

Critique of Modern Oort Comet Theory

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Abstract

The Oort comet theory proposed in 1950 has been extended and modified by modern research. Creationists have used short-period comets as a young-age indicator and suggested that comets caused impacts on the moon and the earth. The original ideas of Jan Oort from 1950 have been modified by scientists today to deal with difficulties in Oort's original proposals. This paper reviews modern theories on comets, especially regarding the orbital dynamics of the different types of comets. Short-period comets are considered as two separate groups: the Jupiter-family comets and the Halley-type comets. Both groups of short-period comets have a limited "lifetime." Long-period comets and near-parabolic comets also are considered as the original rationale for the Oort theory. A young-age view suggests that long-period and near-parabolic comets may have been created along their current orbits, headed inbound toward the sun. Naturalistic comet theories have experienced difficulties related to explaining how comets could make the necessary transitions from one type of orbit to another. The Oort theory is also believed to apply to extrasolar planetary systems. This implies that it should be possible to observe interstellar extrasolar comets, yet none have been observed. These issues show that though it is widely accepted by astronomers, the Oort comet theory has not been successful.

Introduction

In 1950, the well-known Dutch astronomer Jan Hendrik Oort proposed the existence of what is now called the Oort Cloud, a region thousands

of astronomical units from our sun where many comets are believed to reside (Oort, 1950, 1951). Creationists have consistently doubted and rejected the concept (Slusher, 1980; DeYoung,

1989; Faulkner, 1997; Looy, 2006). Yet the concept is widely accepted by the scientific community, though variations on the original proposal have been investigated. Many studies of comet orbits and the Oort cloud have taken place, including many types of computer simulations. After over 60 years of research on the Oort proposal, it is appropriate to evaluate the theory. In fact, a number of persistent problems with the Oort theory have not been adequately explained.

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These include problems related to short-period comets (for Halley-type and Jupiter family comets), the number of long-period comets observed, and what happens to comets in the Oort cloud. Another interesting question arises as an implication of the Oort theory: Why are there not extrasolar interstellar comets entering our system?

It is appropriate to review terminology on comets and orbits before dealing with the Oort theory. Recall that *perihelion* (often designated with lowercase letter q) is the point on an elliptical orbit that is closest to the sun. *Aphelion* is the point that is at the greatest distance from the sun (designated with capital Q). The *semimajor axis* (usually designated with lowercase a) is one-half the longer distance across an elliptical orbit, from the perihelion to the aphelion. Another helpful concept regarding orbits is the concept of *total energy*, which is defined as the kinetic energy plus the gravitational potential energy (usually written as $E=T+V$). *Gravitational potential energy* (V) can be written as $-GM_{\odot}m/r$, where G is the gravitational constant, M_{\odot} is the mass of the sun, m the mass of the comet, and r represents the distance from the sun. If the total energy (E) of an object in orbit is positive, it will travel on a hyperbolic orbit and will likely escape the sun's influence. If an object has a negative total energy, it will travel on an elliptical orbit and will be bound to the sun. If an object had a total energy of exactly zero, then it would follow a parabolic trajectory and possess an orbital eccentricity of exactly 1.0. In astronomy, elliptical orbits have eccentricities between 0 and 1.0, and hyperbolic orbits have eccentricities greater than 1.0.

Comets are grouped into certain categories according to the periods of their orbits. *Short-period comets* have long been considered those with orbital periods less than 200 years, and *long-period comets* have been those with orbital periods greater than 200 years.

Today there are additional categories of comets. One category is for those with orbital periods between 20 and 200 years. These are often referred to as *Halley-type comets*, or sometimes simply as intermediate-period comets. The Halley-type comets often are in highly inclined and sometimes retrograde orbits. Another class of short-period comets is known as *Jupiter-family comets* (JFCs). JFCs are observed in orbits that lie mostly between Mars and Jupiter. Their orbits are also more frequently modified than other comets, even over timescales less than 100 years. A significant number of JFC objects have been discovered in recent years by various observations. The JFC objects are defined in terms of something known as the *Tisserand parameter*, which essentially measures their tendency to be perturbed by Jupiter (Danby, 1962; Jewitt, 2004).

