

Understanding the Universe

PART 1

INTRODUCTION

Presented by Rob Lavoie

Ottawa Astronomers Workshop Series
OAWS #11

+110°
+120°
+130°
+14°
+15°
+16°
+17°
+18°

Look at all
those millions
upon millions
of stars.

Yes... Makes you
realize how
insignificant
a star is.



Intro to Understand the Universe

- How would you answer the question : “How do you relate to the Universe?
- 200 years ago, most people could readily answer, based on their beliefs and long standing philosophies on “creation”
- Since Copernicus, Newton and Galileo, this question no longer appears to be taken personally ... the Universe is a mechanical machine governed by scientific laws
- Today few people consider this question seriously, yet at some time in our lives we all ask: Where do I come from?
- Exploring this line of inquiry from a cosmological and scientific perspective can lead to a very personal understanding of how the Universe acts as a process, and how that process resulted in human minds being able to grasp something as enormous as the Universe itself

Why Understand the Universe?

- We want to expand our horizons and move from “checklist astronomy” towards understanding the nature and significance of observable astronomical objects
- Such an understanding allows us to spend more time observing an object, attempting to see details which before may have been glossed over.
- Additionally, gaining an understanding of how the Universe works allows a more personal and passionate interaction with the observations, an important factor for staying with the hobby for a long period of time.
- Finally, understanding the Universe as a *Process* can lead to a discovery of a personal cosmology where you can give an answer to how you relate to the Universe ... we are indeed star-stuff!

How to start Understanding the Universe

- Propose that we make use of an existing RASC* program as a vehicle to start appreciating the Universe's treasure chest.
- The **Explore the Universe (EtU)** program allows an observer to sample a wide range of astronomical observing experiences
 - Constellations and bright stars
 - The Moon
 - The Solar System
 - Deep Sky Objects
 - Double Stars
- Equipment requirements are modest, as most observations can be made with binocular or small telescopes.

Explore the Universe Certificate Program – Cont.

- The Explore the Universe program was designed to introduce novice astronomers to all aspects of visual astronomy and, by its nature, allow good observing practices and procedures to be learned.
- Although it appears somewhat of a checklist at first glance, following the program....
 - takes time and patience, valuable observing skills
 - allows the participant to learn the night sky in terms of the annual parade of constellations and brighter stars, lunar and planetary progressions
 - presents a wide range of astronomical objects for observation

Explore the Universe Certificate as a Vehicle to Understanding the Universe

- In this series of upcoming workshops, we cover the current science behind the mechanics, processes and nature of the objects listed in the EtU program, and more.
- We propose the you take advantage of the EtU program to make observations on the objects being examined in the workshops, while at the same time earning a handsome certificate as a reward for your efforts.
- The equipment requirements for the EtU are quite modest. A small telescope or binoculars can be used,
- Added incentive: Coaching for candidates.
 - At the 3rd Thursday Gabfest (Tim Horton's – Cyrville and Innes
 - Rerunning past workshops on equipment setup and operation

Other Observing Programs

- Royal Astronomical Society of Canada (RASC) has several excellent certificate programs that cover a range of topics
 - Explore the Universe Certificate, Messier Certificate, Finest NGC Certificate, Isabel Williamson Lunar Certificate, Deep Sky Gems, Deep Sky Challenge
 - Visit www.rasc.ca/certificate-programs for details.
- The OAOG has the OAOG Challenge List, which is a useful document correlating NGC and Messier Catalog numbers as well as object type, constellation, RA and DEC coordinates, magnitude, size (in arc minutes), time of year to observe and common name. Arranged in levels of experience, the document(s) can be found in the Files section of the OAOG Yahoo Group. (need to register for access). A spreadsheet version is also available allowing different sorting features..

Essential Skills and Tools

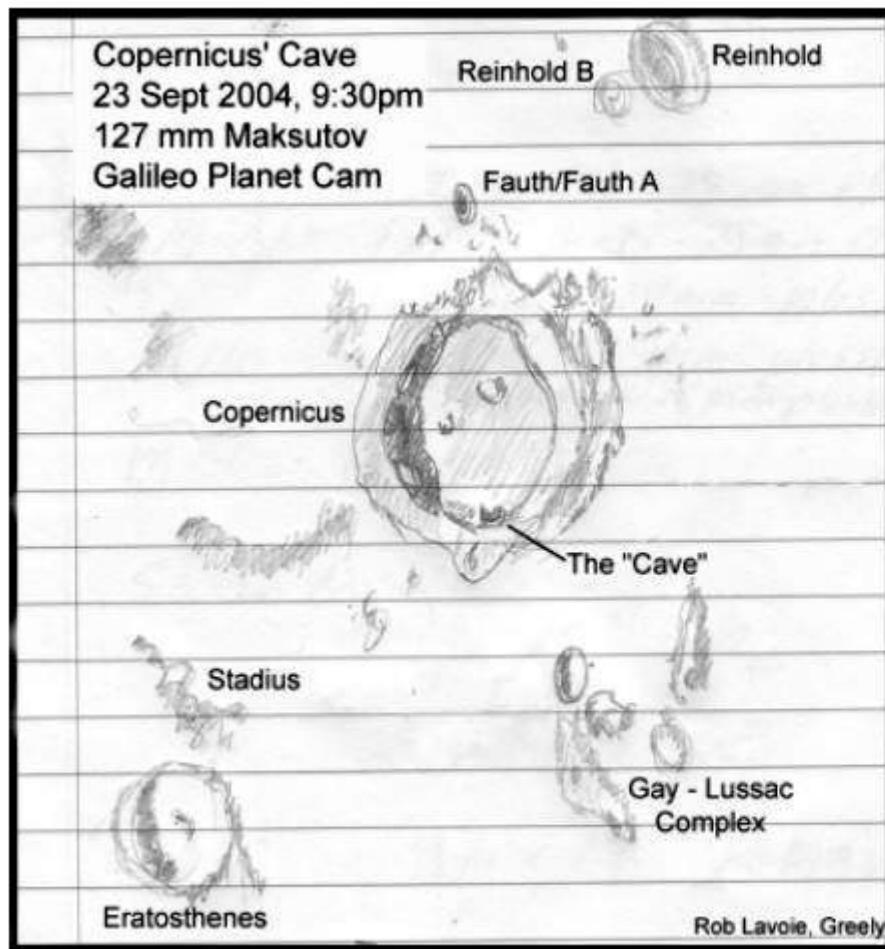
- Gaining an understanding of the Universe through an observation program requires that you practice and learn good observation skills and practices. Notably these are:
 - Learning how to “see” through a telescope ... really, it's not as simple as it may seem, especially in delicate details are to be teased out.
 - Make an attempt to sketch what you see. This seemingly simplistic practice allow the observer to begin to appreciate fine details otherwise missed
 - Keeping notes or logs of your observations
 - Obtain good Maps and Apps. to help you find your way

Building Observing Skills

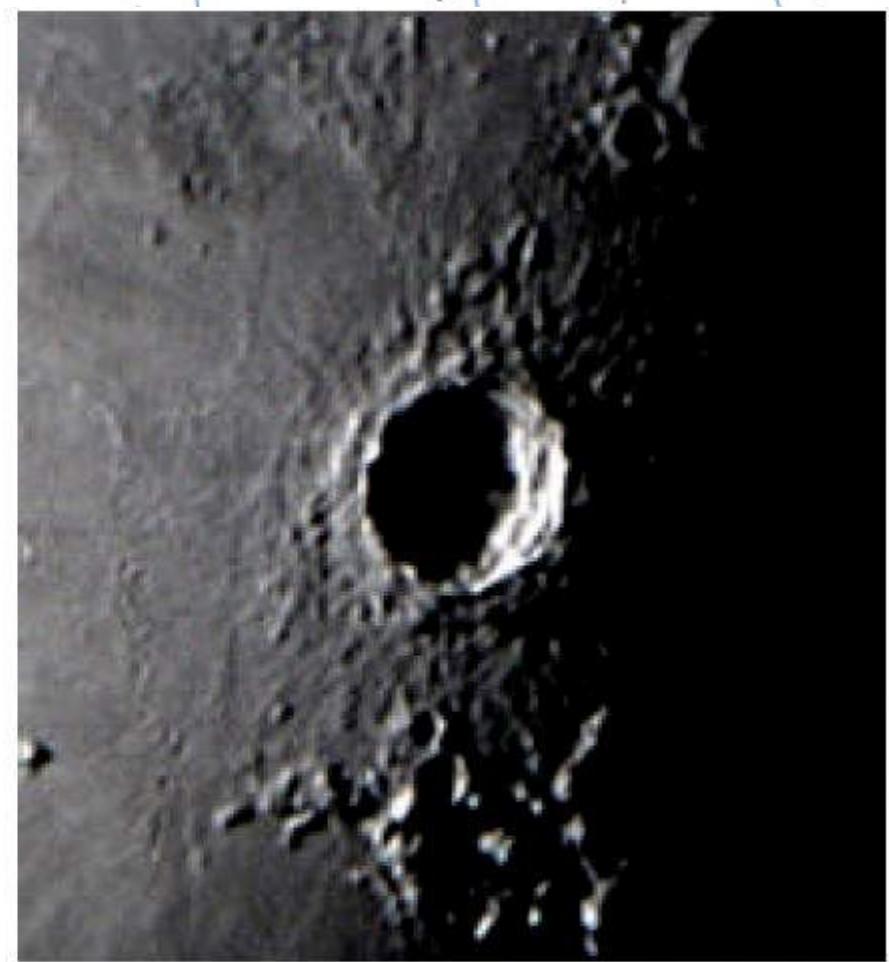
Observing through a telescope is a skill learned through practice. Experienced observers may see things with a small telescope that a beginner will miss with one larger. Here are important tips to help you learn this skill:

- **Patience and persistence** (It takes time to learn to see everything and every night is different – practice observing in all circumstances)
- **Dark adaptation** (Can take 30 minutes. Avoid stray light and use a red flashlight)
- **Averted vision** (For faint targets, look a little off to the side of the object to detect subtle changes in luminosity and detail)
- **Change magnification** (Use eyepieces of varying focal lengths)
- **Sharp focusing** (Critical for detail. Take your time with this to find “the sweet spot”.)
- **Jiggling and not-jiggling the telescope** (Slight nudges of the telescope uses features of the eye for detecting subtle changes in luminosity through motion. Keeping the image steady floods the eye with all the available photons you can see)
- **Adjust** to night sky “seeing and transparency”

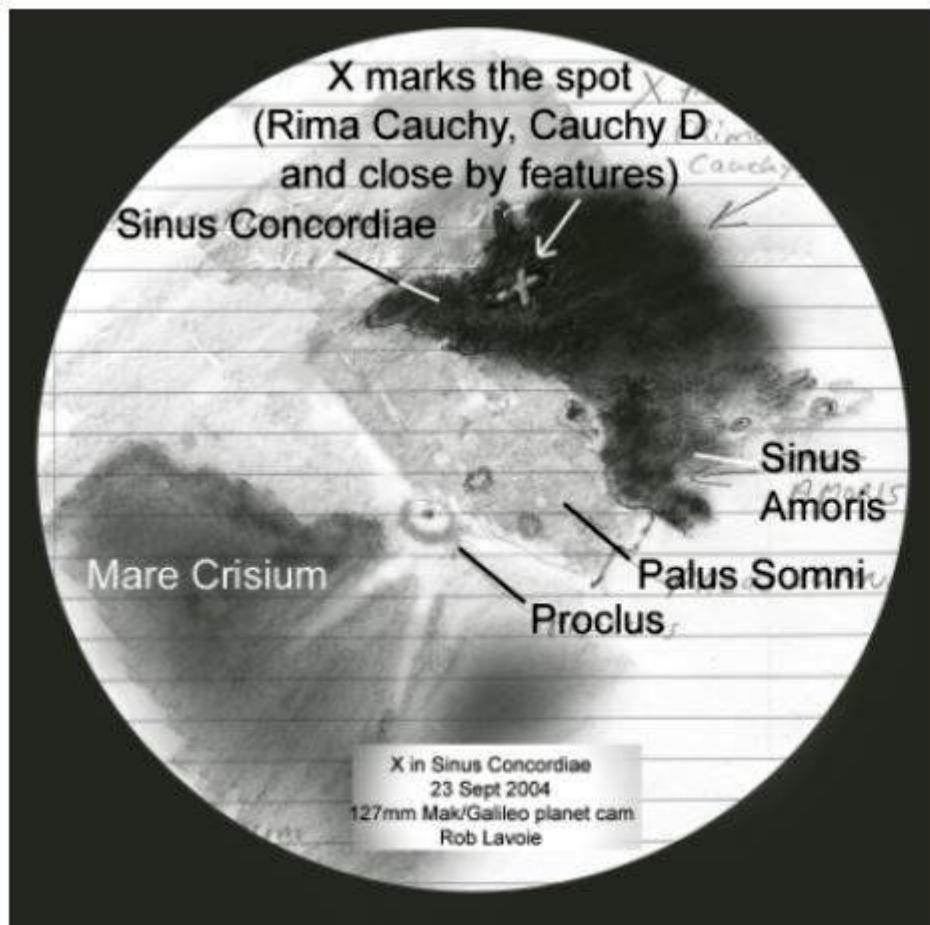
Sketching What You See



Copernicus Cave, 23 Sept 2003



Sketching What You See



X marks the spot, 23 Sept 2003



Sinus Concordiae, 21 Oct 04 / 7:40 PM
127mm Mak / 20mm Plossl, Canon A70

Sketching What You See

Lessons Learned: Almost every seasoned astronomer will tell you that *sketching* is an excellent way to learn how to see detail through a telescope:

- It allows you to focus for minutes rather than “just a glance”,
- You learn to observe more subtle structure,
- Details that were previously invisible become apparent.

