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An Oort cloud origin for exceptional TNOs?

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1. Introduction

The recent discovery of several scattering disk (SD) or detached transneptunian objects [1,3,4,5] has revealed a gap in our understanding of the formation and evolution of the outer Solar System. These TNOs have orbital parameters placing them in parts of phase space that currently have no clearly-accepted cosmogonic explanation. They have either very high inclination i or very large pericentres q.

In attempts to address some of these issues, Brasser et al. [2], and Kaib et al. [6] have computed numerical simulations of SS evolution to study the creation of the Oort Cloud, the end result of which is an orbital element distribution for the SD region. The models require validation through comparison with observations.

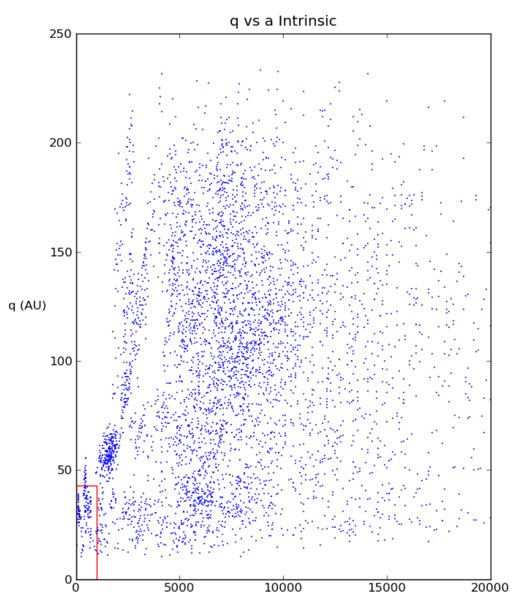

Figure 1: The Kaib model [6] in our parameter space cut. The small lower-left box shows Fig. 2's bounds.

2. Observations

The observational constraints are provided by our North Ecliptic Wedge (NEW), High Latitude (HiLat), and Canada France Ecliptic Plane (CFEPS) surveys [7]. We restricted our comparisons to the region of phase space currently requiring cosmogonic explanation via the following cut: i > 35.5 deg, q > 10 AU, a > 30 AU; this results in one, six and zero detections for the NEW, HiLat, and CFEPS surveys respectively (red circles, Fig. 2).

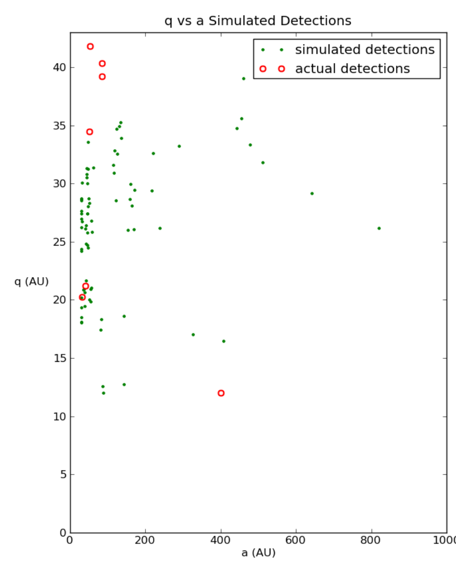

Figure 2: Our real detections and the simulated detections for Kaib's model. The q>35 AU TNOs are rarely produced in this model.

3. Survey Simulator

The CFEPS survey simulator [7] takes a model distribution and exposes it to the same detection biases as the surveys, producing a set of simulated detections to be compared with those found by the observations. An object is drawn from the end-state of a model, assigned an absolute H magnitude, and then passed into the survey simulator. The simulator tests to see if this object would have been detected in any of our surveys. In order to have a more representative sample from the models, which often have few detectable TNOs, objects are drawn at random and the orbital parameters *a, q,* and *i* are then randomly altered by ± 10% for *a* and *q*; and by ± 1 degree for *i.*

4. Preliminary Comparisons

Figure 1 shows the end state of the inner Oort cloud and scattering disk from one of Kaib's simulations. from the Kaib model [6]. Figure 2 (which shows our seven detections and the first eighty simulated detections) illustrates the very strong observational bias towards orbits with low *a* and *q*; all of the simulated detections are well contained in the red box in Fig. 1's lower-left corner. Figure 3 shows that the cumulative distribution of the simulated and actual detections in semimajor axis are not inconsistent. The result is similar for cumulative distributions in i, while the pericentre distribution may be more problematic. Although the detected orbital distributions may be reasonable, preliminary population estimates suggest that this model would require an unreasonably large population in the inner Oort cloud today to produce the observed number of detections in the modelled phase-space cut.

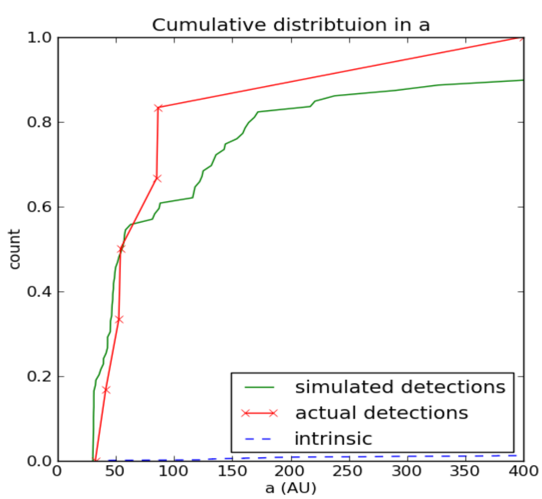

Figure 3: Cumulative distributions in semimajor axis for the Kaib model, for i>35.5 deg and q>10 AU.

5. Summary and conclusions

Preliminary analysis provide tentative optimism that Oort-cloud production models may provide some mechanisms capable of populating extreme regions of phase space, but concerns remain about an overly-large total inner Oort-cloud mass this would require.

Acknowledgements

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