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ASTRONOMY

Chapter 7 OTHER WORLDS: AN INTRODUCTION TO THE SOLAR SYSTEM

PowerPoint Image Slideshow

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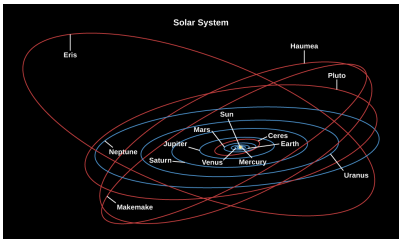
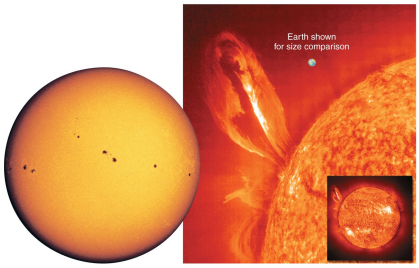
7.1+7.2 OVERVIEW OF OUR PLANETARY SYSTEM & COMPOSITION AND STRUCTURE OF PLANETS



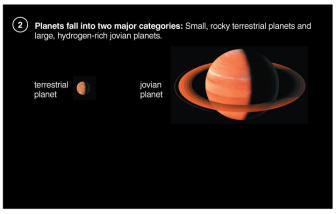
- **Orbits of the Planets.** All eight major planets orbit the Sun in roughly the same plane. The five currently known dwarf planets are also shown: Eris, Haumea, Pluto, Ceres, and Makemake. Note that Pluto's orbit is not in the plane of the planets.

Sun



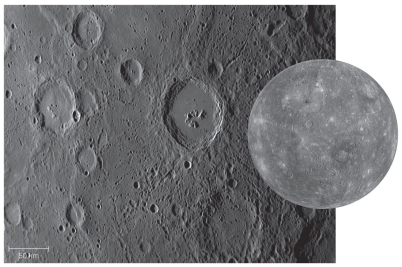
- Over 99.8% of solar system's mass
- 98% H/He gas (plasma), 2% other elements
- You can fit 108 Earths across

Two Major Planet Types



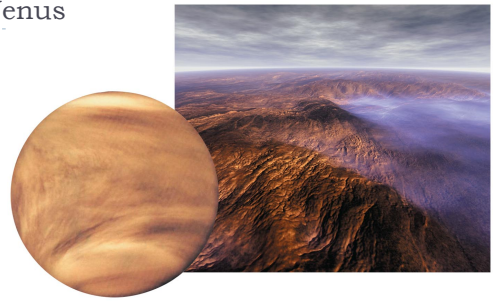
- Terrestrial planets are rocky, relatively small, and close to the Sun.
- Jovian planets are gaseous, larger, and farther from the Sun.

Mercury



- Made of metal and rock; large iron core
- Desolate, cratered; long, tall, steep cliffs
- Very hot and very cold: 800°F (day), -280°F (night)

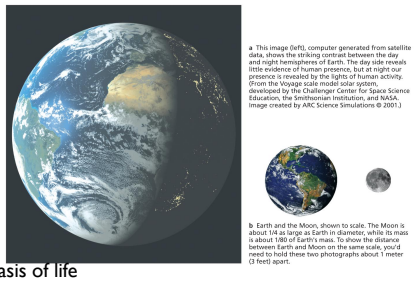
Venus



- Nearly identical in size to Earth; surface hidden by clouds
- Hellish conditions due to an extreme **greenhouse effect**
- Even hotter than Mercury: nearly 900°F, day and night

Earth

Earth and Moon to scale

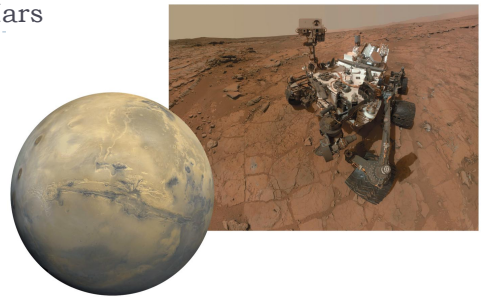


a This image (left), computer generated from satellite data, shows the striking contrast between the day and night hemispheres of Earth. The day side reveals little evidence of human presence, but at night our presence is revealed by the lights of human activity. (From the Voyage scale model solar system, developed by the Challenger Center for Space Science Education, the Smithsonian Institution, and NASA. Image created by ARC Science Simulations © 2001.)

b Earth and the Moon, shown to scale. The Moon is about 1/4 as large as Earth in diameter, while its mass is about 1/80 of Earth's mass. To show the distance between Earth and Moon on the same scale, you'd need to hold these two photographs about 1 meter (3 feet) apart.

