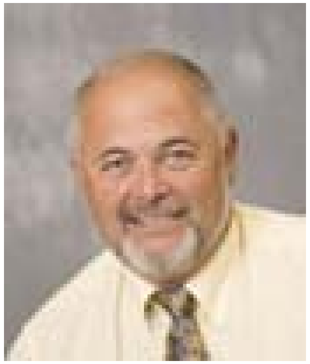
Week 7 Ch 15 PPT

EAPS 10000 Y01
Online Course
Planet Earth

Prof. Lawrence Braile

Welcome to the EAPS 10000 Y01 online course
Planet Earth *(also known as EAPS 100)!*



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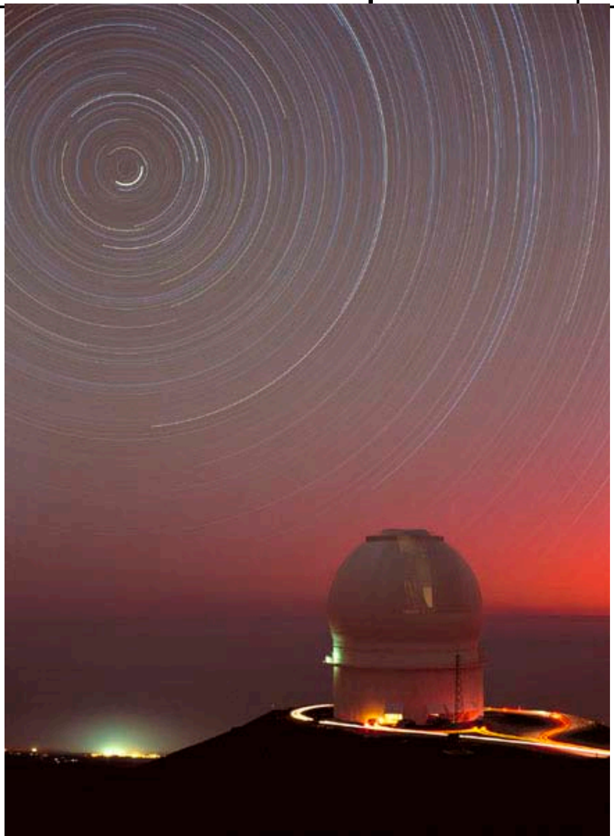
PURDUE UNIVERSITY

Earth Atmospheric Planetary Sciences

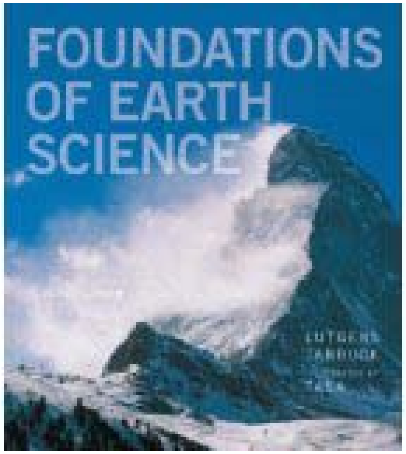
EAPS 10000 Y01 – Planet Earth (online course)
Week 7, Chapter 15 (pages 472-513)

Week	Chapter	Assigned Pages	Major Concepts	Important Terms
7	**15 – The Nature of the Solar System**	472 – 513	History of astronomy, the planets, impact cratering, Earth's moon, water and volcanism on the planets	Jupiter's moons, asteroids, comets, meteors, dwarf planets

The Solar System



Time lapse photo; stars appear to rotate about Polaris (the North Star) – actually due to rotation of Earth about axis that points toward Polaris.



EAPS 10000 Y01 – Planet Earth (online course)
Week 7 Chapter 15 (pages 472-513)

When you have finished reading Chapter 15 and viewing the weekly PowerPoint file for Chapter 15, take the quiz (Quiz13; be sure to read the Syllabus for more information on quizzes). You can use your book, notes, etc. during the quiz.

The PPT files (converted to PDF files) are best viewed with the Full Screen view in browsers.

The following slides illustrate some of the important concepts and topics of Chapter 15:

Astronomy

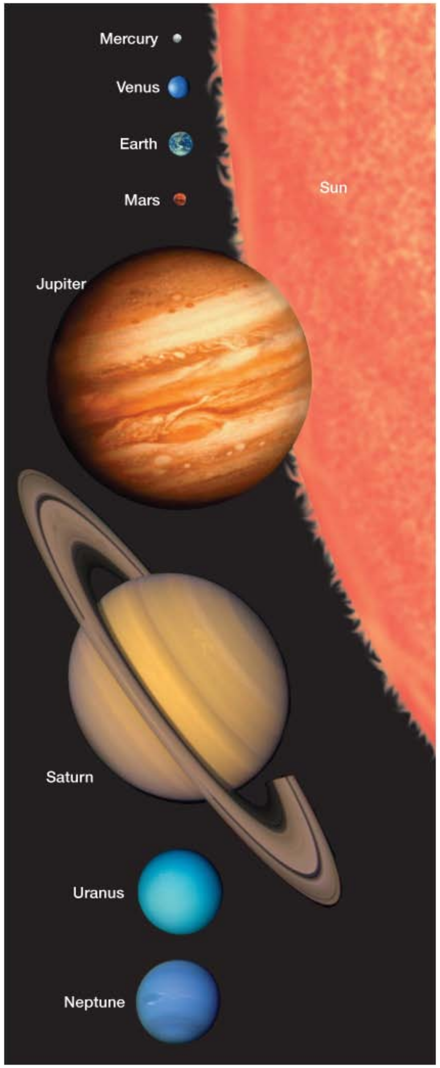
1. Introduction and Observations

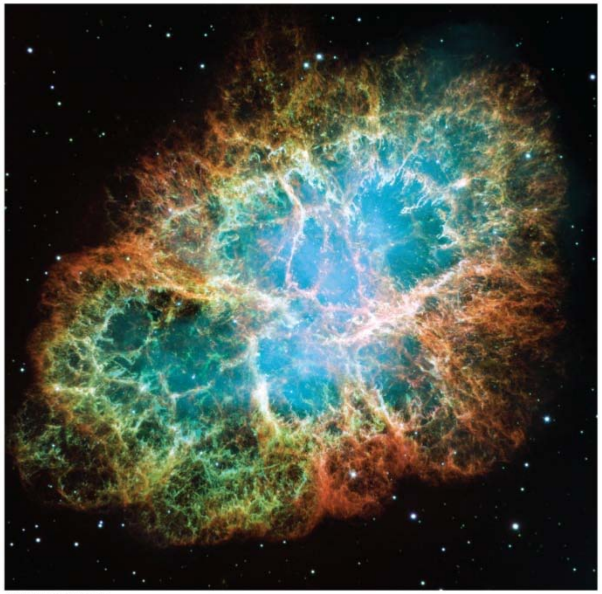
2. Sun and Solar System

3. Stars (Stellar Evolution)

4. Galaxies

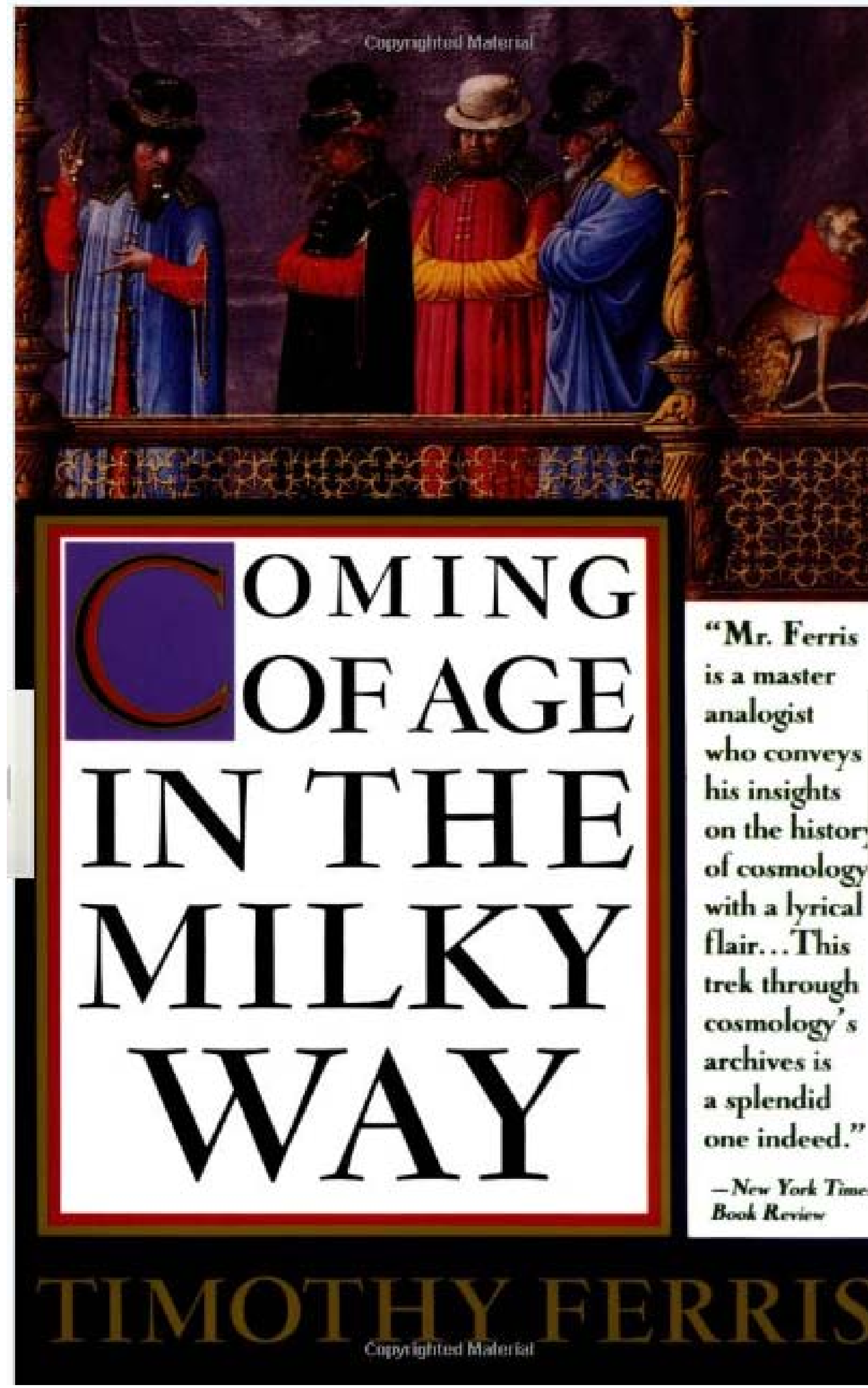
5. Universe (Deep Space, Expanding Universe, Hubble Red Shift, Cosmology)





An excellent book on astronomy by Timothy Ferris
(1988, 2003)

Also, there are two excellent periodicals related to astronomy – *Astronomy* and *Sky and Telescope*



Significance of Astronomy

1. Earth’s position in the solar system and universe
2. Origin of the Universe
3. Natural interest in observing the night sky

Problems in understanding astronomy concepts

1. Scale (distance and time)
2. Frame of reference (changing and 3-D)
3. Vast distance and time (large numbers and unfamiliar units and terminology)

1. Scale of the Universe

Earth orbit	~300 million km (diameter)
	~1 billion km (orbital path)
Solar System	~12 billion km across
	(~ 10^{-3} light years*)
Nearest Star	4.27 light years
Milky Way Galaxy	10^5 light years
Local Group of Galaxies	2.5 million light years
Observable Universe	13.7 billion light years

* One light year ~10^{13} km, or ~10 **trillion** km
(It takes about 1/1000 of a year, or about 9 hours for light to travel across the solar system; 4.27 years for light from the nearest star to reach Earth; 434 years for light from Polaris (the North Star) to reach Earth; and ~10^5 years for light from the most distant stars in the Milky Way, our galaxy, to reach Earth.)

Light Year – A unit of <u>distance</u> - *"how far light travels in one year"*

Calculate a light year:

~300,000 km/s ← *the "speed of light"*
x60 s/min
~18,000,000 km/min ← speed of light in km/min
x60 min/hr
~1,080,000,000 km/hr
x24 hr/day
~25,920,000,000 km/day
x365 days/yr
~9,460,800,000,000 km/yr ← *speed of light (in km/yr)*
~9,460,800,000,000 km ← ***One light year (units = km)***

This is not something that you need to memorize, but you should understand how this calculation is made, and, … "you could do this!"

So, one light year is approximately **10,000,000,000,000 km**,
or,… **10^{13} km**
or,… **10 trillion km**

http://hubblesite.org/newscenter/archive/releases/2004/07/
(~60 MB jpeg file)

Hubble Space Telescope (HST)

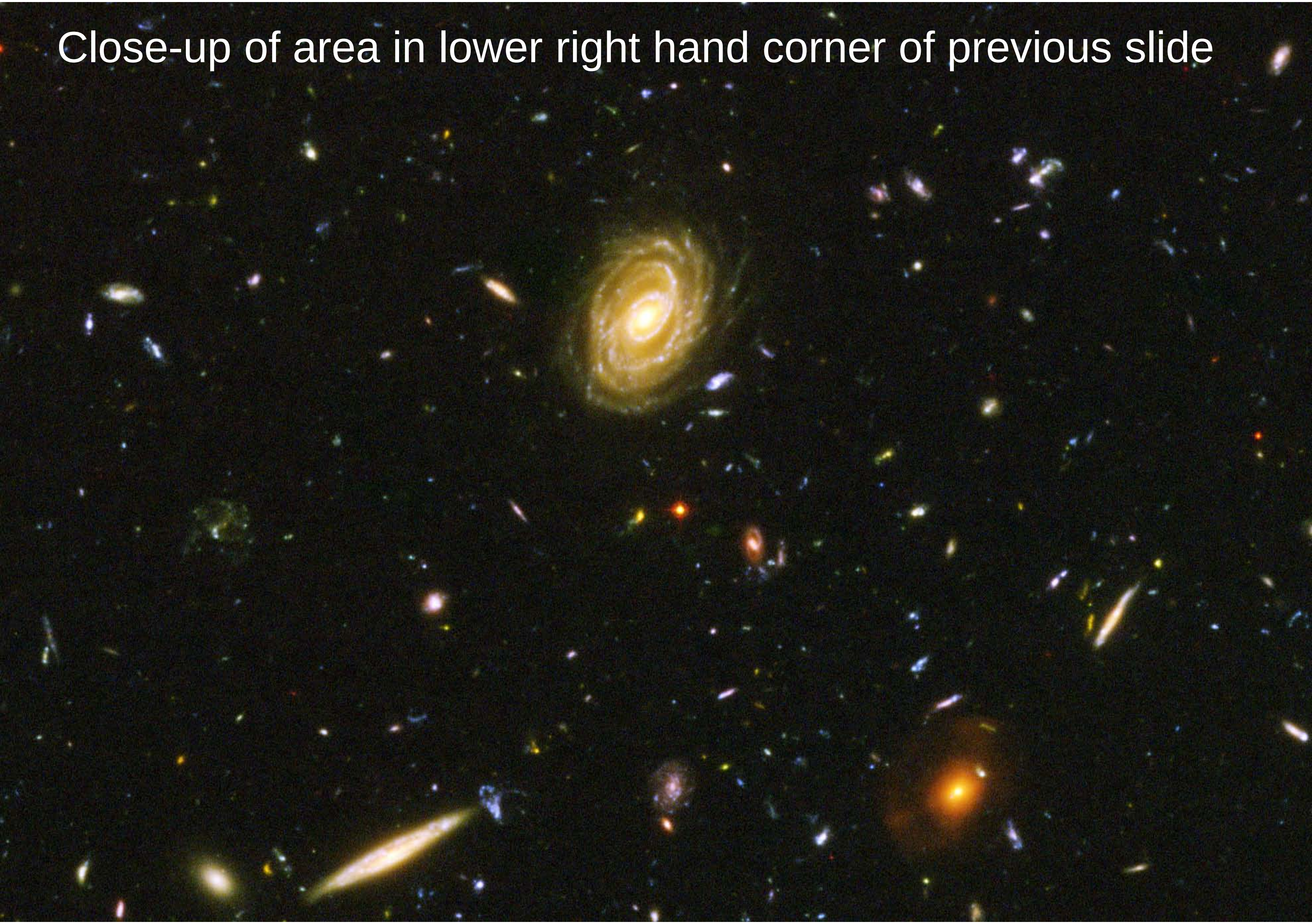
Ultra Deep Field Image (2003-04)

Required 400 orbits, 11.3 days of recording.

