Shepherding the Kuiper Belt Via Ragged Planet–Migration

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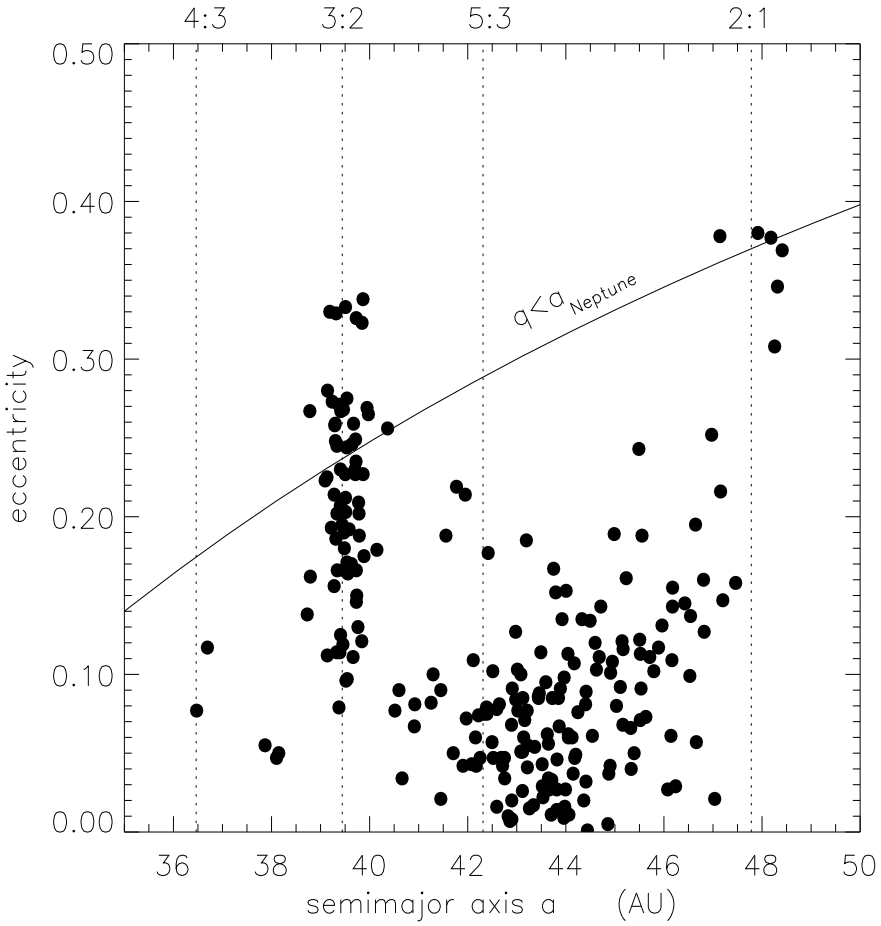
KBO eccentricities e versus semimajor axes a

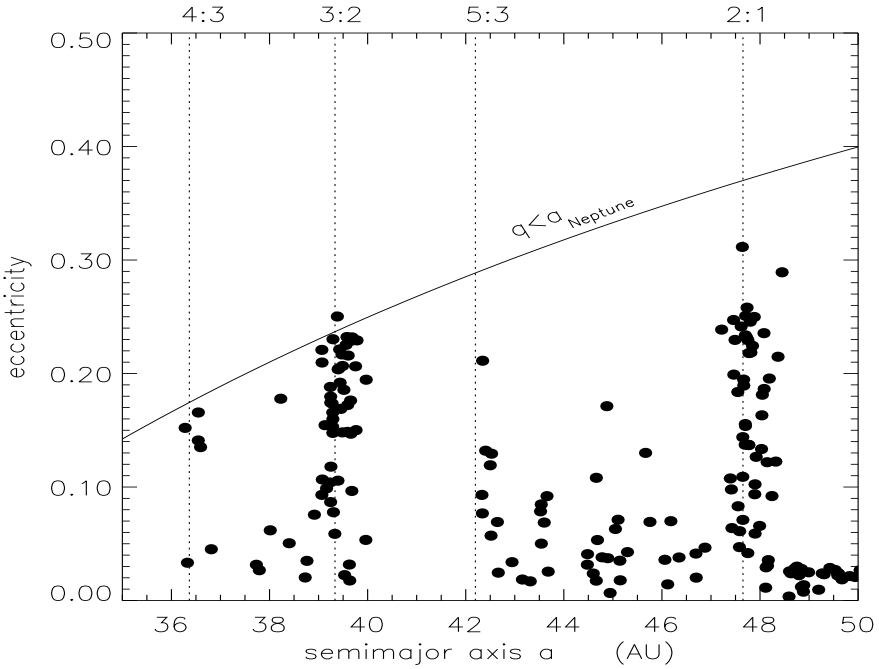


KBO orbit elements suggest that:

