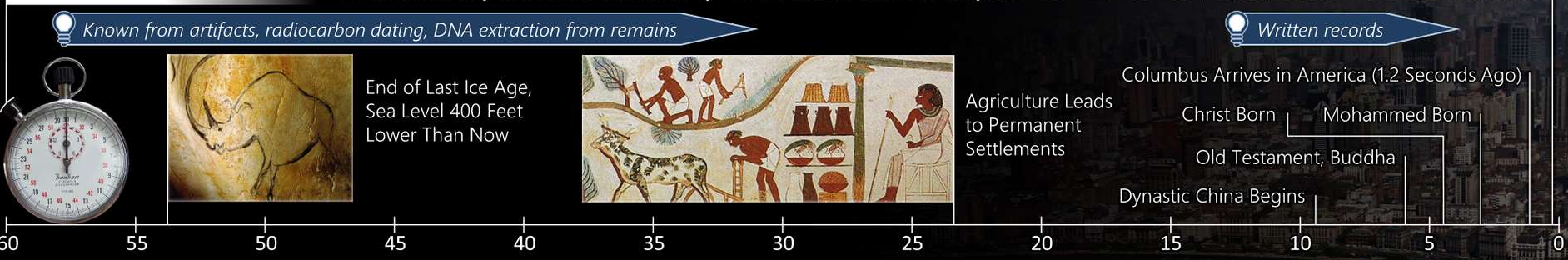
The Cosmic Calendar

The 13.8 billion year history of the universe scaled down to a single year, where the Big Bang is January 1st at midnight, and right now is midnight 1 year later

January	February	March	April	May	June	July	August	September	October	November	December
Known from telescopes looking back in time, physical models					Known from geologic record, fossils, genetic drift						
The Big Bang, Stars First Appear				Thin Disk of the Milky Way				The Solar System, Life	Oxygen from Photosynthesis	Eukaryotic Cells	Multicellular Life

The Month of December...															
1	2	3	4	5	6	7	8	9	10	11	12	13	14		
15 Trace Fossils Only		16		17 Bones and Shells		18 Vertebrates		19 Land Plants		20 Fish with Jaws		21 Insects			
22 Amphibians		23 Reptiles		24 Pangaea Forms		25 Dinosaurs		26 Mammals		27 Birds		28 Flowers			
29 Tyrannosaurids		30 Dinosaurs Extinct, Mammals Take Over on Land and in Sea		31 The Final Day...											
				Dawn: Apes and Monkeys Split		8 PM: Humans and Chimpanzees Split		9:25: Humans First Walk Upright		10:30: Human Brain Size Begins Tripling		11:52: Modern Humans Evolve		11:56 to 11:59: Human Migration	

The Final Minute... A human life only lasts for the blink of an eye on the Cosmic Calendar: $100 \text{ years} * 365 * 24 * 60 * 60 / 13,800,000,000 = 0.23 \text{ Cosmic Seconds}$