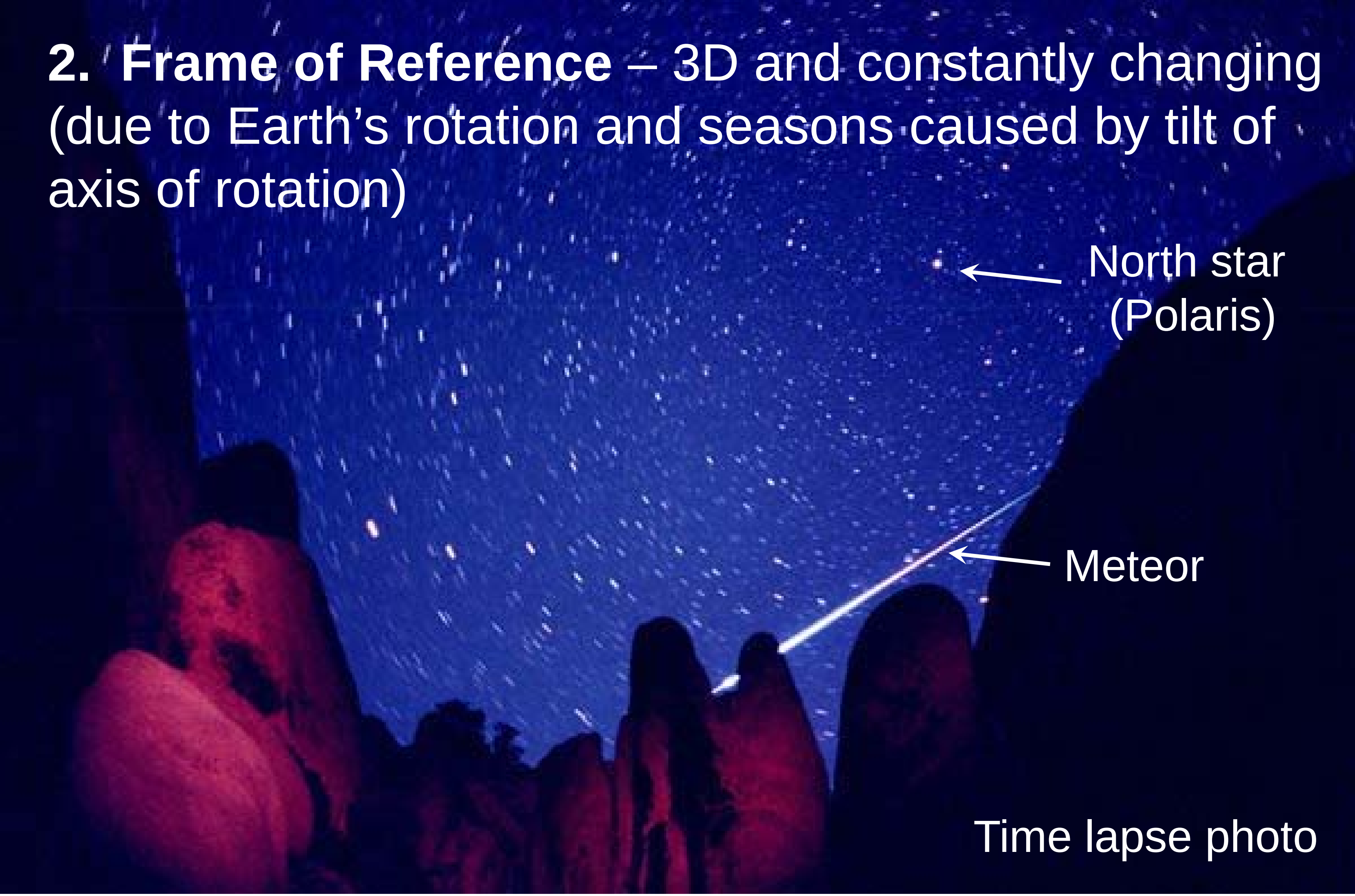
Image contains about 10,000 galaxies.

Area covers 1/12.7 million of the entire sky.

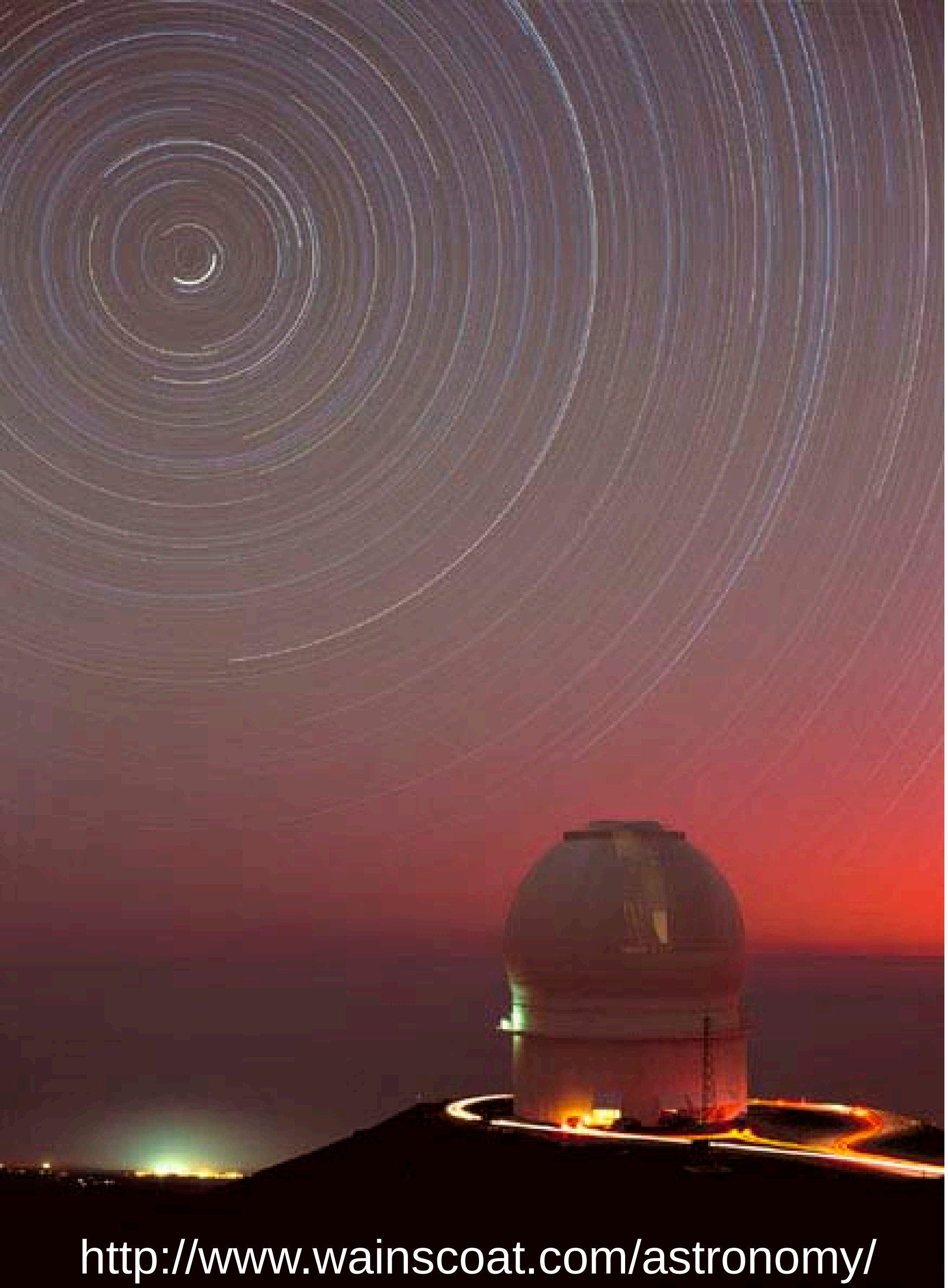
Close-up of area in lower right hand corner of previous slide



2. Frame of Reference – 3D and constantly changing (due to Earth's rotation and seasons caused by tilt of axis of rotation)

