

# Comets, the Kuiper Belt and the Oort Cloud

John G. Hartnett\*

## Abstract

With the development of modern space-based telescopes and the past decade or more of collection of data on both comets and celestial bodies found to orbit the sun at distance greater than that of the planet Neptune, a review of the current data suggests that there can be no longer any doubt that the Kuiper belt does exist. However, the objects contained therein probably more properly should be called trans-Neptunian objects because there is no reason that the solar system ends at Neptune and a new region of space begins. On the other hand, there is no evidence that the putative Oort cloud exists. The Kuiper belt was originally believed to be the primary source from which the Oort cloud was populated over the alleged 4.6-billion-year history since our solar system formed. The latter still has not been found, yet it is critically needed as the only source of long-period comets for the uniformitarian theory. However, I suggest that the existence of short-period comets as a young solar system argument may no longer be tenable.



Figure 1. Comet C/2012 S1 (ISON) April 30, 2013. The comet was 3.9 AU (580 million km) from the sun and 4.3 AU (640 million km) from Earth. Photo from NASA/Hubblesite.org

\* John G. Hartnett, johngideonhartnett@gmail.com, BibleScienceForum.com

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## Introduction

Comets were once thought to be atmospheric phenomena, and there was a time when they were believed to be harbingers of doom (Sarfati, 2003). Comets are now known to be dirty balls of ice and dust and some even icy dirt balls (Hartnett, 2006). They travel into the inner solar system displaying, in some cases spectacularly, their long tails, which comprise escaping gas and dust, the result of ices sublimating<sup>1</sup> from their icy surface. This display gets stronger as they approach the sun, where the sun's radiation has a very strong effect on the volatile chemicals in the ball of ice. Driven away from the sun by radiation pressure and the solar wind, this loss of material depletes the mass of the comet. Some comets have relatively short orbital periods of less than 200 years, whereas others have periods much longer than 200 years. This has become a convenient basis for classifying a comet short-period or long-period. However, the more significant criteria of classification are their orbital characteristics: inclination and whether prograde or retrograde in their orbital trajectories.

The Bible gives an age of the solar system and the universe of around 6000 years, but the nebular hypothesis proposes that the solar system began condensing from a giant collapsing cloud of molecular hydrogen (Hartnett, 2016a) and dust about 5 billion years ago and that the material of comets formed about 4.6 billion years ago. Based on the known loss rate of the material from observed comets, however, there should be no short-period comets left (Faulkner, 1997, 2001).

A typical comet nucleus (5–10 km in diameter) has a mass of  $5\text{--}10 \times 10^{14}$  kg. That may seem like a lot, but comets

lose tens of tons of material per second on approach to the sun. Comet Halley at its peak loss rate loses about 54 tons/second of gas, including gas from volatile ices, at a distance of about 1 AU<sup>2</sup> from the sun. Assuming the process occurs only during one third of its orbit—the portion when it is closest to the sun—a comet loses about  $5.7 \times 10^{11}$  kg/passage, which means it could survive only 95 passages around the sun before there is no matter left (Vanderbilt University, 2016).

Assuming that a comet is sourced from the original material from the creation of the solar system, if it passes the sun once in 200 years, it could pass only 30 times in the biblical lifetime of the solar system, which is completely within expectation. In fact, it would only be 30% depleted of its initial mass. That means it still would have 65 more passages left before all the material from its nucleus would be lost. But how could it pass 25 million times as required in the uniformitarian lifetime of the solar system? There is the problem. Why do short-period comets still exist if the nebular hypothesis is the true description of the formation of the solar system? Quite obviously this problem does not exist for the biblical creationist.

Long-period comets might have a period from a hundred thousand years up to a million years, it is alleged. But if they too can survive only 95 passages around the sun, they have at most only 95 million years of total life.<sup>3</sup> So, why are there still any long-period comets? From the perspective of the uniformitarian nebular hypothesis, where do they come from?

## The Kuiper Belt

One commonly used university astrophysics text (Carroll and Ostlie, 2007, p. 717) reports:

From their orbital characteristics, it seems very likely that the present-day source of the short-period comets is the **Kuiper belt**, a collection of icy objects located predominantly near the plane of the ecliptic and beyond the orbit of Neptune, typically ranging from 30 AU to perhaps 1000 AU or more from the Sun. It is now realized that Pluto and its moon Charon, 2003 UB313, Sedna, and Quaoar are among the largest known members of the family of **Kuiper belt objects** (KBOs), also referred to as **Trans-Neptunian Objects** (TNOs).

