# A coupling of the origin of asteroid belt, planetary ring, and comet

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**Abstract**

Various scenarios had been previously presented to account for the origins of asteroid belt, planetary ring, and comet, but none of them is competent. Asteroid belt that is located between the orbits of Mars and Jupiter is flat, circular, and parallel to the ecliptic, similarly, planetary ring that is located between the orbits of planet and satellite is also flat, circular, and approximately parallel to its planetary equatorial plane. This similarity implies that asteroid belt and planetary ring are likely to derive from a common physical process. Here we propose that it had occurred 5 significant collisional events of the two bodies of binary planetary (satellite) system in the history of the solar system. In these events, the two bodies of a binary planetary (satellite) system due to orbital shrinkage generated a smashing collision to shatter themselves into fragments. But due to the effect of hierarchical two-body gravitation (non-Newton's gravitation), the barycenter of initial binary planetary (satellite) system was survived in the collision, and all fragments were still organized in a series of hierarchical two-body systems. The barycenter continued to drag these fragments by means of a series of subordinate barycenters to orbit, by which nearby fragments (near to the collisional source) were gradually confined to fall on a circular belt (ring), while distant fragments are dragged to wander the solar system back and forth because of the motions of asteroid belt around the Sun, ring around planet, and planet around the Sun, this gives rise to bombardment on the objects they encounter in travel and leave craters on the surfaces, advent of comets when close enough to the Sun, and appearance of meteors when close enough to the Earth, some of the fragments occasionally landed on the surfaces of planets and satellites and become meteorites.

## 1 Introduction

Long-term ground and spacecraft-based observations confirm that there are an asteroid belt, four giant planetary ring systems, and countless comets in the solar system. A great number of scenarios had been proposed to account for their origin. The origin theories of planetary ring are plentiful. Especially for Saturn's ring, they include tidal disruption of a small moon (Roche et al. 1847), unaccreted remnants from the satellite-formation era (Pollack et al. 1976), collisional disruption of a small moon (Charnoz et al. 2009), and tidal disruption of a comet (Dones 1991). Canup recently listed the disabilities of these scenarios and developed a model to propose that planetary tidal forces strip ice material from a Titan-sized satellite to form a pure ice ring (Canup 2010). The origin theory of asteroid belt believes that asteroids are fragments of a destroyed planet (Herschel 1807), the currently accepted scenario believes asteroids to be rocks that in primordial solar nebula never accumulate into a genuine planet (Petit et al.2001). The origin of comet includes Oort cloud hypothesis that proposes a cloud of comets at the outer reaches of the solar system (Oort 1950) and Kuiper belt hypothesis that proposes a disc shaped region of space outside the orbit of Neptune to act as a source for short-period comets (Kuiper 1951).

If Saturn's rings are evolved from a previous pure ice ring as Canup proposed, it is necessary for them to keep identical material, but various spectral characteristics in the rings suggest that a natural contamination from interstellar matter is unlikely to yield this crossbedded distribution of different spectral rings. To support the production of icy moons, Canup employed another research by Charnoz et al (2010) that ring material spreading beyond the Roche limit accretes to form icy moons. However, the Roche limit itself is ambiguous because a lot of satellites whose distances from their father planets (Jupiter, Uranus, and Neptune, for example) are interior to the Roche limit are still survived, and some of these satellites are also embedded in the rings (Burns et al. 2001). Saturn's rings are broad and are divided by many divisions that look like natural boundaries, the particles in each ring appear to orderly orbit and do not ride over these boundaries. It is very difficult for Canup's model to account for these apparent features. To some extent, the majority of these origin theories are based on nebula hypothesis that was first introduced by Emanuel Swedenborg, but this hypothesis itself is being seriously surrounded by a series of problems (Woolfson 1993; Taishi et al. 1994; Andrew et al. 2002; Klahr 2003; Inaha et al. 2003; Wurchterl 2004), this makes related theories uncertain. Moreover, high resolution photographs of well-regulated movement of asteroid family (group) (Hirayama 1918), integrity of Saturn's narrow F ring (Murray et al. 2008), unique spokes in Saturn's B ring (Mcghee et al. 2005), and twisted arc in Neptune's Adams ring (Hammel 2006) appear to indicate that they do not obey the constraint of Newton's gravity. Comets are generally observed to run very eccentric trajectories that cross the orbits of many planets, this in the Newton's gravitational field corresponds to a variation of orbital energy, but we in practice cannot find a mechanism to maintain this variation. On the other hand, the orbital features of short period comets do not approve an origination from Oort cloud, and the mechanism by which the comets are supplied from Kuiper belt to planet-crossing orbits is still unclear (Duncan et al. 1988). In the last 20 years, though a lot of Trans-Neptunian objects had been found from the proposed Kuiper belt, there is no evidence to support that these Trans-Neptunian objects are really linked to comets. In conclusion, the established conceptions of the origins of asteroid belt, planetary ring, and comet are highly incomplete.

Both asteroid belt and planetary ring are flat, circular, and parallel to respectively the ecliptic and planetary equatorial plane; they are embedded respectively in planetary orbits and satellites' orbits; In addition to this, asteroids consist primarily of carbonaceous, silicate, and metallic materials, which is similar to the composition of Earth and Mars. Relatively, planetary ring consists primarily of ice and dust, which is similar to the composition of icy satellites. On large scale, the Sun has a number of planets, each giant planet (Jupiter, Saturn, Uranus, and Neptune) also has a number of satellites. This similarity suggests that the formation of both asteroid belt and planetary ring should share a common physics. On the other hand, the Saturnian F ring and the Uranian ε ring are both narrow, and are generally shepherded by a pair of moons (Esposito 2002), the outer rings of Uranus are similar to the outer G and E rings of Saturn (Pater et al. 2006), narrow ringlets in the Saturnian rings also resemble the narrow rings of Uranus, the Neptunian ring system is quite similar to that of Uranus (Esposito 2002; Burns et al. 2001). This similarity also suggests that planetary rings are likely to be ruled by a common physics. So far, a great number of observations have confirmed that the orbital period of star and planet is generally decreasing. The two stars in binary star system RX J0806.3+1527 are found to be steadily decreasing orbital period at a rate of 1.2 milliseconds per year. The orbital period of binary star Cen X-3 and SMC X-1 is decreasing at a rate of respectively Porb/Porb = 1.8 x $10^{-6}$ $yr^{-1}$ and 3.36x $10^{-6}$ $yr^{-1}$(Kelley et al. 1983; Levine et al. 1993). PSR B1913+16 have a rate of decreasing orbital period of 76.5 microseconds per year, and the rate of decrease of semimajor axis is 3.5 meters per year (Weisberg and Taylor 2004). Recently many hot giant planets are detected to be revolving around stars with very short-period orbits. For instance, the members of "51 Peg" planets, 51 Peg itself, Tau Bootis, 55 Cancri, and Upsilon Andromedae, have orbital periods of just 4.2, 3.3, 14.7, and 4.6 days, respectively, and their orbits are very small, with radii less than 0.11 AU. A steamy planet is recently found to be orbiting a faint star with a distance of just 1.3 million miles (Terquem and Papaloizou 2007). The short-period orbit suggests that these extrasolar planets could have been giant icy planets formed far enough from their stars that ices could condense, and then have migrated towards their stars (Raymond et al. 2008; Charbonneau et al. 2009; Brunini and Cionco 2005). The moon of Mars, Phobos has a decreasing orbit at a rate of 1.8 cm/yr (Clark 2010). A decreasing orbital period means an increase in orbital velocity and a decrease in orbital radius. Contrary to this, there is very less evidence to show that the orbital period of celestial object is increasing. The effect of gravitation is drag objects to approach each other, each celestial object is found to run a curved orbit around a center body in space, this orbit is evidently rooted from a gravitational control of the center body. As a result, a decreasing orbit may be general for celestial object. Recently a model is introduced to show that all objects in the universe are orderly organized in a series of hierarchical two-body systems to orbit and that under the effect of gravitation the two bodies of a two-body system will eventually take place a catastrophic collision due to their orbital shrinkages (Yang 2011). The recent discovery of a population of comets in the main asteroid belt (Hsieh et al. 2006) indicates that comets may derive from various origins. The various craters on the surfaces of planets and satellites suggest it had taken place some significant bombardments in the history of the solar system. Giant planetary rings are generally thought to be derived from the remnants of past large bodies around the planets (Roche et al. 1847; Dones 1991; Burns et al. 2001; Esposito 2002; Charnoz et al. 2009). In this present paper, we totally formulate 5 physical collisional scenarios of the two bodies of binary planetary (satellite) system to clear up all problems above at the same time and further account for some observations.

**2 Modelling**

According to the research by Yang (2011) that under the frame of a hierarchical two-body gravitation all bodies are indirectly fixed together with gravitation (excluding the two bodies of a two-body system that are directly fixed together with gravitation), this indicates that if a moving body is shattered into fragments, these fragments are still constrained by gravitation in a series of hierarchical two-body systems, and the barycenter of the initial body can be survived in the disruption and may thus bring these systems of fragments to continue to orbit. Based on this physics, a conceptual model is developed to demonstrate the formation of a belt (ring system) (Fig.1): A two-body system is orbiting a center body. With the passage of time, the two bodies of the two-body system due to orbital shrinkage occurs a smashing collision to eject fragments. But under the effect of hierarchical two-body gravitation, these fragments are still constrained in a series of hierarchical two-body systems in space. The barycenter of the initial two-body system is survived in the collision, it thus continues to drag these systems of fragments to orbit, by which nearby fragments (with respect to the collisional source) are gradually confined into a circular orbit, while distant fragments, because of the motions of asteroid belt around the Sun, ring around planet, and planet around the Sun, run across the solar system back and forth, this gives rise to great bombardment on the objects they encounter, advent of comets when close enough to the Sun, and appearance of meteors when close enough to the Earth, some of the fragments occasionally land on the surfaces of planets and satellites to become meteorites. As shown in Figure 1(D), the barycenter of the initial two-body system (point *O*) is dragging two components (point *a* and 1) to orbit, at the same time point *a* is also dragging two components (point *b* and *d*) to orbit, point *b* is also dragging two components (point *c* and one fragment) to orbit, etc. Because of this successive hierarchical drag from point *O* to related points, each fragment can always obtain some movement that is parallel to the movement of point *O*. For instance, we assumed that the angle between line *Oa* and the movement of the barycenter (point *O*) is $\alpha$, the angle between line *ad* and line *Oa* is $\beta$, the angle between line *de* and line *ad* is $\gamma$, the angle between fragment M and line *de* is $\delta$, thus the movement of fragment M that is parallel to the movement of point *O* fits to a relation of $\cos\alpha \times \cos\beta \times \cos\gamma \times \cos\delta$. Also because point 1 is also dragging a series of hierarchical two-body systems of fragments, each other fragment undergoes the same dynamical process as fragment M, thus all fragments under the effect of this successive hierarchical drag trend to fall on a circular belt. But because of orbital shrinkage, the barycenter of the initial two-body system is increasingly approaching the center body, this further leads the fragments to move towards the center body, the belt (ring) slowly becomes flat.

