

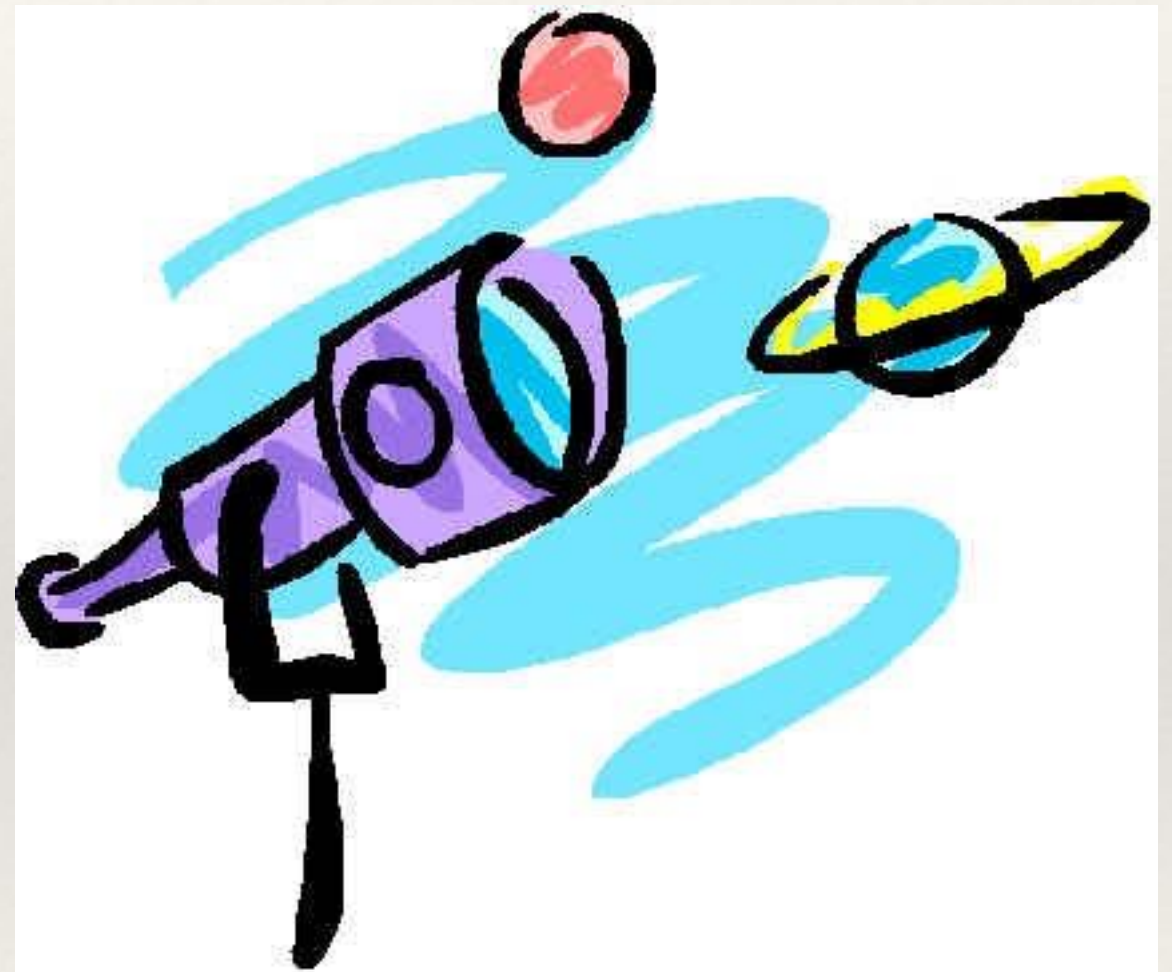


*“Astronomy is more
than a spectator sport”*

Tim Ewbank
18th April 2017

Course Objectives

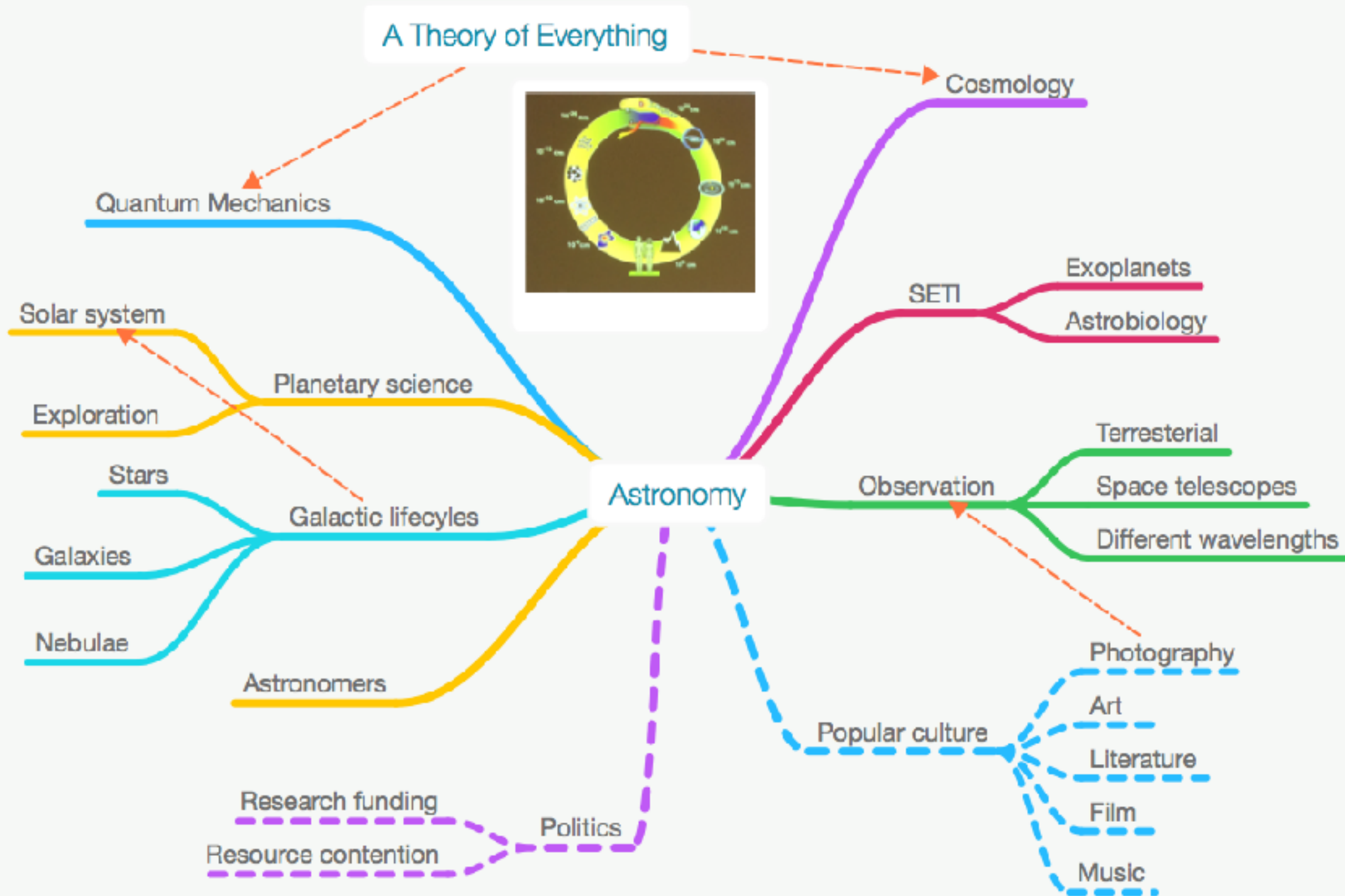
- ❖ Present a *wide-angle* view of astronomy
- ❖ Stimulate your interest in some new area of astronomy
- ❖ Encourage your participation
- ❖ Share sources and experience
- ❖ Learn from each other



My image of the course....



