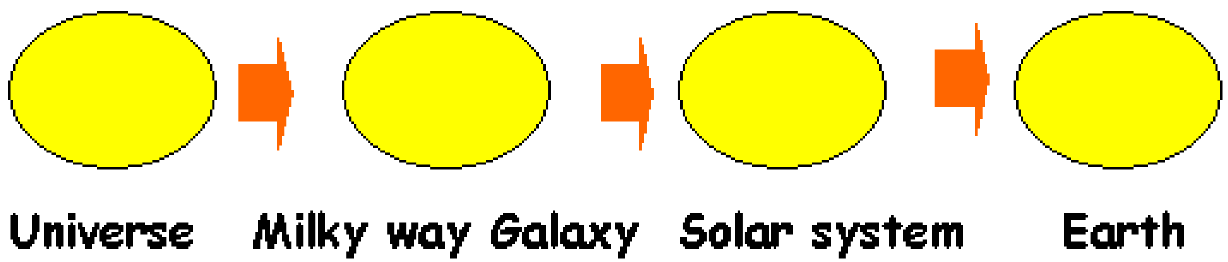
Chapter Two

- THE EARTH IN RELATION TO THE UNIVERSE

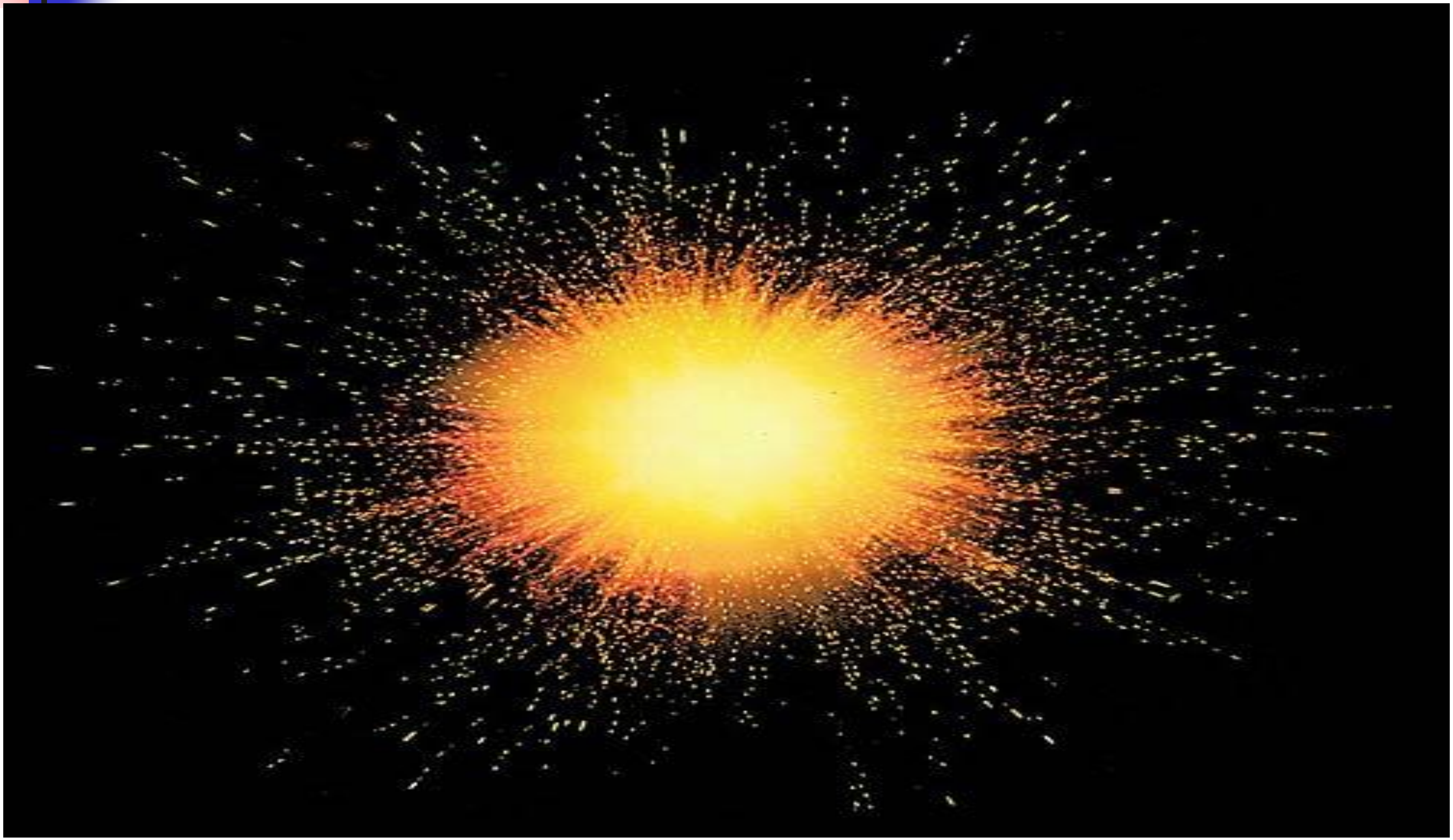


ORIGIN OF THE UNIVERSE

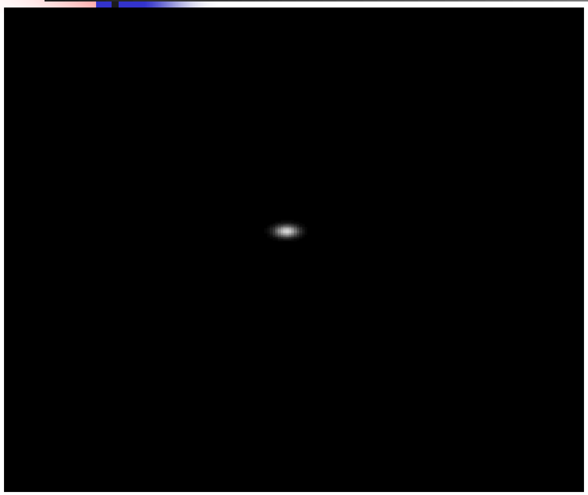
Explosions of dense point ➡ Superfast "inflation" expanding ➡
Elementary particles ➡ Quarks ➡ Neutron and proton ➡
H and He nucleus ➡ H and He atoms ➡ Stars ➡ Protogalaxy ➡
Galaxy

The Big Bang

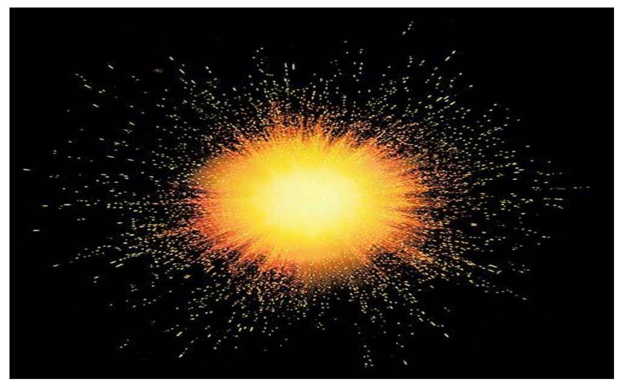
where are we going?



The
Big Bang theory

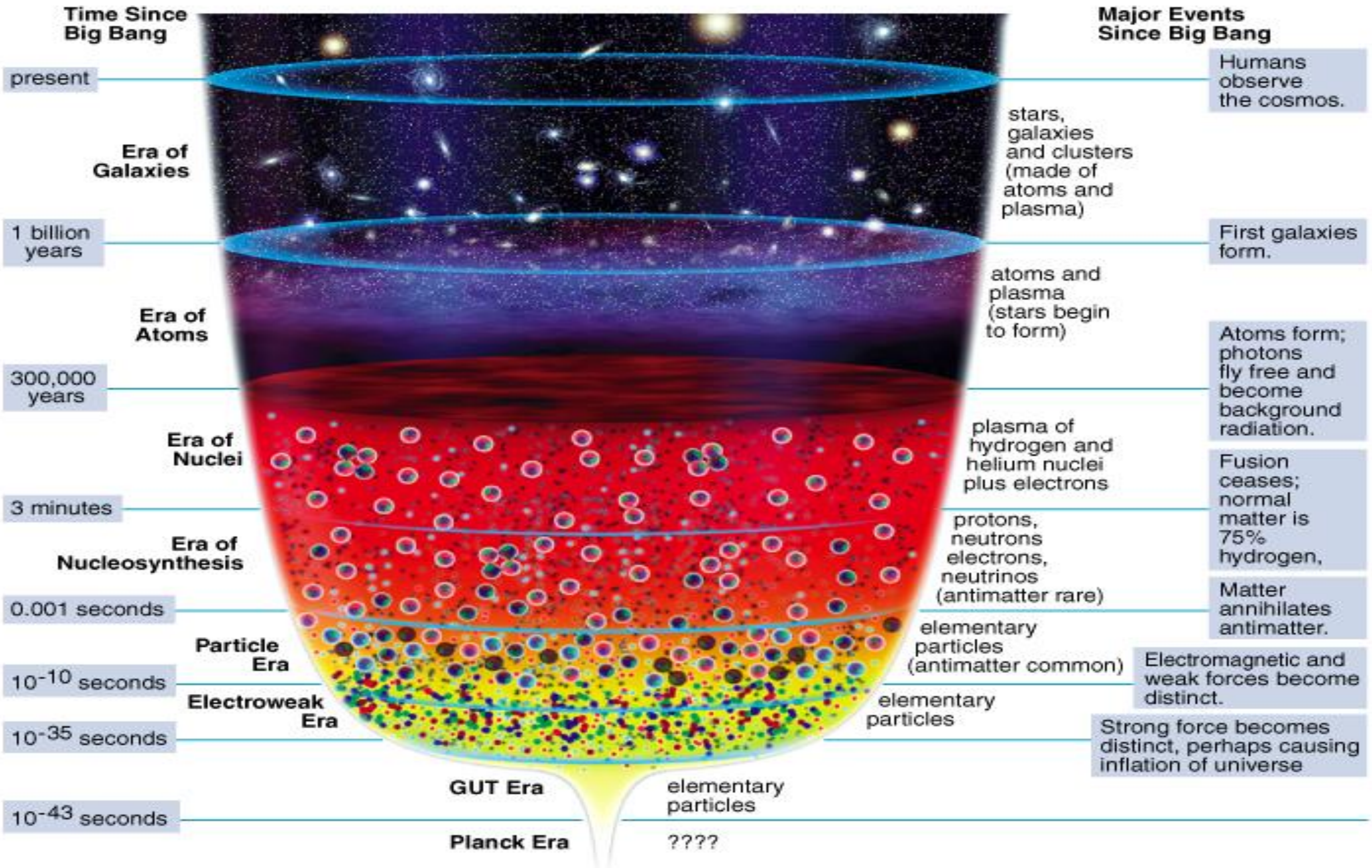


- -All matter and energy was squished together in an infinitely dense point not governed by our physical laws or time
- - all matter and energy contained in one point
- An unknown agent causes the point to explode



•instantaneous filling of space with all matter

What happened after the explosion?



BIG BANG THEORY **The theory that the origin of the universe was a single, giant release of energy from a single point in space-time that has expanding outward**

Most astronomers and astrophysicists now accept that the Universe was created in the so-called “Big Bang”.

Huge explosion of dense point (matter and energy) and then spread the matter and energy in the universe

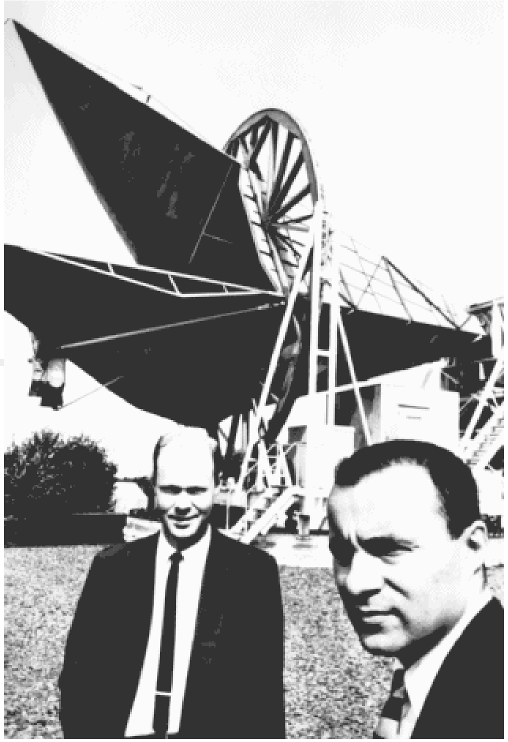
All the mass and energy that the Universe contains today was present at the moment of its البدايةinception.

The Big Bang

- 1920's: LeMaitre proposes on theoretical grounds that the universe is expanding

- 1929: Hubble observed galaxies moving away from us with speeds proportional to distance

- 1964: Penzias and Wilson detect 'primordial static' left over from Big Bang



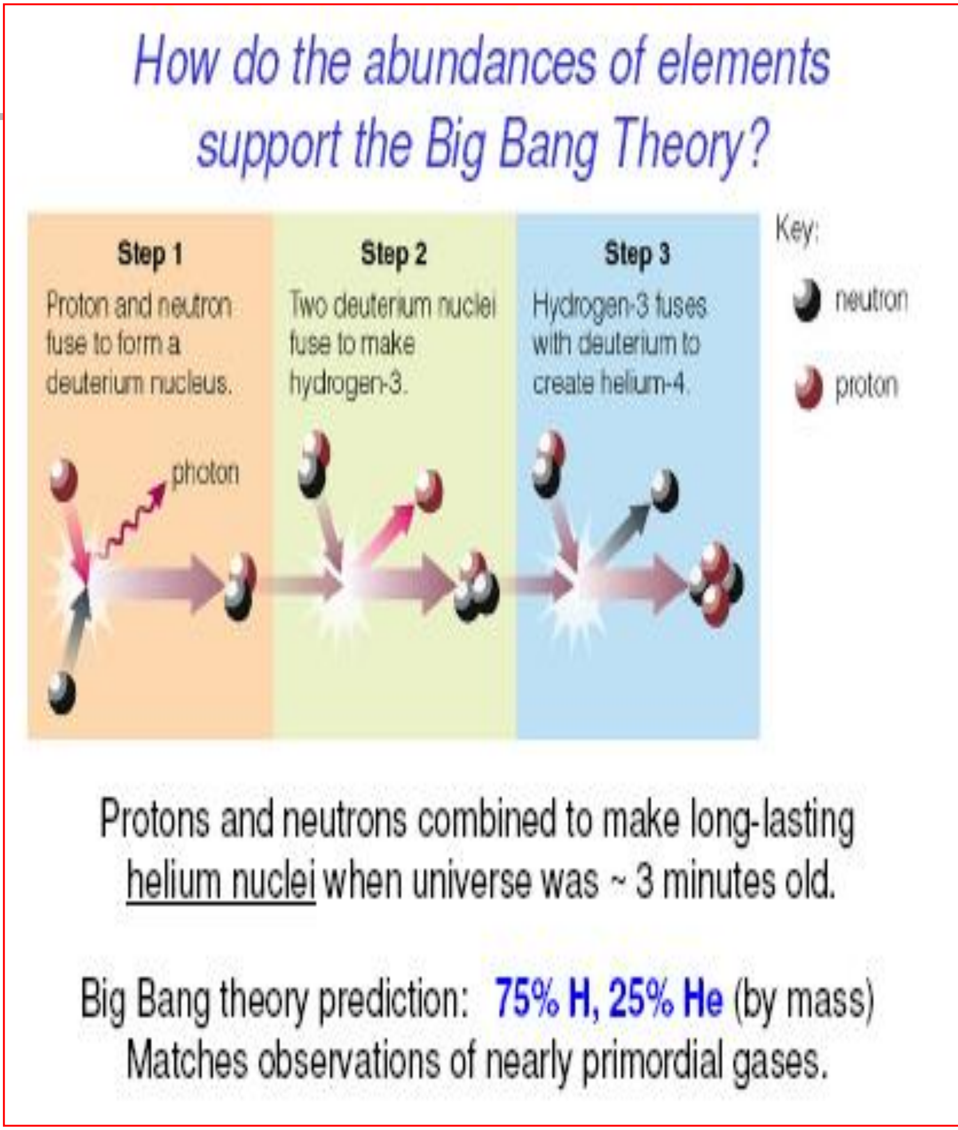
Time After Big Bang	Temperature (K)	Event
5.39×10^{-44} s	--	appearance of space, time, energy, and superforce
10^{-43} s	10^{31}	gravity separates
10^{-35} s	10^{28}	strong force and electro-weak force
10^{-33} to 10^{-32} s	10^{27}	inflation
1×10^{-10} s	10^{15}	electromagnetic and weak force
3×10^{-10} to 5×10^{-6} s	$\sim 10^{13}$	stabilization of quarks, antiquarks
6×10^{-6}	1.4×10^{12}	formation of protons and neutrons
10s	3.9×10^{9}	stabilization of electrons and positrons
3.8 m	9×10^{8}	formation of 2H, 3He, and 4He nuclei
700,000 y	3000	electrons captured by nuclei

AFTER THE BIG BANG

At t ~ 10^{-32} seconds, pressure and temperature were so high that matter existed as a mix of quarks (fundamental components of matter).

At t ~ 13.8 seconds, the Universe cooled to about 3×10^9 K, and the quarks combined to form neutrons, protons, etc., and then H and He nuclei. This continued for ~30 minutes, but only H and He produced. Could not create Li, Be or B.

In June 1995, scientists detected primordial الاساسى helium in the far reaches of the universe - consistent with an important aspect of the Big Bang theory that a mixture of hydrogen and helium was created at the beginning of the universe



AT ~ 700,000 YEARS

1-The temperature cooled to 3 x 10^3 K =Kelvein (273°+t).

2-Electrons finally could become attached to nuclei to form atoms.

3-Eventually matter became organized into stars, galaxies, etc.

4-The Universe continues to expand.

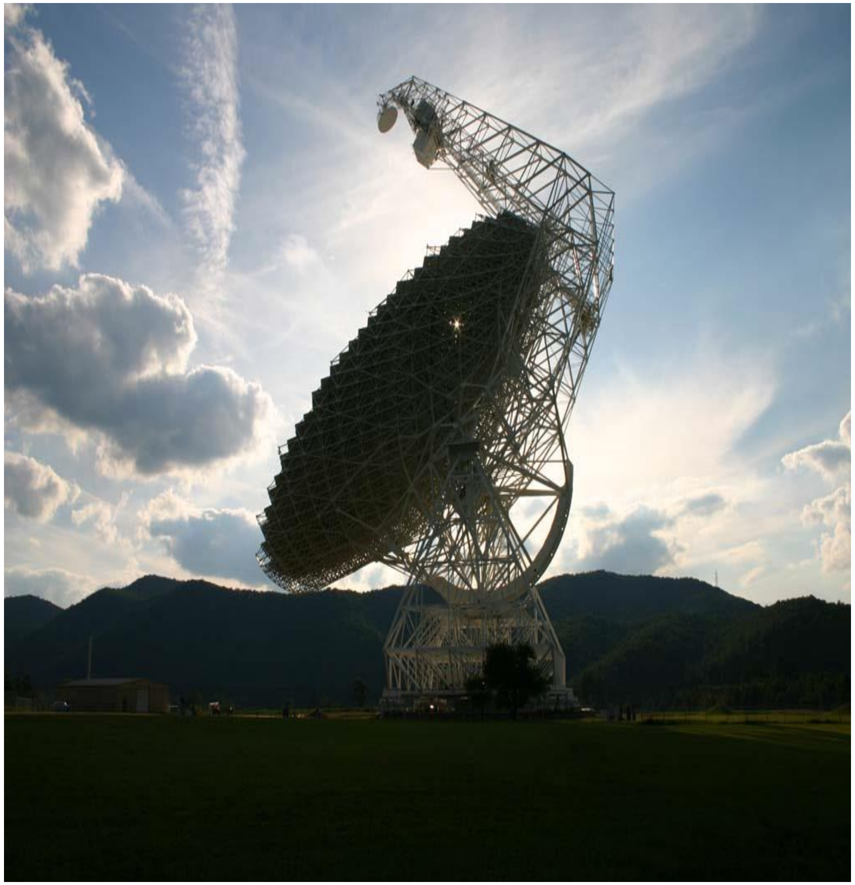
Evidence for the Big Bang

The Big Bang model is supported by 3 independent observations:

- The red shift of light from distant galaxies
- The presence of large amounts of helium in the universe
- The cosmic microwave background radiation

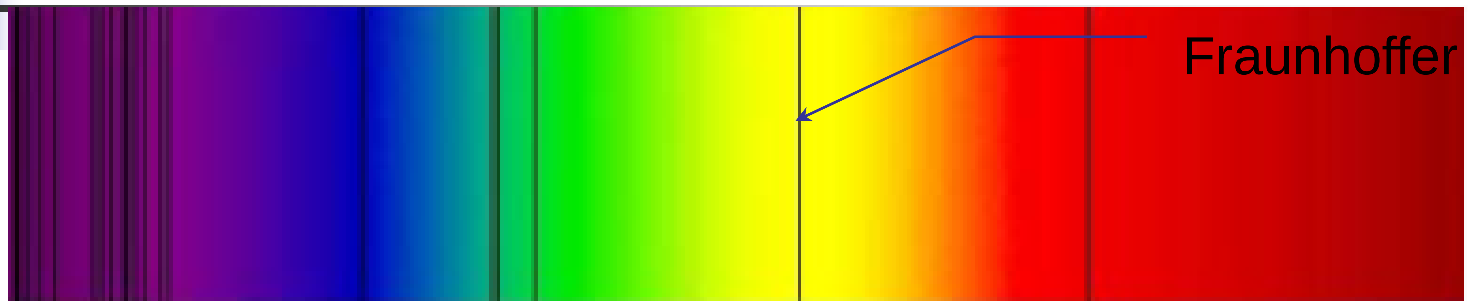
How can you examined the far away stares or galaxies:

- By analyses the spectra of light which reached to us from the stars or from the galaxies on the sensitive films



1-The red shift

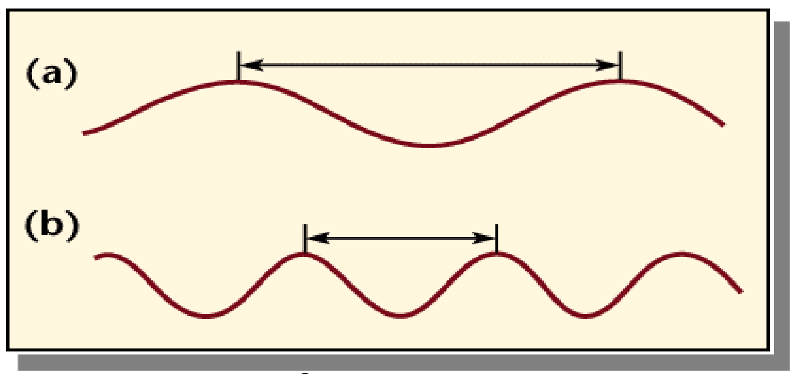
Spectrum of light from the sun



Shorter

Fraunhoffer lines

Longer



Red

Violet

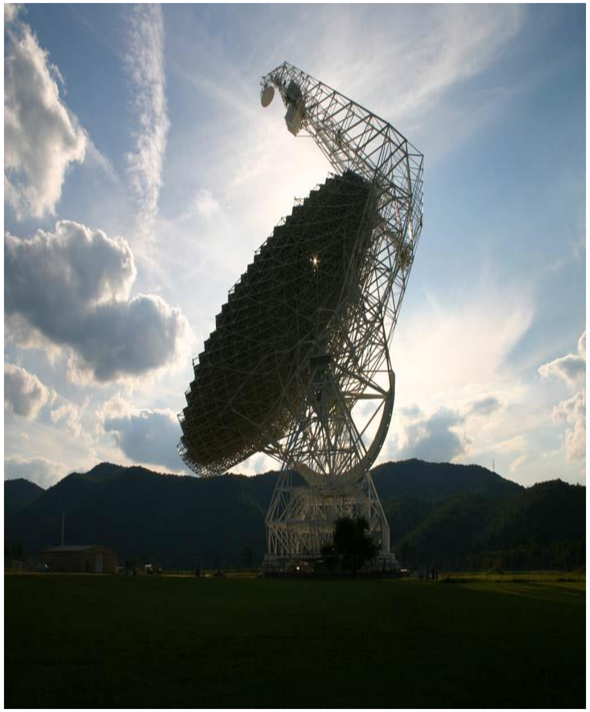
Light from a cluster of galaxies 10^9 light years away

Light can be split into individual wavelengths (giving the colors of the rainbow. . . ROY G BIV)

Each color determined by the wavelength of light.