It is necessary to specify parameters for the collision of binary planetary system. The center body is replaced with the Sun, the two-body system is replaced with a binary planetary system whose physical element and chemical composition are similar to that of the Earth-Moon system (especially it is rich in the composition of carbonaceous, silicate, and metallic material), and it is located at the position of asteroid belt. The smashing collision of the two bodies of binary planetary system occurred at the time of Late Heavy Bombardment. After the collision, all fragments formed are dragged to orbit, by which nearby fragments are gradually confined to fall on a circular belt (the asteroid belt). Water may be immediately froze to surround the fragments, atmosphere is either escaped or sealed in the fragments. We also specify parameters for the collision of binary satellite system. The center body is replaced with giant planet (Jupiter, Saturn, Uranus, and Neptune) respectively, the composition of binary satellite system is similar to that of icy satellites of giant planet, and it is located at the position of present main ring. The smashing collisions of the two bodies of four binary satellite systems occurred later than the time of Late Heavy Bombardment. After the collisions, all fragments are dragged to orbit, by which nearby fragments are gradually confined to fall on a circular belt. The fragments due to mutual collision are further shattered into very small fragments (particles with a size of meter or micron, for instance) that are organized in a series of subordinate hierarchical two-body systems, thereby forming planetary rings. The parameters for the collisional events are specified (Tab.1), while numerical simulation is left to be done in the future work (Manuscript in preparation by Yang et al).

| No. | Center body | Two-body system | Distance from center body | Collisional time | Mass (kg) | Composition (material) |
|---|---|---|---|---|---|---|
| 1 | Sun | planet + satellite | 2.67 AU | earlier than 3.9 ba | $5.97\times10^{24}$ (mass of Earth ) | iron + oxygen + silicate + magnesium + sulfur |
| 2 | Jupiter | satllite + satellite | 130, 000 km | later than 3.8 ba | $48{,}000\times10^{18}$ (mass of Europa) | silicate + iron + ice |
| 3 | Saturn | satllite + satellite | 100, 000 km | later than 3.8 ba | $617\times10^{18}$(mass of Tethys) | ice + silicate + oxygen |
| 4 | Uranus | satllite + satellite | 70, 000 km | later than 0.6 ba | $66\times10^{18}$(mass of Miranda) | ice +silicate + organic compound |
| 5 | Neptune | satllite + satellite | 90, 000 km | later than 0.6 ba | $2{,}141\times10^{18}$(10 % the mass of Triton) | ice + silicate + iron + organic compound |

**Table 1: Parameters of the collisional events of the two bodies of binary planetary (satellite) systems**. Note the distance from center body is specified according to the distance of main ring from the planet, collisional time is determined according to observed events like late heavy bombardment and established literature.

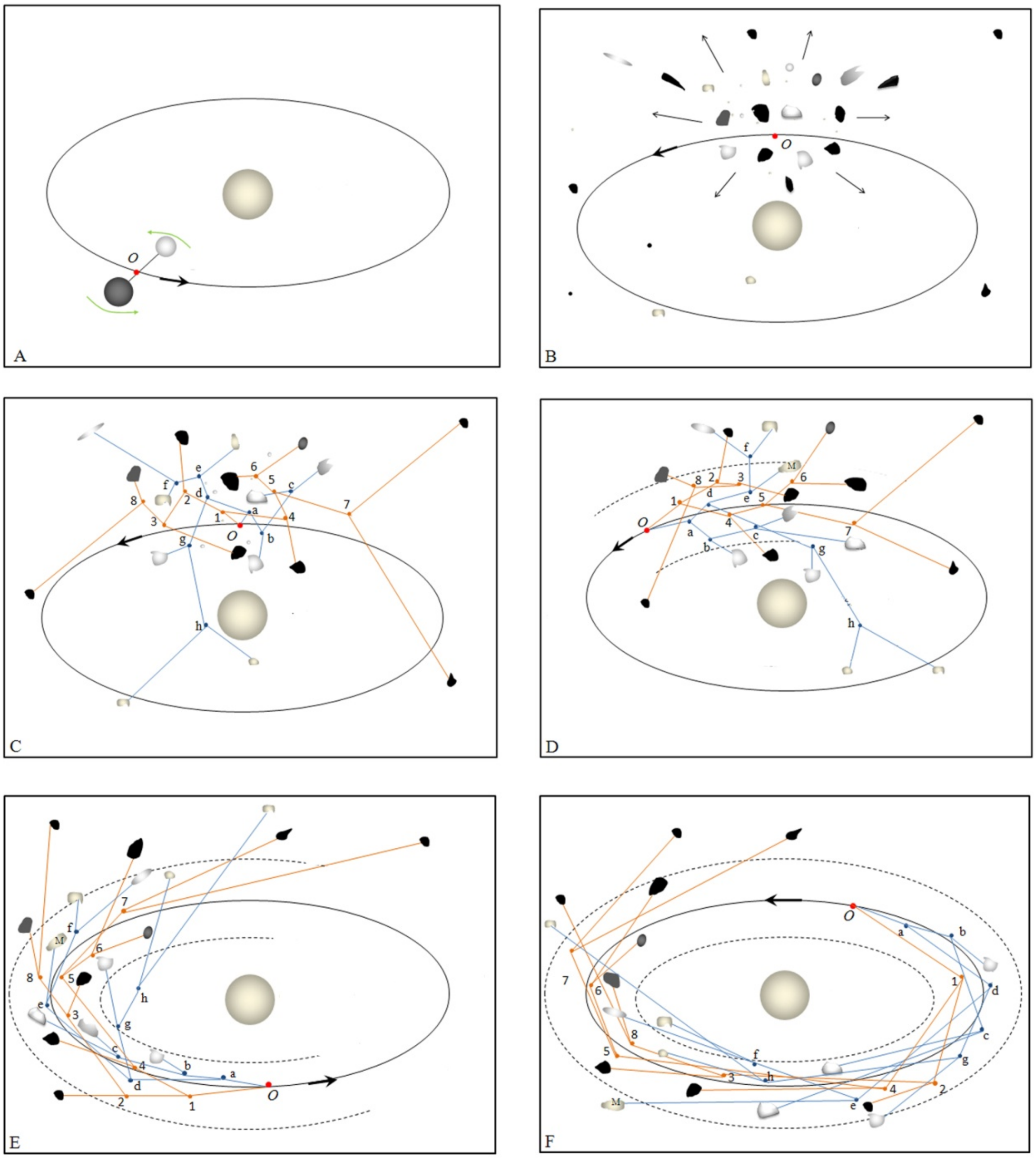


**Figure 1: Simulation of the formation of a belt (ring system) based on hierarchical two-body gravitation.** From A, B, C, D, E to F, it demonstrates the formation of a belt (ring system). Point *O* (marked with red dot) denotes the barycenter of the system. Blue (orange) dots (marked with letter *a*, *b*, *c*, etc., and number 1, 2, 3, etc.) represent the barycenters of related two-body systems in the associations. Blue (orange) line represents gravitation. Large black arrow represents the movement of the integral association. Dashed circle denotes the boundary of the belt (ring system).

## 3 Fits to observation

### 3.1 Asteroid belt

As shown in Figure 2, all fragments are being organized in a series of hierarchical two-body systems to orbit. As every fragment is being dragged by a barycenter to orbit, and the barycenter is being dragged by the barycenter of a superior two-body system to orbit, this determines the fragments in a common association may share identical orbital elements such as eccentricity, period, and inclination. Also because the fragments in a common association are derived from the disruption of a parent body, this determines them to be with identical (or similar) chemical composition. Also because every association of fragments is an independent system, this determines that it may form space (gap) between any two adjacent associations. Observation shows many asteroids in the asteroid belt belong to some independent families or groups (associations), in which these asteroids share nearly identical orbital elements (Andrew et al. 2002; Anne 2004). Literature shows that approximately one-third of the asteroids in the main belt are members of an asteroid family. Three bands of dust within the main belt have been found to share similar orbital inclinations as the Eos, Koronis, and Themis asteroid families (Love et al. 1992). The accepted conception strengthened by theoretical and observational results believes that the members of a family are the fragments produced by the disruption of a common parent body resulting from a catastrophic collision (Zappala et al. 2002). Many Kirkwood gaps have been found in the asteroid belt. Although the current asteroid belt is believed to contain only a small fraction of the mass of the primordial belt, numerical simulations suggest that the original asteroid belt may have contained mass equivalent to the Earth (Petit et al. 2001). It can be inferred from Figure 1(F) that under the frame of hierarchical two-body association, each fragment will have one companion that may be one body or a series of subordinate hierarchical two-body associations of smaller fragments. Johnston's Archive of "Asteroids with Satellites" shows, as of October 2009, 67 asteroids that are in the main asteroid belt had been discovered to have companions (moons). The current belt is composed primarily of three categories of asteroids: C-type or carbonaceous asteroids, S-type or silicate asteroids, and M-type or metallic asteroids, these features are fully consistent with the chemical composition of the proposed binary planetary system.

The motions of asteroid families are unlikely to be explained by conventional conception. For instance, for flora family its members are mutually discrete in space, this means some of the members are located in the far side of the family (far from the Sun) while some are located in the near side (near to the Sun). Assumed we accept Newton's gravity and Keperian law, the members in the near side should have higher velocities than those in the far side due to inverse square law. The difference of orbital velocity naturally leads all members of the family to spread around and eventually terminates the family. But flora family is nearly stable during a timescale of $10^7$-$10^8$ years (Nesvorny et al. 2002), this does not match the expectation from Newton's gravity and Keplerian law. In addition to this, all asteroid families look like running circular trajectories around the Sun, this means that, to maintain the integrity of a family, every member in the rear of the family must follow the members in the front to move. If we empoy Newton's gravity to work, it naturally requires the front members to be massive enough to have ability to drag the rear members, but observation does not agreed to this expectation. The largest member 8 Flora holds about 80% of the total flora family mass, but it is not distributed in the front of the family.

In contrast, we ascribe the members of an asteroid family to be small fragments that are initially derived from the disruption of a common parent fragment, and after the disruption, these small fragments are still organized in a series of hierarchical two-body systems. As the barycenter of the parent fragment is survived in the disruption, it continues to drag the associations (a series of hierarchical two-body systems) of these small fragments to orbit, this determines the integrity of asteroid family and its unimportance of mass distribution in it.

