Astronomy 3:

~~Introductory Astronomy: The Solar System~~

Introductory Astronomy: Planetary Systems

Professor: Jonathan Fortney
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TA: Chris Mankovic
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TA: Emily Cunningham
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Finn, age 6, and Graham, age 4

About Me:

Age: 36
Previous Life: Mountain View and NASA Ames (2004-2008), University of Arizona (1999-2004), Iowa State University (1995-1999), St. Paul, Minnesota (1976-1995)

Married for 9 years, 2 kids

I mostly study that atmospheres and interior structure of "exoplanets" the planets that are found around other stars.

- I realize that the vast majority of you are here to fulfill a requirement

- That being said, you chose this class from a variety of possibilities!

- The #1 thing that I ask of you is to take ownership of your learning
  - This class is 40% first-year students
  - There isn't a tremendous amount of hand-holding, so seek out help when you need it
  - Try your best

- Class web page:
http://www.ucolick.org/~jfortney/3.htm

The Class

- This is a one-term introductory course on planetary systems, covering the properties of the solar system and other planetary systems.
- Topics include the Sun, solar system exploration, the physical nature of the Earth and the other planets, comets and asteroids, the origin of the solar system, the possibility of life on other worlds, planet formation, and
- The discovery and characterization of planets beyond the solar system, which puts our solar system in context. It is intended for nonscience majors.

Part I: Motion of the earth, moon, sun and planets in space
Gravity, explaining and predicting motion
Light, Energy, matter and how we observe the solar system

Part II: Overview of trends in the solar system
Formation the solar system
The Sun

Part III: Inner solar system
Atmospheres and Interiors

Part IV: Outer solar system
Atmospheres and Interiors
Satellite systems

Part V: Other planetary systems
Detecting exoplanets and characterizing them
Ways of making planetary systems

Exams

•Midterm: October 31st

•Final: December 10th, covering all course material

•Multiple choice, T/F and maybe short answer

Homeworks

Due basically every Thursday, plus the Tuesday after Thanksgiving

Office Hours

Professor Fortney: Wednesday, 1:30-3 pm

Emily Cunningham: Mon 3:30-4:30, Tues 5-6, Weds 11:30-12:30

Chris Mankovich: Tues 11-12 and 4-5

Date		Due	Topics	Chapters
9/26,	Th		intro, solar system in perspective, scales	1,2
10/1,	T		seasons, moon phases, history of astronomy	2,3
10/3,	Th	hw1	orbits, Kepler's laws, nature of science	3
10/8,	T		Newton’s laws, energy	4
10/10,	Th	hw2	matter and light	5
10/15,	T		overview of the solar system	7
10/17,	Th	hw3	formation of planetary systems	8
10/22,	T		the Sun	14
10/24,	Th	hw4	geology/geophysics of terrestrial planets I	9
10/29,	T		geology/geophysics of terrestrial planets II	9
10/31,	Th		MIDTERM EXAM	
11/5,	T		atmospheres of terrestrial planets I	10
11/7,	Th	hw5	atmospheres of terrestrial planets II	10
11/12,	T		giant planets	11
11/14,	Th	hw6	satellites of the giant planets	11
11/19,	T		asteroids, meteorites, dwarf planets, comets	12
11/21,	Th	hw7	planetary systems around other stars I	13
11/26,	T		planetary systems around other stars II	13
11/28,	Th		THANKSGIVING	
12/3,	T	hw8	planetary systems around other stars III	13
12/5,	Th		life in the solar system and others	24
12/10	T	FINAL EXAM, 8-11 a.m.		

Basic high school math required
simple equations, ratios (no calculus)

Metric system
length: meters 1000 mm = 1 m, 1000 m = 1 km
1 m ~ 3 ft, 1 mile = 1.6 km
You are 1.5 - 2 m tall

Scientific notation: $0.001\ m = 1 \times 10^{-3}\ m$
Distance to sun: $150{,}000{,}000{,}000\ m = 1.5 \times 10^{11}\ m$
Wavelength of visible light: $0.0000005\ m = 5 \times 10^{-7}\ m$
We (and your calculator) need scientific notation!

Review in Homework 1

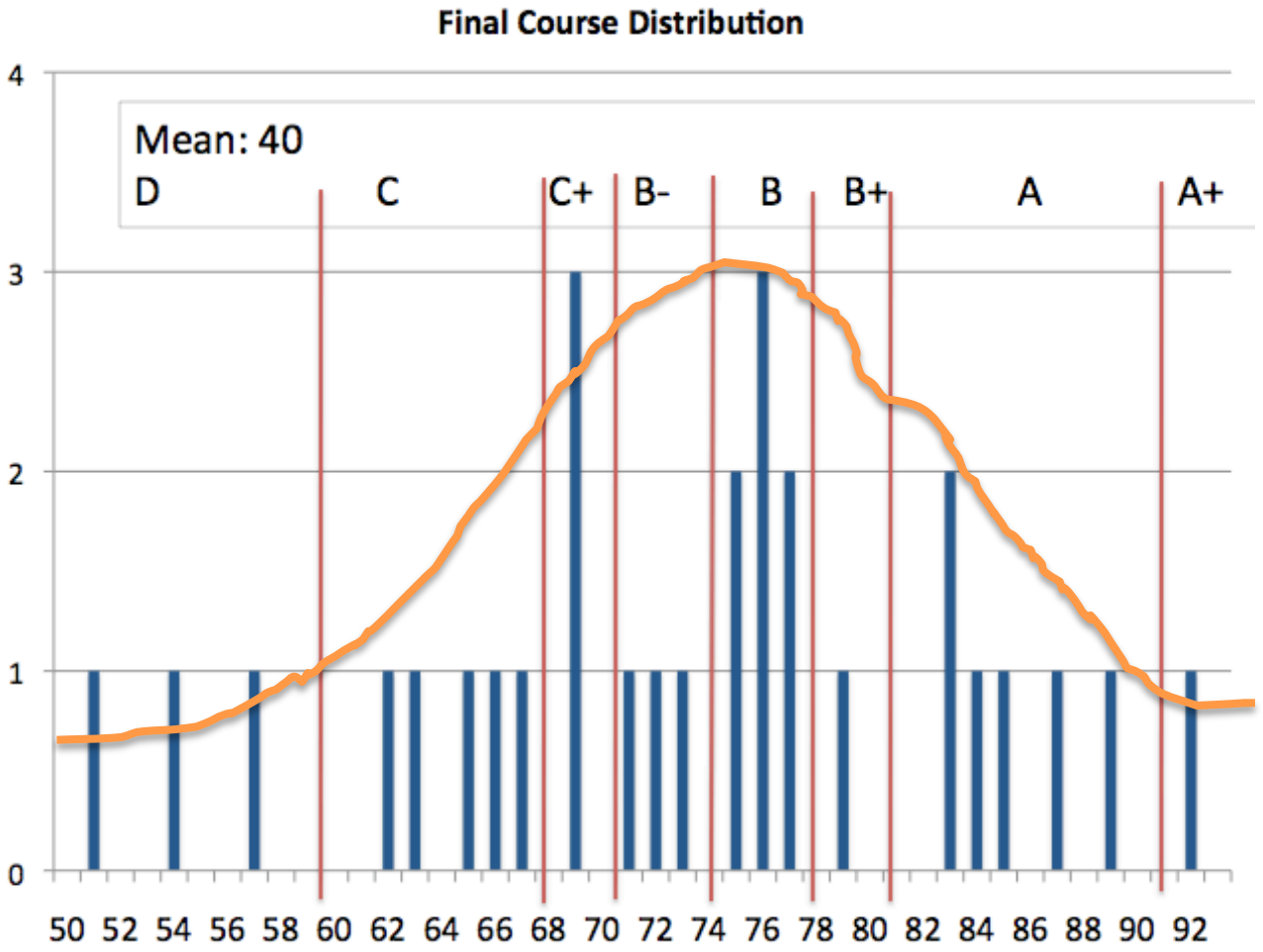
Look at **Appendix C** in Cosmic Perspective

Review in Discussion Sections!

Grading

iClickers	10%	
Homeworks:	25%	(8 total)
Midterm:	30%	
Final:	35%	

Grading will be on a "curve"



Mastering Astronomy

www.masteringastronomy.com

You must register. Instructions are on the class web site.
http://www.ucolick.org/~jfortney/3.htm

Homeworks will be done online

Tutorials and a vast array of additional material that is complementary to lectures and the textbook. Look for the "**Study Area**" link.

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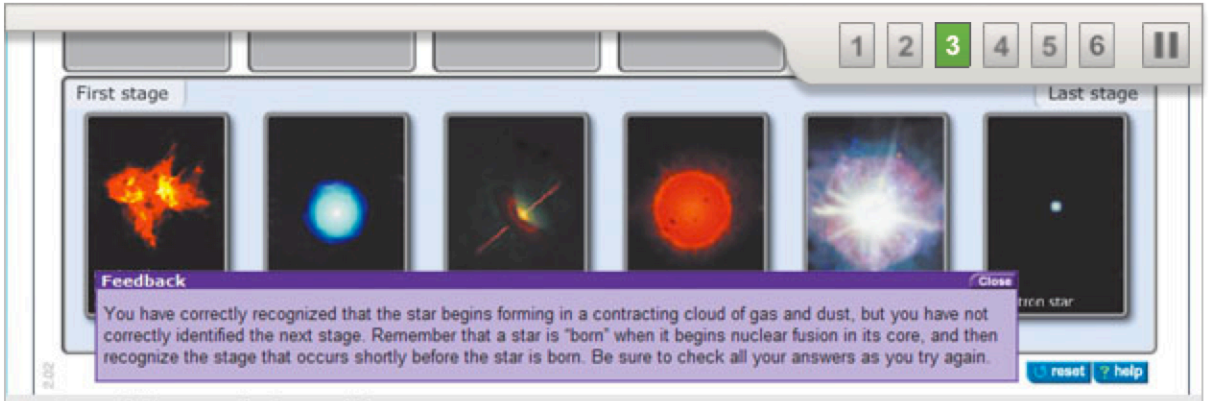
Username:

Password:

Sign In

Forgot your username/password?