As an alternative to sketching from the eyepiece, sketching astro scenes from a *monitor* can provide similar training and is very comfortable method for eyeglass wearers.

Awesome resources for Sketching at the eyepiece.

- www.rasc.ca/astrosketchers-group
- Erika Rix's Astrosketching: www.astronomy.com/magazine/erika-rix
-

Maintaining a Log

- Use a note book to record your observations. Include:
 - Date and time,
 - Seeing (steadiness of stars), transparency
 - Equipment used
 - Object observed and notes on what you saw, what thoughts it instilled etc. (I sometimes made suggestions to compare observations on similar objects).
- May seem pedantic, how ever the idea is to slow yourself down so you have time to really get into your observation. The logs will serve as a record of your sessions and the associated notes may serve as inspirations to make new observations.
- Many observers type their observations up and post them on forums (OAOG etc.), then keep paper or files for more permanent records.

Maintaining a Log

30 June Freely 127mm MAK + 20x
10:30pm Slight Haze/thin clouds
used 20mm ST + 25% ND filter
* A Second attempt at Lunar Navigation

Moon 12 days old. 98.2% ill.

I downloaded a copy of
Virtual Moon Atlas - what
a nice tool. I got printed
with the same exposure
orientation as my telescope.
Hopefully I won't be as
confused tonight.

Tonight's Targets!

Mare

- ✓ Cresium
- ✓ Fecunditatis
- ✓ Nectaris
- ✓ Tranquilitatis
- ✓ Serenitatis
- ✓ Vaporum
- ✓ Frigoris
- ✓ Umbrium
- ✓ Nubium
- ✓ Sinus Iridium

Maps and Apps

- **Celestial Atlases**

- Will Tirion's Sky Atlas 2000
- Cambridge Double Star Atlas
- Deep Sky Hunter - online or downloadable .pdf
 - <http://www.deepskywatch.com/deep-sky-hunter-atlas.html>
- Stellarium, Starry Night, Sky Safari
- World Wide Telescope and Google Sky

- **Lunar Atlases**

- Rukl Lunar Atlas
- Virtual Moon - Windows
- Lunar Map HD (Android)

Facts about our Milky Way

The Milky Way, an average sized galaxy in a universe comprised of billions of galaxies, is home to billions of stars and numerous deep sky phenomena such as stellar nurseries, super nova remnants, open and globular clusters. You will become familiar with these objects as you progress through the Explore the Universe program

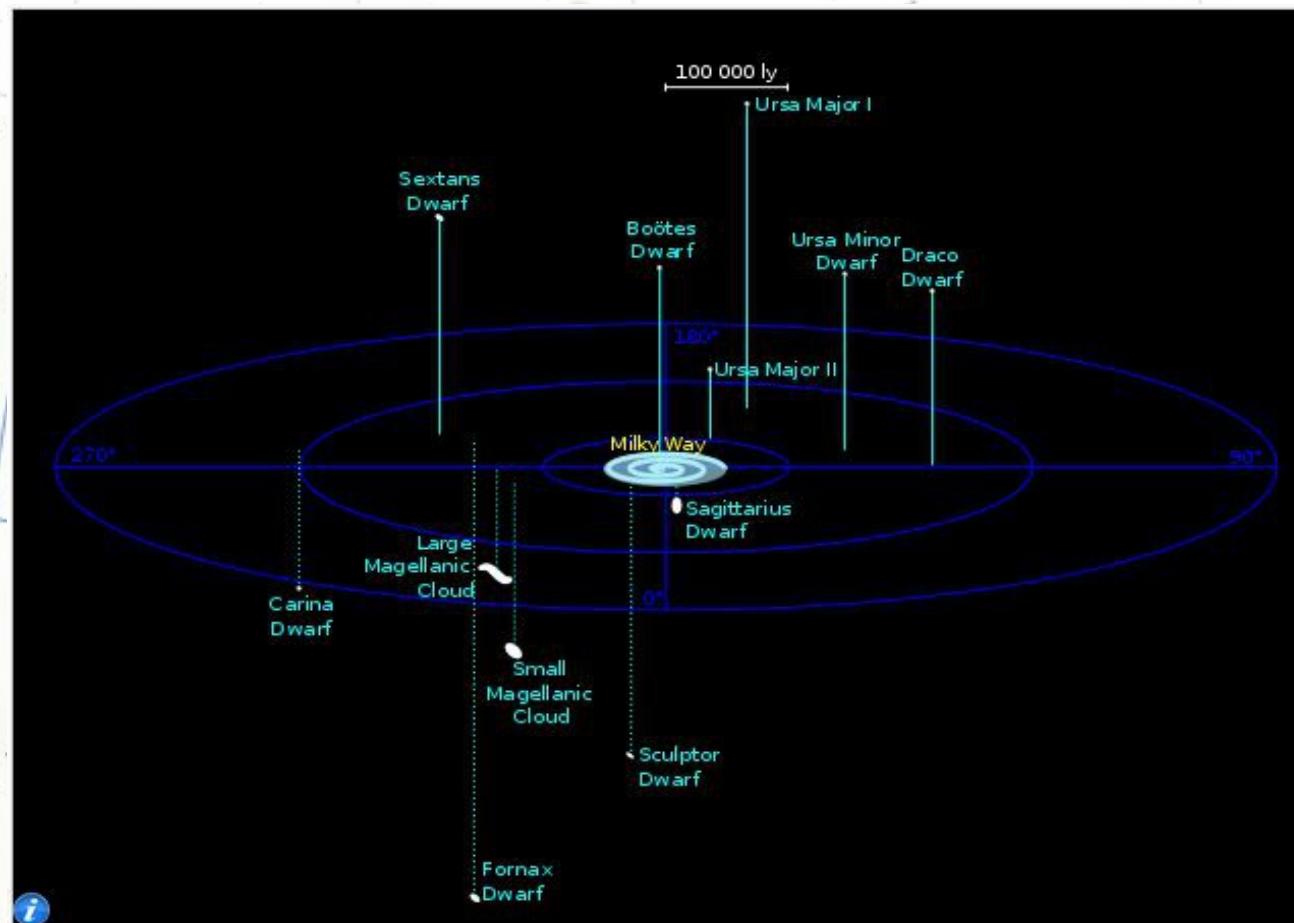
Future workshops will cover many of these objects in greater detail, but for now, let us focus on some things we know about the Milky Way as an introduction to Understanding the Universe.

Facts about our Milky Way

From: <http://www.universetoday.com>, Wikipedia

1

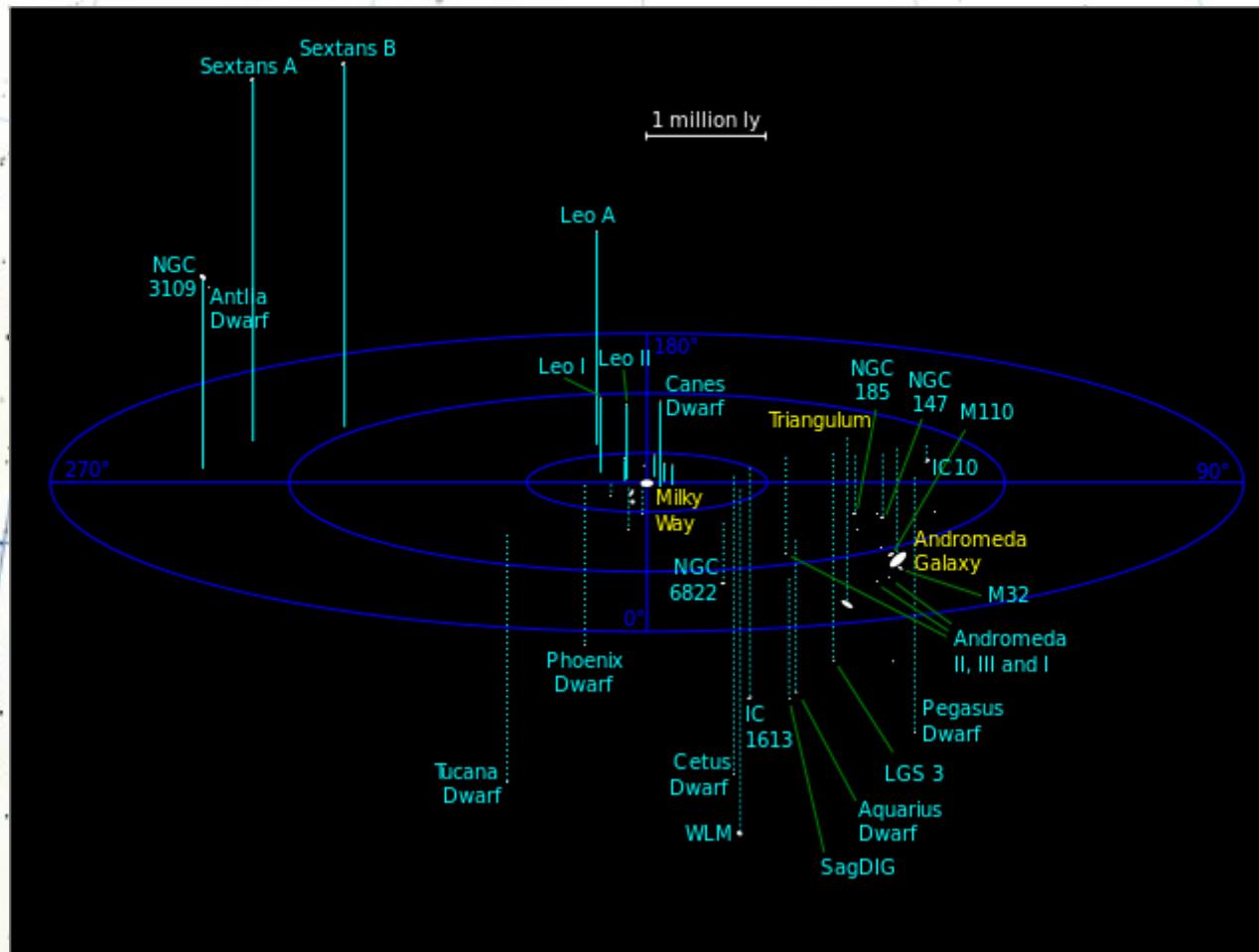
It's a growing Family... The Milky Way Neighbourhood...



Facts about our Milky Way

2

... with lots of neighbours! The Local Group ...

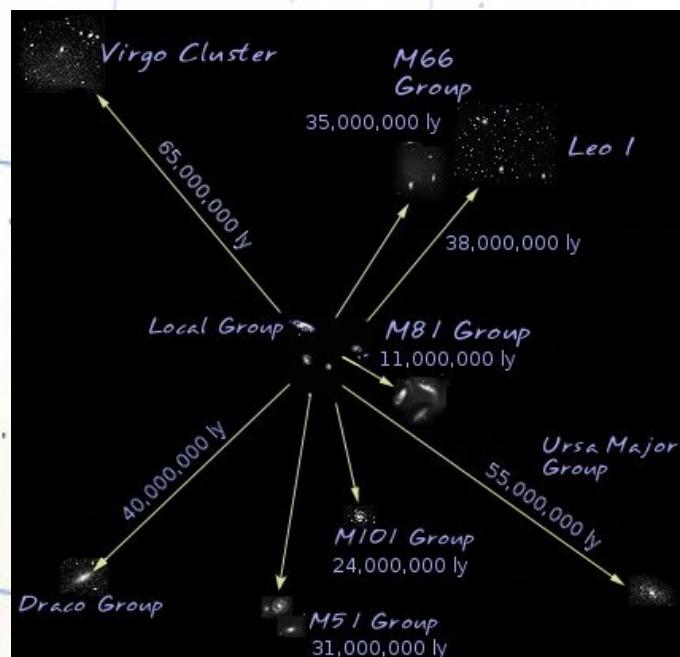


Facts about our Milky Way

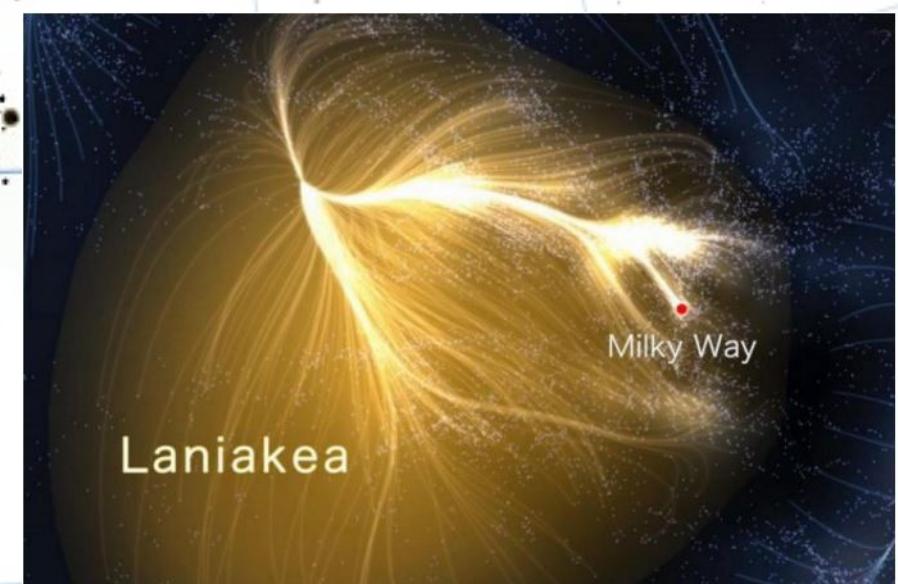
3

...Lots and lots of neighbours! ... The Virgo Super Cluster and the even bigger Laniakea SUPER cluster