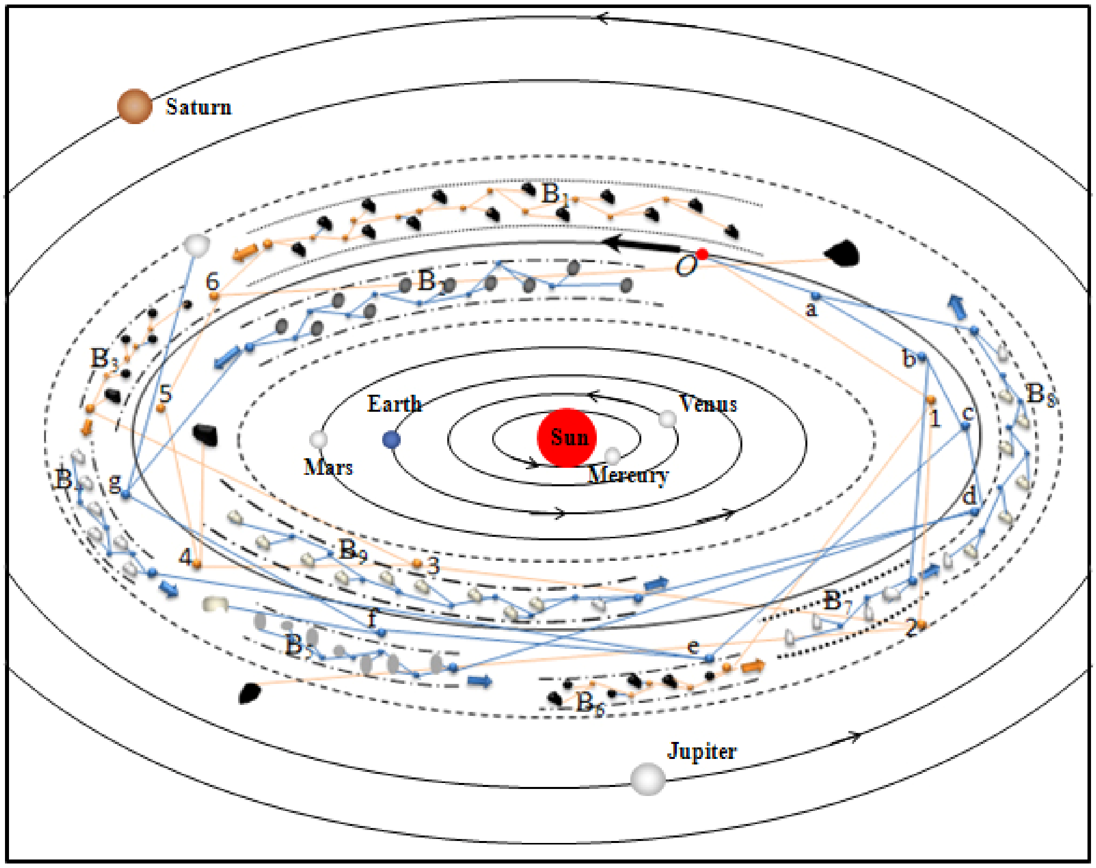


**Figure 2: A hierarchical two-body association of fragments (asteroid) for the asteroid belt.** The span of two dashed circles is the region occupied by the asteroid belt. Point *O* (marked with red dot) denotes the barycenter of asteroid belt. $B_1$, $B_2$, $B_3$ etc. denote asteroid families that consist of a series of subordinate hierarchical two-body systems of smaller fragments (asteroids). Blue (orange) dots (marked with letter *a*, *b*, *c*, etc., and number 1, 2, 3, etc.) represent the barycenters of related superior two-body systems that control these families through gravitation. Blue (orange) line represents gravitation in. Large black arrow represents the mean motion of the asteroid belt, while short blue (orange) arrow represents mean motion of each family.

3.2 Planetary ring

It can be inferred from Figure 1(F) that, with the passage of time, the fragments continue to disrupt into smaller fragments (particles, for instance), every hierarchical two-body association of smaller fragments eventually encircles the center body to form a belt (ring), all associations of fragments may at the same time form many rings that look like divided by gaps. Observation shows that planetary rings are parallel mutually, and that there are many gaps between them. As some of fragments are further shattered into small fragments (particles) to form the rings, while the remaining is survived, this determines that the survived fragments will be embedded to accompany the rings to orbit together, this gives rise to the structure of moonlet and clump in the rings (Esposito et al. 2008). This kind of fragment is currently named after irregular satellite. For example, Adrastea and Metis are embedded in the Jupiter's main ring, while Amalthea is embedded in the Gossamer ring. Satellites Mimas, Enceladus, and Tethys are respectively embedded in the Saturn's E ring. As the two bodies of a binary satellite system are composed of different materials, this means that different fragments from the two bodies may hold different materials, as a result, when these fragments are further shattered into smaller fragments to form rings, different spectral characteristic's rings are determined. Figure 3 demonstrates Saturn's ring system, in which all particles (fragments) are being organized in a series of hierarchical two-body systems to orbit, and thereby maintains the orderliness of integral ring system. It may see that the shepherds and the particles in the rings are co-rotating around the planet.

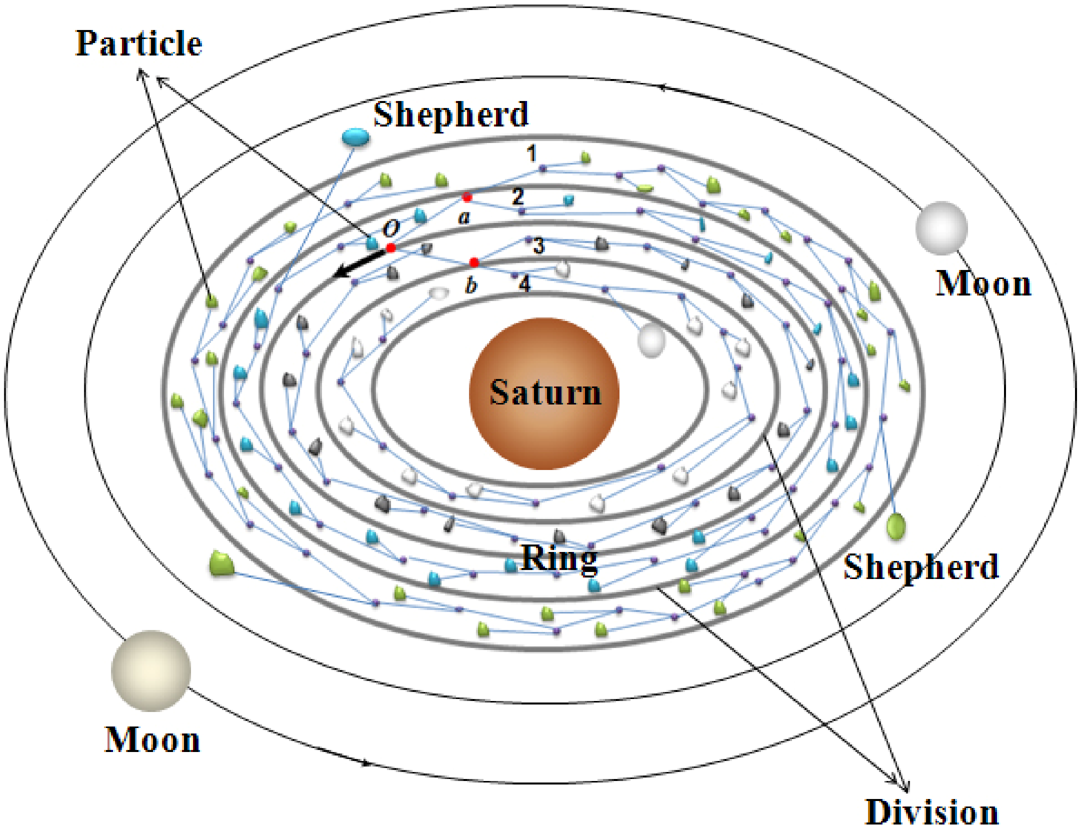


**Figure 3: A hierarchical two-body association of fragments (particles) for Saturn's ring system.** Point *O* is the barycenter of ring system that drags point *a* and *b* to orbit the planet, at the same time point *a* drags point 1 and 2 to orbit, point *b* drags point 3 and 4 to orbit, while point 1, 2, 3, and 4 respectively drags a series of hierarchical two-body associations of fragments to orbit, by which several rings are formed around the planet. Red (brown) dot denotes the barycenter of related two-body system, blue line denotes gravitation. Large black arrow denotes the mean motion of ring system. Thicken circle denotes boundary (gap) between rings.

The propeller-shaped and ringlet structures in Saturn's ring and the twisted Fraternity arc in Neptune's ring may be explained as follows (Fig.4): because the two bodies of a two-body system are derived from the disruption of a common parent body, after the disruption they may run parabolic trajectories, as the two-body system is always being dragged by a superior two-body system to orbit, the two bodies under the interaction of parabolic trajectory and drag can display some kind of rotation in space, this makes them look like a two-armed propeller if they are embedded in the particles of the ring. If the two bodies are further shattered to form two subordinate associations of particles, the two associations can also perform some kind of rotation, which makes them enlace with each other (like a twisted strand or rope). If only one body is shattered to form an association of particles, while another is survived, the survived body will accompany the association to orbit together, which makes it look like a shepherd. Because of the rotation, each association of particles itself looks like a long ringlet.