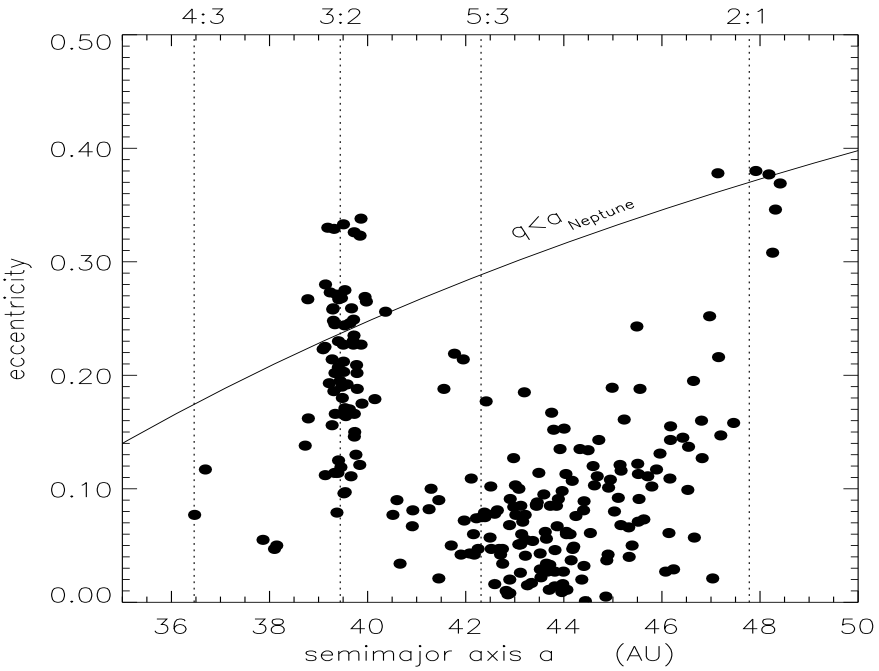
- newly–formed giant planets migrated due to their interactions with the natal planetesimal disk,
- $\Delta a_{Neptune} \sim 8$ AU, which caused mean motion resonances to sweep across the Kuiper Belt,
- resonances would trap KBOs, shepherd them outwards, and excite their e,
- but resonant trapping must have been somewhat inefficient, and that Neptune's migration was not smooth.

Keep in mind that this type of planet–migration is driven by planetesimals that are scattering off the giant planets. Thus some vigorous, random scattering events could contribute some "jitter" to Neptune's outwards migration.