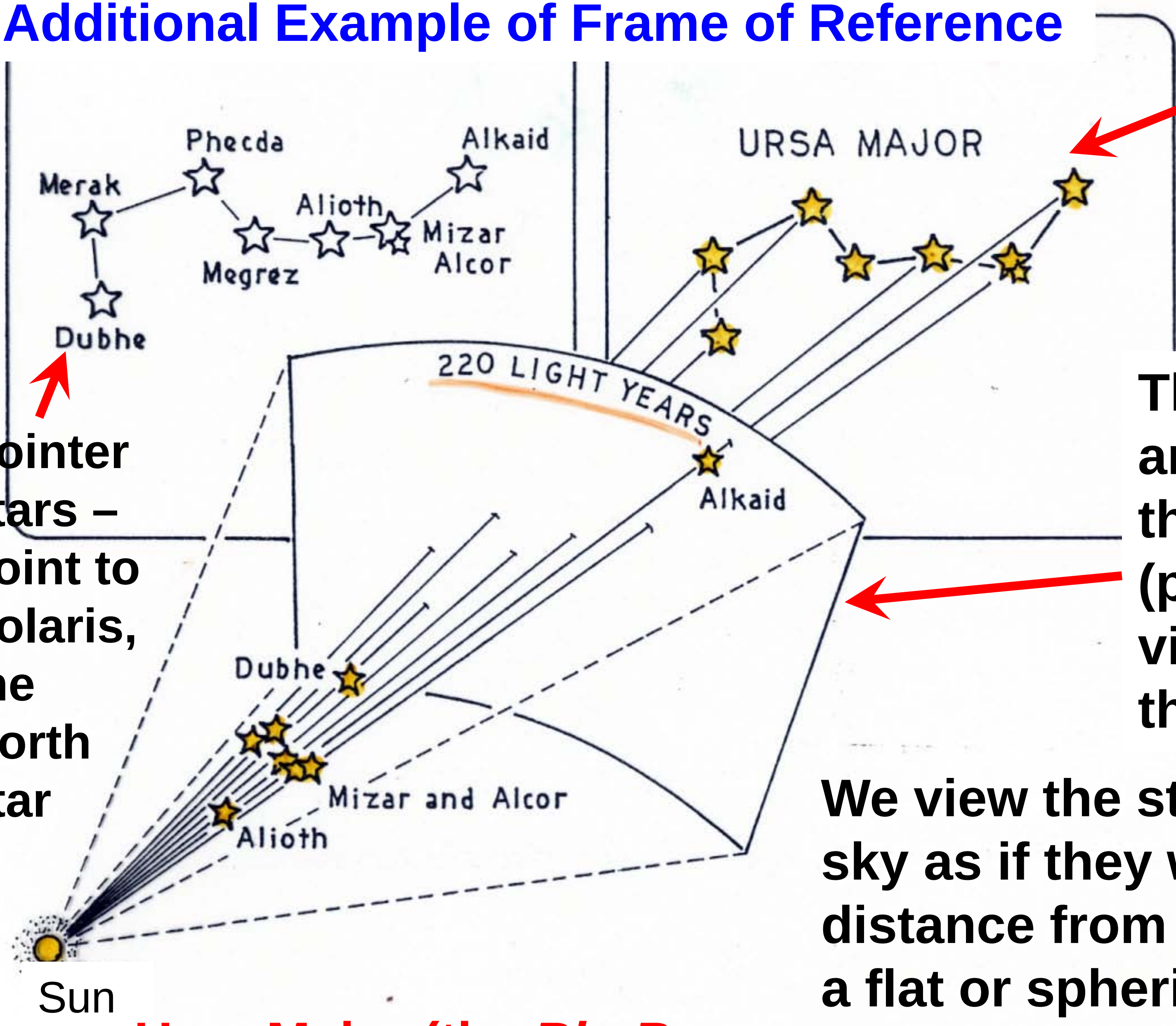


http://antwrp.gsfc.nasa.gov/apod/ap991006.html



Time-lapse (several hours) photograph from Earth (northern hemisphere) showing position of Polaris ("the North star") and other stars that *appear* to circle Polaris (actually due to Earth's rotation)

Additional Example of Frame of Reference



What we see…

Pointer stars – point to Polaris, the North star

The actual arrangement of the stars (perspective view, stars in the Big Dipper)

We view the stars in the sky as if they were all equal distance from Earth (as on a flat or spherical surface). However, the distance to stars varies greatly.

Ursa Major (the *Big Bear*, or the *Big Dipper*)

3. Vast Distances and Large Numbers…

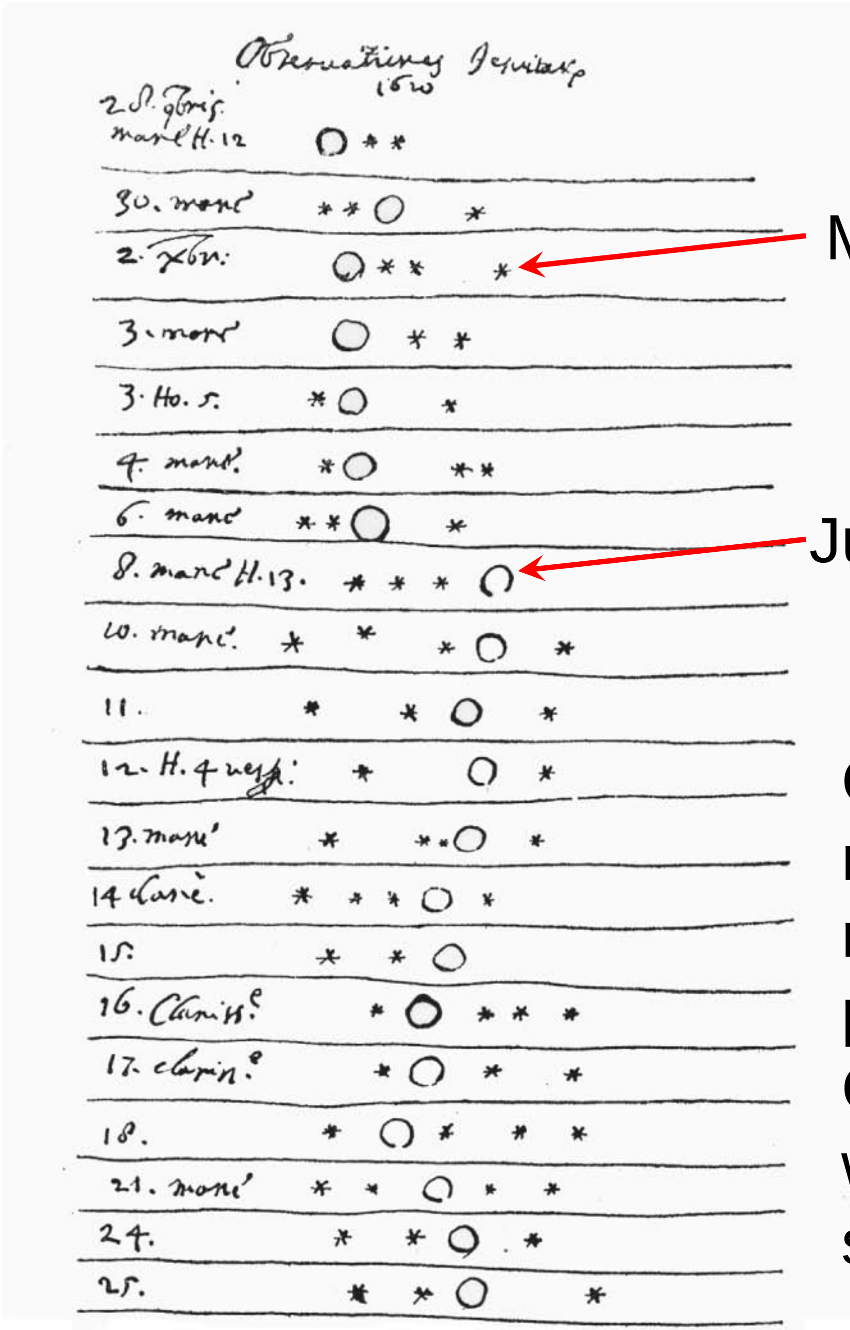
Number of stars in the universe (just recently updated), in at least 3 **trillion** galaxies:

300 sextillion

(300 x 10^{21} or, … 3 trillion *times* 100 billion)

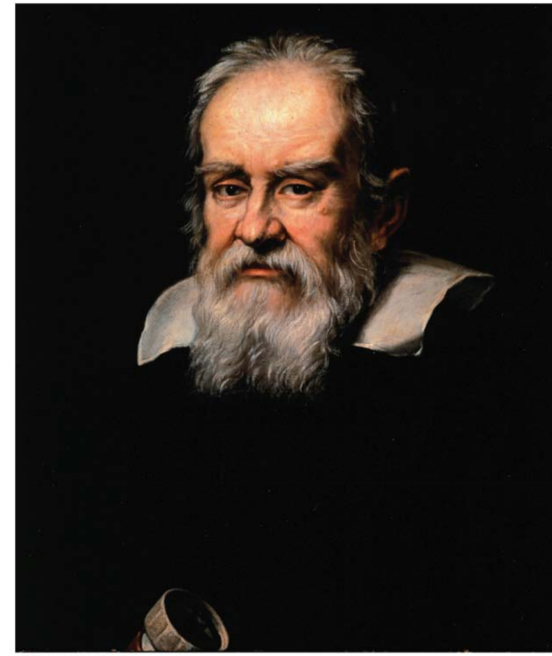
Large Numbers:

10^6	1,000,000	**Million**
10^9	1,000,000,000	**Billion**
10^{12}	1,000,000,000,000	**Trillion**
10^{15}	1,000,000,000,000,000	**Quadrillion**
10^{18}	1,000,000,000,000,000,000	**Quintillion**
10^{21}	1,000,000,000,000,000,000,000	**Sextillion**



Moons

Jupiter



Galileo Galilei

Galileo's observations of Jupiter's moons demonstrated that moons revolved (orbitted) about a planet providing support for the Copernican theory that the Sun was the center of the solar system.