The Tisserand parameter is a number usually defined in relation to Jupiter. It is used in studying the dynamics of asteroids and comets. The Tisserand parameter, sometimes called the *Tisserand invariant* or the *Tisserand criterion*, is an application of the restricted, three-body problem to comets. It assumes the comet's mass is negligible compared to Jupiter and that the center of mass of the sun and Jupiter as a pair is essentially at the sun. The Tisserand parameter (T_J) is defined below and is a constant of the motion as a small body is perturbed by a planet like Jupiter to a good approximation. In this equation a , e , and i represent the semimajor axis, eccentricity, and inclination of the comet orbit. The semimajor axis of Jupiter's orbit, a_J , is 5.2 A.U.

$$T_J = \frac{a_J}{a} + 2 \sqrt{\left[(1-e^2) \frac{a}{a_J} \right]} \cos i$$

If the Tisserand parameter of a comet has a value between 2 and 3, it is usually considered a Jupiter-family comet. Main-belt asteroids generally have $T_J > 3$.

Short-Period Comets

Creationists have used short-period comets as an argument for a young solar system for some time. This argument hinges on the destruction of short-period comets and that proposed mechanisms of replacing the short-period comets are inadequate. It was once generally thought that short-period comets were replaced from the Oort cloud as longer-period comet orbits are modified by the planets into shorter orbits. Today it is generally believed that short-period comets come from either the Kuiper belt (the region from about 30 to 55 A.U.) or from what is called the "scattered disk" beyond the Kuiper belt. Faulkner addressed the Kuiper belt as a comet source (Faulkner, 1997). The Kuiper belt is a plausible source of the Jupiter-family, short-period comets. Short-period comets are still a valid indicator of a young solar system. However, because so much has been learned about the dynamics of the various classes of short-period comets, there is a need to update the subject. Halley-type comets are believed by scientists to have longer lifetimes than the Jupiter-family comets. For example, one estimate of the physical lifetimes of Jupiter-family comets gives a range between 3,000 and 30,000 years, with 12,000 years being a most likely time for the object to be visible (Levison and Duncan, 1997). This applies to JFC objects near the ecliptic, and it supports the view that they come from the Kuiper belt. One recent listing of known observed comets from the University of Central Florida has 479 JFC objects and 70 Halley-type objects (Fernandez, 2013).

The Halley-type comets (HTCs) have presented unique challenges to comet researchers hoping to explain their origin and dynamics. Halley-type comets have Tisserand parameters less than 2, their orbits are generally more inclined than the JFC objects, and a significant number of them orbit retrograde (orbit inclination is greater than 90

degrees). They also tend to have more eccentric orbits and longer periods than the Jupiter-family comets. Since their orbits are more inclined, the Kuiper belt is not a plausible source for many of them. Thus, some scientists argue they originate from the Oort cloud. On the other hand, it has been argued that if they were from the Oort cloud, their orbits would cover a greater range of inclination angles and the retrograde cases would outnumber the prograde cases. However, this is not observed. Therefore, some scientists have argued that the HTC objects come from the region beyond 55 A.U. distance known as the scattered disk. “Transneptunian region” is a broad term that includes both the Kuiper belt and the scattered disk. The distinctions between the Edgeworth-Kuiper belt and the scattered disk are not totally consistent among researchers. Morbidelli and Brown (2004) consider Kuiper belt objects those from about 30 to 50 A.U. distance that are not likely to interact with Neptune. But the scattered disk starts in the same general region near Neptune and then extends out to distances of about 100 to 200 A.U. The scattered disk objects, according to Morbidelli and Brown, are more likely to interact with Neptune. The scattered disk is believed to include objects with a broader range of orbit inclinations. There has been significant debate among researchers regarding how many objects are in the scattered disk. Orbital simulations have generally convinced researchers that the HTC objects are not likely to come from the Kuiper belt or from Jupiter family comets.