Some Good Videos on the Scale of the Universe

- The Scale of the Universe 2, 3:23

<https://www.youtube.com/watch?v=uaGEjrADGPA>

- Size comparison of the Universe 2017, 13:36

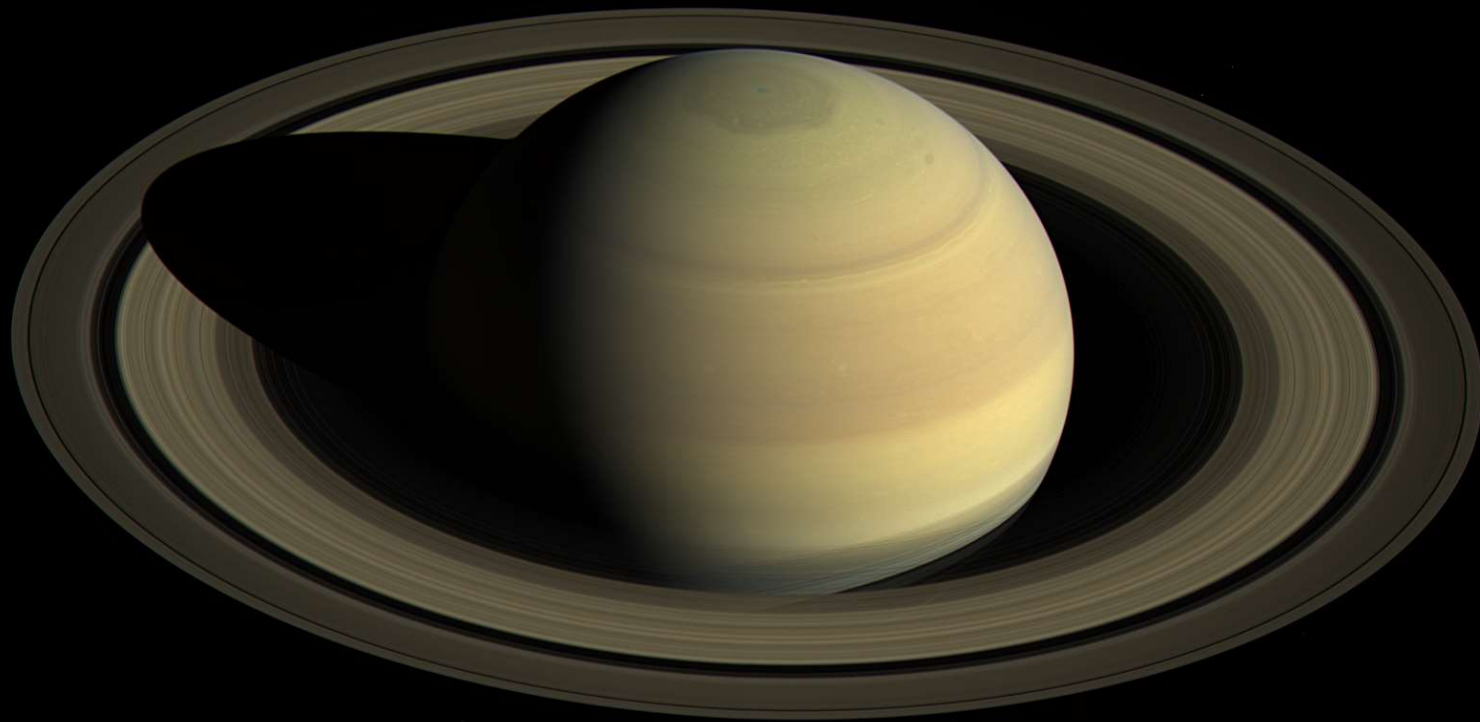
<https://www.youtube.com/watch?v=kliJZINJFiw>