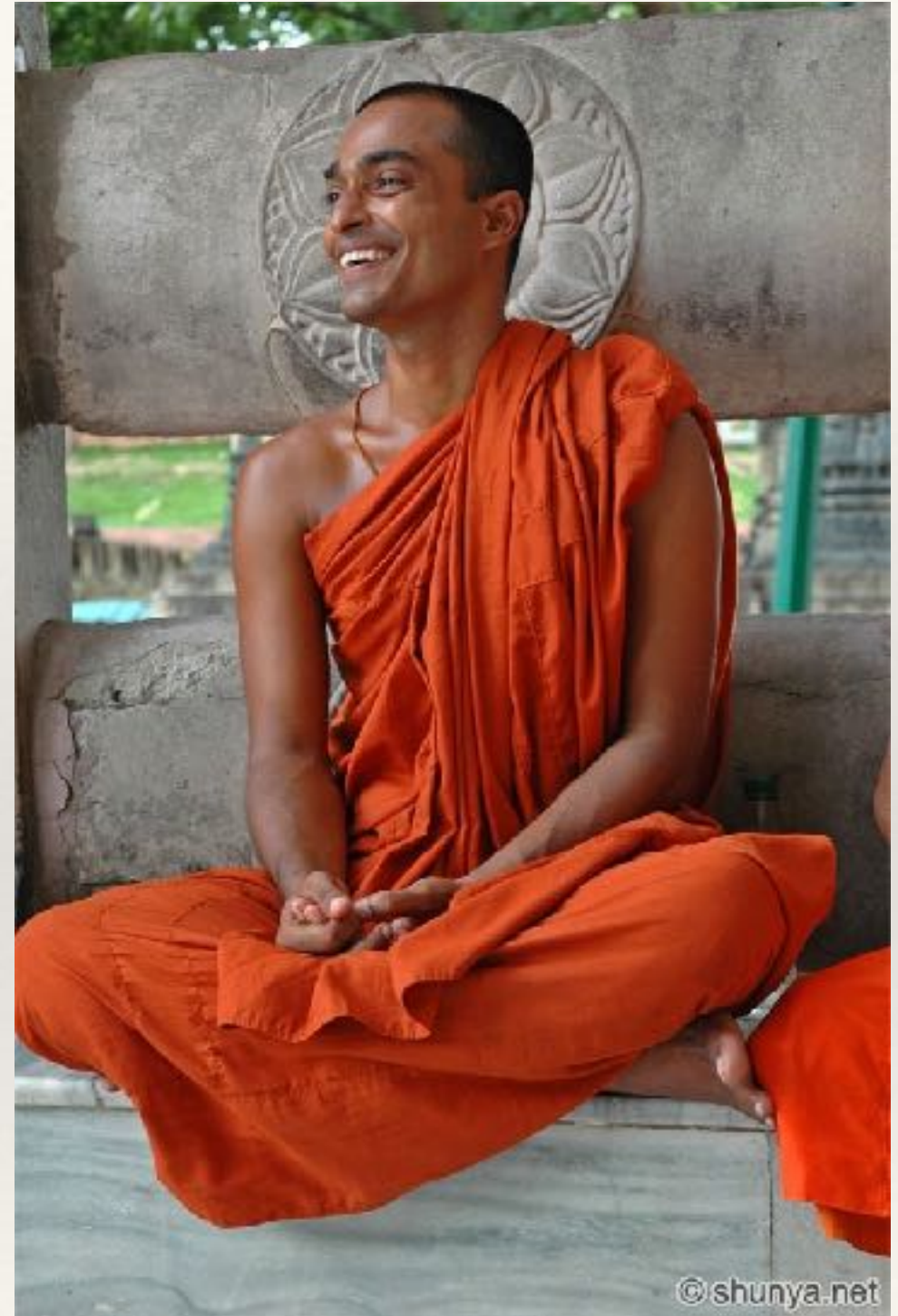
A Wide Angle View of Astronomy



Guiding Principle

*“To know where we’re going,
we have to know where we are.
To know that, we have to know where we
came from & how we got here”*

Ancient proverb



Course Overview

- Today: “where we are”
- 25 April: “how we got here”
- 2 May: “where we’re going”
- 9 May: Observing (D Jones)
- 16 May: Ways of engaging



Rules of Engagement

- My knowledge is strictly finite
- Questions at any & all times
- Encourage participation
- The more you participate, the more you will enjoy the course
- Feedback welcome, in any form



The Challenge of Scale in Astronomy

“Space is big. You won’t believe how vastly, hugely, mind-bogglingly big it is”
 Douglas Adams, *The Hitchhiker's Guide to the Galaxy*

Units	Description	Measure	Notation
Kilometre		10^3 metres	Km
Astronomical Unit	mean earth - sun distance	149.5×10^6 km	AU
Light years	distance travelled by light over one year	9.46×10^{12} km 63,240 AU	l.y.
Parsec	distance equivalent to 1 second of arc	30.86×10^{12} km 206×10^3 AU 3.26 l.y.	pc
KiloParsecs	thousand parsecs	10^3 pc	Kpc
MegaParsecs	million parsecs	10^6 pc	Mpc

“Where we are”

Our place in space

“On a rocky planet, circulating a small, mature star, in the outer suburbs of medium sized spiral galaxy, called The The Milky Way”