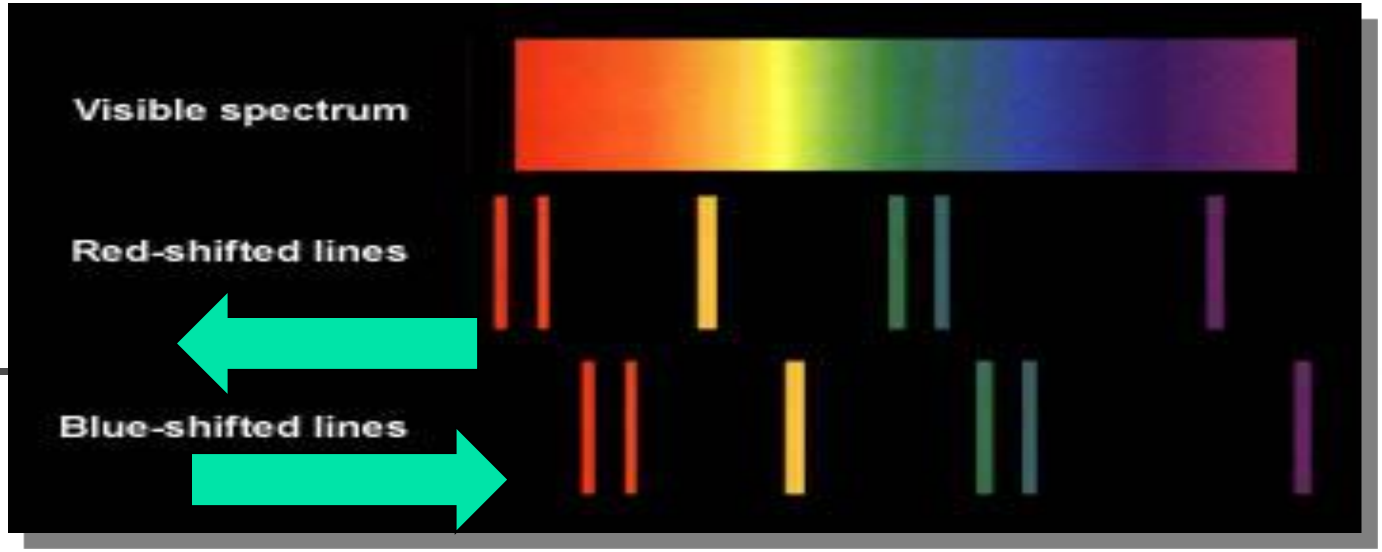
REDSHIFTOF STARS-THE DOPPLER EFFECT

- The wavelength of waves emanating from a moving source (stars or galaxies) appears to be longer or shorter, depending on whether the source is moving towards or away from the observer.



$$\frac{\lambda'}{\lambda} = 1 + \frac{v}{c}$$

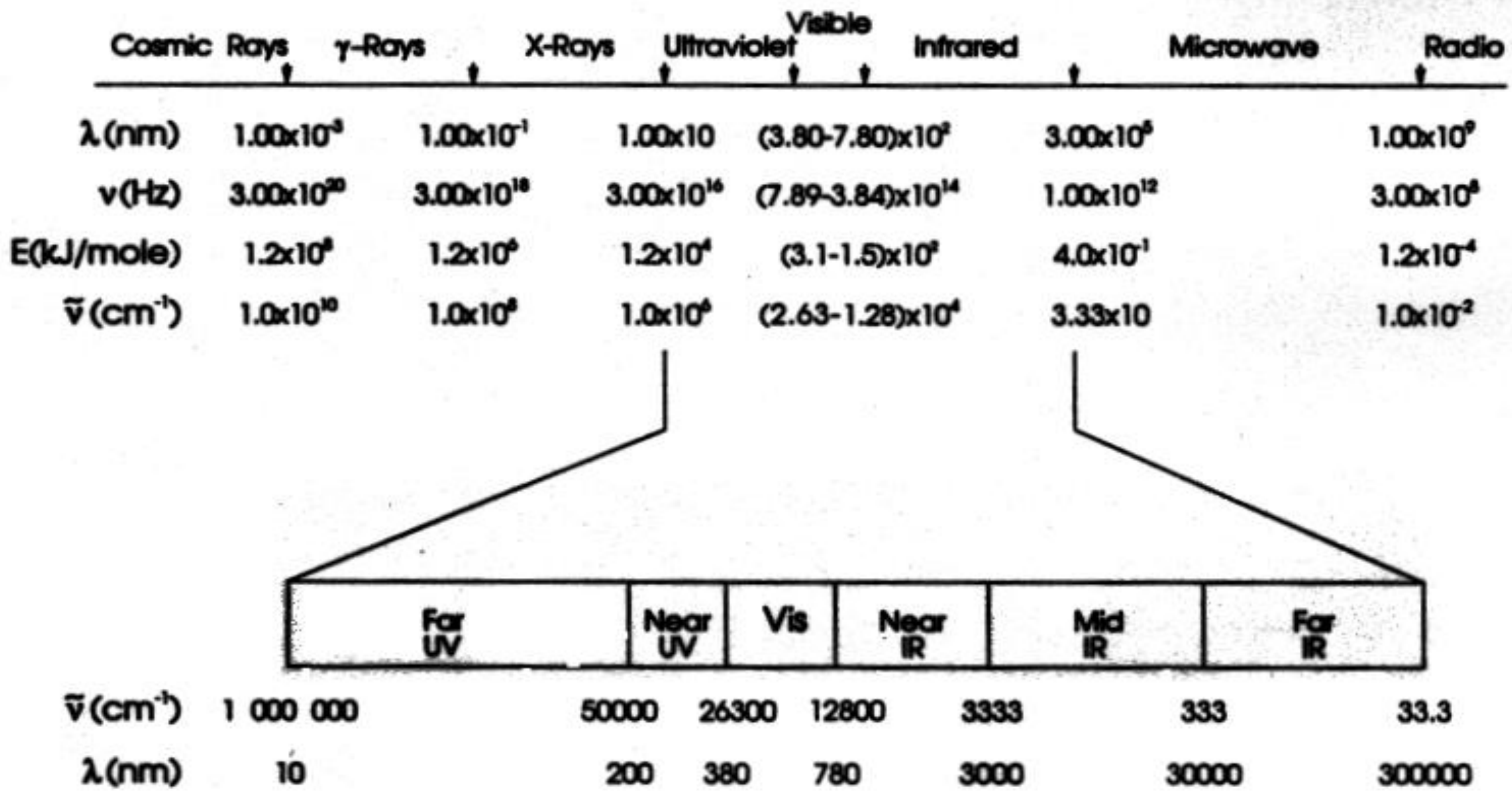
λ' - wavelength from moving source; λ - wave-length from stationary source; v - velocity of source; c - speed of light.



If $v > 0$, i.e., the source is moving away from the observer, $\lambda' > \lambda$, so the light appears **redshifted**.

If $v < 0$, i.e., the source is moving towards the observer, $\lambda' < \lambda$, so the light appears **blueshifted**.

ELECTROMAGNETIC SPECTRUM

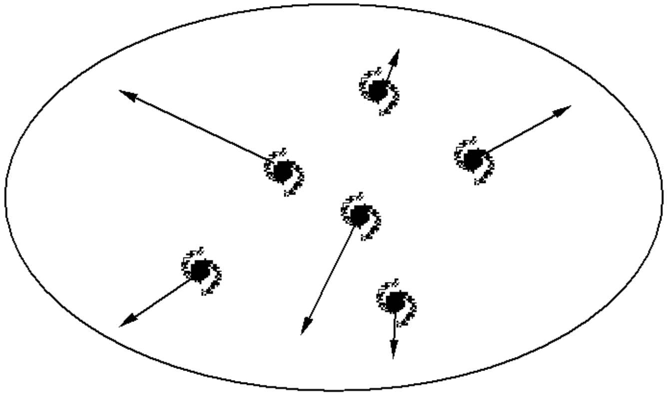


Expanding or Contracting the Universe

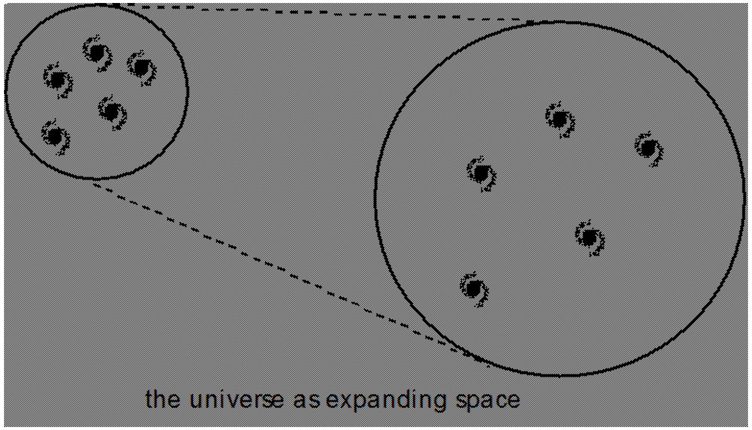
- By analyses the spectra of the nebulae we found that a displacement of the lines toward the red end of the spectrum, this red shift being approximately proportional to their distance and leads to the picture of an expanding universe.

Expansion of the universe

- Expansion of the universe is NOT a rushing to fill empty space
- The WHOLE universe is expanding at the same time with the same rate - there is no empty space



the universe as a box filling with galaxies



2-Helium abundance

- **Universe is 24% He (by mass)**
- **Energy (heat +light) of Stars related to fuse hydrogen into helium**
  - **In 14 billion years ago, stars have not burned hot enough, or long enough to make this much helium**
  - **The oldest stars (11 billion years) *also* have ~ 24% He so this He cannot have been made in stars!**

- Big Bang -Fusion process in the first three minutes of history made the helium and still have the same rate till now
- This shows that the universe was very hot in earliest times

HUBBLE'S DISCOVERY

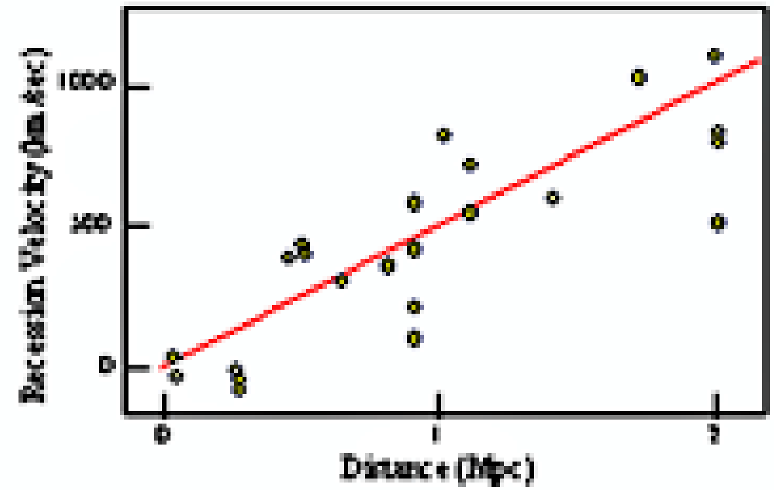
Hubble noticed that spectral lines from stars undergo a "redshift" owing to the Doppler effect.

1-From the apparent intensity of the star, the distance can be estimated.

2-From a knowledge of the composition of stars, i.e., H and He, we know the expected wavelength of emission.

Hubble found that the amount of redshift increased with distance, i.e., stars further away are moving away from us (and each other) at greater speeds.

[redacted]



Hubble's Law

$$\mathbf{v = H_0 d}$$

velocity | Hubble constant | distance

HUBBLE'S EQUATION

$$v = H \cdot d$$

H ~ 65 km/sec/10^6 light years

where V is the velocity of the galaxy

- H is the Hubble Constant ~ 64 km/s/MLY مليون سنة ضوئية
- D is the distance to the galaxy

$$t = \frac{d}{v} = \frac{1}{H} \approx 20\text{x}10^9 \text{ years}$$

T=time=distance/velocity

The accepted age of the Universe is ≈ (14.5±1.0) x 10^9 years

Age of the Universe

- $T = D/V$ (time = distance/velocity)
- But the Hubble relationship is $V = H*D$
- Eliminate V, substituting $T = D/(H*D)$
- then $T = 1/H = 1/65$ km/sec/MPc
- $T = 4.75 \times 10^{17}$ sec/3.15×10^{7} sec/yr $= 15 \times 10^{9}$ yr

The Age of The Universe

- **With certain assumptions as to the rate of expansion, the astronomical age of the universe is computed to be about 15-16x10^9 years.**
-
- **T = D/V (time = distance/velocity)**
- But the Hubble relationship is **V = H*D**
- Eliminate **V**, substituting **T = D/(H*D)**
- then **T = 1/H = 1/65 km/sec/MPc**
- T=4.75x10^{17}sec/3.15 x 10^7sec/yr =**15x10^9yr**

Speed x time = distance
(distance of a particular galaxy) / (that galaxy's velocity) = (time)
or
4.6 x 10^26 cm / 1 x 10^9 cm/sec = 4.6 x 10^17 sec
~ 15 billion years

The Age of the Universe

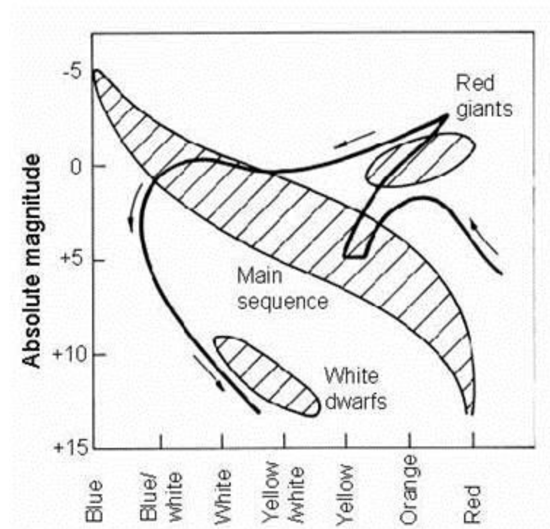
Four methods of determining age of universe:

1) Cosmological models – H_o (the Hubble constant – ratio of velocity to distance in expansion of universe) T_o=13.7 billion years

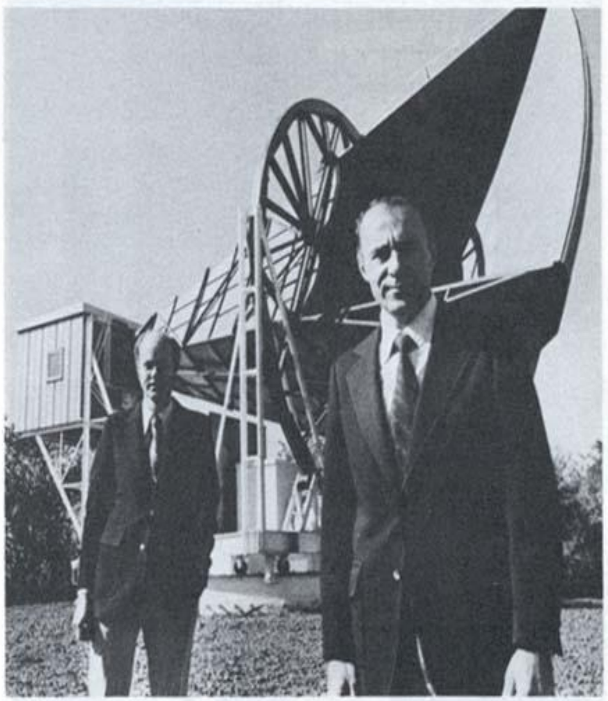
2) Isotope geochemistry – $^{187}Re \rightarrow {}^{187}Os$, $t_{1/2}$=40 billion years T_o=12-17 billion years
^{238}U decay, $t_{1/2}$=4.5 billion years T_o=12.5-16 billion years

3) Age of oldest star clusters -- measure luminosity of brightest star, relies on stellar evolutionary model, T_o=11-13 billion years

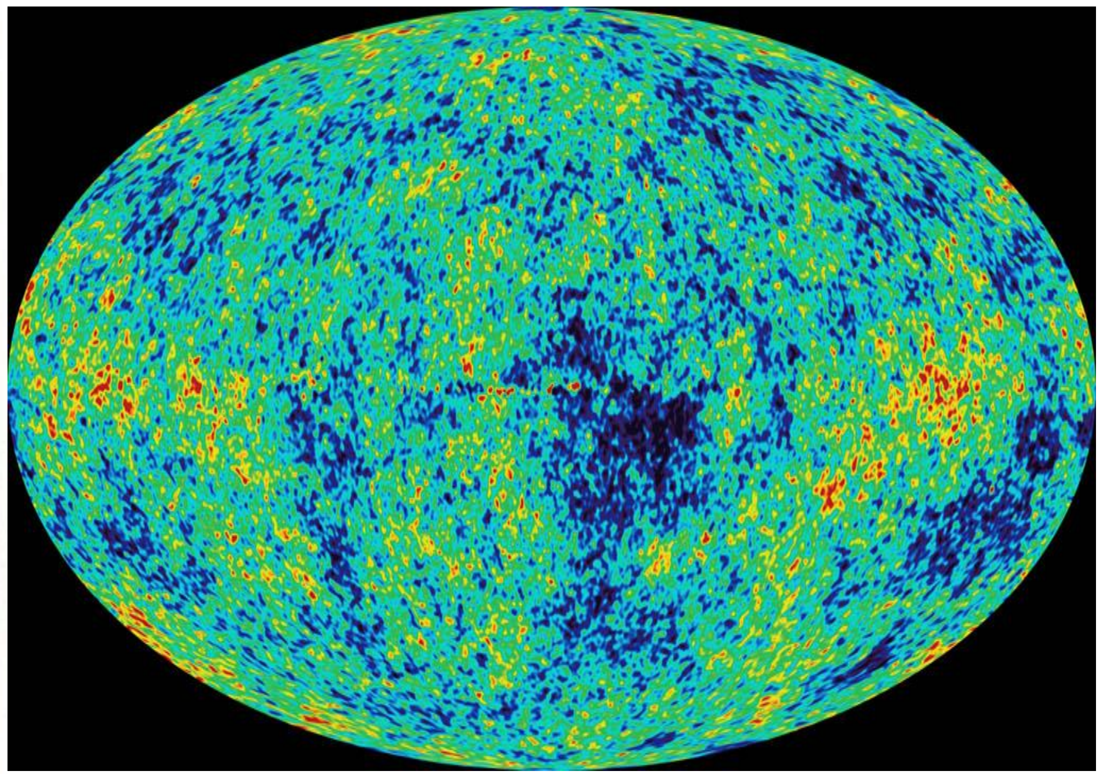
4) Oldest white dwarfs -- measure luminosity of faint white dwarfs to determine how long they have been cooling, T_o=12-13 billion years



In 1964 Penzias and Wilson discovered the remnant heat of the Big Bang. This is called the cosmic microwave background radiation. It is all around us. The universe has cooled off considerably. The radiation corresponds to a temperature of 3 degrees above absolute zero (- 454 F).



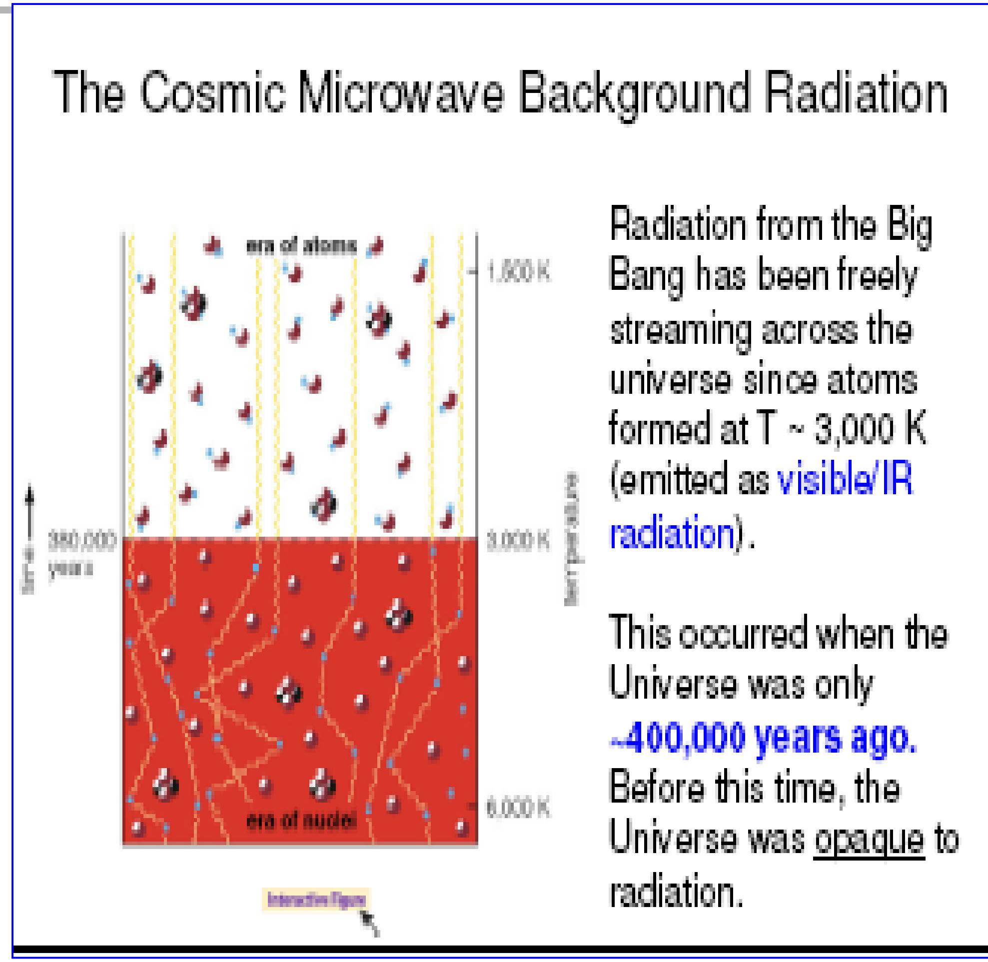
The Holmdel Radio Telescope: Arno Penzias (right) and Robert W. Wilson (left) are shown here with the 20-foot horn antenna used by them in 1964–65 in their discovery of the 3° K cosmic microwave radiation background. This telescope is at the Holmdel, New Jersey, site of the Bell Telephone Laboratories. (Bell Telephone Laboratories Photograph)



3-BLACKBODY REMNANT RADIATION

Penzias & Wilson (1964) discovered a background microwave radiation corresponding to a blackbody temperature of 3K.

This radiation is thought to be a remnant of the radiation that filled the Universe for ~700,000 years when T > 3000 K.



NUCLEOSYNTHESIS

Nucleosynthesis - refers to the creation of the nuclei of the chemical elements.

Only H, and He were created in the initial big bang.

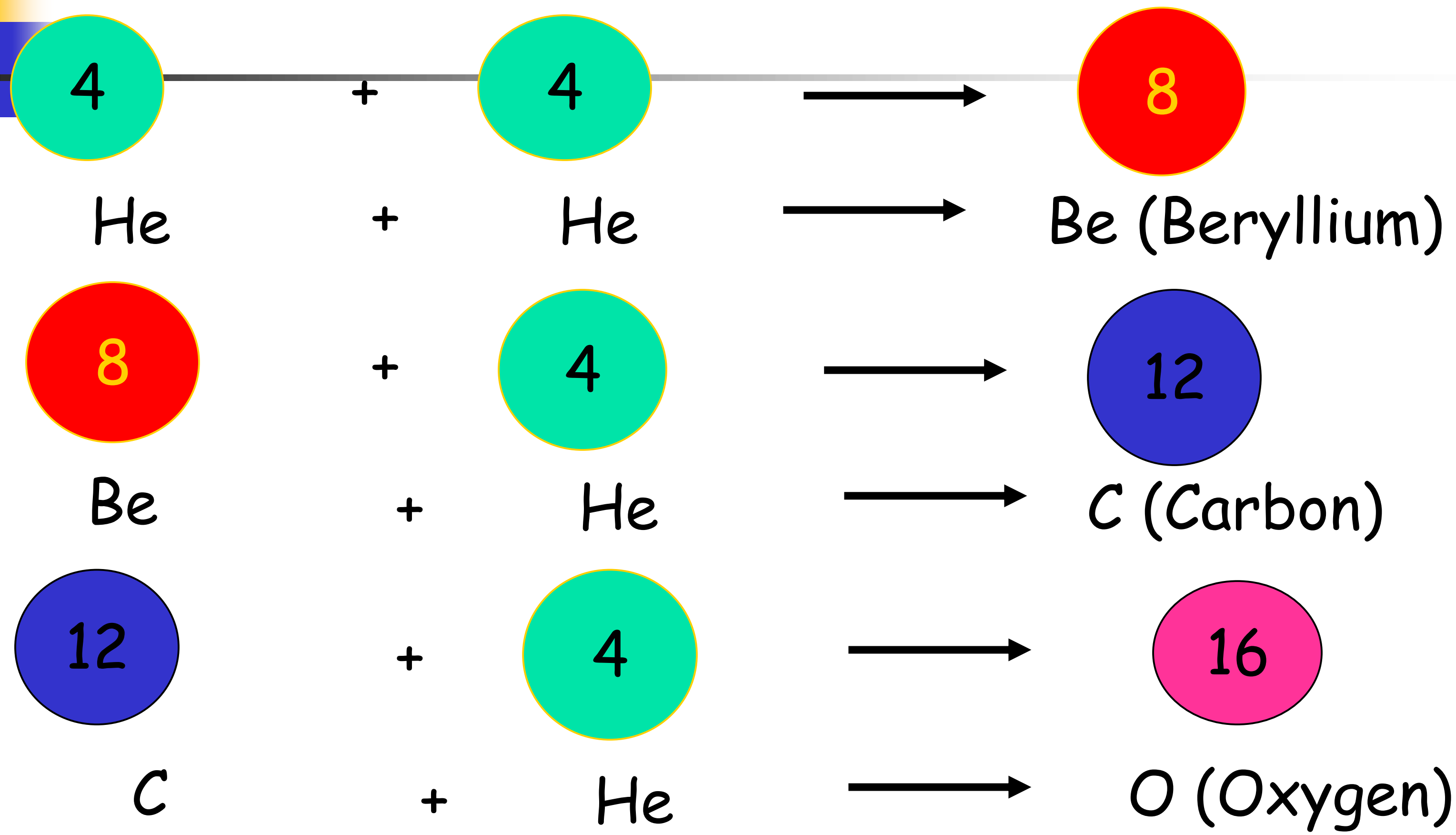
Other elements are generated in stars during their life, or during supernovas that end the star's life.

Hydrogen & Helium: Big Bang

Helium to Iron: Stellar Fusion
Multiples of 4 most common:
Helium Carbon, Oxygen, Neon, Magnesium, Silicon, Sulfur, Iron

Iron to Uranium: Supernova

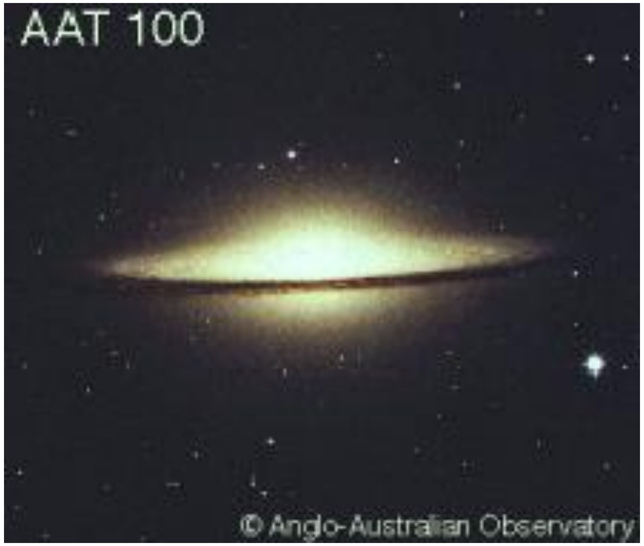
NUCLEOSYNTHESIS: Making heavier atoms by combining lighter atoms. This occurs in stars and is called fusion. This is where stars get the energy to shine.

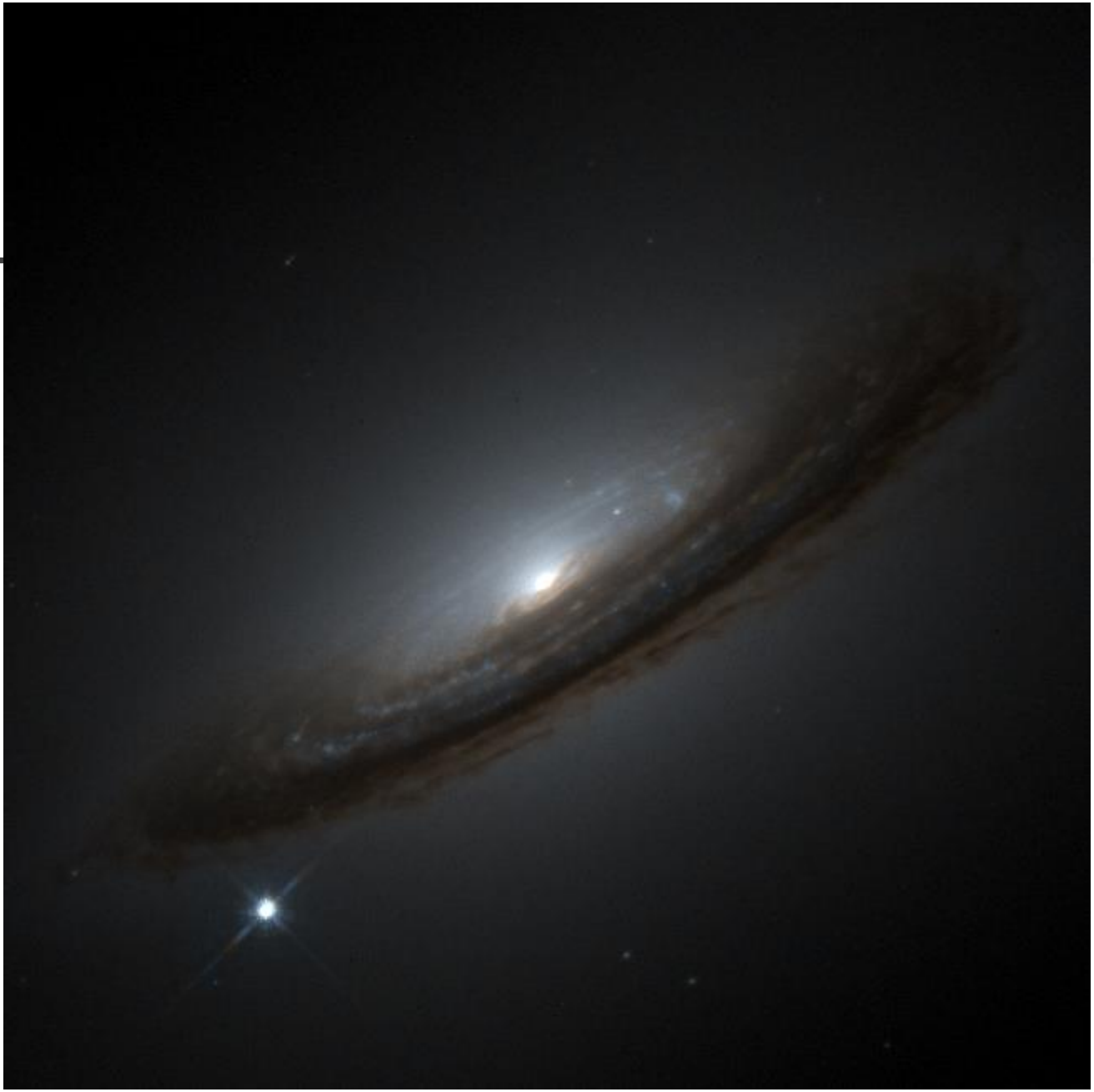


Elements are made in stars. You are made of the stuff of stars.