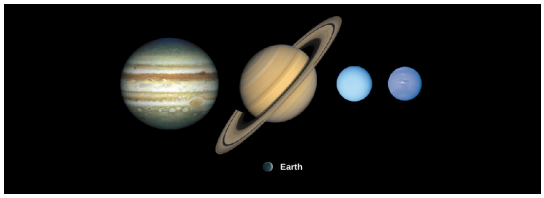
- An oasis of life
- The only surface liquid water in the solar system
- A surprisingly large moon

Mars



- Looks almost Earth-like, but don't go without a spacesuit!
- Giant volcanoes, a huge canyon, polar caps, and more
- Water flowed in the distant past; could there have been life?

Figure 7.5

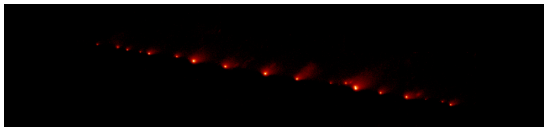


- **The Four Giant Planets.** This montage shows the four giant planets: Jupiter, Saturn, Uranus, and Neptune. Below them, Earth is shown to scale. (credit: modification of work by NASA, Solar System Exploration)

Jupiter

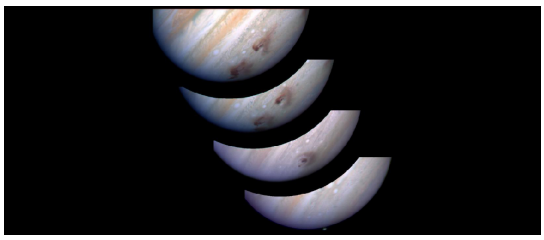
- Much farther from Sun than inner planets
- Mostly H/He; no solid surface
- Massive: you could fit over 1000 Earths inside
- Many moons 67+, rings

Figure 7.13

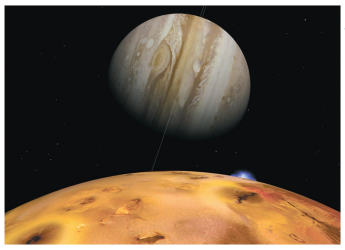


- **Comet Shoemaker–Levy 9.** In this image of Comet Shoemaker–Levy 9 taken on May 17, 1994, by NASA's Hubble Space Telescope, you can see about 20 icy fragments into which the comet broke. The comet was approximately 660 million kilometers from Earth, heading on a collision course with Jupiter. (credit: modification of work by NASA, ESA, H. Weaver (STScI), E. Smith (STScI))

Figure 7.14



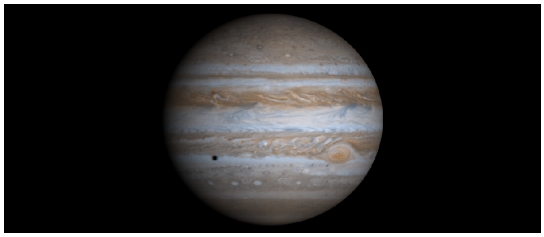
- **Jupiter with Huge Dust Clouds.** The Hubble Space Telescope took this sequence of images of Jupiter in summer 1994, when fragments of Comet Shoemaker–Levy 9 collided with the giant planet. Here we see the site hit by fragment G, from five minutes to five days after impact. Several of the dust clouds generated by the collisions became larger than Earth. (credit: modification of work by H. Hammel, NASA)



Jupiter's moons can be as interesting as planets themselves, especially Jupiter's four *Galilean moons*.

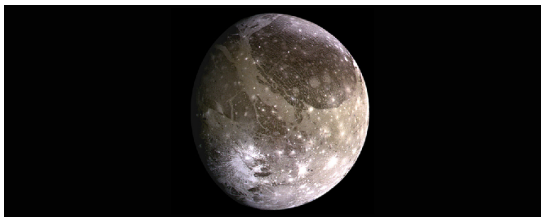
- Io: (young surface) Active volcanoes
- Europa: (smooth surface) Possible subsurface ocean
- Ganymede: Largest moon in solar system
- Callisto: (old surface) A large, cratered "ice ball"

Figure 7.11



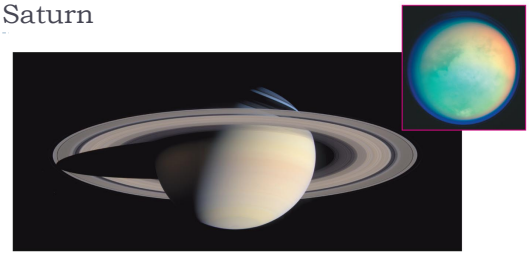
- **Jupiter.** This true-color image of Jupiter was taken from the Cassini spacecraft in 2000. (credit: modification of work by NASA/JPL/University of Arizona)