Simon Singh

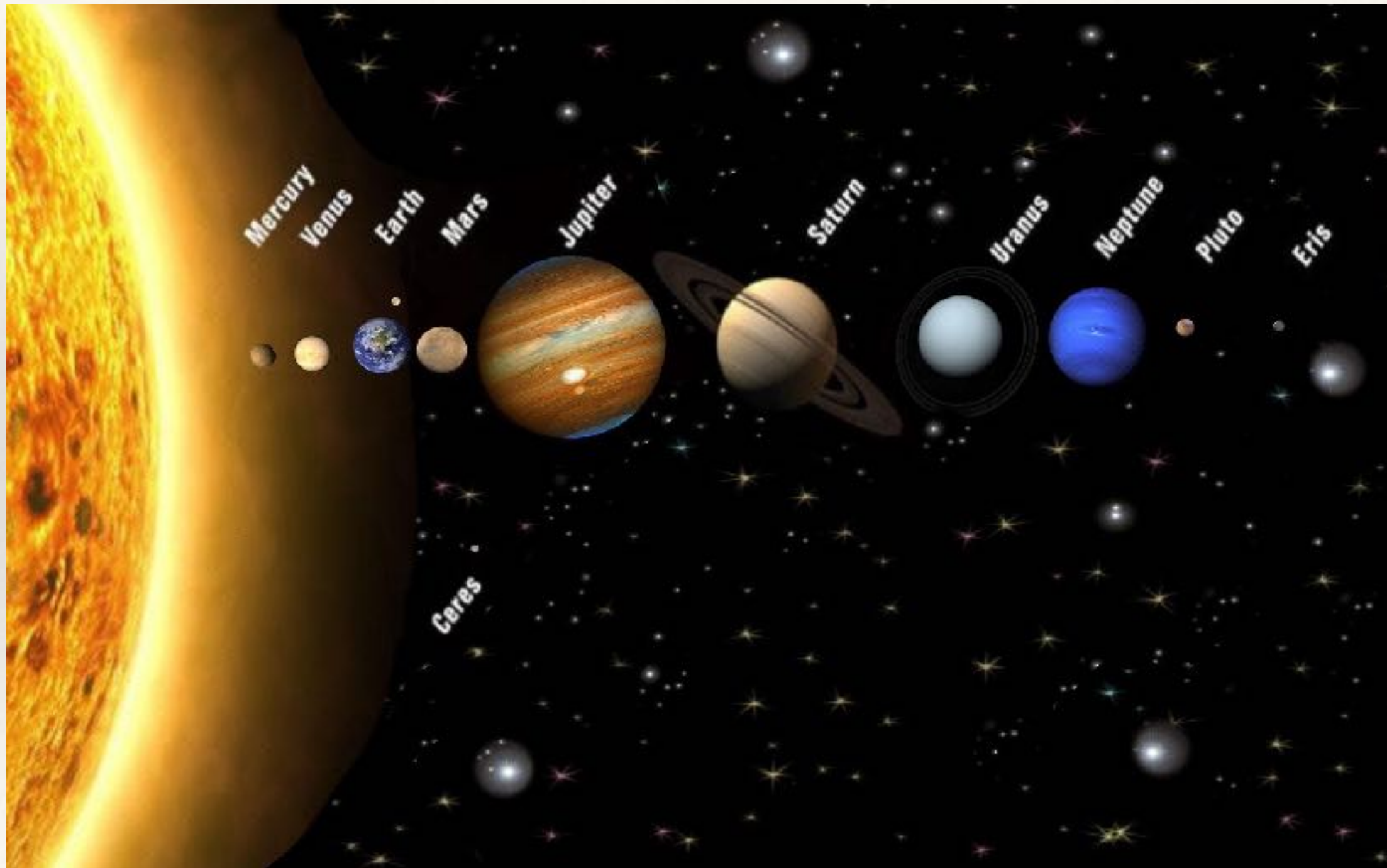
“Earth Rise”



NASA 1969

Our Solar System

My
Very
Excellent
Mother
Just
Served
Us
Nine
(Pluto)

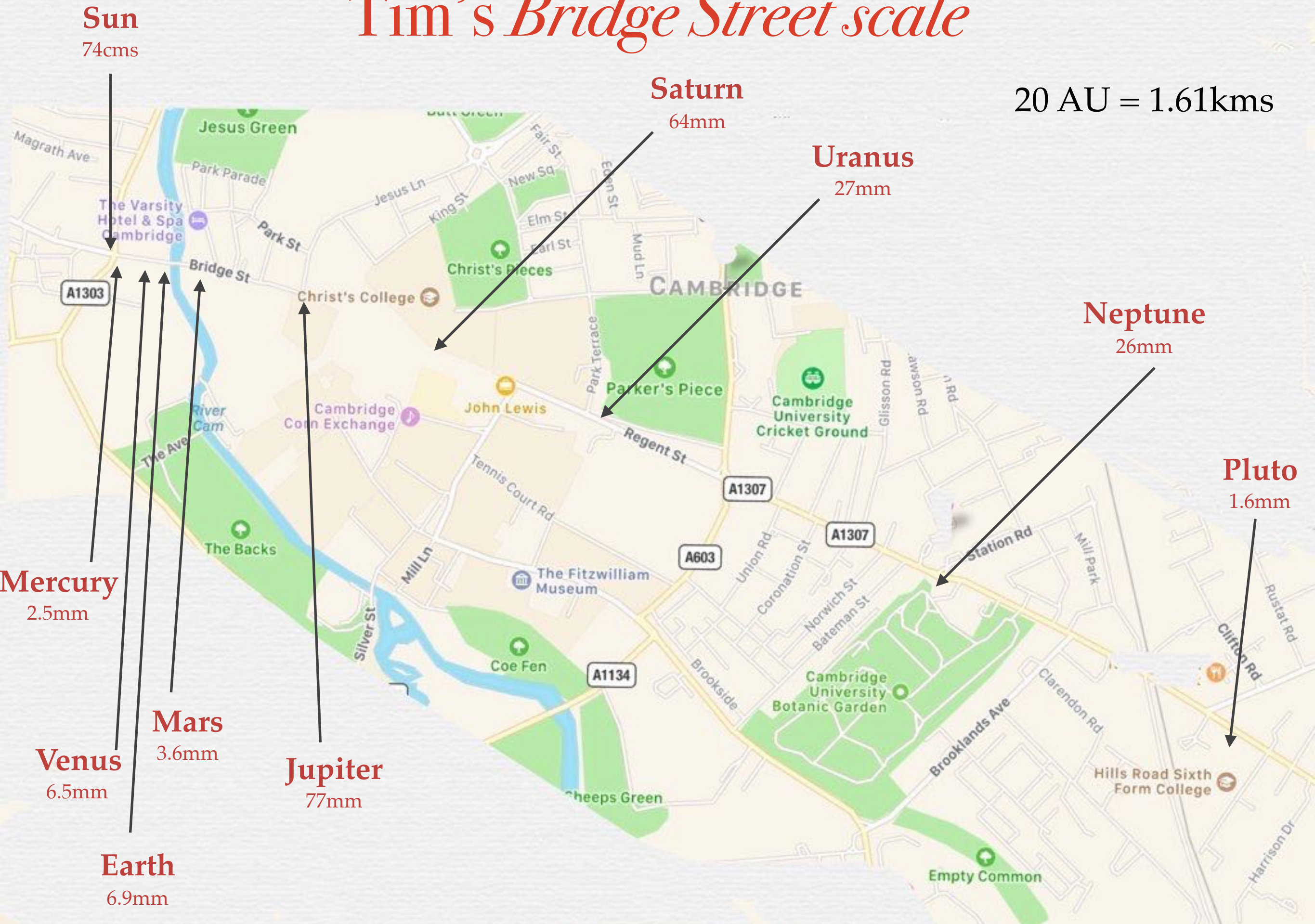


Planets in Our Solar System

Planet	Diameter (kms)	Distance from sun (AUs)	Moons	Orbit Period
Mercury	4,879	0.39	0	88 days
Venus	12,104	0.72	0	225 days
Earth	12,756	1.00	1	365.25 days
Mars	6,794	1.52	2	1.88 yrs
Jupiter	142,984	5.20	67	11.86 yrs
Saturn	120,536	9.57	62	29.37 yrs
Uranus	51,118	19.19	27	84.09 yrs
Neptune	49,528	30.07	13	164.9 yrs

Tim's Bridge Street scale

20 AU = 1.61kms



Recent news of Planet Nine

- “Caltech researchers *have found evidence of* a giant planet tracing a bizarre, highly elongated orbit in the outer solar system”