Therefore, the scattered disk is becoming the preferred source for replenishing the Halley-type comets. The scattered disk is believed to consist of objects left over from solar system formation. Many of them never were in the Oort cloud, though it is thought that some of their orbits would be modified to put them in the Oort cloud. After the formation of the solar system, their

perihelia would initially be in the region of the Kuiper belt. Levison et al. (2006) study a scenario in which scattered disk objects first have their orbits lengthened by the outer planets to put them in the Oort cloud. They may stay in the Oort cloud for a long period of time, but they eventually have a tendency to come near Neptune. Neptune can then alter the orbit so that the perihelion is pulled in (to about 1 to 4 A.U.), and the orbit tends to have its inclination altered in the process. Thus, Neptune can alter the orbits of scattered-disk objects so that they become Halley-type comets. This scenario works in simulations but often requires times of over a billion years.

Modern observations of objects in the transneptune region have noted a few objects that are considered scattered-disk objects. Extrapolating from these observations, the implication is that there are fewer objects in the scattered-disk region than models estimate and there are fewer observed Halley-type comets than models imply should exist. Levison et al point out, “So there appears to be a discrepancy between the value of N_{SD} ($d > 10$) needed by our model to make enough HTCs and the observations of the scattered disk, and perhaps with models of Jupiter-family comet origins” (Levison et al., 2006, p. 630). The same authors give a value of 69,000 years for what they call the “death rate” of HTC objects. This would be the time for these objects to be destroyed near the sun, become inactive from loss of volatiles, be captured, collide with a planet, or be ejected out of the solar system. Observational evidence does not suggest an adequate source to replenish these objects. Computer simulations do not explain the HTC objects’ orbital characteristics in a plausible way, even if they did come from the scattered disk. Also, note that the scattered disk is a largely hypothetical construct. It is not known how many objects are present at that distance since opportunity to observe those objects is very limited.

Some conclusions from recent research on short-period comets include the following:

- It is plausible for orbits of Kuiper-belt objects to be modified by influence of the outer planets into centaur or Jupiter-family comet orbits.
- Both Jupiter-family comets and Halley-type comets have a short lifetime that is consistent with a young solar system.
- Models of the Oort cloud and of comet orbital dynamics imply there should be more Halley-type objects than are observed.

Long-period Comets

What observation or observations of comet orbits provided the impetus for the Oort theory? The observation motivating the Oort theory was mainly the properties of the orbits of the long-period comets. The long-period comets suggested to Oort the existence of another, more distant population of source objects, which are often referred to as the near-parabolic comets. Some long-period comets are considered nonperiodic because they have been observed only once near the sun and it is believed they will never be observed again. The term “near-parabolic” is sometimes taken as synonymous with the term “new comets.” A “new” comet would be a comet that is approaching its perihelion for the first time, thus it would be on its first trip toward the sun. It is debated by scientists how many of the near-parabolic comets are actually “new” comets. A few near-parabolic comets are observed each year. They are in extremely long, narrow elliptical orbits with eccentricities being a decimal value very close to 1. An issue that is debated today is how to determine if a long-period comet is a new comet or a returning comet; that is, is it on its first trip toward the sun, or has it passed its perihelion before? This distinction turns out to be an important issue in comet studies.

Jan Oort's theory proposed that comets formed along with planetesimals in the region near the outer planets very early in the history of our solar system. They would have been deflected outward away from the sun occasionally by the outer planets into longer orbits that put their aphelia at distances on the order of tens of thousands of A.U. from the sun. Oort (1951) reasoned that the cloud would range in distances from the sun from approximately 30,000 A.U. to 150,000 A.U. Estimates both from Oort and more recent scientists suggest the number of comets in the Oort cloud would be approximately 10^{11} . Oort also considered that if an object reached distances of tens of thousands of A.U. from the sun, perturbations from the planets would be negligible and the perturbations of nearby stars would become significant compared to the gravitational pull of our sun. Thus, as comets would form in the early solar system, they would form in nearly circular orbits originally as other planetesimals and asteroids; then planets such as Jupiter or Saturn could modify orbits of some of these small objects and increase the eccentricity and size of the orbits.

