



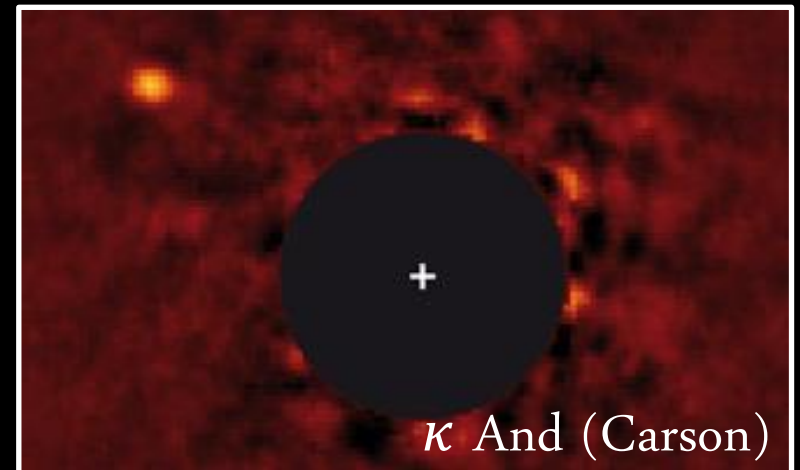
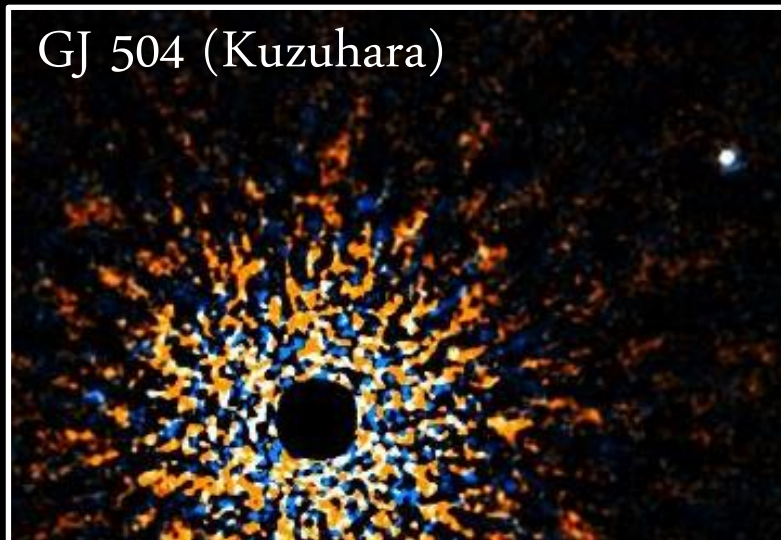
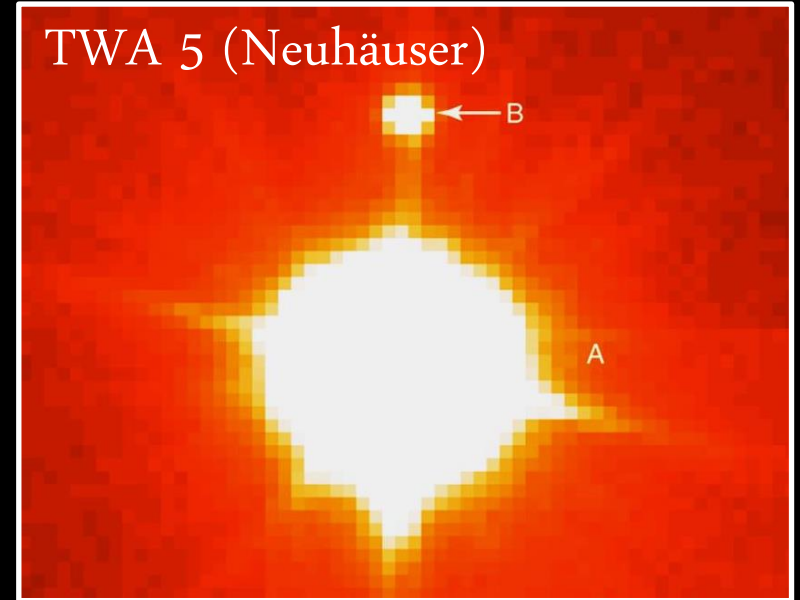
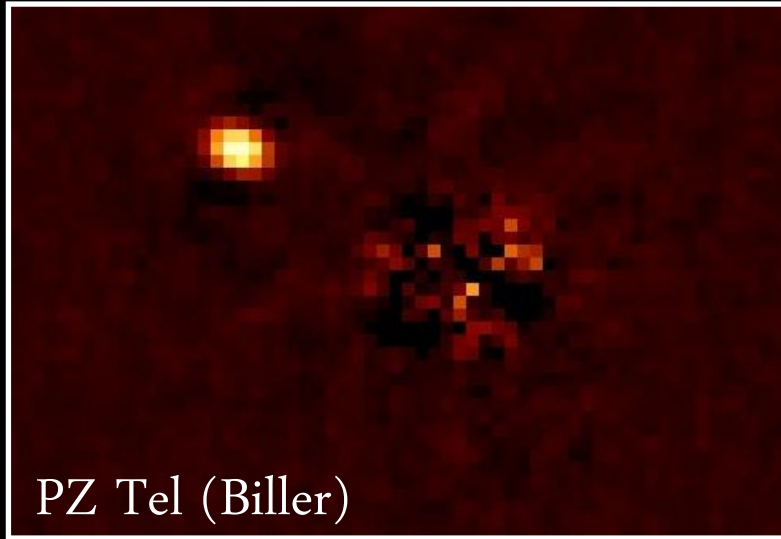