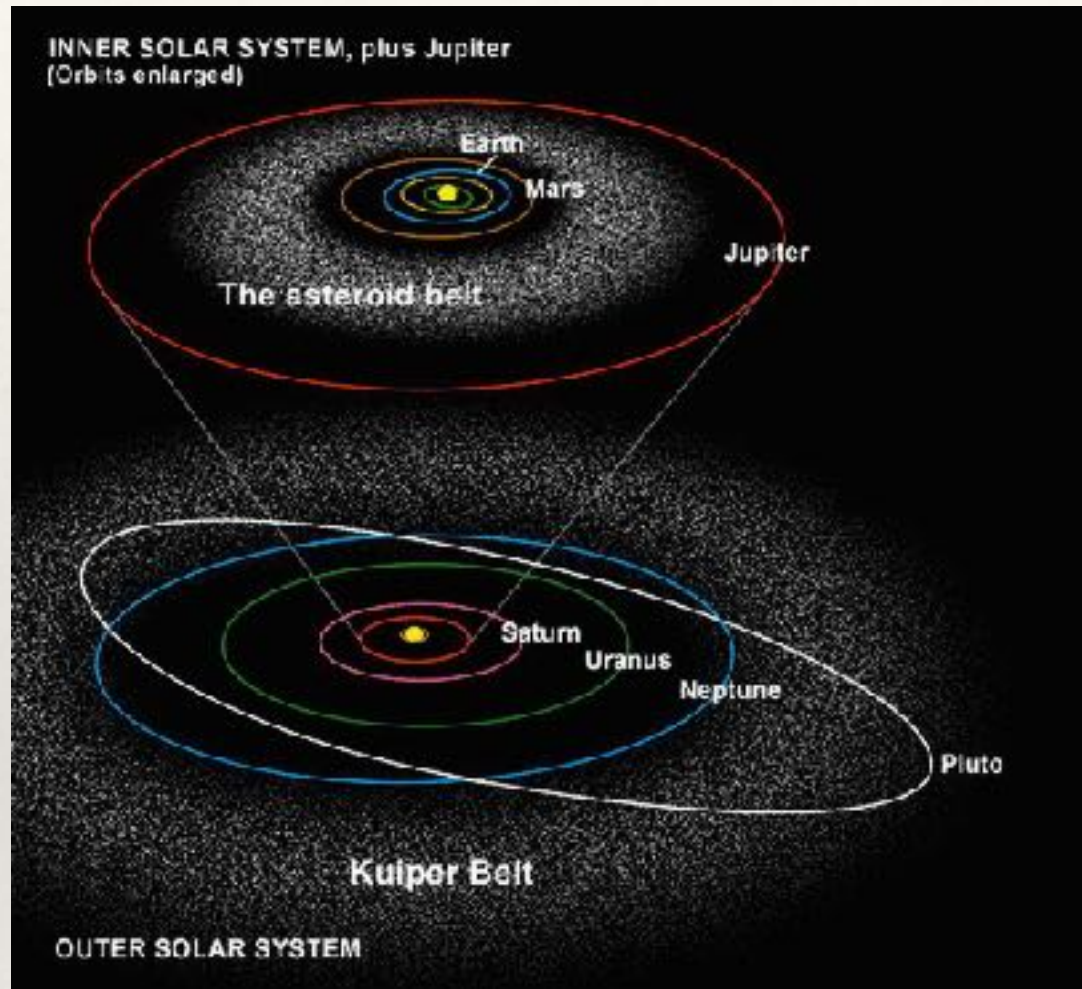
Caltech 21 January 2016

- mass about 10 times size of Earth
- orbits about 20 times further from the sun than Neptune (600AUs)
- (would be at Stansted on *Bridge St scale*)
- 10^4 - 2×10^4 years to orbit around the sun.

Dwarf Planets in Our Solar System

Dwarf Planet	Diameter (kms)	Distance from sun (AUs)	Moons	Orbit Period (yrs)
Ceres	950	2.7	0	4.6
Pluto	2,322	39.5	5	246
Makemake	1,420	46	0	310
Haumea	1,450	44	2	283
Eris	2,326	64	1	561

Asteroid & Kuiper Belts & Oort Cloud



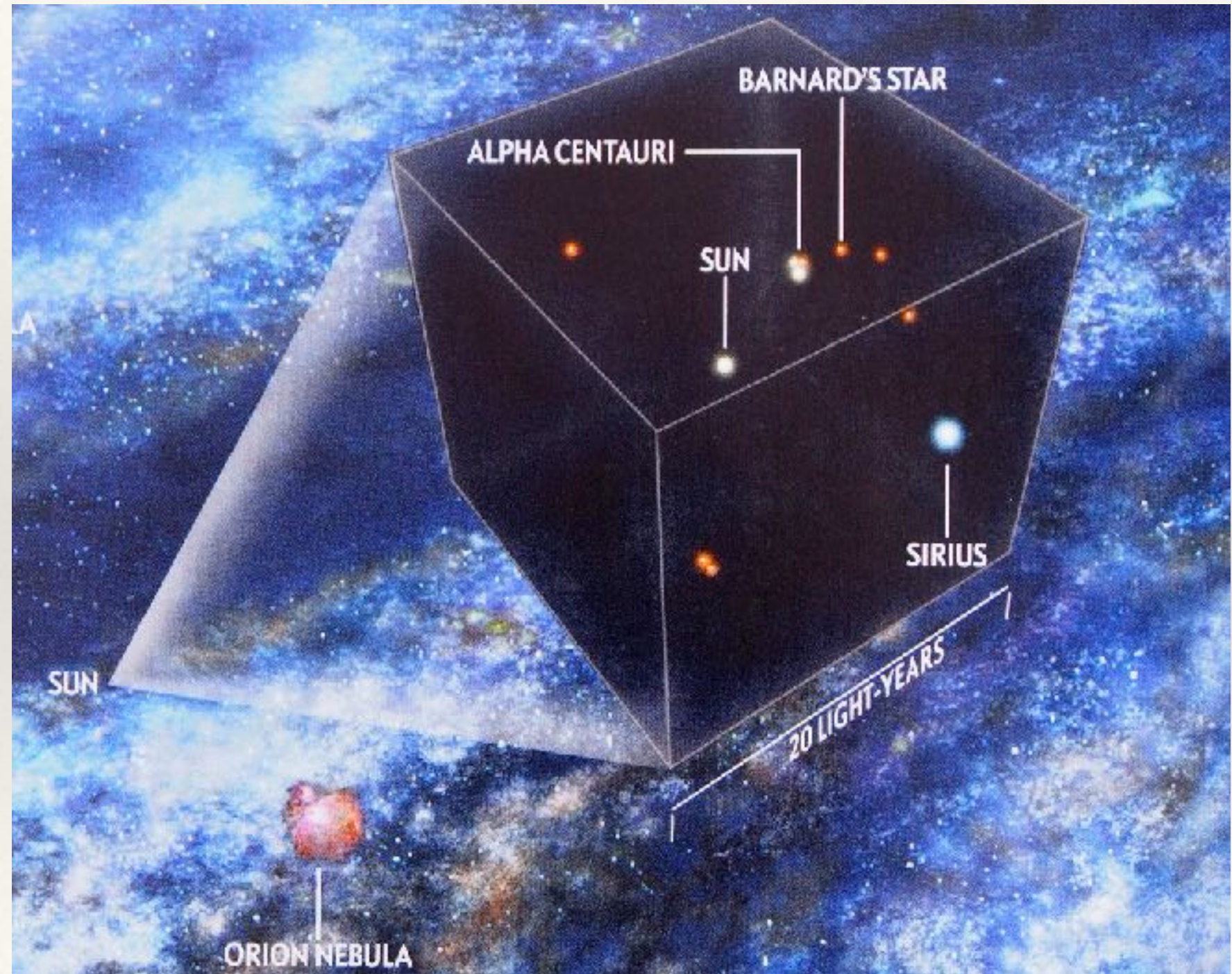
- Asteroid belt is between Earth & Jupiter
- Kuiper Belt region of icy bodies, inc. dwarf planets
Distance of 30-55 AU

