The orbits and dynamics of long-period sub-stellar companions

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Many long-period sub-stellar companions have been detected by direct imaging

- PZ Tel (Biller)
- GJ 504 (Kuzuhara)
- TWA 5 (Neuhäuser)
- κ And (Carson)
Question 1: What constraints can we put on their orbits?
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Interpreting MCMC distributions of orbital elements is difficult
Alternative method: plot orbital elements as functions of $z$ and $\dot{z}$
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We find analytic solutions for the allowed ranges of orbital elements (e.g. a general companion’s minimum eccentricity)
Question 2: How would a long-period companion interact with other bodies in the system?
Planet mass $\gg$ disc mass
Planet mass $\sim$ disc mass
Application to HD 107146

ALMA 1.25mm data: Ricci et al. 2015
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Summary

I study the orbits and dynamics of long-period sub-stellar companions. I am particularly interested in

1) How to constrain the orbits of long-period companions
   - alternative techniques complimentary to MCMC
   - how to remove biases in orbit interpretation

2) How eccentric companions interact with debris
   - how does a general system evolve
   - can debris structures reveal unseen perturbers
   - can we model specific systems