The orbits and dynamics of long-period sub-stellar
companions

Tim Pearce

Mark Wyatt & Grant Kennedy

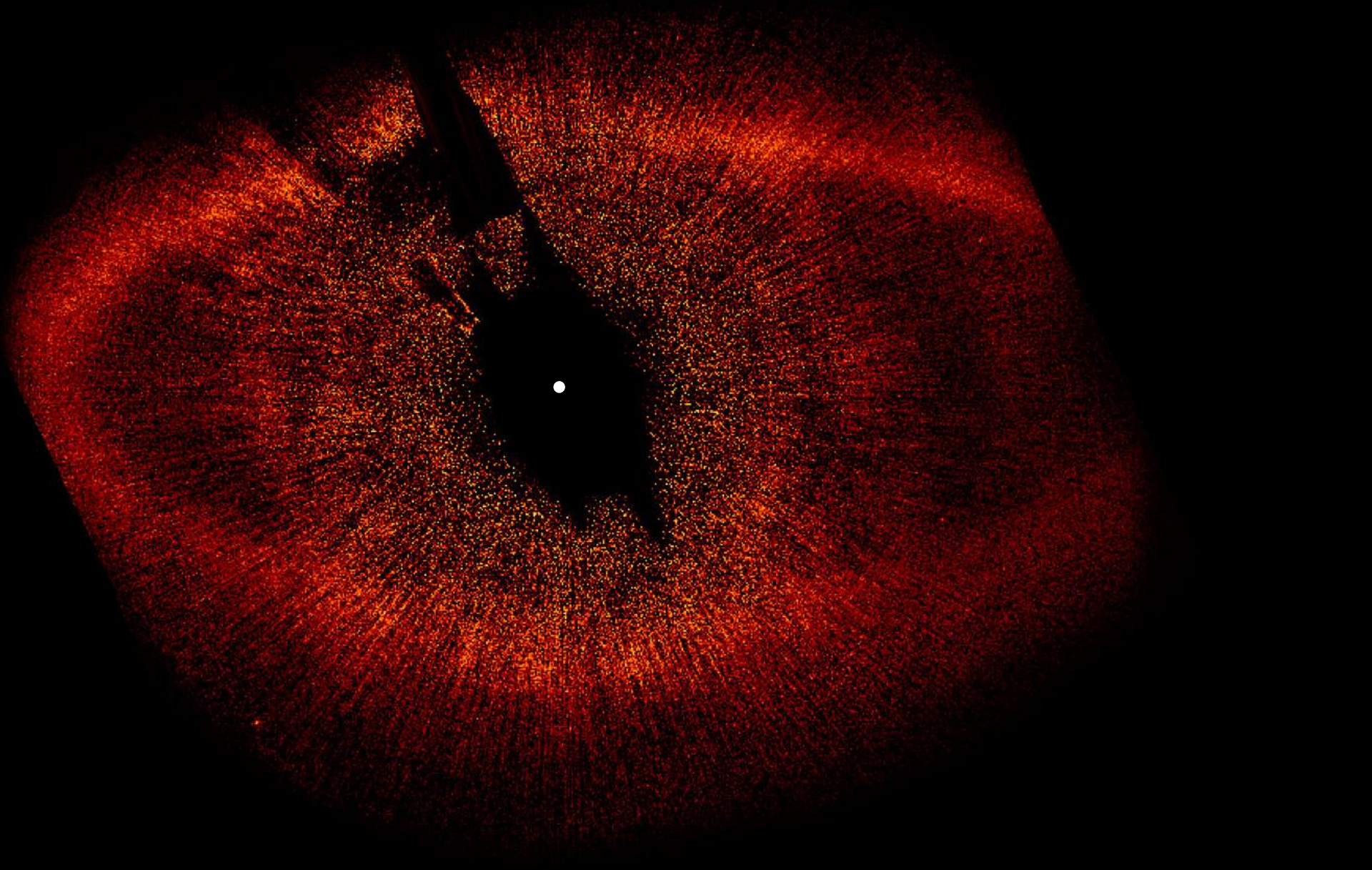
Institute of Astronomy, Cambridge