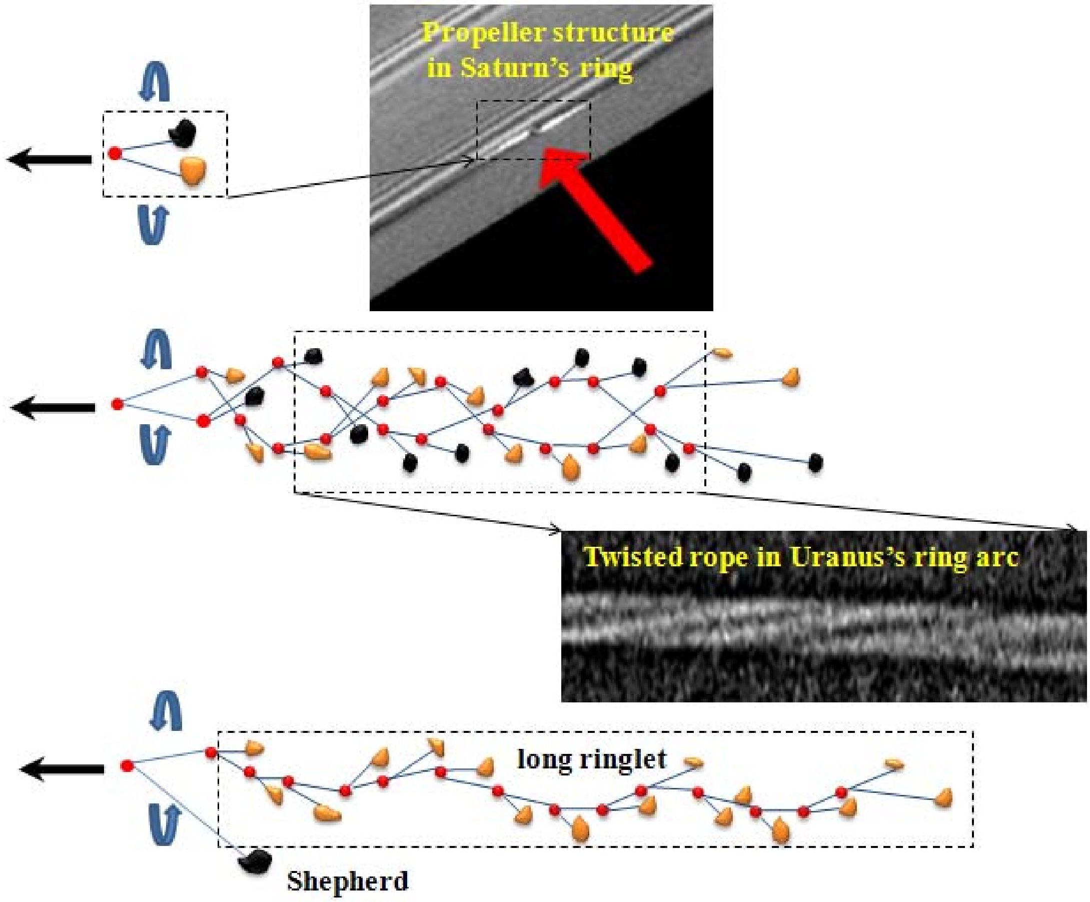


**Figure 4: Model of the formation of unusual structures.** Top shows a moving rotational two-body system that fits to yield a propeller structure in Saturn's ring; Middle does a moving hierarchical two-body association of particles that fits to yield a twisted strand (rope) in Uranus's Fraternity arc. Also note that in the image there are at least three hierarchical two-body associations of particles to build up this twisted rope; Bottom does a moving two-body system that consists of a shepherd (satellite) and a long ringlet (a subordinate hierarchical two-body association of particles). Red dot denotes the barycenter of related two-body system. Large black arrow denotes the motion of an integral system (images by courtesy of NASA).

Uranus possess more than 13 rings that are composed of bodies of 0.2–20 m in diameter, the majority of them are only a few kilometers wide, this requires some mechanism to hold the bodies together (Esposito 2002). The most widely model proposed by Goldreich and Tremaine (1979) is that a series of small satellites exert gravitational torques to confine the rings in radius. To be effective, the masses of the satellites should exceed the mass of the ring by at least a factor of two to three (Porco et al. 1987). But so far only the ε ring is observed to have two small companions - Cordelia and Ophelia, no satellite larger than 10 km in diameter is known in the vicinity of other rings (Smith et al. 1986), this in turn indicates that the narrow rings are not confined by satellites but by other mechanism. Also note that the rings are not solid objects but composed of countless particles with sizes from dust to small moons, these particles in the rings appear to be arranged to orderly encircle the planet, which does not reflect any perturbation from external object. Images show that Saturn's F ring has two additional strands and a background dust population that extends across ≥ 700 km in radius (Porco et al. 2004 and 2005; Murray et al. 1997), the shepherd satellite-Prometheus penetrates the inner dust region each orbital period of 14.7h, Murray et al (2005) explained the streamer-channels as a consequence of Prometheus dragging out materials from the ring. Please note three features: 1) the relative precession rate between Prometheus and F ring is $0.057^{o}$ $d^{-1}$ (Murray et al. 2005), which indicates F ring and Prometheus are synchronously moving forward; 2) the channels relative to Prometheus (see image PIA08397) are moving backward; and 3) there are a series of channels along F ring (reference to PIA11589). Prometheus in its orbit may periodically penetrate the ring region, but it is impossible for it to drag out materials from the ring to maintain these separated longitudinal channels at the same time, because Newton's gravitation is universal and its magnitude is determined by inverse square law. Here I would like to employ this hierarchical two-body model to explain the formation of longitudinal channel. As all particles in F ring and the background dust region are organized in a series of hierarchical two-body systems, when Prometheus approaches and penetrates the ring region, it at first collides with the particles in the near side and pushes some of them away, the departing particles by means of the barycenters of a series of hierarchical two-body systems further drag the particles in the rear to move. But as the rear particles are being dragged by the front particles to orbit, the departing particles will eventually be dragged to return to their initial positions, this gives rise to an impressive effect: the particles are successively pushed away from their positions, but subsequently they are dragged to return, a wave-like appearance (look like a channel) is therefore formed to move backward along the ring. Also because the departing particles further activate local particles, a bright feature is formed for the channel. When Prometheus next time penetrates the ring region and collides with particles, another wave-like appearance (channel) is formed. Periodical collision between Prometheus and the ring region eventually yields a series of separated longitudinal channels in the ring. Figure 5 models a non-timescale collision between Prometheus and the F ring to create a channel. Prometheus has a potato-like shape (about 145 by 85 by 62 $km^3$), movie sequence from Cassini images (PIA08397) shows that as Prometheus approaches the F ring, it often performs some kind of rotation in space. This determines that, when Prometheus periodically collides with the elliptical F ring, the difference in collisional scale is likely to result in different size channel. Figure 6 is a reproduction of PIA08397 that records how Prometheus interacts with F ring. It may see that when Prometheus approaches the ring (from **a** to **b** where it is the closest approach), there is no any clue of universal gravitation. In other words, if there were gravitation between Prometheus and ring, Prometheus's approach will drag the ring to gradually become convex, but before the collision the ring always keeps original shape. It is also clear that after the collision the F ring becomes concave (see $\mathbf{c_1}$ and $\mathbf{d_1}$).

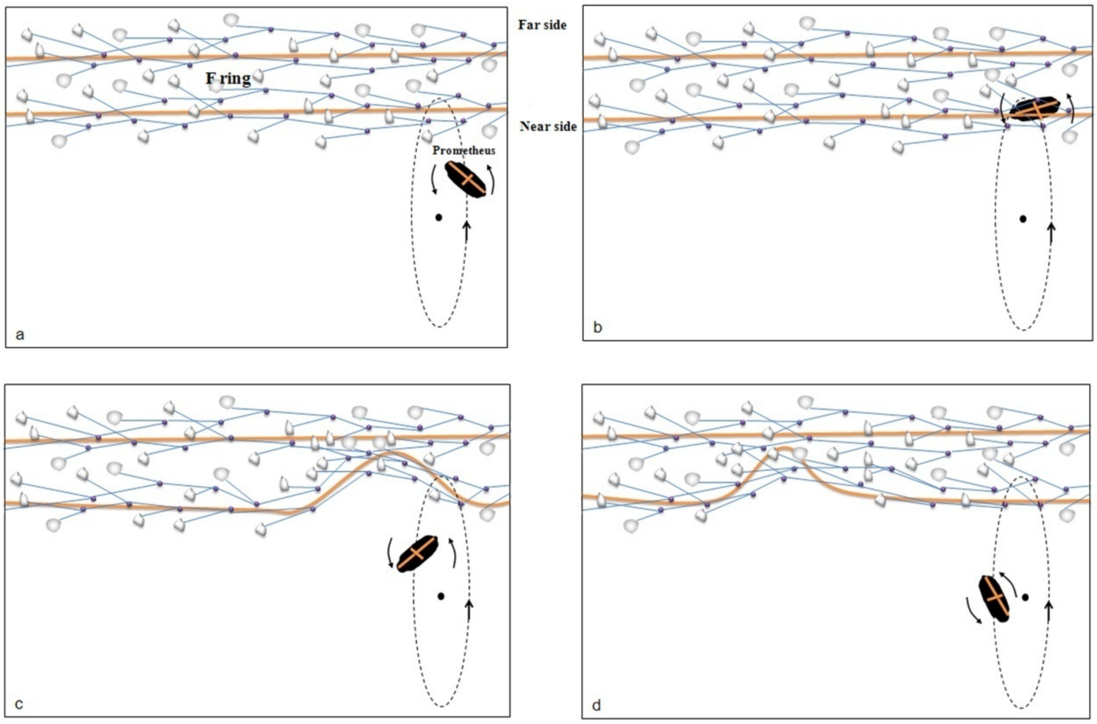


**Figure 5: Modelling a channel's creation in F ring.** From **a**, **b**, **c** to **d**, it succesively demonstrates how Prometeus interacts with the ring particels. Blue line denotes gravitation, the dashed circle denotes Prometheus's orbit. Prometeus and F ring are synchronaly moving towards right.

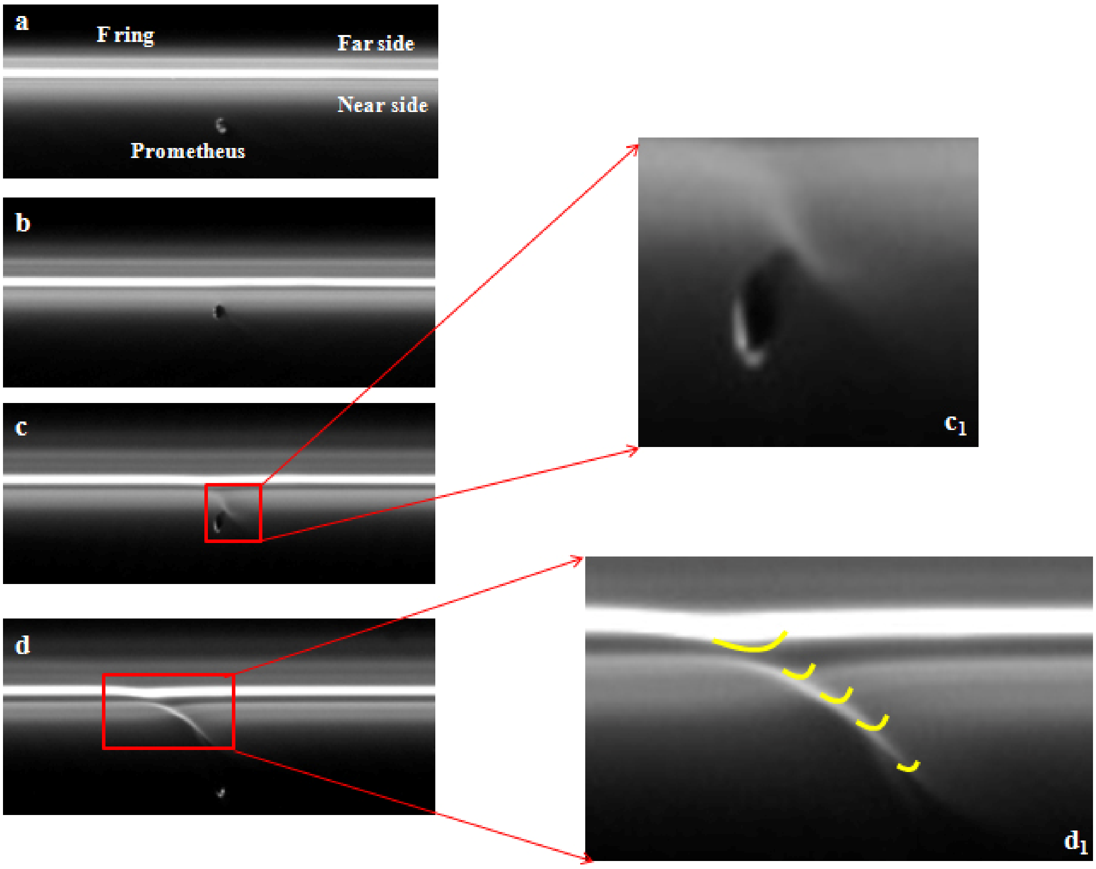


**Figure 6: Images of the interaction of Prometheus and the F ring.** $\mathbf{c_1}$ shows that the collision pushes the ring to become concave, while $\mathbf{d_1}$ does that a long concave channel is created. Note that in **b**

diagram Prometheus is at the closest approach to the ring, but there is no clue of perturbation of gravitation.

