



TRANS-NEPTUNIAN OBJECTS

Lexile Measure: 1220L

FIELDS OF STUDY

Observational Astronomy; Sub-planet Astronomy

ABSTRACT

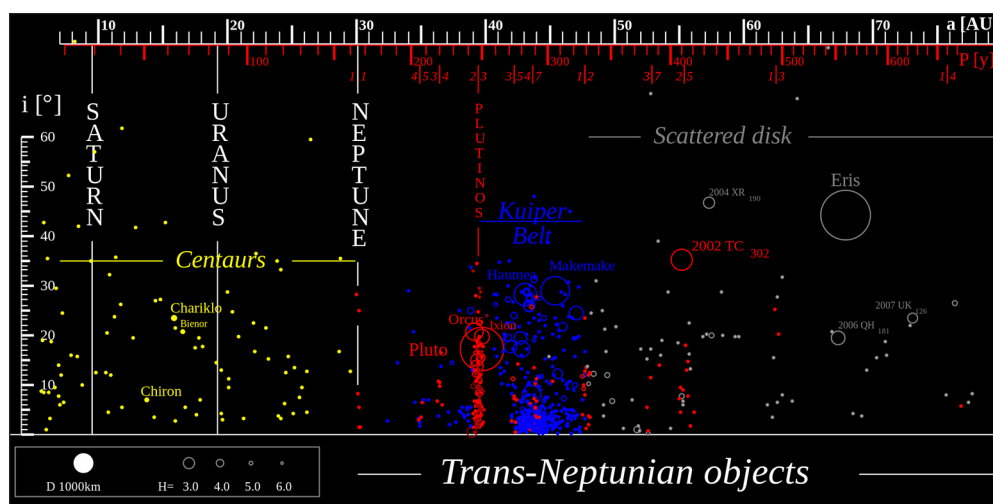
Trans-Neptunian objects (TNO), including Kuiper Belt objects (KBO), are small, icy celestial bodies that are in solar orbit beyond the orbit of Neptune. The first TNO to be discovered was Pluto in 1930. The orbital behavior and characteristics of TNOs provide clues to what lies beyond the boundaries of the known solar system.

PRINCIPAL TERMS

- **detached objects (resonant):** small icy bodies in the Kuiper Belt that are in elongated orbits between 35 and 100 astronomical units (AU) from the sun and are far enough away from Neptune that they are not affected by its gravity.
- **Kuiper Belt:** a ring-shaped section of the solar system populated with small ice and rock objects; also known as the Edgeworth-Kuiper Belt.
- **Kuiper Belt objects (classical and resonant):** small, icy space bodies in the Kuiper Belt, also known as trans-Neptunian objects; most KBOs are classical, with orbits of low eccentricity and inclination; resonant KBOs orbit the sun in a consistent ratio to Neptune's orbit.
- **minor planets:** a celestial object that does not meet the criteria to be a planet or a comet but orbits around the sun.
- **Oort cloud:** a theoretical vast collection of icy space bodies surrounding the solar system beyond the known planets and the Kuiper Belt.
- **plutinos:** KBOs found in the inner edges of the Kuiper Belt that have the same orbital resonance as Pluto, or a resonance of 3:2.
- **scattered disk objects:** also known as scattered Kuiper Belt objects; space bodies made of ice and rock with very eccentric, or flattened oval, orbits that can go both closer and farther from the sun than the other types of KBOs.

Origin and Discovery of Trans-Neptunian Objects

Trans-Neptunian objects (TNOs) are thought to have been formed outside Neptune's orbit in the earliest days of the solar system about 4.6 billion years ago. Many TNOs are likely to be found within one of two regions outside of Neptune's orbit: the Kuiper Belt or the scattered disk. There are differing theories on whether these objects were formed where they are or whether the effects of Neptune's migration into its current position in the solar system moved them to where they are. In either case, the centers of these rocky bodies,



Trans-Neptunian objects are found within the Trans-Neptunian Asteroid Belt, which falls outside of Neptune's orbit (includes the Kuiper Belt and some scattered disk objects).

By Eurocommuter via Wikimedia Commons.

which are also known as **Kuiper Belt objects (KBOs)**, likely contain untouched material from the origins of the solar system.