Tutorials and Coaching

MasteringAstronomy allows students to learn science by practicing science, emulating the one-on-one office hour experience.

Play Movie

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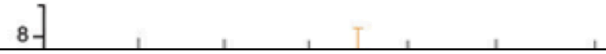


Lectures

Posted on course web page as PDF the day of lecture

Clarify and highlight material

Not a substitute for reading the textbook!

iClicker
feedback (for both of us)
points for participating = responding to questions in lecture
1 point for a correct answer
1 point for a wrong answer!
can miss 4 lectures without penalty

Register your iClicker by Tuesday, 10/1!

Get a small, inexpensive calculator, that does does roots and powers.
No iphones/ipads during exams

www1.iclicker.com/register-an-iclicker/

GMail GCal NYTimes ESPN WPost SI ADS Fb YMail Exo.eu Mint BayFed BRcard NYClean OCA VoxC

i>clicker

Products Solutions Resources Support Purchase Register

Register

- Register an i>clicker
- Find i>clicker ID

Register Your Clicker

Register your i>clicker remote so your instructor will be able to give you credit for using your clicker in class.
Have questions? Visit our **student support portal**.

Does your school use a Learning Management System (such as Blackboard, Moodle, etc.)?

○ No ○ Yes ○ Not Sure

First Name:

Last Name:

Student ID:

The ID assigned by your school. Check your syllabus or ask your instructor if you are unsure what to enter.

Remote ID:

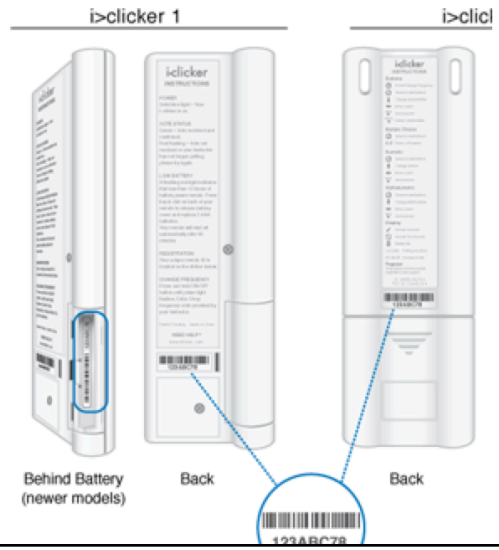
The 8-character code found on your remote (see image). Codes only use letters A-F and numbers 0-9.

r p 3 n x

Image Code:

The verification code shown in the image above.

Register Reset Form



Clicker Question: How many college science classes have you taken, including this one?

- A) 1
- B) 2
- C) 3
- D) 4+

Sections:

Tuesday, 6:00-7:10 p.m., Phys Sciences 114 (Emily)
Wednesday, 8:00-9:10 a.m., Phys Sciences 114 ((Emily)
Wednesday, 11:00 a.m.-12:10 p.m., Nat Sci Annex 101 (Chris)
Friday, 3:30-4:40 p.m., Nat Sci Annex 101 (Chris)

Please attend the section that you signed up for.

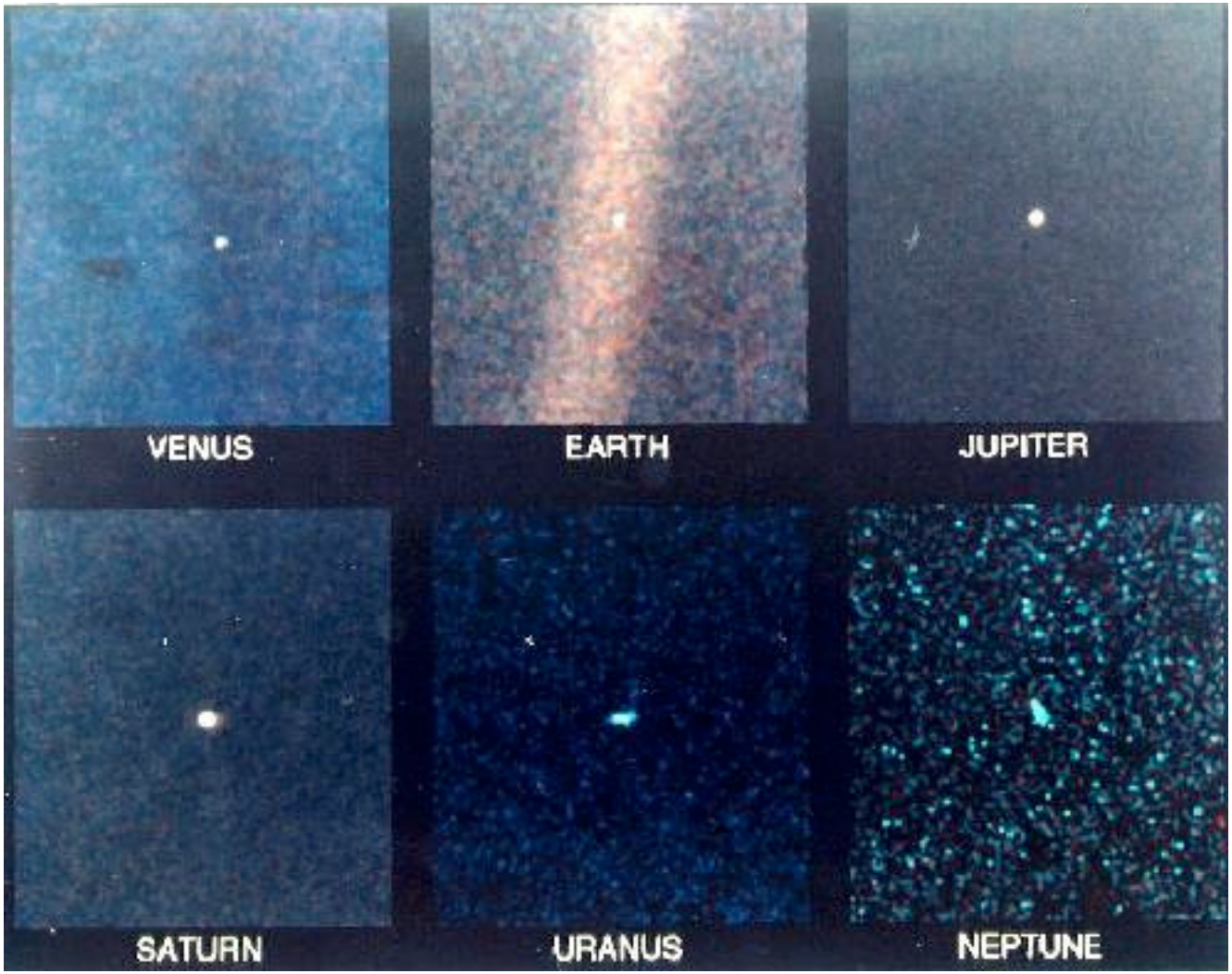
Attendance is not require but is essential to your success.

- Questions from class
- Help with homework
- Help with mathematics

Last Pieces of advice

- Understand your textbook
  - Read the Preface and the Forward
  - Stay ahead of class lecture material
- Meet the people in your class
- Use the masteringastronomy.com tutorials
- Attend Lecture and Discussion Section
- Get a small calculator that can do roots and exponents