The Kuiper belt (KB) is a doughnut-shaped region of space beyond the orbit of the planet Neptune wherein there have now been observed on the order of 2000 bodies orbiting the sun. In reality these should be simply referred to as trans-Neptunian objects (TNOs) because there is no good reason to suppose that our solar system abruptly stops at the orbit of Pluto. The first KBO, 1992 QB1, was detected in 1992. Other large bodies comparable in size to Pluto have been found since—for example, Charon, Eris (Jet Propulsion Laboratory, 2016), Sedna, and Quaoar (See Table I). One of these, Eris, discovered in 2003, is slightly smaller in size than Pluto but more massive, yet Pluto was counted as one of the planets at that time. This was one of the reasons in 2006 Pluto was reclassified to being one of the minor planets.

I think we can definitely say that the Kuiper belt of bodies with masses comparable to Pluto's and smaller does exist beyond the orbit of Neptune. The question then remains: Is the Kuiper belt a solution to the problem of short-period comets (Newton, 2002, pp. 15–17)?

<sup>1</sup> Sublimation is the transition a substance undergoes when directly changing from the solid phase to the gas phase without passing through the intermediate liquid phase.

<sup>2</sup> 1 AU = 1 astronomical unit = the distance from the earth to the sun, about 150 million km.

<sup>3</sup> This is only 2% of the alleged age of the solar system of 5 billion years. It represents an upper limit only, which is much less than the alleged 5-billion-year age.

Name	Diameter (km)	Period (yr)	$a$ (AU)	$e$	$s$ (deg) <sup>†</sup>
Eris	2400	559	67.89	0.4378	43.99
Pluto	2274	248	39.48	0.2488	17.16
Sedna*	1600	12,300	531.7	0.857	11.93
Orcus	1500	247	39.39	0.220	20.6
Charon	1270	248	39.48	0.2488	17.16
2005 FY9	1250	309	45.71	0.155	29.0
2003 EL61	1200	285	43.34	0.189	28.2
Quaoar	1200	287	43.55	0.035	8.0
Ixion	1070	249	39.62	0.241	19.6
Varuna	900	282	42.95	0.052	17.2
2002 AW197	890	326	47.37	0.131	24.4

\* Sedna has a highly eccentric orbit which is much larger than the classical Kuiper belt.

<sup>†</sup> The parameters  $a$ ,  $e$ , and  $i$  represent, respectively, the semi-major axis, eccentricity and inclination of their orbits. Table I is reproduced from (Carrol and Ostlie, 2007).

Table I. A list of the largest known Kuiper Belt objects as of May 2006. Many of the listed diameters are quite uncertain.

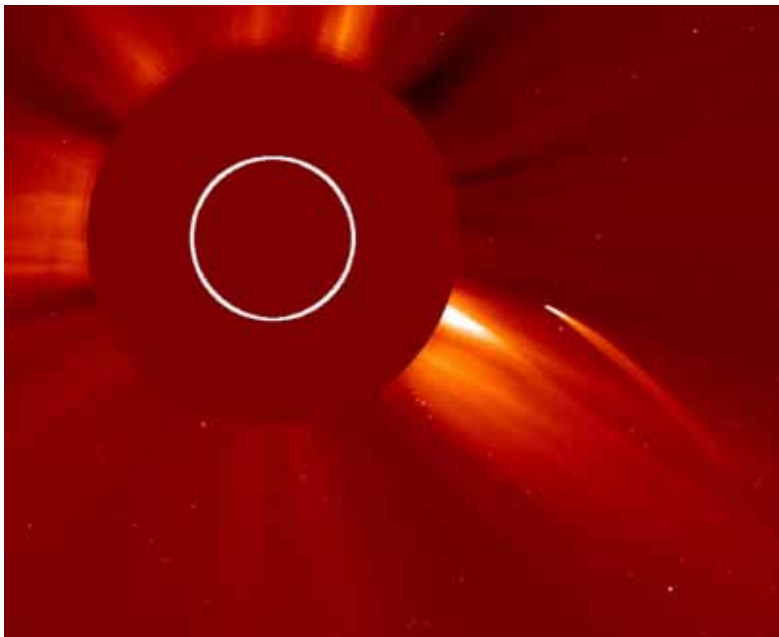


Figure 2. An image of a comet plunging into the sun (right-hand side). The disk of the sun is covered so that the sun's corona and coronal mass ejections can be studied. The image was obtained by the LASCO instrument onboard SOHO on July 5 and July 6, 2011. As of 2015 SOHO has discovered 3000 comets this way. Image from ESA/NASA/SOHO.

## Observed Comets in the Solar System

To add to the loss-of-mass problem for comets, making it even worse than stated above, while some comets approaching the sun

suffer relatively small amounts of sublimation near perihelion compared with their masses, other comets may experience more severe consequences. For instance, when Comet West moved through the inner Solar System in 1976, its nucleus broke into four separate pieces. Comet Kohoutek also split apart in 1974. Perhaps more impressive are the **Sun-grazing comets**. While it has been intensely studying the Sun, the LASCO instrument onboard the SOHO spacecraft has discovered more than 1000 comets that make close approaches to the Sun. In some instances, the comets' orbits cause them to plunge into the Sun, as occurred with Comet SOHO-6. (Carrol & Ostlie, 2007, p. 825)

As of the time of writing this article, the ESA/NASA Solar Heliospheric Observatory (SOHO) spacecraft has catalogued 3,000 comets (Wall, 2015). Some of them were observed plunging into the sun, as shown in Figure 2. The SOHO satellite has permitted an enormous number of sun-grazing (including sun-diving) comets to be detected. One class of those comets are Kreutz comets, which all seem to have approximately the same orbit and appear to be from the past breakup of a larger comet.