The Kuiper Belt, the innermost trans-Neptunian region, is so far away from Earth that its existence was only a theory for many years. Clyde Tombaugh discovered Pluto, then considered a planet, beyond the orbit of Neptune in 1930. It was thought that other objects near planet size might be out there, but none were found until 1992. In that year, astronomers David Jewitt (b. 1958) and Jane X. Luu (b. 1963) confirmed the existence of the first TNO, 1992 QB₁.

Types of TNOs

This first discovery led to the identification of other objects in this region of space and the realization that Pluto had more in common with those objects than with the eight primary planets. Pluto is larger than most TNOs and relatively reflective, making it easier to see from Earth. This is why it was designated a planet in 1930. However, with the discovery of other TNOs of similar size and orbit, Pluto was reclassified as a dwarf or **minor planet** in 2006 by the International Astronomical Union. Minor planets are round and orbit the sun like the primary planets do but are not large enough to knock other objects out of their orbits. They are smaller than the primary planets. They are not thought to be capable of maintaining any known form of life.

Plutinos are another type of TNO. They have the same 3:2 orbital resonance as Pluto, meaning they make three trips around the sun for every two made by Neptune. Because Pluto shares this resonance, it is also considered to be a plutino. The first plutino other than Pluto was discovered in 1993. Plutinos make up the largest class of resonant TNOs, or objects that orbit in resonance with Neptune. The orbital paths of many plutinos cross Neptune's orbit, but because they orbit in resonance, they will never collide. Plutinos make up the inner edge of the Kuiper Belt. This part of the belt is closest to the sun.

Scattered disk objects (SDO) are also known as scattered Kuiper Belt objects. These bodies of ice and rock collect in the scattered disk, a flat band encircling the solar system. They have very eccentric, or thin and long, orbits that bring them as close as 35 AU to the

sun or more than 100 AU away. With such eccentric orbital paths, SDOs can cross through the Kuiper Belt but also travel well beyond it through the **Oort cloud** and toward the outer regions of the solar system. Scientists theorize that some objects in the Oort cloud may have originated in the scattered disk, and that comets can originate in both areas.

Detached objects are another type of TNO. Even when their orbit is at its perihelion, or closest point to the sun, detached objects are far enough away from Neptune that it and the other planets can exert only minimal gravitational forces against them. As a result, they seem to be detached from the rest of the solar system. It is theorized that the long elliptical orbits of detached objects are caused by passing contact from a star other than Earth's sun or by the influences of planets other than the gas giant planets such as Neptune and Jupiter. This makes them different from the other TNOs, all of which have orbits affected by the influence of Neptune or the other large planets. The most commonly known detached object is Sedna. Discovered in 2003, Sedna is a planet-like body at the very edge of the solar system. An estimated 1,300 to 1,700 kilometers (about 800 to 1,000 miles) in diameter, Sedna is larger than an asteroid but smaller than Pluto. Its orbit ranges between about 76 and 972 AU from the sun and takes about 12,000 years to complete. From Sedna the distant sun looks like a bright star.

Significance of TNOs

It might seem that TNOs are so far from Earth that they could be of little significance for study or discovery, but scientists find them to be very important. TNOs are believed to be made up of the material left over from the beginnings of the universe. They have been untouched in the deep regions of space for billions of years. This makes them valuable sources of information about the formation of the universe. It is also thought that the region where they are found could be populated with additional planets.

Using archived Hubble Space Telescope photos, scientists have identified and named a number of TNOs. The Hubble Telescope uses long-exposure photography to capture images as it peers into space. This means the camera lens stays open and captures light for a period of time. When the telescope is pointed at one object and something else moves between the object and the lens, its movement creates a streak of light. Scientists determined that when Hubble is pointed something at the far edge of the solar system and a streak is seen, it is a TNO. More than a dozen new TNOs were identified in early 2015 by this technique.

Scientists have also used mathematical calculations to determine that there could be two or more TNOs that qualify as planets beyond the orbit of Pluto. In observing a number of objects in this region of space, scientists noticed that several showed characteristics that cannot be accounted for unless they are under the influence of a planetary body. Since these TNOs are outside the reach of the influence of Neptune, the logical deduction is that there are other planets beyond the known solar system bodies that are affecting the orbit of these objects.

Study will continue into the TNOs, and an additional tool has been deployed to help with the efforts. The National Aeronautics and Space Administration launched the New Horizons mission to Pluto in 2006. By mid-2015, the probe was more than halfway to its destination. It will spend between five and ten years gathering more information about trans-Neptunian objects.

— Janine Ungvarsky

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