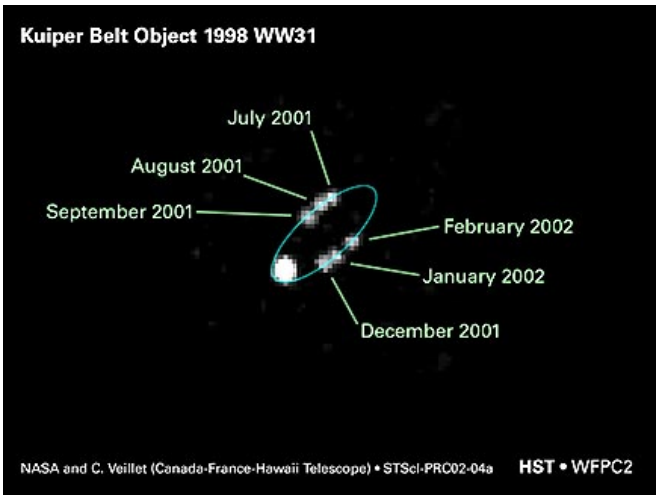
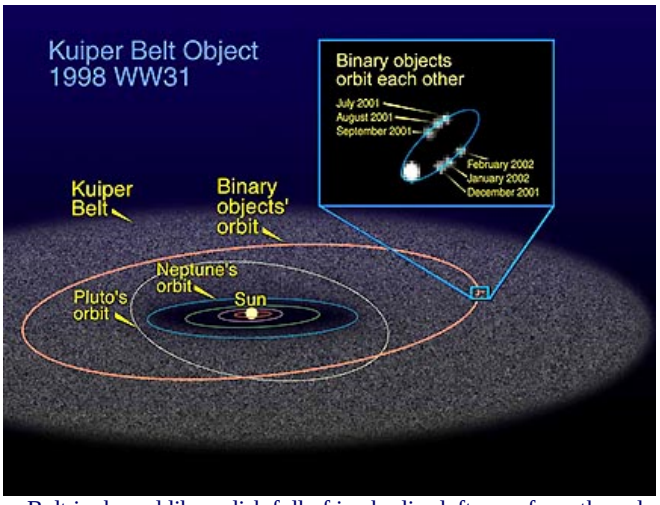
Hubble Telescope Photographs Seven Objects Traveling In Pairs Beyond Pluto



This NASA composite picture shows the apparent orbit in blue of one member of a pair of Kuiper Belt Objects (KBOs) known as WW31. The six fainter points of light are Hubble photographs of WW31 as it moved relative to another object which is the larger, brighter light.
The two objects revolve around a common center of gravity, like a pair of waltzing skaters. Astronomers
assembled this picture from six separate Hubble Telescope exposures taken from July to September
2001, December 2001 and January to February 2002. The location is in the Kuiper Belt of icy objects
that were left over from the solar system's birth and which orbit beyond Pluto.
Graphic courtesy NASA and C. Veillet, Canada-France-Hawaii Telescope.

July 11, 2002 Baltimore, Maryland One of the most recent discoveries in our solar system, NASA reports, is an "intriguing new class of objects, dim and fleeting, which travel in pairs in the frigid, mysterious outer realm of the solar system called the Kuiper Belt." These Kuiper Belt Objects (KBOs), inhabit a region that begins around Neptune and extends out more than *nine billion* miles. At least half of the short-period comets that come through the solar system, around the sun and back out again are from the Kuiper Belt, named after astronomer Gerard P. Kuiper who headed the Lunar and Planetary Laboratory at the University of Arizona until his death in 1973.



The Kuiper Belt is shaped like a disk full of icy bodies left over from the solar system's formation. The region begins around Neptune and extends out more than 9 billion miles. Graphic courtesy of NASA and A. Feild, Space Telescope Science Institute.

The first KBO was discovered in 1992. Then only a year ago on April 16, 2001, Veillet and his colleagues announced the first discovery of the binary 1998 WW31. Since then, with the help of the Hubble Space Telescope, astronomers have discovered seven pairs of small objects which revolve around each other in the Kuiper Belt. No one yet knows why. Christian Veillet of the Canada-France-Hawaii Telescope Corporation (CFHT) in Kamuela, Hawaii, reported in the April issue of *Nature* that, "More than one percent of the approximately 500 known KBOs are indeed binary a puzzling fact for which many explanations will be proposed in what is going to be a very exciting and rapidly evolving field of research in the coming years."