We indeed see a difficulty when conventional conceptions are used to understand the arcs in the Adams ring of Neptune. The most widely accepted theory thinks Galatea confines the arcs via its 42: 43 co-rotational inclination resonance (CIR) (Porco 1991), but the measurement of the rings' mean motion shows that the rings are not in CIR with Galatea (Dumas et al. 1999; Sicardy et al. 1999). Another theory introduced an additional moon orbiting inside the ring, by which the arcs are trapped in its stable Lagrangian points, but later observation by Voyager 2 did not show any moon in the rings (Smith et al. 1989). A more complicated theory introduced a number of moonlets trapped in co-rotational resonances with Galatea to confine the arcs by an assumption that radiation forces do not affect the particles in the arcs and by a proposal of self-gravity (Salo and Hnninen 1998). It is obvious that this theory is trying to get rid of the constraint of Newton's gravity. In conclusion, the problem of the arcs in the Adams ring still keeps unresolved (Miner et al. 2007). Contrary to this, under the frame of hierarchical two-body gravitation, the arcs in the Adams ring may be explained as some of larger fragments from the collisional source are organized in a series of hierarchical two-body systems to form the arcs, these arcs and other smaller fragments are further organized in a series of superior hierarchical two-body systems to form the Adams ring, by which a chain of discrete arcs are created in the Adams ring of Neptune (Manuscript in preparation by Yang et al).

### 3.3 Comet

It may infer from Figure 1 that, as fragments are ejected from the collisional source towards all around, all fragments must be dragged to run across the solar system back and forth due to the motions of asteroid belt around the Sun, ring around planet, and plant around the Sun (Fig.7). Once some icy fragments in motion approach the Sun, the Sun's radiation can make them become comets.

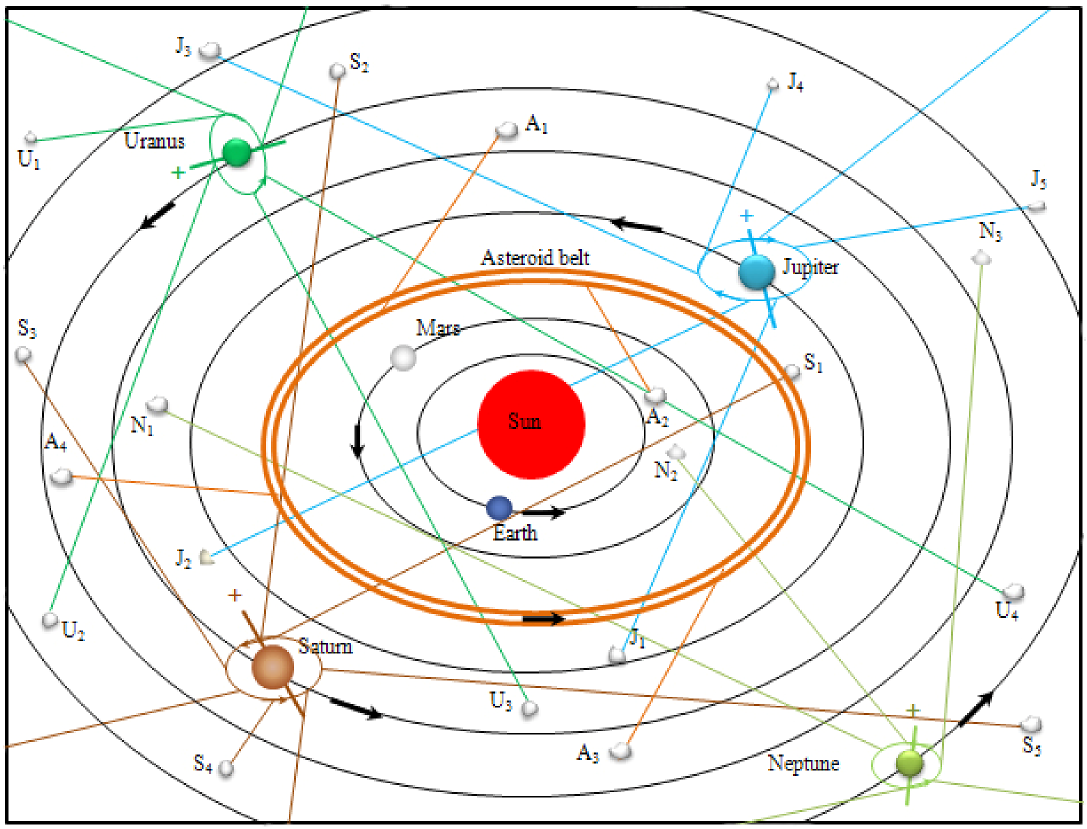


**Figure 7: A cover of fragments over the solar system.** Letter $A_{1,2,3,\text{ etc}}$ ($J_{1,2,3,\text{ etc}}$, $S_{1,2,3,\text{ etc}}$, $U_{1,2,3,\text{ etc}}$, $N_{1,2,3,\text{ etc}}$) respectively denote the fragments dragged by asteroid belt (four planetary ring systems). Various color of straight line represents the gravitation from asteroid belt (planetary ring) to fragment. "+" denotes the north pole of the planet.

Galileo's experiment of projectile tells us, the fragments ejected must run parabolic trajectories around the collisional source. Given the influence from the motions of asteroid belt around the Sun, ring around planet, and planet around the Sun, these parabolic trajectories gravitationally dominated by the barycenters in the asteroid belt and 4 giant planets' rings must be dragged to be highly distorted in space (Fig.8). It may further speculate, if the speed of projectile is rather high, it may circle around the Earth, if speed is high enough, it will run a very big parabolic trajectory to circle around the Earth, but anyway, the projectile due to the pull of the Earth will eventually fall on the ground, even if it needs to run many circles to finish this falling. This gives us an implication that all fragments ejected will eventually fall back to the collisional sources. In this falling process, old comets will gradually disappear while new ones may be cultivated.

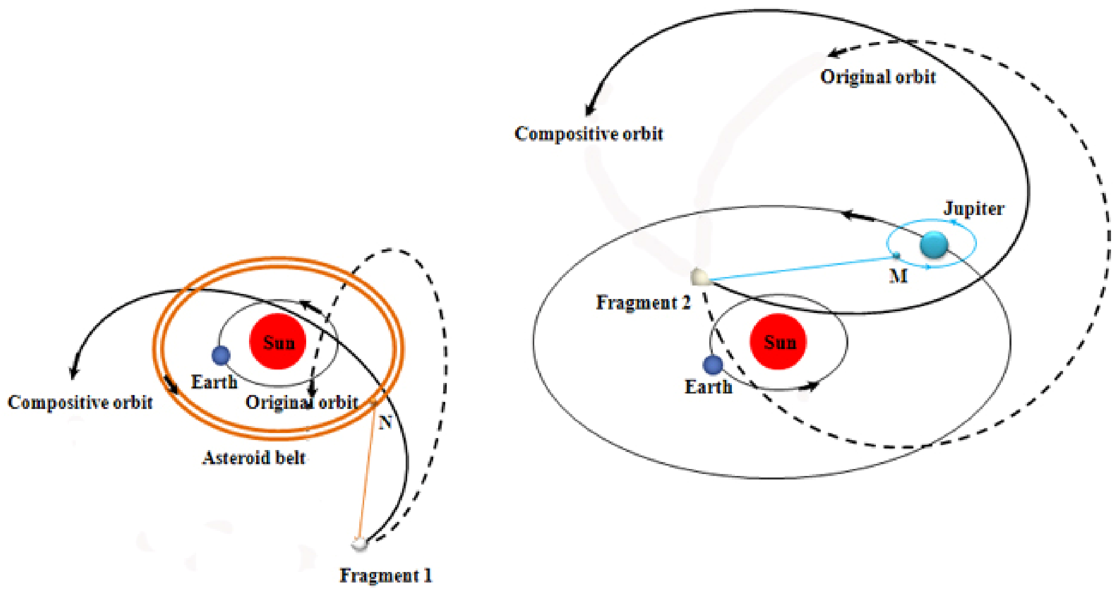


**Figure 8: The trajectories of fragments dominated by asteroid belt and the Jupiter.** Original orbit denotes fragment 1(2) is running parabolic trajectory around a barycenter N (M) in the asteroid belt (planetary ring), compositive orbit denotes the parabolic trajectory due to the motion of the barycenter around the Sun is highly distorted in space.

As the distances of the asteroid belt and the Jupiter to the Sun are shorter than that of the Saturn, Uranus, and Neptune, this determines that the asteroid belt and the Jupiter may drag more fragments to approach the Sun to become comets than the Saturn, Uranus, and Neptune may do. As each fragment runs a parabolic trajectory circling around the barycenter in the asteroid belt (or planetary ring), this determines that the comets dominated by the asteroid belt and the Jupiter should have shorter periods than those dominated by the Saturn, Uranus, and Neptune. Also because the orbital velocity of the asteroid belt and the Jupiter around the Sun is quicker than that of the Saturn, Uranus, and Neptune, the parabolic trajectories of the comets dominated by the asteroid belt and the Jupiter are easier to be dragged to fall on the elliptic than that of dominated by the Saturn, Uranus, and Neptune. In other words, short-period comets should have less inclination (with respect to the elliptic) than long-period comets. Statistical results indicates that long period comets are generally on high-inclination orbits while short period one are mostly on low-inclination prograde orbits (Duncan et al. 1988).

