Comparative planetology based on material physics
- How planets were formed –

by Shinji Karasawa

[CG was provided by Pixta]

The conventional theory that the solar system was formed by the gravitational collapse on hydrogen atoms from the cloud of interstellar molecules with only gravitational force is unconvincing. **The molecules or fine particles of cosmic dust will be adhered to other particles by short-range force. Its short-range coulomb force is equivalent to about 10^{36} times the gravitational force.** The clump of substance is formed from space dusts by gentle contact. Since the cosmic substances head to the center of the gravity, the density of the particles increases as those approach the center, and the number of times the particles collide increases. At the collisions, some of substance adheres and the others change the direction of motion. As the mass grows, the ratio of the surface decreases to a low energy state. When the direction of motion is changed, a part of the energy of the translational motion is converted into the energy of rotational motion. Most of substances in the solar system are collected into the Sun.

The cosmic substance orbiting the equatorial plane remains in the same orbit with the balance of the Sun's centripetal force and of its centrifugal force, while the dust with motion components perpendicular to the equatorial plane can't stay in the same orbit. Eventually, 0.13% of random state remained in orbitals by rotation. The planet grows on the plane of the Sun's equator by the perturbation of the Sun. As there is a planet on the equatorial plane of the Sun, there is a satellite on the plane of the planet's equator. It is difficult to create a huge gas planet like Jupiter or Saturn in an environment where the solar wind is blowing. The planets were already growing when the Sun and planets began to form at the same time and the Sun began its fusion reaction. (J. S. Lewis's Theory of Equilibrium Condensation [1974]).

With the exception of Mercury and Venus, which are close to the Sun, the planet's orbital cycle is inversely proportional to its own mass. This means that the planet has greater by taking in material orbiting its orbit. On planets, the orbital period is different, but many satellites have a similar orbital cycle to an orbital cycle. This suggests that when the Sun began its fusion response, the planets and satellites had already grown significantly. When the core of the Sun exploded at the nuclear fusion, large amounts of debris splashed into the universe. Those meteorites reached to the terrestrial planet, and the bombardment caused a catastrophic degassing in the terrestrial planet. This website will explain the formation process of the solar system.

As a result of the investigation by “Hayabusa” on an asteroid termed as "Ryugu", the asteroid is the structure with a lot of gaps, and the material is released to the universe at a speed of 30cm/sec by its low gravity. **This indicates that the interstellar material is born by quiet phenomena with the adheres at contact points.** As planet adheres interstellar medium by short-range force, the grown celestial body increase gravitational force that is the long-range force, and it increases the energy on collision of meteorite. **The short-range force which composes the material works to form the early structure of a celestial body.** (Uploaded on June 25, 2021)

[Reference: Videos]

[https://youtu.be/0qchcYRxuG4];[Oxidation of ultrafine iron powders by solid carbon dioxide.
[https://youtu.be/Wi5G2F_pDXM];The internal structure of the Earth explained from the viewpoint of condensed matter physics.
[https://youtu.be/Kz8TTGlCHXI]; Origins of meteorites.
[https://youtu.be/medU_Rq6StI]; Asteroid belt remains debris of the planet that failed to become the second Sun.
[https://youtu.be/BrzQAS2rr8Y]; The birth of planets those are understood by condensed the matter physics.

Chap. 1 Introduction

The "Pegasus za 51 star B" of the extrasolar planet was discovered in 1955. The planet was a big planet like Jupiter and was located very close to the center star. It became clear that this planet is not rare. So, such a planet is called "Hot Jupiter". It is not thought that a huge gas planet is forming near the star in which the reacting of nuclear fusion is taking place.

At the first stage in the traditional theory is "the gravity collapse of hydrogen", that is, hydrogen gathers by the gravity of hydrogen itself. But, hydrogen is the lightest atom in which the contraction by gravity is the slowest. A new formation theory of the solar system will be described in this description. That is, the Sun and the planets began to collect the dust at the same time. The planets that grew large the most first, it began to collect hydrogen gas the most first, and the nuclear reaction begins the most first. The large planet is possible to collect hydrogen gas and to begin the nuclear reaction. The primitive Sun became huge planet the first in the solar system, and it is not necessary to discuss such as the gravity collapse of hydrogen.

The primitive Sun in the center of the solar system accelerates growth as it grows. The internal structure of the Sun became similar to Jupiter before it began the nuclear fusion. In the center of the Sun, there existed a core. The core was exploded by the first nuclear reaction and the debris is released into the universe. The most of exploded fragments were incorporated into the Sun. But the massive explosion of the core of the Sun produced a lot of meteorites or asteroids. There are traces of a large meteorite or asteroid collision in the early solar system on the planet of the solar system.

It shows that many of the meteorites flying on the Earth were born about 4.6 billion years ago. It is natural to imagine that the origin of the meteorite was a fragment of the core of the primitive Sun. The fragment does not cause the nuclear fusion and it can be captured by planets. Since there are hydrogens abundant, the Sun may continue the nuclear fusion reaction in a steady manner.

Herein the formation of the planets in the solar system will be explained under the assumption that the Sun was born before the fusion reaction began.

Chap.2 Bonding through contact of fine particles

2.1 The adhesion of fine particles by close-range forces

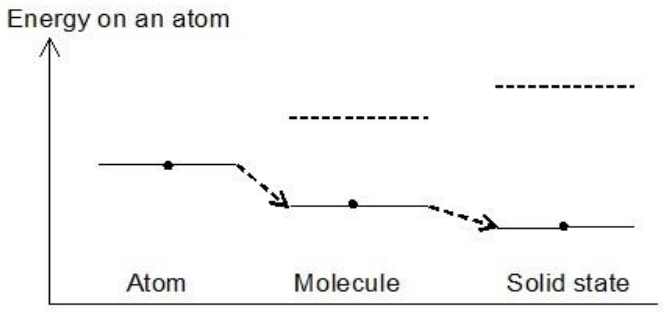

Fig.1. The energy state of an atom that changes with the combined state

The dust is a particle that many atoms gather. The internal state of the particle does not change even if the gaseous molecule collides with a fine particle by the thermal motion, and the gaseous molecule bounces. However, when the particle and fine particles contact slowly, the electronic state in the contact point becomes low energy, and a chemical reaction is learnt locally. When the electronic state becomes steady state with low energy, the state is kept. The substance does not bond directly by the force of the gravitation. When atoms approach the distance of atomic size, electrons of atoms interact with electrons of other atoms, generating high energy states and low energy conditions, and new electronic states can be generated.