- At least 100 galaxy groups and clusters are located within the Virgo Super Cluster's massive 110 million light-year diameter. A 2014 study indicates that the Virgo Super cluster is only a lobe of a greater galactic structure, **Laniakea**, which is centered on the Great Attractor (think Cosmic Web)



https://en.wikipedia.org/wiki/Virgo_Supercluster



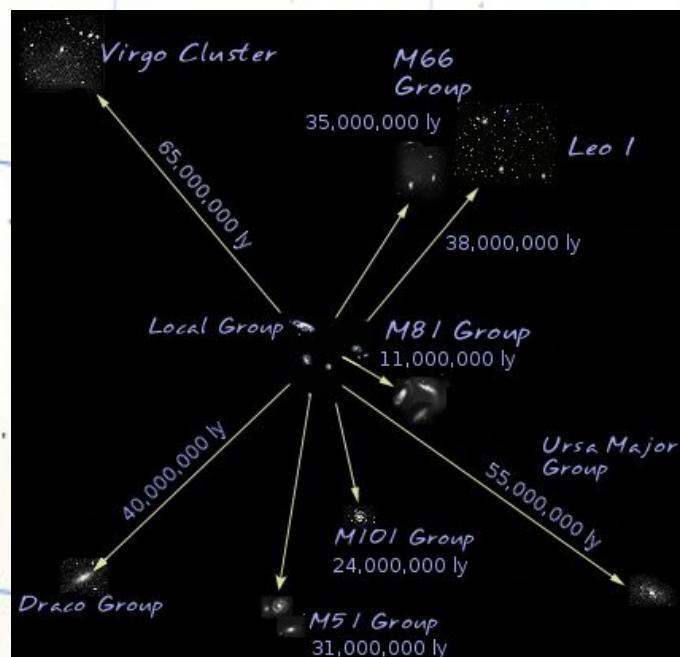
<http://wordlesstech.com/laniakea-home-supercluster-cosmos/>

Facts about our Milky Way

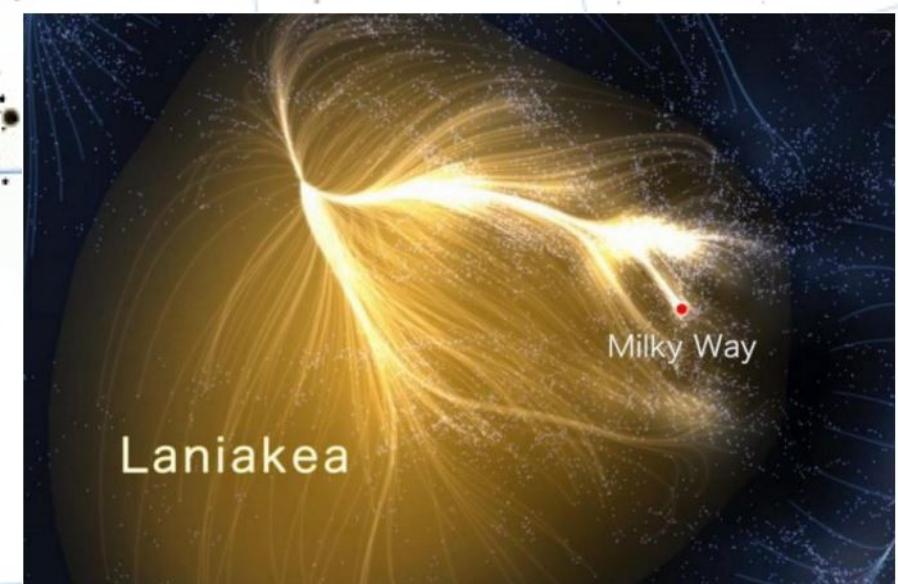
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https://en.wikipedia.org/wiki/Virgo_Supercluster

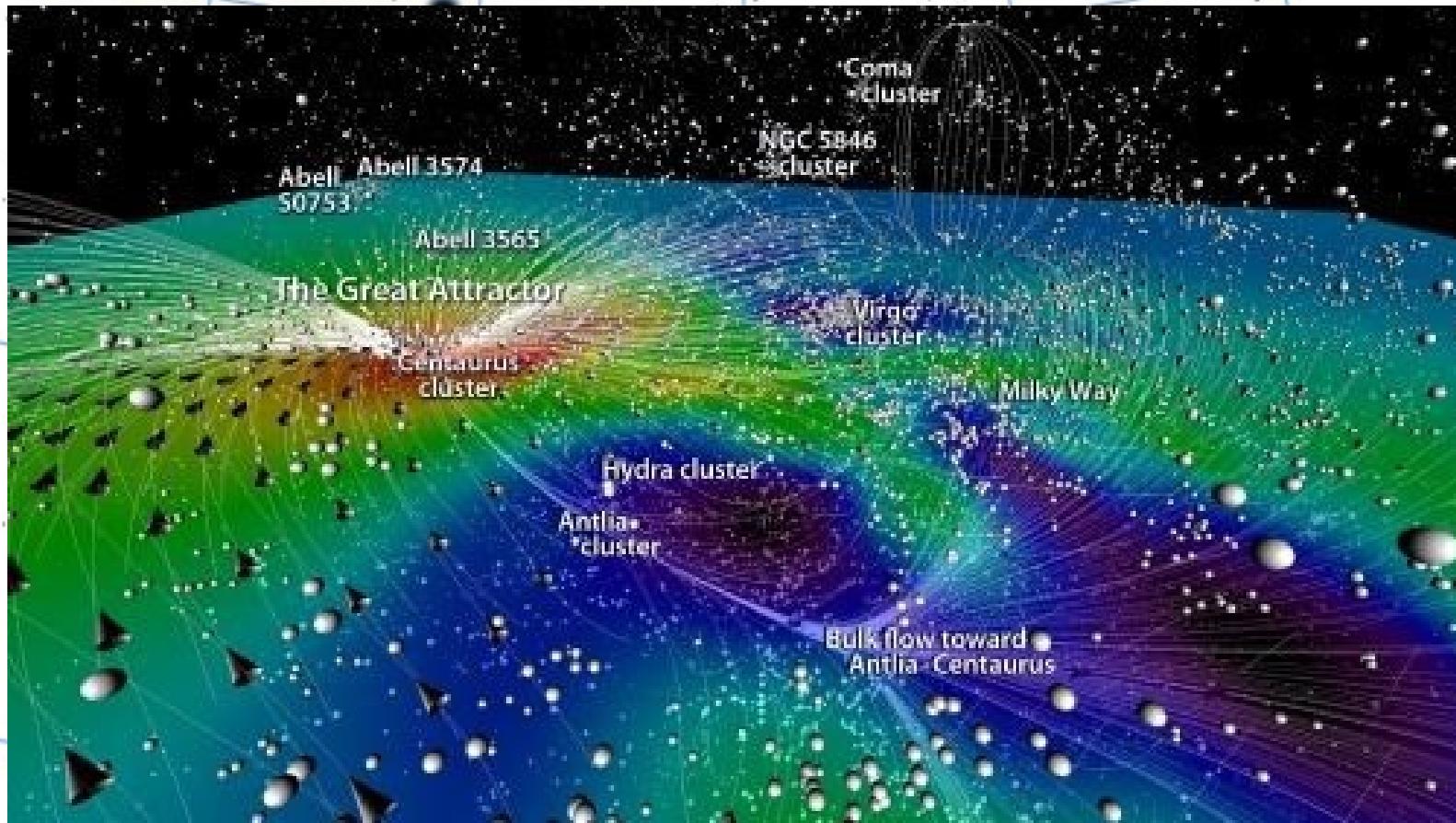


<http://wordlesstech.com/laniakea-home-supercluster-cosmos/>

Facts about our Milky Way

The Great Attractor

A huge volume of space that includes the Milky Way and super-clusters of galaxies is flowing towards a mysterious, gigantic unseen mass named "The Great Attractor," some 250 million light years from our Solar System:



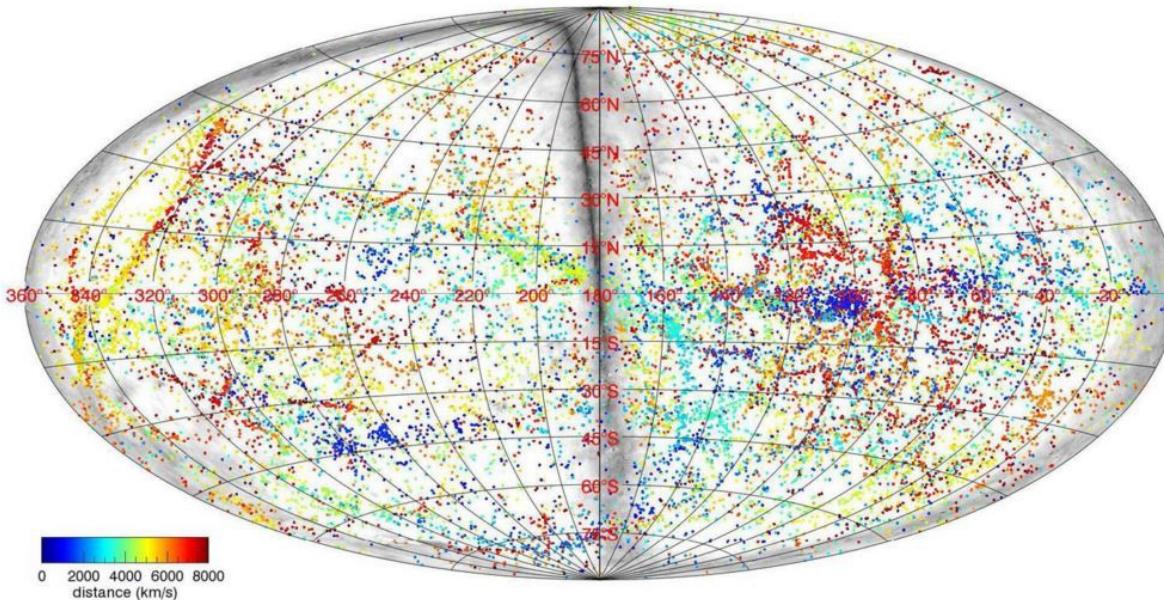
Facts about our Milky Way

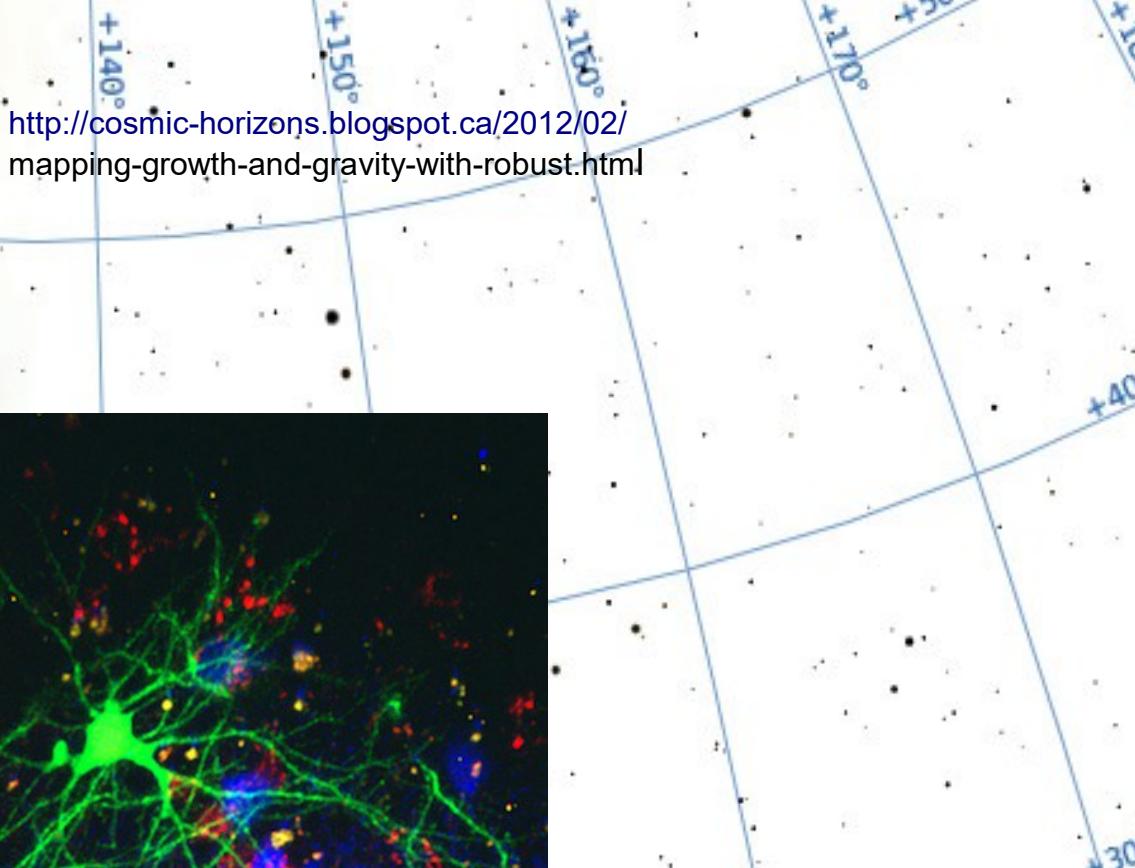
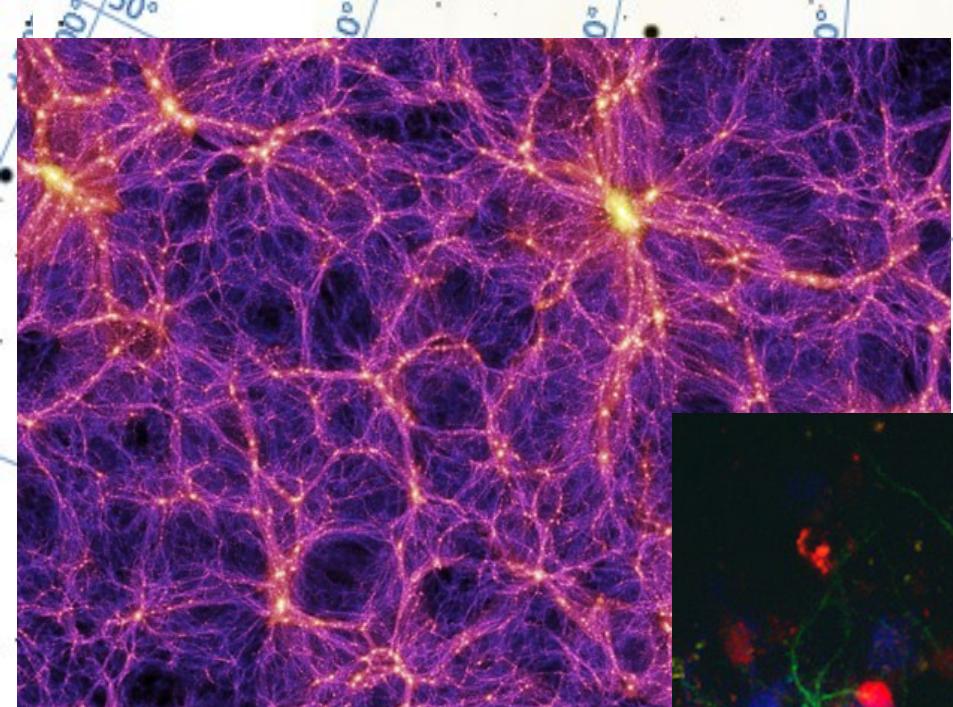
The Cosmic Flows Project

