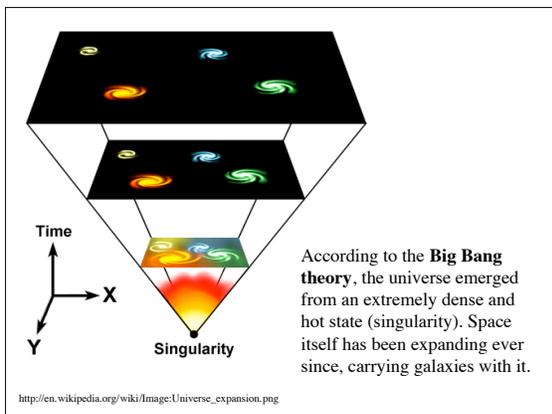


Origin of the Lithosphere, Hydrosphere, Atmosphere, & Biosphere

and a brief tour through the
“Precambrian”
(~4.0 billion years of Earth history!)

Origin of the Universe

- *How old is the universe?*
~13.7 Ga (giga-annums or billion years)
“**Big Bang Theory**”
- *How do we know?*
 1. **the universe is expanding** (galaxies are moving away from each other at tremendous speeds; “redshift” doppler effect)
 2. **pervasive background radiation of 2.7°K** (-270.3 °C); afterglow of the Big Bang





Hubble Space Telescope

Image of the **spiral galaxy NGC 4414**
 More information at the NASA website. Credits: Hubble Heritage Team (AURA/STScI/NASA)

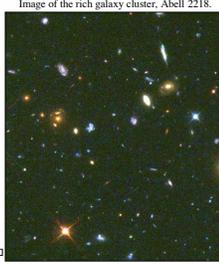



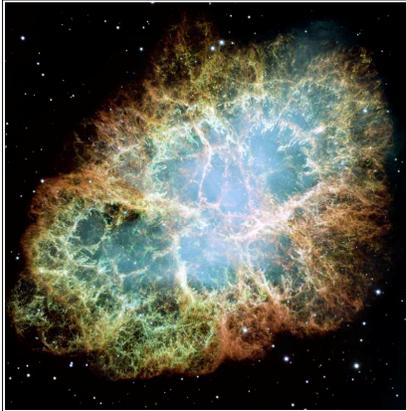
Image of the rich galaxy cluster, Abell 2218.

True color image of faint blue galaxies. More information at the NASA website. Credits: Rogier Windhorst and Simon Driver (Arizona State University), Bill Keel (University of Alabama), and NASA. □

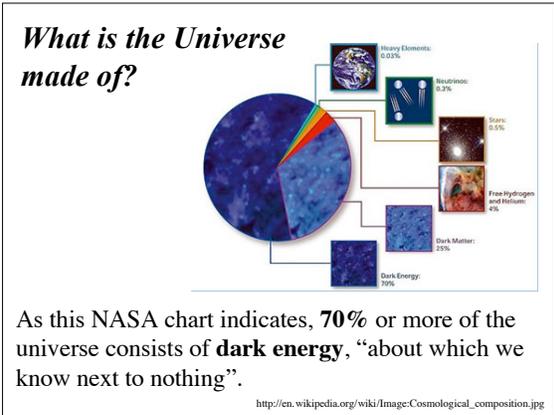


Galaxies, galaxies everywhere - as far as NASA's Hubble Space Telescope can see. This view of nearly 12,000 galaxies is the deepest visible-light image of the cosmos. Called the **Hubble Ultra Deep Field**, this galaxy-studded view represents a "deep" core sample of the universe, cutting across billions of light-years.

Source: <http://hubblesite.org/newcenter/newsdesk/archive/releases/2004/07/image/a>



Crab Nebula - a six-light-year-wide expanding remnant of a star's supernova explosion. Japanese and Chinese astronomers recorded this violent event nearly 1,000 years ago in 1054, as did, almost certainly, Native Americans. The orange filaments are the tattered remains of the star and consist mostly of hydrogen. The rapidly spinning neutron star embedded in the center of the nebula is the dynamo powering the nebula's eerie interior bluish glow. The blue light comes from electrons whirling at nearly the speed of light around magnetic field lines from the neutron star. The neutron star, like a lighthouse, ejects twin beams of radiation that appear to pulse 30 times a second due to the neutron star's rotation. A neutron star is the crushed ultra-dense core of the exploded star.
http://hubblesite.org/gallery/album/entire_collection/pr2005037a/large_web



Origin of Our Solar System

- *What does our solar system consist of?*
 Sun, 8 planets, 1 dwarf planet (Pluto), 153 known moons/satellites, tremendous number of asteroids

Solar Nebula Theory

- condensation and collapse of interstellar material (gas and small grains) in a spiral arm of the **Milky Way Galaxy**
- rotating cloud = **solar nebula**
- localized eddies allowed gases and particles to condense into small masses called **planetesimals**

the Milky Way Galaxy http://en.wikipedia.org/wiki/Image:Milkyway_pan1.jpg



This image is **mosaic of multiple shots on large-format film. It comprises all 360 degrees of the galaxy from our vantage.** Photography was done in Ft. Davis, Texas for the Northern hemisphere shots and from Broken Hill, New South Wales, Australia, for the southern portions. Note the dust lanes, which obscure our view of some features beyond them. Infrared imaging reaches into these regions, and radio astronomy can look all the way through with less detail. The very center, however, shows a window to the farther side. In the center, stars are mostly very old and this causes the more yellow color.