Figure 15.11, 15.13, text

Jupiter and the Galilean Moons as viewed through a modern amateur telescope (25 cm Meade).

http://en.wikipedia.org/wiki/Moons_of_Jupiter

Io Europa Ganymede Callisto

Jupiter has at least 63 moons. The largest (and mostly closest to the planet) were discovered by Galileo in 1610 and are called the Galilean moons (Figure 15.33, text)

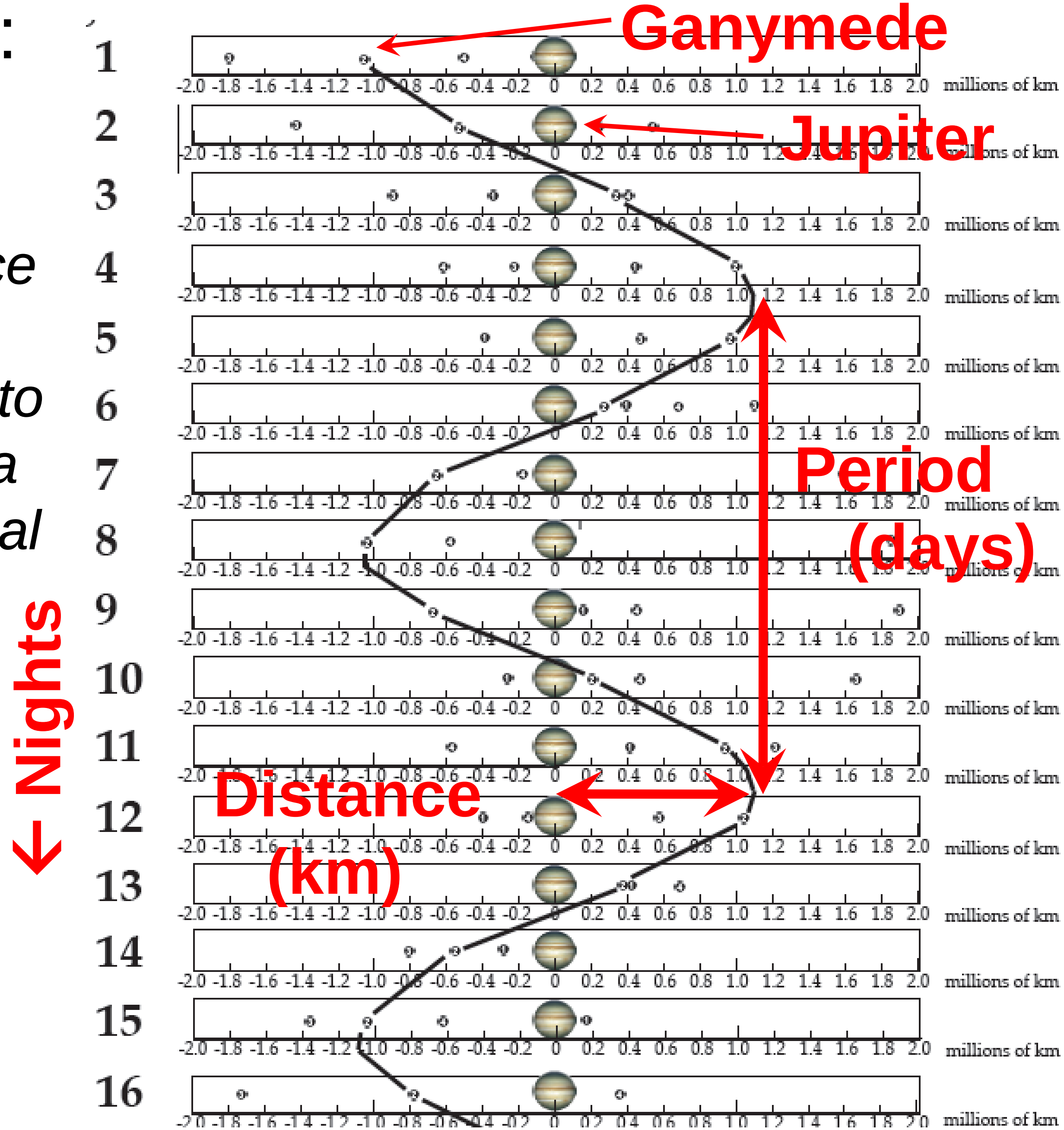
http://en.wikipedia.org/wiki/Moons_of_Jupiter

Kepler's 3rd law:

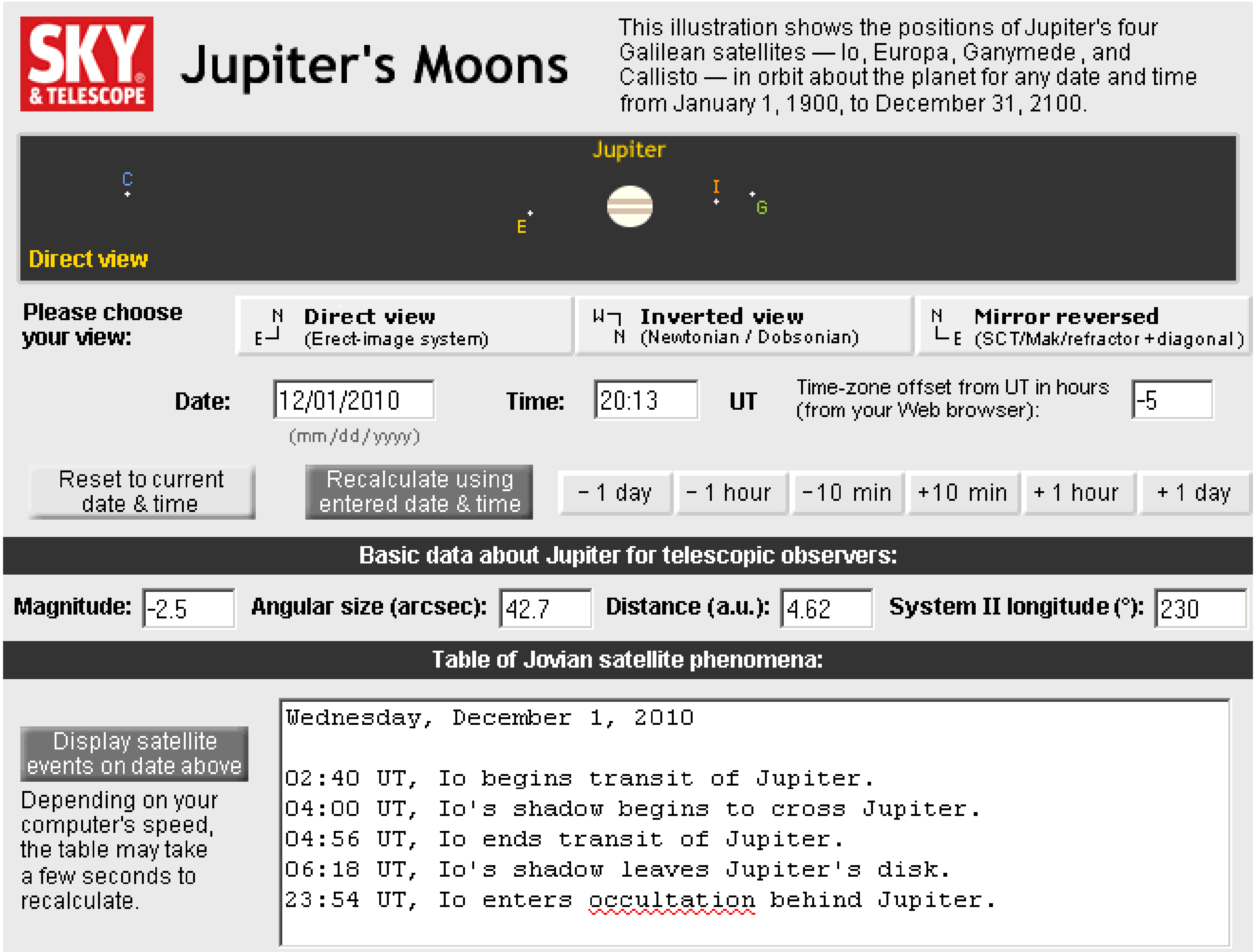
$P^2 \sim D^3$

Period (P) squared is proportional to Distance (D) cubed. This exact equation can be used to calculate the mass of a planet (G = gravitational constant):