This NASA composite picture at the beginning of this report shows the apparent orbit in blue of 1998 WW31 and its binary companion. The two objects revolve around a common center of gravity, like a pair of waltzing skaters. This composite photograph shows six fainter points of light that are WW31 moving relative to the other object which is the larger, brighter light. Astronomers assembled this picture from six separate Hubble Telescope exposures taken from July to September 2001, December 2001 and January to February 2002. Scientists have been surprised that in one year, seven objects in the Kuiper Belt have been discovered orbiting in binary pairs. The objects are quite small, at least 5,000 times less massive than Pluto, so small that the most Hubble can see are white pinpoints of light.

An artist's depiction of the Kuiper Belt binary object known as 1998 WW31 in the foreground.
The dark, round object in the distance is its companion. The objects are thought to be about the
same size of 100 kilometers diameter (70 miles) and move around their common center of gravity
the way ice skaters waltz around each other. The Sun is the small white dot in the upper left

corner.
These binary objects take 301 years to revolve around Sun compared to Pluto which takes 248 years.
Illustration courtesy NASA and G. Bacon of the Space Telescope Science Institute.

The orbit of 1998 WW31 is the most eccentric ever measured for any binary solar system object or planetary satellite. According to NASA scientists, "its orbital distance varies by a factor of ten, from 2,500 to 25,000 miles (4,000 to 40,000 kilometers). The challenge is to understand how the KBOs end up traveling in pairs. Did they form that way together? Or were they bumped into each other by other bodies passing through the Kuiper Belt?

Ian Griffin, Ph.D., Astronomer and Head of the Office of Public Outreach at the Hubble Space Telescope in Baltimore, Maryland, talked to me about the challenge to learn more about the strange Kuiper Belt Objects, their binary nature and the evolution of our solar system.

Interview:

Ian Griffin, Ph.D., Astronomer and Head of the Office of Public Outreach at the Hubble Space Telescope in Baltimore, Maryland: "The Kuiper Belt is a very mysterious region. It's a place we're still learning lots about. We know of about 500 objects in that region of the solar system which are outside the orbit of Pluto going outward. The first one was discovered back in 1992, so our knowledge of this region only extends back about ten or twelve years.

How far beyond Pluto?

In the case of WW31, it's just a little further out than Pluto. Its orbital period and its partner's is about 301 years. So, it's very similar in orbital period to the orbit of Pluto.

What do you astronomers think the Kuiper Belt Objects are made of and why would seven of them be in a binary relationship with other objects?

First off, they are most likely rocky and icy bodies. Secondly, the orbit of WW31 is very, very strange. Because of this high eccentricity where the orbit is very squashed, nothing this eccentric has been seen in the solar system before. And precisely how this object got into this strange situation is a subject of intense discussion. When you think about satellites going around objects in space, they tend to be fairly circular orbits. But this object has a very squashed orbit. It is very eccentric. Why it should be in that orbit is really unknown.

It varies from 2,500 to 25,000 miles?

That's exactly right, yes. It is a very interesting tiny world. If you were an astronaut standing on the surface of one of the members of the pair, you would see the other member of the pair approach and recede dramatically during the course of the 570 day orbital period.

Do you have any speculation?

Oh, perhaps the bodies were split, maybe in a collision. Perhaps they came close enough to each other and very loosely captured each other in a very loose way and that resulted in the orbit we see. There are lots of different possibilities. As I say, we really don't know which is right.

There are now seven known binaries. that means scientists will have to explain why there would be at least seven pairs of the Kuiper Belt Bodies revolving around the Sun.

That's right. In fact, if we look in other areas of the solar system, we see that binary objects are pretty common. In the main asteroid belt, the one between Mars and Jupiter, there are several known binary asteroids. Then there is

another set of asteroids that cross the orbit of the earth called Near Earth Asteroids. At least six of those are known to be double, too. So, it's not uncommon out there in space to have partners or binary companions.