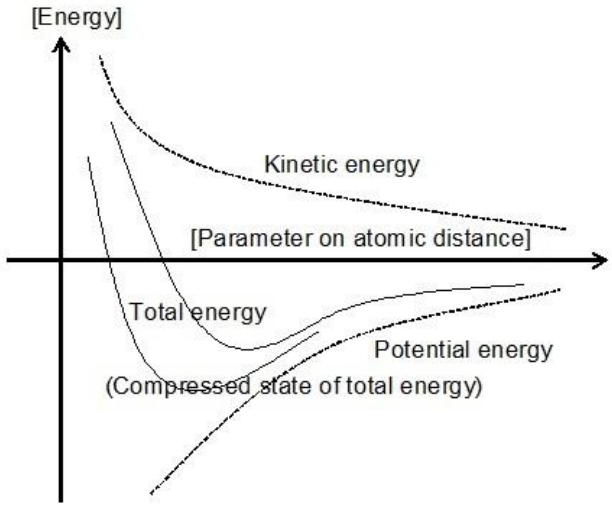

Fig.2. Decrease in energy state due to reduction of atomic distance

When the volume size (V) is compressed without changing the product of pressure and the volume (P・V= constant) in the ideal gas, the kinetic energy (K) increases inversely. The condition which does not change the product of this momentum space and the distance space (p・q=constant) becomes a certain condition of the quantum state (p・q=n・h). Fig. 2 shows the change of energy in the case of compression and expansion without changing the quantum state of the material. The potential energy that works for nuclei and electrons decreases inversely in size, but kinetic energy increases inversely proportional to the size squared.

Therefore, the lowest energy condition is given by the kinetic energy in half of the potential energy (Virial theorem). The gravitational force decreases in inverse proportion to the square of the distance ($1/q^2$), but the effect of long-range force reaches far. On the other hand, the short-range force does not affect beyond several times of atomic size, because the Coulomb force cancels between positive and negative charge. A cluster of the fine particle is constructed by locally intermolecular bond. The celestial body is formed by the short-range force via cosmic dust. There are approximately 36 digits of difference between universal gravitation Eq.1 and Coulomb Force Eq.2, as shown in Eq.3.

$$FG = G \cdot (m\ p)^2/d^2 ; \quad G=6.67\times10^{-11}\ [N \cdot m^2 \cdot kg^{-2}], \quad m_p=1.66\times10^{-27}\ [kg] \qquad (1)$$

$$FC = k \cdot (q\ p)^2/d^2 ; \quad k=9.0\times10^{9}\ [N \cdot m^2 \cdot C^{-2}],\ q\ p = 1.6\times10^{-19}[C] \qquad (2)$$

$$FG / FC = 1.84\times10^{-64}/(2.3\times10^{-28}) = 8\times10^{-35}. \qquad (3)$$

2.2 Surface oxidation of iron powder by mixing of dry ice
- Contact reaction between solid and solid –

Reactivity of iron powder becomes higher in accordance with the down-sizing. The energy state of the fine particle is high compared to the solid state. The intermolecular bond at the contact points between cosmic dusts plays the role of adhesives. The larger chunk increases the ratio of the atomic coupling state, so the overall energy is low. The cosmic dust cannot connect each other by the gravitation. And the solid cannot be decomposed by the power of gravitation.

The oxidation of iron powder is slow in the air. Carbon dioxide gas (CO_2) does not oxidize iron powder (Fe) in a short time. However, when iron powder (Fe) and dry ice (CO_2) are mixed and those are sealed in a jar, the iron powder is oxidized by the dry ice as shown in Fig.3. The edge of the glass container is shown in Fig.4. Here, Gray particle is Fe, Black particle is Fe_3O_4 and Brown particle is Fe_2O_3. The left side of Fig. 5 is reduced-iron powder is shown in the left side and oxidized surface of the powder by dry ice (CO_2) is shown in the right side [5].

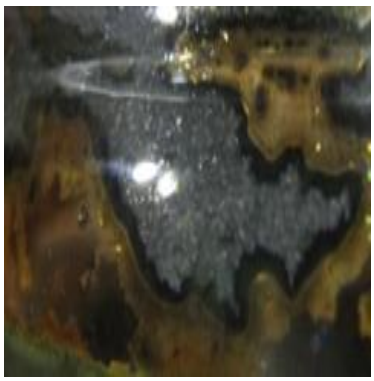


Fig. 3. Iron powder in glass container
Fig. 4. Iron powder of the wall of glass container
Fig. 5. Surface oxidation of reduced ferrous fine particles (right)

The iron powder is highly reactive in accordance with fine particles. It is possible to experiment to make sure that the fine powder of iron is oxidized by dry-ice as follows. Fine iron particles, those are made from iron oxalate ($FeC_2O_4 \cdot 2H_2O$), are oxidized by putting on a solid dry-ice (CO_2).

After a while to sprinkle the iron fine powder on dry ice, as shown in Fig. 6, a very fine particle of smoke occurs, and the iron particles become reddish color powder from black powder. Reddish color is red iron-oxide (Fe_2O_3).

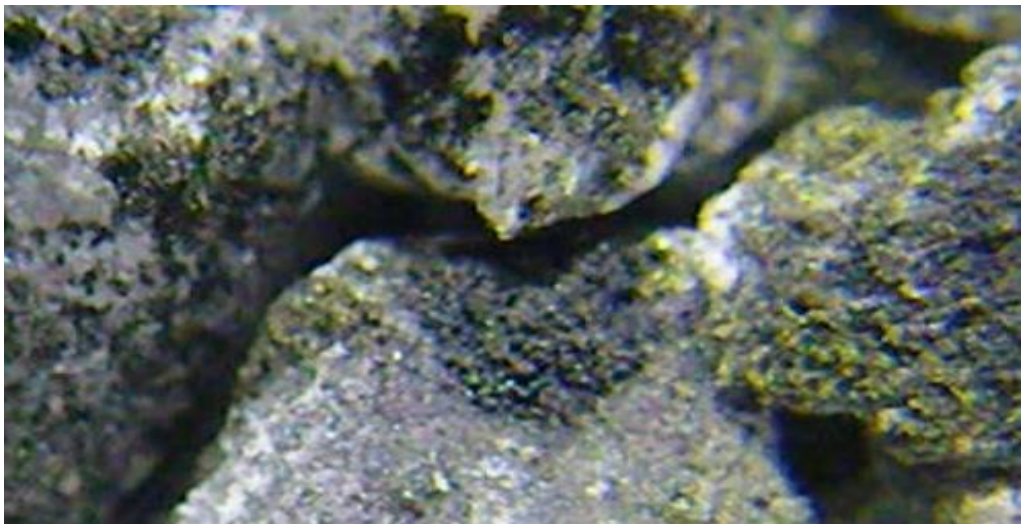

Fig.6 Oxidation of ultra-fine particles of iron were observed by sprinkle on the solid dry-ice. [Refer the movie: Oxidation of ultrafine iron powders by solid carbon dioxide] [https://www.youtube.com/watch?v=0qchcYRxuG4]