## Why Are We Seeing So Many Sun-grazing Comets?

A NASA video available on YouTube (<https://youtu.be/2u73bIzg5CU>) offers an answer to this question.

Before 1979, there were less than a dozen known sun-grazing comets—comets that swing by incredibly close to the sun. But that was before the ESA/

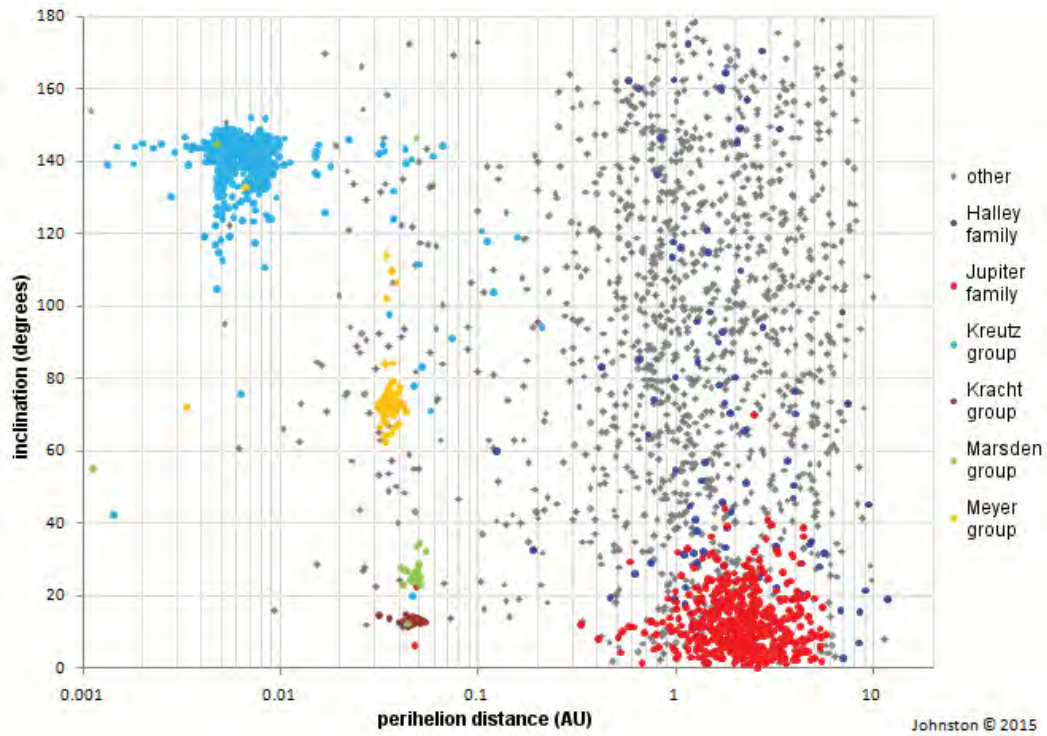


Figure 3. Inclination versus perihelion distance for 3,821 comets. Reproduced from Johnston (2015a).