- Oort Cloud is hypothesised envelope of icy debris
@ distance of $5 \times 10^3 - 10^5$ AU

Our Stellar Neighbours

Approx a dozen stars within 10 light yrs, nearest are:

- *Alpha centauri - triple star system 4.4 lyrs*
- *Bernard's star - low mass, red dwarf; 6 lyrs*
- *Sirius - brightest star in sky (-1.44) 8.6 lyr*



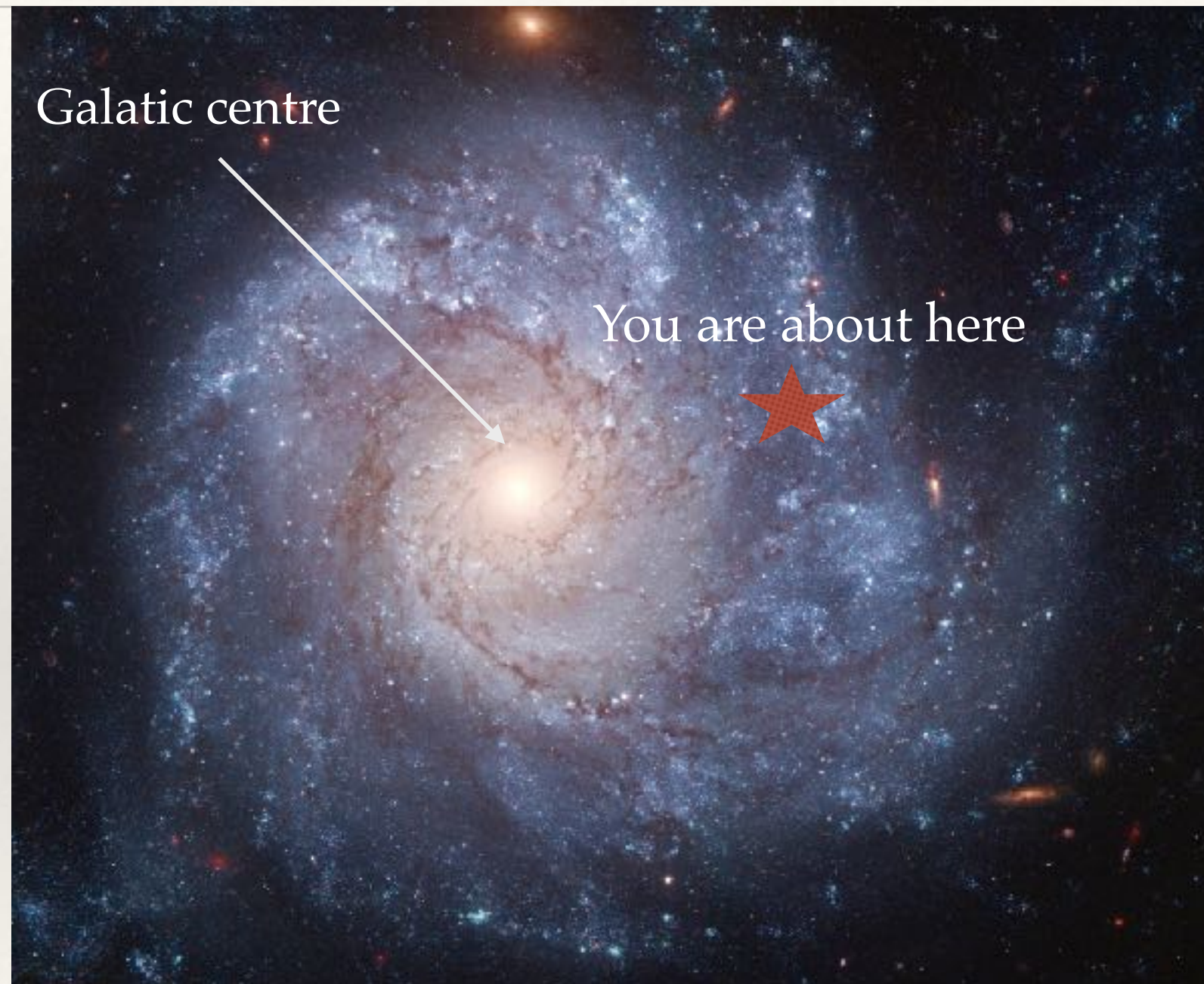
The Milky Way Galaxy

as it appears to us from earth; a belt of stars obliquely across the sky, through 30 constellations

- ❖ Massive rotating disc of stars, planets, meteors, dust and gas clouds around the gravitational attraction of a central black hole
- ❖ Contains 200 - 400 billion stars, plus 100+ billion planets
- ❖ Takes 225×10^6 years for a single rotation of the galaxy
- ❖ formed 4.8 billions years ago