Chap. 3　Accumulation of cosmic dust

3. 1　Distribution of interstellar medium in the solar system

Since the gravity acts on all substances, the center of gravity exists even in uniform sparse density where the cosmic dust is gathered. The interstellar medium is concentrated toward the center of gravity according to gravitational potential, and the density of the material is higher as it is closer to the center of gravity. **As individual particles approach toward the center, the number of collisions increases, and the direction of motion is changed. At the collision, a part of the energy of translational motion is converted into the energy of rotational motion, and the density of the center increases.** The equilibrium state of orbital near the center of gravity has large kinetic energy, and the revolution period of the orbital is shortened. When the cosmic dust shrinks by the self-gravity, it continues orbiting the orbital with the balance between the centrifugal force of rotation and the gravity of the center. As the results, about 0.1% of the solar system's substance has remained in the orbital.　The relationship between the primitive density distribution of the cosmic substances and the distance from the Sun is estimated from the mass (m_{planet}) of the outer planets and the positions ($L_{Sun\text{-}planet}$). The gravitational potential energy of a planet is defined as follows. The value of gravitational potential is the change of energy that the planet moves to its current position from the infinite point of the Sun. Here, the value is 0 at infinite point from the Sun. According to Newton's dynamics, the planetary

gravitational potential energy is inversely proportional to the distance ($L_{Sun\text{-}planet}$) from the center of gravity. It is the gravitational potential of each point. The value of accumulated potential energy that was accumulated by the planet from the interstellar material in the surrounding area is proportional to the mass of planet, and it is inverse proportion to $L_{Sun\text{-}planet}$. Φ_{planet} represented by Eq.4 reflects the density distribution of the interstellar medium in the area where the planets exist.

$$\Phi_{Planet}=-M_{Planet}\cdot(G\cdot M_{Sun})/(L_{Sun\text{-}planet})=-G\cdot M_{Sun}\cdot(M_{Planet}/L_{Sun\text{-}planet}) \quad (4)$$

Fig.7 illustrates the value of the normal logarithm of ($M_{Planet}/L_{Sun\text{-}planet}$) on each planet in the solar system as the horizontal axis of the distance from the Sun. Values of $M_{Planet}/L_{Sun\text{-}planet}$ on Jupiter, Saturn, and Uranus are decreasing exponentially by increase of the distance from the Sun. Here, Jupiter has a strong magnetic field of about 20,000 times the Earth, and the mass is increased because the ion of the solar wind is wound in the magnetic flux and it captures it in the planet.

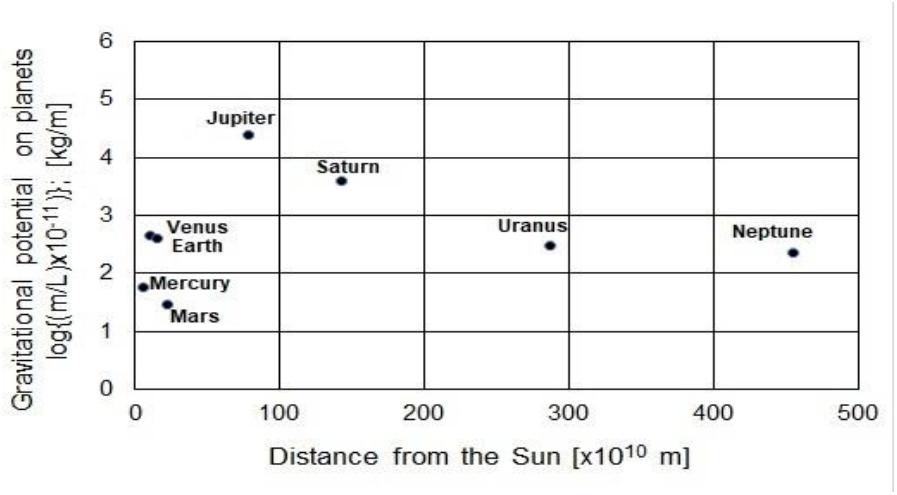

Fig.7 Comparison of gravitational potential accumulated by planets in the solar system

This suggests that the giant planet grew in a state where the density is exponentially distributed against the distance from the sun. But, the value of the (M/L) beyond 4 billion km distance from the Sun does not hold the exponential function rules. Moreover, the rule of the exponential function does not hold on the rock planets because it approaches to the Sun.

3. 2 Orbital motion and rotation motion of the planet

The celestial body, which is orbiting around the center celestial body, has an angular momentum that corresponds to the gravitational potential of the position. The orbiting period of the planets is determined by the orbiting speed that maintains the equilibrium in its gravitational field. The Earth's orbiting cycle is one year. The revolving cycle of planets that revolve away from the Sun is longer.

On the other hand, the origin of the rotation of the celestial body has not been discussed.

It is not uncommon for a celestial body that the orbiting period coincides with the rotation period. In the early celestial bodies, the revolution cycle and the rotation cycle are matched as follows.

The center of the revolution movement becomes a common center of gravity when a uniformly distributed cosmic dust. When the dusts become a mass on the orbital orbit, the center of gravity which was in the center comes to do eccentric movement. If there is the eccentric movement, or the rotation of the deformed center celestial body, the dusts orbiting in the geostationary orbit (synchronous orbit) can be integrated and those can be formed a celestial body. If the center celestial body rotates eccentric, or the center celestial body transforms and rotates, the cosmic dusts orbiting in the geostationary orbit (synchronous orbit) are gathered. In this case, the eccentric movement of the center of gravity synchronizes with orbiting planets.

The potential of gravity becomes stronger in the state that the orbit of the celestial body shrinks toward the center of gravity, and the kinetic energy to which it balances increases and the rotation becomes fast. As the planets and satellites get closer to the center star, the orbiting cycle becomes shorter, so if the rotation of the center star is mediated, the rotation cycle of the planets or satellites a is shortened. When the center celestial body grows, the rotation cycle is shortened by including the falling cosmic dust while it orbits. This is the mechanism how the growth of the celestial body is reflected in the speed of rotation.

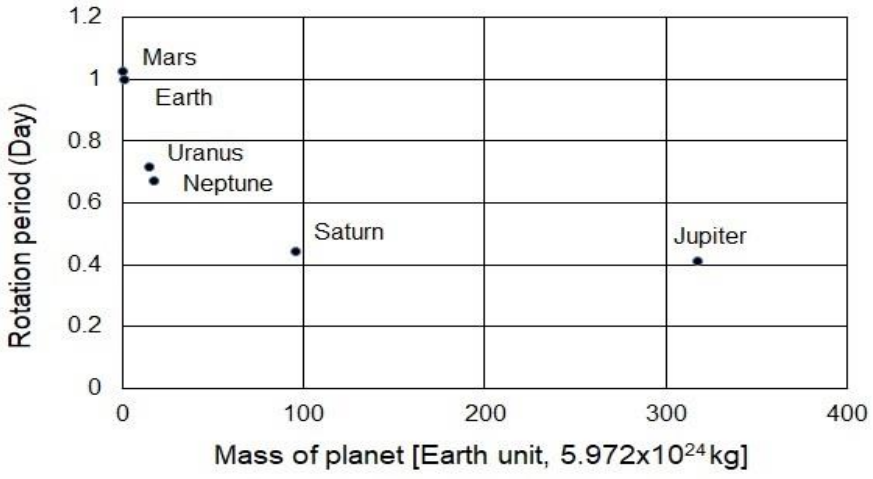

Fig.8 Planetary rotation cycle inversely proportional to the mass of planets

The planets in the solar system are inversely proportional to the planetary mass as shown in Fig.8, except for Mercury and Venus, which is very slow in rotation. This indicates that six planets, including the Earth and Mars, have grown and developed materials orbiting around the planet. The rotation cycle of Earth and Martian is one day, and Jupiter and other planets are less than 24 hours. However, the rotation cycle of mercury is 59 days, and Venus is 225 days. Mercury and Venus, orbiting the area near the sun, do not have satellites. In addition, if the orbit cycle is mediated by the eccentric of the rotation of the

center star, the orbit cycle becomes short when the planet and the satellite approach the center star.