$$M = \frac{4\pi^2 D^3}{G P^2}$$

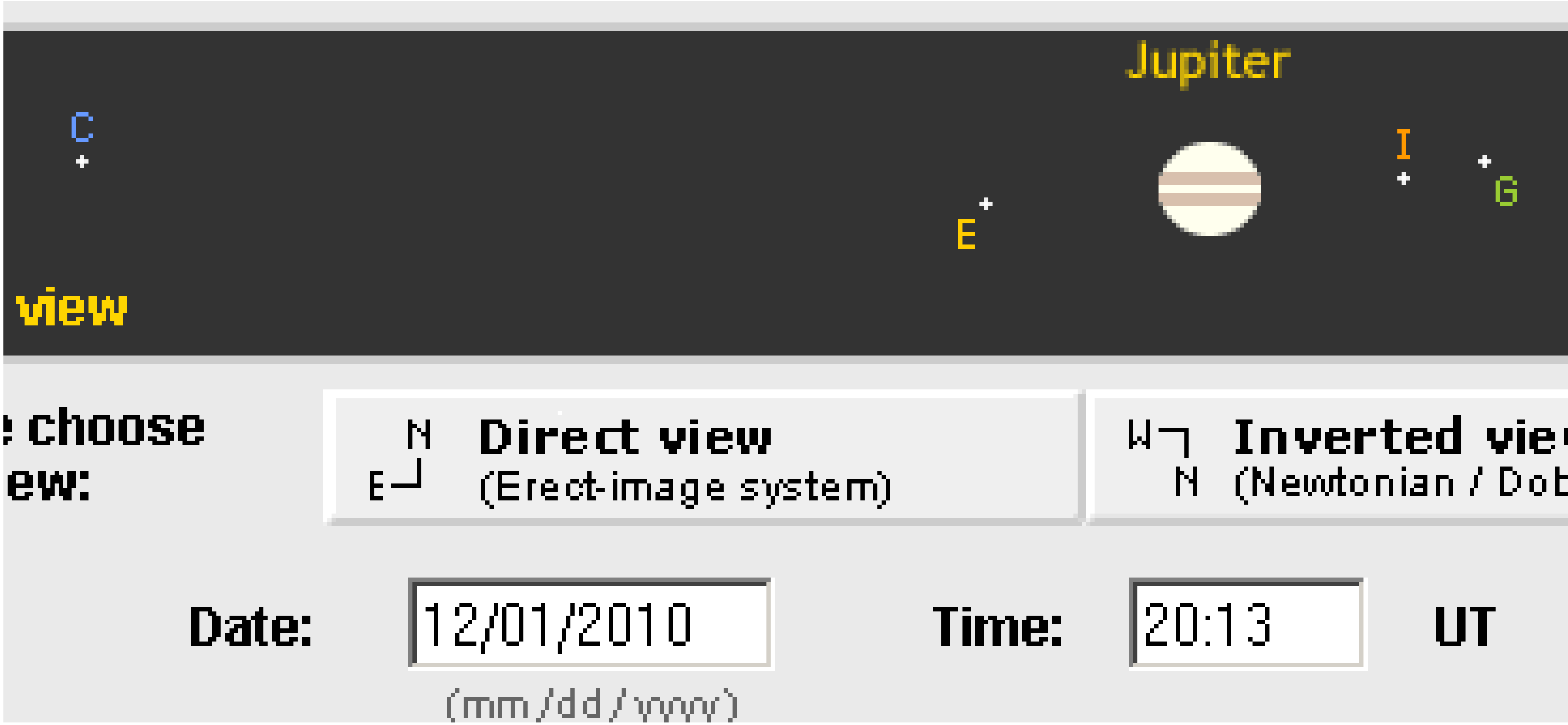


http://kepler.nasa.gov/files/mws/OrbitsOfJupitersMoons.pdf



Sky and Telescope javascript Jupiter’s moons orbit calculator:

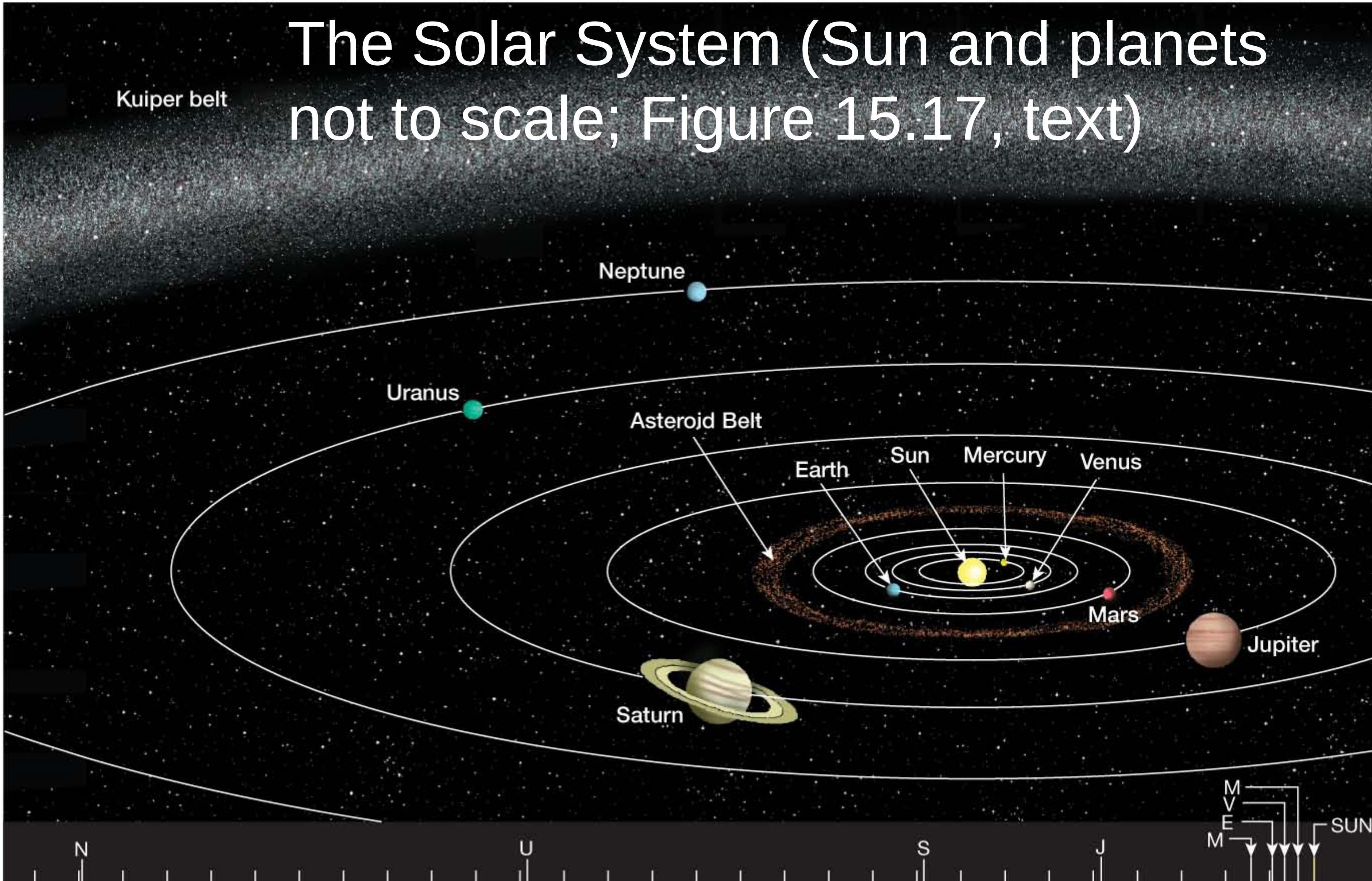
http://www.skyandtelescope.com/observing/objects/javascript/jupiter