The really exciting thing for astronomers is that since the discovery of 1998 WW31 in the Kuiper Belt only last year (2001), that really excited the field. As a result of its discovery, other people went looking for binary objects in the Kuiper Belt and seven have turned up. It's a very hot area of astronomy at the moment, trying to find these double objects.

Does anybody yet know what the sizes are?

Thanks to Sir Isaac Newton using the magic of gravity, we can roughly figure out the masses of these objects and their densities. We've been able to figure out that the objects are not very dense at all. They are similar in density to comets and that is interesting because we know outside of the Kuiper Belt there is a vast reservoir of comets called the Oort Cloud, named after the famous astronomer Jan Oort. Maybe the Kuiper Belt is a transition region between the rocky stuff we see in the inner solar system and the kind of more icy stuff we see out in the Oort Cloud.

This is the first time we have analyzed the mass and density of a Kuiper Belt Object and the only reason we can do that is because it's in a binary system. And the exciting thing is that as we turn up more of these binary systems and as we measure their orbits and understand their masses, we're going to gain insight into the Kuiper Belt in a way we couldn't have done before.

Will these icy Kuiper Belt Objects become comets at some point?

They may be cometary in nature, but we won't see that because they are so far from the sun that the energy from the sun isn't enough to melt, vaporize their ice, to give them additional comet tails. So, because they are so far away we wouldn't see them as cometary type bodies.

Why would there be comets come from the Oort cloud and not from the Kuiper Belt?

They could come from both regions. Some of these objects are comet-like, rather than rocky. Really we are going to need to look at a lot more to say anything with any certainty. The field of binary Kuiper Belt Objects is only a year old and we only have 7 objects and of those 7 objects, only one has had its orbit really well determined. So, it's going to take a lot of work to understand the story these objects can tell us about this interesting region of the solar system.

What is the diameter of 1998 WW31?

That's another interesting thing about it. The components are both about 100 kilometers across. They are small compared to planets. Most planets are significantly larger than that. But both components of the binary system are about the same size, one is slightly smaller by 20 kilometers or so than the other. But they are the same size and that's kind of interesting in itself.

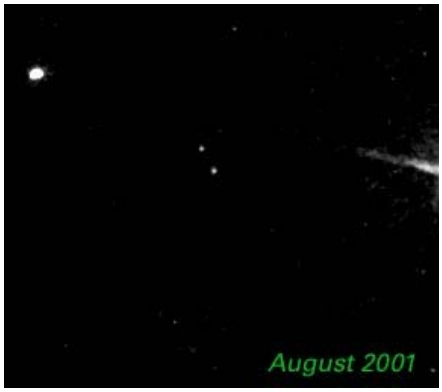
Implying that something in the process of solar system creation would produce Kuiper Belt debris of similar size?

I guess it's not that surprising that objects are similar in size out there. Much of this material is left over from the time the solar system formed roughly 5 billion years ago.

Are most of the KBOs 100 kilometers in diameter?

No, the only ones we know their sizes with any certainty is this one pair, 1998 WW31. The components of those are about 100 kilometers, or 70 miles, across. Until the other binary objects have their orbits measured, we won't know the sizes of them. So, the only objects we have any degree of certainty at the moment are this pair.

Hubble Photographed WW31 Over 8-Month Time Period



Could you comment about the sequence of photos Hubble took of the KBOs?

What you are seeing there is a bit like a time lapse movie being combined to show the motion of one object around the other. There are six observations above from July 2001 through to February 2002 this year. On each occasion, Hubble took a picture and what we did to measure the orbit was to measure the position of one object relative to the other object. You can see that it changes over time. That's because the two objects are in orbit *around* each other. Using those observations, we were able to calculate what the orbit would look like. From that we can measure the masses and get information about the diameters of the objects, too.

The Object Perturbing the Oort Cloud (See **Earthfiles 01/26/02**)

Can Hubble be used to search for the hypothesized brown dwarf that might be perturbing comet paths in the Oort cloud?

One of the biggest problem with using Hubble to look for anything like that is we don't know precisely where to look. Even with the marvelous new cameras we have on Hubble, their field of view on the sky is tiny. It's a bit like having a needle at the end of your arm and holding it up to the sky. That's how much you are looking at when you observe with Hubble.