<http://www.dailygalaxy.com/>

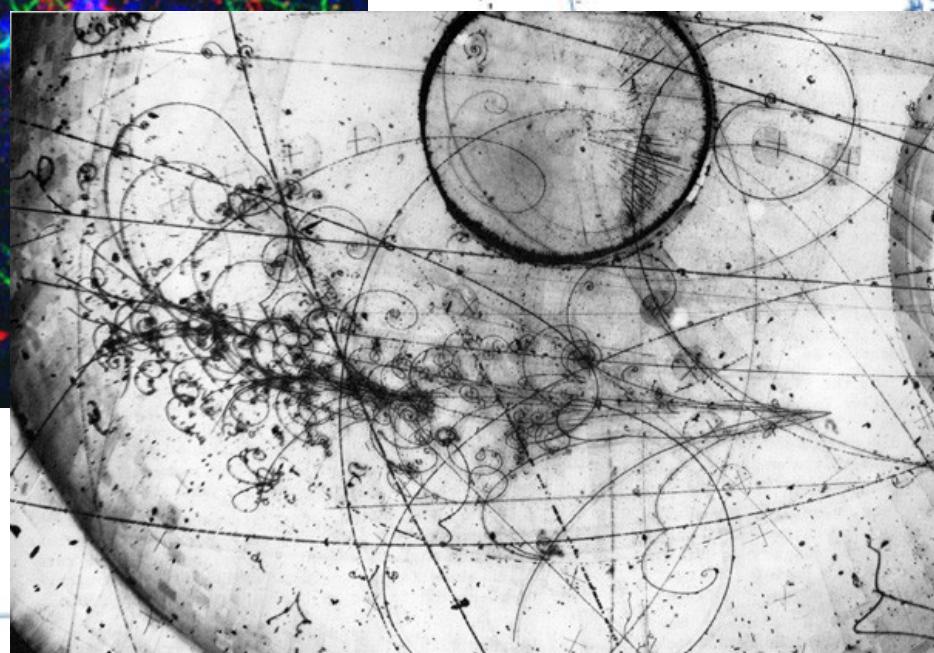
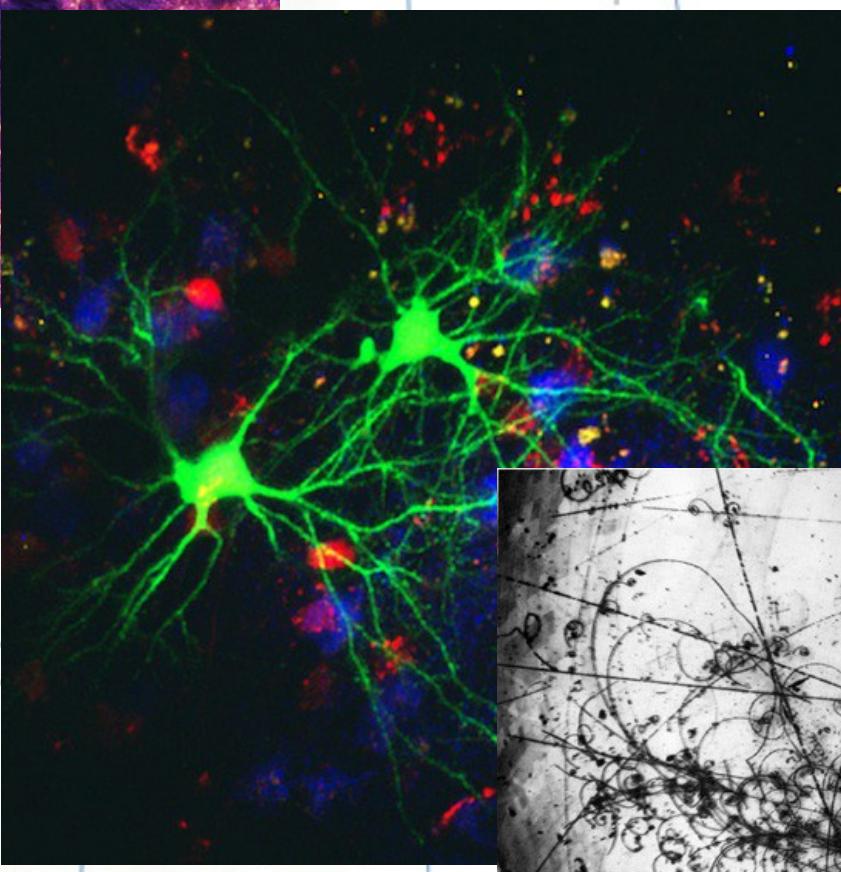
The Cosmic Flows project has mapped visible and dark matter densities around the Milky Way galaxy up to a distance of 300 million light-years.

The large-scale structure of the universe is a complex web of clusters, filaments, and voids. Large voids—relatively empty spaces—are bounded by filaments that form superclusters of galaxies, the largest structures in the universe.





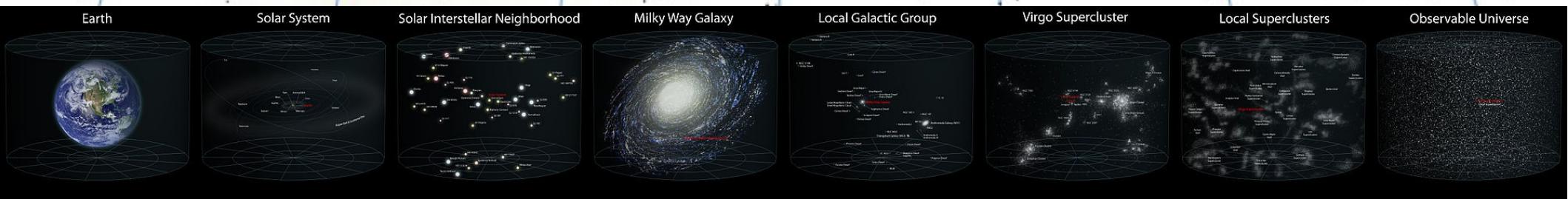
[http://www.utsouthwestern.edu
/labs/roberts/](http://www.utsouthwestern.edu/labs/roberts/)



Source: The Village Crier Vol. 8 No. 18, May 6, 1976

[http://cosmic-horizons.blogspot.ca/2012/02/
mapping-growth-and-gravity-with-robust.html](http://cosmic-horizons.blogspot.ca/2012/02/mapping-growth-and-gravity-with-robust.html)

The Cosmic Scale



Facts about our Milky Way

From: <http://www.universetoday.com>, Wikipedieia

4

It's Warped!

- Past mergers and the current influence of the Large and Small Magellanic Clouds (dwarf galaxies) are putting a twist into the works (via gravitational action on dark matter)



The warp of Spiral Galaxy ESO 510-13 is similar to that of our own. Credit: NASA/Hubble

Facts about our Milky Way

From: <http://www.universetoday.com>, Wikipedia

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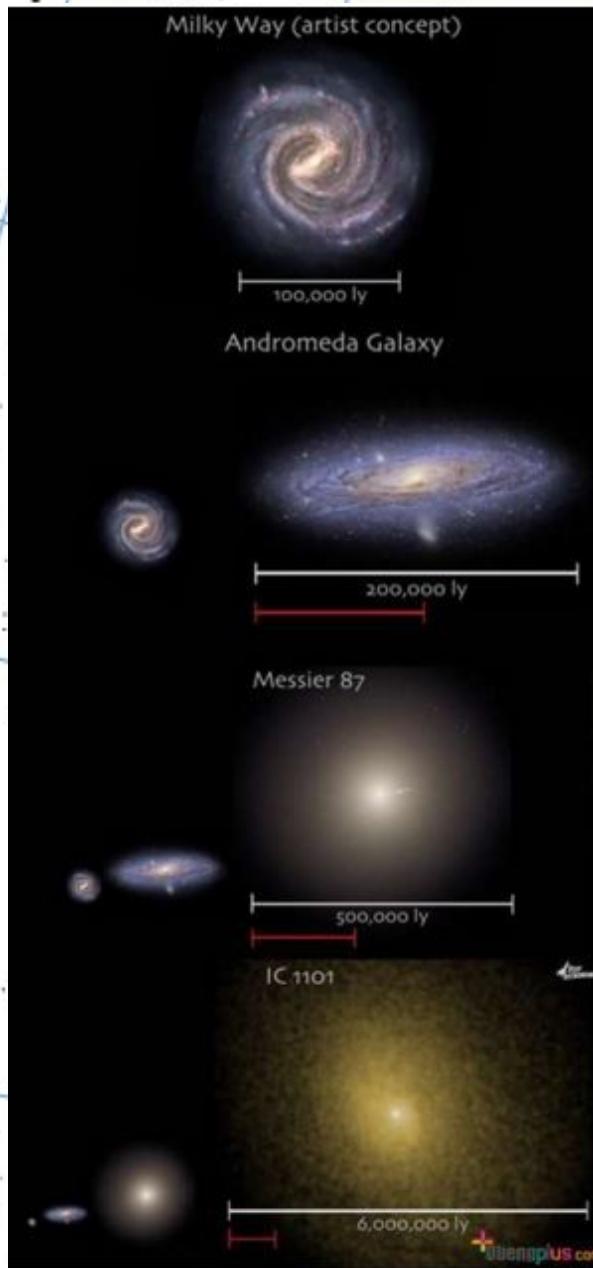
About 300 Billion Stars! (+/-)

- It's a middleweight as far as galaxies go
- IC1101, the largest known galaxy has 100 trillion stars!
- The LMC has about 10 billion stars
- New stars are being added every year (about 7 stellar births/yr.) and we're still recruiting stars from the Canis Major Dwarf Galaxy



Facts about our Milky Way

IC1101 vs The Milky Way



IC1101, discovered in 1790 by Frederick William Herschel, is a super giant elliptical galaxy considered to be the largest and most luminous known.

Unlike the Milky Way, it is devoid of internal structures containing dust and gas lanes where star formation could happen.

Home to 100 trillion stars, many with rich metal content showing considerable sophistication along the evolutionary process. Never the less, it in its wind down stage, a fate all galaxies will face.

Facts about our Milky Way

6

Very old, but still a lot of life!

- Estimated age is about 13.6 Ga (Universe is estimated to be 13.8 Ga)
- The disk and bulge didn't form until about 10-12 billion years ago. And that bulge may have formed earlier than the rest of the galaxy
- Orbited by 158 (+/-) globular clusters, many of which are at least as old as the Milky Way itself. Globular clusters are associated with most galaxies. Currently, the Sagittarius and the Canis Major Dwarf Galaxies appear to be in the process of donating its globulars to the Milky Way.

Facts about our Milky Way

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Facts about our Milky Way

From: <http://www.universetoday.com>, Wikipedieia

7

...Lots of Gas and Dust!

- Gas and dust makes up 10-15% of the luminous and visible matter in the galaxy. Stars make up the rest. (Dark matter is a topic for another day)
- This amount of gas and dust indicates that the Milky Way can still generate new stars with the possibility of planets.
- When compared to IC1101 (a homogenous mass of 100 trillion stars with no evidence of stellar births), the Milky Way has structure, spiral arms with areas of active stellar nurseries. Thus it has a lower entropic state than IC1101, however at the end of its life, well after countless mergers (esp. with the Andromeda galaxy in about 4Ga), the resulting galaxy mass will take on the appearance of IC1101 as it winds down.