Our Solar System in the Milky Way Galaxy



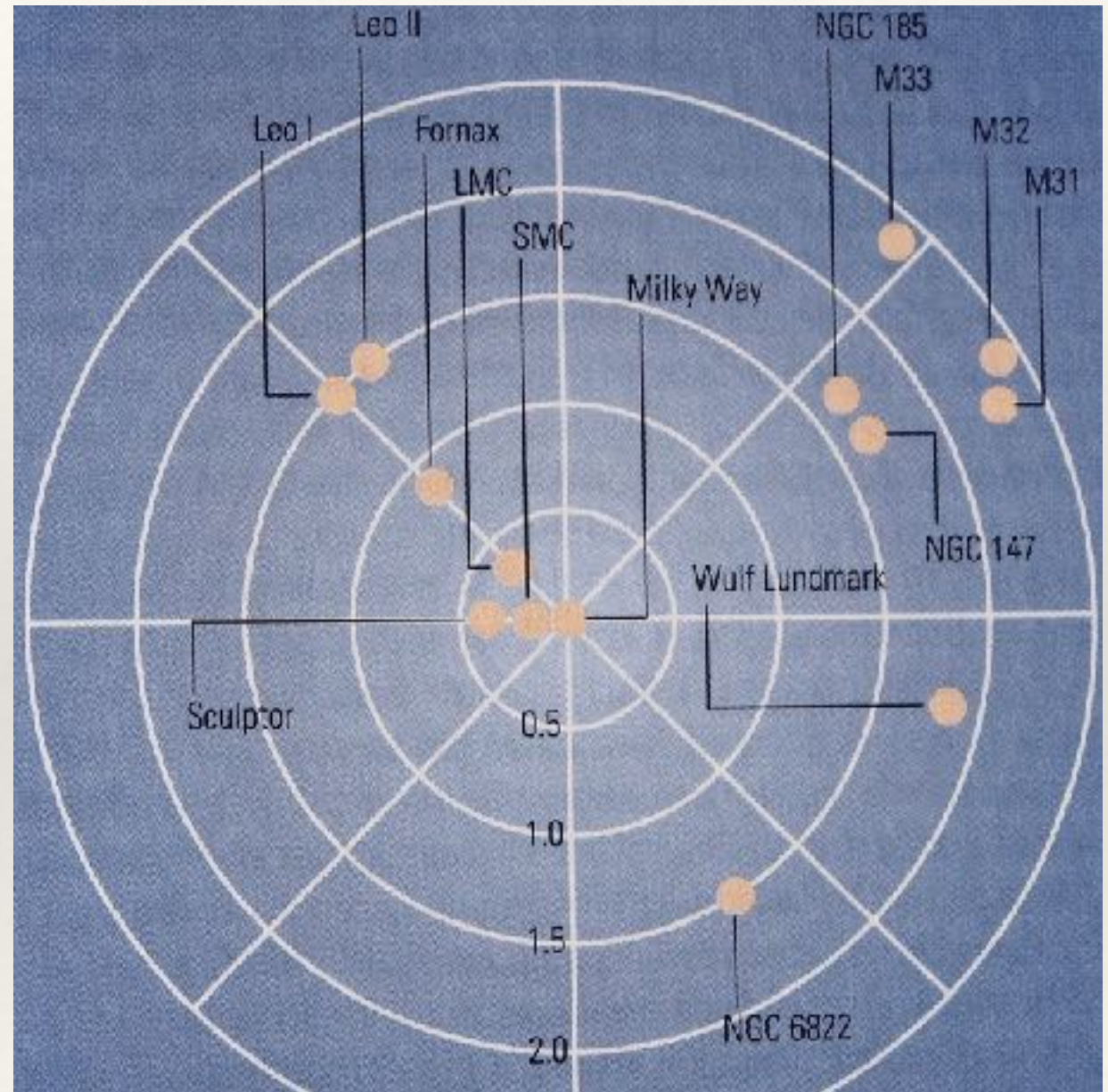
100,000 light years



33,000 lyrs

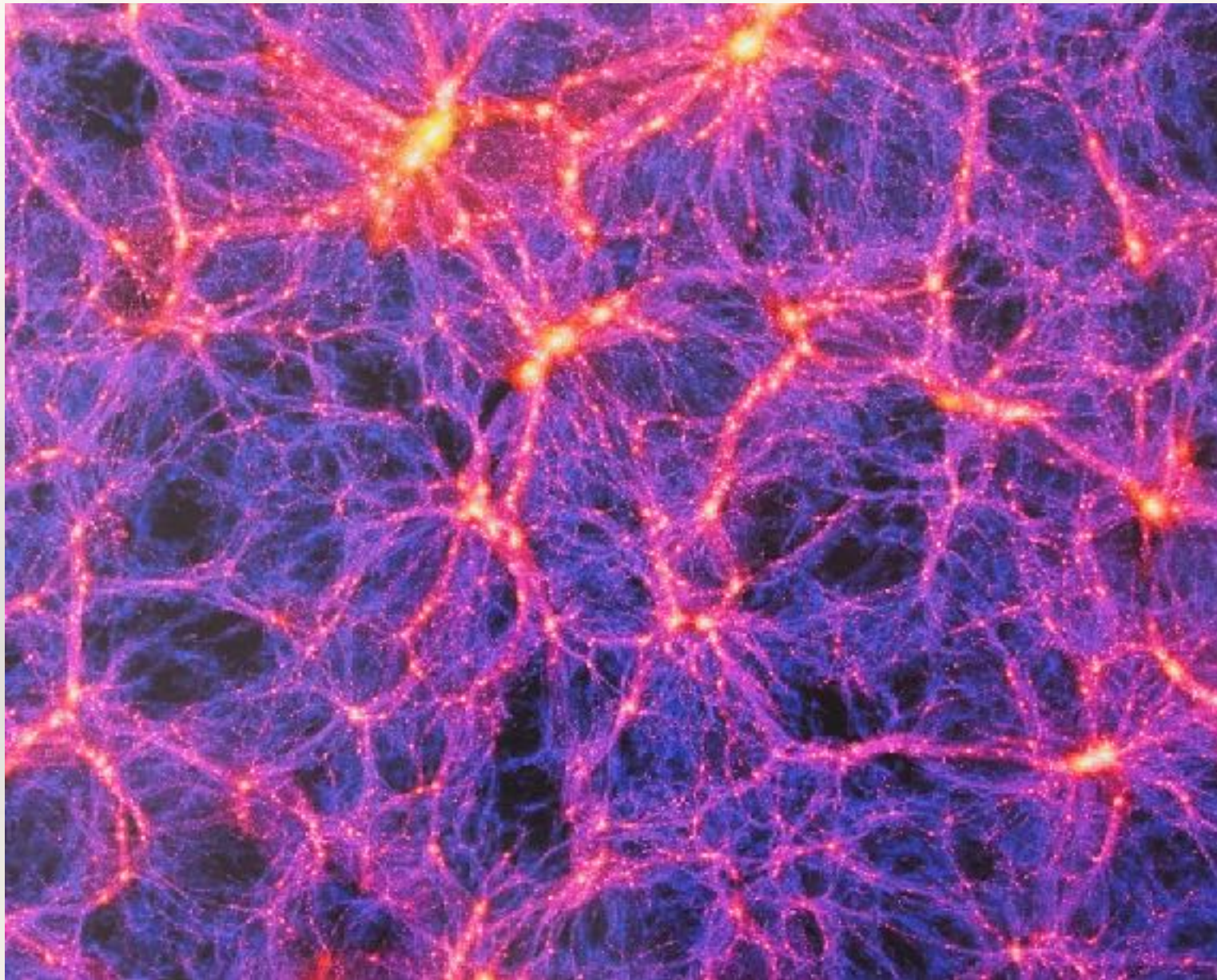
Our Galactic Neighbours

- ❖ The Local Group (of galaxies)
- ❖ approx 40 members
- ❖ Milky Way, two Magellanic Clouds, Andromeda & Triangulum
- ❖ Approx 3×10^6 l.y. across
- ❖ gravitationally bound together, so not receding from each other



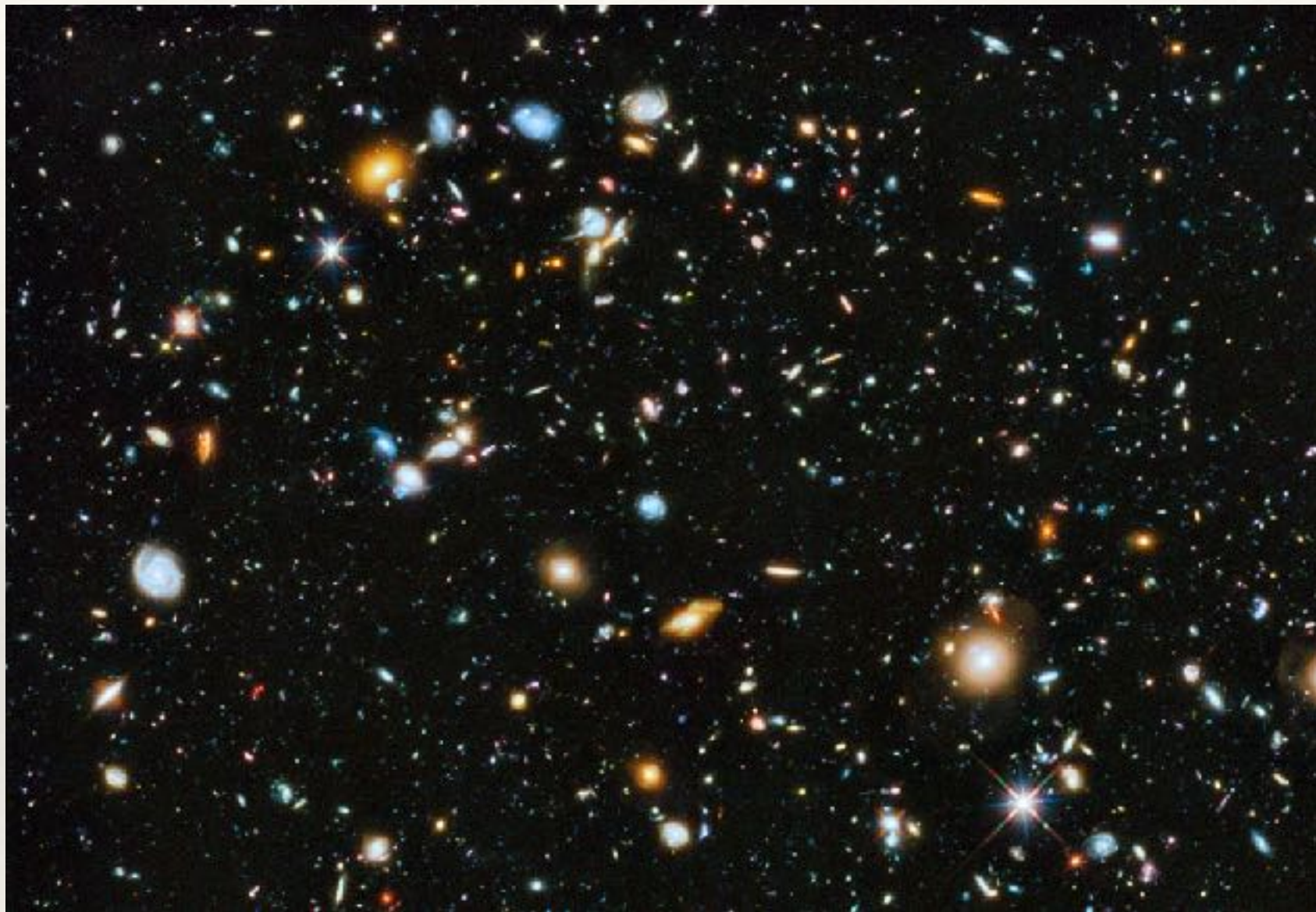
Philips "Encyclopaedia of Astronomy"