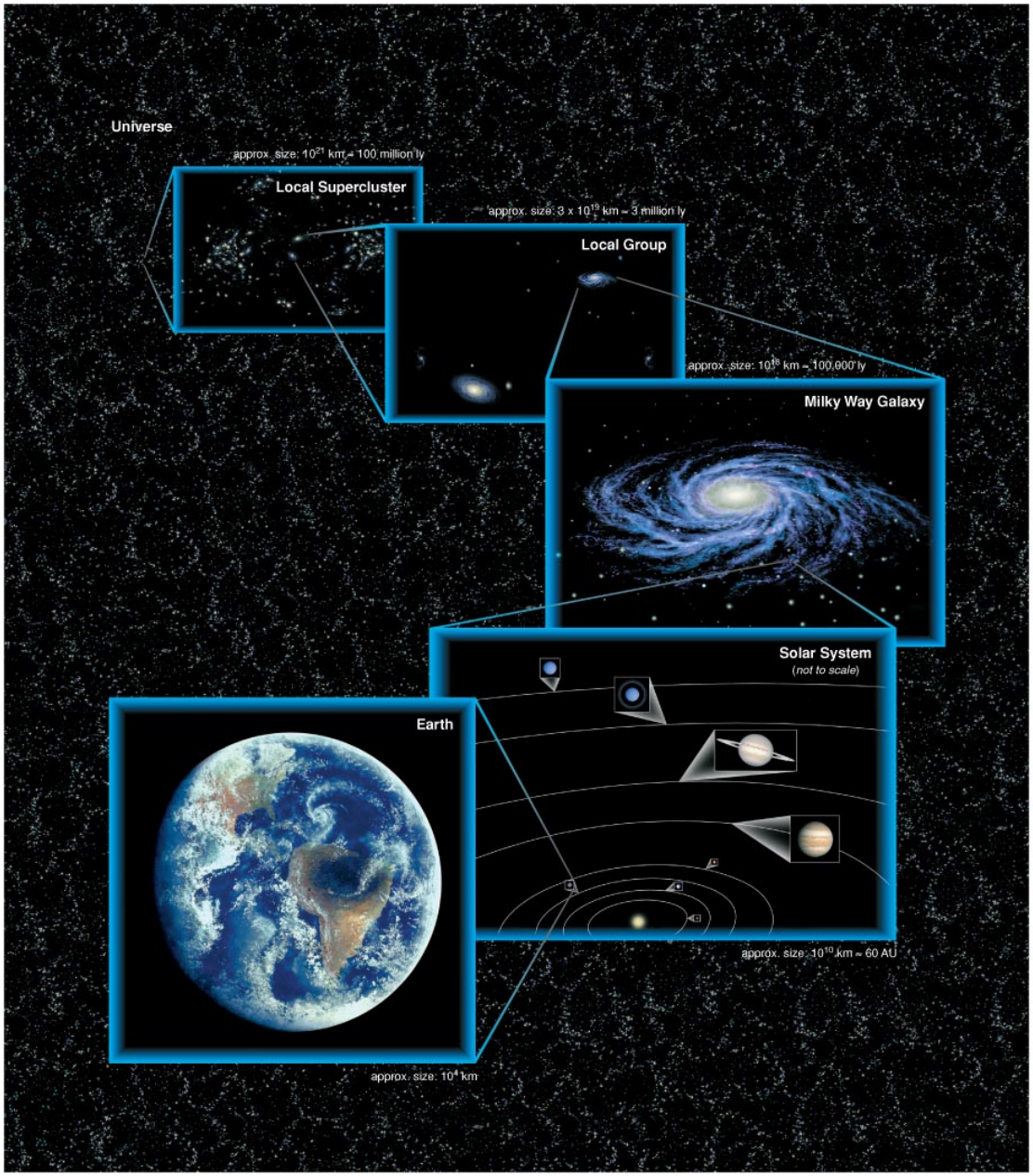
The "Cosmic Perspective"



Earth as a Pale Blue Dot
Read pages XXV-XXVII of the Forward

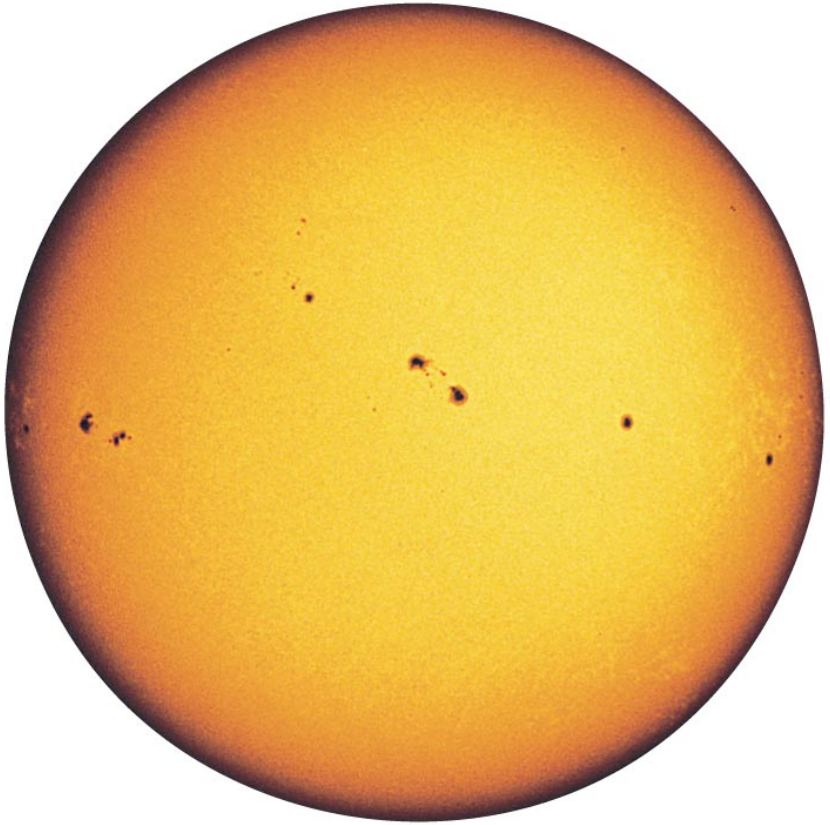
Powers of Ten

What is our place in the universe?

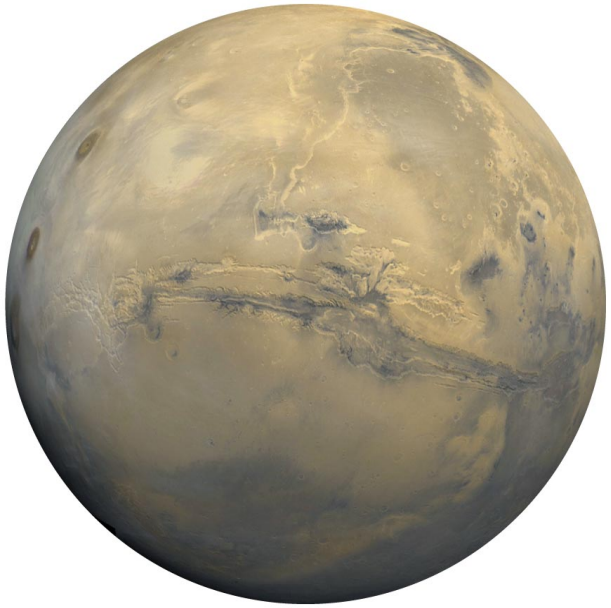


Star

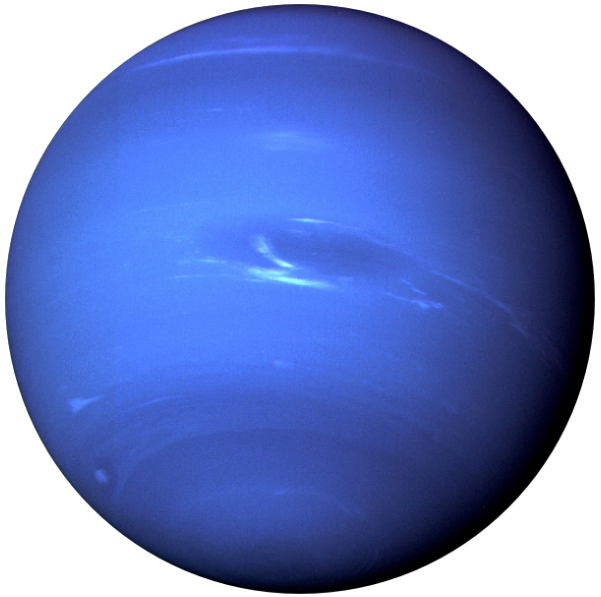
- A large, (10^{30} kg) ball of gas, mostly hydrogen, that generates heat and light via nuclear fusion
- Fusion happens because stars compress under their own gravity and create extremely high pressure in their centers



Planet



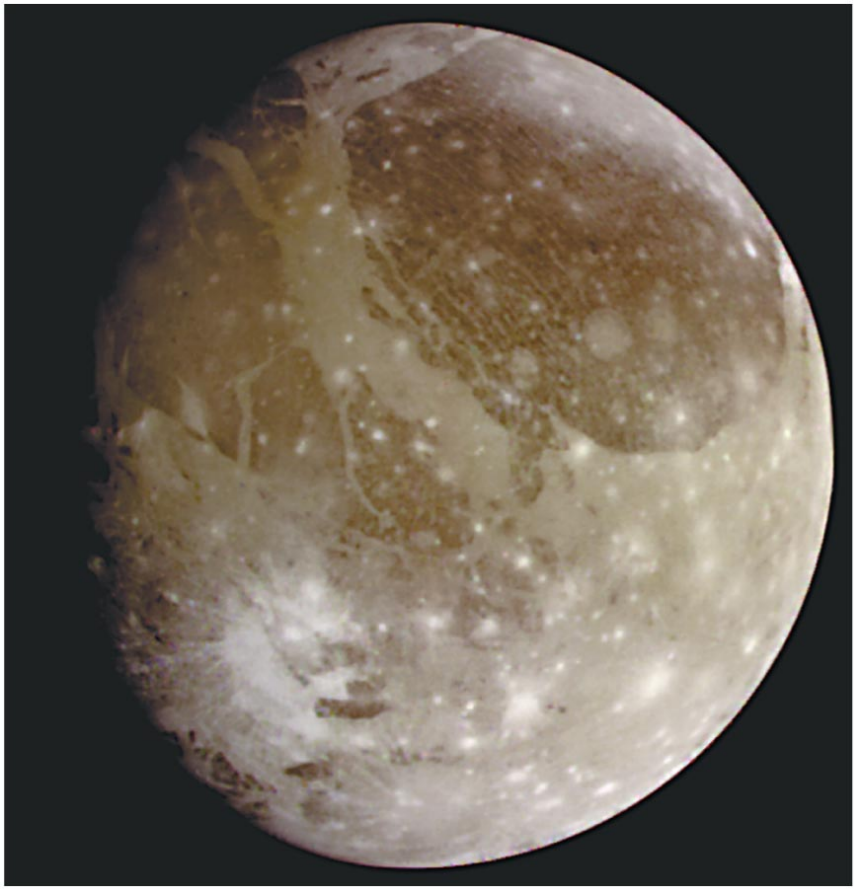
Mars



Neptune

- A moderately large object that orbits a star; it shines by reflected light. Planets may be rocky, icy, or gaseous in composition.
- Massive enough to form spherical objects