There are two types of universe:

- 1-The far cosmic (universal) space
- a-Although stars are very far from each others, they lie in groups called Galaxies.
- B-The galaxy consists of millions of stars and the universe consist of millions of galaxies.
- C-The vast huge space in which these galaxies spread is known as the far space.
- d-One of these glaxies is known as "The Milky Way", the sun is one of the millions of stars forming it.
- e-Stars in a galaxy can be divided into smaller groups called "Constellations"Ex: Great Bear and Scorpio
- 2-The near Cosmic (universal) space : is the space where earth and other planets of the solar system



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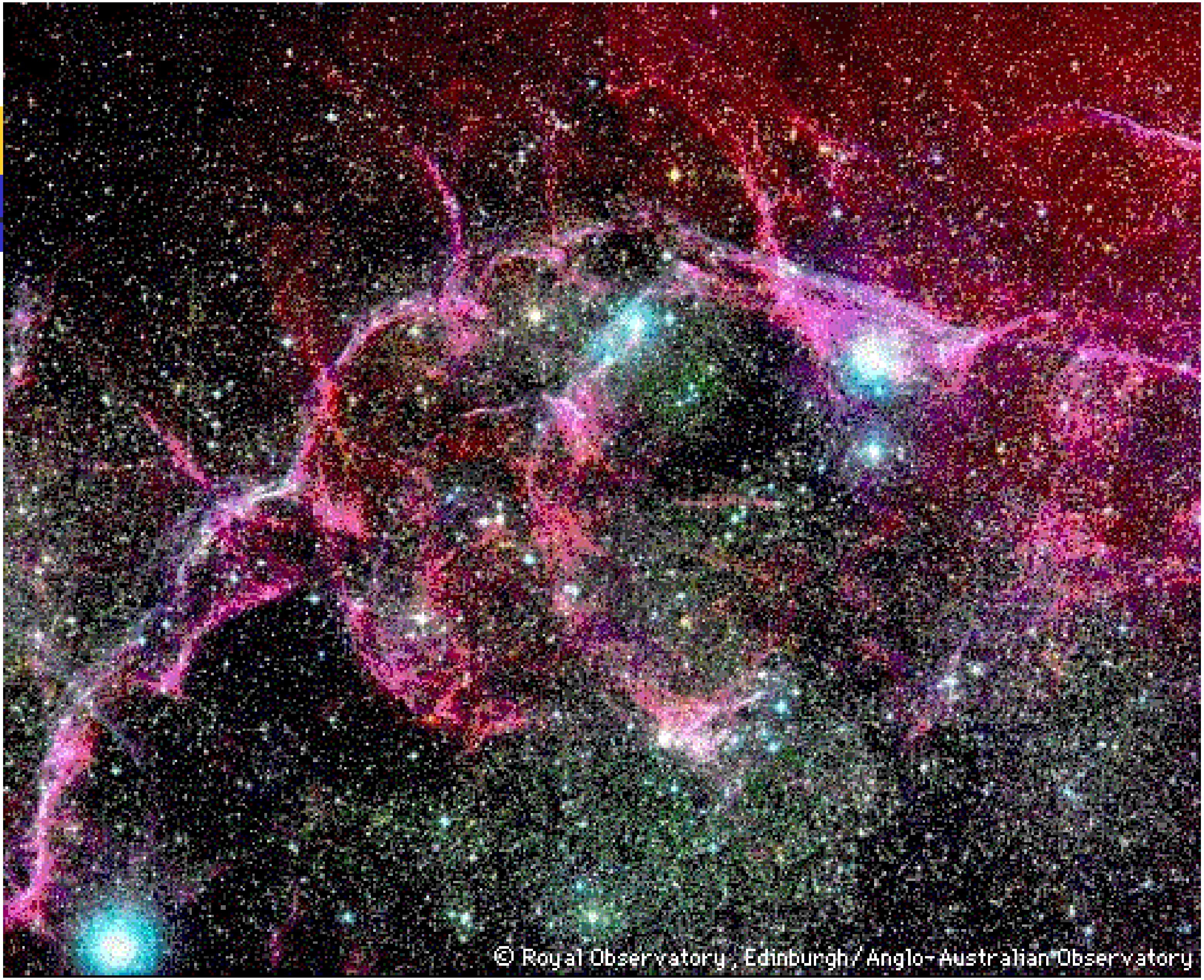
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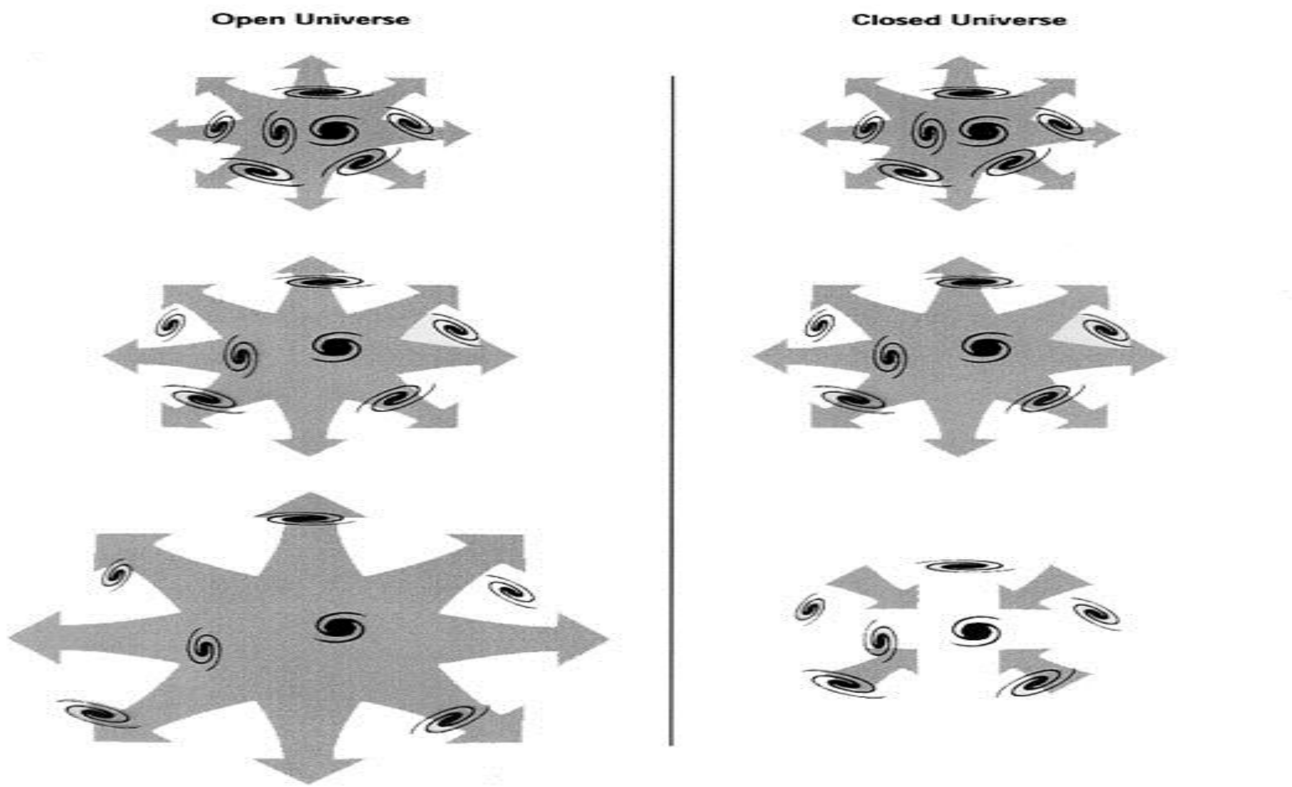
Crab Nebula

The Composition of The Universe

- Spectroscopic observation indicates the :
- 1-elements responsible for the radiation
- 2-analysis of the intensities of the spectral lines rough estimates can be made of the relative amounts of the different elements present in the outer layers of the radiating body.
- 3-The data are consistent with the belief that the universe consists of the same elements,
- 4-The different percentage of the elements in the difference parts of the Universe are due to participation of these elements for energy production in the stars

What Happens Next?

Astronomers feel that the Big Bang theory leads to two possible futures for the Universe.



An open universe expands forever because it does not contain enough mass, and so does not have enough gravity to slow the expansion of space. A closed universe contains enough mass to halt the expansion, and eventually collapses. A universe with a "critical density" of matter in space is ex actly balanced between these two alternatives, and expands at an ever-slowing rate.

Open Universe

Galaxies will continue racing outward (continue to expand). All of the stars will die off as the last of their energy is released. There will be nothing left,

total emptiness.

والسماء بنيناها بأيد وانا موسعون{

سورة الذاريات الآية 47

Closed Universe

Gravitational attraction between the galaxies will cause the movement away from each other to slow and, eventually come to a halt. The gravitational pull will begin to pull the galaxies back to the center of the universe.

All of the matter and energy will again come close together and end in a central area (possibly no larger than a time). Then another Big Bang will occur and the formation of the universe will begin all over again

What Happens Next?

{يَوْمَ نَطْوِي السَّمَاءَ كَطَيِّ السِّجِلِّ لِلْكُتُبِ كَمَا بَدَأْنَا أَوَّلَ خَلْقٍ نُعِيدُهُ
وَعْدًا عَلَيْنَا إِنَّا كُنَّا فَاعِلِينَ}. (الأنبياء:104)

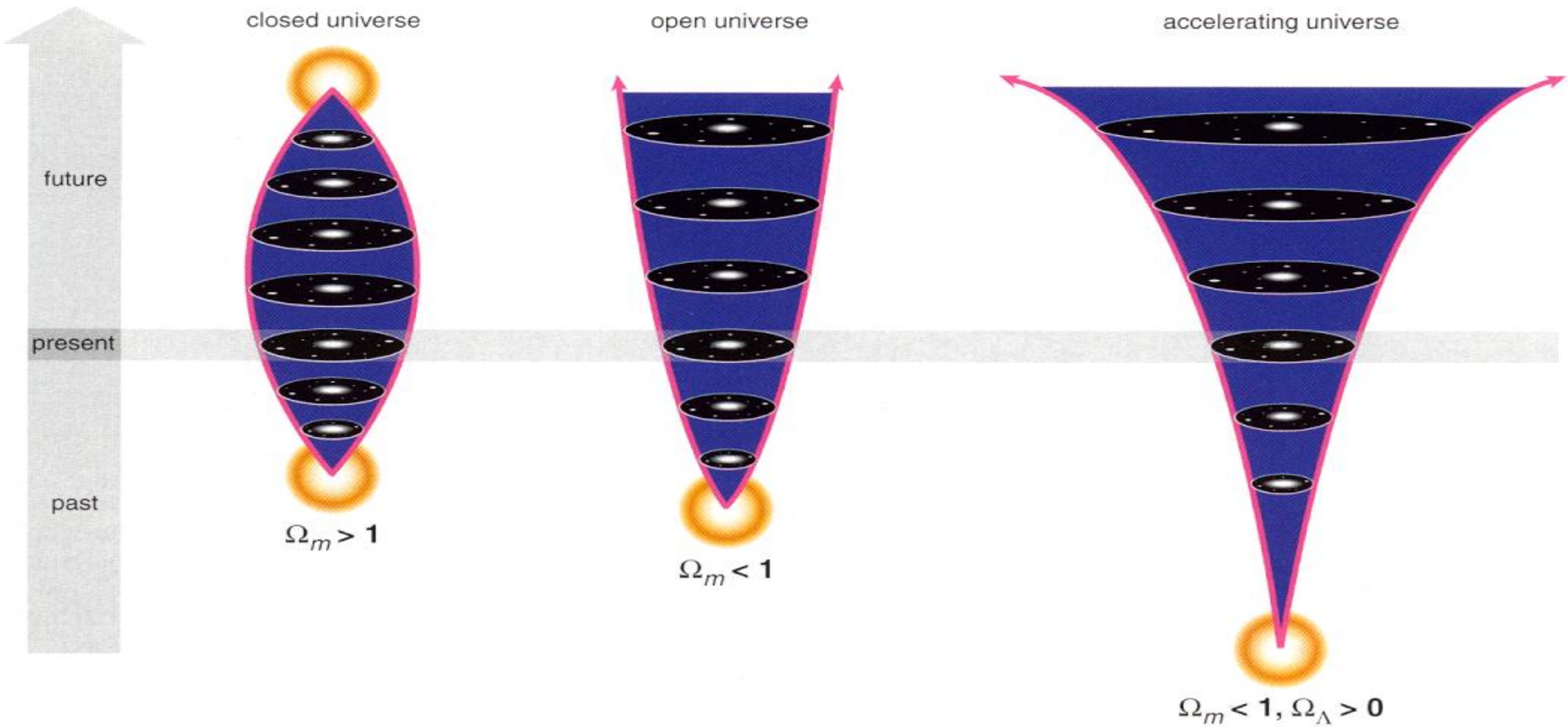


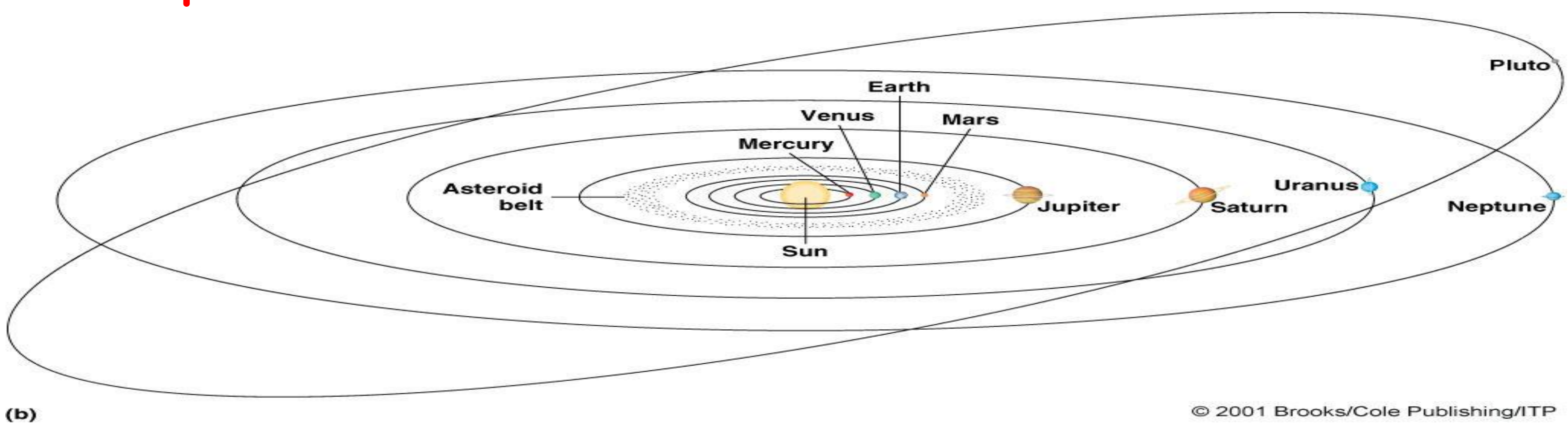
Figure 7. Evolutionary course of the expanding universe depends on the total amount of matter it contains. The parameter Ω_m is the ratio of the actual density of the matter in the universe relative to the critical value, which marks the dividing line between a universe that expands forever and one that ultimately collapses again. The critical value is defined as $\Omega_m = 1$, where there is just enough matter in the universe to prevent its eternal expansion or eventual collapse. In a "closed" universe, with $\Omega_m > 1$, the gravitational pull of matter ultimately causes the universe to collapse in a "big crunch." In an "open" universe, with $\Omega_m < 1$, there is not enough matter to gravitationally halt the expansion, and so it continues forever. Astronomers have determined that we live in a universe with $\Omega_m < 1$, but that a dark (or vacuum) energy ($\Omega_\Lambda > 0$) appears to be causing the expansion to accelerate. Each of these models also implies a different age for the universe, based on its current expansion rate. (Adapted from a NASA illustration.)

The Nature of the Milky way Galaxy

- 1-Our Galaxy has a lense like form with a diameter of about 70.000 light years.
- 2-Our Galaxy is one from 26 other galaxies which discovered until now in the Universe.
- 3-The distance between any galaxy and the other may be reached to 10^{19} km.
- 4-The age of the Milky way Galaxy is computed to be $8.5-10x10^{9}$ years and the diameter is of the order of 10^{18} km.
- 5-The galaxy closest to Milky way Galaxy is the Andromeda Galaxy.
- 6-The Sun and The solar system rotated around the center of the galaxy each 200Ma.

The Nature of the Solar System

- In the study of geochemistry the solar system is a primary importance, although it is not clear within our galaxy and insignificant in relation to the universe as a whole. The most important are the following:
- 1-The Sun contains over 99.8% of the mass of the system
- 2-The planets all revolve in the same direction around the sun in elliptical orbits, and these orbits all lie in practically the same plane.

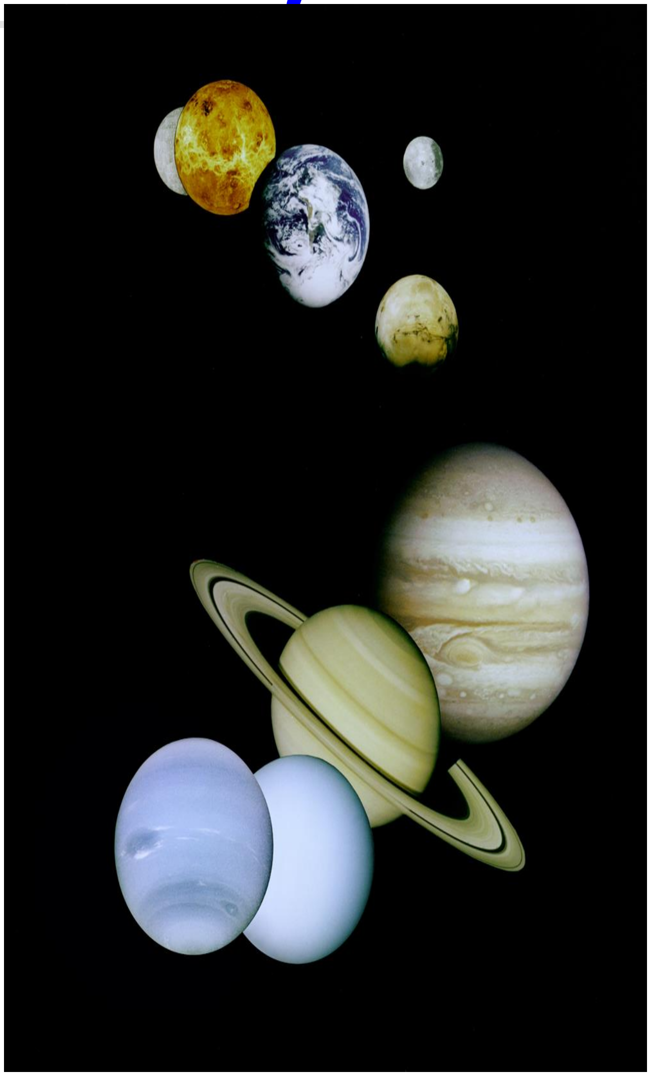


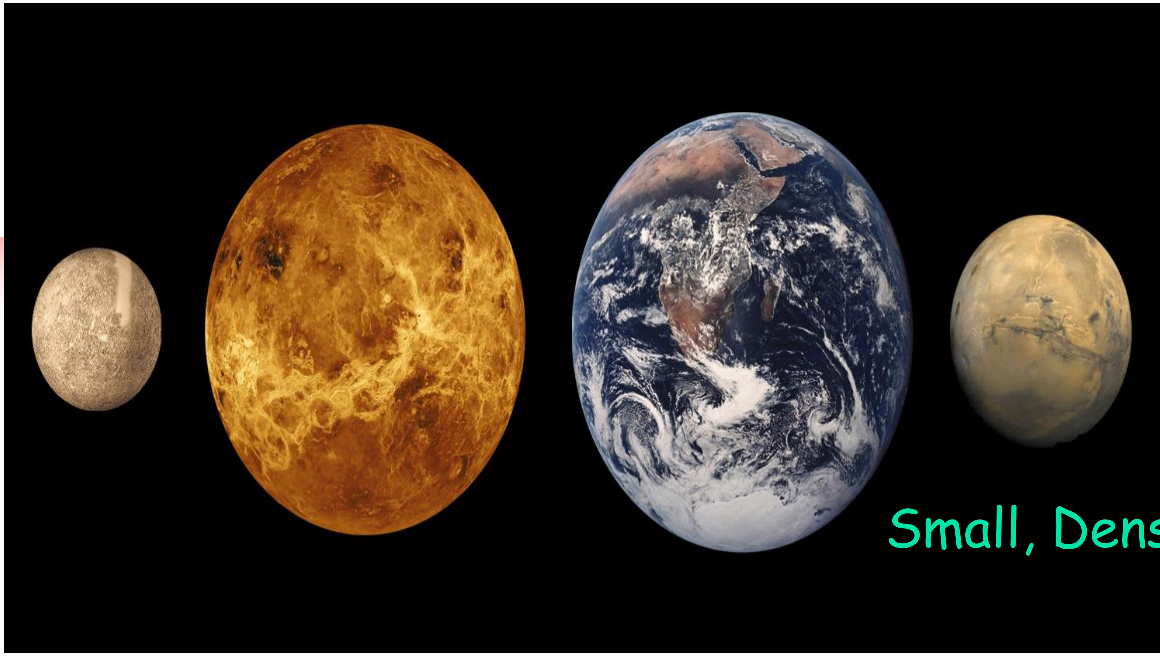
The Nature of the Solar System

- 3-The planets themselves rotate about their axes in the same direction as their direction of revolution around the sun (except Uranus and Venus, which have retrograde rotation).

- 4-The planets form two contrasted groups: an inner group of small planets (Mercury, Venus, Earth and Mars), which are called the terrestrial planets, and an outer group of large planets (Jupiter, Saturn, Uranus and Neptune), which are called the major planets.

- 5-There are 31 satellites which rotate around the different planets, in addition to 150,000 asteroids , meteorites and comets.

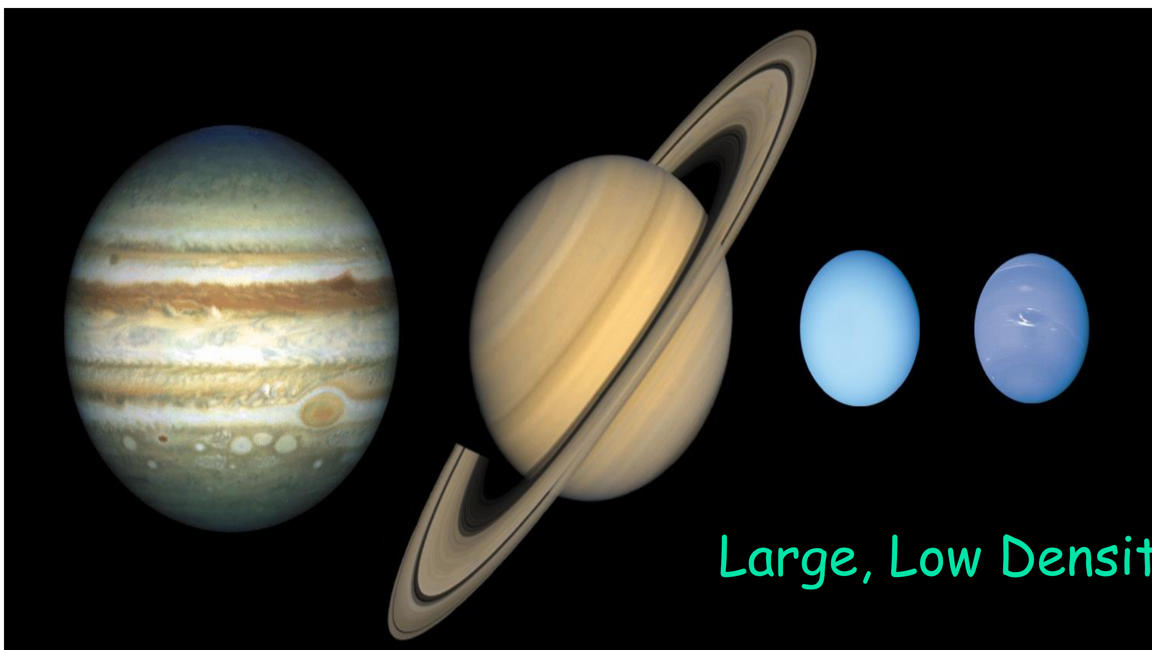




inner group

Terrestrial Planets

Small, Dense and made of Rock and Iron



outer group

Jovian Planets

Large, Low Density, and Made of Gas and Ice

The gravitational force between the planets and the Sun

- 1-The Sun affects the planets with a central gravitational force which makes the planets rotate around it in specific orbits.

- 2-The force of attraction between the planets and the Sun as well as the planets and their moons is defined by "Newton's universal low of gravitational attraction":

- (The attraction force between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them).

  - $F=mass/distance^2$

The relation between the Earth and the Solar system

The relation between the earth and the solar system depend on the fact that the solar system is essentially a closed system (as an isolated unit) and its element composition the same when it formed. But there are two exceptions:

1-Conversation of Hydrogen (H) to Helium (He) in the Sun.

$4H^1$ _Nuclear Fussion_______________ He^4 + Energy

$3He^4$ ______________________________ ^{12}C + Energy

$^{12}C + He^4$ __________________________ ^{16}O + Energy

$^{16}O + He^4$ __________________________ ^{20}Ne + Energy

$$^{56}_{28}Ni \rightarrow {}^{56}_{27}Co \rightarrow {}^{56}_{26}Fe$$

H-FUSION
CNO CYCLE **(HOW GENERATED THE NEW ELEMENTS)**

- After the supernova of 1st generation stars, processes involving elements with higher Z were possible.
- CNO cycle is higher probability process than proton-proton chain.

$$ {}^{12}_{6}C + {}^{1}_{1}H \rightarrow {}^{13}_{7}N + \gamma $$

$$ {}^{13}_{7}N \rightarrow {}^{13}_{6}C + \beta^{+} + \nu $$

$$ {}^{13}_{6}C + {}^{1}_{1}H \rightarrow {}^{14}_{7}N + \gamma $$

$$ {}^{14}_{7}N + {}^{1}_{1}H \rightarrow {}^{15}_{8}O + \gamma $$

$$ {}^{15}_{8}O \rightarrow {}^{15}_{7}N + \beta^{+} + \gamma $$

$$ {}^{15}_{7}N + {}^{1}_{1}H \rightarrow {}^{12}_{6}C + {}^{4}_{2}He $$

He-FUSION
TRIPLE-ALPHA PROCESS

At T ~ 10^8 K, He is the fuel for the "triple-α" process.

$$^{4}_{2}He + ^{4}_{2}He \rightarrow ^{8}_{4}Be$$

$$^{8}_{4}Be + ^{4}_{2}He \rightarrow ^{12}_{6}C + \gamma$$

- This process bridges the gap in the stability of Li, Be and B.
- For ^{8}Be, $t_{\frac{1}{2}}$ ~ 10^{-16} seconds. Thus, ^{8}Be must absorb an α-particle very quickly to get ^{12}C.

