The Kuiper belt

Project in Space physics

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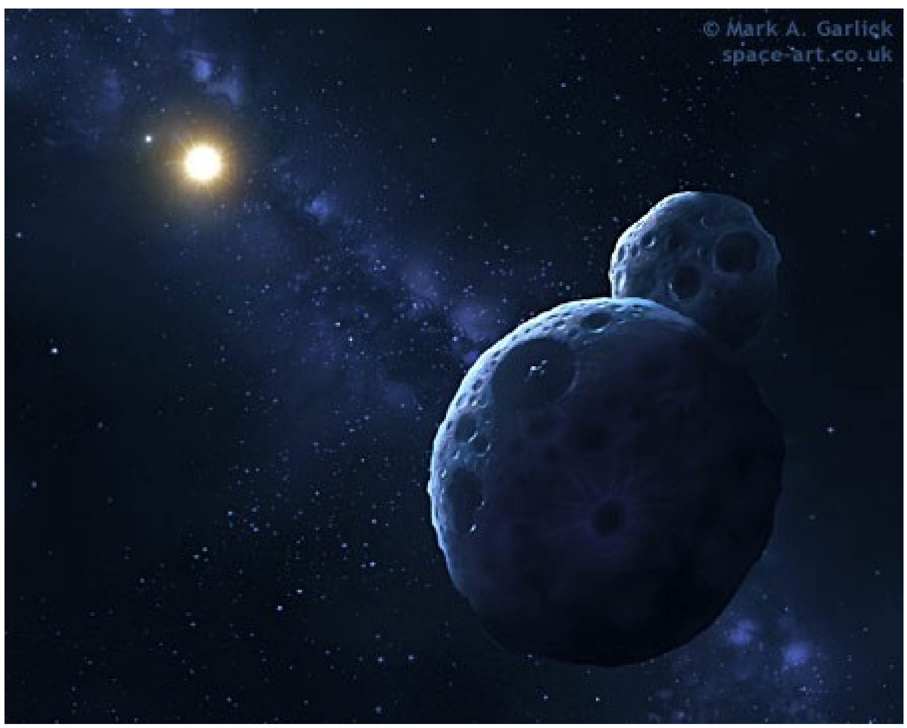

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Introduction

The Kuiper belt, seen in fig. 1 is a disc region containing icy bodies. It lies outside the orbit of Neptune and extends roughly 30-50 AU (1AU = 149597870.691 km) from the sun. Gerard Kuiper was the first person who wrote about this region, thus the name the Kuiper Belt. At times this region is referred to as the Edgeworth- Kuiper Belt giving credits to Kenneth Edgeworth who also wrote on this region. It consist of one dwarf planet and many other small bodies. These bodies called Kuiper belt objects(KBOs) were discovered in 1992 and there are about 70000 over 1km in diameter and about 3500 over 100km.

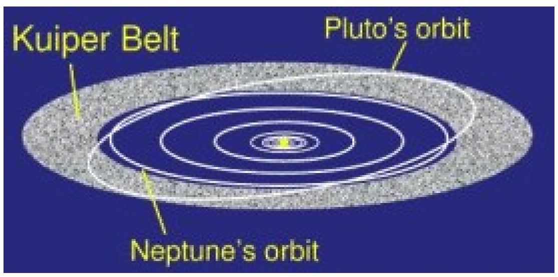


Fig.1: The position of the Kuiper Belt.

The bodies, which can be seen in Fig.2, are composed of largely frozen volatile "dubbed ice" such as methane, ammonia, and water. There are considered as one of the sources of collisionally generated interplanetary dust and most short period comets. Short period comets could also come from the Oort Cloud (situated about 50,000 *AU* from the sun) and the asteroid belt between Jupiter and mars. The Oort cloud is considered as the source of long period comets.

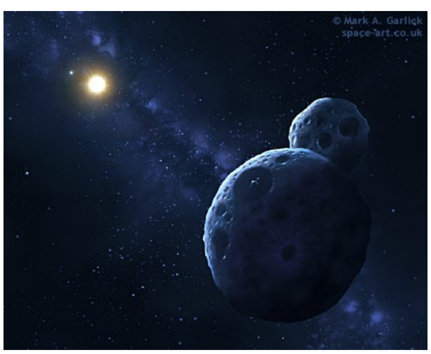
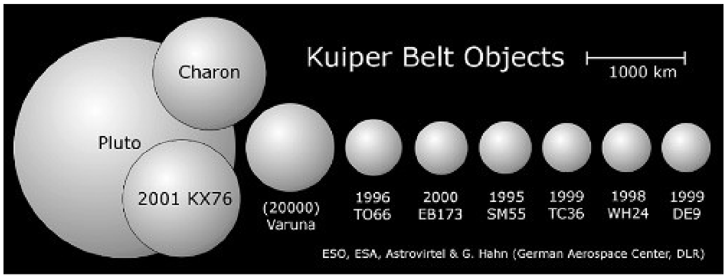


Fig.2: The structure of a BKO.