NGC 7331 is often referred to as "**the Milky Way's twin.**" This is what an observer from another galaxy might see when looking at the Milky Way.



http://en.wikipedia.org/wiki/Image:NGC_7331.jpg

Our Solar System (cont.)

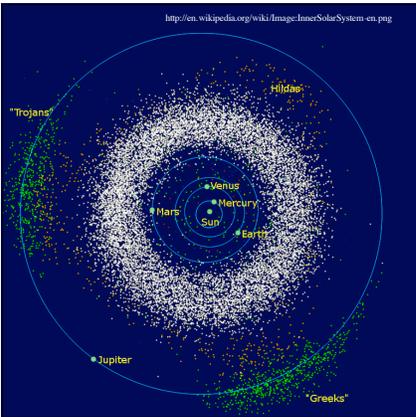
- material collided; planetesimals grew in size and mass to become **planets**

Terrestrial Planets - Mercury, Venus, Earth, Mars

- all small; composed of rock and metal
- condensed at high temps. of inner nebula

Jovian Planets - Jupiter, Saturn, Uranus, Neptune

- small rocky cores; surrounded by gasses of hydrogen, helium, ammonia, and methane
- condensed at lower temps. of outer nebula



<http://en.wikipedia.org/wiki/Image:InnerSolarSystem-en.png>

The inner Solar System, from the Sun to Jupiter, also includes the **Main Asteroid Belt** (the white donut-shaped cloud), the Hildas (the orange "triangle" just inside the orbit of Jupiter) and the Jovian Trojans (green). The group that leads Jupiter are called the "Greeks" and the trailing group are called the "Trojans"

Earth Structure

- **homogeneous accretion** of Earth
- **gravitational collapse** (condensation), large **impacts**, and **radiogenic decay** caused **heating to melting point of iron and nickel**
- **differentiation of planet by density: Fe-Ni core** and **silicate mantle** (eventually **crust**, **hydrosphere** and **atmosphere**)

<http://library.thinkquest.org/CO03124/images/struct.jpg>

Hadean Eon

~4.6-4.0 Ga
(giga annums = billion years)

Hadean Eon

- little or **no rock record** preserved
- continual and rapid recycling (subduction) of earliest crust due to **radiogenic decay** and **high heat flow** (much higher geothermal gradient)
- extensive **volcanism** and outgassing
- intense **meteorite bombardment**
- establishment of the **magnetic field** (shields Earth from the solar wind and deadly radiation)
- first **atmosphere, ocean(?)**

Oldest Rocks on Earth vs. Age of the Solar System

How do we know the age of our solar system?

- Age of meteorites and oldest moon rocks:
~4.56 Ga
- Age of oldest rocks on Earth:
3.96 Ga* (Acasta gneiss, Northwest Territories, Canada)
*zircon grains in an Australian sandstone:
4.1-4.4 Ga; this suggests the presence of crust very soon after Earth formed

Acasta Gneiss, Northwest Territories, Canada



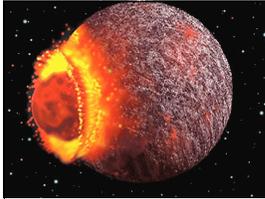
The **Acasta Gneiss** is a rock outcrop of **Archaean tonalite gneiss** in the Slave craton in Northwest Territories, Canada. **It is the oldest known crustal rock outcrop in the world.** The Acasta Gneiss is named for the nearby Acasta River east of Great Slave Lake some 350 km north of Yellowknife. The rock exposed in the outcrop formed just over four billion years ago; an age based on **radiometric dating of zircon crystals (4.03 Ga;** Bowring & Williams, 1999), which are the oldest rocks in the world so far.
http://en.wikipedia.org/wiki/Acasta_Gneiss

Early Crust

- Probably thin crust of **mafic** (basalt) or **ultramafic** (komatiite) composition
- Readily recycled (thin and dense)
- Little crust of **felsic** (granite) composition

Komatiite sample collected near Engelhart, Ontario, Canada. Specimen is 9 cm wide. **Bladed olivine crystals are visible.**
http://en.wikipedia.org/wiki/Image:KomatiiteCanada_682By512.jpg





http://www.jonlomborg.com/tp_bigwhack.gif

Formation of Our Moon

A major, near catastrophic event, seems to have occurred in the first 50 million years after the initial spherical Earth had formed and started (completed?) melting. A body (Planet X) roughly the size of Mars, i.e., another terrestrial-type planet or a huge asteroid, collided violently with Earth but more by grazing (at an angle near 30°) than direct, head-on impact, which would almost surely have totally disrupted the Earth.



So why do you think it's called the 'Hadean Eon'?



http://www.illustrationsofearthhistory.com/Sect19_2a.html