- Universe Size Comparison 3D, 5:07

<https://www.youtube.com/watch?v=i93Z7zljQ7I>

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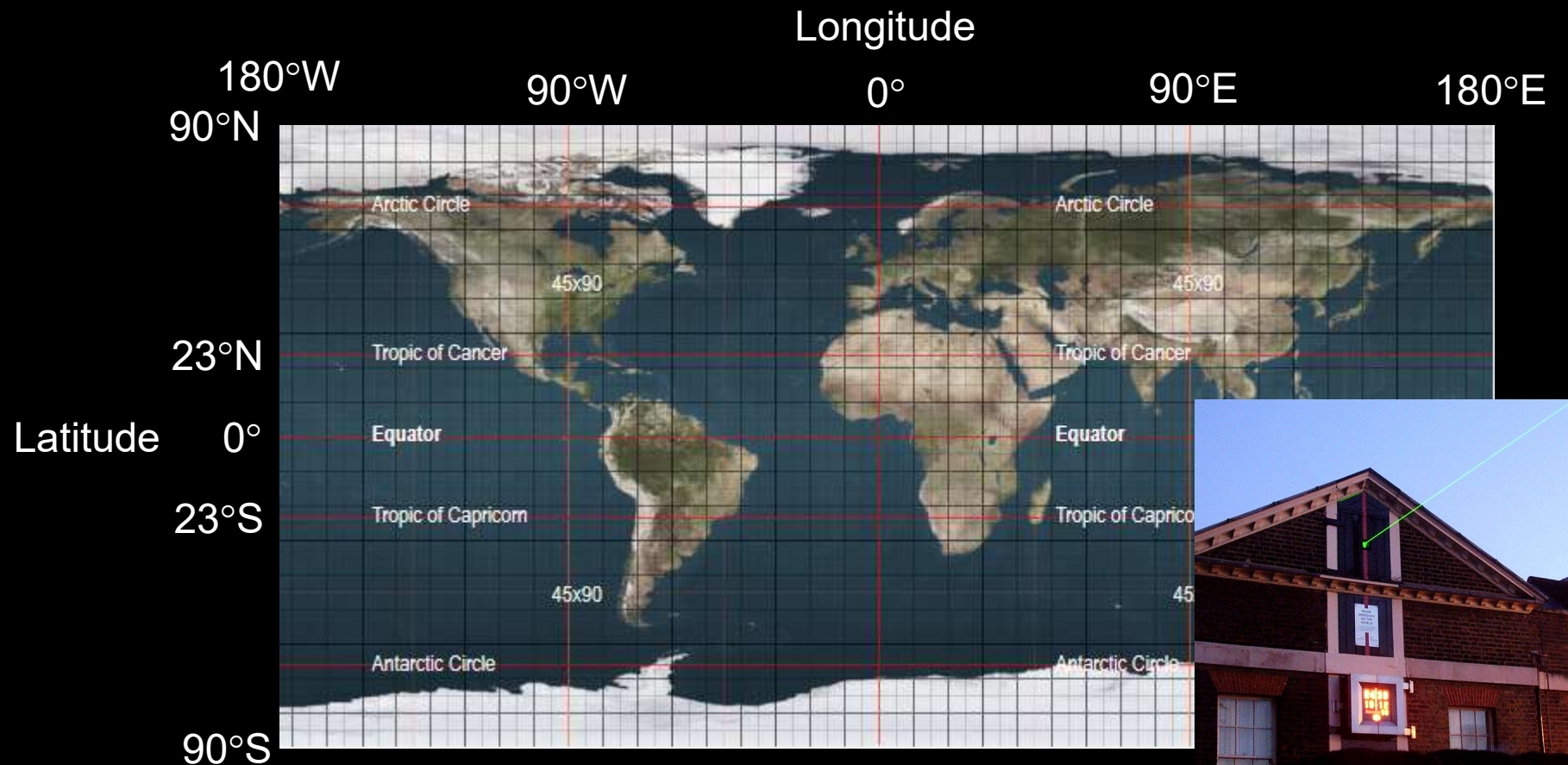
Introduction to Astronomy



[Next Chapter](#)