The rotation period of the primitive Sun is shortened by the orbiting substance that is included among the constituent substance of the Sun. The current rotational period of the Sun is 25.38 days.

3. 3 Period of orbital on the Moon and rotation period of the Earth

The Moon is composed of the lighter material ($\rho_{Moon} = 3.34$ g/cm^3) than the Earth ($\rho_{Earth} = 5.52$ g/cm^3), because the Moon collects the dust that is orbiting outer from the Earth. When the primitive Moon grows, it orbits the circumference of the common center of gravity of the Earth and the Moon, and the rotation period and the revolution period of the moon is the same. The backside of the moon is thick due to light materials compared with the front of the Moon. The volcanic magma was drained into the lowlands on the front of the Moon and the sea of the Moon was formed.

The rotation period of the primitive Earth, which was the same as the revolution of the primitive Moon, became short by collecting the dust orbiting the Earth. The current Earth's rotation cycle is one rotation per a day. The geostationary orbit, of which cycle is the same to Earth's rotation, is located at the distance of 42,300 km from the Earth. The delaying movement on seawater of the Earth links with the orbital movement of the Moon. The “tidal” increases the Moon's orbital radius. Today, the Moon is 380,000 km away from the Earth, and the revolution period is 27.3 days. The rotation cycle of the Moon coincides with the revolution period of the Moon, because the eccentricity rate of the orbit of the Moon is 0.055 and large. Earth and Moon have been orbiting around common center of the gravity.

The sea water evaporates and condenses in the troposphere and becomes a cloud and is returned to the Earth by the rain. The “cold trap” saves the amount of seawater. Moreover, there is magnetic flux in the sky above the earth, the oxygen decomposed from H_2O by ultraviolet rays will be bonded with hydrogen ion (H^+) of the solar wind. The magnetic flux invades the earth in Arctic and the South Pole. The amount of water in the sea did not change after the sea was born.

The third law of Kepler may calculate the ratio of the orbit radius from the ratio of the revolution period. The third square of the orbital radius is proportional to the squared of the revolution period by Kepler's law, the orbital radius of the moon is obtained from the revolution period of the Moon by the Eq.5.

$$L_{Orbit\ of\ Moon} = \{G \cdot M_{Earth} \cdot T_{Orbital\ period\ of\ Moon}^2/(4\pi)^2\}^{1/3} \qquad (5)$$

If the mass of the earth does not change, the ratio of between the orbit distance calculated by 27.3 days and the orbit distance calculated by one day, that is coincides with the rotation period of the Earth, is given by $L_{(27.3days)}/L_{(1day)} = \{(27.3)^2\}^{1/3} = 9.1$. But, the ratio on the actual length of radius is (38/4.23) = 8.98. The ratio of the current Earth's mas (M_{Earth}) with the primitive Earth's mass (M_{*Earth}) at the time when the Moon was in the geostationary orbit and the sea was formed, is given (m_{*Earth}/m_{Earth}) = $(8.98/9.1)^3 = 0.96$. When the sea was born, the Earth was 96% of the present mass.

The moon moves from the Earth's geostationary orbit to the current orbit during 4.5 billion years by the tidal action and the delay of the revolution of the moon. Today, it is away from the Earth by 3.8 cm/year from the laser ranging experiments.

Here, for reference, the data of the satellite of Mars are as follows.

[Phobos] L_{Phobos} = 9,3800km, T_{Phobos} =7.65hours, d=26.8km,

[Mars $_{geostationary\ orbit}$] $L_{Synchro\ of\ Mars}$ =20,400km, $T_{Synchro\ of\ Mars}$ = 24.62 hours,

[Deimos] L_{Deimos}= 23,500km, T_{Deimos} = 30.30hours, d=15km,

According to Mars satellite data, it is estimated that the period of time when Mars was filled with water was short.

3. 4 Effects of the solar wind on Venus and Mercury

The revolution period of Venus is 225 days, and the rotation cycle is 243 days in the opposite direction. The rotation of the reverse direction caused by the external action. The solar wind is released in the mass of 10^9kg/sec from the Sun of which rotation cycle is 25.38 days, and the rotational speed of the solar surface is 2km/sec. 96.5% of the atmosphere of Venus is carbon dioxide. When the solar wind which has the rotating component by the rotation of the Sun collides with the atmosphere of the Venus, the orbit of the atmosphere reverses in the direction of the revolution via the mechanism of gear. The rotational speed 2km/sec solar wind is causing “the super rotation” of the 100 m/sec sulfuric clouds.

Venus has a thick cloud of micron sized sulfuric acid (H_2SO_4) aerosol in the sky above the 70km. The sulfuric acid air sol absorbs the surrounding water-vapor and dissolves itself in its waters and is dissociated. This particle layer is reflected by 80% of the sun's light, and the sun and solar wind heats the troposphere. Where the solar wind includes the rotation of the 2k/sec speed. It causes a super-rotation of a 100 m/sec speed of cloud by a mechanism of loose gear coupling. The speed of the atmosphere near the ground coincides with the rotation of the Venus in the breeze of 2m/sec.

The effect of the atmosphere, that turns the rotation to opposite direction, is not on other planets or satellites. Momentum of solar wind rotation on the surface of the Sun ($P = mv = 2x10^{12}$[kg・m/sec]). Area ratio in the position of Venus $(R_{Venus})^2/4\pi(R_{Sun\text{-}Venus})^2 = 2x10^{-10}$. It decreases to the rotational momentum of about 400 [kg・m/sec].

Table 1. Orbital orbit, rotation cycle, gravitational zone and synchronous orbit

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	[Unit]
$L_{distance\ from\ the\ Sum}$	0.579	1.082	1.496	2.279	7.783	14.294	28.750	45.445	[10^{11}m]
$T_{period\ of\ rotation}$	58.65	243.0	0.997	1.026	0.414	0.444	0.718	0.671	[day]
$L_{geosynchronous\ orbit}$	24.3	153.7	4.23	2.04	16.01	11.22	8.27	8.35	[10^7m]
$L_{gravitational\ zone}$	2.4	16.9	25.9	12.9	2402	2416	1899	3231	[10^7m]

On the other hand, the orbital period of the Mercury is 88 days, and the rotation cycle is 59 days. It was observed that a huge cloud of sodium suddenly appeared in mercury and disappeared in the blink of an instant. It is difficult for the celestial planet to be born in the environment where the strong solar wind exists.

Table 1 shows the data on the planets in the solar system. Here, the third law of Kepler shown by Eq.5 was used, and numerical values were used from the Chronological Scientific Table Ed National Astronomical Observatory of Japan.

$$L_{\text{Orbit of Planet}} = \{G/M_{\text{Sun}}\, T_{\text{Orbital period of planet}}{}^2/(4\pi)^2\}^{1/3} \qquad (6)$$

The gravitational circle in Table 1 shows the results obtained by using the equation (6) as an approximation for the distance from the planet where the gravitational force of the Sun and the gravitational force of the planet are equal in the middle of the sun and planets.

$$M_{\text{Sun}}/(L_{\text{Sun-planet}})^2\ M_{\text{planet}}/(L^*_{\text{planet}})^2 \qquad (7)$$

The current solar rotation period is determined by using the geosynchronous orbit t of the Sun (5), $L_{\text{geosynchronous orbit of the Sun)}} = 2.53\ X10^{10}$. The distance from the Sun to Mercury is half the value on the orbital of Mercury.