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

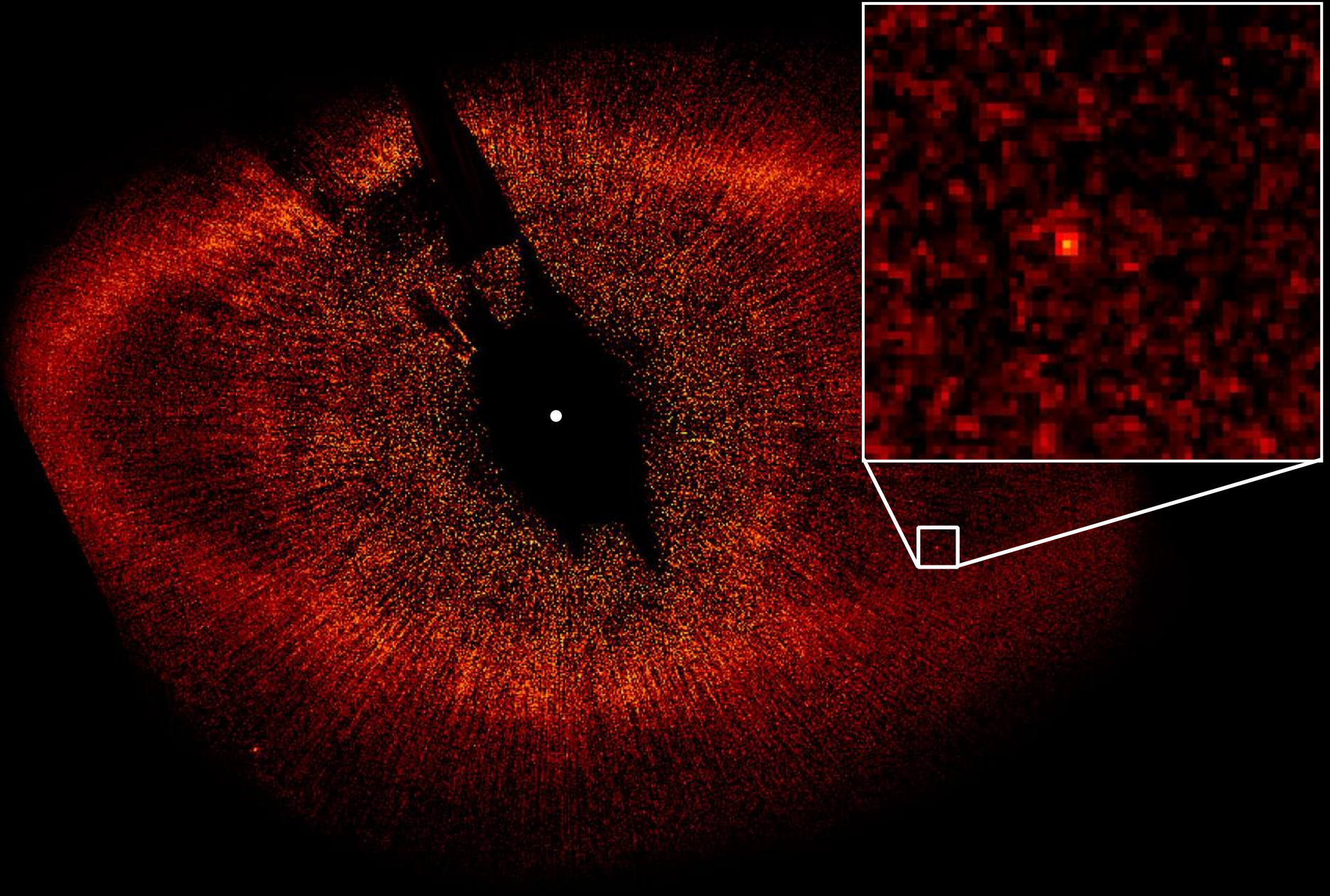


Question 1: What constraints can we put on their orbits?