N–body model

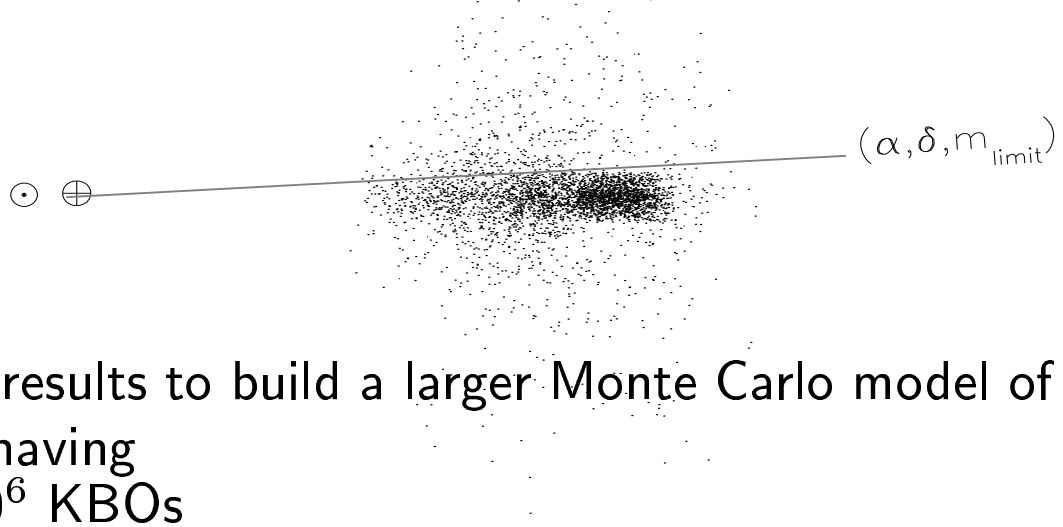


Observations



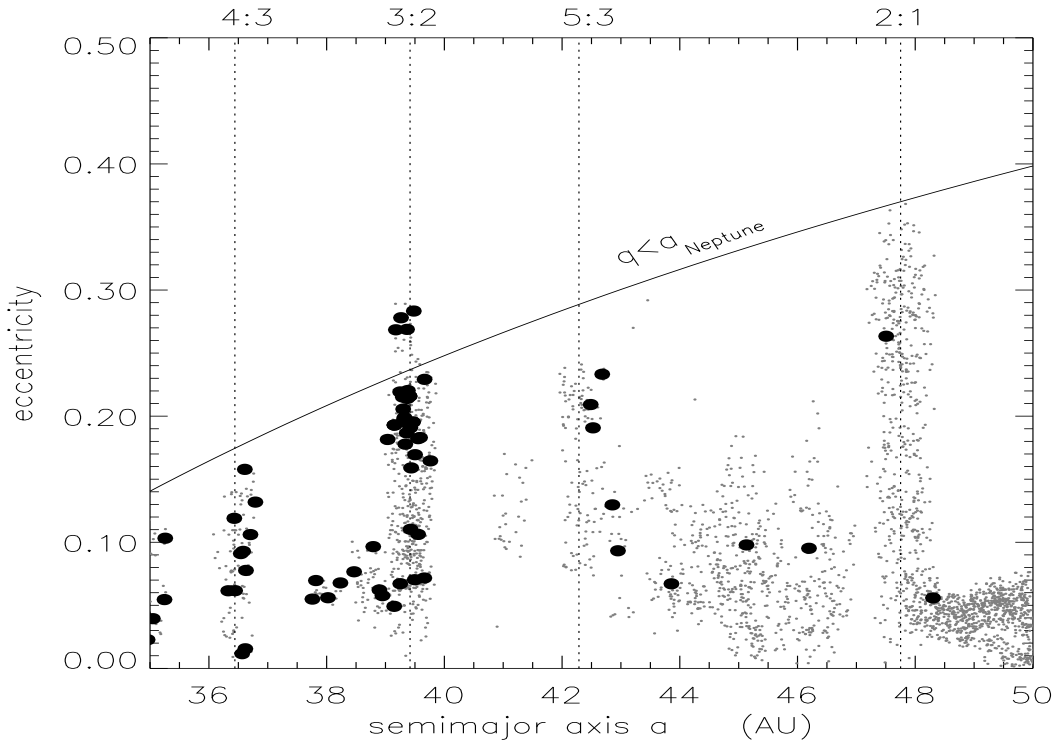
Note the high abundance of model KBOs in the 2:1, and the dynamically cold disk of KBOs beyond.

Before comparing model KBOs to the observed population, telescopic selection effects must be accounted for.



Use N–body results to build a larger Monte Carlo model of the Kuiper Belt having

- $N_{\text{total}} \sim 10^6$ KBOs
- having the observed cum. size distribution $N(R) \propto R^{-2.6}$.
- observe MC Kuiper Belt along each line–of–sight (α, δ) to the limiting magnitude m_{limit} reported in published KBO surveys; only ~ 60 KBOs are reported in these surveys.



However median $i_{\text{obs}} \sim 5 \times$ Monte Carlo.

Preliminary Findings

If a migrating Neptune was the only significant perturber in the Kuiper Belt, then

- some jitter in Neptune's outward migration can account for the $e \sim 0.1$ KBOs in the so–called Classical Disk ($i.e.$, the zone between Neptune's 3:2 and 2:1 resonances). This jitter could have been be due to stochastic scattering of planetesimals by Neptune during its migration episode.

- The planet–migration hypothesis predicts a well–populated 2:1 resonance; their apparent low abundance is probably due to telescopic selection effects.

- There might also be a dynamically cold population of low e and i KBOs beyond Neptune's 2:1 resonance at $r > 48$ AU. They might be small, hard to see, and quite coplanar...

- I am still trying to reconcile the high KBO inclinations with the planet–migration scenario...