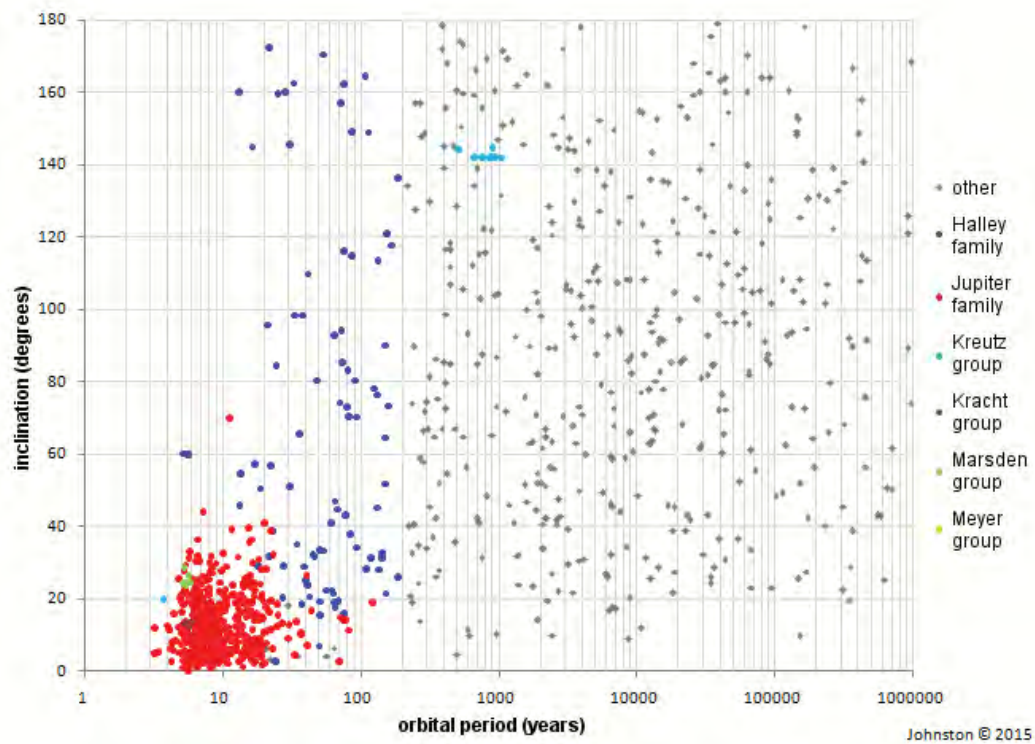


Figure 4. Inclination versus orbital period for 1,152 comets. Reproduced from Johnston (2015a).

NASA SOHO spacecraft was launched in 2000. Since then, SOHO has become the greatest sun-grazing comet hunter of all time, with a current comet find of 3000.

The existence of so many sun-grazing comets again shows the fragility of comets, which means the supply of comets will be depleted even faster than any uniformitarian calculation would indicate. Consider the following quote:

The overwhelming bulk—some 85 percent—of SOHO’s comet discoveries are what’s [sic] called Kreutz comets. Scientists think a single extremely large sun-grazing comet broke up thousands of years ago, leading to thousands of leftover fragments, which continue to follow the same Kreutz path. On average, a new member of the Kreutz family is discovered every three days. Unfortunately, the long journey for these fragments invariably ends as they pass the sun. If they’re close enough to the sun to be seen by SOHO, they’re too close to survive.

“They just disintegrate every time we observe one,” said Karl Battams, a solar scientist at the Naval Research Labs in Washington, D.C., who has been in charge of running the SOHO comet-sighting website since 2003. “There’s only one Kreutz comet that made it around the sun—Comet Lovejoy. And we are pretty confident it fell apart a couple of weeks afterwards.” (Fox, 2015)

Some sun-grazing comets have been discovered after getting around the sun, but most sun-grazers do not make it past. Figure 3 shows the inclination ( $i$ ) versus the perihelion distance<sup>4</sup> for 3821 comets (Johnston, 2015a). The Kreutz family

are closely grouped (light blue dots in Figure 3) at very similar inclinations to the plane in which the planets orbit (the ecliptic), and they have similar perihelion distances, very close to the sun.

Figure 4 illustrates, using different colors, the different families of comets, most of which have been discovered since 1990. The Jupiter family (red dots in Figure 4) are a class of comets that have orbits where they pass within 1 AU and 5 AU at perihelion and have aphelion between the orbits of Jupiter (5 AU) and Saturn (10 AU), and orbital periods less than 200 years. They all have very low inclinations, which means they essentially orbit in the plane of the planets. The well-known Halley family (dark blue dots in Figure 4) have orbital periods mostly from 10 to 200 years. Above 200 years, we clearly see the long-period comets, which are plotted in Figure 4 as grey diamonds and a few light-blue dots. The Kreutz group that there is data for (light-blue dots) have orbital periods between 500 and 800 years, which also makes them long-period comets. The Halley family and the Kreutz family and the other long-period comets have a whole range of orbital inclinations, which means they form a spherical cloud around the sun.

## The Oort Cloud

And what about the long-period comets? They

apparently originate in the **Oort cloud**, an approximately *spherically symmetric cloud of cometary nuclei* with orbital radii of between 3000 and 100,000 AU. Having spent most of their existence in “deep freeze” at the outer reaches of the Solar System, comets and Kuiper belt objects appear to be ancient remnants of its formation, although perhaps not entirely unaffected by nearly 4.6 billion years of exposure to the environment of space. (Carroll and Ostlie, 2007, p. 717, emphasis added)

The textbook argument is now being made that long-period comets and Kuiper belt objects originate from the Oort cloud. See Figure 5. This includes Kuiper belt objects. Hence the KB’s existence is now being linked to an unobserved spherical halo of trillions of icy cometary nuclei, which was proposed only because of the observed existence of comets, both short and long period, in an alleged 4.6-billion-year-old solar system.