Clusters & Super Clusters



- ❖ Milky Way is part of the Virgo Cluster which is part of Local Supercluster (40-50 Mpc)

Hubble Ultra Deep Field

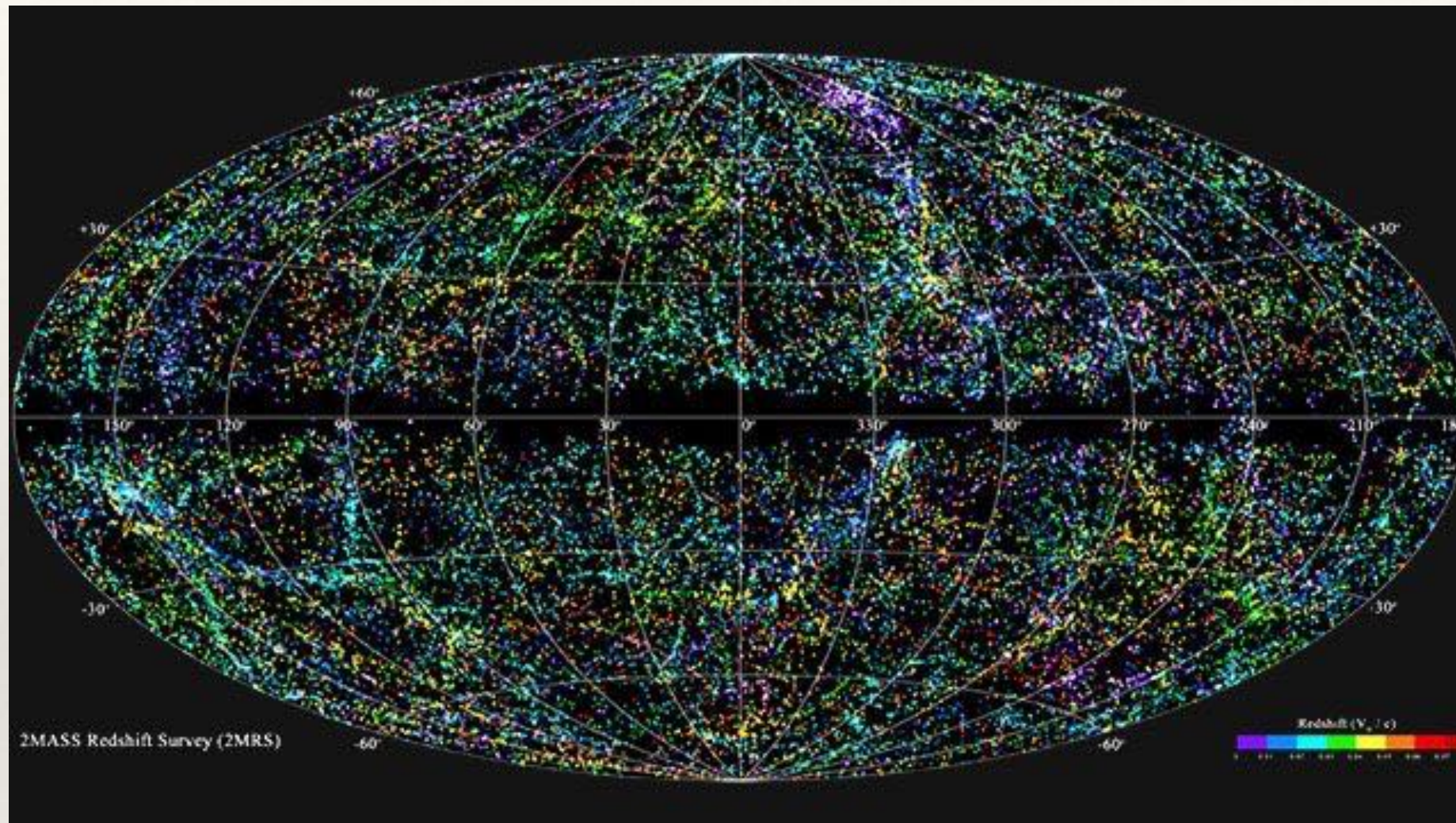


2nd HST Deep Field image

NASA 2004

Covers the entire range of wavelengths available to Hubble's cameras, from ultraviolet through visible to near-infrared. Capability of studying star formation 5 and 10 billion light-years distant.

The Large Scale Structure of the Universe



- ❖ Distribution of matter in wider space is uniform in all directions.
- ❖ Clusters of galaxies loosely held together, separated by huge areas of space
- ❖ Clusters have similar morphology to galaxies; rotating discs

“Where we are”

Our place in time

Each of us is a tiny being, permitted to ride on the outermost skin of one of the smaller planets for a few dozen trips around the local star.