It may see that there is an orbital relation that the value of (aphelion – perihelion)/2 of a fragment is equal to the orbital radius of its owner (planet or asteroid belt) around the Sun. Encke’s and Halley’s comets therefore may be classified to the domination by the asteroid belt and Uranus’s ring system, respectively. The perihelion and aphelion of Encke’s comet are respectively 0.33 and 4.11 AU, the value of (aphelion - perihelion)/2 is equal to 1.89 AU, this is roughly close to the orbital radius of the asteroid belt (2.67 AU). The orbit of Halley's comet from the Sun is between 0.586 and 35.1 AU, the value of (aphelion - perihelion)/2 is equal to 17.26 AU, this is roughly close to the orbital radius of the Uranus (19.23 AU). Encke’s orbital period is 3.30 years, reference to Figure 8, this value is in fact the synodic period of the orbit of the barycenter around the Sun and the orbit of Encke around the barycenter in the asteroid belt, and thus the period of Encke around the barycenter is worked out to be 1.88 years (where $T=T_1\times T_2/(T_2+1)$, $T_1$

represents synodic period, $T_2$ represents the period of the barycenter around the Sun (around 4.36 years), which is actually equal to the period of asteroid belt around the Sun), and its orbital velocity is calculated to be 47.54 km $s^{-1}$ (where V= 2 π r/T, r represents orbital radius of Encke around the barycneter). Similarly, the orbital period and velocity of Halley around the barycenter are worked out to be 74.42 years and 7.93 km $s^{-1}$. It is necessary to note that the parabolic trajectory of a fragment around the barycenter is approximately a circle.

In the past decades some small celestial bodies (they are currently named after Centaurs) had been found orbiting the Sun between Jupiter and Neptune and crossing the orbits of one or more of the giant planets (Horner et al. 2008), some of the centaurs are here classified (Tab.2). It is very important to keep in mind that a comet or centaur in the distance is very difficult to be observed because of its very small size and obscure appearance, the value of aphelion is theoretically derived from a Keplerian elliptical estimate but not from observation, and thereby has a high uncertainty to influence the precision of this classification.

| Owner | Name | Perihelion (AU) | Aphelion (AU) |
|---|---|---|---|
| Jupiter (a = 5.2AU) | 2060 Chiron | 8.4 | 18.9 |
| | 1994 TA | 11.7 | 21.9 |
| | 1995 $Dw_2$ | 18.9 | 31 |
| | 10370 Hylonome | 18.9 | 31 |
| Saturn (a = 9.3AU) | 5145 pholus | 8.7 | 31.8 |
| | 7066 Bessus | 11.8 | 37.5 |
| | 1995 GO | 6.8 | 29.4 |
| | 5576 Amycus | 15.21 | 35.09 |
| | 8045 Asbolus | 6.8 | 29.31 |
| | 7066 Nessus | 11.8 | 37.48 |
| Asteroid belt (assumed a = 2.67 AU) | 1997 $CU_2$ | 13 | 18.5 |
| | 10199 Chariklo | 13.08 | 18.66 |

**Table 2: Classification of Centaurs.** Note the values of perihelion and aphelion are derived from JPL Small-Body Database Browser.

Figure 9 demonstrates the Jupiter how to create orbits for comet and centaur. The orbits of comet and centaur are assumed to be parallel to the elliptic, the orbital period around the Jupiter are respectively 4.5 and 6.0 year, the orbital radius are respectively 5.5 and 13.6 AU, the initial position are respectively $x_{comet}$ = 5.5 AU, $y_{comet}$ = - 5.2 AU; $x_{centaur}$ = 13.6 AU, $y_{centaur}$ = - 5.2 AU, the Jupiter's orbital radius and period around the Sun are respectively 5.2 AU and 11.86 year. It may see that the centaur runs an eccentric orbit that crosses the orbits of Saturn and Uranus, and that the comet also runs an eccentric orbit and enters the inner solar system from one corner of the sky and then drops out, but next time it enters from another corner of the sky. This may make people believe significantly that it is two different comets. Planetary ring system has inclination to the orbit of plant around the Sun, and the ring itself is always rotating, this determines that a comet dragged by a rotating ring may enter the inner solar system in different time from different corner of the sky.

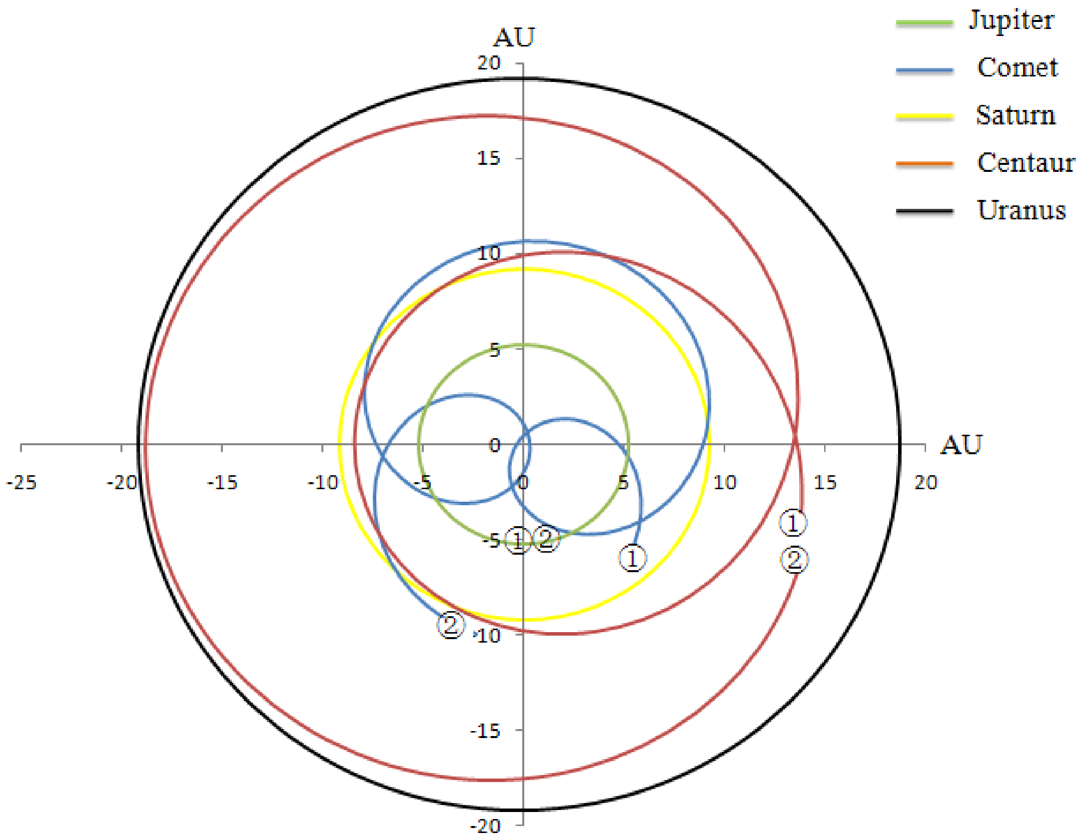


**Figure 9: Simulation of the orbits of a comet and a centaur that are dragged by the Jupiter.** The Sun is located at the center. Time interval is 12 years. ① represents the initial position of the comet and centaur, while ② represents the final position.

**4 Discussion**

Celestial objects are commonly believed to be constrained by gravitational force to orbit, and the effect of gravitation is to drag object to mutually approach each other, thus with the passage of time the orbit of each celestial object will be forced to shrink, and then the collision between objects is destined. In the solar system, the Earth has a satellite -the Moon. As of October 2009, more than 180 minor planets have been found to have moon (s) (reference to Johnston's Archive: Asteroids with Satellites). Each of four giant planets (Jupiter, Saturn, Uranus, and Neptune) generally holds a number of satellites, which makes it look like a small solar system. It is possible that some of these satellites in the past hold their own moons, but due to orbital shrinkage these moons had lost to the collision with their father satellites. Countless craters on the surfaces of planets and satellites suggest that they were severely bombarded after their formations but not before, this naturally requires some special events to responsible for. In recent years a number of irregular moons have been found to orbit the Jovian planets, they form some groups and families that are similar to the asteroids in the main belt (Huebner 2000). It is undoubtedly certain that these irregular moons are the fragments that were ejected from the collisional events. As a result, it is not difficult to distinguish conventional moons of giant planets from their irregular satellites according to physical feature. Conventional moons are generally round (spherical) and massive, and their orbits are standard-circular, and approximately parallel to planetary equatorial plane. For instance, Mimas, Enceladus, Tethys, Dione, Rhea, Titan, and Iapetus may be classified as the conventional moons of the Saturn, while the remaining should be the fragments of a previous binary satellite system; Io, Europa, Ganymede, and Callisto may be classified as conventional moons of the Jupiter, while the remaining should be the fragments of a previous binary satellite system; Miranda, Ariel, Umbriel, Titania, and Oberon may be classified as conventional moons of the Uranus, while the remaining should be the fragments of a previous binary satellite system; Triton may be classified as conventional moons of the Neptune, while the remaining should be the fragments of a previous binary satellite system. It is necessary to note that, because all fragments (irregular moons) are running parabolic trajectories around the barycenters in the rings, this determines that the orbits of irregular moons with respect to planet are highly eccentric and with respect to planetary equatorial plane are various inclinations. However, due to the successive drag of a series of hierarchical two-body systems, the inner irregular moons (close to planet) are easier to form low-inclination orbits than these outer irregular moons. The low density of Saturn's small moons and their spectral characteristics similar to those of the main rings, closeness to the rings and rapid disruptive timescales have long suggested that their origin may be linked to the planet's icy rings (Mcghee et al. 2005; Jewitt et al. 2006; Nesvorny et al. 2003; Porco et al. 2007). It is generally believed that planetary rings are derived from the collisional fragmentations of a number of small bodies that once existed around the planet (Esposito 2002; Burns et al. 2001). The collision scenario proposed here may fully satisfy with this expectation.