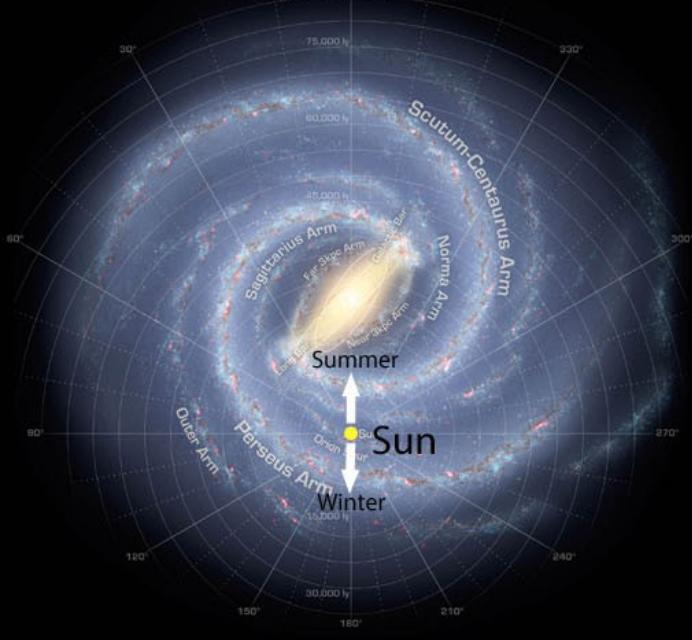
Facts about our Milky Way

From: <http://www.universetoday.com>, Wikipedeia

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How we think the Milky Way must look, and where the Solar System is located

Face-on view



Edge-on (inside) view

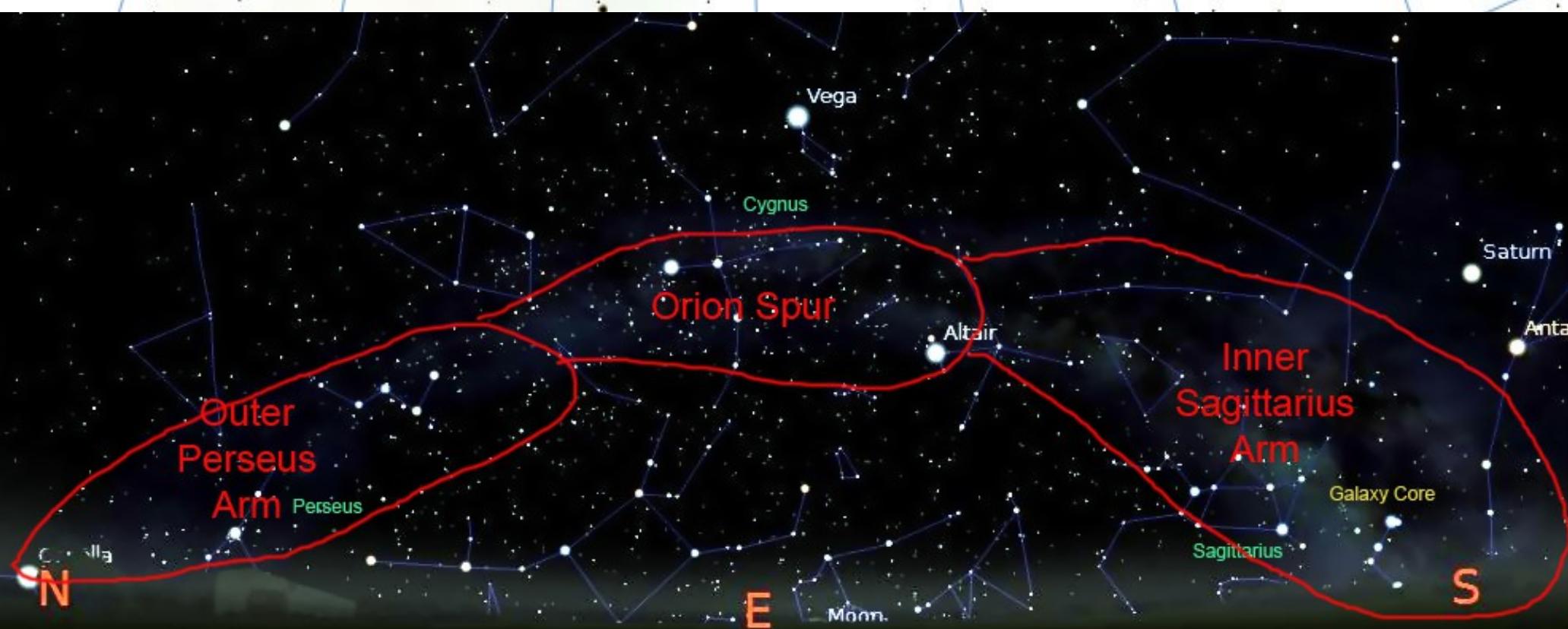


http://www.universetoday.com/wp-content/uploads/2014/11/Milky-Way-face-on-edge-on-NASA-Richard-Powell_ANNO.jpg

3D Milky Way



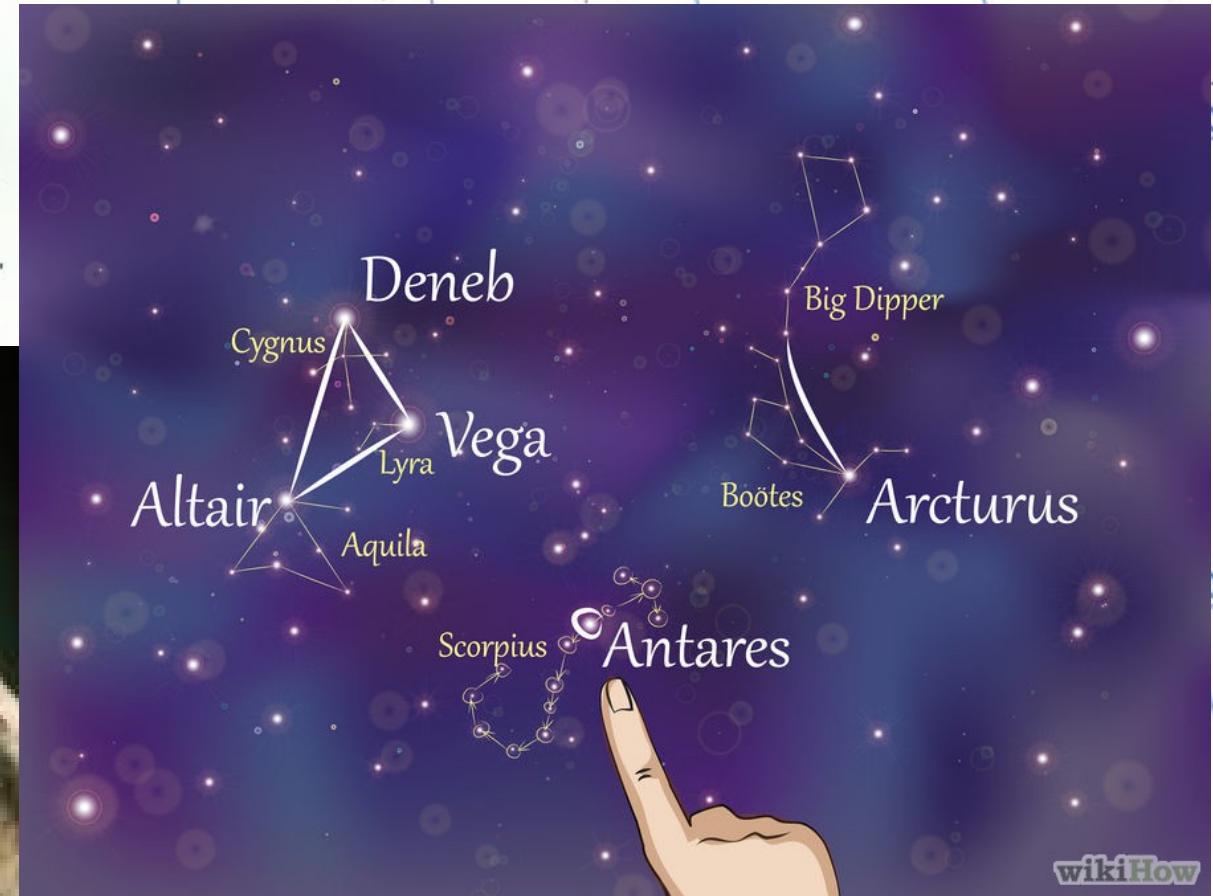
3D Milky Way



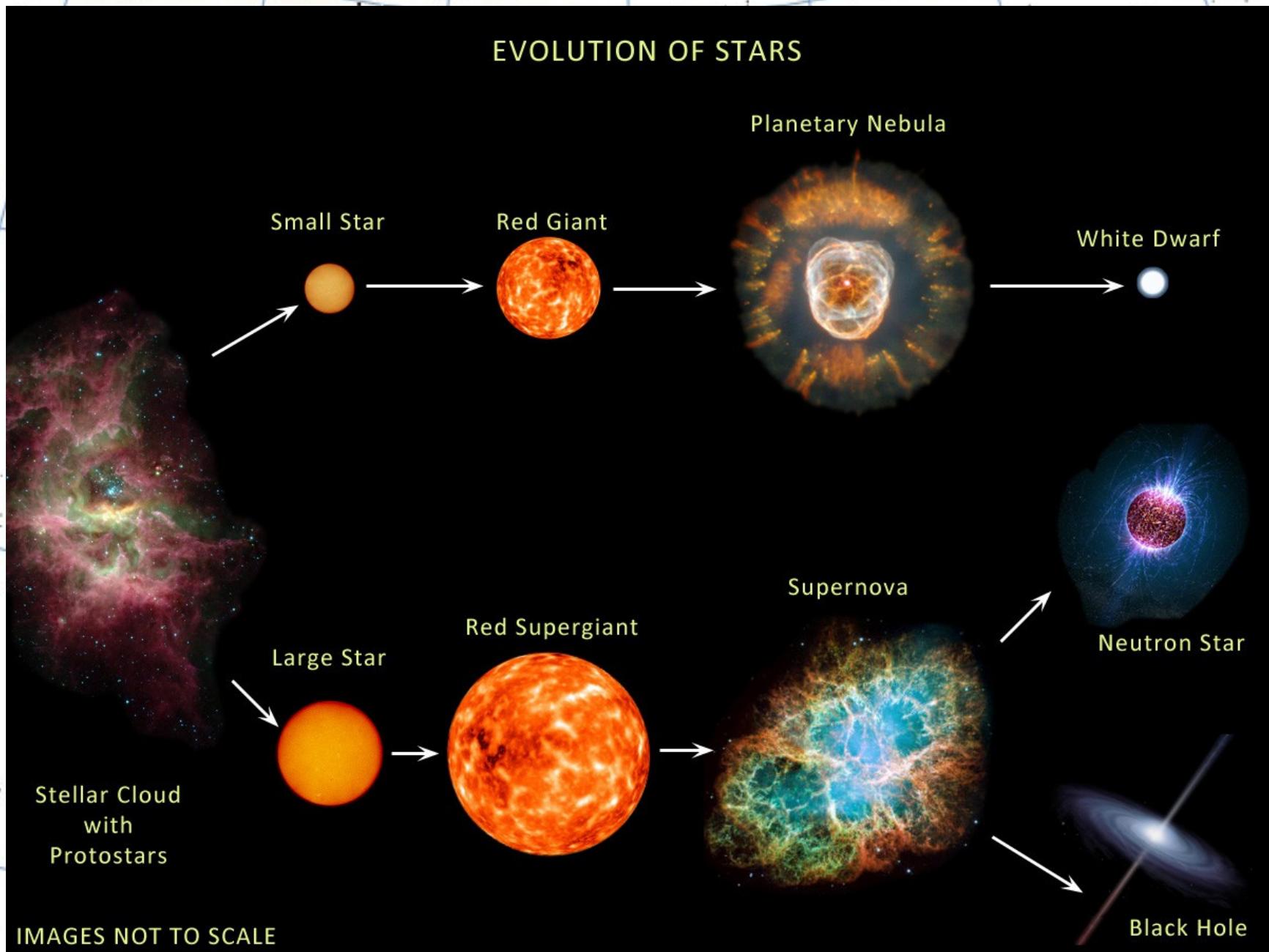
What's Next ?