ALPHA-CHAIN PROCESS

- With further increases in temperature, α-particles fuse with ^{12}C to form higher atomic number atoms in an α-chain process.

$$^{12}_{6}C + {}^{4}_{2}He \rightarrow {}^{16}_{8}O$$

$$^{16}_{8}O + {}^{4}_{2}He \rightarrow {}^{20}_{10}Ne \quad \text{etc.}$$

The process stops at ^{56}Fe. Thus, Fe is the last element produced in normal stars.

$$^{56}_{28}Ni \rightarrow {}^{56}_{27}Co \rightarrow {}^{56}_{26}Fe$$

Decay Series:

2-Decay of radioactive elements. The radioactive elements are very important to determined the age by used the half time of these elements (Isotopes)

U^{238} ______ $Pb^{206} + 8\ \sigma\ (He^{4}) + 6\ \beta$ + heat

1- U^{238} ______ $Pb^{206} + 8\ \sigma\ (He^{4}) + 6\ \beta$ + heat

2- U^{235} ______ $Pb^{207} + 7\ \sigma\ (He^{4}) + 4\ \beta$ + heat

3- Th^{232} ______ $Pb^{208} + 6\ \sigma\ (He^{4}) + 4\ \beta$ + heat

Radioactive Decay

- The missing isotopes must change into atoms with less nuclear potential energy (mass).
- The energy will be released as heat.
- Any change must obey all of the laws

Examples of Radioactive Decay Rates

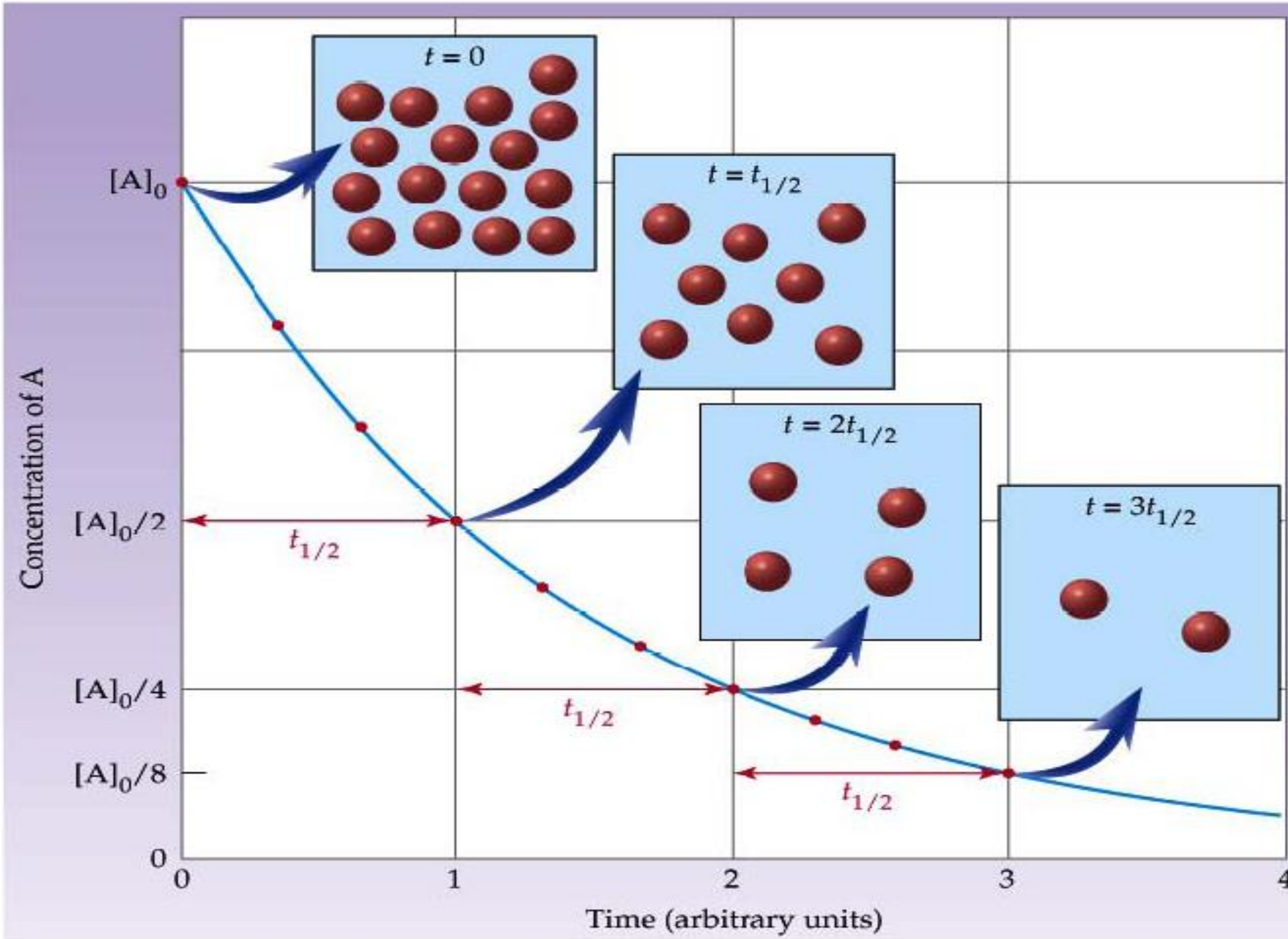
TABLE 22.2 Half-lives of Some Useful Radioisotopes

Radioisotope	Symbol	Radiation	Half-life	Use
Tritium	$^{3}_{1}H$	β^-	12.33 years	Biochemical tracer
Carbon-14	$^{14}_{6}C$	β^-	5730 years	Archaeological dating
Phosphorus-32	$^{32}_{15}P$	β^-	14.26 days	Leukemia therapy
Potassium-40	$^{40}_{19}K$	β^-	1.28×10^9 years	Geological dating
Cobalt-60	$^{60}_{27}Co$	β^-, γ	5.27 years	Cancer therapy
Technetium-99*m**	$^{99m}_{43}Tc$	γ	6.01 hours	Brain scans
Iodine-123	$^{123}_{53}I$	γ	13.27 hours	Thyroid therapy
Uranium-235	$^{235}_{92}U$	α, γ	7.04×10^8 years	Nuclear reactors

*The *m* in technetium-99*m* stands for *metastable*, meaning that it undergoes gamma emission but does not change its mass number or atomic number.

The period of time, after which the number of radioactive nuclei of a particular element decreases by 50%, is called the **half-life period** of that element. ...

First–Order Reactions/Decay Rates

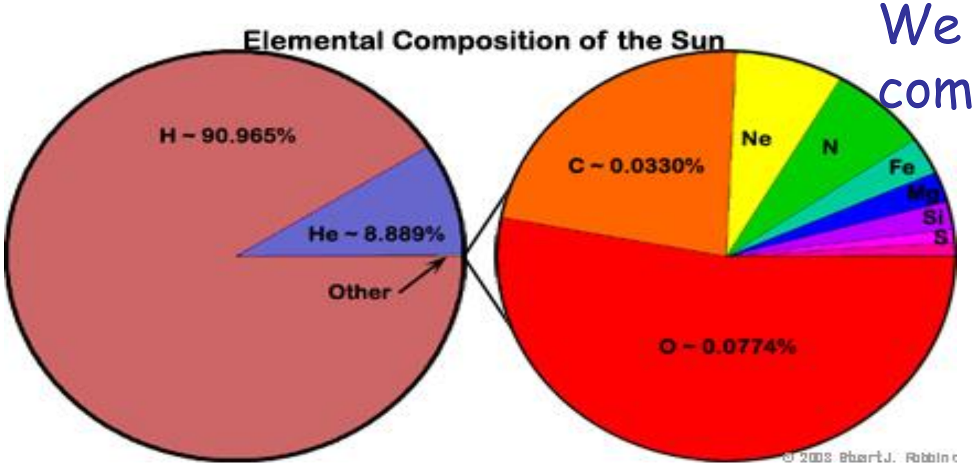


Geochemistry of the Sun

1-By study and analyses of Sun spectrum and radiation indicate that it contains the same elements which present in the earth but in different concentrations.

2-The Sun contains over 99.8 % of the mass of the solar system

3-The Sun consist of 70% hydrogen,28%helium, and 2% heavier elements.



We know the composition of the sun

Geochemistry of the Sun

4-The Sun generates its heat and light by converting hydrogen to helium.

5-The Sun can be considered as small star in the Milky Way Galaxy.

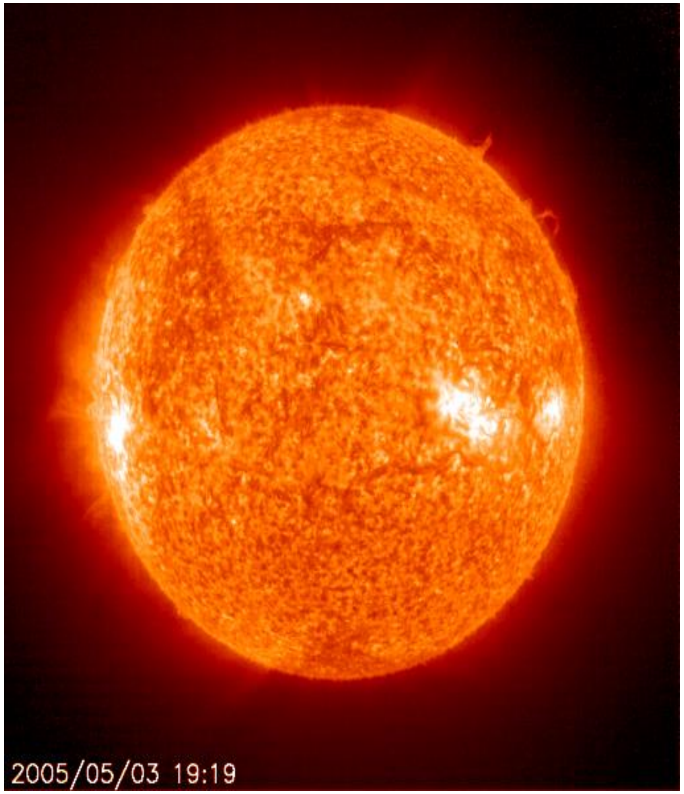
6-The Sun present single without any neighbor

7-The surface temperature of the Sun 6000 C, while in the center the temperature reached about 14 million degree.

8-The diameter of the sun 1.49×10^6km.

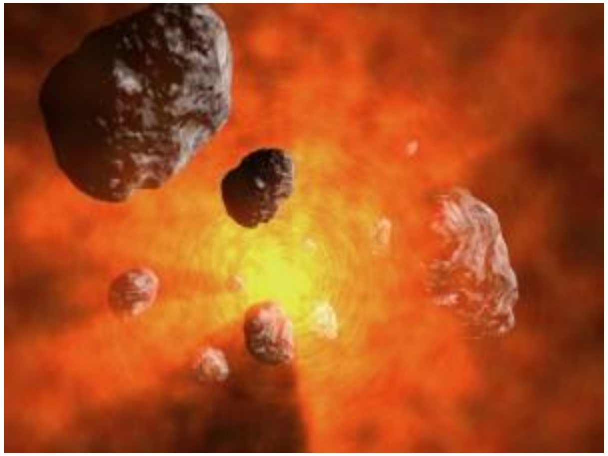
9-Stars of the Milky Way galaxy have similar composition the Sun.

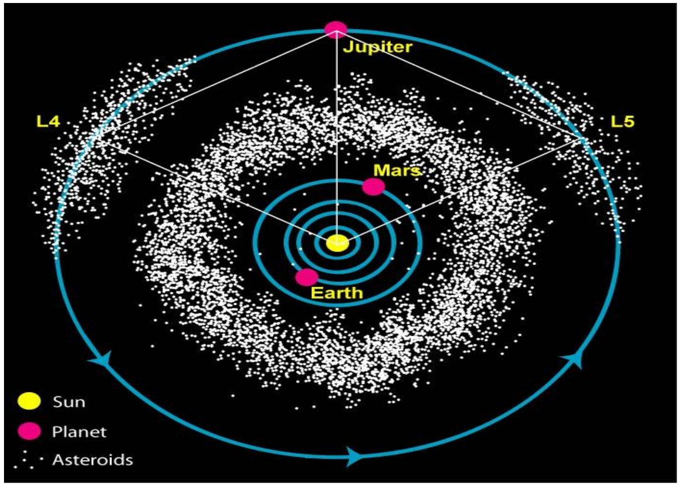
10-The Sun floats in space with a speed of 20km/sec. And the Sun rotates around the center of the Galaxy with speed 320km/sec. in addition to rotation about is axis.



Asteroids

- Asteroids are rocky or metallic objects
- A few asteroids approach the Sun more closely.
- None of the asteroids have atmospheres.
- Asteroids are also known as planetoids or minor planets.





Composition of Asteroids

- The asteroids are varied in their composition. Most are made of rock, but some are composed of metals and other materials.

Type	Composition	Percentage of Asteroids	Albedo (reflectivity)
Carbon (C-type)	Carbon	over 75 percent	0.03-0.09 (Very dark)
Silicate (S-type)	Metallic iron mixed with iron-silicates and magnesium-silicates	17 percent	0.10 -0.22 (Relatively bright)
Metallic (M-type)	Iron/ nickel	less than 7 percent	0.10-0.18 (Relatively bright)
Dark (D-type)	Water ice/frozen carbon monoxide mixed with rock	less than 1 percent	0.05 (Relatively dark and reddish

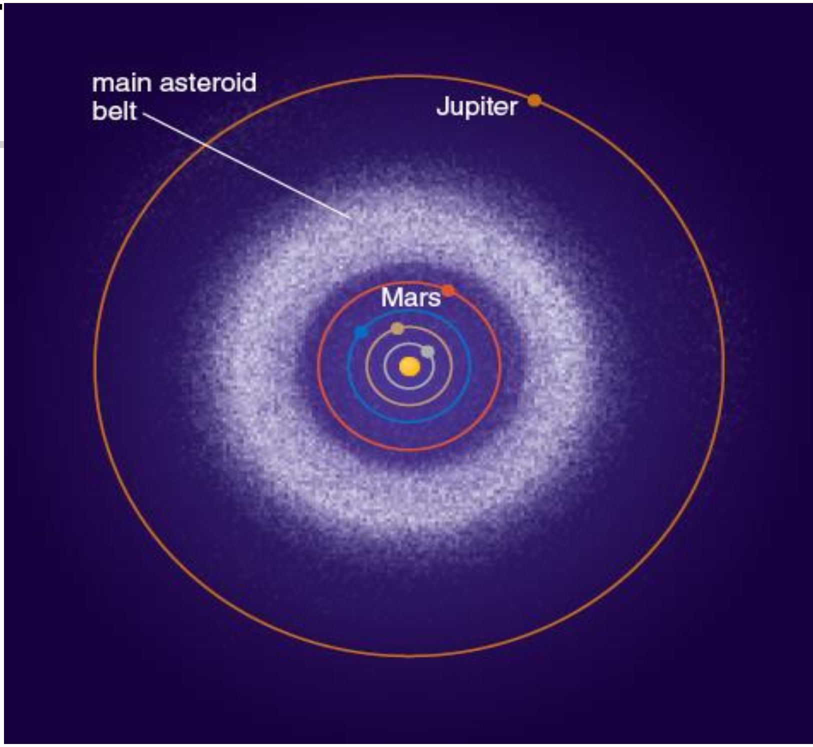
THE ASTEROID BELT

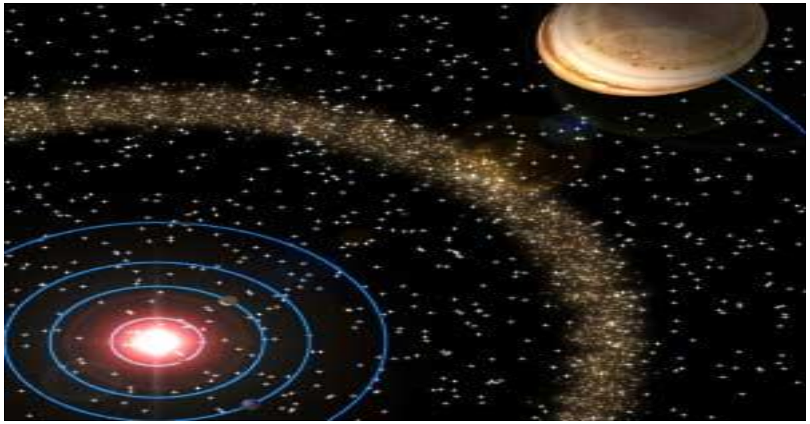
- The asteroid belt lie between the orbits of Mars and Jupiter, closer to the orbit of Mars.

- Most asteroids orbit from between 186 million to 370 million miles (300 to 600 million km from the Sun.

- The asteroids in the asteroid belt have a slightly elliptical orbit. The time for one revolution around the Sun varies from about three to six Earth years.

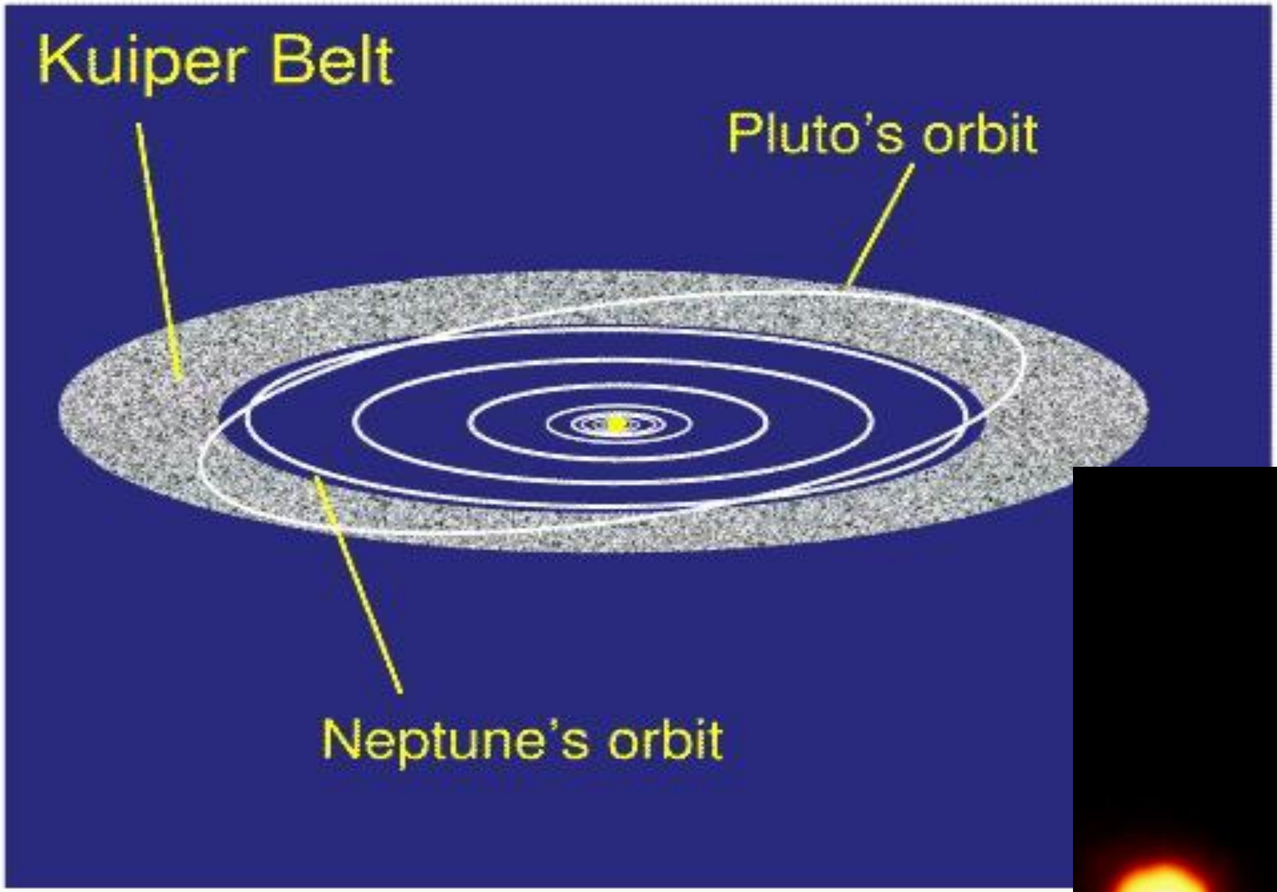
- The strong gravitational force of the planet Jupiter pulling the asteroids away from the Sun, keeping them from careening تميل الى into the inner planets.

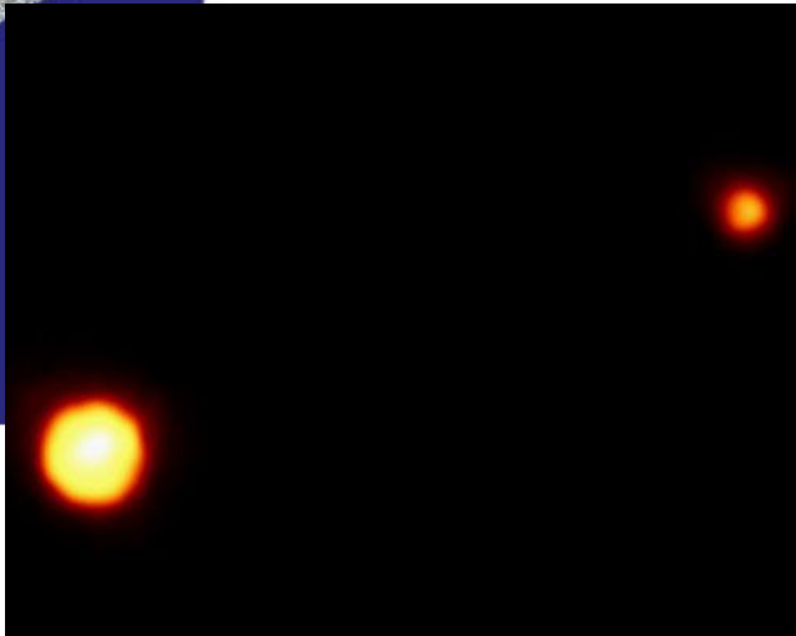




Kuiper Belt & Pluto

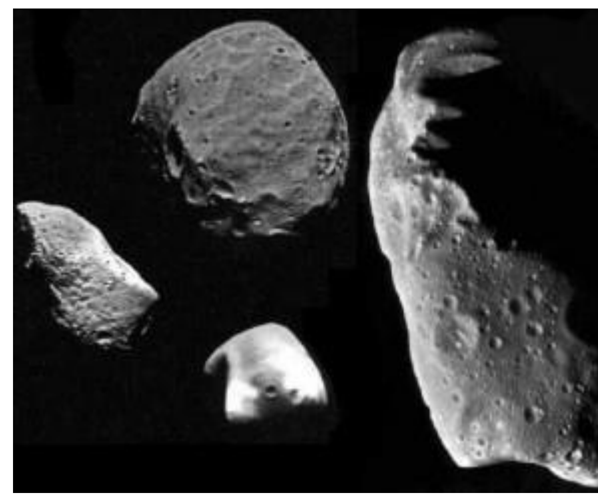
2-Most asteroids lie between the Mars and Jupiter and have periods ranging from three to six years and few of it lie in kuiper belt .





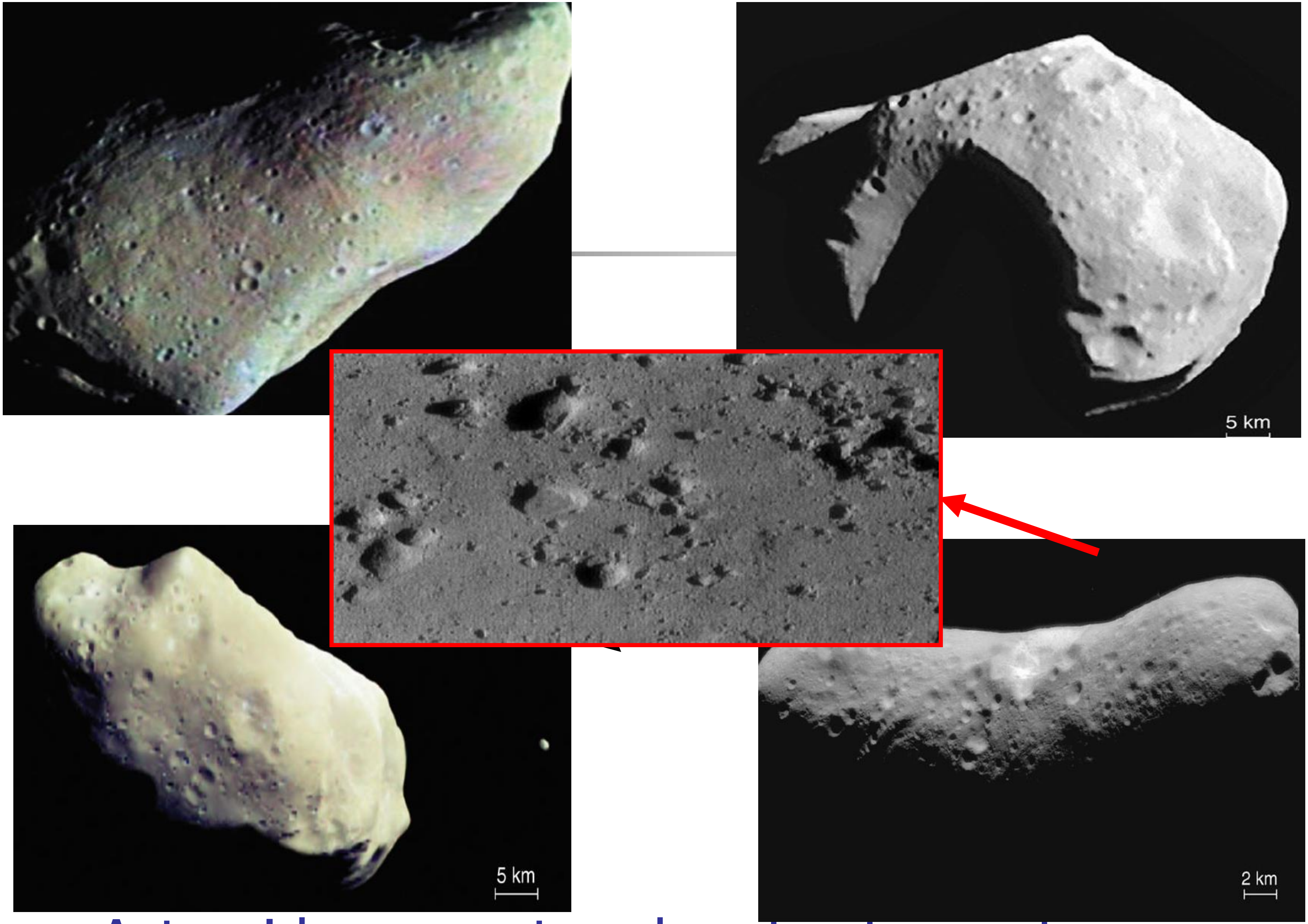
HOW MANY ASTEROIDS ARE THERE?