Once an orbit is made more elliptical, it becomes likely for it to cross the orbits of the planets. Thus, some kind of gravitational interaction with a planet would also be more likely. This is believed to lead to comet orbits being altered into very long eccentric orbits that would put their farthest point (the aphelion) possibly at tens of thousands of A.U. distance. At the aphelia, comets would be moving very slowly, and thus they would be easily perturbed by forces from outside our solar system, such as nearby stars. If there were many other comet objects in the same region, the objects essentially could be "caught" by the cloud while they moved slowly near the aphelion of their orbit. The comets then could be stable in the comet cloud for millions of years. Oort suggested that nearby passing stars could sometimes

perturb comets out of the comet cloud so they would head inward toward the sun and possibly become observable (Oort, 1950, 1951).

Modern Modifications to the Theory

Modern theory attempts to explain comets by thinking of them as if moving up and down a ladder. Some of the steps in the ladder were not envisioned by Jan Oort. The comets with the longest orbits are those referred to as the near-parabolic comets, whose aphelia are in the farthest regions of the Oort cloud. These represent the "top" of the ladder. Then there are long-period comets with orbital periods ranging from hundreds of thousands to millions of years. Within those orbits are the comets of the inner Oort region (aphelia distances from roughly 3,000 to 20,000 A.U.); then, moving inward, we find the short-period comets. To explain all the comets, modern scientists attempt to argue that comets can move both up and down this "ladder" of distance scales, thus explaining our observations on the one hand and sustaining the Oort cloud on the other hand. But there have always been difficulties explaining the various orbital transitions required for objects to move up and down the distance ladder. The scattered disk, which lies outside the Kuiper belt, and the inner Oort cloud can be thought of as the "middle" of the distance ladder. They constitute transition regions from which comets are evolving both inward and outward in the theory.

In recent years scientists have modified the original Oort proposal. First, it has been found through many computer simulations that passing stars are not very efficient at perturbing comets inward toward the sun (Fernandez, 1994; Dones, et al., 2004). This mechanism was the only one seriously considered by Oort, but it is generally accepted today that by itself this mechanism would not provide

enough comets to explain observations through history. Today it is generally accepted that the forces that perturb comets out of the Oort cloud are three. In order of their importance, they are (1) galactic tidal forces, (2) passing stars, and (3) occasional nearby giant molecular clouds. The galactic forces from the plane of the Milky Way galaxy are believed to be the most effective of these forces in nudging comets out of the Oort cloud and sending them inward toward the sun so that they may be observed.

A second change from Oort's original concept regards short-period comets. It was thought that short-period comets could have come from the Oort cloud, as could long-period comets. But today it is generally understood that short-period comets could not come from the Oort cloud (though for HTC objects this is still debated). Where the short-period comets come from is still a mystery debated by astronomers, but the Edgeworth-Kuiper belt is considered the best candidate source. After a comet has been perturbed out of the Oort cloud, it will require hundreds of thousands or even millions of years for it to make its way near to the planets so that it might be observed. The outer planets, especially Jupiter and Saturn, tend to modify incoming comet orbits. An incoming long-period comet is about equally likely to get accelerated such that it is ejected out of the solar system or have its orbit modified so it is a smaller, less elliptical orbit (Dones et al., 2004).

These long-period comets may have their orbits further modified as they make more frequent passes near the outer planets. Jupiter tends to capture or deflect comets relatively frequently. So the comets that are thought to come in from the Oort cloud will face one of several fates, according to theoretical studies. They may pass near enough to Jupiter (or Saturn) that they get accelerated into a hyperbolic path that causes them to escape the sun's gravity and continue indefinitely into space. Or

they may collide with a planet or other object in the solar system. They could fall into the sun or be broken up near the sun. Or they could be deflected by Jupiter or Saturn back out toward the Oort cloud again. Of comets that are deflected outward into long orbits, some of these could get “caught” in the Oort cloud once again (about 5% return to the Oort cloud by one estimate in Dones et al., 2004). Even some of the objects in the Oort cloud may also get perturbed out into space and escape the sun’s gravity after being in the Oort cloud for a long period. Oort seemed to underestimate the tendency of objects in the Oort cloud to be lost into space, escaping the sun’s gravity.