So, unless you have a very precise position for any suspected object, Hubble wouldn't know where to look. We couldn't point and look for the object.

How Kuiper Belt Objects Were Discovered

How were the Kuiper Belt Objects first discovered?

All of the Kuiper Belt Objects were discovered from ground based observations. Their orbits are pretty well known. For example, with 1998 WW31, we know where it's going to be in the sky very precisely for the next few years. So, if we point Hubble to where we think the object is, we'll see something.

Does that mean the KBOs give off enough light to be seen by ground-based telescopes?

Yes, everything that Hubble looks at in the solar system shines by reflected light. What we are looking at when we look at the pictures of WW31 are two bright dots. The dots are made by ice and rock on the surface of these objects reflecting sunlight. So, when you look at 1998 WW31, what you are seeing is a reflection of sunlight off the surface of the object.

If the objects average only 100 kilometers across, how could astronomers with ground-based telescopes ever find them in the first place?

That is actually one of the most interesting things you can do as an astronomer is to hunt for new objects. And the way these things were found is to take a very

large telescope in the case of this object, WW31, it was discovered in 1998 using a 4 meter telescope on the ground at Kitt Peak Observatory in Arizona. What happened is that the telescope was looking at a patch of sky and it took a picture. And then the astronomers would wait an hour or two and take another picture. And in the time between the two pictures, the object moves. And basically, the way you look for these objects is to take a series of pictures of the sky and you look for things that move between the pictures.

Astronomers were actively looking for new objects at the time because the first Kuiper Belt Object had been discovered in 1992. They were looking for new objects. Since 1992, 500 have been discovered, but only seven are binary. The number of KBOs keeps increasing by several per month.

Going back to 1992, how did anyone even find the first object if the objects had never been seen before?

It's like all things in astronomy. Often times there are theories, and the Kuiper Belt was a region of space that was theoretical up until 1992. It's an excellent example about how theorists sometimes get theories right. The theory was out there that there was this region of space that should have lots of objects in it formed when the solar system was formed, a bit like rubbish left over. And so astronomers decided to go looking for things out there. And it was only in the early 1990s that the combination of a large telescope with a sensitive detector and astronomers looking in the right place at the right time discovered the first objects.

Pluto - Planet or Kuiper Belt Object?

One of the interesting thing about the story is it relates back to the discovery of Pluto back in 1930. The way Pluto was discovered is that an astronomer was taking pictures of the entire ecliptic, the region of the sky where the planets are found, looking for faint objects. In 1930, using photographic plates, Clyde Tombaugh turned up the planet Pluto appearing in different places on different plates since it is an orbiting body in the solar system.

There is still controversy about whether Pluto should be classified as a planet or a Kuiper Belt Object, right?

Yes, it's one of those debates where there is no real right or wrong answer. Pluto is, in most people's minds, a planet. But when you look at it, it's quite different than the other planets in the solar system. It's significantly smaller. It is different from the giant gas planets. So, some astronomers would say that Pluto is just the largest member of the Kuiper Belt. Other astronomers say that it's so much bigger than what we think the other Kuiper Belt Objects are, it really deserves the title of a planet.

I sit on the fence, but I remember growing up and learning Pluto was a planet, so to me it will always be a planet.

Do we know if Pluto is nearly solid ice?

Pluto is probably a mixture of ice and rock.

It would be primordial, right from the beginning of the solar system's cooling down from gas to matter?

That's right, material left over. Water ice could be there as well as other types of ice.

Infrared Telescope (SCIRTF)

Any possibility that with spectroanalysis, astronomers will be able to find out if Pluto and the KOBs are made of the same stuff?

Yes, over the next few years we are going to learn a lot more about the Kuiper Belt, both through the simple use of the binary systems and weighing some of these objects and finding out how big they are. But there are going to be telescopes launched into space in the next few years which will revolutionize our understanding of this region. Perhaps the most important telescope that's due to launch in 2003 is the Space Infrared Telescope Facility (SCIRTF) which is going to be an infrared telescope to one of the earth's LaGrangian points way out in space. And this telescope will look at these Kuiper Belt Object and take spectra of them and those spectra will hopefully give us insight into the composition of the bodies. And we need to use infrared because these objects are very cold and they are a long way out.