Carl Sagan

“Earth Rise”



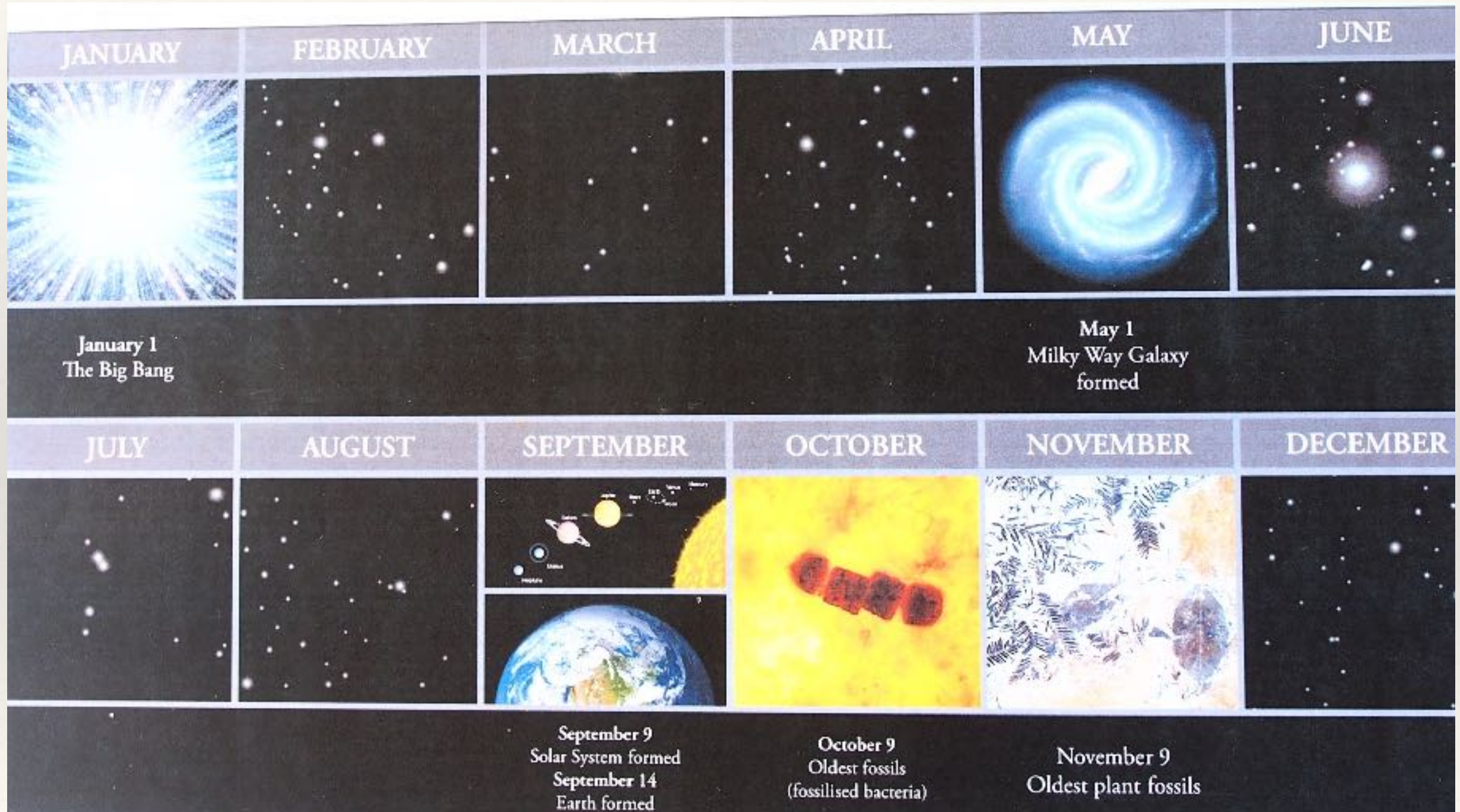
Our place in time



Hawking *The Universe in a Nutshell*

- Universe came into existence 13.7×10^9 years ago
- Milky Way galaxy formed 4.8 billion years ago
- Solar system inc earth formed at roughly the same time

The Cosmic Year

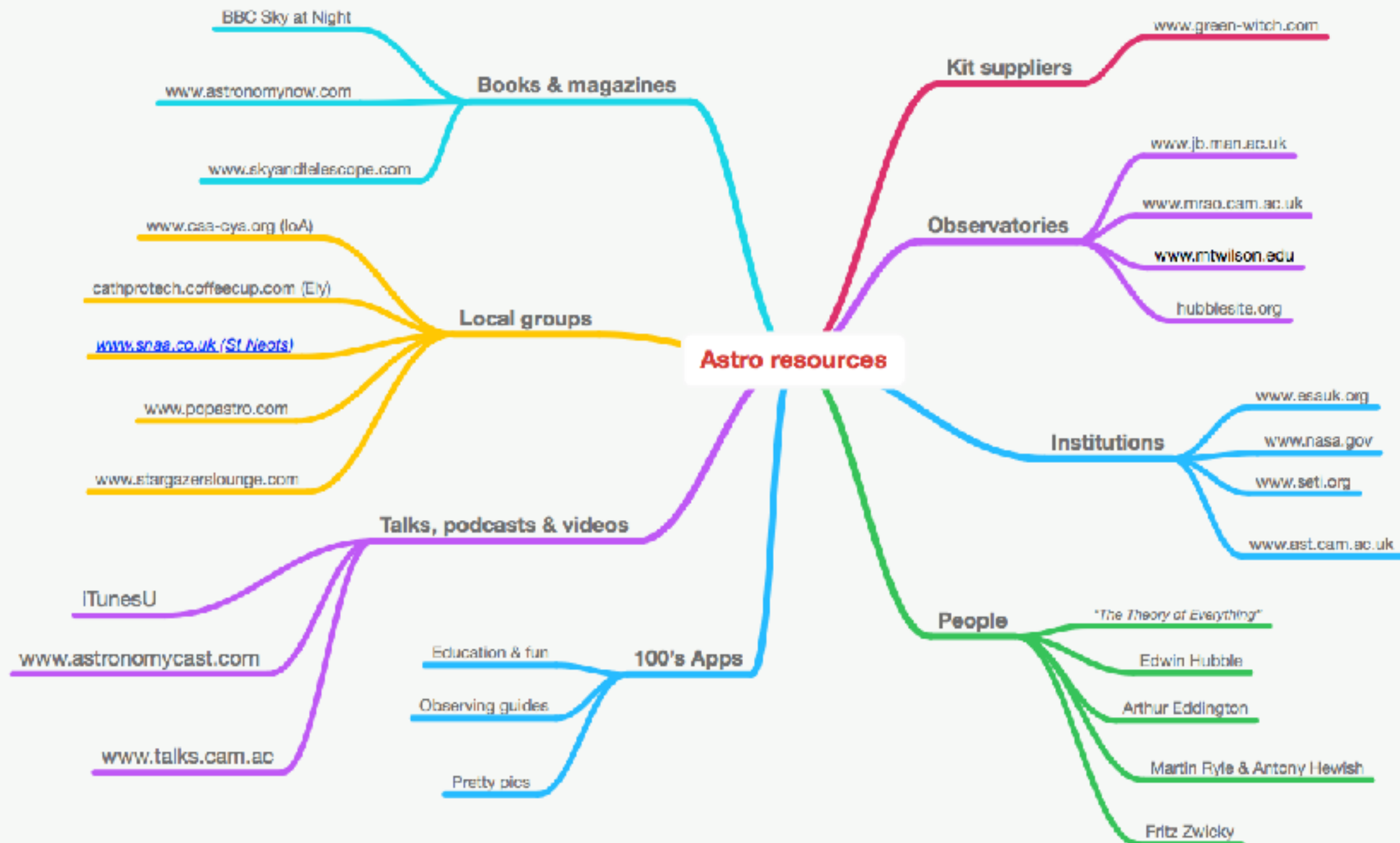


Summary of today's session

- ❖ Explained where we are in universal space & time
- ❖ Provide a sense of scale
- ❖ Key concepts of nature of the universe:
 - ❖ hierarchal structure
 - ❖ constant motion
 - ❖ uniformity
- ❖ Deliberately not covered how we got here (that's next week)



Some Astronomy Resources To Explore...



Slides will be available via Dropbox