In 1950, based on a very careful statistical study of their apparently random orbits, Jan Oort (1900–1992) concluded that long-period comets originate in a distant distribution of cometary nuclei now known as the **Oort cloud**. *Although the Oort cloud has never been observed*, its existence seems certain. As we noted [above], the reservoir of nuclei appears to be located between 3000 AU and 100,000 AU from the Sun and probably contains  $10^{12}$ – $10^{13}$  members with a total mass on the order of  $100 M_{\oplus}$ . For comparison, the nearest stars are approximately 275,000 AU away. The inner Oort cloud (3000 AU to 20,000 AU) may be slightly concentrated along the ecliptic, while the outer Oort cloud (20,000 AU to 100,000 AU) has a *nearly spherical distribution of cometary nuclei*. (Carroll and Ostlie, 2007, p. 825–826, emphasis added)

The alleged structure of the unseen Oort cloud is described, but that has been based on the believed evolutionary theory of the formation of the solar system (Hartnett, 2016a, 2016b). Since there still does not exist any observational evidence for the Oort cloud, it remains as evolutionary storytelling.

As of 2016, no Oort cloud has been detected, yet 1,947 TNOs, centaurs, and scattered disk objects (SDOs) are now identified (Johnston, 2015b). Centaurs are fairly large icy bodies that orbit the sun but are not classed as comets, though some say they may become

<sup>4</sup> Perihelion distance is the comet’s closest approach to the sun while the aphelion distance is its greatest distance on its path in an elliptical orbit.

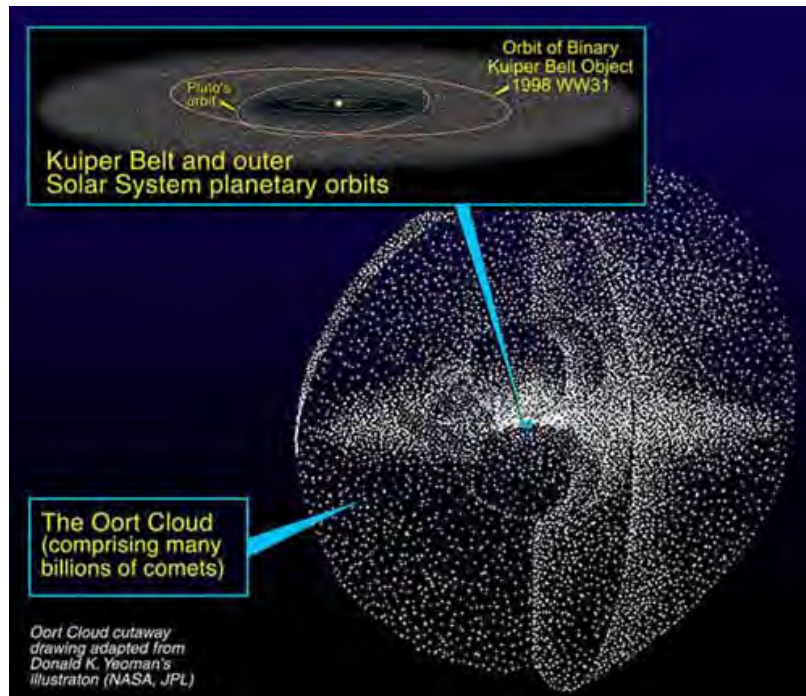


Figure 5. The alleged Oort cloud with the Kuiper belt inset. Image from NASA via Wikipedia.

short-period comets if they are knocked out of their current orbits.

As detections have increased, KBOs have been classed into three different groups based on their orbital characteristics. **Classical KBOs** are those that orbit between 30 AU (Neptune's distance) and 50 AU from the sun, with orbital inclinations less than about 30°. Then there are **Scattered KBOs** with much higher orbital eccentricities. Eris (2003 UB313) is one example of a scattered KBO. The perihelion distances of scattered KBOs are around 35 AU, and they have greater orbital inclinations than classical KBOs. Scattered KBOs are suggested as another source of the short-period comets. Lastly, a class of **resonant KBOs** exists that has orbital resonances with Neptune. Pluto is locked in a 3:2

orbital resonance<sup>5</sup> with Neptune that protects it from ever colliding with the ice giant. As a result, Pluto (and its binary partner Charon) are resonant KBOs. Any KBOs that have 3:2 orbital resonances with Neptune are referred to as Plutinos (see Figure 6). Many other different orbital resonances have been observed for KBOs as well (Carroll and Ostlie, 2007; Johnston, 2015c). Figure 6 shows many classical, scattered, and resonant KBOs.

Figure 7 plots known KBOs and inner solar system bodies (inside the orbit of Uranus at semimajor axis of 19 AU). This is data from September 8, 2005, but it clearly shows many

<sup>5</sup> 3:2 resonance means the body (Pluto, in this case) completes two orbits of the sun for every 3 orbits that the other body (Neptune, in this case) completes.

bodies outside the orbit of Neptune and seems to define the concept of the Kuiper belt and TNOs. The locations of KBOs, centaurs, comets, and Jupiter's Trojan asteroids are shown.<sup>6</sup> These are projected onto the plane of the ecliptic. And due to the projection effect and the relatively very large size of the symbols compared to the actual sizes of the objects, the outer solar system appears more crowded than it actually is. Even though the Kuiper belt was proposed independently by Edgeworth in 1949 and Kuiper in 1951, though not as a solution to the problem of short-period comets at that time, there can be no denying it exists.