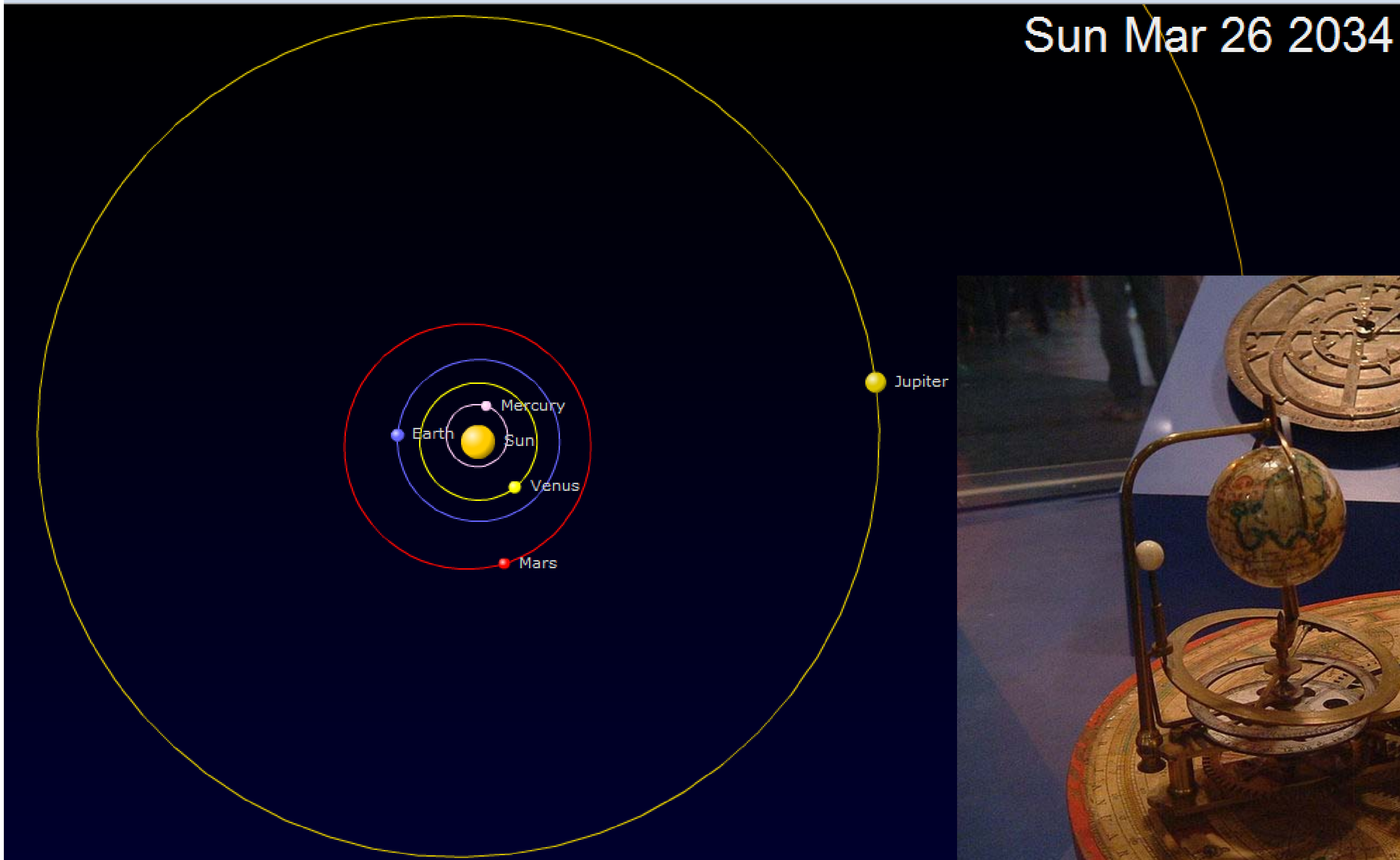
Close-up of Galilean Moons positions relative to Jupiter on the date and time shown (C = Callisto, E = Europa, I = Io, G = Ganymede). With the calculator (below) you can step through time to see the orbits of the moons about Jupiter.

Sky and Telescope javascript Jupiter's moons orbit calculator:
http://www.skyandtelescope.com/observing/objects/javascript/jupiter

The Solar System (Sun and planets not to scale; Figure 15.17, text)



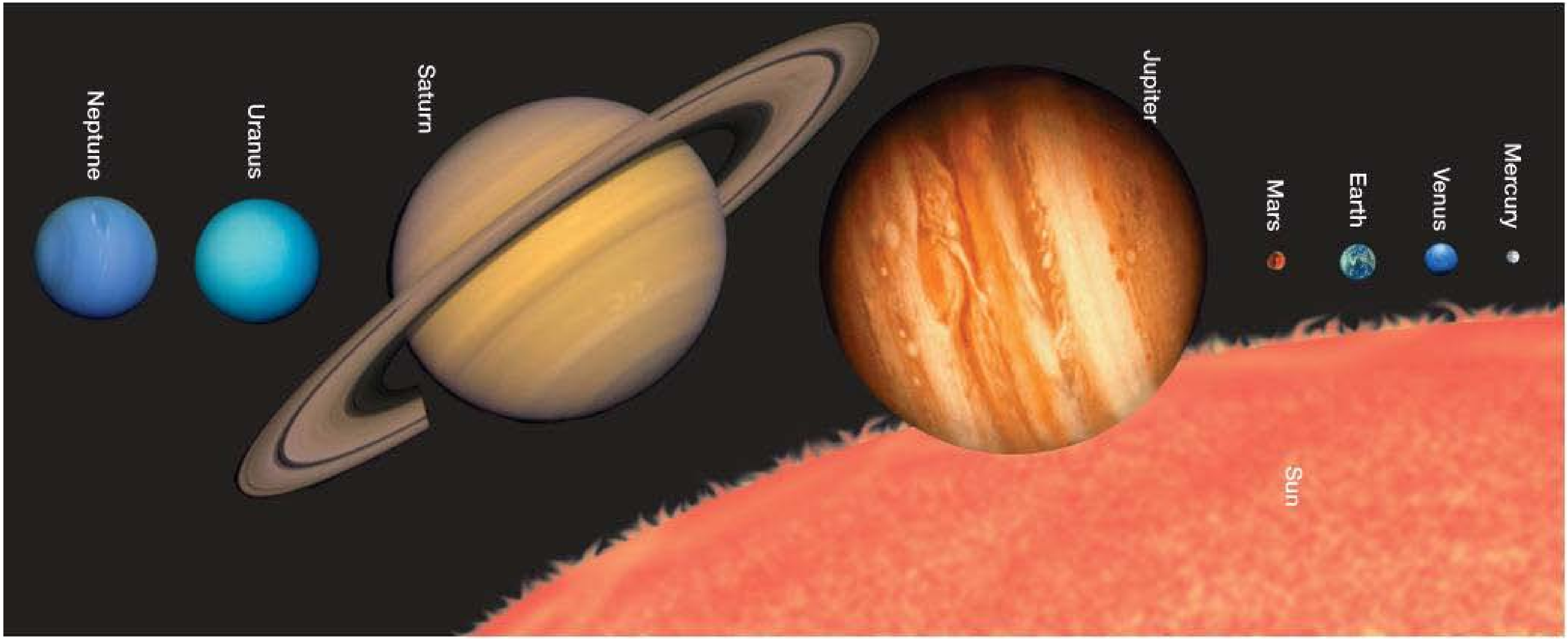
Orbits to scale



Orrery

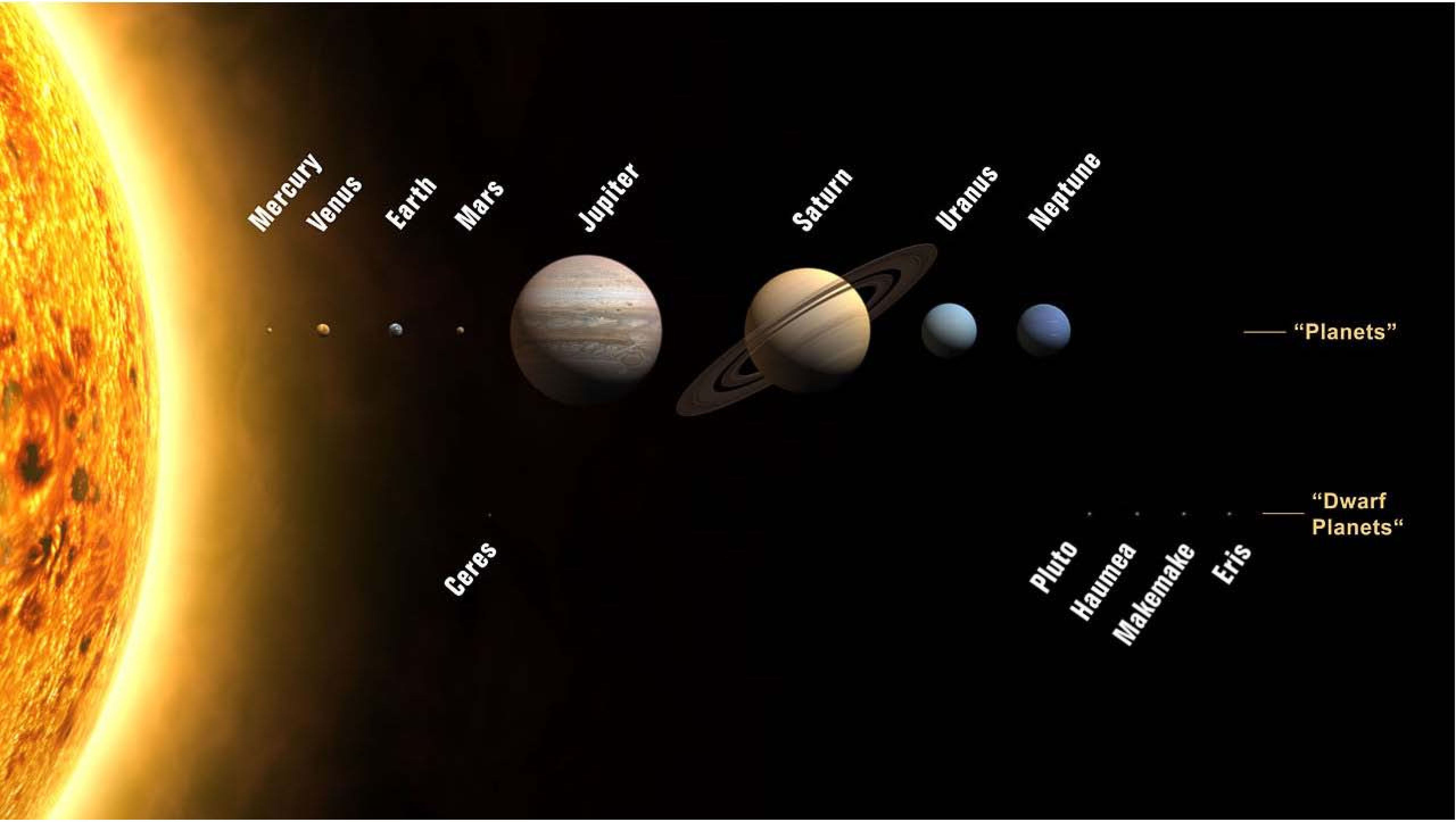
An excellent online ***Orrery*** (for viewing the planets in orbit) can be found at: http://gunn.co.nz/AstroTour - main controls are: ***speed*** *(*adjust*)*, ***orbit brightness*** *(*increase*)*, ***planet size*** *(*increase*)* and ***zoom*** *(*zoom in to view inner planets*)*. (also: http://www.pbs.org/wgbh/nova/space/tour-solar-system.html)