The asteroid belt was once thought to be the fragments of a much larger planet that once occupied the Mars-Jupiter region, but this hypothesis has been out of the belief of mainstream due to the following reasons: 1) no enough energy may be used to shatter the planet into fragments; and 2) the significant chemical differences between the asteroids are difficult to explain if they come from the same planet. We here believe the collision of a previous binary planetary system may rule out these suspicions absolutely. Estimate of energy follows this process. Due to $M_{earth}$= $5.97\times10^{24}$ kg, $M_{moon}$= $7.35\times10^{22}$ kg, $L_{earth-moon}$ = 384 000 km, $P_{moon}$ = 27.32 days, $R_{earth}$ = 6 370 km, $R_{moon}$ = 1 738 km (where $M_{earth}$ and $M_{moon}$ are respectively the mass of the Earth and Moon, $L_{earth-moon}$ is the distance between the Earth and Moon, $P_{moon}$ is the orbital period of the Moon, $R_{earth}$ and $R_{moon}$ are respectively the radius of the Earth and Moon), thus the orbital radius of the Moon in the Earth-Moon system is $L_{moon} = (M_{earth}\times L_{earth-moon})/(M_{earth}+M_{moon})$ =379 330 km, the orbital velocity is $V_{moon} = 2\pi L_{moon}/P_{moon}$ = 1.0 km s$^{-1}$, the orbital radius of the Earth in the Earth-Moon system will be $L_{earth} = L_{earth-moon} - L_{moon}$ = 4 670 km, the orbital velocity is $V_{earth} = L_{earth}\times V_{moon}/L_{moon}$ = 0.012 km s$^{-1}$. The kinetic energy for the Earth-Moon system will be $E_k = (M_{earth}\times V_{earth}^2 + M_{moon}\times V_{moon}^2)/2 = 3.72\times10^{28}$ J. When the Moon collides with the Earth, their gravitational potential is converted to kinetic energy, thus

$E_p = GM_{earth}M_{moon}[(1/R_{moon1}-1/R_{moon2}) + (1/R_{earth1}-1/R_{earth2})]$ (where $R_{moon1}$ is the distance of the Moon to the barycenter of Earth-Moon system when the collision occurs, $R_{moon2}$ is the initial distance which is equal to $L_{moon}$. $R_{earth1}$ is the distance of the Earth to the barycenter of Earth-Moon system when the collision occurs, $R_{earth2}$ is the initial distance which is equal to $L_{earth}$. After a deduction, $R_{moon1}$= 8 009 km, $R_{moon2}$ = 379 330 km, $R_{earth1}$= 98 km, $R_{earth2}$= 4 670 km), thus the gravitational potential work is worked out to be $E_p = 2.93\times10^{32}$ J, the total energy for the Earth-Moon system at the moment when the collision occurs will be $E = E_k + E_p \approx 2.93\times10^{32}$ J (we assumed that the collision occurs at the moment when $L_{earth-moon} = R_{earth} + R_{moon}$ = 8 108 km). Such a quantity of energy is powerful enough to shatter the two bodies of a binary planetary system into small pieces. If the chemical composition of this binary planetary system resembles that of the Earth-Moon system, the diversity of chemical composition between the asteroids may be satisfied easily. In the smashing collision, the ejected fragments due to the conservation of momentum are likely to symmetrically distribute around the barycenter of binary planetary system. This means that the average orbital radius of the fragments around the Sun is approximately equal to the planetary system's orbital radius around the Sun. We through JPL Small-Body Database Search Engine search for asteroids located at a range between Mars' and Jupiter's orbit (1.52AU <R<5.2 AU). Around 536818 asteroids are found and their average semi-major axis around the Sun and inclination with respect to the elliptic are worked out to be 2.67 AU and 8.30 degrees, respectively. At a distance of 2.67 AU from the Sun, the Sun's mass may determine an orbital period of 4.36 years. These should be the constraints of the previous binary planetary system orbiting the Sun at the moment. Titius-Bode Law has an experience expression of $a= (n+4)/10$ (where $a$ is the semi-major axis of a planet around the Sun and $n$=0, 3, 6, 12, 24, 48 ...). Consider the distribution of established planets (like Mercury, Venus, Earth, Mars, Jupiter …) with respect to the Sun, the position of the proposed planetary system from this formula is expected to be $a= (24+4)/10 = 2.8$ AU. Our result is nearly equal to this expectation.

If such a smashing collision had occurred for the proposed binary planetary system in the past, a natural aftermath is that a large number of fragments would be ejected from the collisional source towards all around (refer to Figure 1(B)), and therefore can bombard the objects they encounter in the travel, and thereby leave craters and scrapes on the surfaces of these objects. In general, the nearer the objects are from the collisional source, the more the objects can encounter bombardment from the fragments. As shown in Figure 10, when the fragments from the collisional source are ejected, the Mars and Earth in their orbits can inevitably be bombarded by some of inward fragments. As the Mars is more close to the collisional source than the Earth, the Mars and its satellites can naturally receive more bombardment than the Earth and Moon can do. In particular, the synchronous rotation of the Moon around the Earth can get its far side receive more bombardment than the near side. As stated previously in this paper, the ejected fragments under the effect of hierarchical two-body gravitation can be dragged to fall on a circular belt, also because the Moon is a sphere and its orbit has an inclination of 5.15 degrees to the elliptic, this determines that the Moon in motion can repeatedly run through part of the fragment belt. In the course of penetration, the south and north poles of the Moon can inevitably collide with the fragments to leave heavy craters (Fig.11). From Figure 10, we conclude, the satellites of the Mars (Deimos and Phobos) might had hold perfect spherical shape like the Earth's satellite- the Moon, but subsequently they were severely bombarded by the fragments from the collision of binary planetary system and thereby left disabled structures.

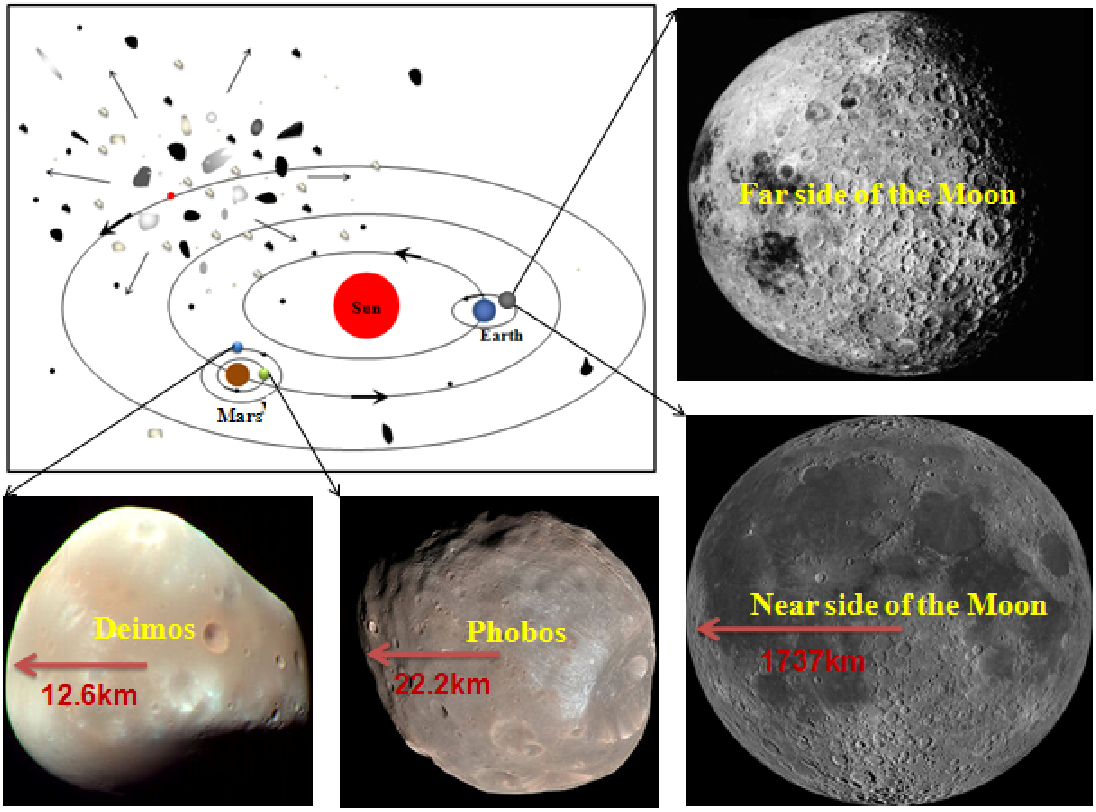


**Figure 10: Ejecting fragments inward bombard planets and their satellites to form various craters.** Red dot in the model diagram represents the barycenter of the proposed planetary system. Images of Deimos, Phobos, far side of the Moon, and near side of the Moon are by the courtesy of NASA.