Moon (or Satellite)

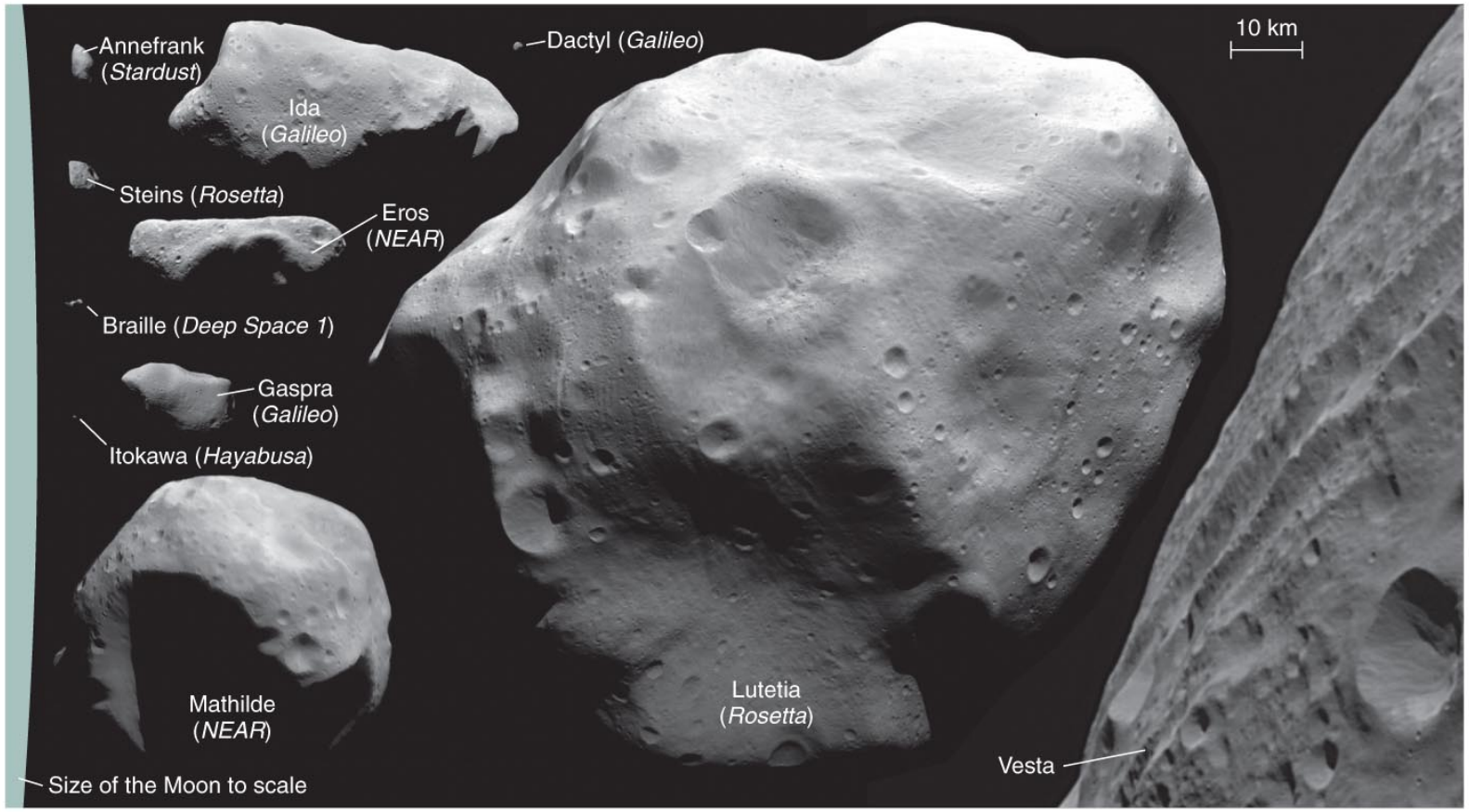


Ganymede (orbits Jupiter)

- An object that orbits a planet
- They can be be just as complex and interesting as planets