Because of the issue of how often objects in the Oort cloud could escape into space, as well as move inward toward the sun, astronomers have modified the dimensions of the Oort cloud. Oort believed the cloud would continue possibly somewhat beyond 150,000 A.U., but today scientists argue it would not continue farther than about 100,000 A.U. Today it is generally understood that the outer part of the Oort cloud has a tendency to lose objects into outer space. This has been shown in computer simulations studying stellar perturbations. Nearby stars are just as likely to make a comet in the Oort cloud escape into space as come inward toward the sun. Thus, it is believed tidal forces from the galactic plane are more effective at perturbing comets inward. In addition, there have been no observations of comet objects on trajectories suggesting they could have come from outside our sun’s influence.

Considering the relative speed of our sun compared to the local standard of rest in our galaxy, objects coming from other stars and passing into our solar system should be travelling at very high-speeds (such as tens of km/sec at the outer Oort cloud). Thus any extrasolar interstellar comets would be on hyperbolic orbits very different from

any other objects in our solar system and would have eccentricities much more than 1.0. In other words, even if a comet were “at rest” in space relative to the galaxy, it would still approach our sun at a significant speed if coming from another star. Since no extrasolar comets have been observed approaching our system, there is no prospect of the Oort cloud being refilled from outside our solar system. Thus, it is not just short-period comets that must be replenished over long periods of time. The Oort cloud itself must be replenished to last for billions of years.

Astronomers have proposed that there is an inner Oort cloud, sometimes referred to as the inner core of the Oort cloud. The inner Oort region ranges from about 3,000 A.U. out to about 20,000 A.U. It is believed that Jupiter and Saturn could occasionally “pump up” the orbital energy of comets in the inner Oort region to replenish comets in the outer Oort region. Thus, the outer planets, particularly Jupiter and Saturn, are believed to have a crucial role in explaining both inbound comets that we can observe and outbound comets that are thought to replenish the Oort cloud over billions of years.

Jan Oort did not believe that objects would be stable in the region now called the inner Oort cloud. Significant research has been done on perturbations to comets that could reside in the Kuiper belt region and the inner Oort region. It is believed some objects from this region could be modified to become Jupiter-family comets or centaur objects (if their orbits are shortened). Other inner Oort comets could be modified into longer orbits that move them farther out into the Oort cloud. Thus, the inner core region in essence is treated as an important transition zone. Orbital periods of inner core comets would range from several thousand to a few million years. Note that in an old-age perspective, some long-period comets have been able to orbit the sun multiple times and return

again. But a young-age alternative may be to understand almost all the inbound, long-period comets as being on their first orbit.

Difficulties with Modern Comet Theories

It is important to test comet models against observations and ask how successful the models have been in their explanatory power. One obvious issue with the Oort theory, even with modern observational techniques, is that development of the theory depends greatly on supposing populations of objects that cannot be observed, such as most of the scattered disk, all of the inner Oort cloud, and all of the main Oort cloud. There are valid insights from the many orbital evolution simulations of comets. But these studies do not actually establish the existence of a spherical comet cloud. The orbital studies do show that there are objects (the long-period comets) that tend to have aphelia on the order of 10,000 to 50,000 A.U. But this does not establish the existence of the Oort cloud; it merely establishes that these objects are in extremely long elliptical orbits.

The near-parabolic comet orbits possess the longest and most eccentric orbits known of all objects gravitationally bound to our sun. The existence of these comets may be one of the best arguments in favor of the Oort theory. These objects seem to move as if they were started almost at rest and allowed to fall toward the sun. This is essentially what the Oort theory says. It has these objects existing for a long period at great distance from the sun, where they drift in quasi-stable orbits until some effect imparts a small acceleration to them—enough to make them begin falling toward the sun. Then after a few million years, they come nearer to the planetary region, where they can be observed in the highly elliptical near-parabolic orbits. This may be consistent with the Oort theory, but a creation perspective

could allow for them being created or forming at a lesser distance along their current orbits. It is not necessary to assume that comets have traversed their entire orbits or even half of their orbits since creation. The period of a comet orbit does not tell us the age of the universe, the galaxy, or the solar system.