- There are about 40,000 known asteroids.
- That are over 0.5 miles (1 km) in diameter in the asteroid belt.
- About 3,000 asteroids have been cataloged.
- There are many more smaller asteroids.
- The first one discovered (and the biggest) is named Ceres; it was discovered in 1801



CERES: THE LARGEST ASTEROID

- Ceres is the largest of the asteroids.
- It was the first asteroid ever discovered (by the Italian astronomer Giuseppe Piazzi on January 1, 1801).
- Ceres is the size of the state of Texas! It is so huge in comparison with the other asteroids
- that its mass is equal to over one-third of the 2.3 x 10^{21} kg estimated total mass of all the 3,000 cataloged asteroids.
- Ceres is about 578 miles (930 kilometers) in diameter.
- Ceres is now considered to be a dwarf planet.



Asteroids are cratered and not round

Why there are very few asteroids beyond Jupiter's orbit?

وراء

A. There was no rocky material beyond Jupiter's orbit.
B. The heaviest rocks sank towards the center of the solar system.
C. Ice could form in the outer solar system.

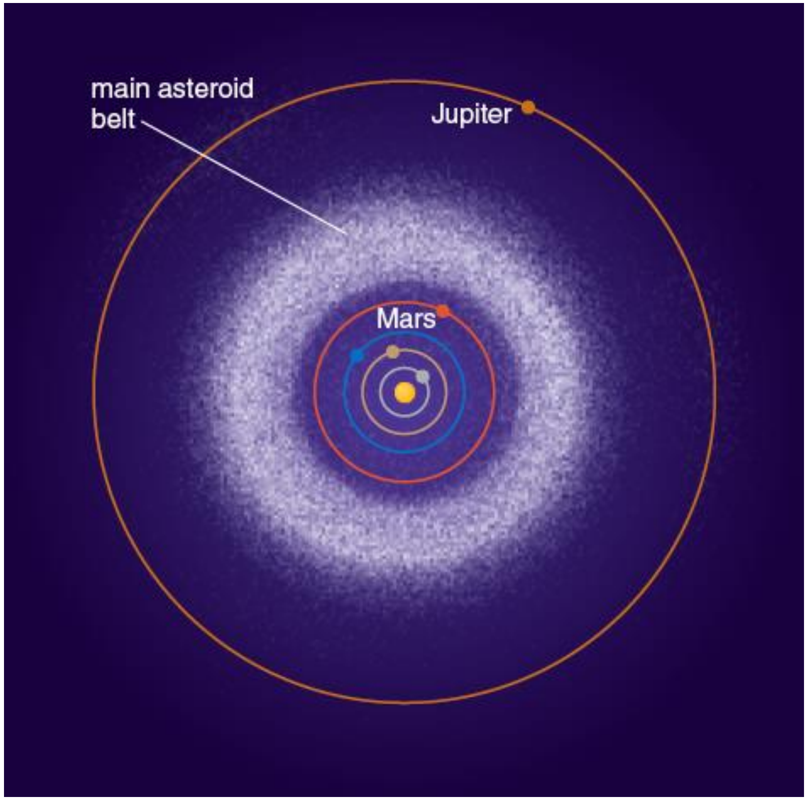
Origin of the asteroids

There are three scenarios about the origin of the asteroids

1-Due to explosion planet

2-Due to collisions of two planets

3-Small parts from the nebula have not the chance to forming the planet.

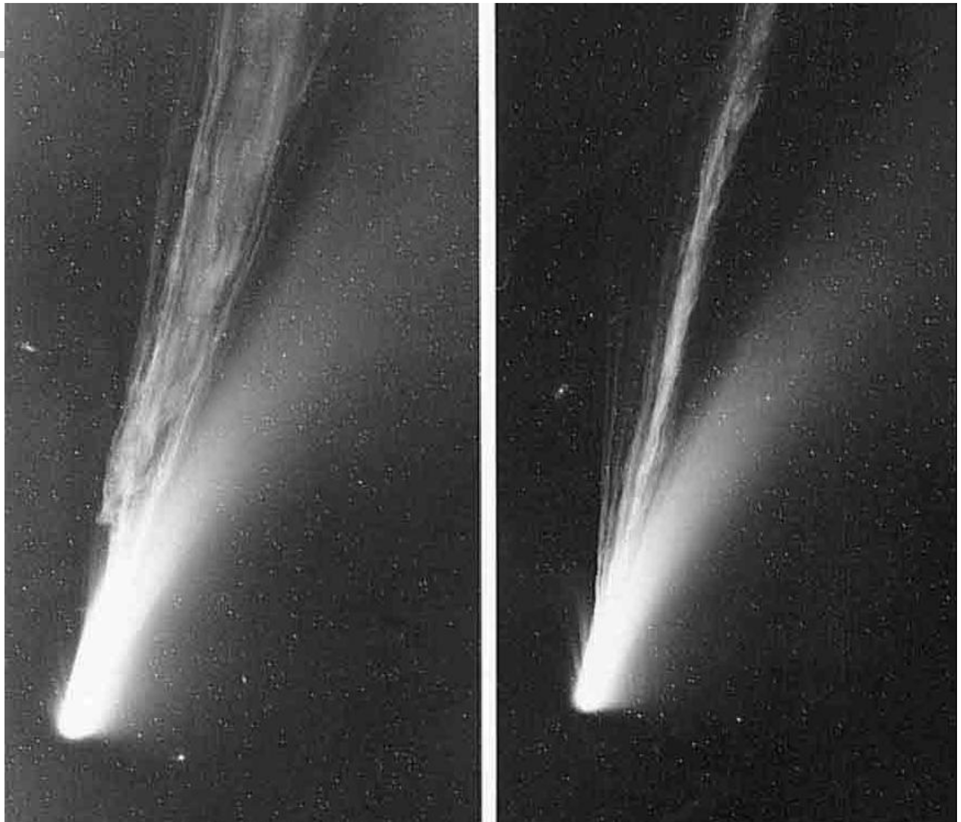


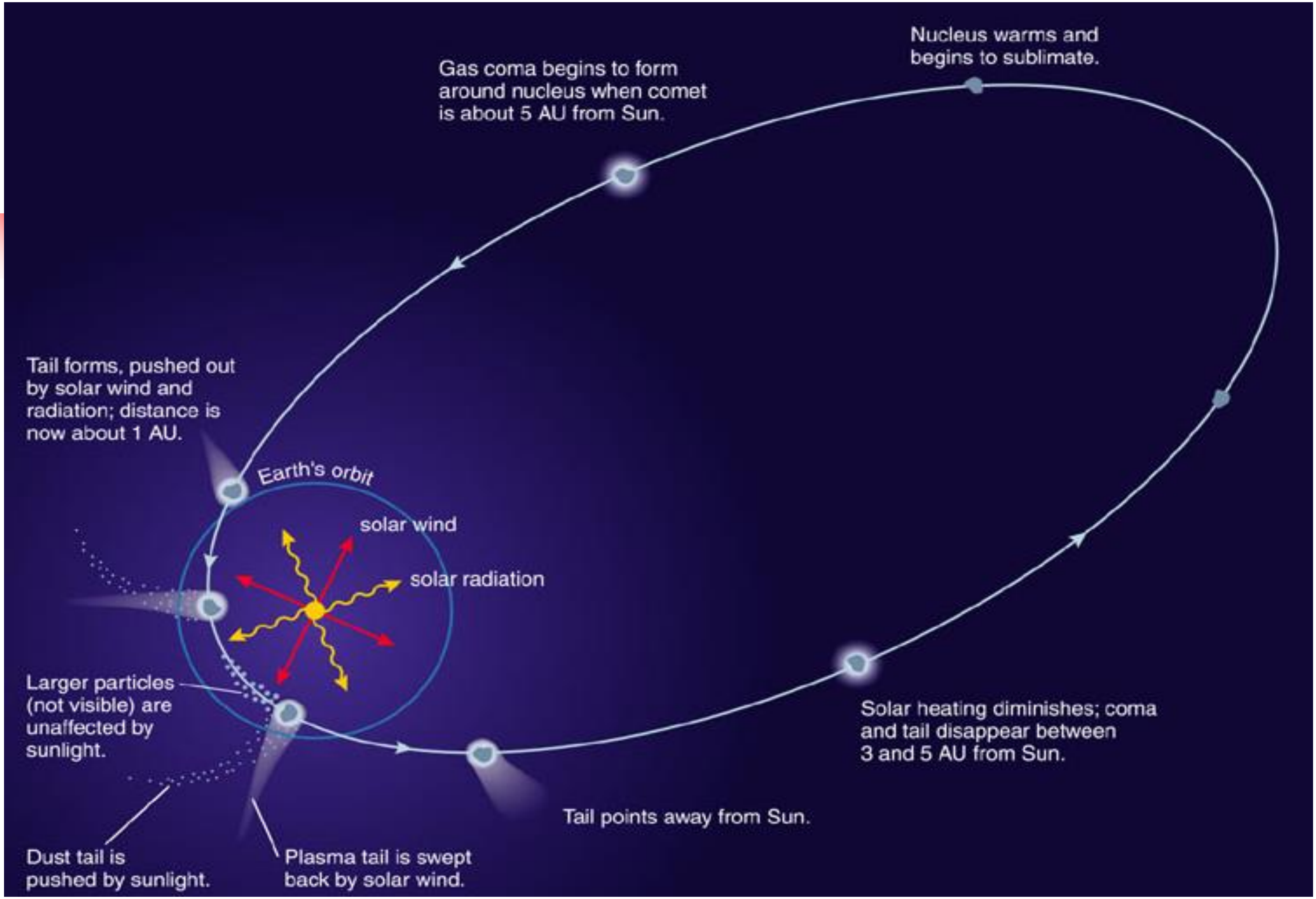
HOMEWORK…….

Comets

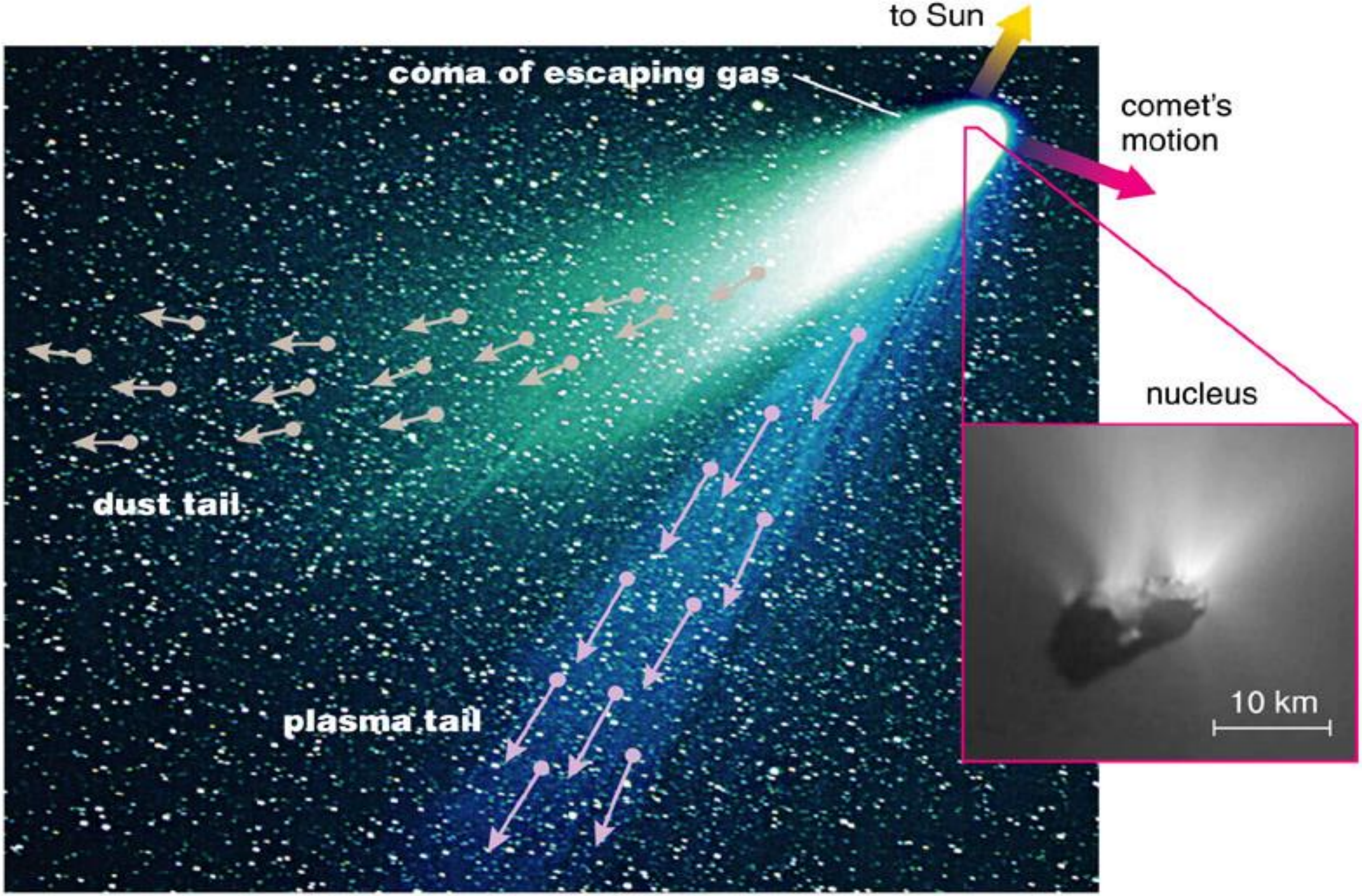
Comet Facts

- comets are icy counterparts شقيق to asteroids.
- "Dirty snowballs" = the nucleus
- Most comets do not have tails.
- Most comets remain frozen in the outer solar system.
- Only a few enter the inner solar system, where they can grow tails.





When a comet nears the Sun, its ices can sublimate into gas and carry off dust, creating a coma and long tails. **1 astronomical unit** $=149.60\times10^{6}$ km


to Sun
coma of escaping gas
comet's
motion
nucleus
dust tail
plasma tail
10 km

Comet Structure

#Nucleus

*10 km “Dirty Snowball”

#Coma

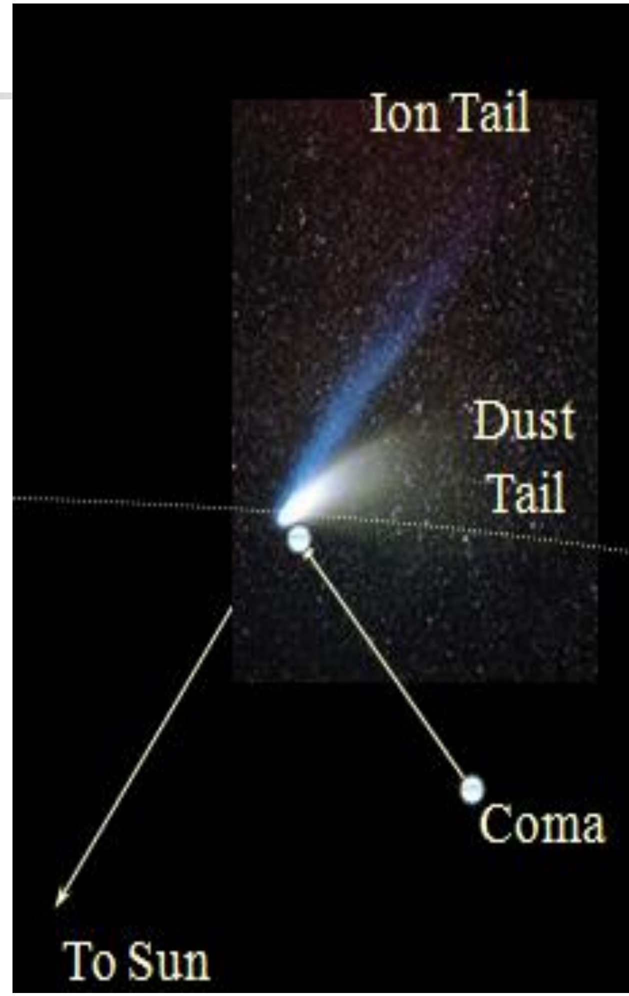
Cloud of evaporated ices and ions

may be 100,000 km in diameter

#Tail

Always points away from Sun

Solar Wind and Radiation Pressure



Comets

1-They are bodies which revolve around the sun in Fixed elliptical orbits.

2-Comets consist of ice spheres and they are a mixture of solidified gases (carbon dioxide, nitrogen, methan), rocky parts and water particles.

3-The main part of the comet is called the head.

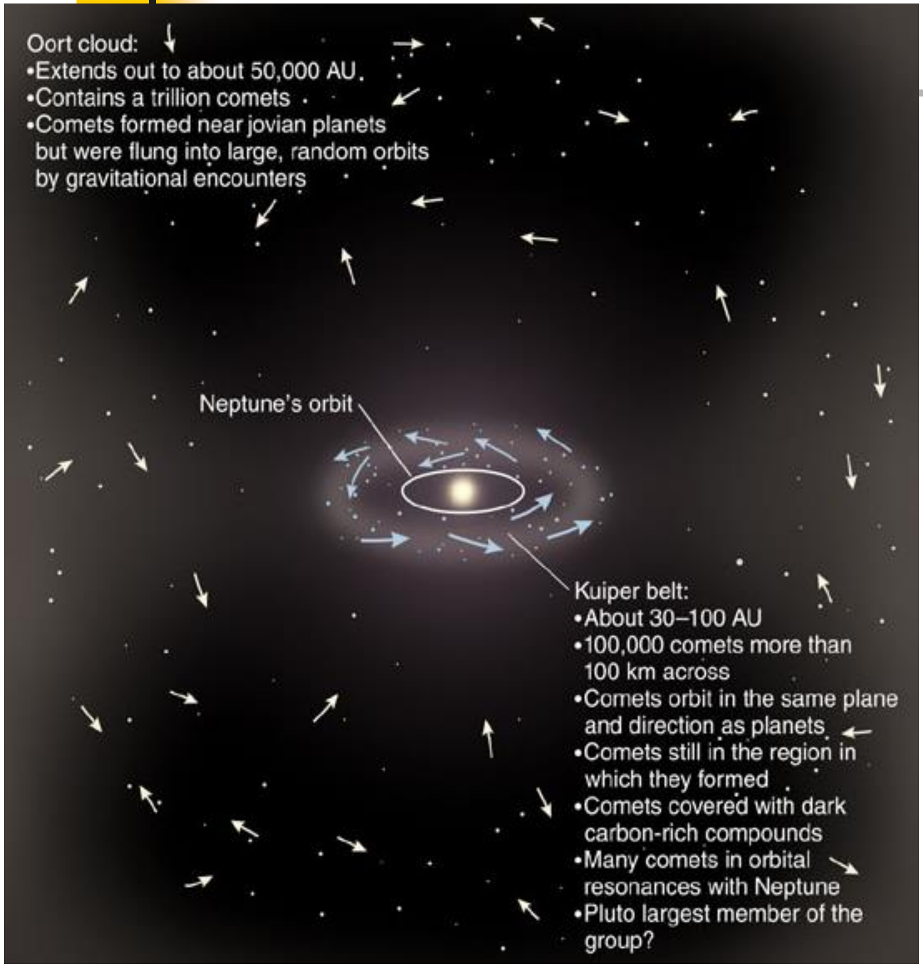
4-When the comet gets near the sun, the heat of the sun is able to change a part of the solid head of the comet into a gaseous cloud, which surrounds the remaining solid part of the head which is called the nucleus.

5-As a result of expansion of a part of this gaseous cloud the tail of the comet is formed.

6- From the most well known comets is Halley, which completes its revolution around the sun 76 years.

How do comets get their tails?

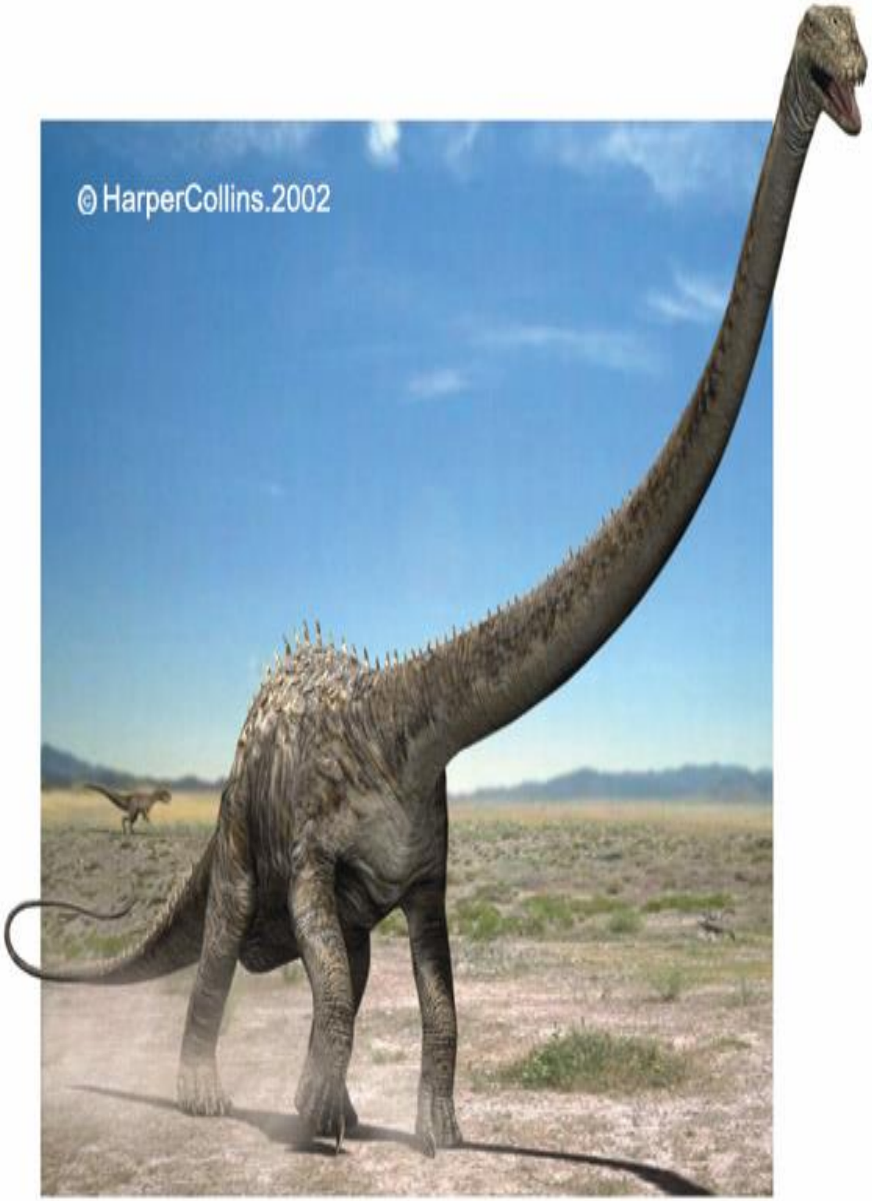
Where do comets come from?



Comets that enter the solar system come from one of two reservoirs in the outer solar system: the Kuiper belt and the Oort cloud.

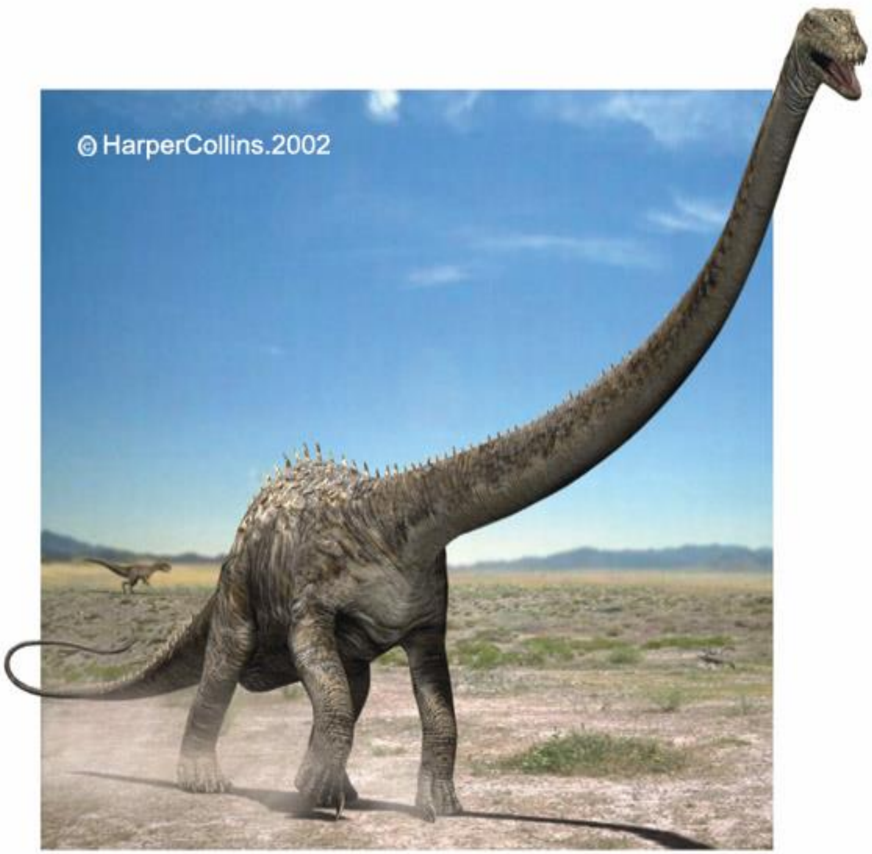
The Kuiper belt comets still reside يقيم **in the region beyond Neptune in which they formed during the birth of the solar system.**

The Oort cloud comets are thought to have formed in the region of the jovian planets, and were kicked رفس **out to the great distance of the Oort cloud by gravitational of the planets.**



Did an impact kill the dinosaurs?

Mass Extinctions



Large dips in total species diversity in the fossil record.

The most recent was 65 million years ago, ending the reign of the dinosaurs

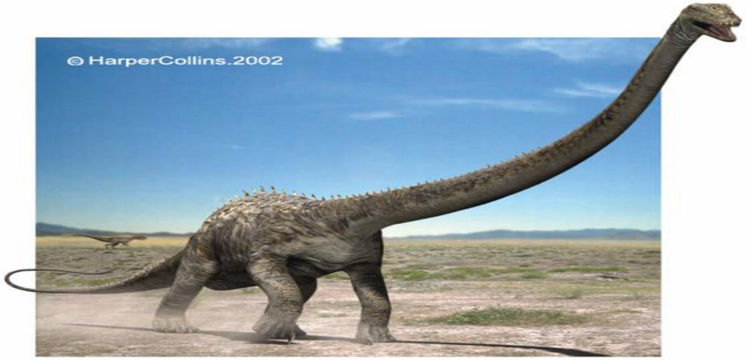
Was it caused by an impact?

How would it have happened?