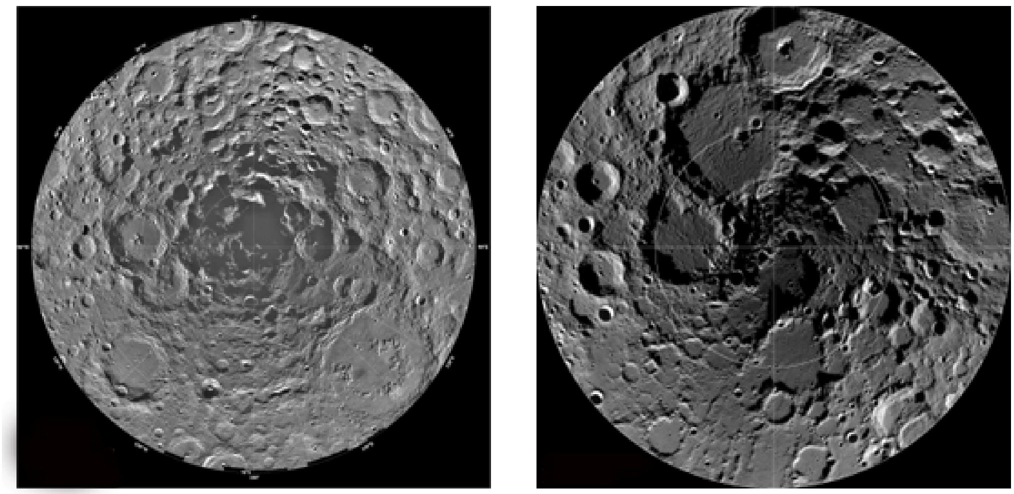

**Figure 11: South (left) and North (right) Poles of the Moon.** Images are by the courtesy of NASA/JPL/USGS.

Similarly, if planetary ring is derived from a common mechanism as the asteroid belt undergoes, a smashing collision between the two objects of a binary satellite system should have occurred in the past, the ejected fragments would naturally bombard the objects they encounter in the travel. The craters and scrapes should be observable on the surface of these objects. Evidence from the images of the satellites of the Uranus supports this deduction (Fig.12). As shown in Figure 12 (refer to Figure 10), a feature is that the satellites close to the collisional source should receive more bombardment than further satellites. As Miranda, Ariel, Umbriel, Titania, and Oberon hold synchronous rotation around the Uranus and their orbital radius are large than the radius of Uranus's ring, this means that the near side of these satellites may receive more bombardment than that of far side as long as the bombardment is occurred later than the satellites are locked by the Uranus. Strange shaped- triangle feature on the Miranda's surface might be created by the scrapes of several fragments. It is not easy to compare the bombardments encountered by planets at a long timescale, because the resulting effect is closely determined by physical condition of both the ejected fragments and the planets, for instance, planetary atmosphere, rotation, and geological activities (volcano and Earth plate movement） can seriously moderate craters and scrapes. A latest analysis of dust particles from near-Earth asteroid 25143 Itokawa shows that the asteroid is likely to be made of reassembled pieces of the interior portions of a once larger asteroid (Nakamura et al. 2011). This means larger asteroids might had been further shattered into smaller asteroids. The impact crater record of the terrestrial planets and the Moon confirms an inner solar system impact cataclysm occurred 3.9 Gy ago, and provides compelling evidence to identify the main asteroid belt as the source of the impactors (Strom et al. 2005). The heavily crater surfaces on Ganymede and Gallisto discovered by Voyager 1 confirms other bombardments occurred in the outer solar system (Strom et al. 1981). Possible causes proposed for these bombardments include gas giant migration (Gomes et al. 2005) and Late Uranus/Neptune formation (Levison et al. 2001). However, the story of gas giant migration has two uncertainties, the first one is it assumed a rich trans-Neptunian belt to firstly interact with giant planets, but so far no evidence can support the existence of this trans-Neptunian belt, the second one is it cannot account for the difference of crater distributions, for instance, on the Moon's surface there are more craters on the far side, south and north poles than on the near side. The proposal of late Uranus/Neptune formation has not yet obtained support from numerical simulation. In recent years NASA John Chambers and Jack Lissauer proposed a fifth planet (V) that exists between Mars and the asteroid belt to increase crater rate, but Planet V and its disruption are unclear. The comparison of cratering record from Mercury to Uranus shows that the solar system cratering record cannot be explained by a single family of objects in heliocentric orbits, e.g., comets (Strom 1987). All these problems inevitably require more compelling model to account for. In a private communication with professor Robert G. Strom, he states that the younger population of crater has been accumulating from the end of the period of Late Heavy Bombardment about 3.8 -3.7 ba up to the present time. In this present paper we totally propose 5 collisional scenarios: one occurred in the inner solar system around 3.9 ba that yielded a large number of fragments to create the old population of craters (the Late Heavy Bombardment), other four independently occurred in the outer solar system after the Late Heavy Bombardment (later than 3.8 ba) that yielded a lot of fragments to create the younger population of craters, but because all fragments are always running parabolic trajectories around the barycenters in the asteroid belt and planetary rings, they will be destined to return to the asteroid belt and planetary rings, in this falling process an accumulating population of craters is inevitably formed on the surfaces of planets and satellites. The collision of comet Shoemaker-Levy and Jupiter may be such a case.

A large number of meteorites in the past have been found on the Earth. The majority of the meteorites are chondrites, they are composed mostly of silicate minerals that appear to have been melted while they were free-floating objects in space. Even some types of chondrites contain small amounts of organic matter (Ceplecha et al. 1961). A little proportion of the meteorites are achondrites (meaning they do not contain chondrules), while about 5% of meteorites are iron with intergrowths of iron-nickel alloys. But the scenario that accounts for the origin of meteorite still remains uncertain. The majority of meteorites are believed to come from the asteroid belt, some are thought to come from the Moon and the Mars due to the dispersion of impactors. Indeed, the chemical composition of the majority of meteorites is similar to that of the asteroids in the asteroid belts (plentiful carbonaceous and silicate material but less metallic material, for instance), but this needs a kind of mechanism to explain how meteorites transport from the asteroid belt to the Earth. Carrying meteorites from the Moon and Mars to the Earth appears to be extremely difficult. Hamilton et al (2005) presented an analysis to show that Eos Chasma in the Valles Marineris canyon appears to be the source of the meteorite ALH 84001. The theory speculates that ALH 84001 was initially broken by one or more meteorite impacts on the surface of the Mars to stay at the planet's surface, and subsequently was blasted off from the surface and transported to the Earth. ALH 84001 was stipulated to originate from a time period of wet Mars. It is clear, to run this transportation, a chain of events is needed. The first step is a meteorite firstly needs to penetrate the Mars' atmosphere (liquid water needs enough atmosphere to maintain) to break the father material of ALH84001, the second step is subsequently another impact hit ALH84001 accurately and blast it off from the planet's surface, the third step is the ejecting ALH84001 needs to successfully overcome the Mars' gravitation and penetrate the Mars' atmosphere and then run a long distance of 0.6~2.6 AU to accurately reach the Earth (this is like we stay at distance of more than 7.0 km to shoot a target of 1.0 m in diameter), the last step is ALH84001 needs to successfully penetrate the Earth's atmosphere and land on the Earth. This chain of successive events is technically difficult to occur. Of course, this does not mean that it is impossible to take place, but its possibility is absolutely low. It is already known that meteoroids strike the Moon every day. In 2005 NASA's Opportunity Rover captured an iron meteorite on the Mars. A collisional scenario proposed for a previous binary planetary system in this paper may create condition for fragments to travel and land on the surfaces of planets and satellites and further become meteorites. In the collision some materials (including rock and iron) may be melted by powerful heat and subsequently be crystallized, while some organic matter may be sealed in the voids of fragments. Once these fragments including organic matter are captured by human being, they may be treated as a sign of alien life. If such a binary planetary system was existed in the past at the position of present asteroid belt, a distance of 2.67 AU from the Sun is suitable for the cultivation of simple life.

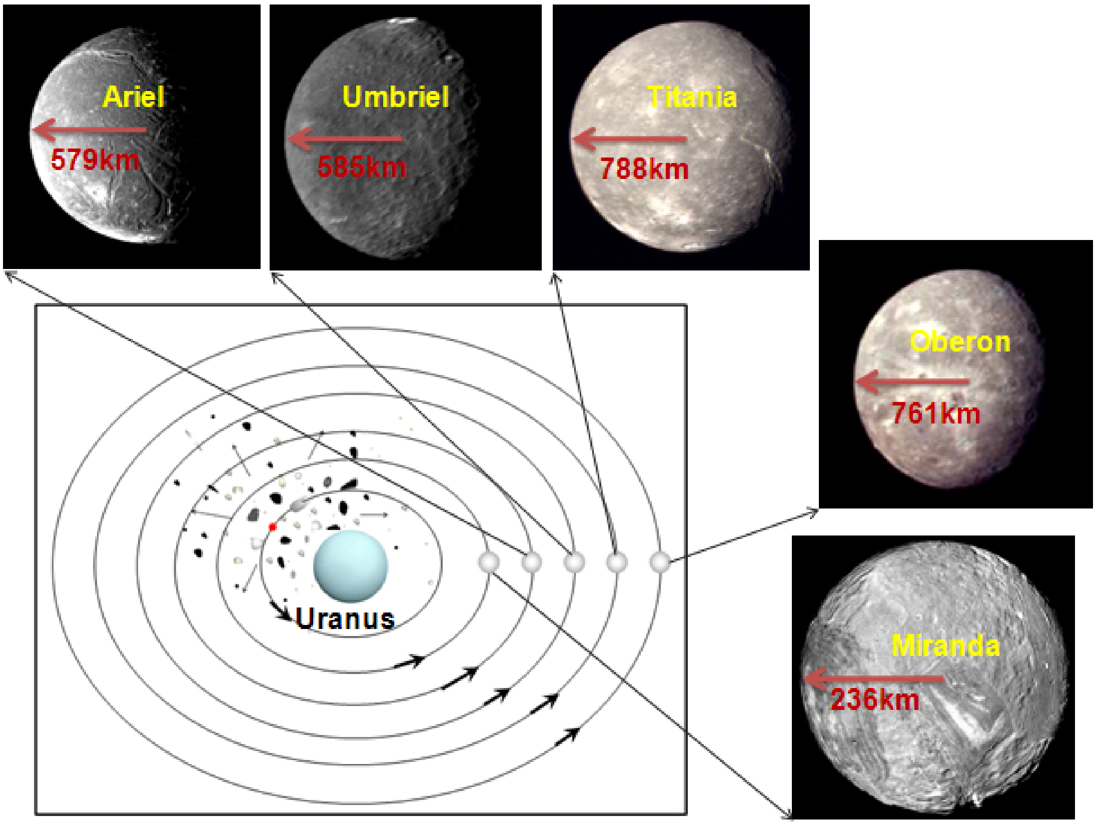


**Figure 12: Ejecting fragments outward bombard moons of the Uranus to create craters and scrapes on the surfaces.** Red dot in the model diagram represents the barycenter of the proposed binary satellite system. Images of Miranda, Ariel, Umbriel, Titania, and Oberon are by the courtesy of NASA.

Jan Oort in 1950 statistically found that there is a strong tendency for aphelia of long period comet orbits to lie at a distance of about 50,000 AU and then proposed that comets reside in a vast cloud at the outer reaches of the solar system (Oort 1950). It is very important to note that the so-called aphelia of long period comet orbits is derived from a theoretical estimate, nobody in person sees that the aphelia of a cometary orbit is indeed located at such a distant place. On the other hand, when we observe a comet, the Earth is rotating around its axis, at the same time the Earth and Moon are also rotating around their common center of mass, and this center is also revolving around the Sun, the Sun is also moving, what we observe for the comet is a compositive effect of multiple motions, it is very difficult to determine the comet's proper motion. Both two make Oort Cloud Hypothesis uncertain. In addition to this, the solar system itself is flat, no mechanism may be found to support the presence of a spherical cloud of comets. The Kuiper Belt that is proposed to account for short period comets encounters at least two obstacles: 1) the mechanism by which the comets are supplied from Kuiper belt to planet-crossing orbits is unclear (Duncan et al. 1988); and 2) there is no observation to indicate that short period comets are really originated from Kuiper Blet Objects. Some people would argue that comets can employ their own angular momentum to run eccentric orbits around the Sun. I don't think so because within a changeable gravitational field there must be a third part to work. For instance, bird can fly in the sky, plane can fly from ground to high altitude, evidently, the bird and plane rely on the help of a third part (chemical energy in their bodies) fighting against the Earth's gravitation. So, can planet, satellite, and comet rely on what fighting against the Sun's gravitation? Also note angular momentum is vector, any change of angular momentum must employ an external force to work. Planets and comets are observed to have different motional directions in space, as the effect of force is mutual between any two objects, when the Sun works an object to move by means of gravitation, the object in turn has to work the Sun to move. As a result, the Sun itself is impossible to work these objects to move at the same time. The only explanation for this discrepancy is the established conception is seriously disabled. This is the reason why I strongly introduce a hierarchical two-body model in the previous work (Yang 2011), and thus account for the comet's motion. Most of comets are composed of water ice, rock, dust, and frozen gases (Poulet et al. 2003), planetary ring also consists of mainly water ice and dust. As of 2008, three centaurs such as 2060 Chiron, 60558 Echeclus, and 166P/NEAT have been found to display cometary coma (Coradini et al. 2009). This similarity indicates that both planetary ring and comet (centaur) may be related. The collisional scenario of binary planetary (satellite) systems proposed in this paper is too conceptual to consider the timescale in the solar system, nevertheless, it provides a hopeful point to integrally consider the origin of asteroid belt, planetary ring, and comets, future work in both observation and numerical simulation may strengthen the expectation of this model.

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