Asteroid

- A relatively small and rocky object that orbits a star

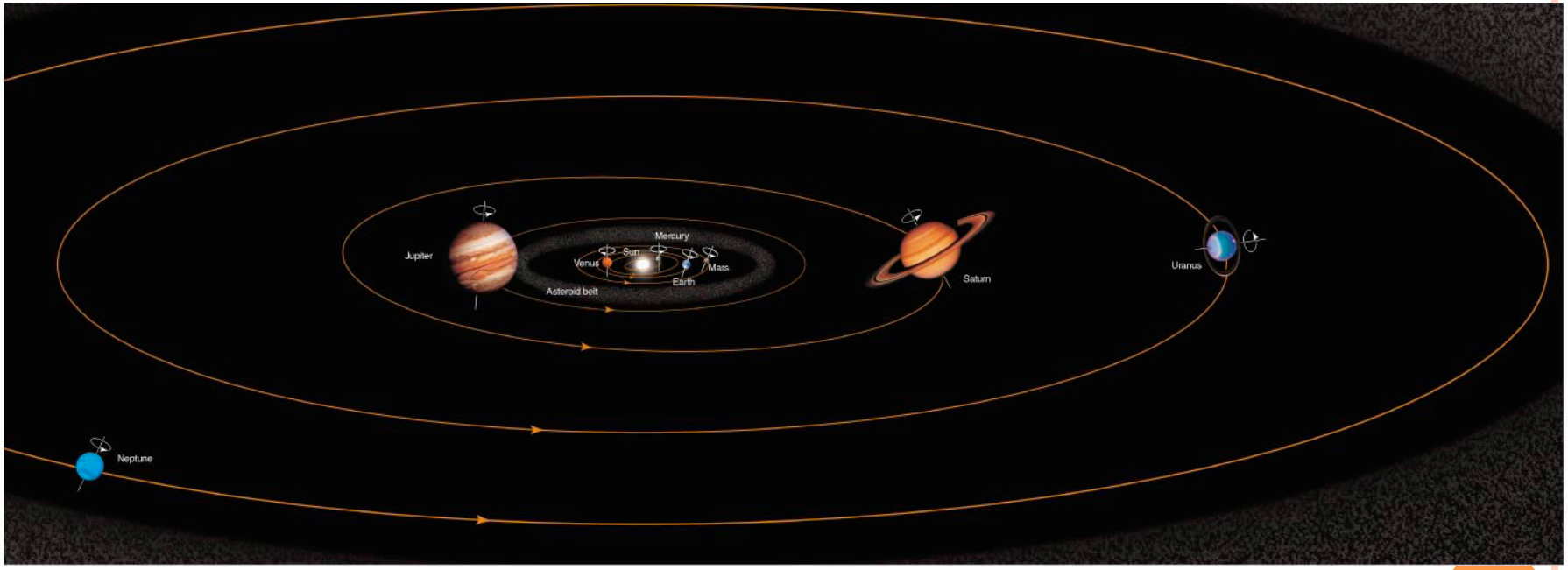


Comet

- A relatively small and icy object that orbits a star

Solar (Star) System

- A star and all the material that orbits it, including its planets and moons



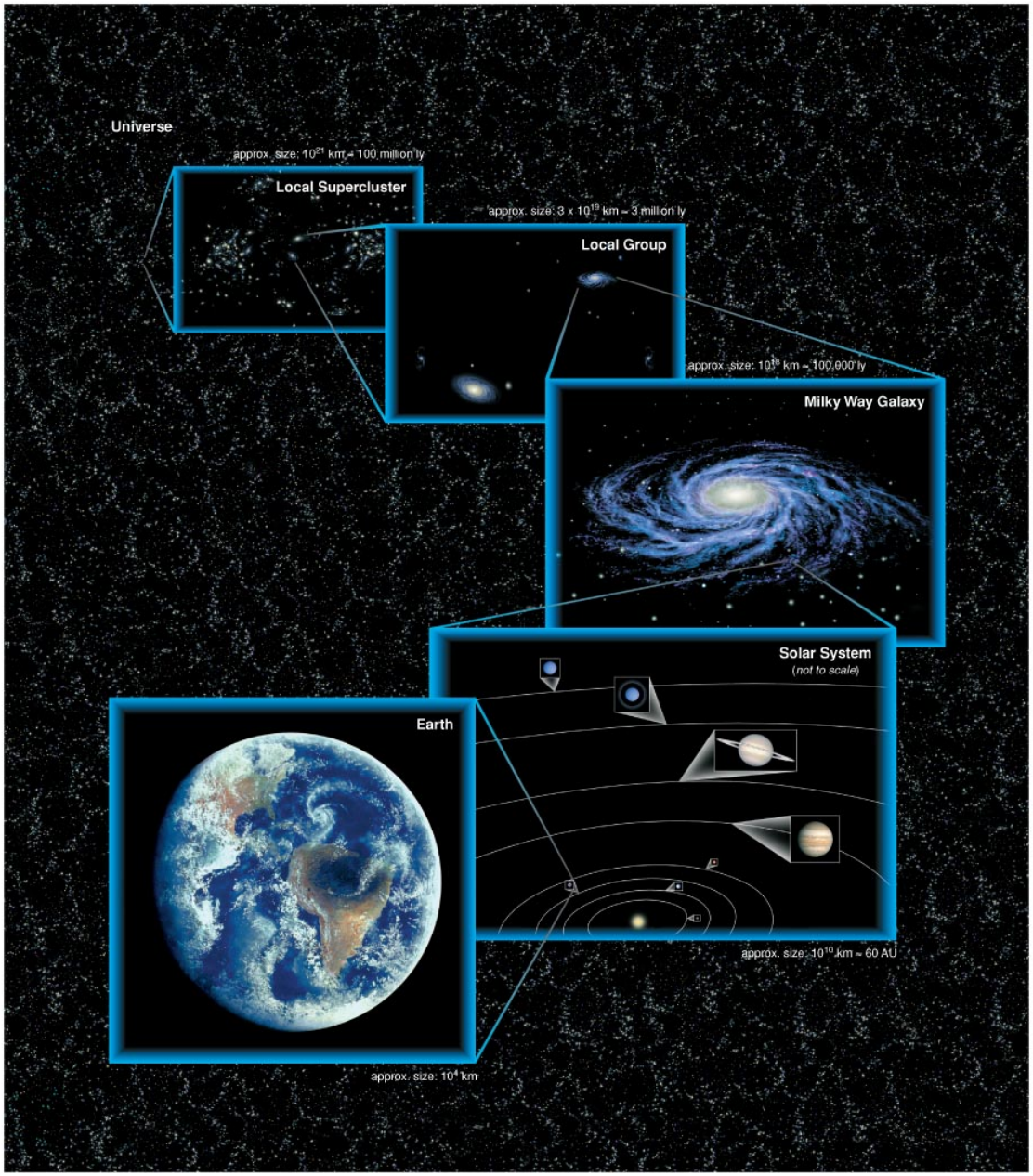
Galaxy

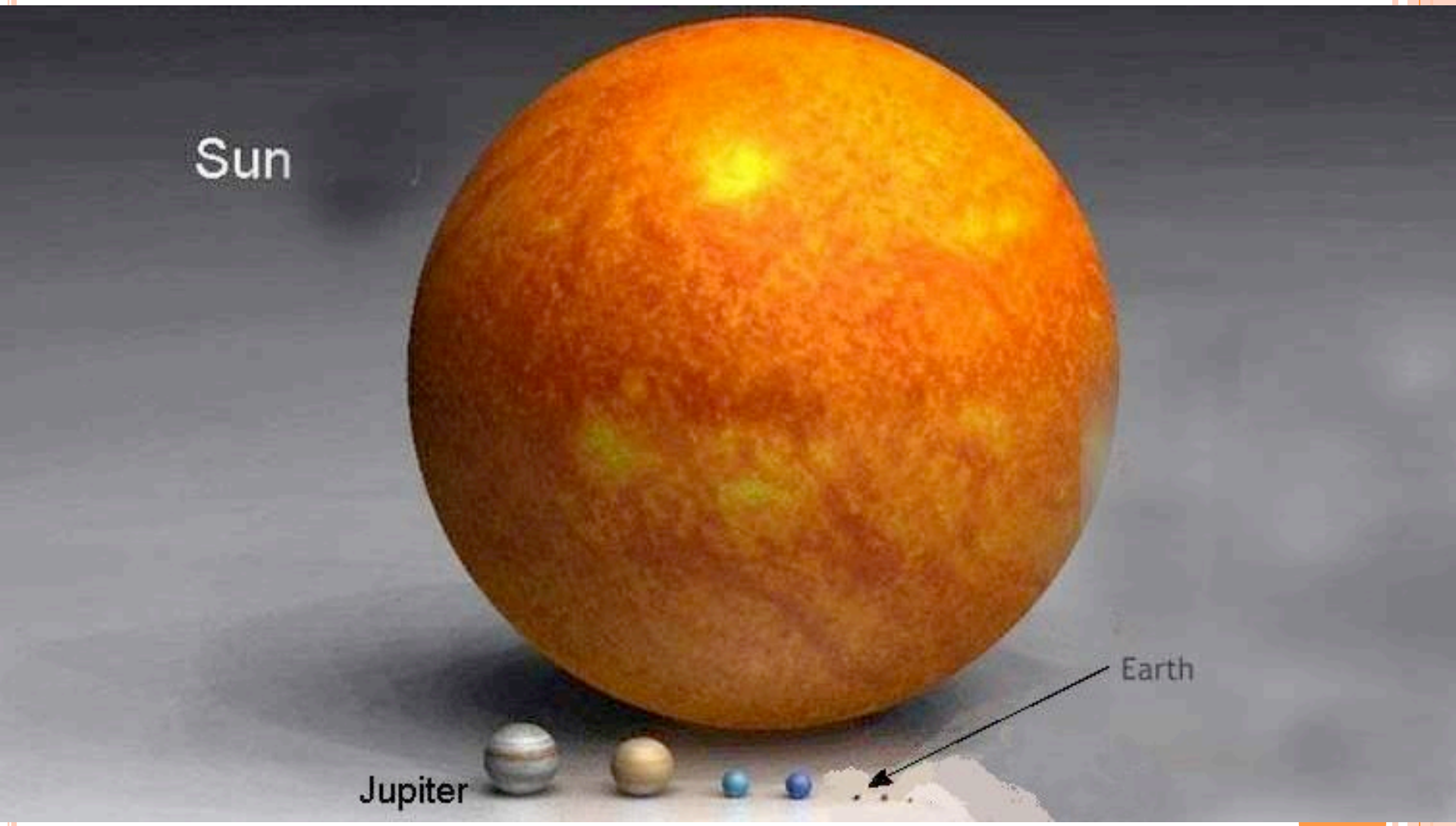
- A great island of stars in space, all held together by gravity and orbiting a common center

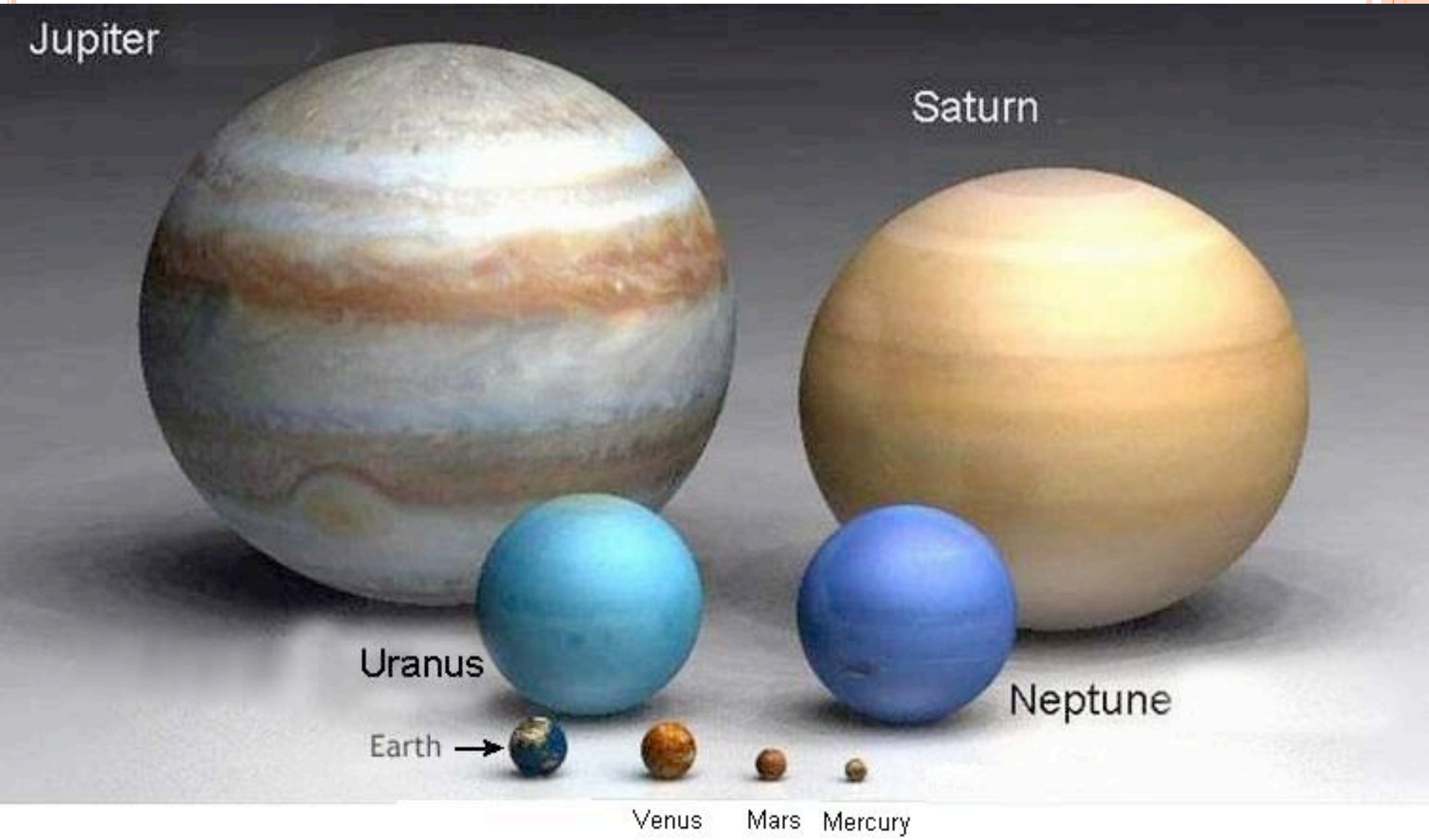
Universe

- The sum total of all matter and energy; that is, everything within and between all galaxies

What is our place in the universe?