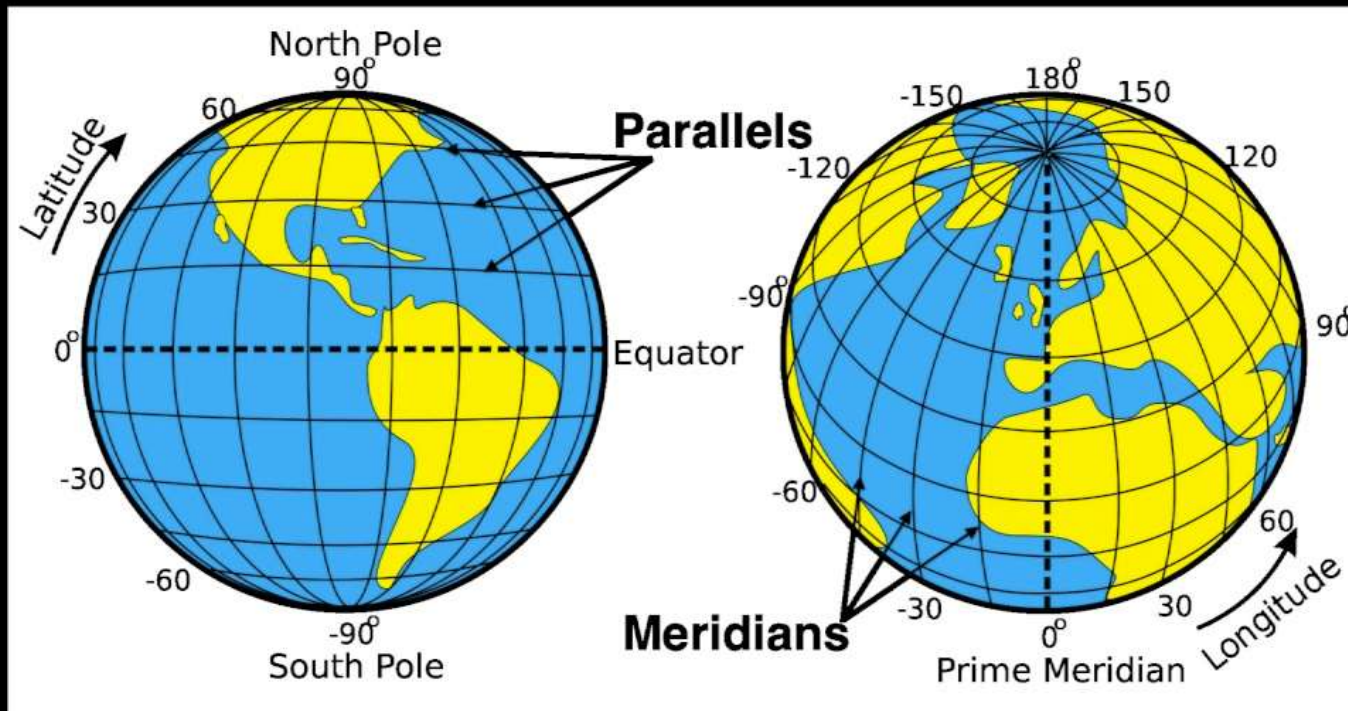
Longitude and Latitude on a Map

How is this projected onto a sphere?



**0° longitude is defined as the prime meridian
(Greenwich meridian – royal observatory, UK)**

Longitude and Latitude on a Sphere



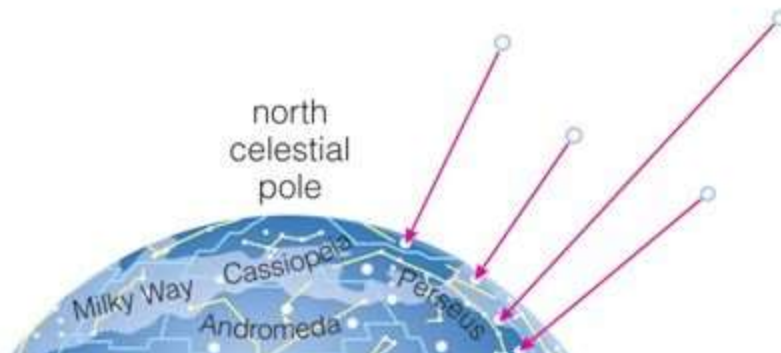
What happens at the same longitude?



Same night sky

What happens at the same latitude?