Chap.4 The formation of Planets

4. 1 Contraction by the gravitation of the Sun and Expansion by solar wind

The nuclear fusion of the Sun affected today's planets. The following can be assumed according to the former descriptions. That is, the Sun was born from the same substance as the planets, and the planets had grown just before the Sun began the nuclear fusion. When the nuclear fusion of the Sun begins, a large amount of core debris is emitted from the Sun. Up to now, the nuclear fusion has continued and the solar wind blowing.

The solar wind is reached to regions of the outer solar system. The distance to the end of the solar system can be estimated from the Virial theorem of Eq. (8). That is, the gravitational potential energy is twice as large as the total energy (E_{total}).

$$2 \cdot E_{\text{total}} = m_p \cdot M_{\text{sun}} \cdot G/(L_{\max}) \qquad (8)$$

Here, total energy; $10K=1.38\ x10^{-22}$ J, $M_{\text{Sun}}=1.988\ x10^{30}$ kg,
Distance to the end of the solar system ($L_{\max}$) $L_{\max} = 8.0 \times 10^{14}$ m.

$L_{\max}$ is much farther than the orbital orbit of Neptune ($4.5\ x10^{12}$ m), about half of the distance to the Oort cloud (10,000 au = $1.5\ x10^{15}$ m). The solar-wind emitted from the Sun goes up to the edge of the solar system, where a comet gathers the dust in the region, and is pulled back by the gravitation of the Sun.

4. 2 The small distorted satellites that exists close to the center planet

The data on the four satellites orbiting the nearest Jupiter and two satellites of the Mars are shown as follows.

[Metis] $L_{\text{Metis}} = 120{,}960$km, $T_{\text{Metis}} = 6.97$ hours, d=40km,
[Adrastea] $L_{\text{Adrastea}} = 128{,}980$km, $T_{\text{Adrastea}} = 7.15$hours, d=26km,

$L_{\text{Geostationary orbit of Jupiter}}$ = 160,180km, $T_{\text{Geostationary orbit of Jupiter}}$ = 9.94 hours
[Amalthea] L_{Amalthea} = 181,300km, T_{Amalthea} = 11.77hours, d=262km,
[Thebe] L_{Thebe} = 221,900km, T_{Thebe} = 16.08hours d=110km.

[Phobos] L_{Phobos} = .9,370 km, T_{Phobos} = 7.65 hours, d=26.8km.
$L_{\text{Geostationary orbit of Mars}}$ =20,400 km, $T_{\text{Geostationary orbit of Mars}}$ = 24.62 hours.
[Deimos] L_{Deimos} = 23,500 km. T_{Deimos} = 30.3 hours, d=15km.,

These satellites are small and distorted, and the orbiting cycle and rotation cycle are the same, because these satellites are located near each center. The high gravitational energy of substance around the satellite is given from the central planet. The corresponding kinetic energy prevents the aggregation.

The celestial body has been stayed in the state of equilibrium. The ring of Saturn can be explained by the mechanism that gradually collapses itself owing to increase of kinetic energy in equilibrium with the increase of gravitational potential on an asteroid. If it is decomposed by the gravitational force, the broken pieces must move to the Saturn. But, each broken piece of a satellite orbits the same orbital, because the orbital does not depend on the mass from the third law of Kepler.

4. 3 Galileo satellites: Moons of Jupiter

Galileo satellites are helpful to infer the initial state of planetary formation. Those satellites were not growing as large as the gas planet. And the central planet did not begin a nuclear fusion. The density of Galileo satellites is as high as close to the position of Jupiter. The substance that adheres the dust in the Io is sulfur (S) or sodium (Na) which became the high kinetic energy state of Jupiter's gravity.

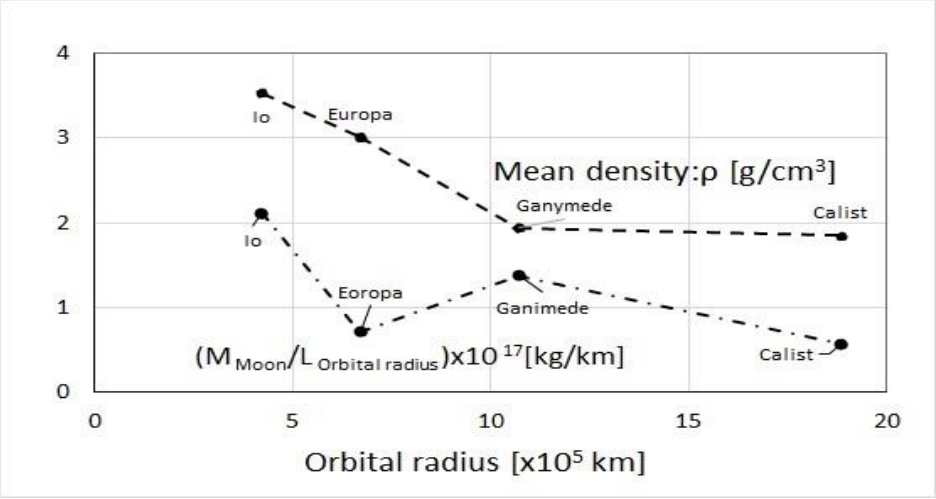

Fig. 9 The density of Galileo satellites, and the value of ($\Phi_{\text{satellite}}$) that was collected gravitational energy by each satellite

Fig. 9 shows the density of Galileo satellite, and the value of ($\Phi_{satellite}$ i.e. Eq.4 in Sec.3.1) gravitational potential energy that was collected by each satellite.

The average temperature increase for each satellite by the gravitation is estimated as the half of the gravitational energy ($E_{Gravity}$).The gravitational energy (E gravitation) of the Galileo satellite with radius (r) and mass (m) is represented by Eq.9.

$$E_{Gravity} = \{(3/5)\ G \cdot M^2\}/R \qquad (9)$$

$\Delta T_{Io} = +1,230K$, $\Delta T_{Europa} = +750K$, $\Delta T_{Ganymede} = +1,410k$, $\Delta T_{Callisto} = +1,120K$ are obtained by assuming the value of specific heat of the satellite 0.8 J/(g・K).

[Io] ($\rho_{Io} = 3.528$, $L_{Io} = 421,600$km) is located at the closest position to Jupiter. The distance is 6 times of Jupiter's radius. There is magma under the Earth's crust, and the volcanic activity is active, and sulfur and sodium are gushing. The surface temperature of the Io is 130k. Atmosphere is 90% is SO_2. The internal structure of the Io has a relatively large iron nucleus at the center, a layer of dissolved silicic acid, and a thin silicate crust on it. These facts helped to predict the formation of Mercury and Venus.