But could the Kuiper belt have been the supply of short-period comets for the alleged past 4.6 billion years?

From the above analysis, I think it is unsustainable to argue that the KB does not exist. In 2003 there were only 651 KBOs identified, and it was argued that they are not KBOs but TNOs, and hence there is no Kuiper belt (Newton, 2002, pp. 15–17). The argument hinges on the fact that it was proposed as a solution to short-period comets and that the observed bodies are too large to be cometary cores. You can call them all TNOs, but they are located in the region that Kuiper and Edgeworth suggested, and hence they are KBOs.

Whether or not there is a sufficient supply of cometary material there, is another question. But it is fair to note the following:

- The period of time mankind has been observing this region with very good telescopes has been extremely brief.

<sup>6</sup> Trojan asteroids (also called Trojans) are a large group of asteroids that share the orbit of Jupiter around the sun. Jupiter Trojans are distributed in two elongated, curved regions around the two stable Lagrangian points lying 60° ahead of the planet in its orbit, and 60° behind.

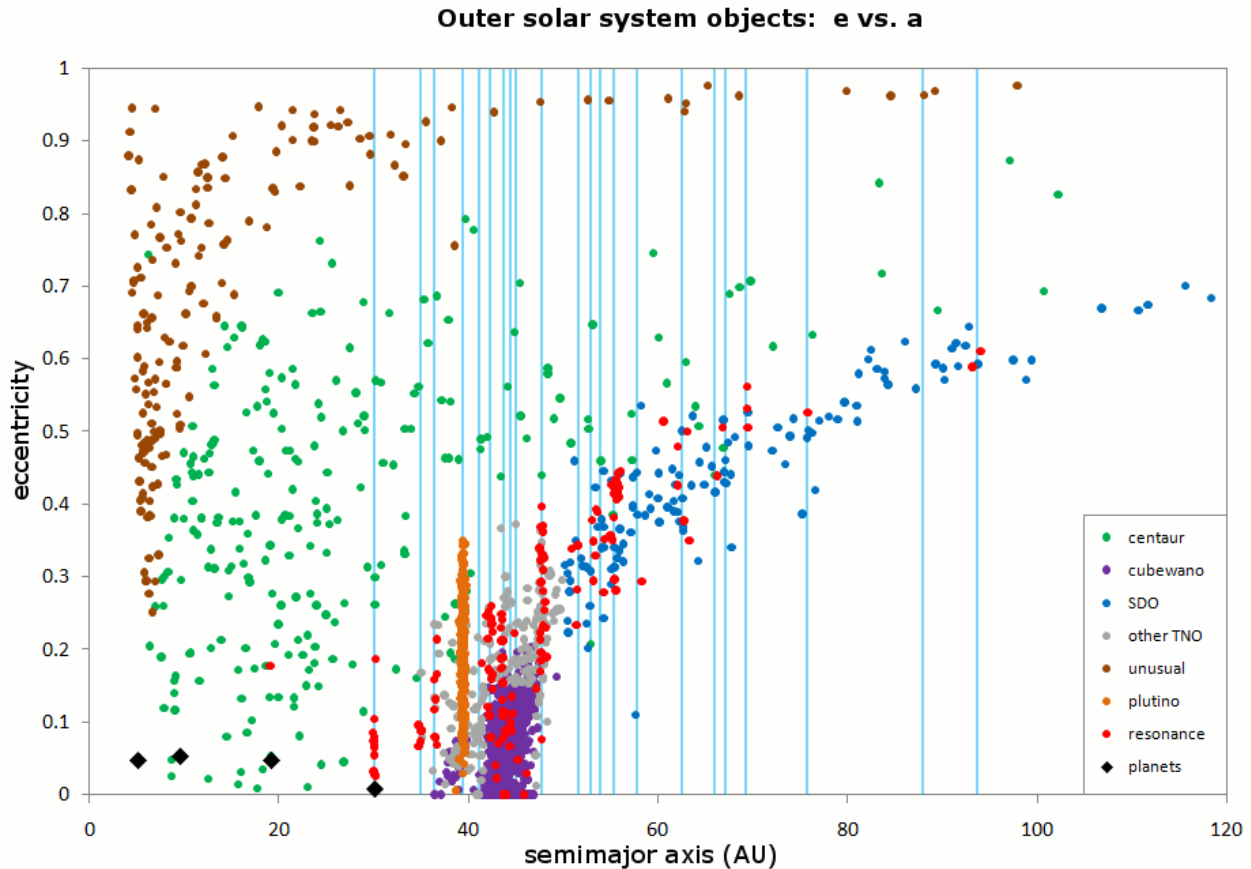


Figure 6. Plot of the eccentricity versus semimajor axis for outer solar system objects (Johnston, 2015c). Red (color in online version found at creationresearch.org) points indicate orbital resonances with Neptune as identified by vertical lines (light-blue, color online). The planets are shown by black diamonds. Neptune is at 30 AU. Beyond 40 AU (Pluto) is a large group of TNOs (purple dots, color online) called cubewano, which is a name for a classical KBO.

