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The Humps of KBO's Size Distribution

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Abstract. We study the possible humps or deviation from the single-power law for the size distribution of the Kuiper Belt Objects (KBOs). Both the current observational data and theoretical simulations show evidence of such humps. We conclude that this is an imprint of the depletion of the outer Solar System in the Kuiper Belt region.

1. Introduction

It is known that the outer Solar System beyond Neptune is populated by small bodies after the first KBO was discovered (Jewitt & Luu 1993). One of the most important properties of KBOs is their size distribution because this gives us some hint of the evolutionary history of the Solar Nebula. Kenyon & Luu (1999) did planetesimal accretion calculations for a mass-conserved single annulus at 35 AU and found that all models produce power-law size distributions.

2. Current Observations and Theoretical Simulations

We obtained the data of currently known KBOs from the daily updated list of Transneptunian Objects at the web site: http://cfa-www.harvard.edu/iau/lists/TNOs.html. The size distribution was determined directly from both the data of 27th July 2000, when there were 282 discovered KBOs and the data of 13th Dec. 2000, when there were 346 discovered KBOs. Figures 1(a)-(b) show that there are humps for the size distribution and the least-square fitting curve of the single-power law fails to be located within the error bars for most of the bins. Is this just a bias effect or is it an important hint for KBOs' history?

Of course, the current observational data may not be statistically significant enough to determine the true size distribution because only a small fraction of the total KBO population has been discovered. In particular, the current data has no constraint or information about the size distribution of smaller KBOs, i.e. objects a few km to 150 km in size. This is the region that the TAOS project (Chen 2000, King 2001) should be able to contribute to.

Therefore, we investigate the humps of the size distribution by the theoretical simulations. We randomly place KBOs in the region between 30 to 50 AU and assume that they follow a single-power-law size distribution. Our calculations show that the size distribution will keep changing as some KBOs escape from this region. This is because the growth of the KBOs causes local gravitational instability, which depends on the size of the objects. This result implies that the

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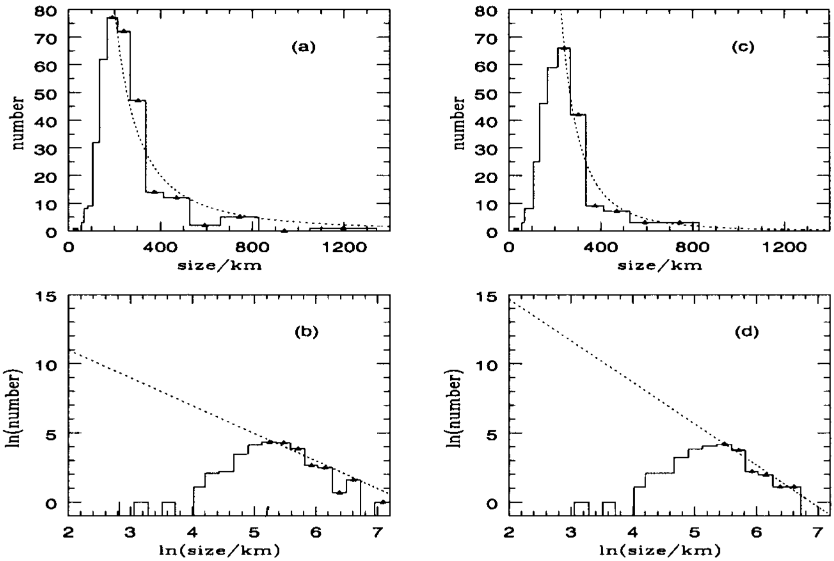

Figure 1. The observational size distributions. Each triangle point is the mean of each bin and these data points are used to determine the power-law least-square fitting curve (dotted line). Panel (a) shows the data from 13th Dec. 2000 and Panel (b) is the same thing but in ln-space. Panel (c) shows the data from 17th July 2000 and Panel (d) is the same thing but in ln-space.

size distribution should have changed during the depletion of the Kuiper Belt region. Moreover, these humps or deviation from the single-power law, as can be seen in both the simulations and the observational data, could be an imprint of the depletion of the Kuiper Belt.

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