[Europa] ($\rho_{Europa} = 3.013$, $L_{Europa} = 670,900$km) is located between Io and Ganymede. The orbital period of Europa is twice times of Io, and half of Ganymede. Europa receives the larger gravitation in the direction of Jupiter when the orbit resonates with Io, and at the time of Ganymede and orbital resonance, it receives gravitation in the opposite direction of Jupiter. So, Europa is shaken by the gravitation of Io and Ganymede and is heated and the ice in the inside turns to liquid state. The surface of Europa is covered with ice and the atmosphere is dilute.

[Ganymede] ($\rho_{Ganymede} = 1.936$, $L_{Ganymede} = 1070,000$km) is the largest satellite in the solar system and is larger than Mercury. It is thought that the inside is the nucleus of a hard ice crust, a weak ice layer, the mantle of the rock, and the metal quality. The atmosphere of Ganymede is thin, and it is composed of O_2 which is made from de-hydrogen of H_2O.

[Callisto] ($\rho_{Callisto} = 1.851$, $L_{Callisto} = 1880,000$km) is the most distant from Jupiter among the Galileo satellites. Although the surface is cover with ice, the inside is undifferentiated. There is a lot of ice in the crust and there are many rocks in the center. The surface temperature is less than 120k, and its atmosphere is 100% CO_2. As mentioned in section 2.2, the fine powder of metal adheres with solid state CO_2.

4. 4 Mercury and Venus

4. 4. 1 Mercury

The temperature of the surface of Mercury facing the Sun rises to 440 ℃ and emits steam of sodium (Na), but at night it drops to-180 ℃. It is observed that a cloud of Na appears in mercury and disappears in the blink of an instant. This phenomenon is involved in a solar wind that is emitted from the Sun. The amount of solar wind is 1 million tons per second. The rotation of the solar wind is 2km/sec and it runs half of the Mercury in an hour.

It is difficult for Mercury to be born with such a solar wind blowing. The primitive Mercury had grown before the nuclear fusion began. The mass of today's Mercury is 0.055 times the Earth. This is probably due to the environment close to the Sun. In other words, near the Sun, as in the vicinity of Mercury, the material has a large kinetic energy that balances its large gravitational potential. For this reason, solids such as ice and dry ice are decomposed into molecules.

In Mercury, metals such as sodium and low melting rocks play the role of adhesives, and the relatively large iron core in the center is covered with a thin rock mantle. There is a magnetic field in mercury because the liquid state exists at a comparatively low temperature where sulfur and iron mixing. The revolution cycle of Mercury is 88 days, and the rotation period is 59 days. The rotation period of Mercury had become short by the inclusion of the material.

4. 4 .2 Venus

Venus has a slightly smaller mass than the Earth, but atmospheric pressure is 90 times the Earth. There is a thick cloud of sulfuric acid (H_2SO_4) in the atmosphere of Venus, and its 96.5% is CO_2. So, it is considered that the primitive Venus had grown from the dust adhered to the solid state of CO_2 (dry ice) or the liquid state of sulfur (S).

The orbit of the present Venus is close to the circle, and only the Venus rotates very slowly in the opposite direction of the revolution. When the planet grows, it is normal for the revolution and rotation to be the same direction. The explanation that the rotation became the opposite direction is as follows.

The solar wind colliding with the atmospheric sphere of Venus at speed of 2 km/sec rotation with 350 to 700 km/sec. There is a thick cloud layer of sulfate air-sol with a micron-sized particle in the sky between 70km and 28 km. SO_2 absorbs water and it dissolves itself into the water. Therefore, the sulfate aerosol is stable as dissolved in water where it consists of hydrogen ions (H^+) and sulfate ions ($S_2O_4^-$). As described in Sec. 3.4, the solar wind rotates the atmosphere by the mechanism of gears, and "Super rotation" of the orbiting speed of 100m/sec is caused.

A cloud of micron-sized sulfuric acid particles reflects most of the sunlight, and the remaining 2% of the solar radiation reaches the ground. The atmosphere of the sulfate aerosol is heated by sunlight and solar wind. That is why the atmospheric temperature of Venus is high. It is orbiting Venus by the convection of the atmosphere without scattering into the universe. The particles that make up the cloud disappear below 31km, and the rotation of the gas is slowed down to the rotational speed of the Venus at a rate of 2m/sec. The temperature of Venus's surface is uniform at 464 ℃. H_2O, which was removed from the crust, evaporated and stayed in the clouds of sulfuric acid in the sky, and the remainder was released from the upper layer into the universe.

4. 5 How was the habitable planet formed?

The water in liquid state cannot stay in the cosmic space, because the hydrogen atom which connects the molecule of water in liquid state is replaced violently. If it is cold at the

space, it exists as ice, and the mass is composed. If it is ice in space, it exists, and it composes the mass.

The ice plays a role to accumulate dusts in the region away from the Sun. However, in places where gravity is strong, substances such as sodium and sulfur play a role of accumulating dusts. As mentioned in Sec. 4.3, Io of the Jupiter satellite is spewing sulfur and sodium. And in Europa, Ganymede and Callisto, the ice covers the surface of the planet, and there is ice and liquid water inside. In the solar system, the Mercury is melted Na and adheres to the dust, and the atmosphere of Venus is CO_2 and SO_2. There is plenty of water on the Earth, and there are traces of liquid water on Mars.

Formation of Earth or Mars is thought to have been born through the ice like Europa, Ganymede. As shown in Fig. 3.1, the planetary gravitational potential on Mars or also Earth is unusually low. If the primitive Martian or the primitive Earth had become the gas planet where the hydrogen was collected, the gas is lost by the shock wave generated by the nuclear fusion. Then, the volatile material of the terrestrial planet is degassed because a meteorite come from the core of Sun falls in large quantities.

On the Earth and Mars on the inside of the freezing line, the ice thaws and becomes liquid water. The total amount of water in the Earth was mainly maintained by cold traps, as stated in Section 3.3. The water of the liquid does not exist on the surface of today's Mars. The reason why the water was disappeared in the Mars is small size. The cooling of the core of Mars was early, the geomagnetic field became weak quickly, and the function to hold hydrogen in the sky became weak, and it was released into space.

Emitted amount of the gravitational energy on today's Mars was calculated to estimate the internal temperature of Mars. The Mars's Gravitational Energy (W_{Mars}) is determined under the assumption of constant density as expressed in Eq. (11). Here, Martian mass: $M_{Mars} = 6.42 \times 10^{23}$ kg, radius of Mars: $R_{Mars} = 3{,}397$ km, Then, $W_{Mars} = 4.86 \times 10^{30}$J. As the heat energy emitted by half of W_{Mars} , W_{Mars} is converted to the temperature rise (ΔT_{Mars}) using the value of sand ($c = 0.8$ [J/(g・K)]) (10).

$$\Delta T_{Mars} = 4{,}730 \ ℃ \qquad (10)$$

Therefore, the Mars was considerably hot, and the metal melted in the inside.

4.6 Earth and Mars

4.6.1 Primitive Earth and the formation of today's Earth

How was the sea of the Earth born? The primitive Earth is assumed that had grown by capturing a large amount of ice before the Sun began the nuclear reaction. When the fusion begins with the Sun, the shock wave attacks the Earth and the gas that covers the primitive Earth is blown away. Then the fragments of the Sun's core attacked the Earth where the solid core was exposed. A catastrophic degassing occurred in the Earth, i.e. the included ice melted, and the liquid water were evaporated. However, even if liquid water evaporates in the earth, it is condensed in the sky, it rains, and the sea was formed.