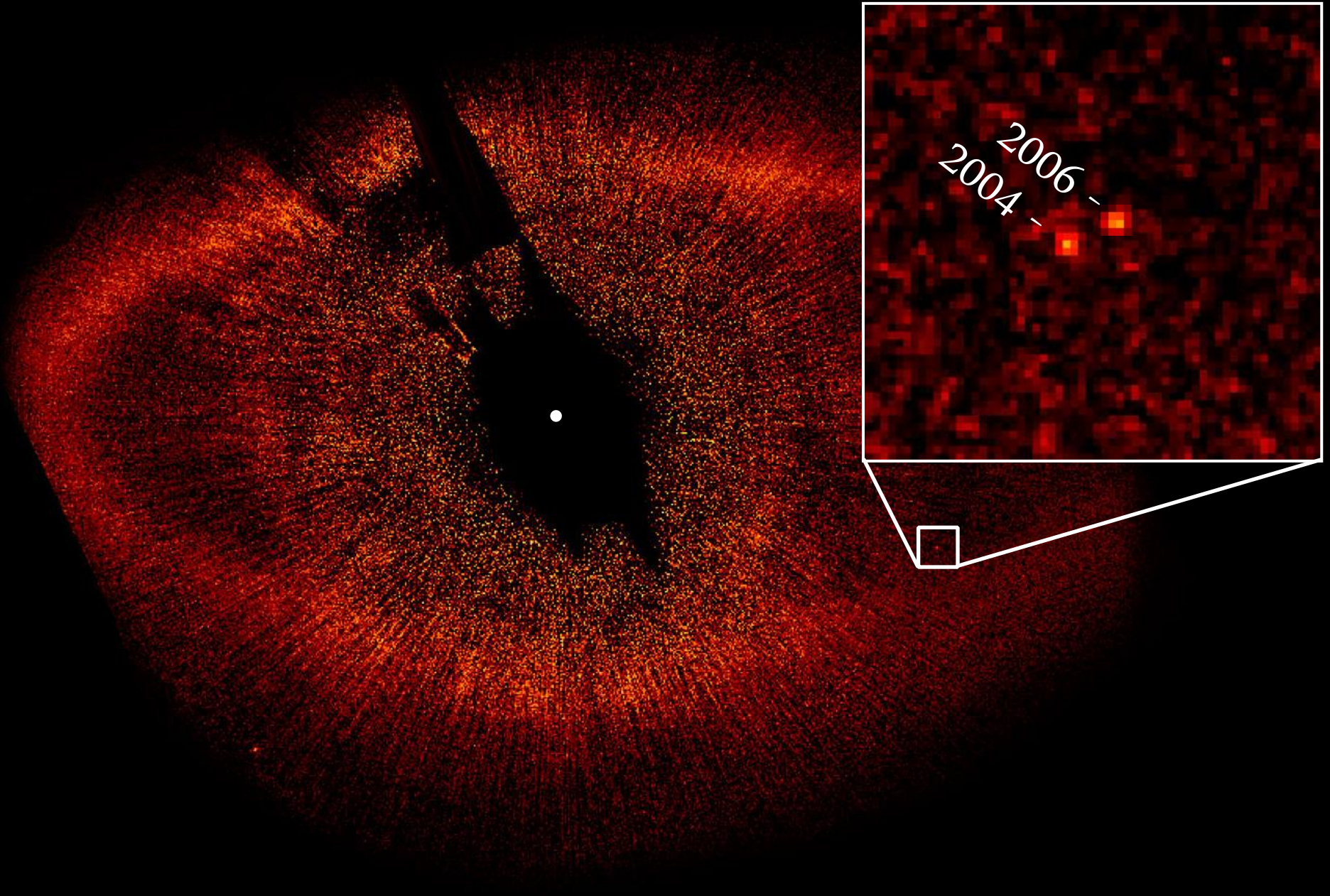
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