Take a look at some of the
upcoming workshops
we have planned

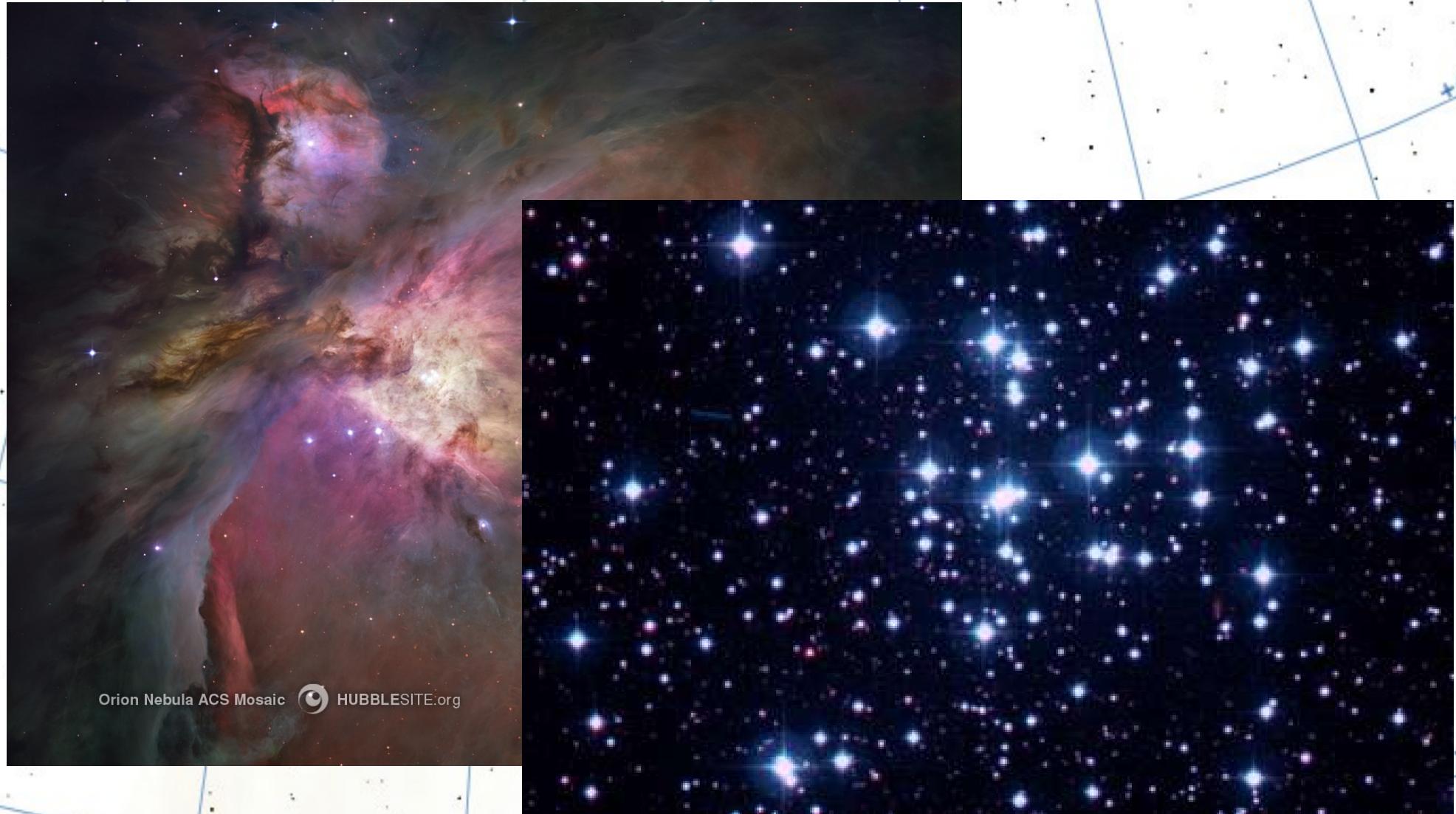
Finding Your Way Around the Sky



Stellar Evolution



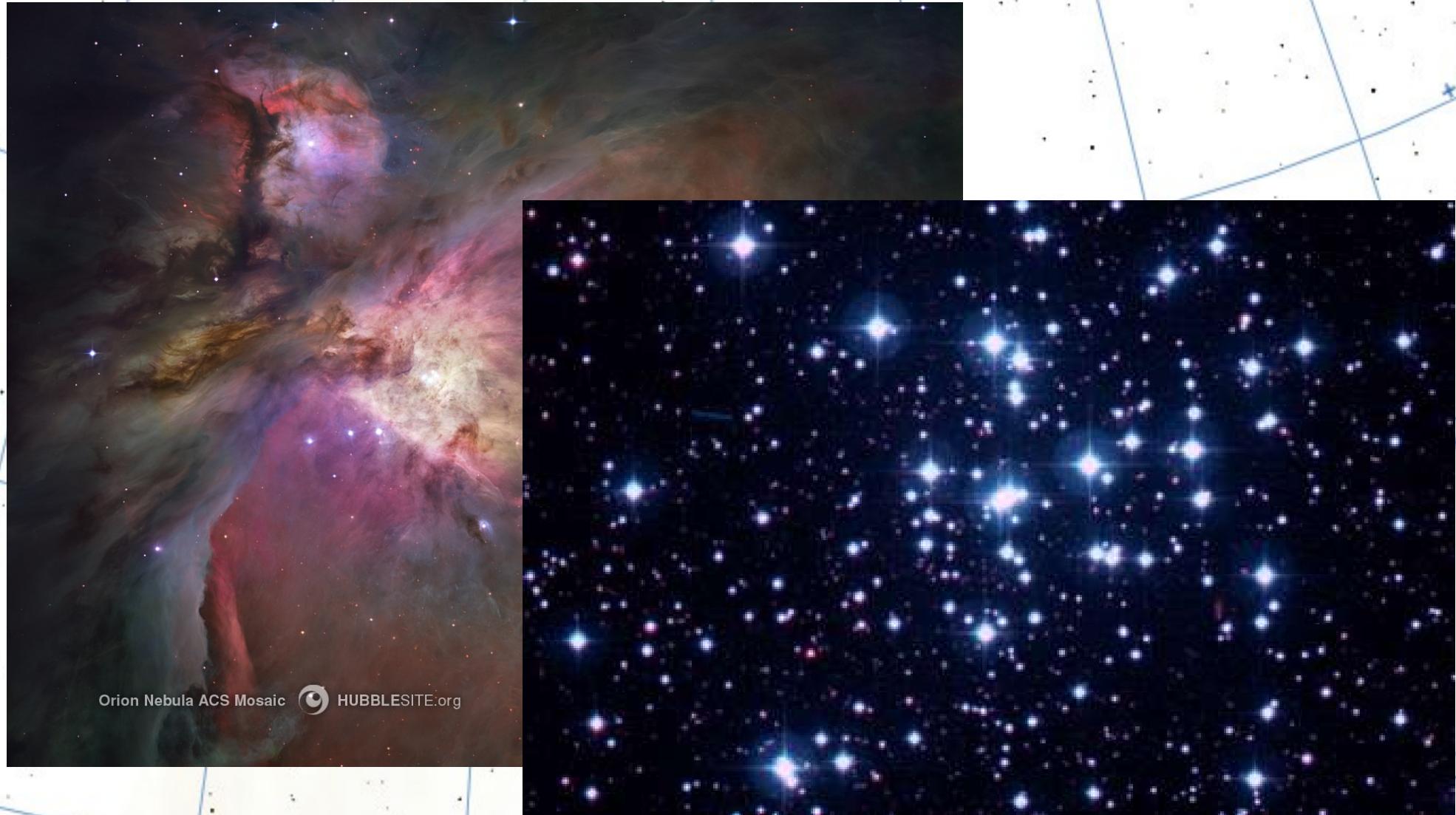
Stellar Nurseries to Open Clusters



Orion Nebula ACS Mosaic © HUBBLE SITE.org

<http://www.atlasoftheuniverse.com/openclus.html>

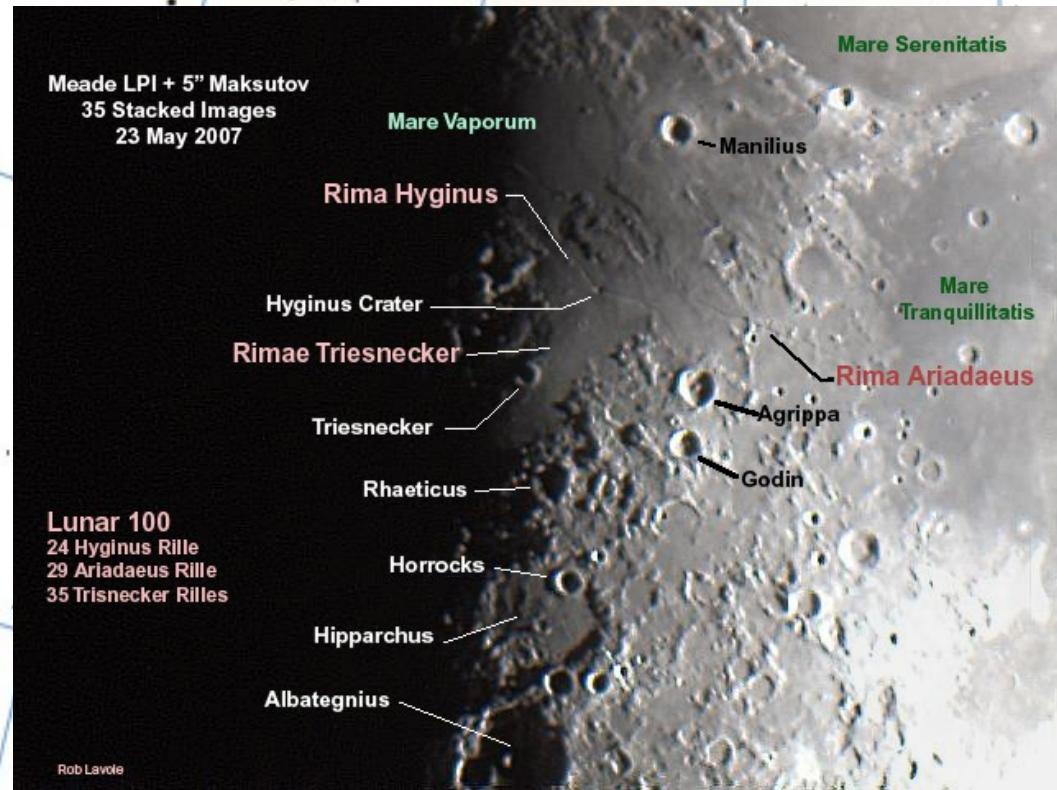
Stellar Nurseries to Open Clusters



Orion Nebula ACS Mosaic © HUBBLE SITE.org

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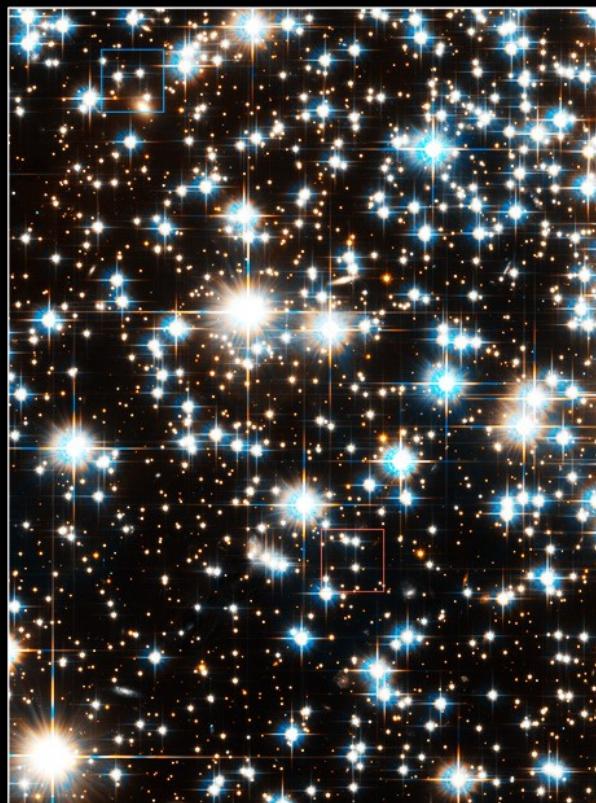
Observing the Moon



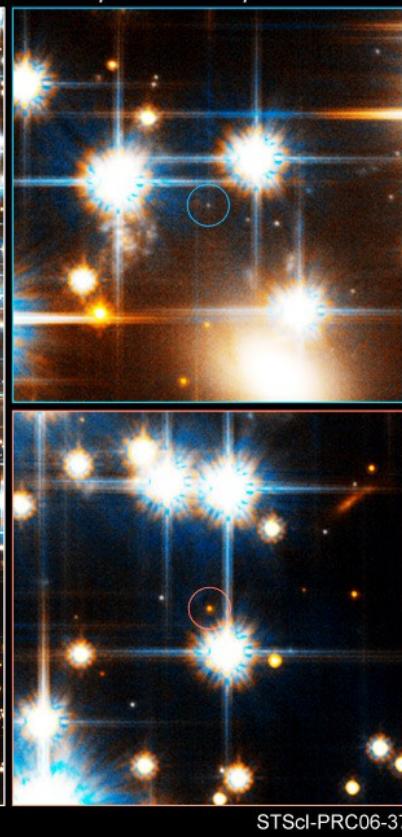
The geography of another world

Globular Clusters

Globular Cluster NGC 6397



Hubble Space Telescope • ACS/WFC



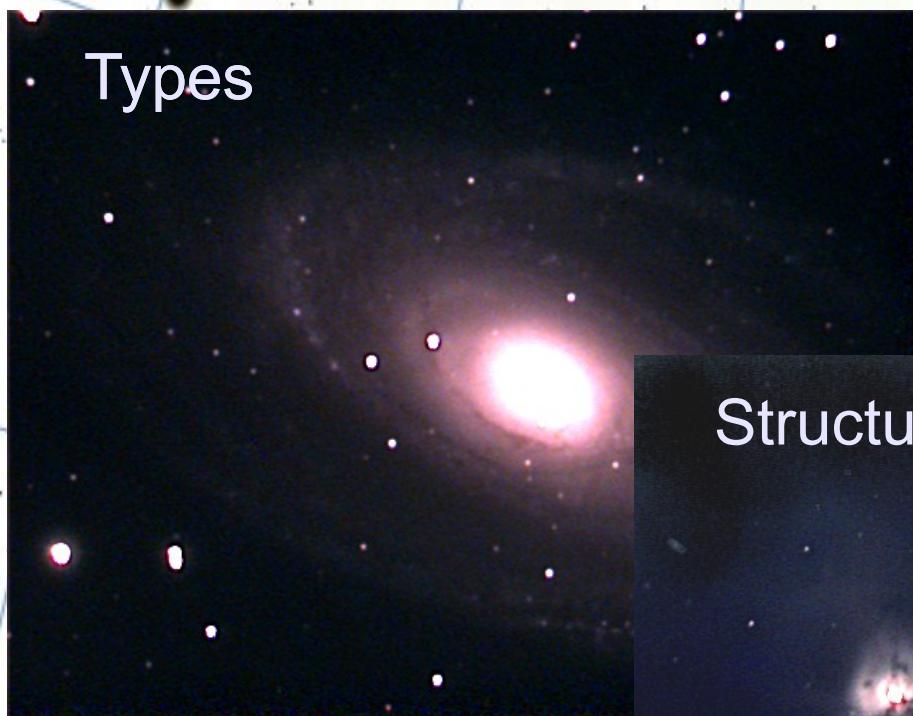
NASA, ESA, and H. Richer (University of British Columbia)