A significant difficulty with today's comet theories is that the number of observed, returning long-period comets are less than that predicted by the models. For example, Jewitt states "The dynamical part of Oort's model predicts a ratio of returning comets relative to first-appearing comets that is larger than is observed" (Jewitt, 2004, p. 660). Generally, researchers assume that comets with aphelia greater than 10,000 A.U. are new; they have never reached their perihelion before. However, researchers admit this is a crude assumption. Hughes stated, "We are not able to divide the long-period comets sensibly into different 'age' groups" (Hughes, 2001, p. 523). Here "age groups" assumes there will be identifiable orbital characteristics that indicate something about how many orbits comets have made. This is a very questionable assumption for the long-period comets. It is true that a comet will be brighter at its first perihelion passage than it will be at later perihelions. However, brightness variations do not seem to give much insight into long-period comets that have not yet been observed near perihelion. It is also possible to calculate backward and determine the prior position of a comet, within limits. Dybczynski (2001) proposed a different definition of new comets, saying they must have a previous perihelion of at least 15 A.U. Dybczynski's approach attempts to account for planetary perturbations on observed comets to determine their previous perihelion. By this definition only 44 comets would qualify as new. It has proved difficult to identify orbital characteristics that would be related to the number of orbits a comet has completed. Thus, comet orbit studies

suggest it is questionable that researchers can make a reliable determination of whether a particular observed comet is "new" or not. We may know about how many orbits an observed comet has made, but comet researchers attempt to use statistical analyses of comet orbits to infer whether comets not observed near the sun are new or not. This effort has not been successful in my opinion.

Hughes (2001) also summarized his results modeling comet visual magnitudes (represented by H) and distance and compared them to observations by another study. He says, "In passing, equation (10) predicts that 15 long-period comets per year pass the Sun having $q < 1$ A.U. and $H < 10.5$, in comparison with the 3 yr^{-1} quoted by Fernandez (1999)" (Hughes, 2001, p. 523). A number of studies of the statistics of comet magnitudes and aphelia distance have noted that the number of long-period comets seems to "fade" or drop off with decreasing distance more than would be expected. Jan Oort referred to this in his 1950 paper, and it is still noted by researchers today. On the other hand, some have applied special analysis methods that give somewhat better agreement with observations (Francis, 2005). But various methods of comparing models to observations give widely varying results. Francis (2005) shows discrepancies in how the LINEAR mission observations of comets compare with his own and two other comet models, especially regarding the number of comets as a function of perihelion distance. Here LINEAR represents the Lincoln Near Earth Asteroid Research project conducted by MIT. In studying near-earth objects, LINEAR has discovered 279 comets. Astronomers have not arrived at a consensus on an explanation for this "cometary fading" effect. This fading effect is not related to a comet being less bright after passing near the sun. This is assumed to be some effect occurring before the comet exhibits a coma—before it reaches the inner solar system that makes these

comets hard to observe. This could be an indication long-period comets do not transition into the planetary region as often as suspected. Long-period comets are not generally believed to be modified into short-period comets directly. But once a long-period comet comes near the outer planets, the outer planets tend to further modify the orbit, often by reducing the semimajor axis and reducing the eccentricity. Without adequate numbers of transitioning long-period comets, this leads to difficulties with explaining the short-period comets, as well as the frequency of comets being deflected outward to replenish the Oort cloud.

Planetary science has in recent times been propelled by an enhanced motivation from the discoveries regarding extrasolar planets. The evidence for the existence of extrasolar planets is good, and many examples now exist (Spencer, 2011). It is generally accepted among scientists that solar systems outside our own generally form in a manner similar to how our system is believed to have formed. A solar disk contracted and condensed into our sun and planets. Comets are believed to have formed in the regions of our system near the forming outer planets, where ices and volatile compounds could condense into small bodies. Therefore, if the processes that formed many comets in our solar system also occurred in other solar systems, this has an interesting implication. Models have estimated that of all the comets that could form near the outer planets early in the history of our solar system, only a small percentage would traverse to the Oort cloud and be stable there. Some comets that would form among the newly forming planets may collide with a planet or fall into the sun. Others stay in orbit relatively near the sun and never make it to the Oort cloud. In our solar system, Jupiter and Saturn are able to accelerate comets to escape velocity in a number of cases, leading to objects that are observed to follow hyperbolic