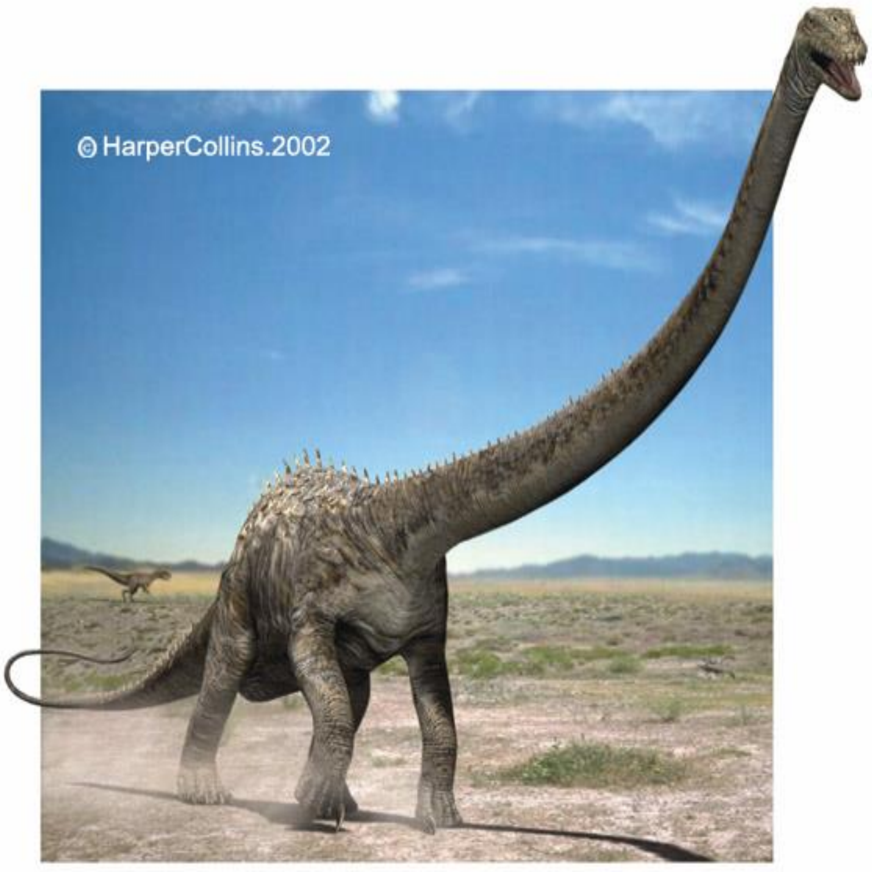
No dinosaur fossils
in these rock layers

Thin layer containing
iridium from impactor

Dinosaur fossils in
lower rock layers



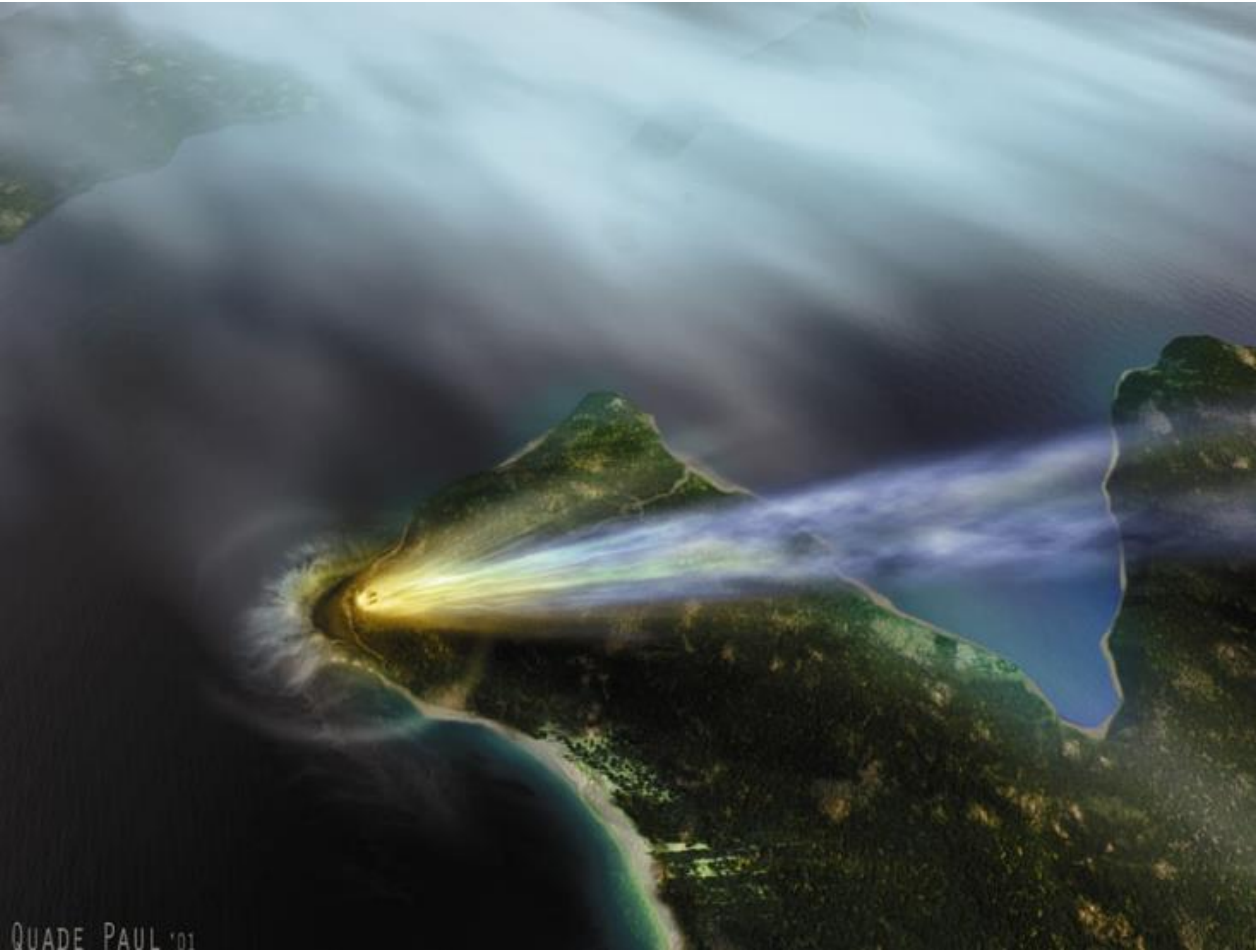
Iridium - evidence of an impact



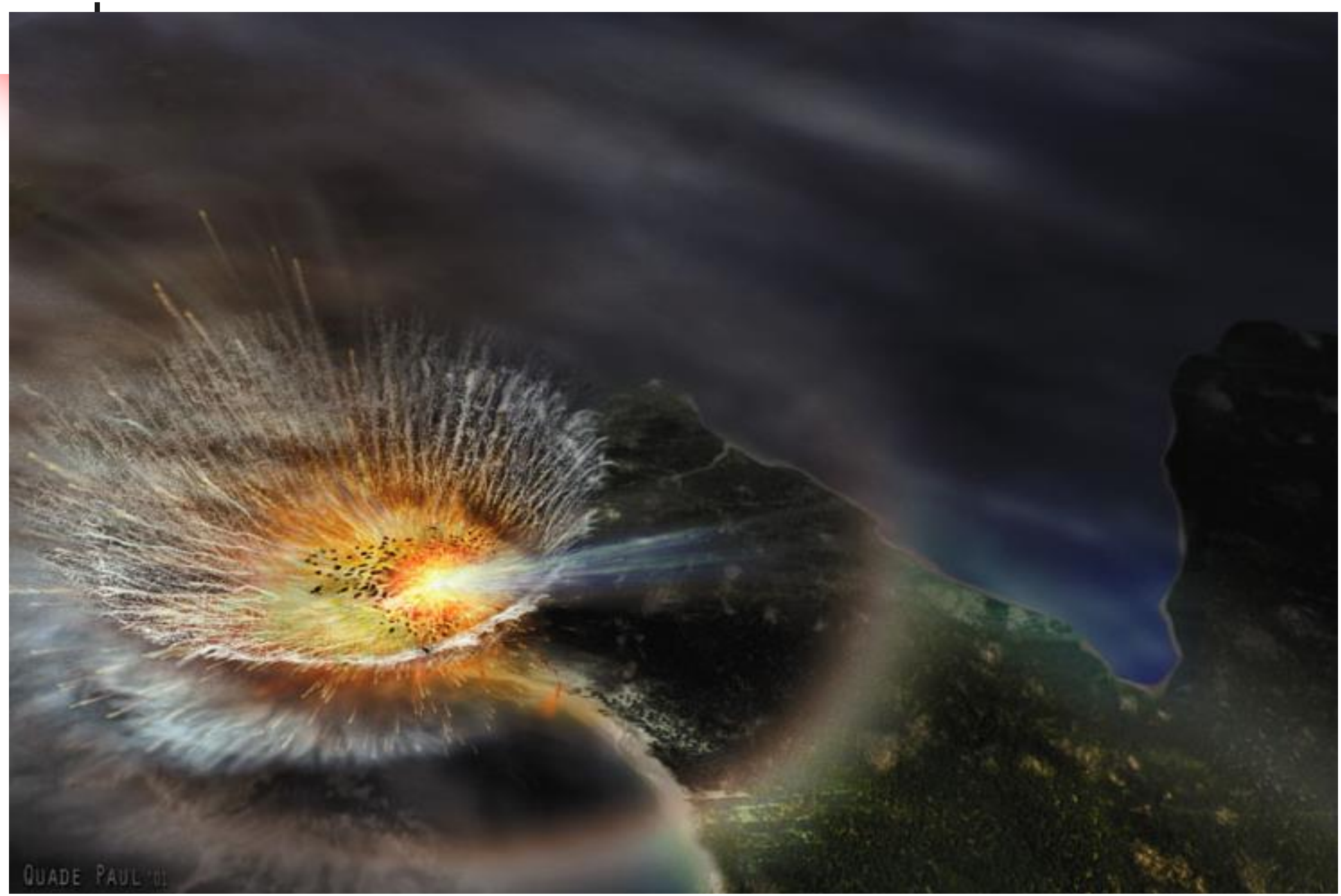
Iridium (Ir) is very rare in Earth surface rocks but often found in meteorites.

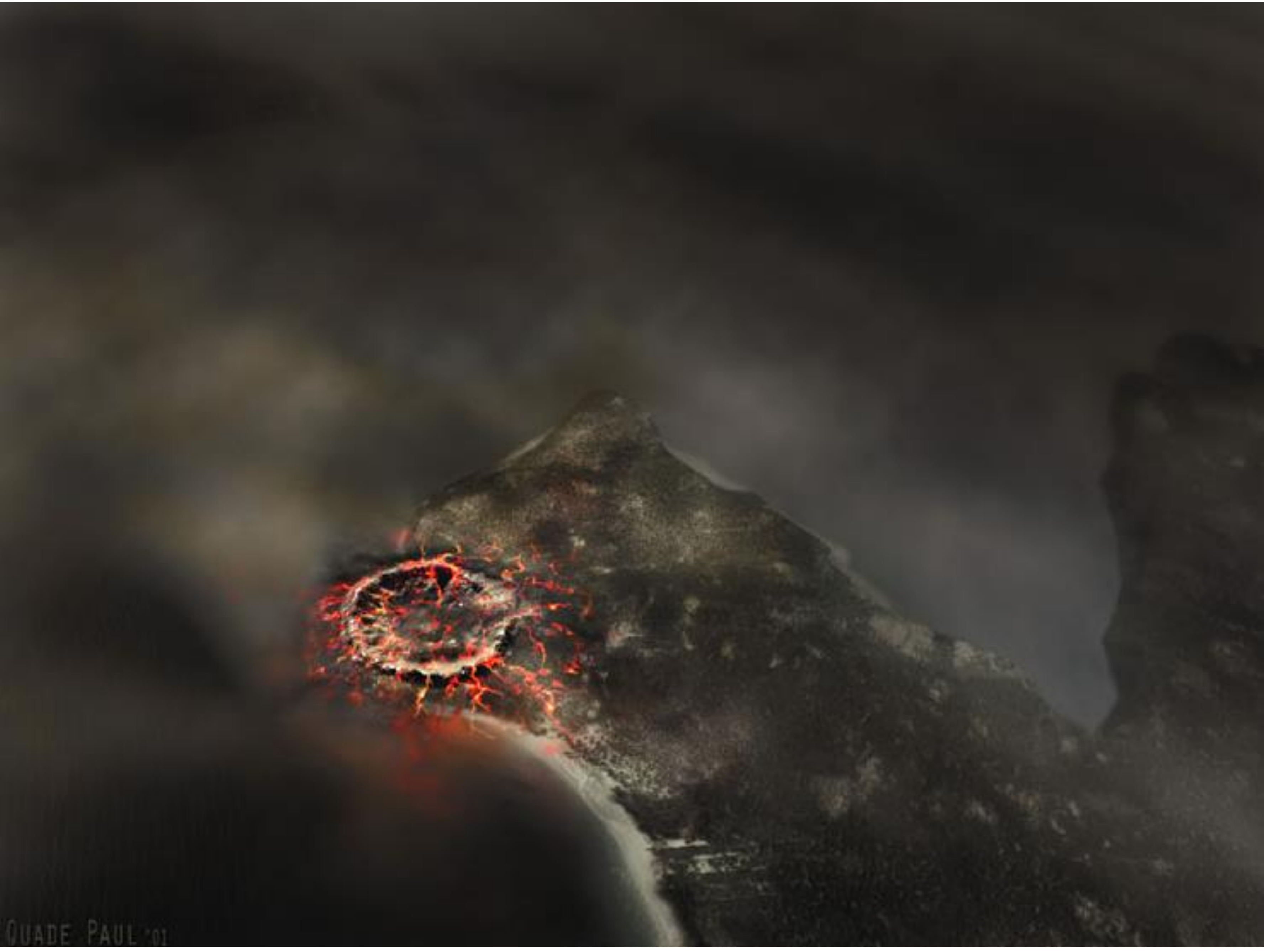
Luis and Walter Alvarez found a worldwide layer containing iridium, have 65 million years ago.

Comet or asteroid about 10km in diameter approaches Earth


QUADE PAUL '01

Collision with the earth surface

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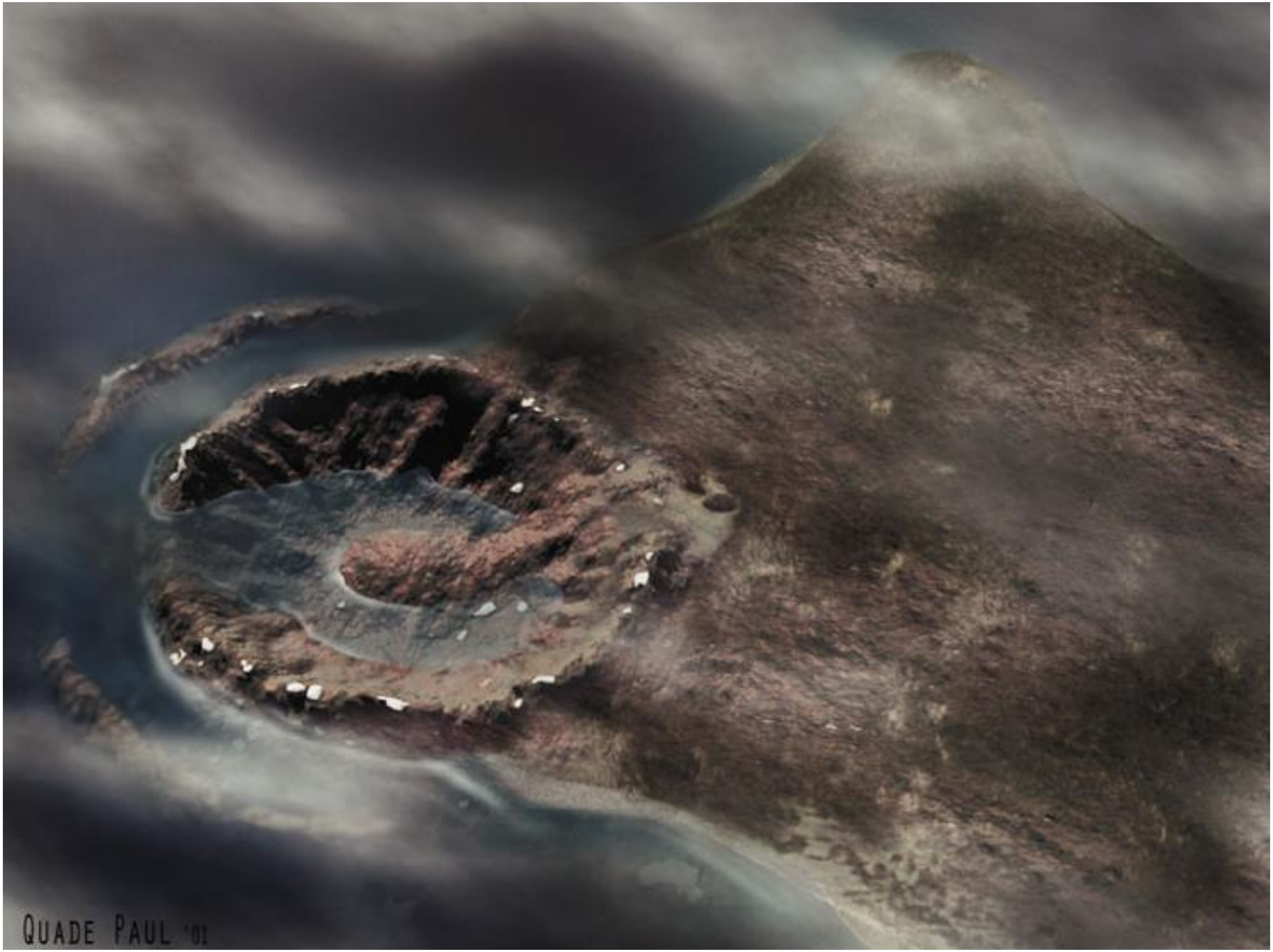
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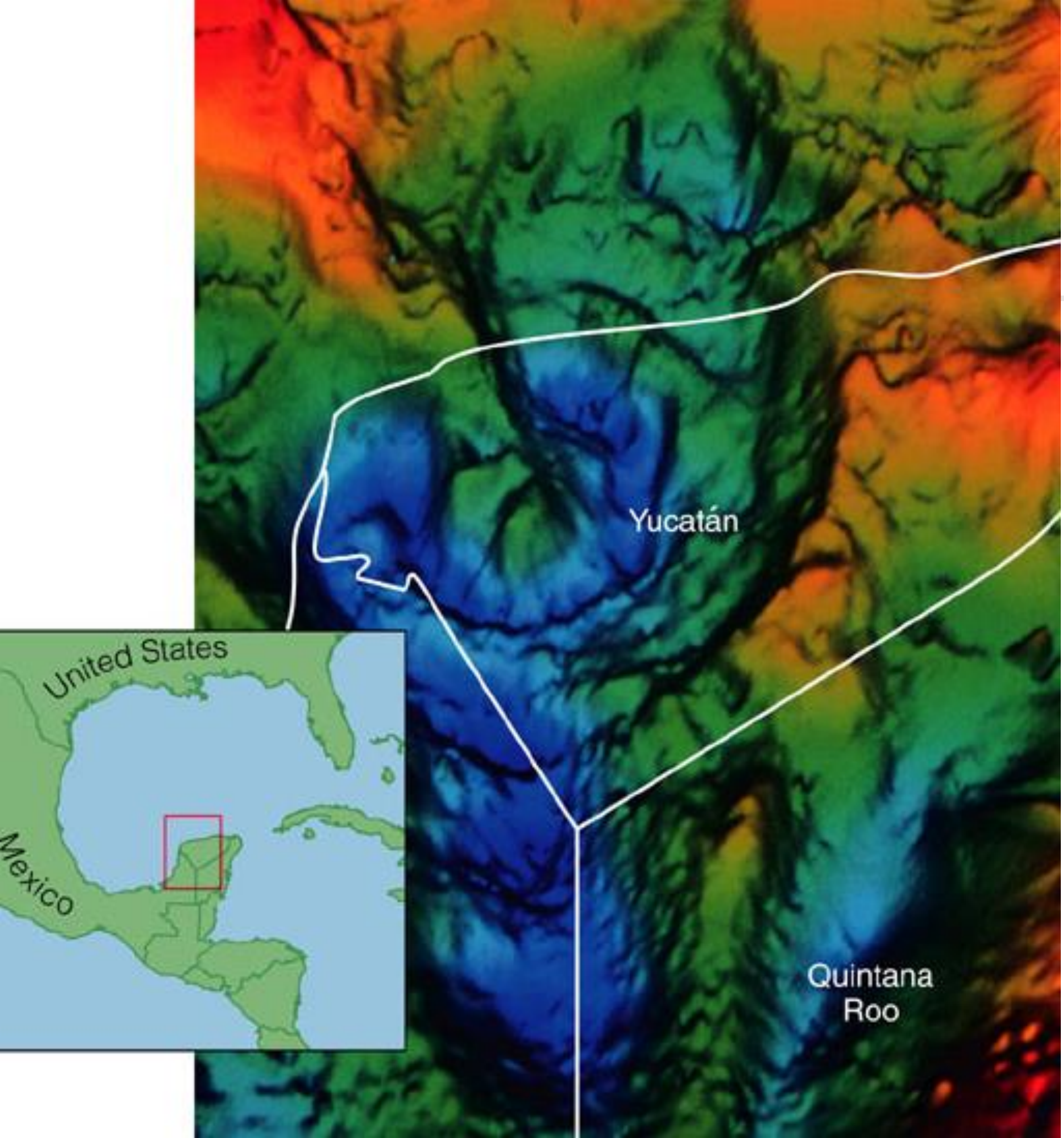


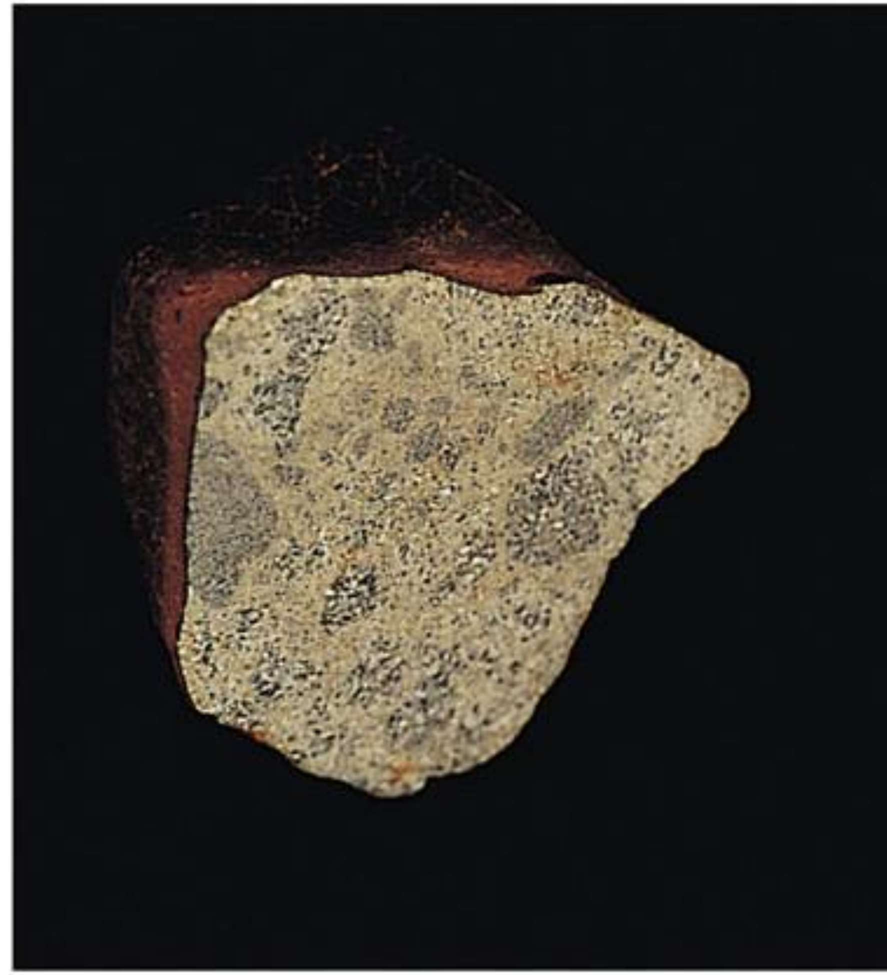
An iridium-rich sediment layer and an impact crater on the Mexican coast show that a large impact occurred at the time the dinosaurs died out, 65 million years ago.

Meteorites

Meteor Crater, Arizona: 50,000 years ago (50 meter object)

How are meteorites related to asteroids?

Meteorites are pieces of asteroids - or sometimes planets or the Moon.



Meteor: The bright tail of hot debris from the rock

Meteorite: A rock from space that reaches Earth's surface

Peekskill, NY:

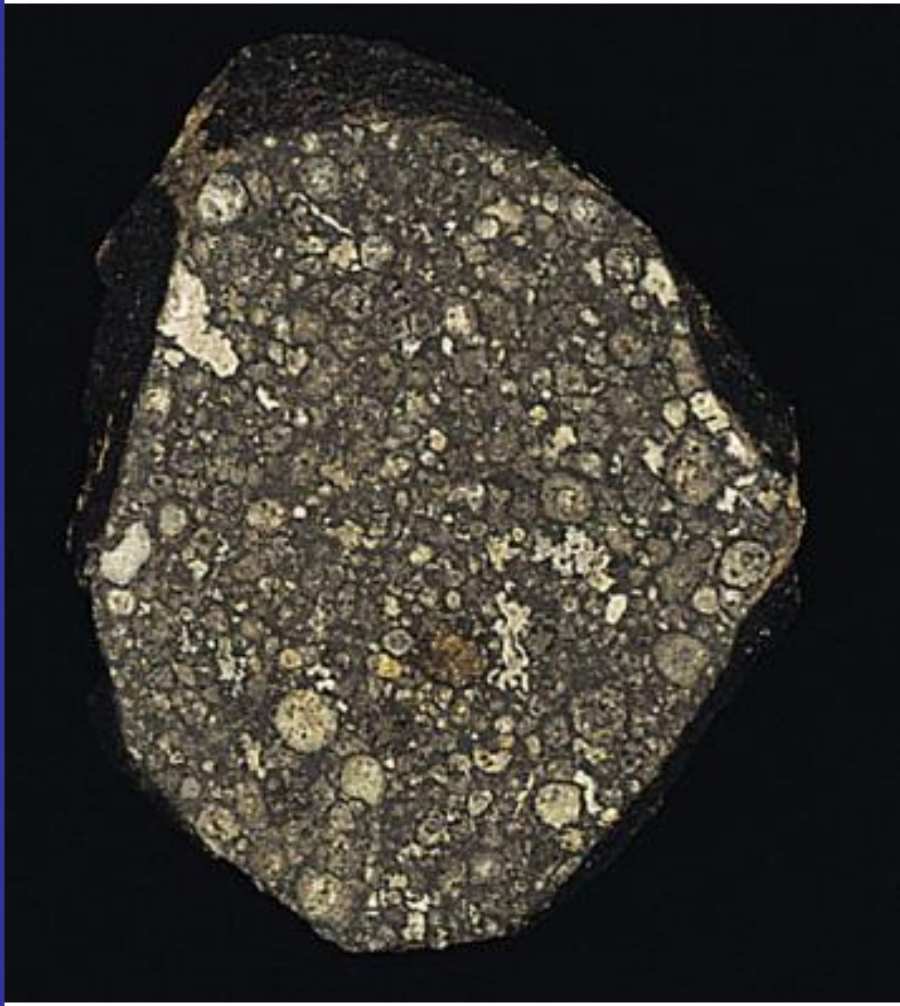
October 9, 1992

Meteorite Types

1) **Primitive**: Unchanged in composition since they first formed 4.6 billion years ago.