STScI-PRC06-37

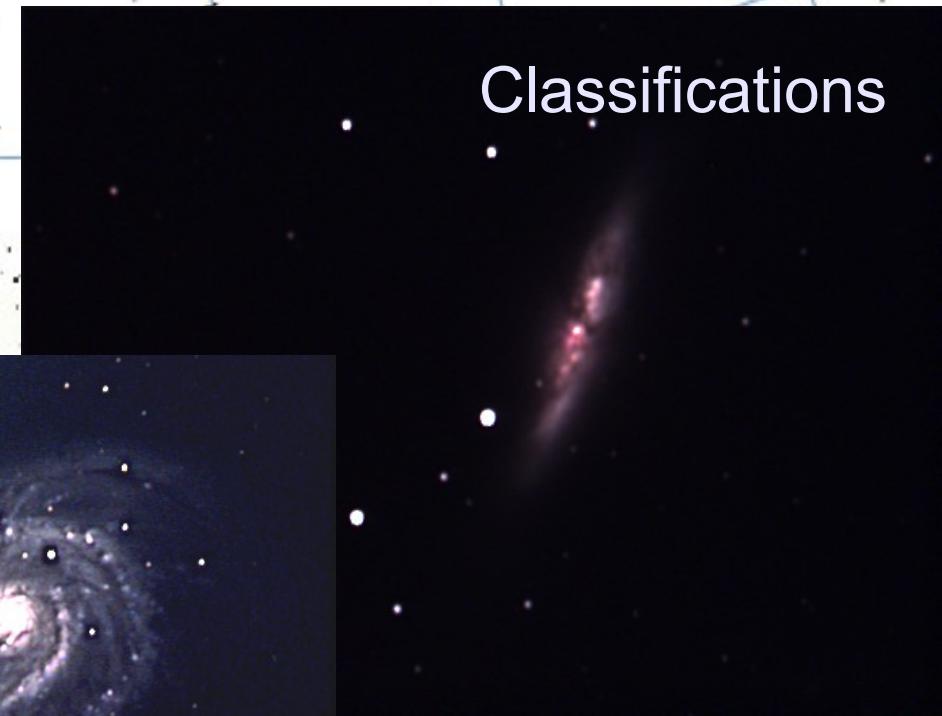


Galaxies

Types



Classifications

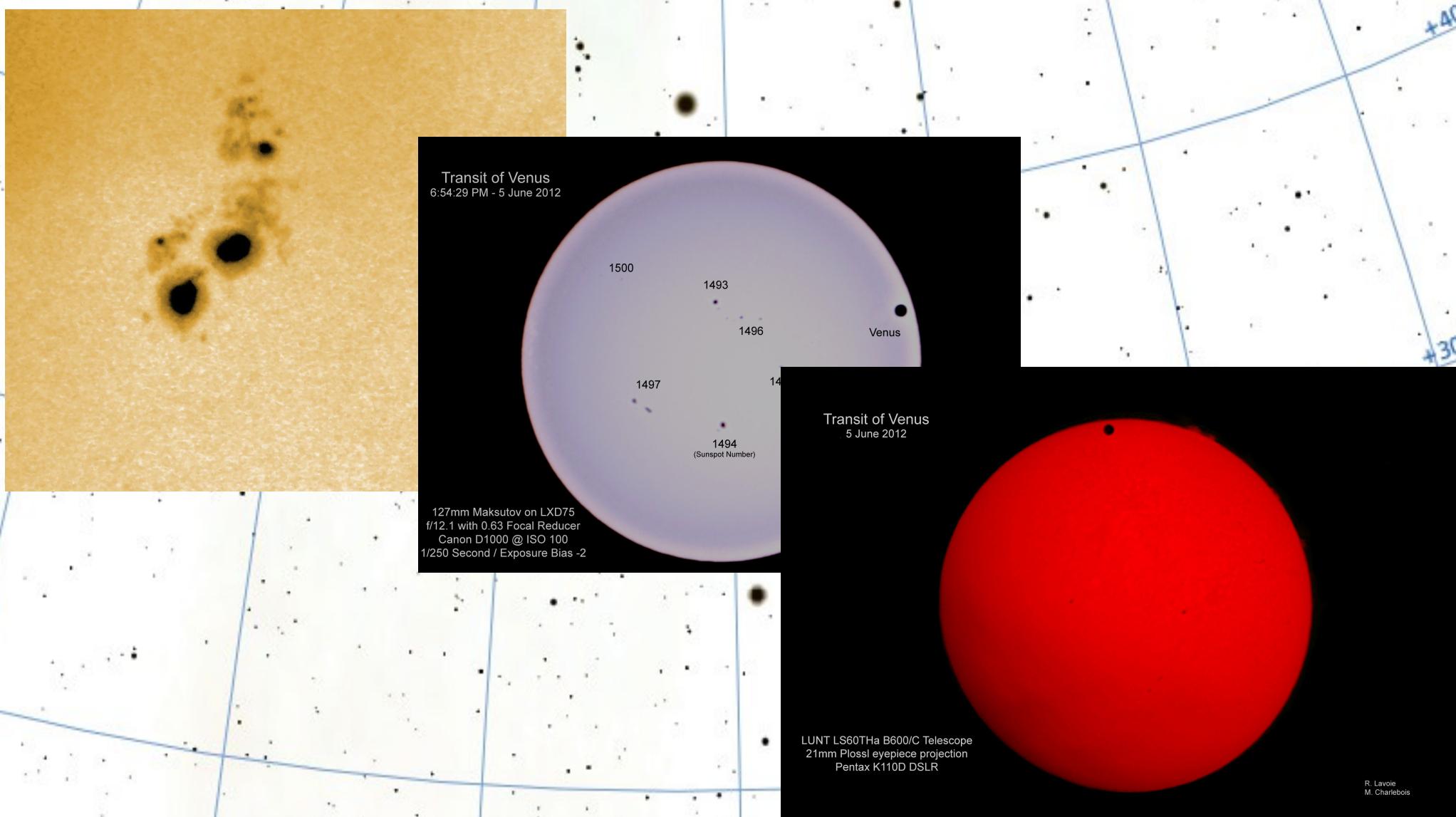


Structure

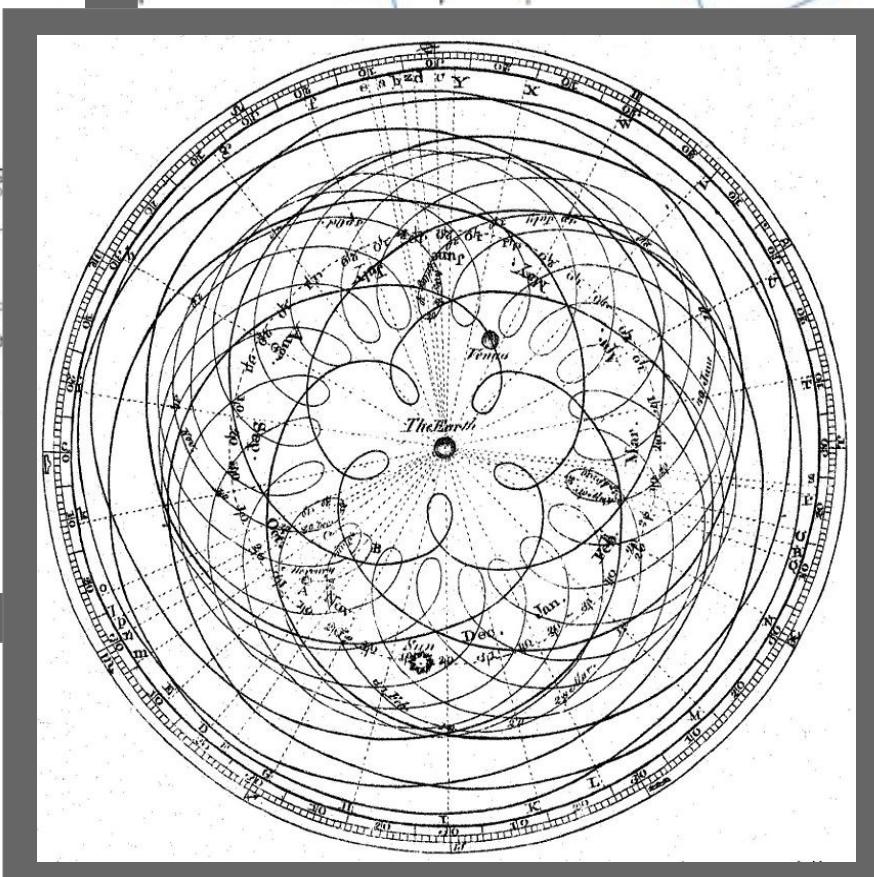
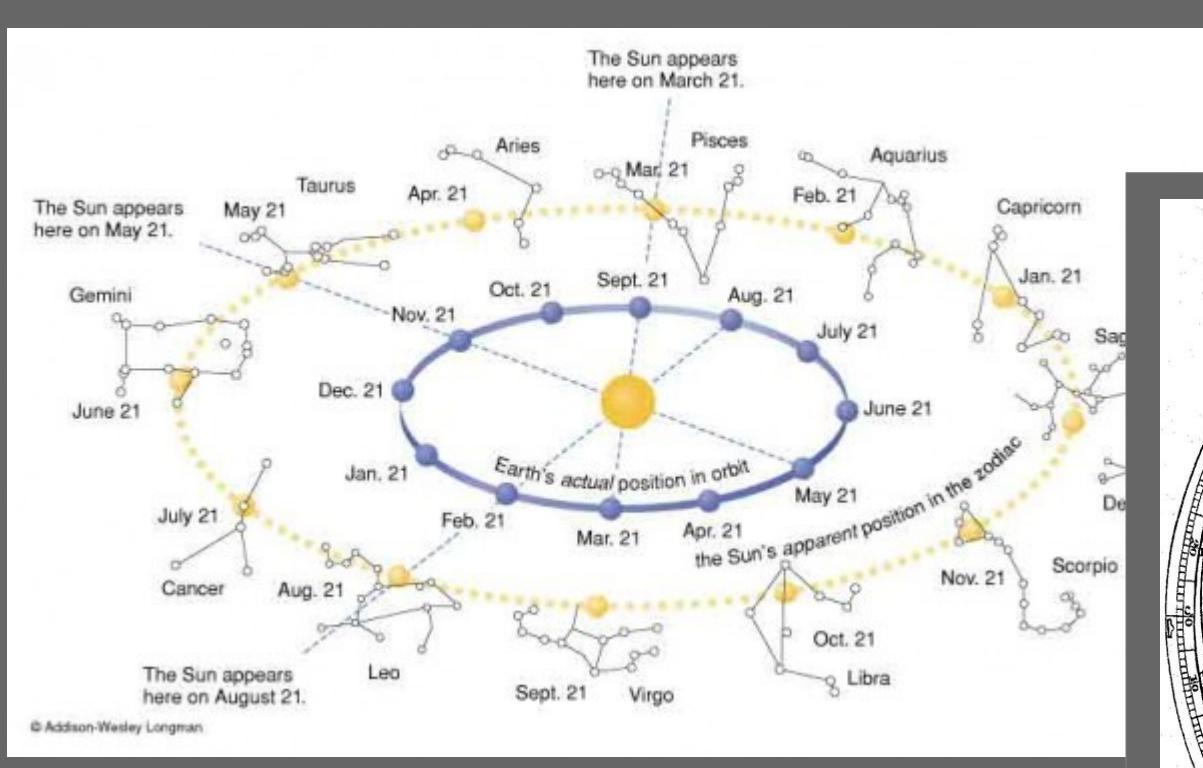