Sun
Earth
Jupiter


Jupiter
Saturn
Uranus
Neptune
Earth
Venus
Mars
Mercury

Far away means back in time?

- Light travels at a finite speed (300,000 km/s).

Destination	Light travel time
Moon	1 second
Sun	8 minutes
Sirius	8 years
Andromeda Galaxy	2.5 million years

- Thus, we see objects as they were in the past:

The farther away we look in distance, the further back we look in time.

Far away means back in time?

Example:

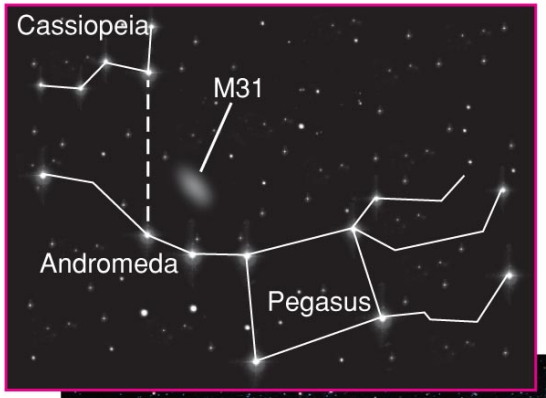
- We see the Orion Nebula as it looked 1500 years ago.

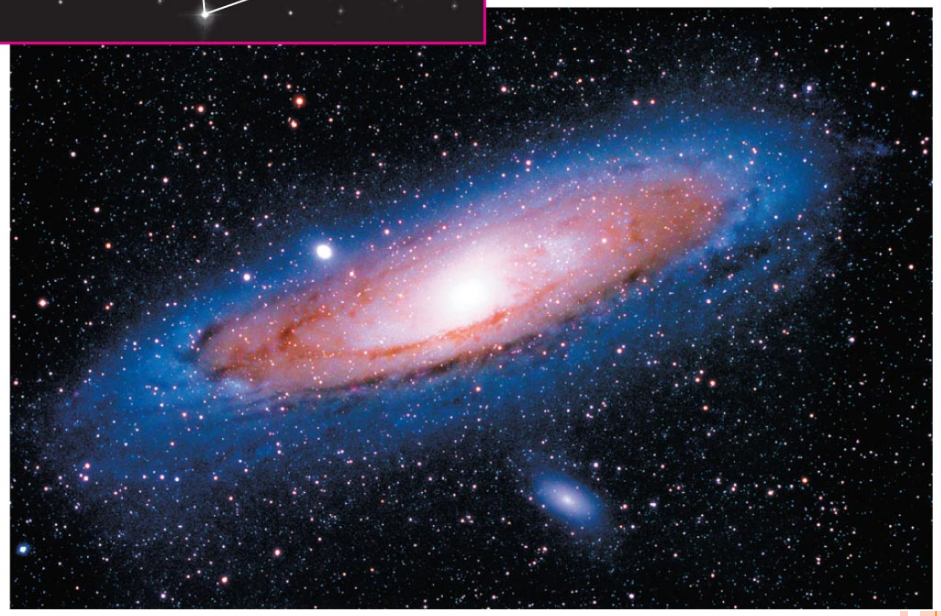
Interactive Figure

Far away means back in time?

Example:

- This photo shows the Andromeda Galaxy as it looked about 2 1/2 million years ago.



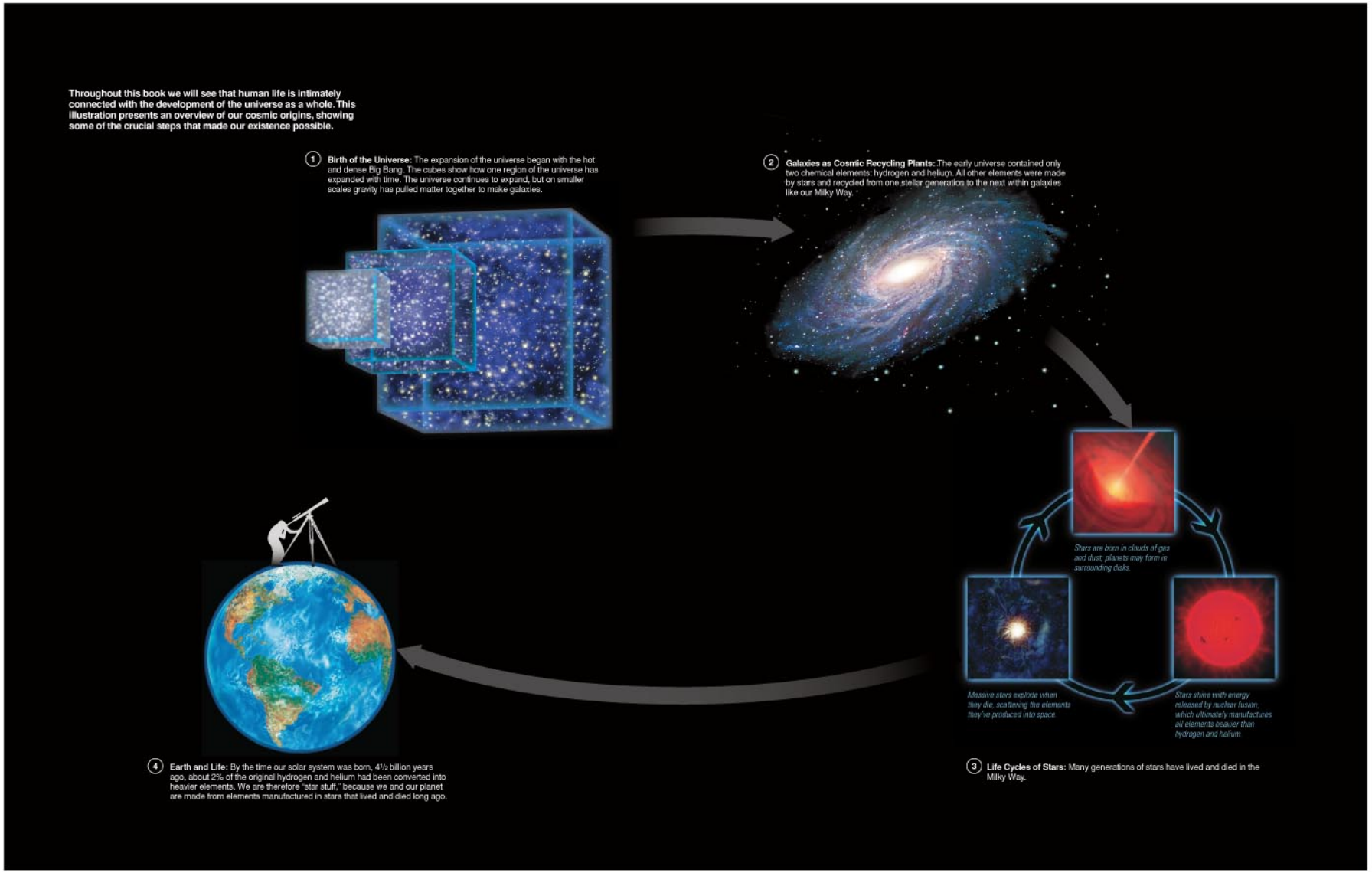


The Astronomical Unit ("AU")