The Celestial Sphere



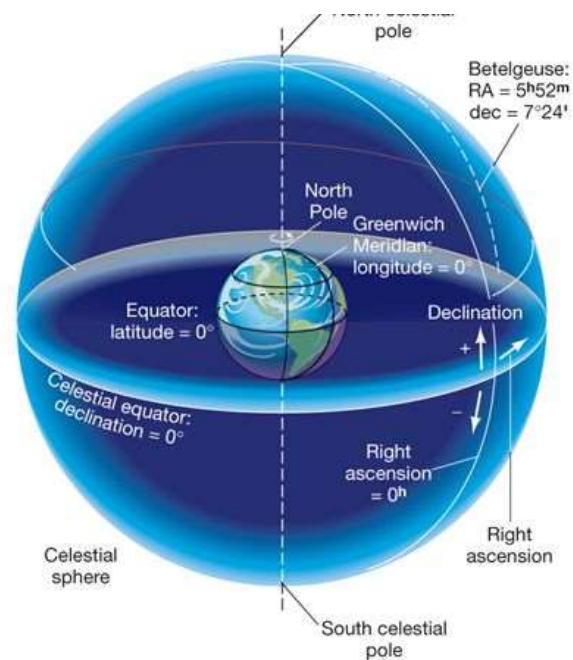
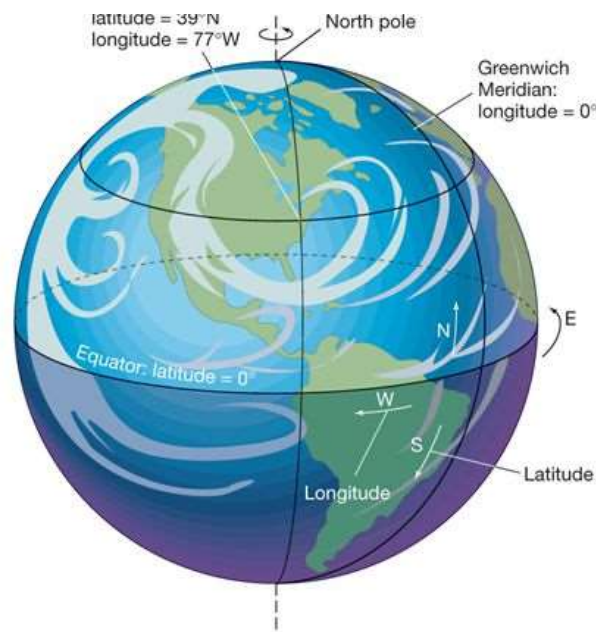
Stars at different distances all appear to lie on the celestial



Describing Positions on the Celestial Sphere

Declination: Degrees north or south of celestial equator (*cf. Latitude*)

Right Ascension: Measured eastward position from the 0° (given in degrees, or hours and minutes). 0° is defined as the position of the Sun at *Vernal equinox* (*cf. longitude*)



Earth Rotates East (Anti-clockwise)