- The ability to detect 5 to 10 km-sized objects at 50 to 100 A.U. (see Figure 8) may be extremely poor; hence making an unbiased budget estimate is extremely problematic.
- There are needed on the order of 1 billion cometary cores to maintain a supply for the 4.6-billion-year uniformitarian timescale, which means only about 1000 are needed on a 6000-year timescale.

A comet has the mass of  $10^{-10} M_{\oplus}$  (Earth masses), and early solar system formation theory has that there was about 1 Earth mass of material out there initially. Some argue for a much higher mass of  $100 M_{\oplus}$  in the Oort

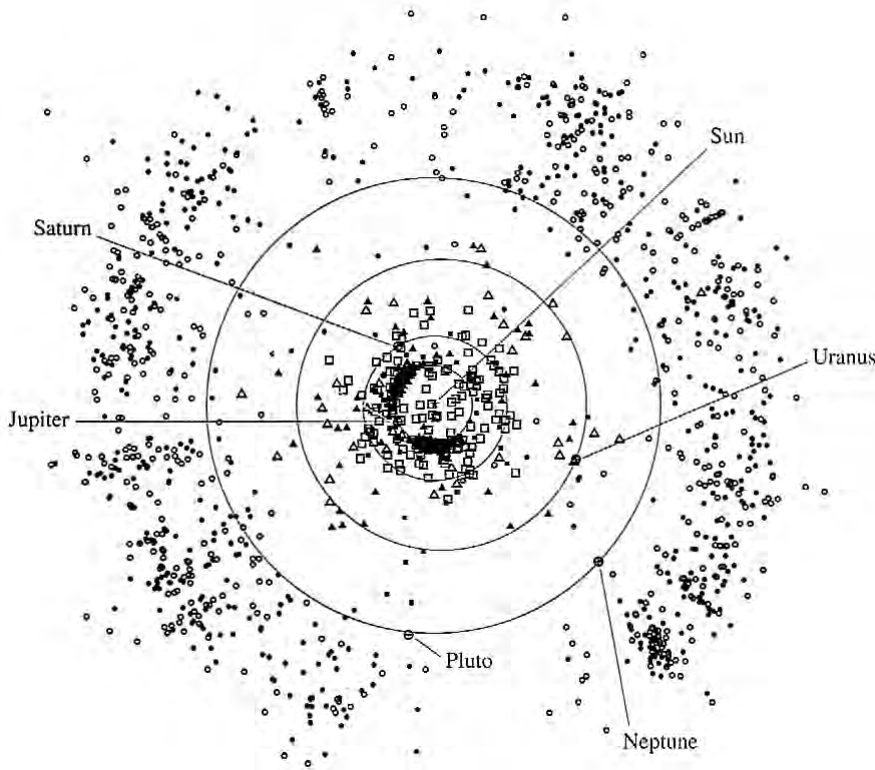
cloud. So even if it was  $0.1 M_{\oplus}$  initially in cometary core material, that gives the evolutionists 1 billion comet cores at their origin.

Certainly the existence of about 2000 known KBOs now is consistent with only about 3000 cometary cores at Creation, assuming the smaller cometary cores had a similar abundance to the large KBOs that have been observed. But if there were 1 billion there 4.6 billion years ago, at the observed rate of loss in the solar system, it is possible to have reduced that to only a matter of thousands today. Of course a mechanism is needed to eject the comet cores out of stable orbits in the KB over those

billions of years. The suggestion is that the comets mostly dove into the sun. A total mass of  $0.1 M_{\oplus}$  would have had negligible effect on the sun.

Based on the nebular hypothesis and the idea that the Oort cloud resulted from the formation of the solar system, it would be reasonable to say that astronomers regard the KB as an initial reservoir of cometary material that led to the formation of the alleged Oort cloud over the alleged 4.6 billion years.