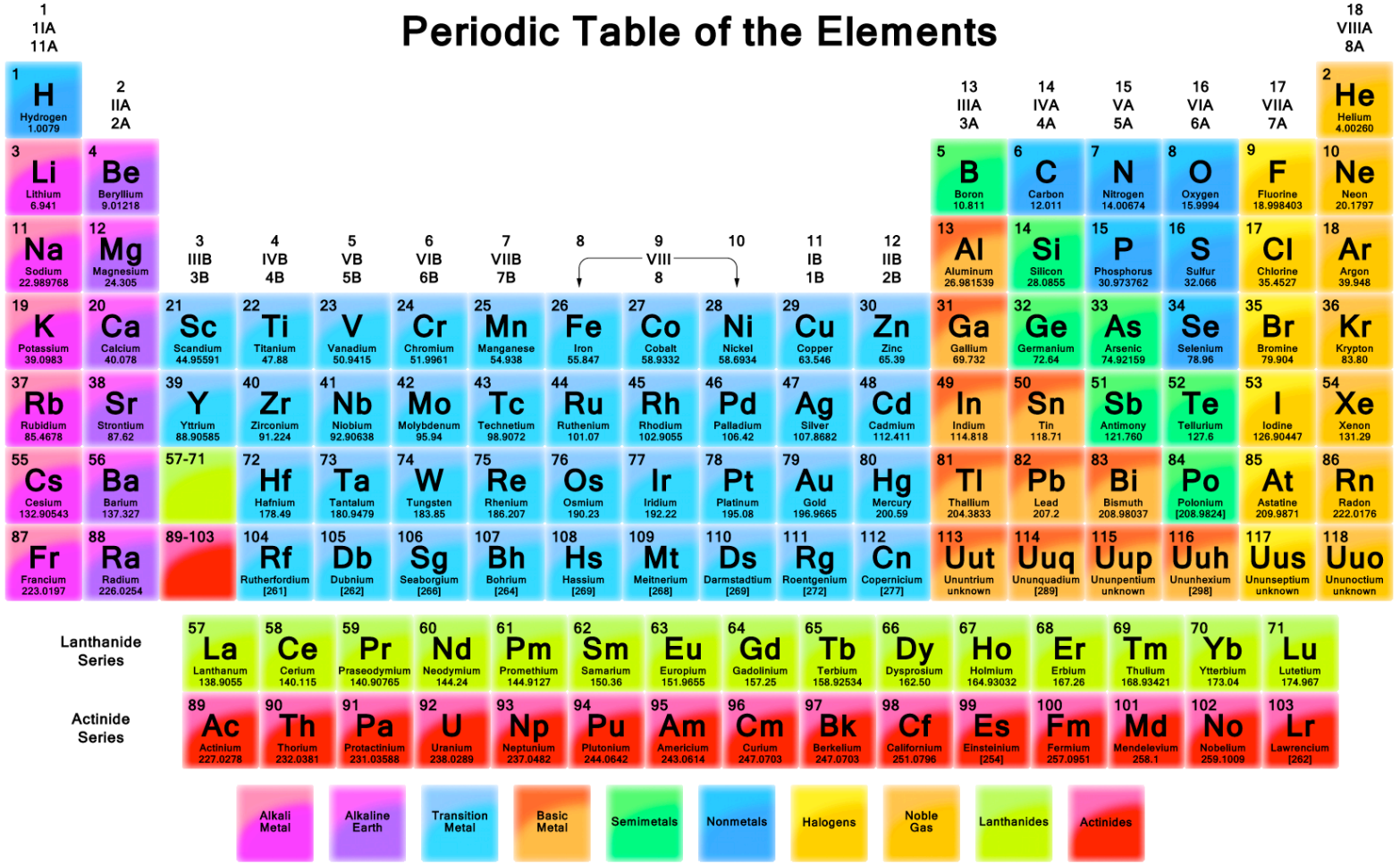
- One of our units of choice in this class
- The average distance of the Earth to the Sun
- It sets our basic distance unit for planetary systems
- 1 AU = 1.5×10^{11} m
- 1 AU = 1.5×10^{8} km
- 1 AU = 93 million miles
- 1 AU = 8 light minutes

- Planetary orbits can be 0.01 AU to 1000+ AU.

How did we come to be?



When the Universe formed, there was only H, He, and Li



- Stars have created every other element, and are continuously making more

Where did you come from?

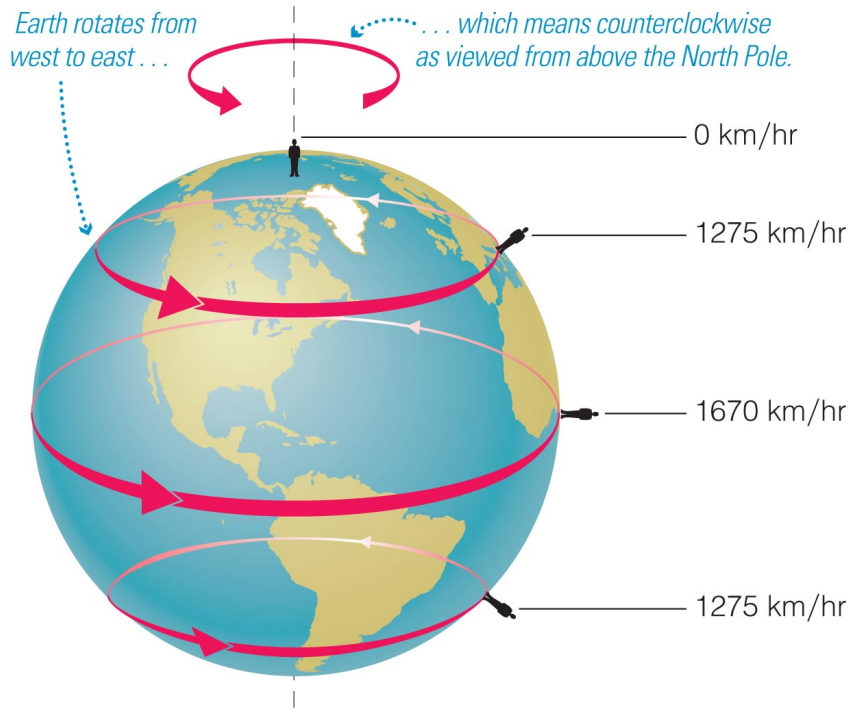
- Every atom in your body was manufactured in either:
  - **The creation of the Universe (13.8 billion years ago)**
  - **Stars living their normal lives, making, C, N, O**
  - **Supernovas (Exploded stars)**
- We are made of parts of the Universe that came together via gravity to make a large rock/iron planet we call Earth, 4.5 billion years ago
- Over the course of the next 4.5 billion years, a very small fraction of the elements on Earth were incorporated into carbon-based molecules that eventually obtained the ability to propagate, learn, and eventually examine the Universe around themselves
- We are not IN the Universe, we ARE the Universe

1.3 Spaceship Earth

- Our goals for learning:
  - **How is Earth moving through space?**

How is Earth moving through space?

- Contrary to our perception, we are not "sitting still."
- We are moving with Earth in several ways, and at surprisingly fast speeds.

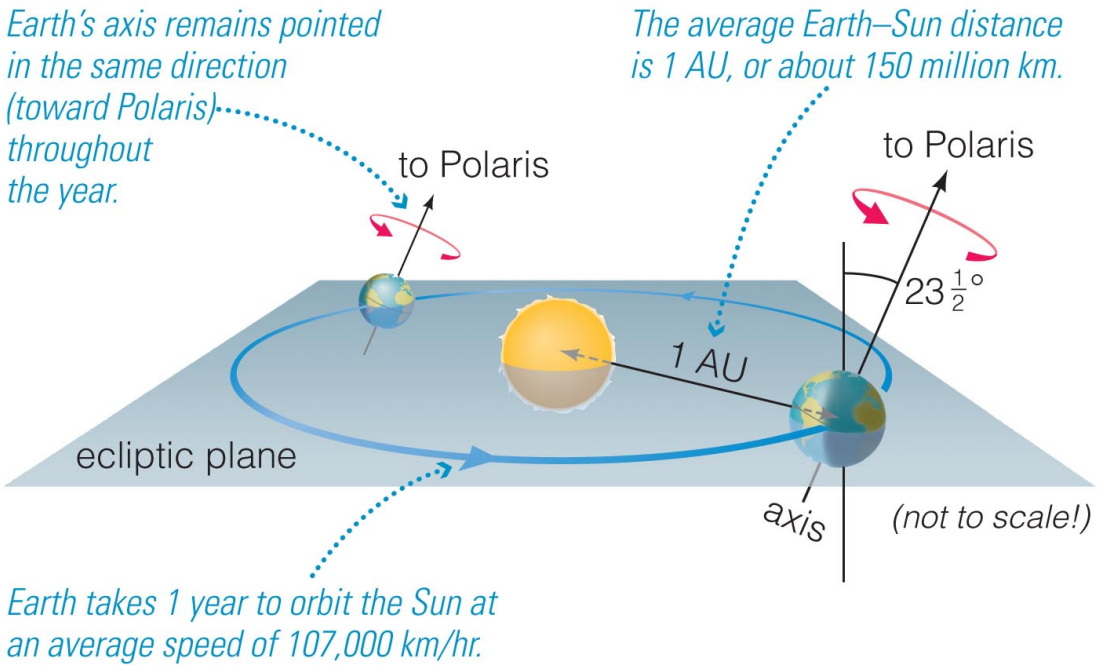


The Earth **rotates** around its axis once every day.

How is Earth moving through space?