Figure 7.12

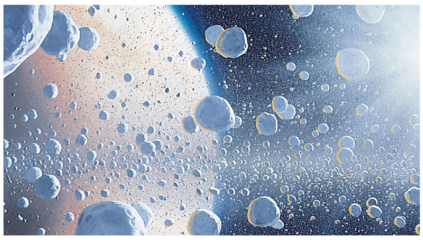


- **Ganymede.** This view of Jupiter's moon Ganymede was taken in June 1996 by the Galileo spacecraft. The brownish gray color of the surface indicates a dusty mixture of rocky material and ice. The bright spots are places where recent impacts have uncovered fresh ice from underneath. (credit: modification of work by NASA/JPL)

Saturn



- Giant and gaseous like Jupiter
- Spectacular rings
- Many moons 62+, including cloudy Titan
- Density .70 g/cm^3 *(water has density of 1 g/cm^3)*

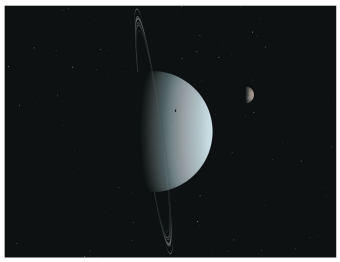


INTERACTIVE FIGURE

Rings are NOT solid; they are made of countless small chunks of ice and rock, each orbiting like a tiny moon.

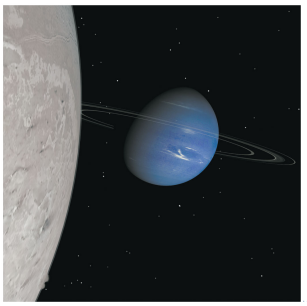
Artist's conception of Saturn's rings

Uranus



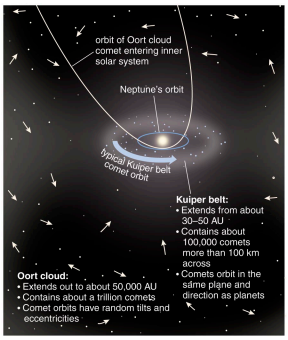
- Smaller than Jupiter/Saturn; much larger than Earth
- Made of H/He gas and **hydrogen compounds** (H_2O, NH_3, CH_4)
- Extreme axis tilt
- Moons 27+ and rings

Neptune



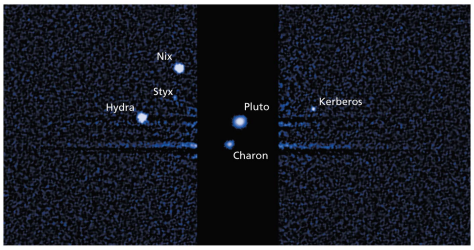
- Similar to Uranus (except for axis tilt)
- Many moons (including Triton)

Smaller Members of the Solar System



- Many rocky asteroids and icy comets populate the solar system.

Pluto and Other Dwarf Planets



- Much smaller than other planets
- Icy, comet-like composition
- Pluto's moon Charon is similar in size to Pluto

Figure 7.6

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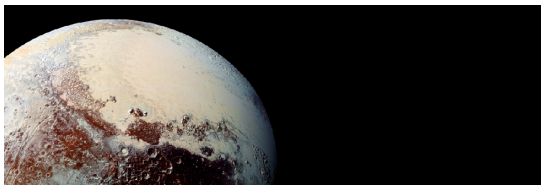

- **Pluto Close-up.** This intriguing image from the New Horizons spacecraft, taken when it flew by the dwarf planet in July 2015, shows some of its complex surface features. The rounded white area is temporarily being called the Sputnik Plain, after humanity's first spacecraft. (credit: modification of work by NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute)

Figure 7.8

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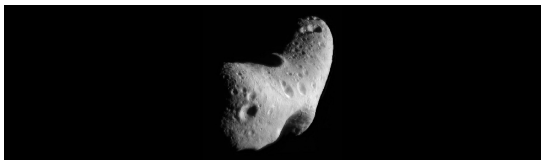
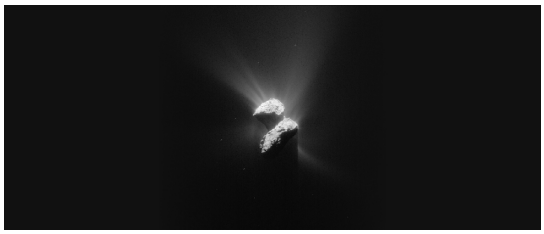


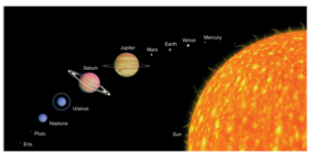
- **Asteroid Eros.** This small Earth-crossing asteroid image was taken by the NEAR-Shoemaker spacecraft from an altitude of about 100 kilometers. This view of the heavily cratered surface is about 10 kilometers wide. The spacecraft orbited Eros for a year before landing gently on its surface. (credit: modification of work by NASA/JHUAPL)