The comets in the Oort cloud probably did not form at their present locations. Instead, they may be ancient planetesimals that coalesced near the ecliptic in the vicinity



**Figure 7.** The positions of known classical and resonant KBOs (circles), centaurs and scattered KBOs (triangles), comets (squares), and Trojan asteroids from the orbit of Jupiter outward (two dark patches) as on September 8, 2005. Open symbols are objects observed at only one opposition; filled symbols are objects that have been observed at multiple oppositions. For the comets, the filled squares represent numbered periodic comets; other comets are indicated by open squares. The classical Kuiper belt is clearly evident beyond the orbit of Neptune. In this orientation, the planets and most of the other objects orbit counterclockwise. Excerpted from Carroll and Ostlie (2007, p. 829).

of Uranus and Neptune. After repeated gravitational interactions with the ice giants, the nuclei were catapulted out to their current distances. Because these nuclei were so far from the Sun, passing stars and gas clouds ultimately randomized their orbits, resulting in the nearly spherical distribution that exists in the outer cloud today. With the inner cloud being deeper in the Sun's gravitational well, these cometary nuclei did not become quite as randomly distributed. Therefore,

comets in the inner Oort cloud were able to retain some history of their original locations when the Solar System was young. It is probably the gravitational perturbations of other stars and gas clouds that cause some of the cometary nuclei to start their long falls into the inner Solar System. (Carroll and Ostlie, 2007, p. 826)

Of course this is more storytelling. From the available data, it is now clear that most of the long-period comets have a broad range of inclinations to the plane

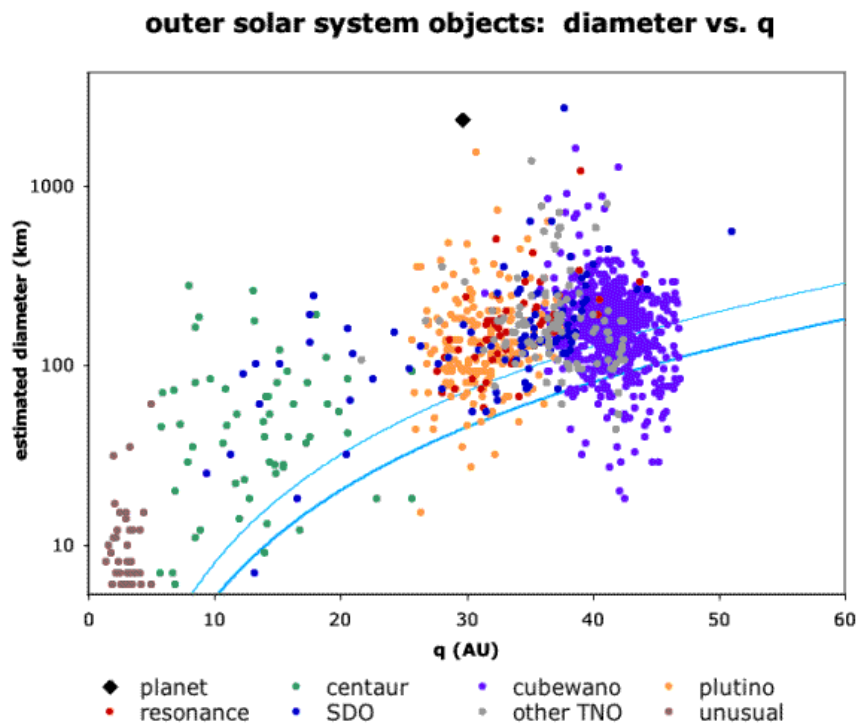
of the orbit of the planets—the ecliptic. KBOs are confined near the plane of the ecliptic, so they are unlikely the source of the long-period comets. That leaves only the hypothetical spherical Oort cloud as their main supply. That still has not been observed. There is the claim that there are observed inner Oort-cloud objects (Johnston, 2015d)—objects orbiting beyond the classical Kuiper belt, with perihelia greater than 55 AU. But that seems to be more special pleading than anything else. The minor planet Sedna has a very wide orbit, but that is still within the region of space given to the KB, not the inner Oort cloud, which is supposed to start at 3000 AU.

## Conclusion

Observations of comets, the Kuiper belt, and the Oort cloud are consistent with a 6000-year-old solar system, in terms of both short-period and long-period comets. The orbital inclinations of most short-period comets is low, so it may be a straw man to rule out the KB as a source of short-period comets for the uniformitarian theory. It depends critically on the existence of cometary nuclei in the KB, which so far have not been observed in any numbers (Johnston, 2015b). The orbit inclinations of long-period comets is distributed through all inclinations, forming a spherical distribution around the sun. Therefore, the KB cannot be their source, but rather the Oort cloud is needed.

Therefore, the existence of the Kuiper belt no longer is in doubt, and given that most TNO objects are in stable orbits, it is erroneous to say it does not exist. Of course that does not necessarily guarantee a supply of short-period comets over billions of years. There are other problems as well; many binary TNOs have been discovered, for example (Johnston, 2015b). The short-period-comet argument may not be a good young-solar-system argument to make. Since the KB cannot be the source of





**Figure 8.** Estimated diameter as a function of perihelion distance ( $q$ ) for TNOs. Black diamond at 30 AU represents Neptune. A line indicates the nature of the cutoff that would result from detectability limits; in other words, objects lying along this line would have the same apparent brightness from Earth (assuming the same albedo). Note the lack of detected objects with perihelia beyond 47 AU. Reproduced from Johnston (2015d).

long-period comets, the invisible Oort cloud is still needed as the final supply reservoir. However, its existence remains hypothetical.

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