Kuiper belt objects (KBOs)

As mentioned above there are about 7000 KBOs over 1km and about 3500 KBOs with diameters greater than 100km. Some of the KBOs are: Pluto the largest, Xena, the 2003 UB313, 2003 EL61, 2005 FY9, Charon, Sedna, the 2004 DW, Quaoar, Ixiaon, 2002 AW197, Varuna. Comparative sizes of some large KBOs are seen in fig.3.



Relative Sizes of Large Kuiper Belt Objects

Fig.3: The largest KBOs and their comparative sizes.

Tab.1 below shows the largest KBOs, their diameters and types.

Object	**Diameter [km]**	**Type**
2003 UB313	2400?/-100	Scattered
Pluto	2320	Plutino
2003 EL61	1200?	Classical
2005 FY9	1250?	Scattered
Charon	1270	Plutino
Sedna	<1500?	Detached
2004 DW	~ 1500	Plutino
Quaoar	1200?/-200	Classical
Ixion	1065/-165	Plutino
2002 AW197	890?/-120	Scattered
Varuna	900?/-140	Classical

Tab.1: Size and type of the largest KBOs

Pluto is the largest member of the KBOs. 2003 UB313 is comparatively large. KBOs are some times called trans- Neptunian objects i.e. they orbit the sun at a greater distance on average than Neptune. Their orbits are disturbed be the interactions of giant planets. Thus unlike the planets their orbits are not circular. They have eccentric orbits.
KBOSs are some times divided into the classes: Scattered, Classical, Detached and Plutinos.
Scattered KBOs, as seen in fig.4, have large, eccentric, inclined orbits with a perihelion distance near 35 *AU*.
Classical KBOs have large distance from Neptune even at perihelion.
Like Pluto, Plutinos complete 2 orbits around the sun in the time it takes Neptune to complete 3 orbits thus are called Plutinos.
Detached have aphelion at about 975 *AU* and perihelion at about 76.16 *AU*.

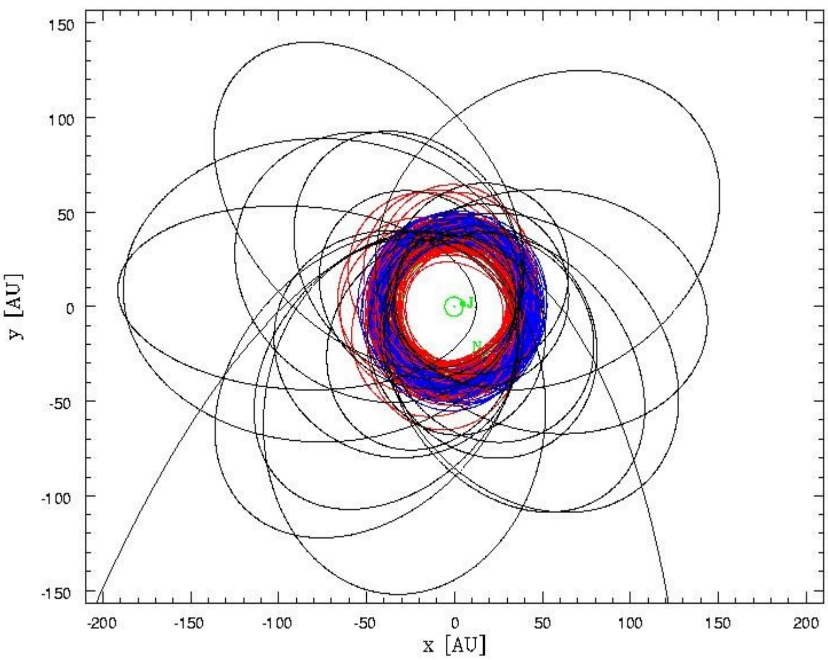


Fig.4: Orbits of scattered KBOs.

