

THE INFLUENCE OF DWARF PLANETS ON THE STABILITY OF OBJECTS IN THE KUIPER BELT. John A. Burgener¹, Telegistics Inc., 944 Meadow Wood Rd., Mississauga, Ontario, Canada L5J 2S6, John@Burgener.ca

Introduction: Short period comets are generally considered to come from the Scattered Disk of the Kuiper Belt and it is considered that the majority of objects in the Classical and Resonate Kuiper Belt areas are stable and not a likely source of comets.

The Dwarf planets are large enough to have some influence on the orbits of other Kuiper Belt objects. Pluto is the largest dwarf planet to consider since it spends a significant amount of time passing through the 38 – 44 AU zone at speeds similar to the objects in the classic zones. Eris passes through the main Kuiper belt at a steep angle and has much less time to interact so it is a minor influence. Other dwarf planets are smaller and therefore less influential, but some spend sufficient time in the classical belt to have an influence.

The Zone of Influence (ZOI) changes depending on the size of the dwarf planet and its relative speed compared to other objects. For a reasonable estimate, one may take the time required for a dwarf planet's gravity to pull in an object over a two year period, and limit the zone to objects having not more than 0.1 Km/s different speeds to the dwarf planet. The two years relates to the relative speed differences moving objects apart after two years outside of the ZOI.

Pluto's Zone of Influence: Pluto's orbit has a duration of approximately 12 years as it passes from 38 to 41 AU. The two year distance of gravitational pull is a radius of 1.4 million km. Within this ZOI, the orbit of any Kuiper belt object will be impacted, with the resulting change ranging from minor to dramatic depending on how close Pluto passes and the relative speed differences. A minor change in an object's orbit will still alter the orbit of the Kuiper belt object. A major change will dramatically change the orbit of the object and in many cases move the object out of the Classical zone into Neptune's range of influence or into the Scattered Disk.

A simple calculation of Pluto's sphere of influence spread over the length of its journey in the Kuiper Classic Belt zone will give a volume of $\sim 1.075 \times 10^{22}$ cu km, or 0.0032 cu AU. The Classic zone is about 40,000 cu AU assuming the zone extends from 38 to 48 AU and is 10 degrees either side of the Ecliptic.

Therefore, Pluto's ZOI is 0.0032/40,000 of the Classic zone. With estimates of ~ 2 million objects in the Kuiper Belt over 5 km in diameter, this portion of the ZOI should effect $2 \times 10^6 \times 0.0032/40000$ objects each orbit. This is 0.16 objects per orbit, or one 5 km object every 6.25 orbits. With Pluto's orbit of

247.74 years, this works out to be one every 1548 years. Estimating that one of every 50 objects influenced by Pluto's ZOI will eventually cross earth's orbit, then it would be expected that a 5 km comet would occur every 77,400 years, and a 10 km comet occur every 310,000 years. The number of smaller objects is approximately inversely proportional to the size², so 0.5 km objects should be 100X more abundant. Therefore, it should be expected that there should be Earth crossing comets of 0.5 km every 774 years.

These frequencies are much higher than presently expected and warrant further study.