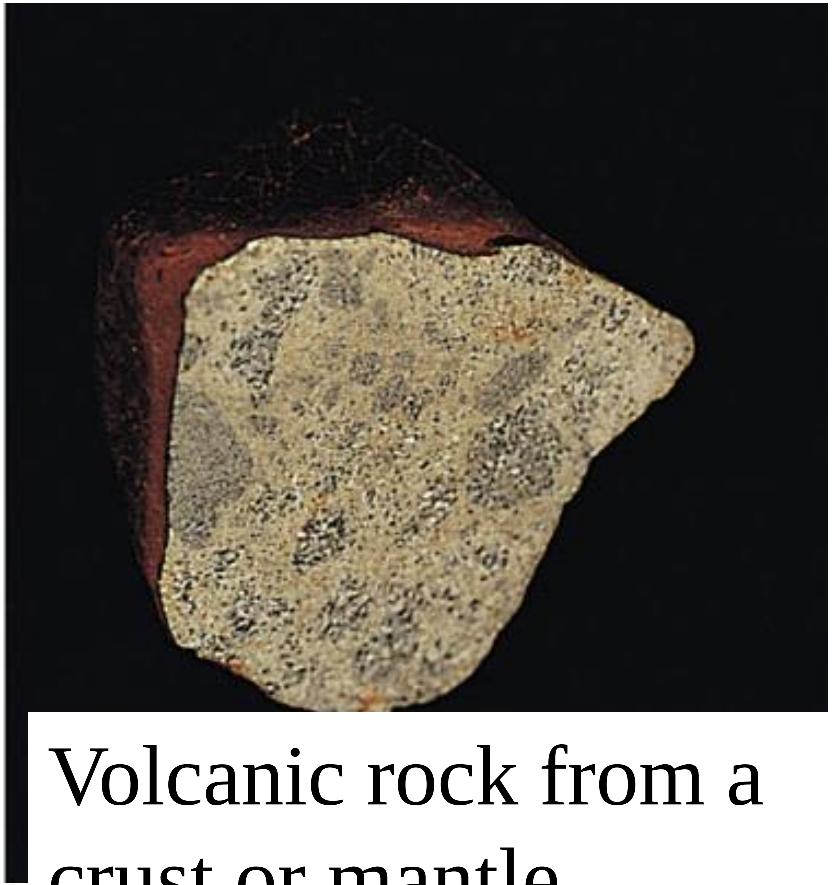
2) **Processed**: Younger, have exposed to processes like volcanism or differentiation.

Primitive Meteorites: simple, mixed together



Processed Meteorites:
of larger اجزاء محطمة shattered fragments objects

Iron



Volcanic rock from a crust or mantle

What do we learn from meteorites?

- Primitive meteorites tell us what:
- 1-the original planet were like.
- 2-The ages of primitive
- 3-when solar system formation began.
- Processed meteorites tell us what:
- 1- The inside compositions of asteroids
- 2- what happened on asteroids by the process of differentiation and volcanism

Mineral composition of Meteorites

Meteorites consist of different essential minerals:

Kamacite	(Fe-Ni) 4-7% Ni	Cubic system
Taenite	(Fe-Ni) 30-60%Ni	Cubic system
Troilite	(Fe-S)	Hexagonal
Olivine	$(Mg, Fe)_2\ SiO_4$ 15-25%	Orthorhombic
Orthopyroxene	$(Mg, Fe)_2\ Si_2O_6$ 0-30%	Orthorhombic
Clinopyroxene	$(Mg, Ca, Fe)_2\ Si_2O_6$	Monoclinic
Plagioclase	$(Ca, Na)\ Al\ Si_3O_8$	Triclinic
Chlorite	$(Mg,Fe^2, Ni, Al)_6(OH)\text{-}OSi_4O_{10}$	Monoclinic

Common Minor minerals:

Schreibersite	$(Fe, Ni)_3P$	Hexagonal
Cohenite	$(Fe, Ni)_3C$	Orthorhombic
Daubreelite	$FeCr_2O_4$	Cubic
Magnetite	Fe_3O_4	Cubic
Chromite	$FeCr_2O_4$	Cubic

Meteorites divided into two groups, the finds (those collected but not seen to fall) and the falls (those collected after having been seen to fall). The following table show a remarkable reversal in proportions between the finds and the falls.

	Finds		Falls	
Type	Number	Per Cent	Number	Per Cent
Irons	545	58.1	33	4.6
Stony-irons	53	5.7	11	1.5
Achondrites	7	0.7	56	7.8
Chonderites	333	35.5	621	86.1
Total	938	100.0	721	100.0

Classification of the meteorites

Meteorites are classified according to their mineral composition and their structure into 4 groups:

1- Siderites (iron group)

2-Siderolites (stony iron)

3-Aerolites (stones)

4-Tektites (glassy body)

1- Siderites (iron group)

1-Siderites consist essentially of a nickel-iron alloy.

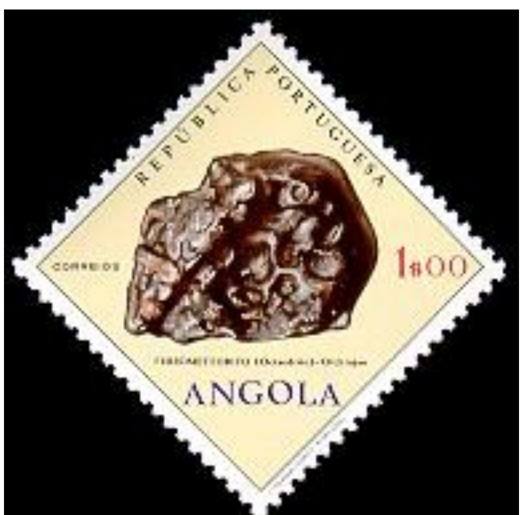
2- Ni is usually in range between 4 and 20%

3-It contains kamacite and taenite as essential minerals, in addition to troilite, schreibersite, graphite and cohnite as accessory minerals.

4-Intergrowth of lamellae of Kamacite bordered by Taenite are the most abundant. This structure can be visible through polished surface and called Widmanstatten structure.

5- This structure is typical of exsolution in an alloy that has cooled very slowly from high temperature.

Iron Meteorite



2- Siderolites (stony-iron)

1- Siderolites are made up of nickel-iron and silicate in equal amounts.

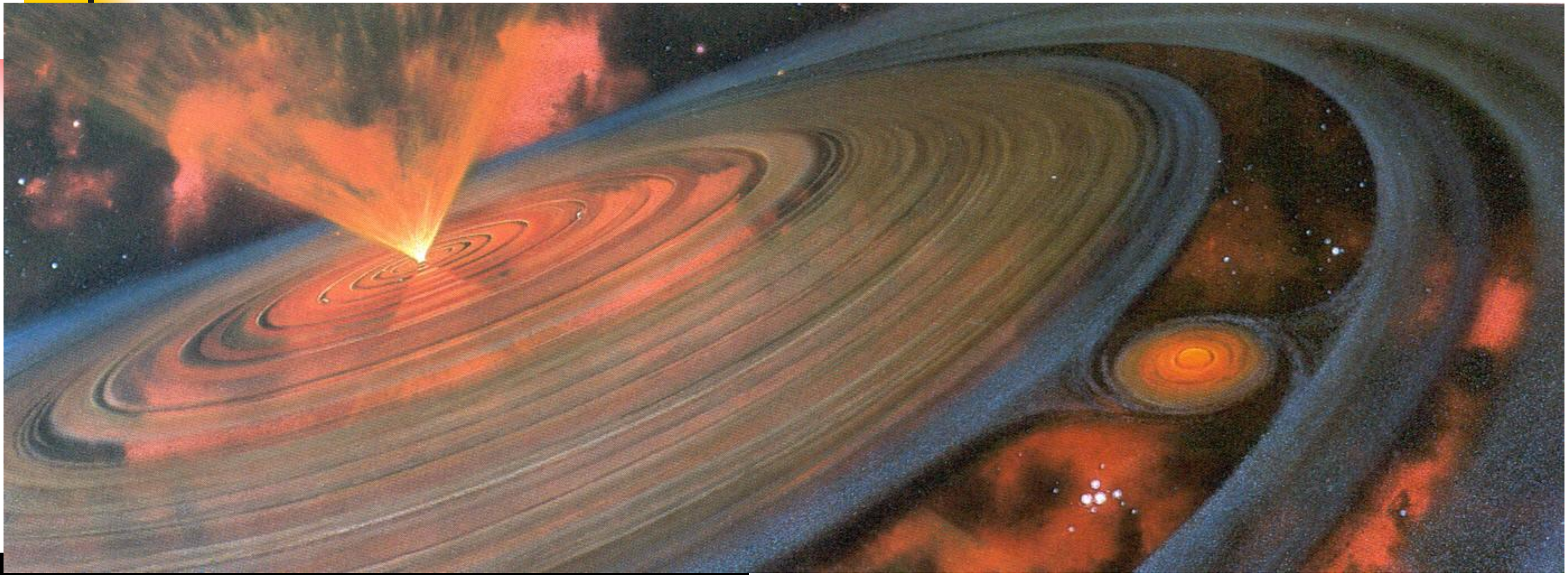
2- Two distinct groups, the pallasites and the mesosiderites, of different chemical and mineralogical composition are recognized.

3-The Pallasites are made up of a continuous base of nickel-iron enclosing grains of olivine which show good crystal forms.

4-In the mesosiderites the metal phase is discontinuous and the silicates are mainly plagioclase feldspar and pyroxene, sometimes with accessory olivine.

Stony-Iron: **mesosiderites**

Cosmochemistry: Formation of the Earth from primitive solar nebula



Chondritic meteorites represent the primitive solar nebula composition

3- Aerolites (stones)

The aerolites or stones are divided into two groups the a-Chonderites and b-the Achondrites.

1-The Chonderites are so named because of the presence of chondrules or chondri, which are small rounded bodies (average 1 mm in diameter) consisting of olivine and /or pyroxene.

2- The average composition of Chonderites is about 40% Olivine, 30%Pyroxene, 10-20% Nickel-iron, 10% plagioclase, and 6%troilite.

3-The Chonderites are similar to ultra-basic igneous rocks in composition.

4-The Achondrites are a diverse group of stony meteorites which do not contain chondrules and which are usually much more coarsely crystalline than the Chonderites.

5- The Achondrites are similar to the igneous rocks in composition and textures.

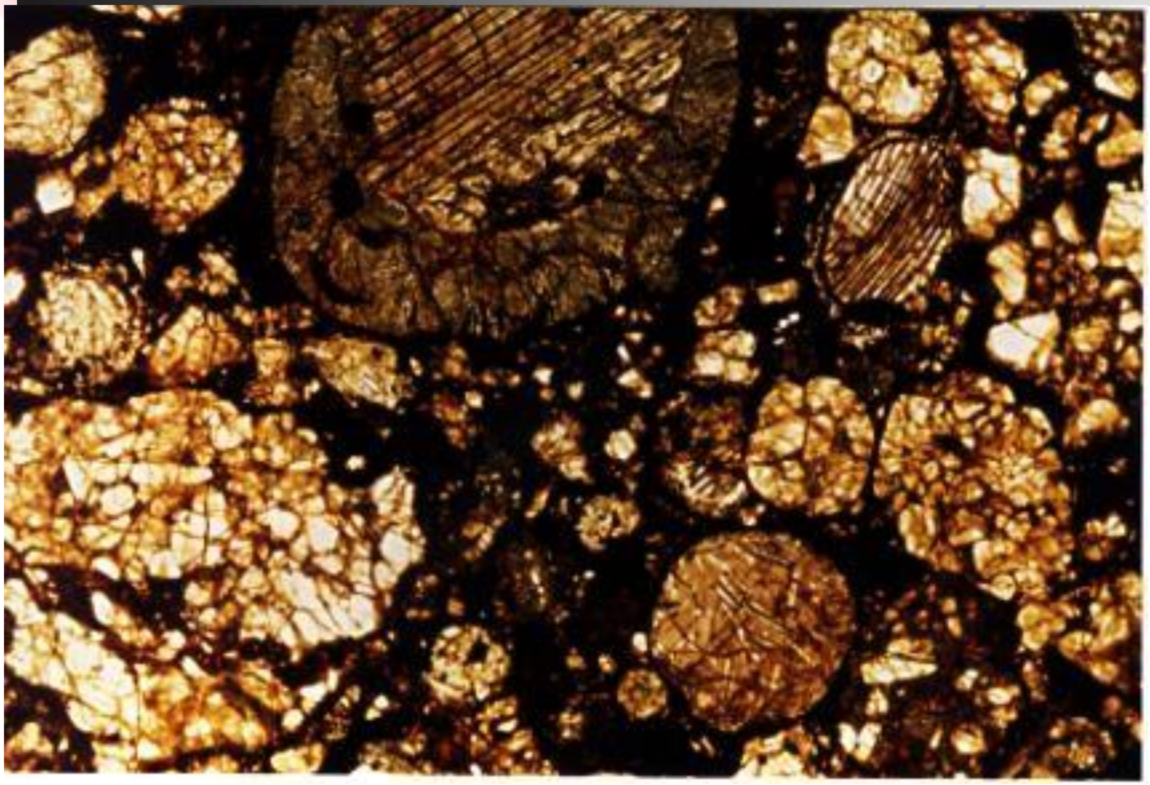
6- The Achondrites have probably crystallized from a silicate melt.

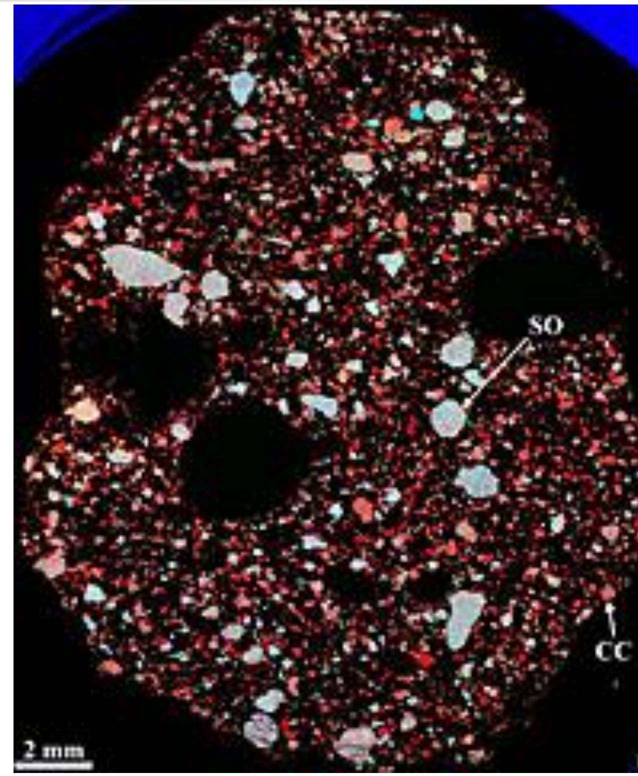
Chondrites

Carbonaceous

Ordinary

Chondrules under a scope





X-Ray Image

Achondrite - Stony Meterorite

A stone from the Stannern eucrite shower
that fell over Moravia, Czech Republic in 1808.

4- Tektites

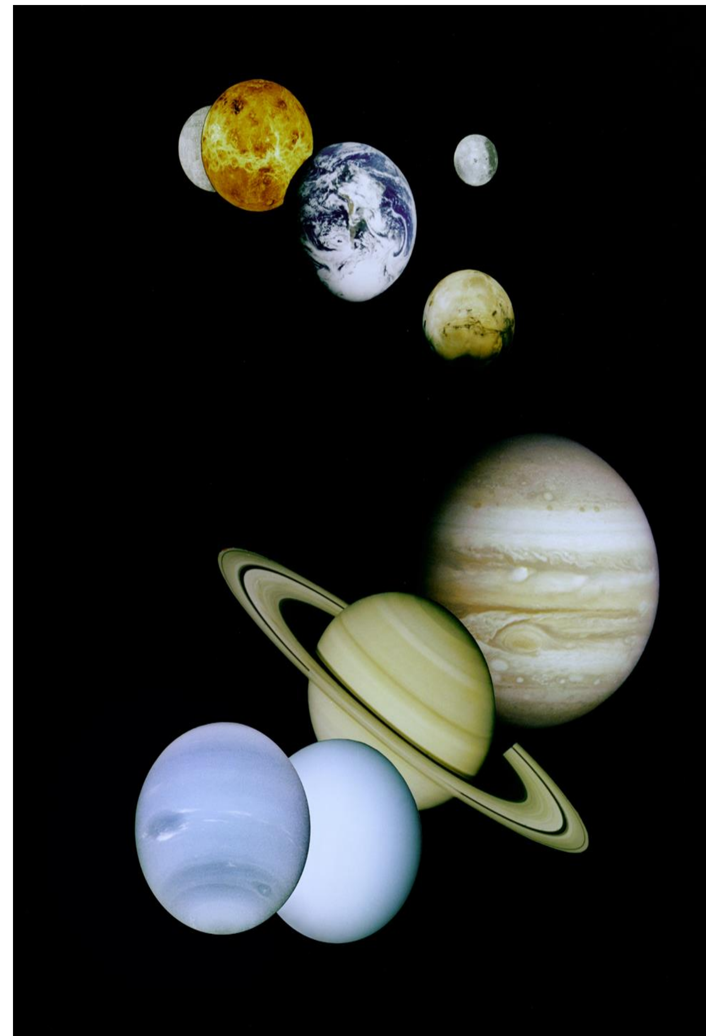
1-Tektites consist of a silica-rich glass (average about 75% SiO_2) resembling obsidian.

2-They consists of high silica and comparatively high alumina, potash and lime with low magnesia and soda.

3- This composition resembles a few granites and rhyolites, and some silica-rich sedimentary rocks.

The origin of the solar system

Two main schools discussed the origin of the solar system. The both accepted that the solar system originated from one source : ancestral sun or solar nebula. They differ essentially about the action of an external force to form the planets from the sun, whereas the other rejects the idea of an external force and finds the energy required to form the planets within an ancestral solar nebula.

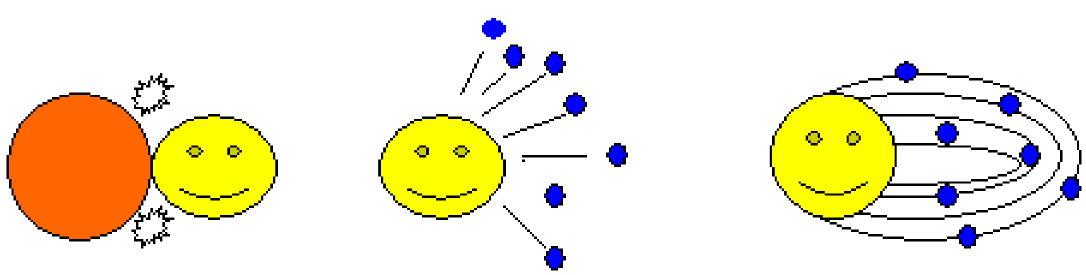


A-Buffen theory, 1749

1- The planets were formed from the sun by a collision with another huge star.

2- This led to broken some parts from the Sun

3- By action of the Sun gravity, these parts have been taken a limited direction surrounded the Sun.



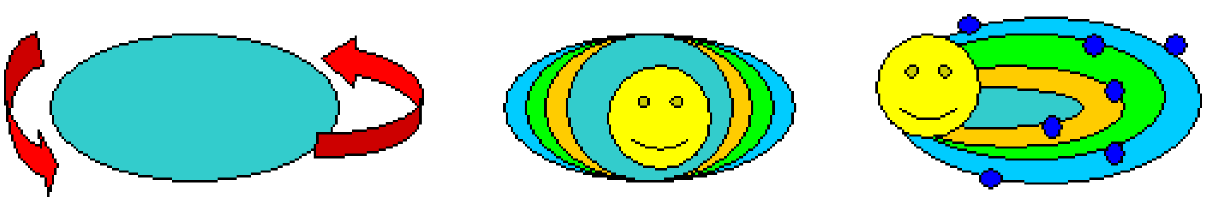
B-Laplace theory, 1796

1-The Sun and the planets originated as a rotating mass of gas occupying the volume of the present solar system.

2-By increasing rotational speed, a disk of gas rotate faster as it contracts, until the centrifugal force exceeds the gravitational attraction, the rotating disk of gas changed to different rings. (like Saturn)

3-The rings condensed to form the present planets.

4-The central mass becomes the sun

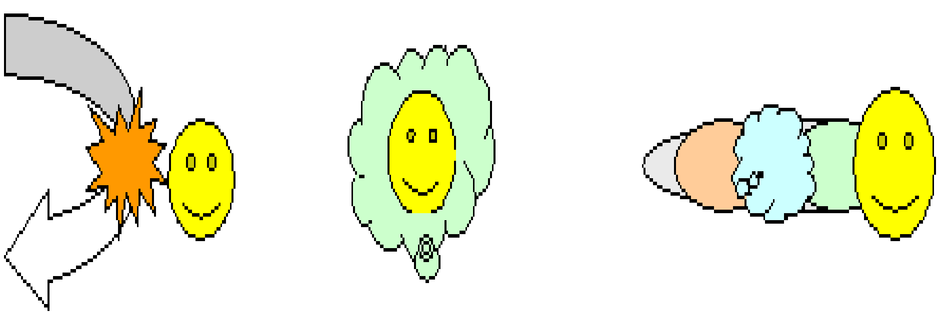


C-Planetesimal theory (Chamberlin &Moulton), 1843-1928

1- Due to passage of a star near the Sun this led to a huge explosion and tides in the Sun. The Sun materials get out as a tongues of gaseous material.

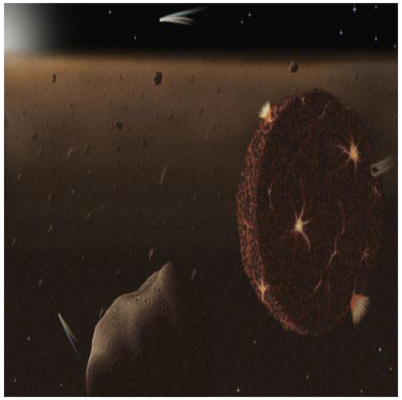
2- After the star departs, the tongue condensed into small particles.

3- The formation of the planets took places by the aggregation of small solid particles (Planetesimals)



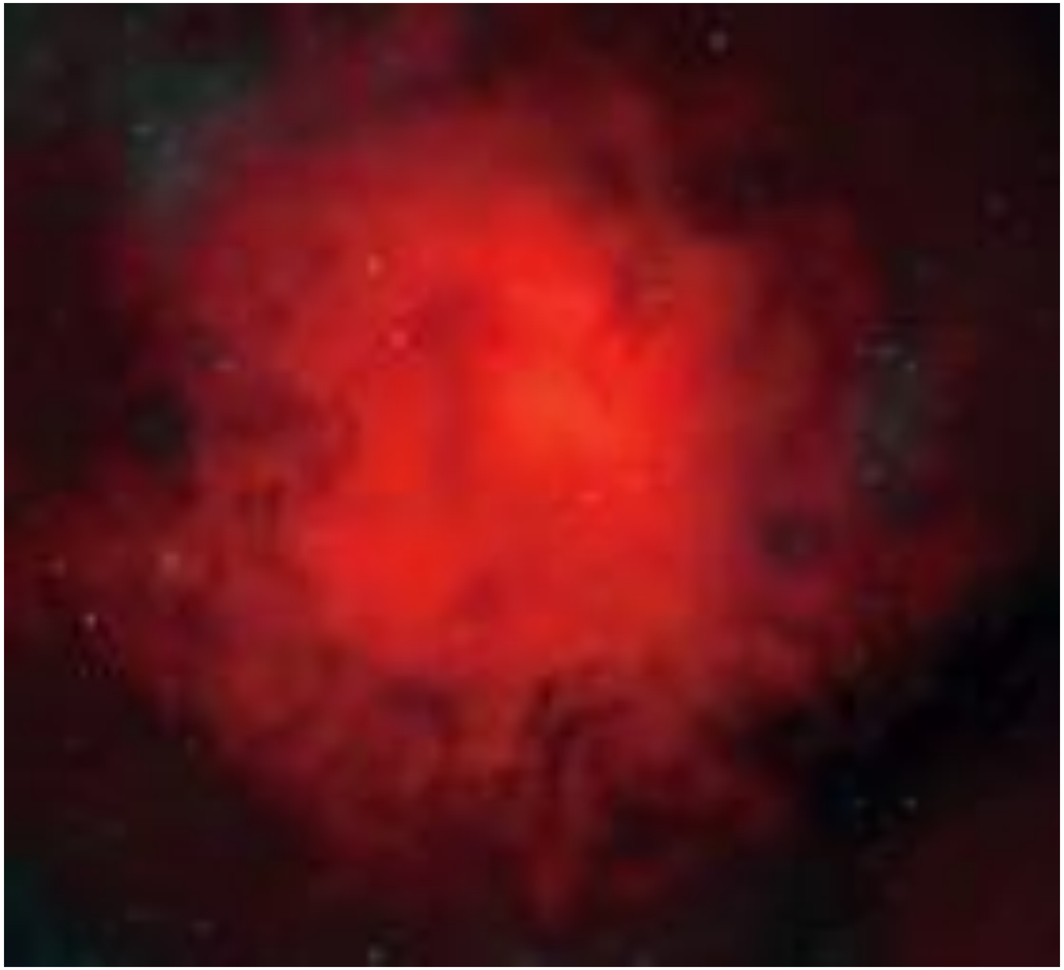
Dust particles accrete into Planetesimals

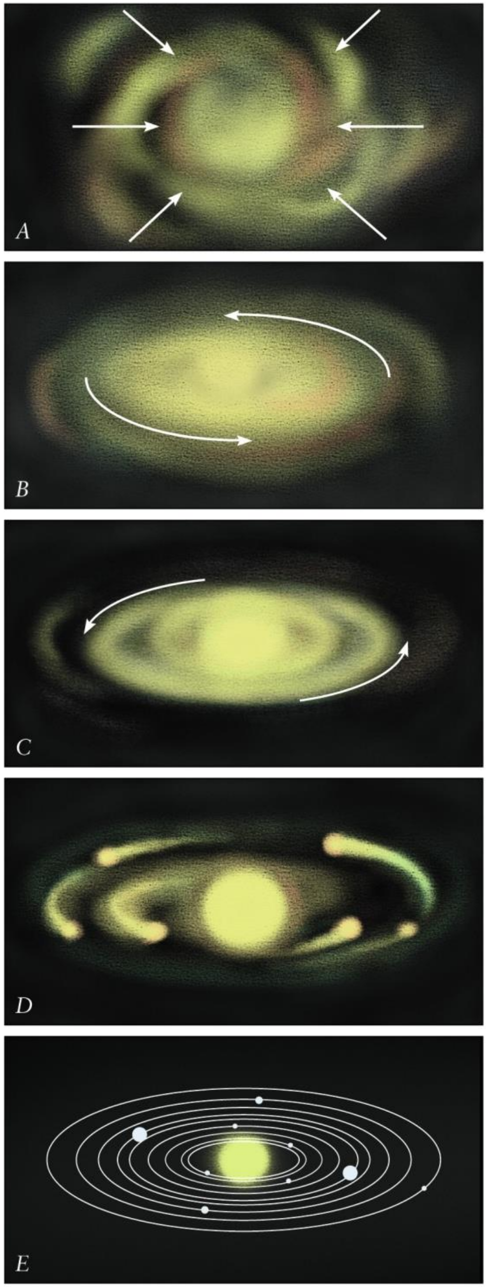
Planetesimals Accrete into Planets



Origin of the Solar System: Interpretation

Solar Nebula Hypothesis





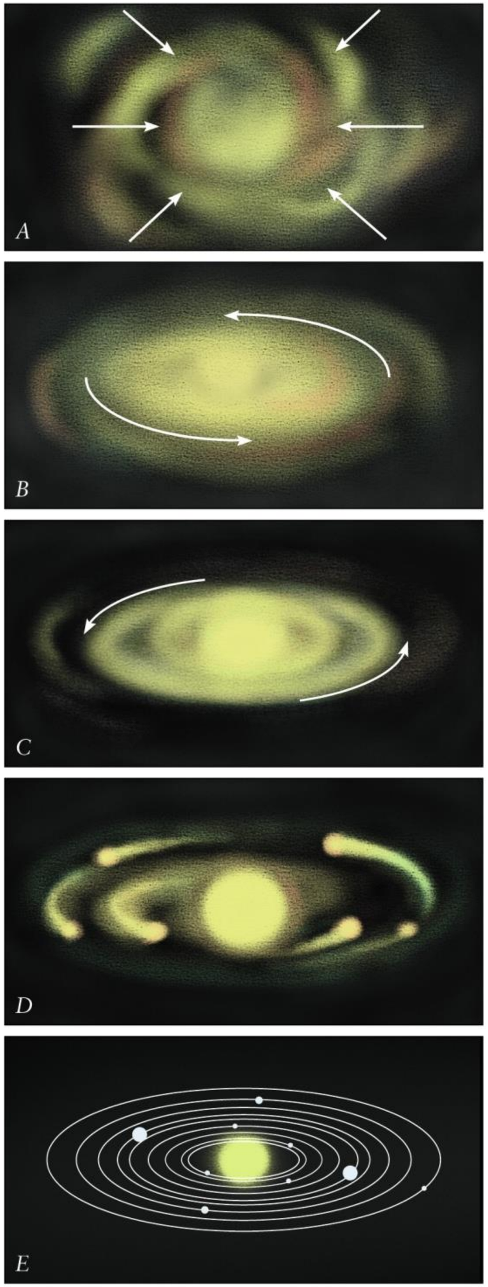
D-Modern Nebula theory

1- The nebular hypothesis suggests that all bodies of the solar system formed from an enormous nebular cloud consisting of approximately 80 percent hydrogen, 15 percent helium, and a few percent of all the other heavier elements known to exist.