<https://www.youtube.com/watch?v=GI3rBwqWDbw>

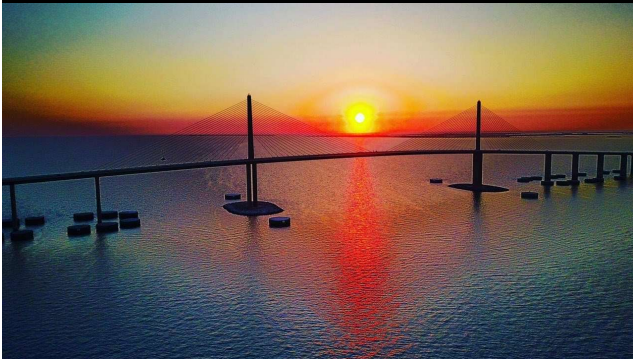


The Sun always rises in the East

Earth is Rotating
Towards the EAST



Sunshine Skyline Bridge, Tampa



The Sun always sets in the West

At the equator, at equinox

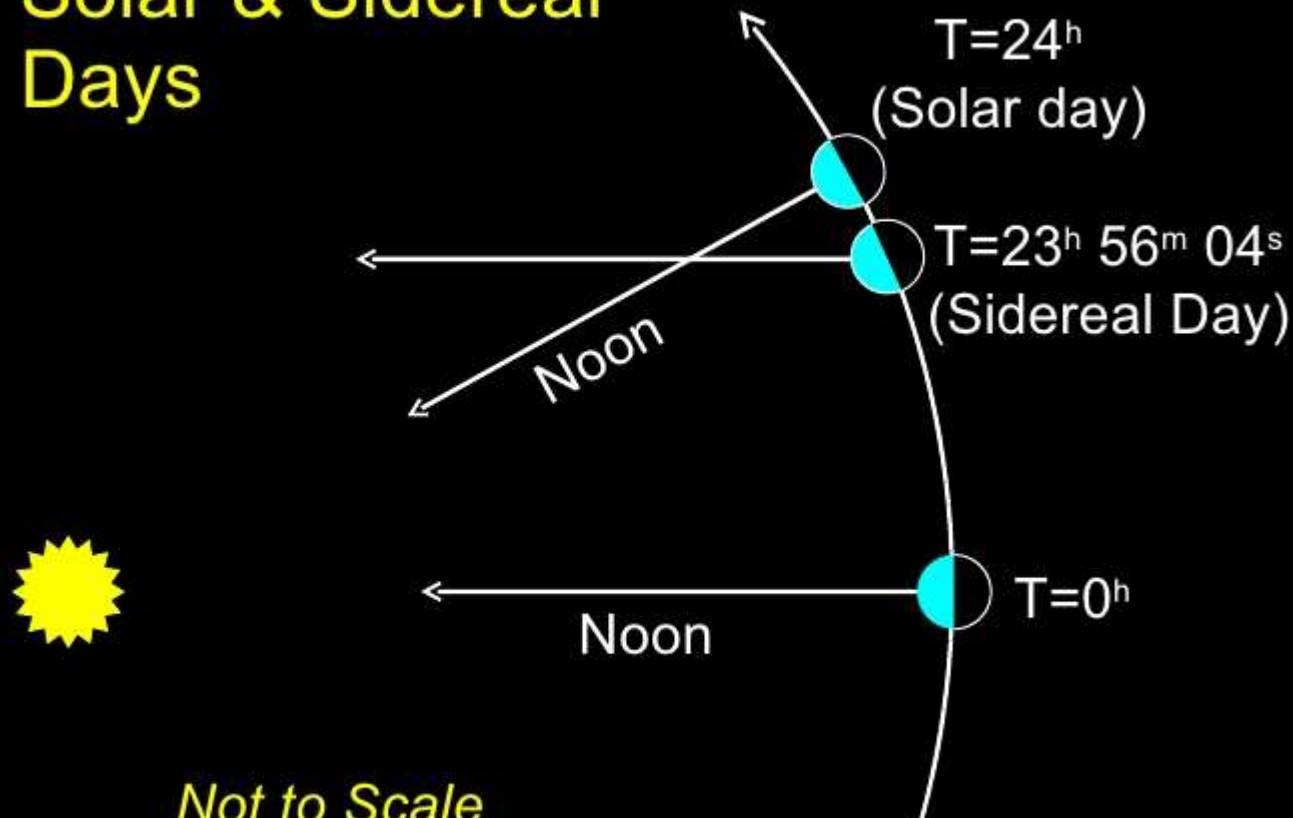
sunrise at ~6am, sun is directly overhead at ~12pm, sunset at ~6pm



Kennedy Space Center

Solar Day versus Sidereal Day

Solar & Sidereal Days



What Are the Constellations?