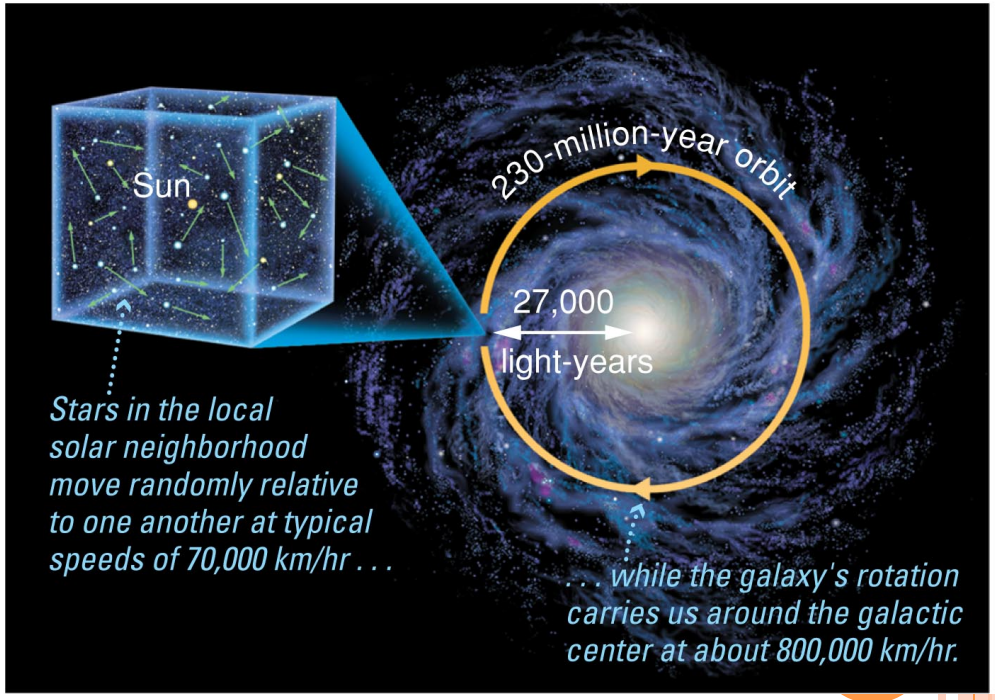
- Earth **orbits** the Sun (revolves) once every year:
  - at an average distance of 1 AU ≈ 150 million kilometers.
  - with Earth's axis tilted by 23.5° (pointing to Polaris)

- It rotates in the same direction it orbits, **counterclockwise** as viewed from above the North Pole.



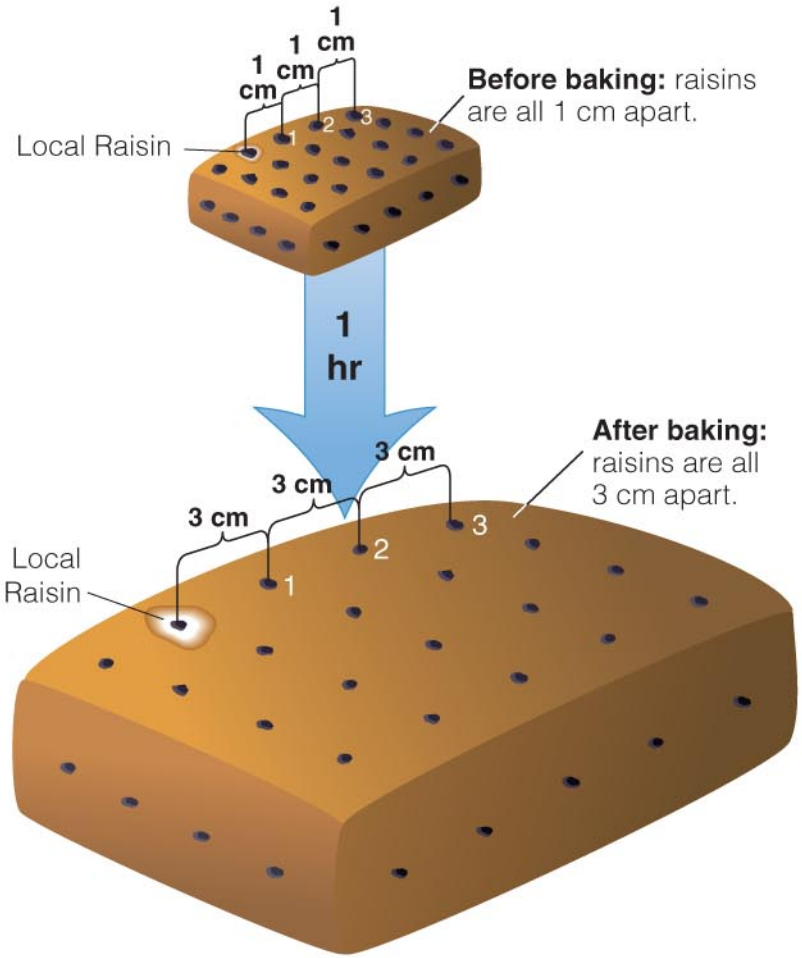
How is our Sun moving in in the Milky Way Galaxy?

- Our Sun moves randomly relative to the other stars in the local solar neighborhood…
  - typical relative speeds of more than 70,000 km/hr
  - but stars are so far away that we cannot easily notice their motion
- … and orbits the galaxy every 230 million years.

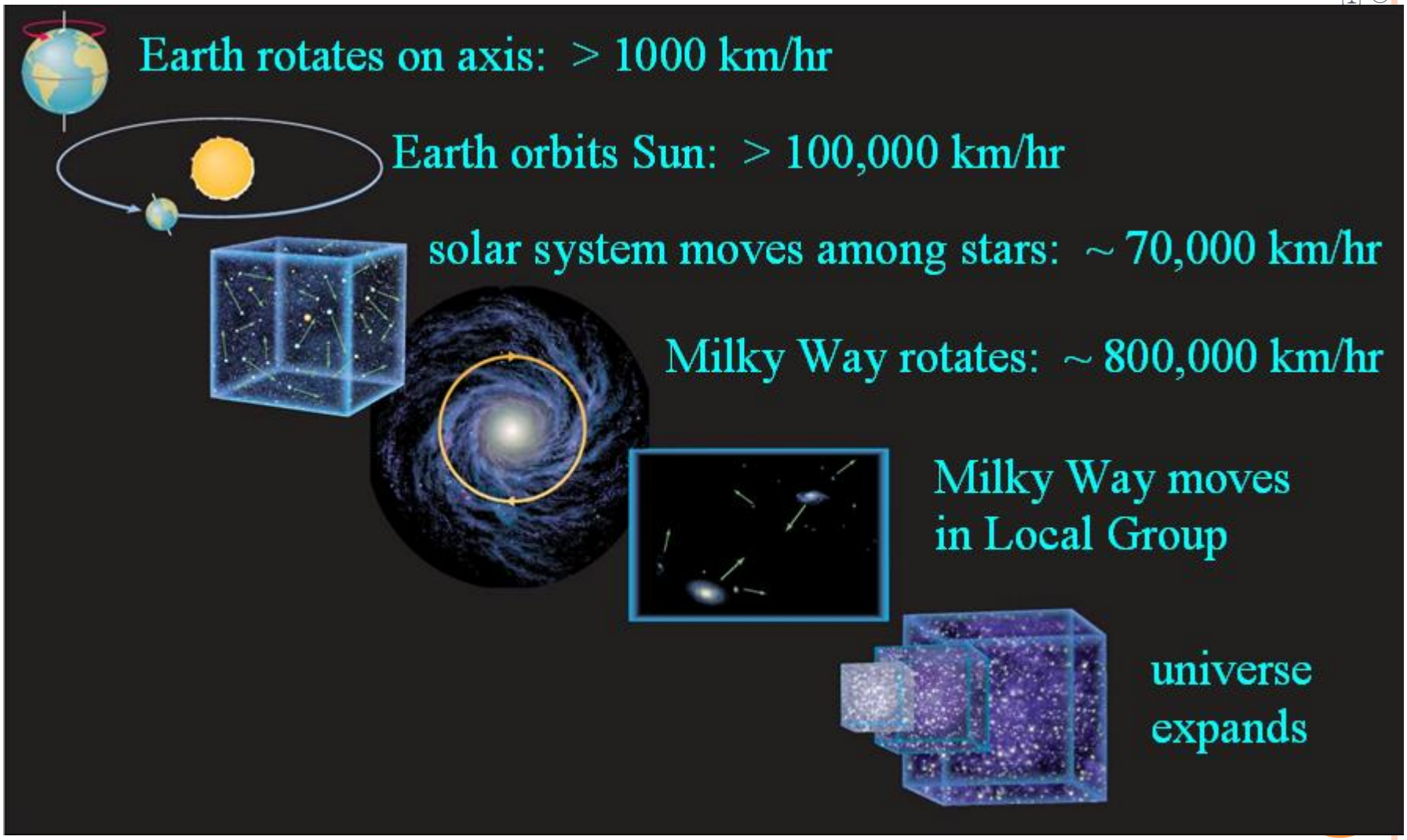


How do galaxies move within the universe?

- Galaxies are carried along with the expansion of the universe.



Are we ever sitting still?



What have we learned?

- **How is Earth moving through space?**
  - It rotates on its axis once a day and orbits the Sun at a distance of 1 AU = 150 million kilometers.
  - Stars in the Local Neighborhood move randomly relative to one another and orbit the center of the Milky Way in about 230 million years.

How has the study of astronomy affected human history?

- The Copernican revolution showed that Earth was not the center of the universe (Chapter 3).
- Study of planetary motion led to Newton's laws of motion and gravity (Chapter 4).
- Newton's laws laid the foundation of the industrial revolution.
- Modern discoveries are continuing to expand our "cosmic perspective."

For Next Week:

Check the class web site: http://www.ucolick.org/~jfortney/3.htm

Register at www.masteringastronomy.com

- You will need to purchase access if you didn't buy the textbook package at the bookstore
- I will e-mail you the class code this afternoon.

Register your iClicker:
www.iclicker.com/support/registeryourclicker/

Do the reading (check syllabus on web page)

HW 1 will be posted Friday by noon. Do it by next Thursday!

Go to section, meet your TA, get started on the homework