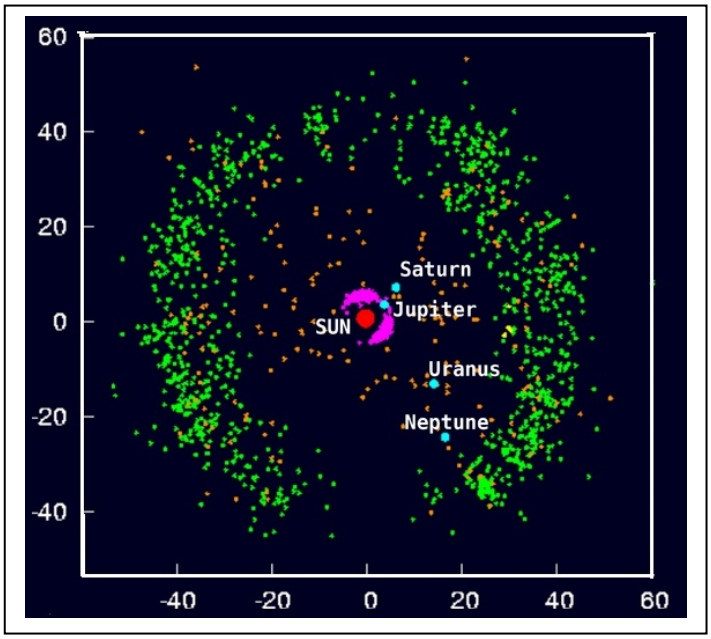

Since the belt was discovered in 1992, the number of known Kuiper belt objects (KBOs) has increased to over a thousand, and more than 100,000 KBOs over 100 km (62 mi) in diameter are believed to exist.

Pluto is the largest known member of the Kuiper belt. Originally considered a planet, Pluto's status as part of the Kuiper belt caused it to be reclassified as a "dwarf planet" in 2006

This figure shows the locations of the known KBOs with the X and Y positions given in terms of Astronomical Units (AUs), where 1 AU equals the distance from Earth to the Sun (93 million miles or 149 million km).

Problem 1 – The Kuiper Belt stretches from 30 to 60 AU and has a torus shape. What is the volume of the Kuiper Belt in cubic kilometers if the volume of a torus is given by

$$V = 2\pi^2 r^2 R,$$

where R is the Kuiper Belts average distance from the sun and r is its radius?

Problem 2- It is estimated that over 100,000 objects larger than 100 km reside in the Kuiper Belt, of which 1,200 have been discovered by 2013. What is the density of the estimated 100,000 objects in objects/km^3 if they are uniformly distributed throughout the toroidal volume of the Kuiper Belt?

Problem 3 – Based upon the average density calculated in Problem 2, about what is the average distance between the Kuiper Belt Objects compared to the distance between Earth and Sun?

Problem 1 – The Kuiper Belt stretches from 30 to 60 AU and has a torus shape. What is the volume of the Kuiper Belt in cubic kilometers if the volume of a torus is given by $V = 2\pi^2 r^2 R$, where R is the Kuiper Belts average distance from the sun and r is its radius?

Answer: R = (60+30)/2 = 45 AU or $45 \times 149 \times 10^6$ km = 6.7×10^9 km
r = (60-30)/2 = 15 AU or $15 \times 149 \times 10^6$ km = 2.2×10^9 km

$V = 2\ (3.141)2\ (2.2 \times 10^9)^2\ (6.7 \times 10^9) =$ **6.4×10^{29} km^3**

Problem 2- It is estimated that over 100,000 objects larger than 100 km reside in the Kuiper Belt, of which 1,200 have been discovered by 2013. What is the density of the estimated 100,000 objects in objects/km^3 if they are uniformly distributed throughout the toroidal volume of the Kuiper Belt?

Answer: $N = 10^5 / 6.4 \times 10^{29}$ km^3 = **1.6×10^{-25} objects/km^3**.

Problem 3 – Based upon the average density calculated in Problem 2, about what is the average distance between the Kuiper Belt Objects compared to the distance between Earth and Sun?

Answer: We just need to calculate the cube root of the density to get the reciprocal of this distance:

$D = 1 / (1.6 \times 10^{-25})^{1/3}$ = **183 million kilometers**.

Since the Earth-Sun distance is 149 million kilometers, the average distance between KBOs is about 1.2 AU or **1.2 times the Earth-Sun distance**.