A Brief Tour of the Solar System



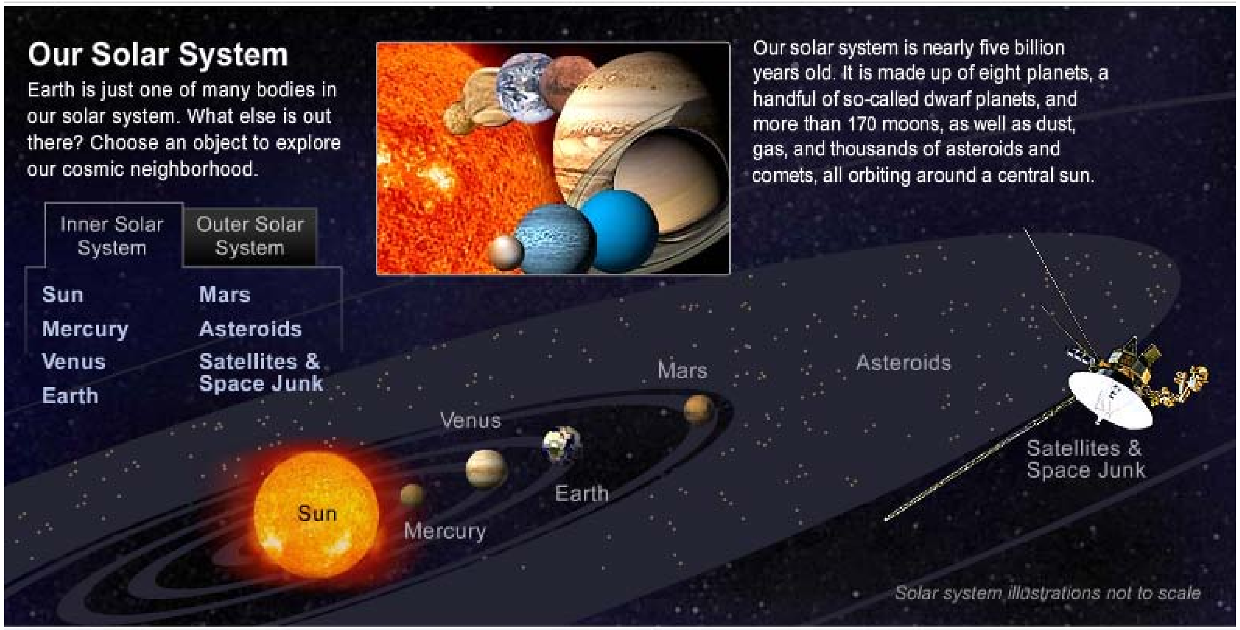
The Sun and planets drawn to scale (orbital positions not to scale; Figure 15.17, text)

Another view of the Solar System



The Sun and planets drawn to scale (orbital position not to scale) (http://en.wikipedia.org/wiki/Planet).

Planets and Solar System Websites



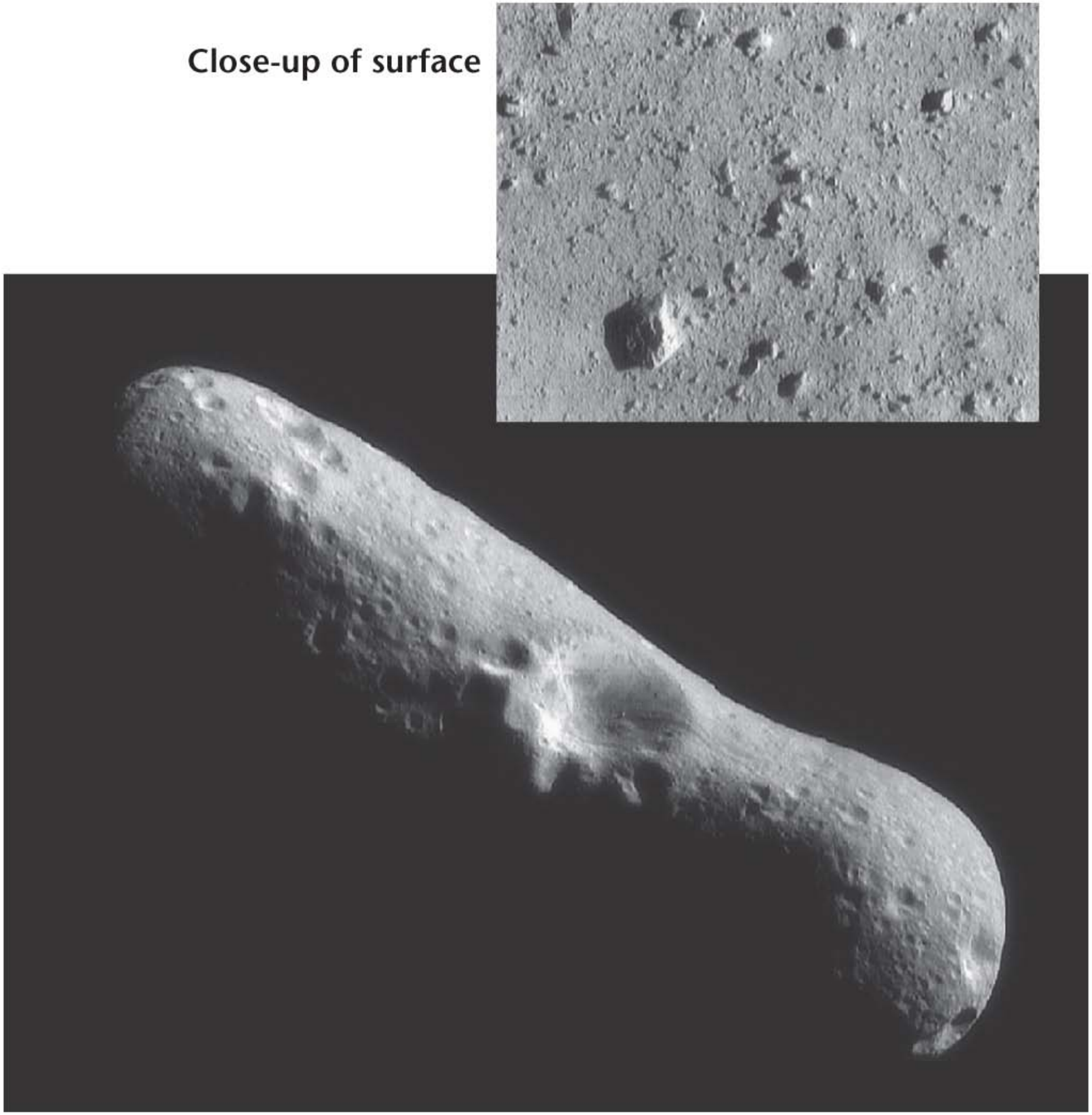
http://www.nasa.gov/worldbook/planet_worldbook_update.html

http://en.wikipedia.org/wiki/Planet

http://pds.jpl.nasa.gov/planets/

http://www.space.com/planets/

http://science.nationalgeographic.com/science/space/solar-system



Asteroid Eros (note craters cause by smaller object impacts; Figure 15.41, text)