Figure 7.9



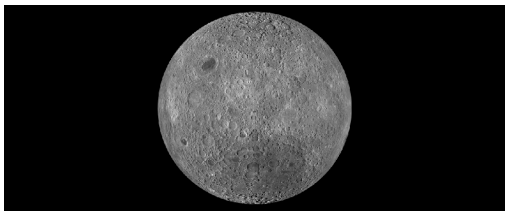
- **Comet Churyumov-Gerasimenko (67P).** This image shows Comet Churyumov-Gerasimenko, also known as 67P, near its closest approach to the Sun in 2015, as seen from the *Rosetta* spacecraft. Note the jets of gas escaping from the solid surface. (credit: modification of work by ESA/Rosetta/NAVACAM, **CC BY-SA IGO 3.0 (http://creativecommons.org/licenses/by-sa/3.0/igo/)**)

A Scale Model of the Solar System



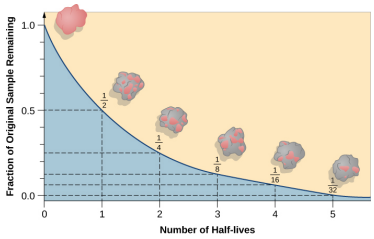
- On a 1-to-10 billion scale:
  - Sun is the size of a large grapefruit / softball (14 cm or 5.5 in).
  - The size of the solar system would be about the size of your campus at LBCC.

7.3 DATING PLANETARY SURFACES



- **Our Cratered Moon.** This composite image of the Moon's surface was made from many smaller images taken between November 2009 and February 2011 by the Lunar Reconnaissance Orbiter (LRO) and shows craters of many different sizes. (credit: modification of work by NASA/GSFC/Arizona State University)

Figure 7.16



- **Radioactive Decay.** This graph shows (in pink) the amount of a radioactive sample that remains after several half-lives have passed. After one half-life, half the sample is left; after two half-lives, one half of the remainder (or one quarter) is left; and after three half-lives, one half of that (or one eighth) is left. Note that, in reality, the decay of radioactive elements in a rock sample would not cause any visible change in the appearance of the rock; the splashes of color are shown here for conceptual purposes only.

Dating the Solar System

Age dating of meteorites that are unchanged since they condensed and accreted tells us that the solar system is about 4.6 billion years old.

Dating the Solar System

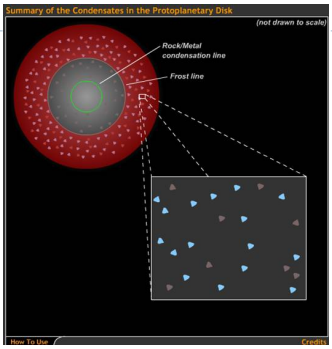
- Radiometric dating tells us that the oldest moon rocks are 4.4 billion years old.
- The oldest meteorites are 4.55 billion years old.
- Planets probably formed 4.5 billion years ago.

7.4 ORIGIN OF THE SOLAR SYSTEM

- **Solar Nebula.** This artist's conception of the solar nebula shows the flattened cloud of gas and dust from which our planetary system formed. Icy and rocky planetesimals (precursors of the planets) can be seen in the foreground. The bright center is where the Sun is forming. (credit: William K. Hartmann, Planetary Science Institute)

Figure 7.18

- **Atlas of Planetary Nurseries.** These Hubble Space Telescope photos show sections of the Orion Nebula, a relatively close-by region where stars are currently forming. Each image shows an embedded circumstellar disk orbiting a very young star. Seen from different angles, some are energized to glow by the light of a nearby star while others are dark and seen in silhouette against the bright glowing gas of the Orion Nebula. Each is a contemporary analog of our own solar nebula—a location where planets are probably being formed today. (credit: modification of work by NASA/ESA, L. Ricci (ESO))

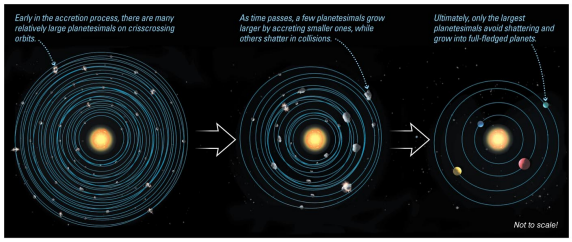


Gravity draws ***planetesimals*** together to form planets.

This process of assembly is called ***accretion.***

PLAY Summary of the Condensates in the Protoplanetary Disk

Accretion of Planetesimals



- Many smaller objects collected into just a few large ones.

Links

- VIDEO Origin of SS 13min
- VIDEO scale SS 7min

Reading

- 7.1
- 7.2
- 7.3
- 7.4