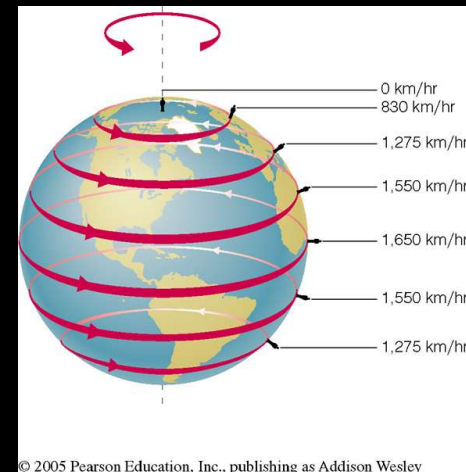
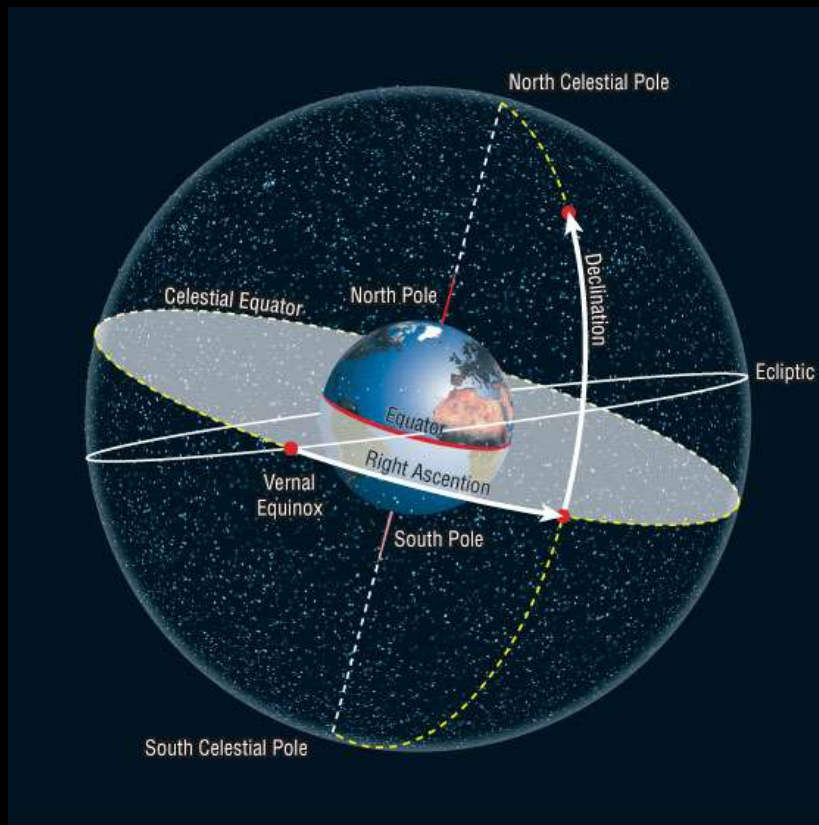


The Earth is Tilted 23.5°

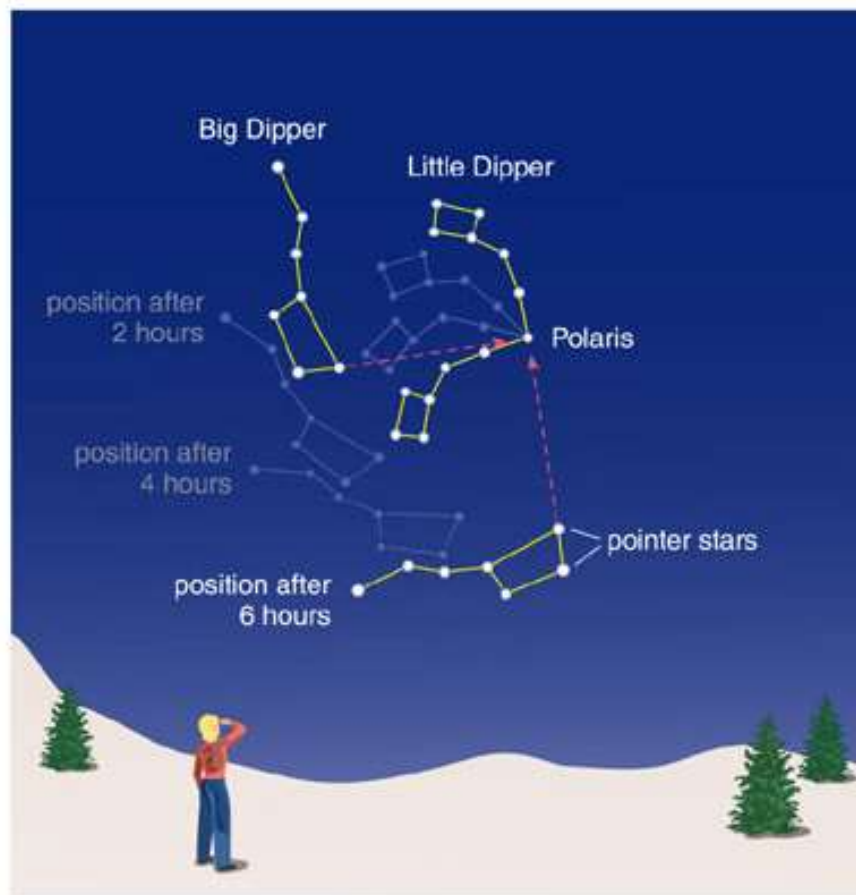
The Earth rotates around the **equator**