As Gravitational Lenses

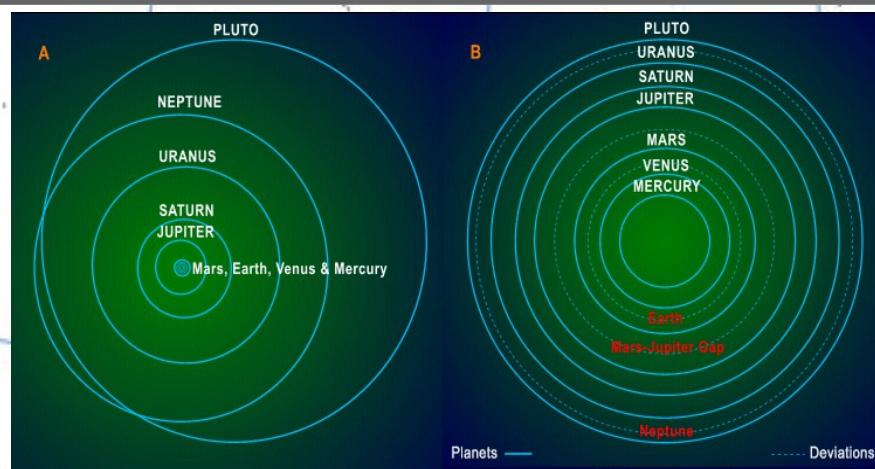
Observing the Sun



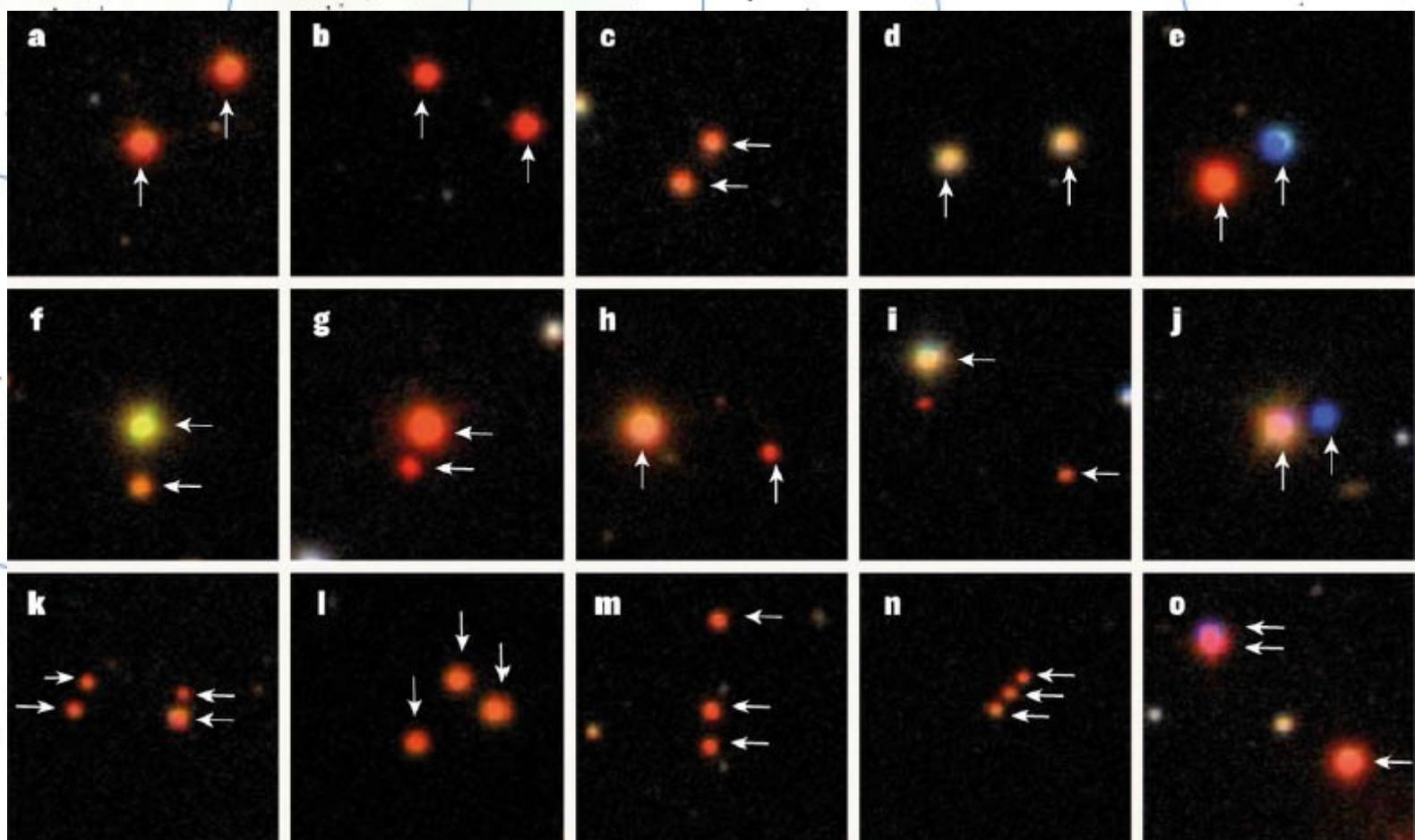
Solar System Orbital Mechanics



[wikipedia.org/wiki/Deferent_and_epicycle#/media/File:Cassini_apparent.jpg](https://en.wikipedia.org/wik.../File:Cassini_apparent.jpg)

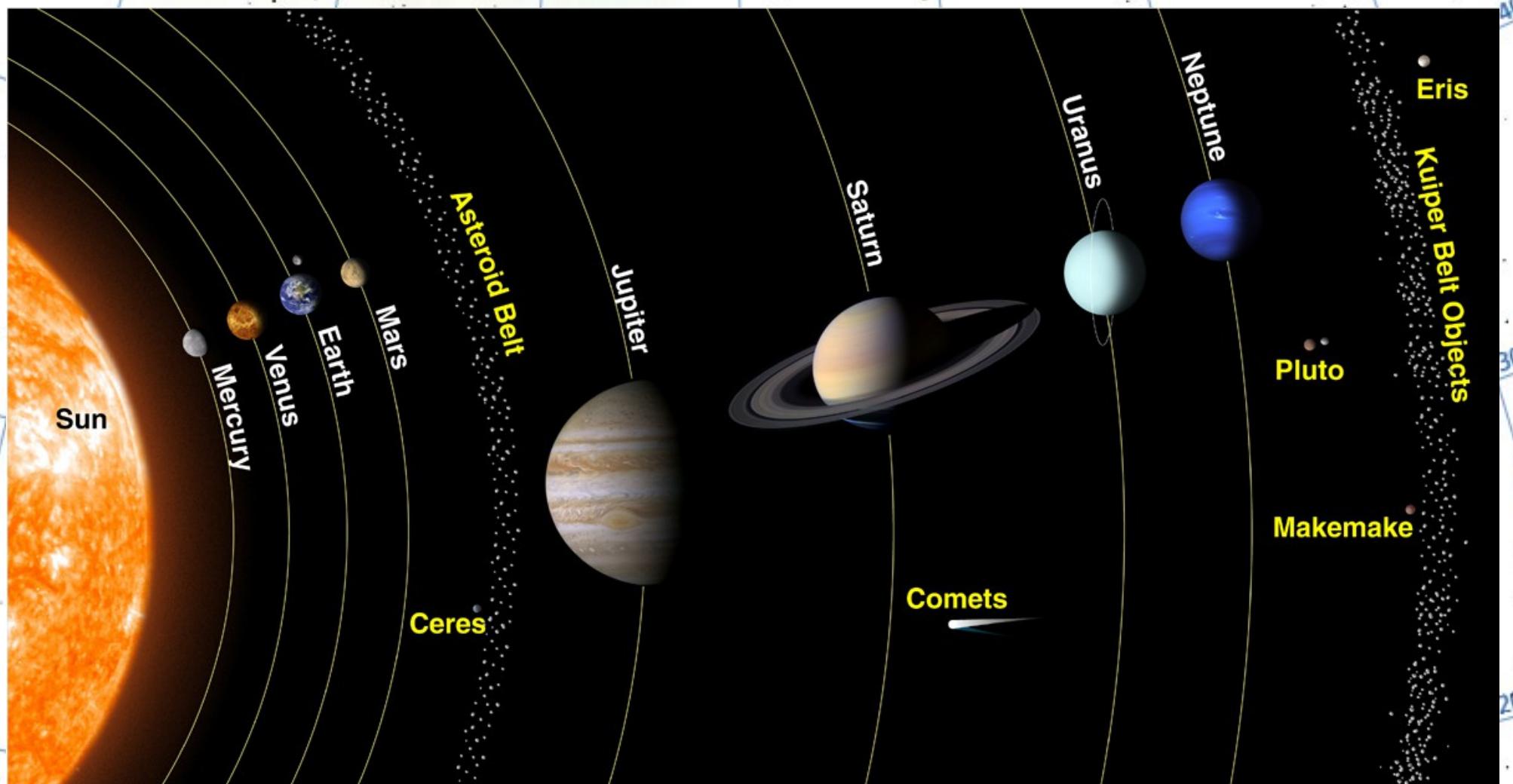


Multiple Stars

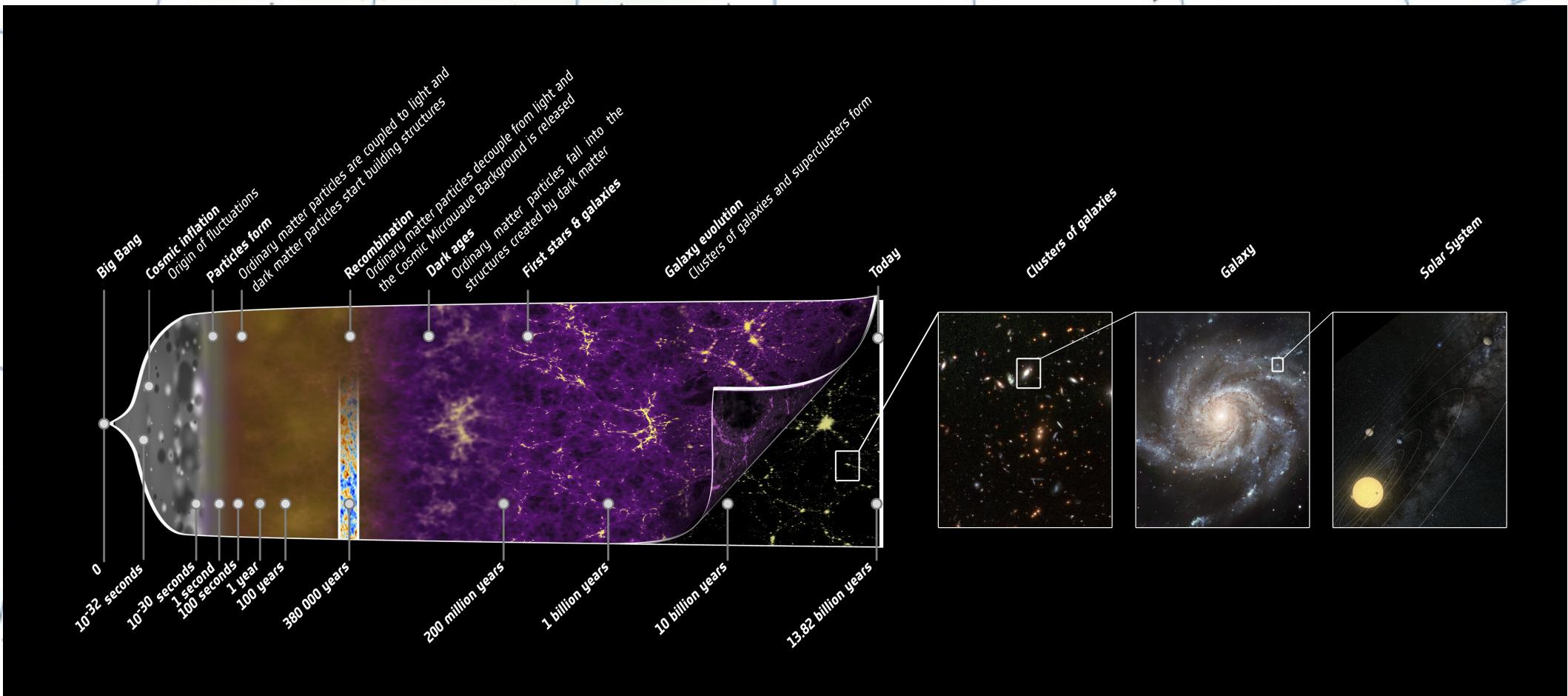


<http://www.walkingmountains.org/wp-content/uploads/2013/04/doublestars.jp>

The Planets



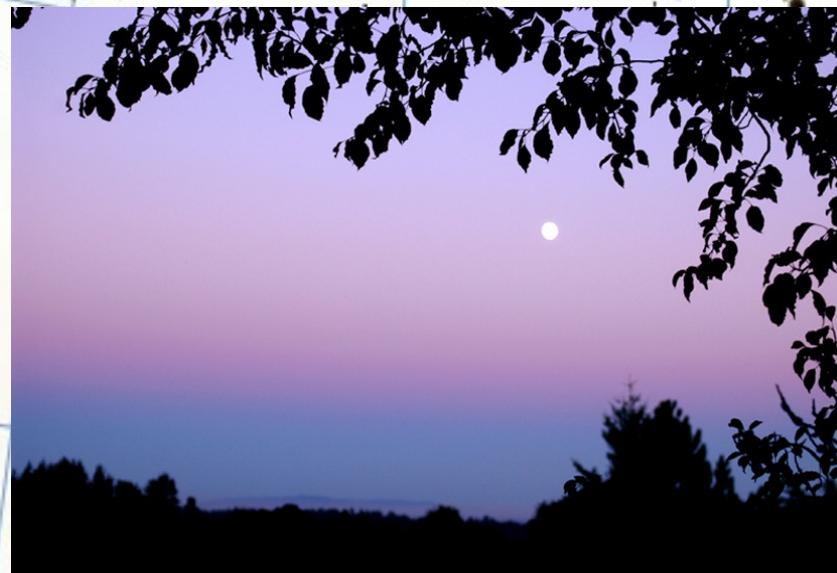
What's Next – History of the Universe



What's Next – Atmospheric Phenomena



- Twilight, the earth's shadow and Zodiacal Light



© David Malin

...About the OAWS

- Non-profit, (free to attend), run by volunteers (Jim Thompson, Simon Hanmer and Rob Lavoie and numerous guests) from local Ottawa area clubs, (RASC - Ottawa Chapter and the OAOG)
- Typically held 6x/year, hosted at Davis Engineering, 1620 Old Innes Rd. Ottawa
- Workshops focus on amateur Astronomy topics ranging from equipment how to's, imaging techniques, solar, lunar, planetary and Deep Sky, to deeper astronomical topics like the current Understand the Universe series.
- Done for Fun! Outreach to the local astronomer community for the benefit of all involved.