The analysis that SCIRTF will give us will hopefully tell us a lot more about what these objects are, what they are made of and will help us understand the very early solar system because we think these objects are pretty primordial. They are left over from very early in the solar system's history. Pluto might have come from there.

You're describing a new astronomical frontier that is only ten years old and in Pluto's back yard.

That's right.

The Kuiper Belt and the Oort Cloud

What is the relationship between the Kuiper Belt and the Oort cloud?

That's another good question. The two overlap and the two have different types of objects. More than that, it's going to take us research to learn. There are different scientists who say different things. If you really want to know the answer to that question, you need to speak to one of the experts on the Oort cloud because they are better versed in the different types of objects than I would be.

The main difference would be what?

The main difference is that one is mostly comets (the Oort cloud) and one is made up of somewhat more dense objects.

The Kuiper Belt is more ice dense and the Oort cloud has more comets?

Yes.

Do astronomers know if there is anything that ever comes out of the Kuiper Belt through the solar system?

I think the answer to that is no. We don't have any examples of objects. There are some comets, such as Halley's Comet its orbit goes out into the Kuiper Belt region. It goes out beyond the orbit of Pluto and then back to the sun.

Did Halley's Comet come from the Kuiper Belt?

No, originally it probably came from the Oort cloud. These things get somewhat complicated.

Would any of the known 500 Kuiper Belt Objects ever come through the solar system?

Collisions can certainly change the orbits of objects out there. But at the moment, all of the Kuiper Belt Objects are in very safe, almost circular orbits around the sun. They are not the source of objects that might hit the earth.

Near Earth Asteroid Potential Collisions With Earth

Of course, there is a large population of objects that cross the earth's orbit the Near Earth Asteroids. At the moment, there are about 1000 objects called Near Earth Asteroids that could cross the orbit of the earth. Those objects, the source of those objects was originally the main asteroid belt, the asteroids in that belt that diverted somehow by gravity, collisions or whatever, to change their orbit and cross the orbit of the earth and they become dangerous. Now, that kind of thing could go on out in the Kuiper Belt, but it is much less likely.They certainly do pose a threat to the future of the earth, a significantly greater threat than the KBOs.

When Will Astronomers Have Photographs of the Kuiper Belt Objects?

Any future plans to take a closer look at the KBOs and photograph them?

There were plans to launch a mission to flyby Pluto. That mission might have gone on close to one of the Kuiper Belt objects. Unfortunately, that mission is not funded. It is still being developed. One of the problems with a mission like that is it takes a long time for the spacecraft to get out to those parts of the solar system at least seven to ten years. Even if we launched a mission next year, which we won't, it wouldn't get any pictures back to us before 2010 or 2011. So it's going to be a long time before we have any pictures of these objects in close-up.

In the meantime, Hubble will continue photographing them?

Yes. We've got Hubble and ground-based astronomers with their huge several-meter-diameter telescopes can also give us useful information about these objects. When the Space Infrared Telescope is operational in late 2003, hopefully we will get much more information about the binaries.

At that point, do you think the infrared telescope can search for the hypothesized brown dwarf that might be perturbing the comet paths in the Oort cloud?

Not unless we get more information about the position of the proposed object, no telescope will ever be able to look for it. All of these telescopes have very small fields of view. Unless we know pretty precisely where any object is, it's going to be much worse than hunting for a needle in a haystack."

More Information:

The Martian Moon Phoebos Has Not Disappeared

Martian moon Phoebos on the left, photographed in 1977,
and Deminos on the right, photographed in 1974.

"What about using Hubble to confirm the Russian rumor that the Martian moon, Phoebos, disappeared. Have you heard about that?

Yes, it is one of those non-sensical things that one hears on the internet. The Phoebos and Deimos both orbit around Mars and it comes back to some eccentric theory about a comet getting close to Mars or hitting Mars, which did

not happen. Mars is where it should be. Its moons are where they should be. Unfortunately, this is another example of what I call 'internet cranks.'"

Website:

http://sirtf.caltech.edu/

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