2- the dust consists mostly of elements such as silicon, aluminum, iron and calcium.

3- About 5 billion years ago, and for reasons not yet understood, this huge cloud of dust (rocky fragments) and gases began to rotated and contract under its own gravitational influence.

4- When the rotating cloud contracted , it rotated faster and faster.



D-Modern Nebula theory

5- This rotation caused the nebular cloud to assume a disk like shape.

6- The greatest concentration of material was gravitationally pulled toward the center, forming the protosun.

7- Within this rotating disk, small eddy-like contractions formed the nuclei from which the planets would develop.

8- The nebular material located near the protosun reached temperatures of several thousand degrees and was completely vaporized.

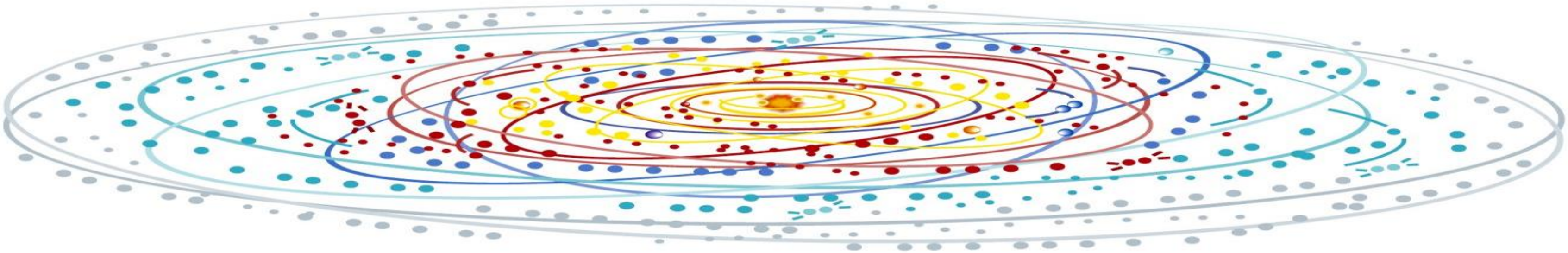


Figure 11-8c
Earth System History, Second Edition

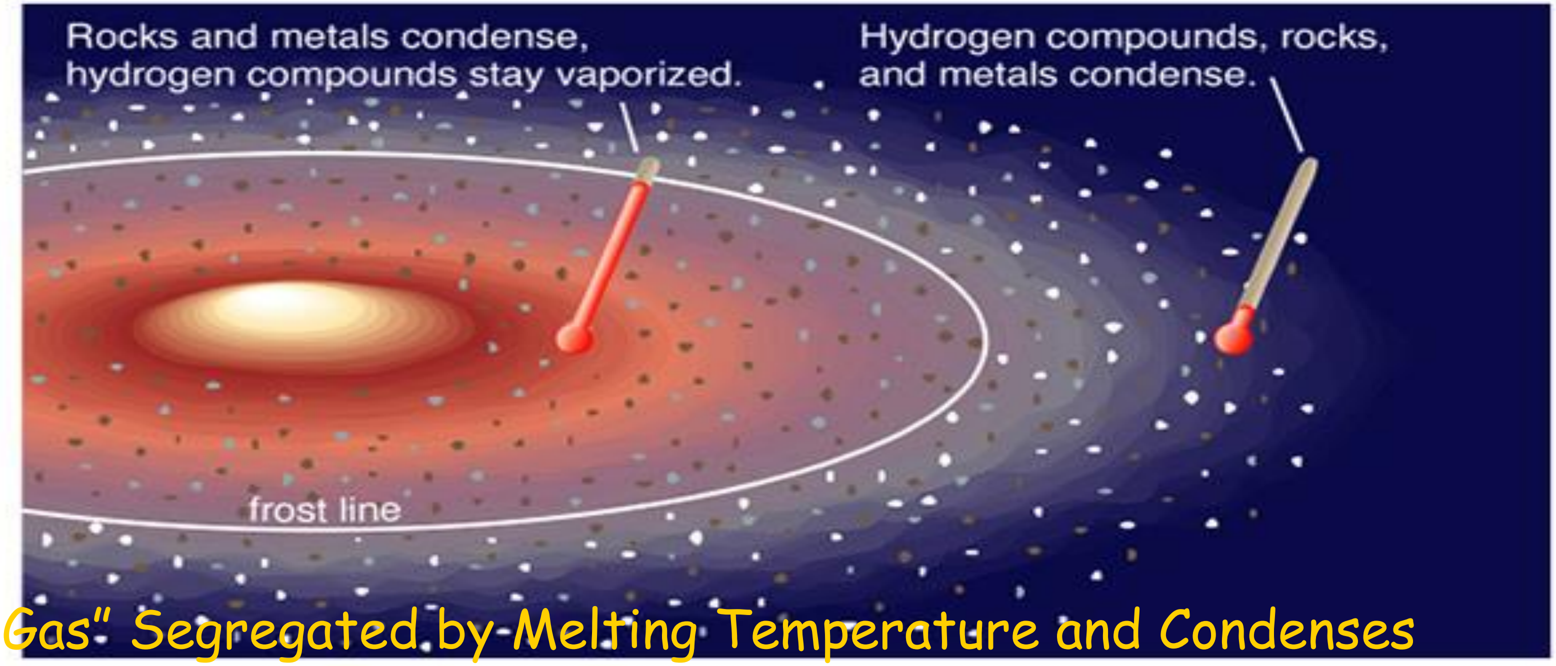
Residual Material Begins to Cool and Accrete

Disk Like shape: small eddy-like contractions

D-Modern Nebula theory

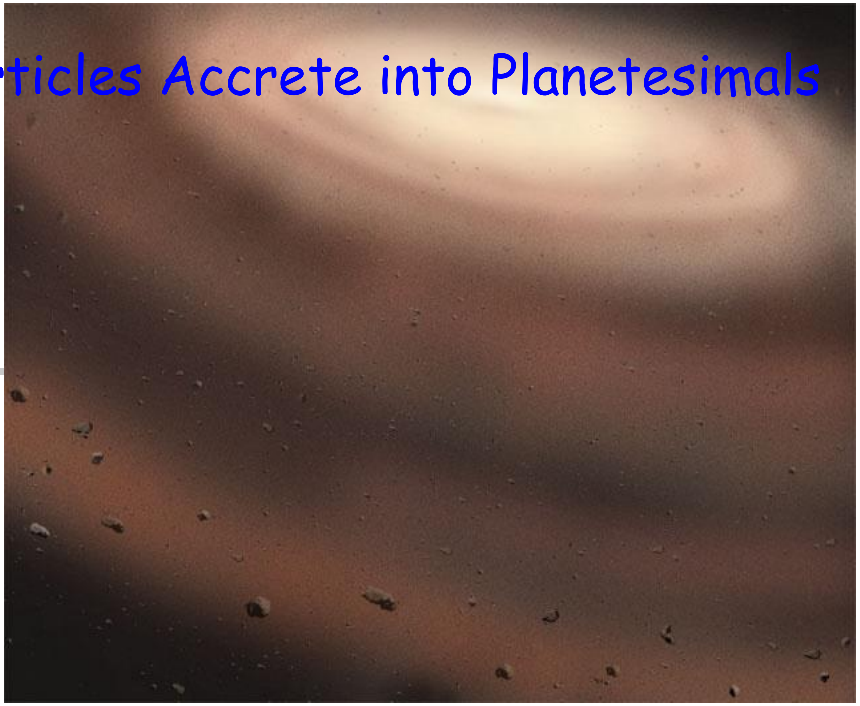
9- In a relatively short time after the protosun formed, the temperature in the inner portion of the nebula dropped significantly.

10- This decrease of the temperature led to : those substances with high melting points (Fe + Ni) solidified first to condense into sand sized particles.



Gas" Segregated by Melting Temperature and Condenses

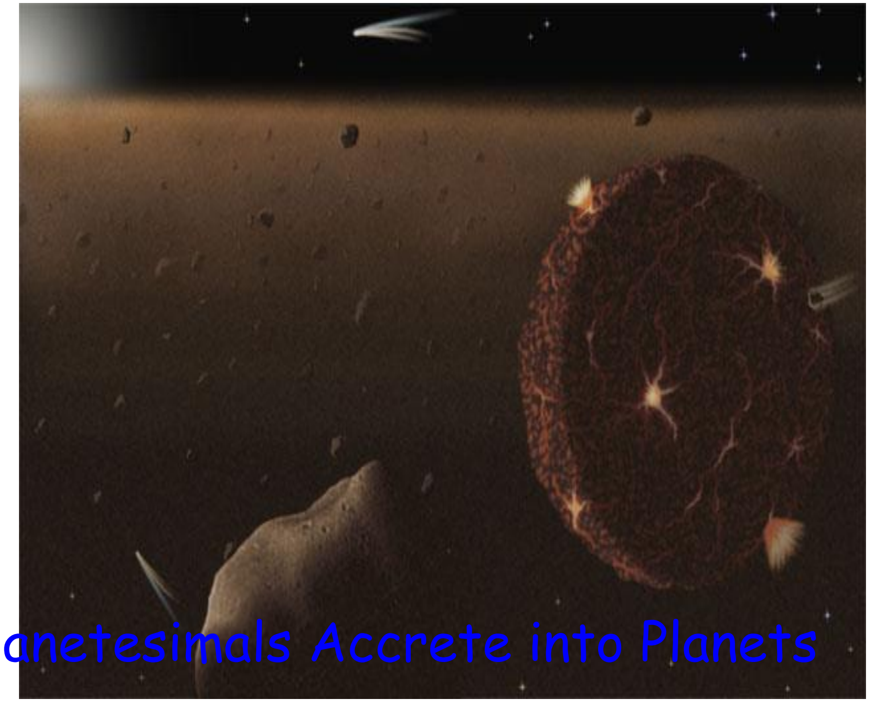
Accretion: Dust Particles Accrete into Planetesimals



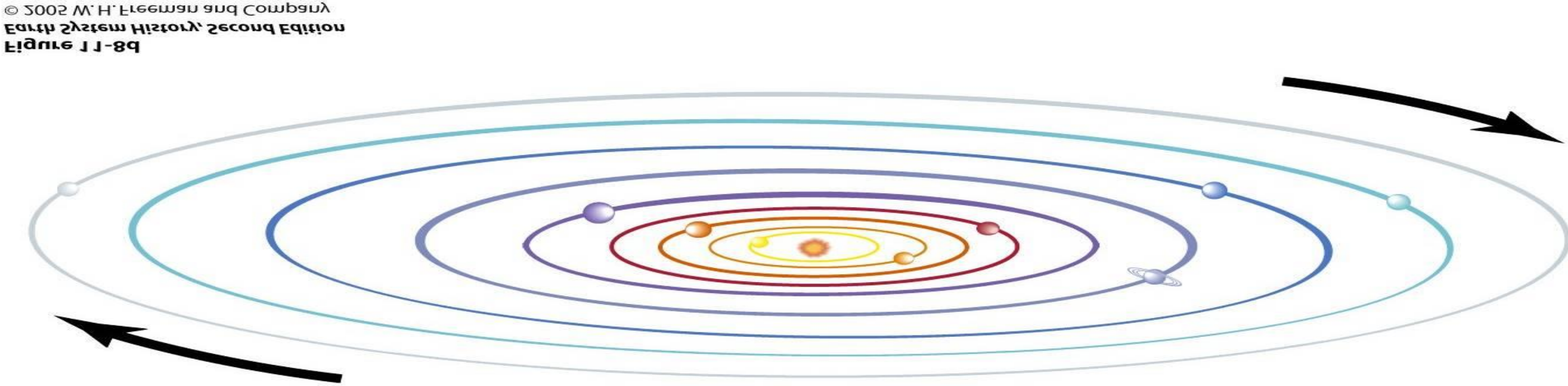
D-Modern Nebula theory

11- As these particles collided, they joined into larger, asteroid-sized objects which in a few tens of millions of years accreted into small and dense four inner planets (Mercury, Venus, Earth, and Mars).

12- Due to high temperatures and weak gravitational fields, the inner planets were unable to keep their contents of gasses such as hydrogen, ammonia and methane which accumulated in the outer planets..



Planetesimals Accrete into Planets



D-Modern Nebula theory

13- After the four terrestrial planets formed, The temperatures increased due to the following reasons:

a- decay of radioactive elements

b- accretion of cosmic bodies(Colliding particles) and

c- gravity compresses the planets into smaller volume.

14- This led to melting the heavier elements such as iron and nickel to sink as a core, while the semi lighter silicate minerals floated upward as a mantle and the lighter minerals floated upward as a crust.

Terrestrial Planets Heat up and Differentiate: *Iron Catastrophe*

Heat Comes From:

1. Kinetic Energy of Accretion
2. Gravitational Energy
3. Radioactive Decay
4. Differentiation

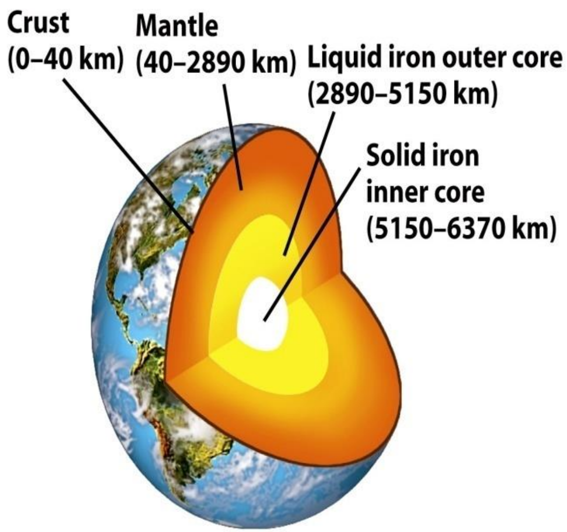
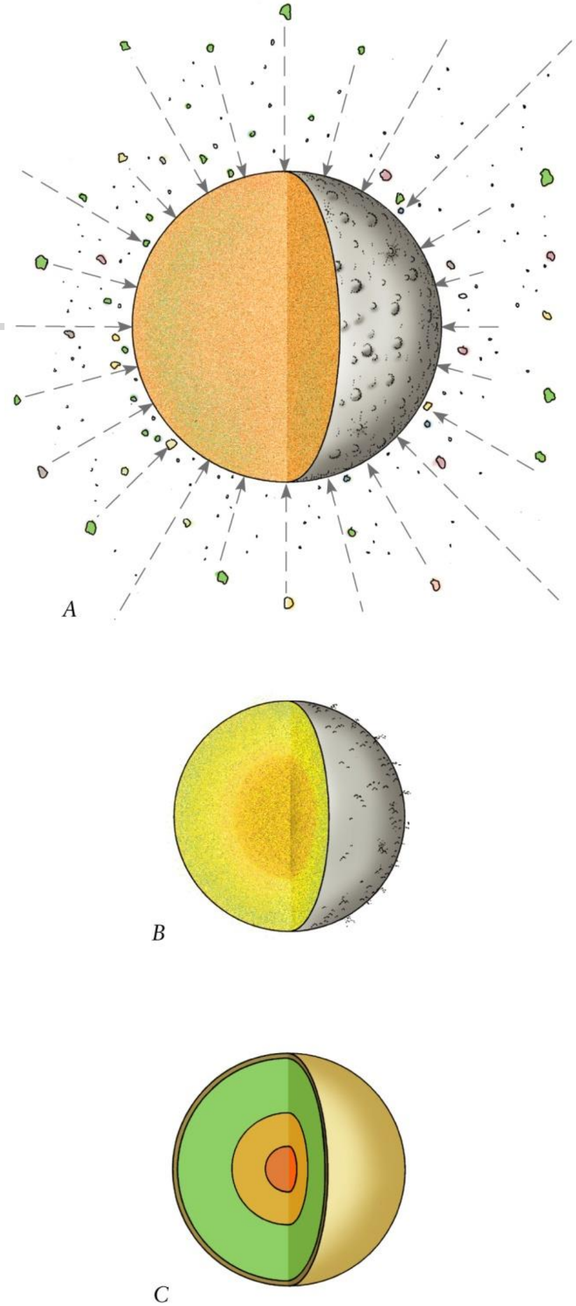
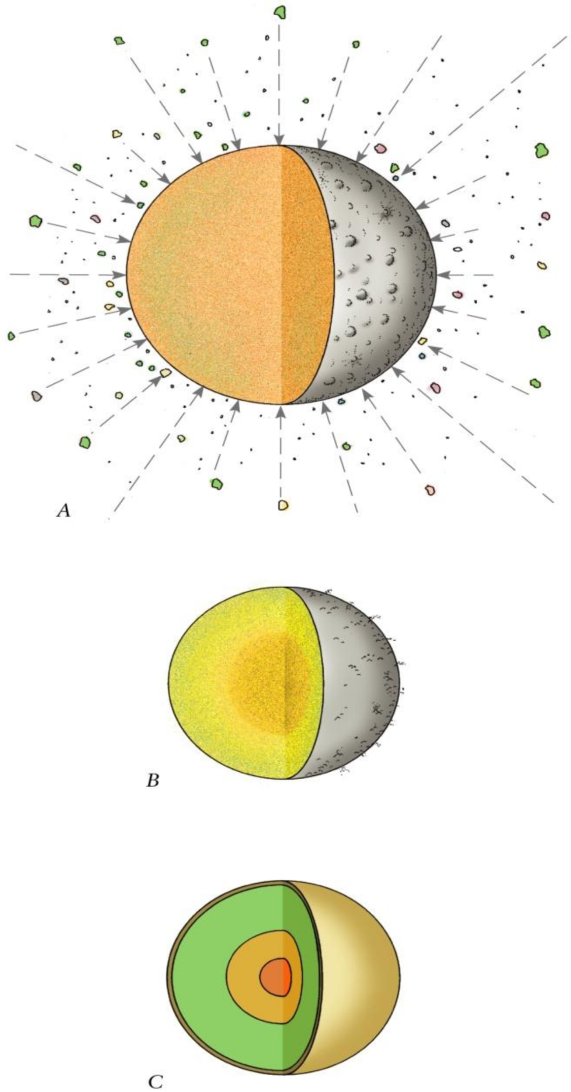


Figure 11-11c
Earth System History, Second Edition



THE COSMIC ABUNDANCE OF THE ELEMENTS



1-On the basis of data on the composition of meteorites and of solar and stellar matter, Goldschmidt in 1937 compiled the first adequate table of cosmic abundance of element and isotopes.

2-The data on hydrogen and helium were derived largely from examination of the sun and stars,

3-Suess and Urey (1956) have published a following table using the more extensive and accurate data accumulated than the Goldschmidt data.

THE COSMIC ABUNDANCE OF THE ELEMENTS

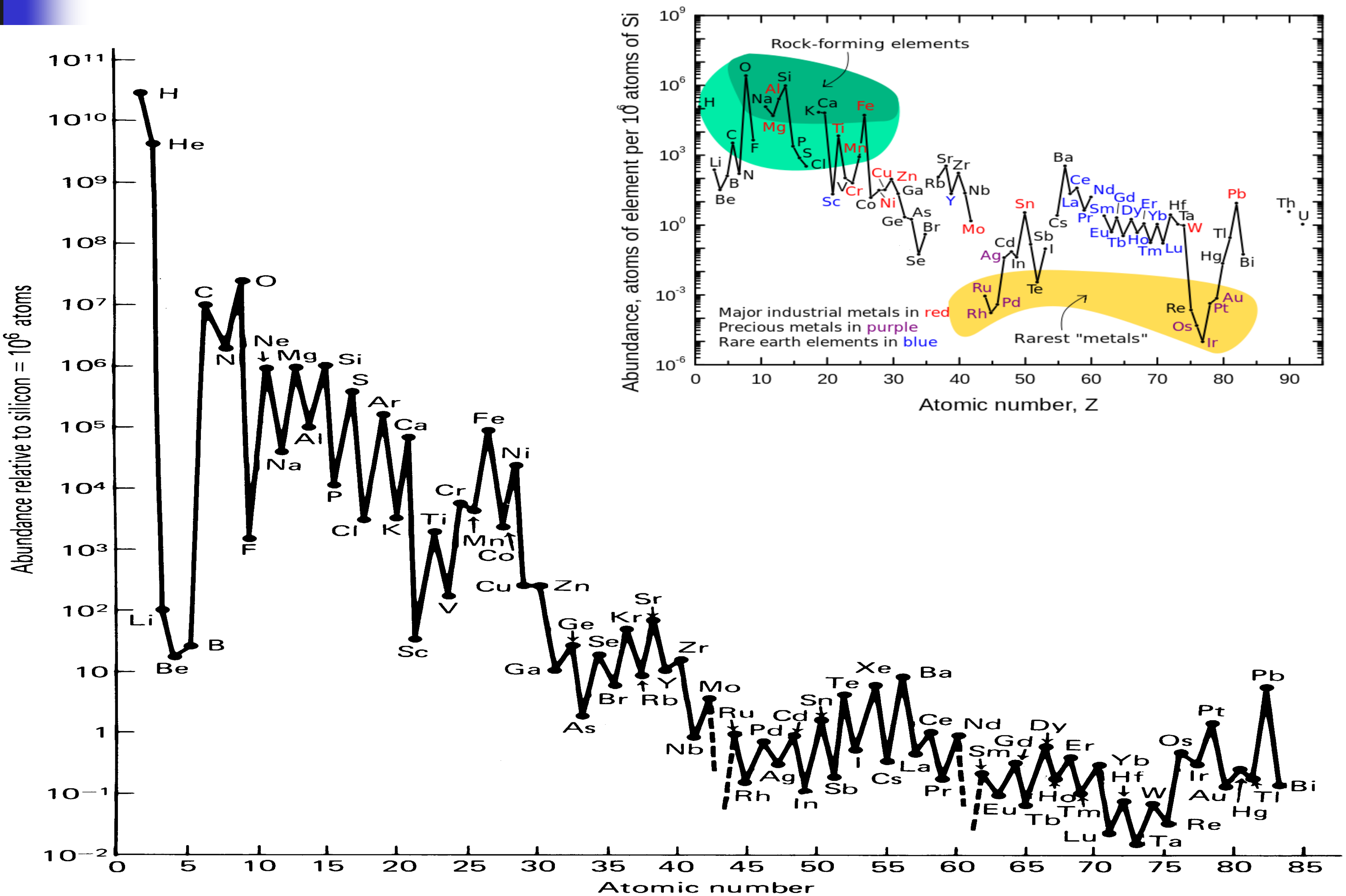
4-Variations in the abundances of H, He, Li, Be, B, C, N……. in the difference parts of the Universe are due to participation of these elements for energy production in the stars.

5- In the recent years, the scientist found that the abundance of elements varies from star to star due to:

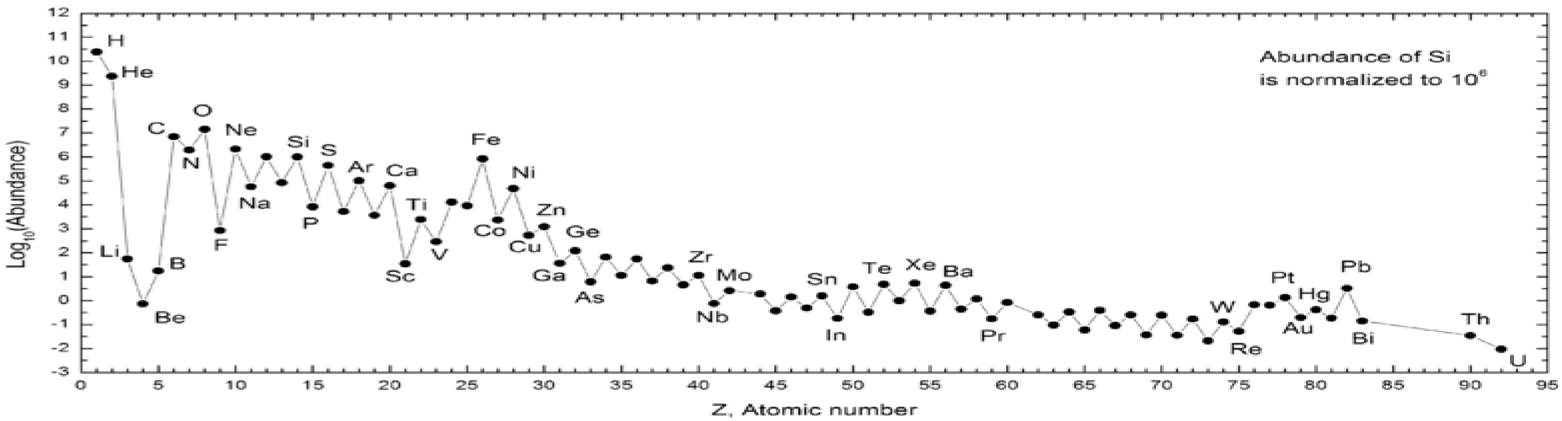
a-Stellar age   b-Stellar explosions

II. ABUNDANCE OF THE ELEMENTS

B. Element Abundance (relative to Si atoms)



Rules cosmic abundance of the elements



In the periodic table the elements are classified according to the atomic number from hydrogen(1) to uranium(92), in the following the rules which used to controred the abundance of the elements:

1-General decrease in abundance as the atomic number of the elements increase.

2-The elements which have atomic number from 1 to 30 decrease suddenly in abundance

3-The elements which whose atomic number greater than 30 decrease slightly in abundance.

4-The elements with even atomic number are more abundance than odd elements.

5-The more abundance element in the table is H,He,O,N,C,S,Si, Fe,Mg.

6- Rare earth elements are less abundance in the cosmic, U, Th, Ta, Lu, Tm, Ir…

Rules cosmic abundance of the elements

The regularities displayed in previous table suggest that the absolute abundances of the elements depend on : Nuclear rather than Chemical properties and are related to the inherent stability of the nuclei.

An element characterized by same number of protons (Z) in its nucleus, but the number of neutrons (N) associated with theses protons can vary . The result, element may have several isotopes

A (mass number) =Z (atomic number) + N (number of neutrons)

Isotopes

are different forms of the atoms of an element having the same atomic number (N) but different mass number (A) due to the difference in the number of neutrons (Z).

A (mass number) =Z (atomic number) + N (number of neutrons)

Ex: Isotopes Z = 20 (Calcium):

40	=20	+20
42	=20	+22
43	=20	+23
44	=20	+24
46	=20	+26
48	=20	+28

Isotones

A (mass number) =Z (atomic number) + N (number of neutrons)

An elements characterized by same number of neutrons (N) in its nucleus but with different values of (A) and (Z).is known that Isotones

Ex: Isotones N = 20

Ca	40	=20+20
K	39	=19+20
Ar	38	=18+20

Isobars

A (mass number) $= Z$ (atomic number) $+ N$ (number of neutrons)

An elements characterized by same mass number (A) in its nucleus but with different values of (Z) and (N). is known that Isobars

<u>Ex: Isobars A = 20</u>

Ca	40=20+20
K	40=19+21
Ar	40=18+22