In the sky, H_2O is decomposed by ultraviolet rays. However, the Earth has geomagnetic field, and the hydrogen ion (H^+) of the solar wind reacts with the decomposed H_2O in the

magnetic flux and returns to the water, so the amount of water in the Earth is preserved. In addition, a stratospheric cloud is observed at the ozone hole region where hydrogen ions and ozone are combined. This phenomenon explains the ozone hole in the arctic and the south pole.

The number of protons (H^+) in the solar wind in the vicinity of Earth (1.5 x 10^8km away from the Sun) is 1 to 10, /cm^3. Therefore, the number of protons coming through the area of 1cm per second reaches 10^8 pieces. The solar wind of which speed is average 450km/sec collide with CO_2 and N_2, and it may generate the constituent elements of biomolecules such as -NH_2, -OOH, -C_nH_{2n-1} etc.

4.6.2 Primitive Mars and today's Martian formations

As mentioned in the previous section, it is assumed that the primitive Mars became a huge gas planet which collected hydrogen just before the Sun began the nuclear reaction. When the nuclear fusion of the Sun began, the primitive Mars changes drastically. The core of the Sun explodes by the nuclear reaction, and the shock wave swept out the gas of hydrogen from the Mars. When the mass is lost, the gravitational force weakens, so it falls into the cycle of losing mass. After that, the core of the Mars is exposed, and the debris of the Sun's core collided. The hydrogen that was trapped inside the core were released. The mass of Mars became smaller because it released hydrogen contained in the core. So, a large scale crustal deformation occurred in the Mars.

The current surface temperature of Mars is-125 to + 25 ℃. There are traces of liquid water in the past on Mars, but not now. It is not the main cause of the meteorite collision that the water is lost on Mars. The reason why the Mars was not able to keep water is that the power to detain the evaporated water is weak because the gravity is small, and the geomagnetic operates is lost early that the core became cools early.

The density of Mars is small (ρ_{Mars}=3.39) because it had once contained a large amount of hydrogen. Observation from the Gamma ray spectrometer conducted by NASA spacecraft Mars Odyssey have been confirmed to contain a large amount of hydrogen in the ground. The current Martian atmospheric components are CO_2 = 95.2%, N_2 = 2.7%, Ar = 1.6%, O_2= 0.13%, CO = 0.07%, H_2O = 0.03%.

Chap. 5 The Birth of the Sun

5. 1 Jupiter, Saturn, Uranus, and Neptune

The planet grows rapidly when it grows and can collect hydrogen molecules. Jupiter, Saturn, Uranus, and Neptune have an atmosphere mainly composed of hydrogen molecules. It also has a core containing liquid hydrogen layers and ice. Four giant planets have ring systems. The planetary ring system can be explained by the mechanism that gradually collapses itself by increasing kinetic energy in equilibrium with the increasing gravitational field of a comet falling on the giant planet. If it is decomposed by gravitational force, the debris has to move toward the center of gravity.

Since Jupiter and Saturn on the outer planets of the solar system had become a big planet, the Sun was not able to lose its primary atmosphere even when the nuclear reaction began. Conversely, a large gas planet was able to capture hydrogen emitted by the fusion of

the Sun. Uranus and Neptune were far away from the Sun, so they did not have the effect of capturing hydrogen emitted by the fusion of the sun.

It is thought that the structure of the Sun before the nuclear fusion begins is a structure like Jupiter. Jupiter has a strong magnetic field. However, there is no layer of ice or water. Jupiter has a thick layer of metal hydrogen, hydrogen in low-energy state metal becomes even lower energy. The hydrogen atom of H_2O in contact with the layer of metal hydrogen is taken as part of the metal hydrogen layer, because hydrogen atom is able to move around in the liquid. The free oxygen (O) of H_2O which is dehydrogenation is compound with the metal. In addition, hydrogen ions (H^+) penetrates into the core to produce metal and hydrogen compounds. An inner structure of a giant gas planet is shown in Fig.10.

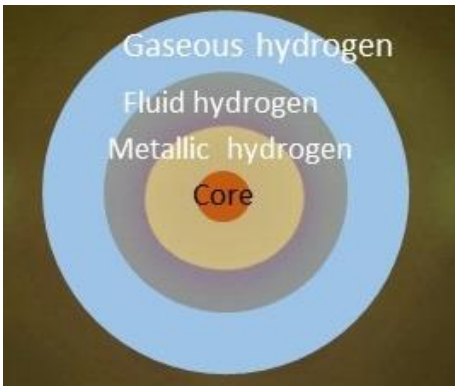

Fig. 10. An inner structure of a giant gas planet

5. 2 Nuclear fusion in the Sun

In the standard model of the solar system formation, the primitive sun before the start of the nuclear fusion was formed through the state of the T-Tauri star. [4]. Because the ion group is fast-orbiting in the state of the T-Tauri Star, a vertical magnetic field is generated in the center of the circular motion. This phenomenon occurs on a celestial body composed of hydrogen ions. On the other hand, when the Sun collects the dust and it comes to collect hydrogen gas after forming the core, there is no such rotation movement of large-scale ions generated in the state of the T Tauri Star.

There is a layer of hydrogen in the super giant gas planet with a core. In the primitive Sun there is a core, and its core is composed of elements that does not react by nuclear fusion. However, nuclear fusion is able to happen even if there is a core when hydrogen is abundant. When the core is given enormous energy by fusion of hydrogen, the core exploded. The debris were radially emitted from the Sun.

Most of the substances released in the explosion by the nuclear fusion were brought back to the Sun by gravity. There were also substances that reach the Edgeworth-Kuiper belt. If the debris on the move passes near the planet, it will fall to the planet. The fusion reaction of hydrogen can be continued without pausing, because the fusion by the explosion and the accumulation by the gravity act simultaneously. Even if a nuclear fusion reaction is paused

due to an explosion of expansion, hydrogen is accumulated again by the gravity of the Sun, which can cause a fusion reaction again.

5. 3 Many meteorites were made by the explosion of the Sun's core

The material of the core of the Sun is exposed to radiation by nuclear fusion and released into space. The fragment of the core in the primitive Sun became a meteorite. The fact that any radioactive element contained in the meteorite was born 4.6 billion years ago shows that the primitive sun had a core formed from dust and was released by an explosion caused by the fusion reaction.

Majority of the substance scattered by the first nuclear fusion explosion in the primitive Sun returned to the Sun by the gravity of the Sun. However, a part of the substance emitted from the Sun was captured by the planets on the way back to the Sun. There are many craters on the surface of the planets. Many of them are fragments emitted in the first solar fusion explosion 4.6 billion years ago.

There are many celestial bodies with irregular shapes in the Jupiter's gravitational area, many of which revolve in the direction opposite to the rotation of Jupiter. These retrograde satellites were captured from the opposite direction to the rotation of Jupiter.

Chap. 6 Formation of the asteroid belt.

6. 1 How was the asteroid belt formed?