The Earth rotates around the Sun in the **Ecliptic plane**

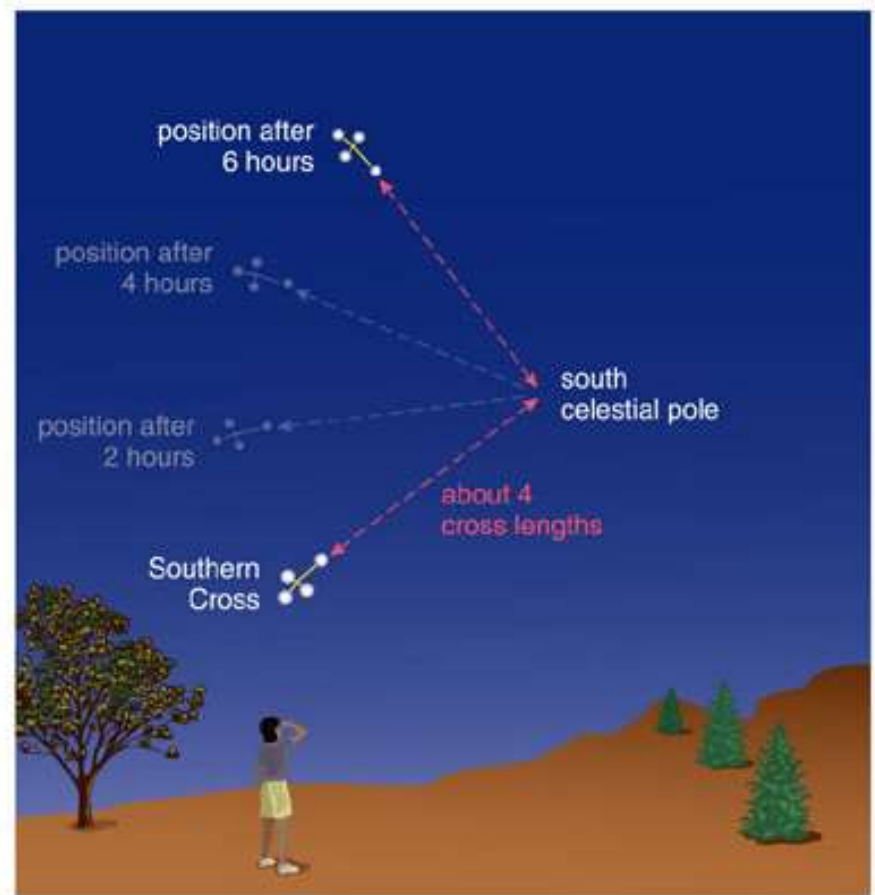
Some places on Earth are moving more than others...



North & South Celestial poles are ~Fixed (*precession slowly changes this*) *North and South rotate in opposite directions*



looking northward



looking southward



Star trails – 15 degrees ~ 1 hour.

created with Advanced Stacker PLUS
StarCircleAcademy.com

Steven Christenson
StarCircleAcademy.com

How long was this exposure for?

Samsung NX100 | -s | ISO 400

Samsung 12-24mm f/4-5.6 ED | 12 mm | f/4.0



Circumpolar stars are stars near the celestial poles

iClicker2's that Need to be Registered with Webcourses

- #91E2A2D1
- #9919D454
- #9D8F3A28
- #9D8F697B
- #A14D678B
- #A42C9810
- #A52CDA53
- #A6B56A79
- #A6C1D9BE
- #A7128035
- #A7B51C0E
- #A9F76739
- #AA9B7849
- #AAAA9797
- #AC174FF4