trajectories out of the solar system. So the only objects that would make it to the Oort cloud in the beginning would be those that happened to pass by one of the planets so that it was deflected outward away from the sun; then of those that were deflected outward, a few might get captured into the Oort cloud. This is how the Oort cloud is believed to have formed. Valtonen and Innanen estimated that “at least one out of 1000 original comets would remain in the solar system in the Oort cloud” (Valtonen and Innanen, 1982, p. 307). This implies that many more escape from the Oort cloud into interstellar space. Thus, if this were happening for most nearby stars, there should be many comets in the interstellar medium. We should then be able to observe some of these extrasolar interstellar comets.

Since 1982 other estimates that consider more modern observational techniques have led to discussions of the issue of “missing interstellar comets.” Sen and Rana (1993 p. 298) refer to estimates saying that for every comet “trapped in the Oort cloud, there should be 30–100 comets lost into the interstellar medium.” A more recent study by Francis (2005) uses a lower estimate for the number of long-period comets and arrives at the conclusion that with modern methods a 5-year observational study could detect one or two interstellar comets if the work could detect objects of 24th magnitude. So even with the most conservative assumptions regarding the number of comets, it should be possible to observe interstellar comets. As two researchers said, “This lack of detections of extrasolar comets is becoming an embarrassment to the theories of solar system and cometary formation” (McGlynn and Chapman, 1989, p. L105). These comets would have a very distinctive hyperbolic trajectory and would travel at velocities at least several kilometers per second faster than any other observed comets. Such a finding would be a newsworthy event. But comet

researchers seem to always agree that no one has ever observed an object like this.

It might be objected that these interstellar comets would be so faint that they would be impossible to observe. If you assume traditional observation techniques with one person using a telescope, it may be impossible to observe such objects. But today there are multiple projects that do totally automated searches of the sky in which multiple CCD cameras collect large amounts of data. Some of these projects can detect very faint objects. Thus, astronomers are more hopeful now than in the past that interstellar comets could be observed. There are only a few projects active today that can observe objects of 24th magnitude. Others are planned. There is at least one new telescope that is especially well suited to detecting faint interstellar comets. It is called the Pan-STARRS telescope at the University of Hawaii. The Pan-STARRS results website shows that since its mission began in 2010, 14 long-period comets have been discovered, but no interstellar comets have been reported (Hsieh, 2013). There are a number of efforts to do automated data collection and automated software searches of image data to find faint objects in our solar system. The near-earth asteroid search is one of the drivers of this effort; the search for extrasolar planets is another. There is also interest in mapping objects in the Kuiper belt. It is these automated searches with wide-field cameras specifically made for finding faint objects and doing sensitive photometric measurements that would be most likely to find interstellar comets.

Why is it no interstellar comets have been observed? First, it may be that they aren't there in the numbers predicted by the Oort theory. Also, if both the galaxy and our solar system are young, we would not expect to see such objects. Such extrasolar comets, if they exist, would not have had time to cross space from nearby stars in a time frame of 6,000 years. Long-period comets would

traverse only a small part of their orbit in several thousand years. Observations of comets tell us about comet orbits, but they do not really confirm the Oort theory. It would be appropriate for creation scientists to examine the research on comet orbits. The shortage of observed Halley-type comets, the shortage of observed returning long-period comets, the young physical lifetime of short-period comets, and the lack of any observed extrasolar interstellar comets all imply the Oort theory has not been successful. A young-age creation perspective does not dictate how many comets should be observed or how long their orbits should be. We should question the assumption that all comets can be explained by their orbits transitioning up and down a great “distance ladder.” Orbital simulation studies of comets give insight into the dynamics, but they do not tell us the actual history of long-period comets or the near-parabolic comets.

This review has not addressed issues regarding the composition of comets. This is an area where much has been learned in recent years as well. Young-age creationists should explore alternatives to the Oort theory that begin with supernatural biblical creation and yet deal with the scientific evidence realistically. Comets also could have relevance to explaining cratering in the solar system and some of the effects of Noah's Flood.

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