The asteroid belt is located between Mars and Jupiter. There are many meteorites and asteroids in the asteroid belt, but the whole mass of them is estimated with 2.1×10^{21} kg, which is (1/35) of the Earth's Moon. This area is now a blank area of the planet.

There is no mechanism that many meteorites conveniently stop in the asteroid belt. One of the candidate theory is that the fragments of a huge planet (A) were scattered by a deuterium nuclear reaction. It is assumed that the planet (A) in the central Ceres position of the asteroid belt collected hydrogen gas and it became a super-huge planet compared with Jupiter.

The current Jupiter has a layer of metal hydrogen inside, and it has a strong magnetic field. The magnetic field captures hydrogen ions in the solar-wind, and the ions collide with the molecules of the upper atmosphere around the magnetic pole, losing speed and being incorporated into Jupiter. Planet (A) also have a layer of hot metal hydrogen inside like Jupiter, and it has a strong magnetic field. When the Sun began fusion, the Super Giant Planet (A) can capture debris and ions from the core of the Sun.

Assuming that there was a planet (A) of 13 times the Mass of Jupiter (i.e. $m_{(A)} = 2.5 \times 10^{28}$kg) in the position of Ceres in the asteroid belt ($L=4.28 \times 10^{11}$m). The gravitational force of the planet (A) is equal to the Sun's gravitation toward the Sun at the point L $_{(\text{Gravitational sphere on X})} = 0.71 \times 10^{11}$m. The distance is less than half the distance to Jupiter. The position of Ceres in the asteroid belt is more densely than that of Jupiter. It is a possible growth of a large planet in the past.

6.2 The explosion of a planet that failed to become the second Sun

There is the report that more than 13 times the mass of Jupiter can temporarily perform deuterium nuclear fusion [5]. The planet (A) accelerates the speed of growth by high hydrogen density than Jupiter. In the interior of the hydrogen layer, the ratio of deuterium is higher in the position close to the center of gravity by material differentiation. There is a possibility that deuterium at the high temperature with high pressure causes a nuclear reaction. When the nuclear fusion of deuterium occurs at the planet (A), the core explodes owing to the nuclear reaction, and the debris become meteorites and asteroids.

Hydrogen gas scattered by the explosion due to nuclear fusion in planet (A) is swept away by the solar wind, and it does not return to the original planet (A). The planet (A) loses most of its mass. The debris were captured by the Sun and planets such as Jupiter. The explosion by the deuterium nuclear fusion in the planet (A) ends only once. Many fragments of the exploded Planet (A) fell on the other planets. It explains the cause of the late meteorite heavy bombing that the planet received 3.8 billion years ago. Some of the core debris emitted by the explosion collided with each other and remained in the current asteroid belt.

6. 3 Possibility of the existence of giant planet (A) in asteroid belt

The planet (A) that had caused deuterium fusion in the asteroid belt was considered as follows.

There did not exist frost line before the Sun had begun the nuclear fusion (4.6 billion years ago). The primitive Earth and the primitive Mars had grown up before the sun starts the nuclear fusion. Suppose that the mass of the primitive Earth was the same as Uranus, and the mass of Mars was the same as Saturn. However, suppose the structure of core in the primitive Earth was nearly same as the core of the Saturn, and the core of the primitive Mars was nearly same as the core of Jupiter, where H_2O is decomposed by metal hydrogen. Suppose that there existed a planet (A) with five times the mass of Jupiter in the position of Ceres in the asteroid belt just before the Sun begins the nuclear reaction.

4.6 billion years ago, when the Sun began the nuclear fusion, the solar wind struck the primitive Martian and the primitive Earth and heated by radiant heat. So, the hydrogen that is majority of the mass of primitive Martian and the primitive Earth are lost. However, since the planet (A) has a much larger mass and a strong magnetic field than Jupiter, it captures the hydrogen ions of solar wind, and it also captures the hydrogen freed from primitive Mars and the primitive Earth. Thus, planets (A) continue to grow more and more by capturing a wide range of hydrogen. At last, the planet (A) reached 13 times the mass of Jupiter, And the planet (A) caused a deuterium nuclear fusion 3.8 billion years ago.

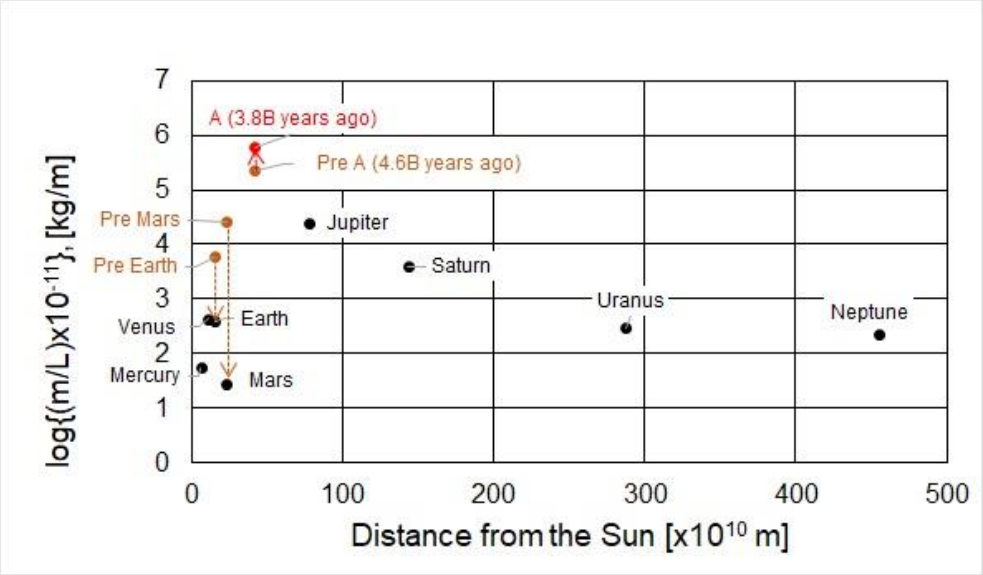

Fig. 11. Planets (A) and primitive Mars and the primitive Earth and current planets

Fig. 11. shows the planets (A) that is assumed to have caused deuterium fusion in the asteroid belt, and primitive Mars, primitive Earth, and today's planet. Here, the distance of the orbit of the virtual primitive planet was unchanged, and the primitive Mars was the same mass as Saturn, and the primitive Earth was the same mass as Uranus, and the planet (A) was in the position of Ceres.

Chap 7　PostScript。

The movement of the planets is described by the long-range force described by Newton Mechanics. However, the planets consist of short-range forces such as intermolecular bonding or chemical bonding. The substance is not formed by the gravitation, but it is formed by the Coulomb force. So, the mechanism of planet's formation needs the science of the substance.

In the past, the theory of the formation of the solar system has been discussed mainly from the viewpoint of mechanics. Hayashi et al described three unresolved issues at the beginning of the thesis, "Formation of the Solar system" in 1985. (1) The formation of the primitive Solar system disk, (2) The disappearance of the gas component of the primitive solar system, (3) The origin of the meteorite. Up to now, the planetology has been tried to explain by the movement of the celestial body and the collision of the meteorite. The issues pointed out are not fully resolved yet.

The author expects this website to contribute to the progress of the planet.

This website was produced by Shinji Karasawa.

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