Pluto

Pluto originally classified as a planet is now considered to be the largest member of the KBOs. The reasons for this are as follows:
It has characteristics of a KBO and shares it orbit with a number of similar KBOs now called plutinos (i.e. KBOs smaller than Pluto following similar orbits).
It is small with an eccentric orbit that takes it from 30 to 49 *AU* from the sun,
It is highly inclined with respect to the planets.

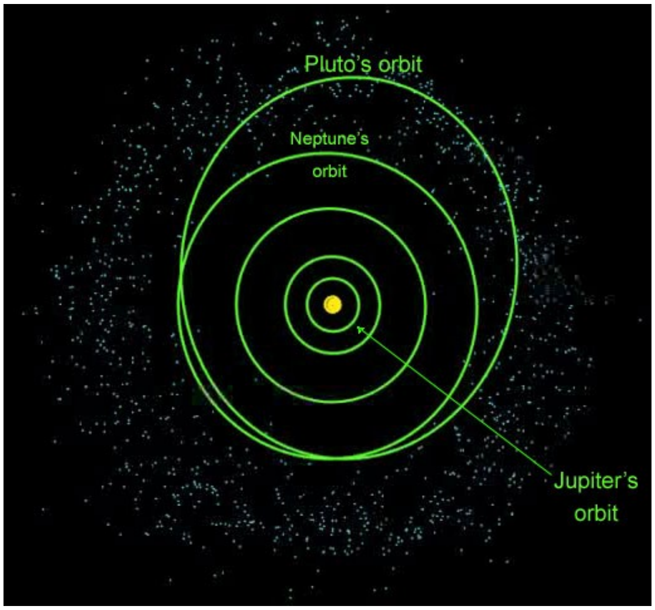


Fig.5: The orbit of Pluto.

Pluto occasionally comes closer to the sun than Neptune as seen in fig.5. It has no atmosphere but sublimation of surface ice generates a weak atmosphere (pressure is about a millionth of the earth's atmospheric pressure). It's surface is made of frozen CO, CH4, and ice mixed with dirt.

Surface composition of KBOs

As mention above, their surfaces are made of ice, ammonia, methane and water. Obtaining information about the surface properties of KBOs is a real challenge. Figures from spectra show that KBOs exhibit a wide range of optical colours, from nearly neutral (reflecting all wavelengths equally), to very red. Recent spectra show absorption features that correspond approximately to that of Pluto, with frozen CO, CH4, and ices mixed with dirt.

Their surface temperatures are approximately 50 *K*, very low, suggesting that the ices trapped at formation should have been preserved over the age of the solar system. Again, unfortunately, most of the KBOs are too small to be meaningful compositional study, even with the largest available telescopes. Water and ice has been reported in a handful of them, but most appear spectrally featureless. Report of Quaoar reveal the presence of crystalline water ice and ammonia hydrate. Crystallinity indicates that the ice has been heated to at least 110 *K*. Both ammonia hydrate and crystalline water ice should be destroyed by energetic particles irradiation on timescale of about 10^7 years(or since creation), but this seems not to be the situation. Thus Quaoar has recently resurfaced, either by impact exposure of previously buried (shield) ices or by cryovolcanic outgassing or by a combination of these processes. We could say here that this may be same with other members of the KBOs although studies are still going on. It could be noted that since the temperatures are really very low this implies that the pressure in KBOs should also be very low.

The atmosphere of KBOs

The presence of an atmosphere on a KBO depends on a few factors. The presences of surface ice for sublimation, high enough temperature to make the ice sublimate and enough gravity to retain gas that has been sublimated. Basically, warm icy bodies can sublimate but will lose the gas if they are insufficiently large (i.e. the escape velocity of the gases depend on the mass of the KBO). The size required for a body will depend on the gas. For carbon monoxide or nitrogen, KBOs much smaller than 2000 *km* diameter would quickly lose their gas into space. Thus it could be clear that most KBOs may not have any atmosphere, although it maybe just a sensitivity problem; the gas may be there but we lack the sensitivity to detect it. Like a reminder here, Pluto has no atmosphere but sublimation of surface ice generates a weak atmosphere.

Conclusion

There are about 70000 KBOs over 1 km in diameter and about 3500 with diameters greater than 100 km.with Pluto the largest member. There are no clear details about their surface compositions and atmosphere, but as far as can be told, they compose largely of frozen volatile (dubbed “ice”) such as methane, ammonia, and water and are considered as the source of collisionally generated interplanetary dust and short period comets.

References

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