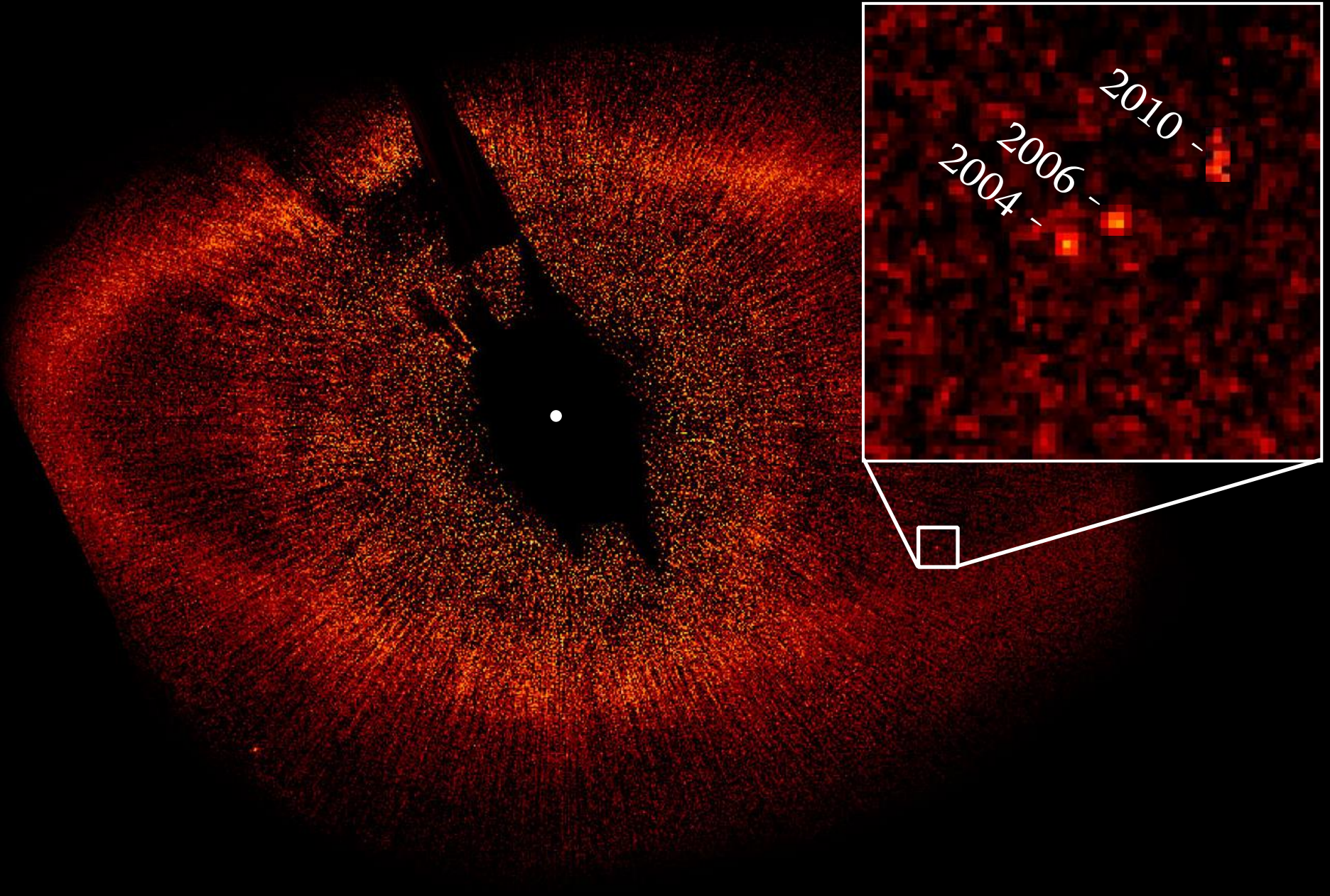
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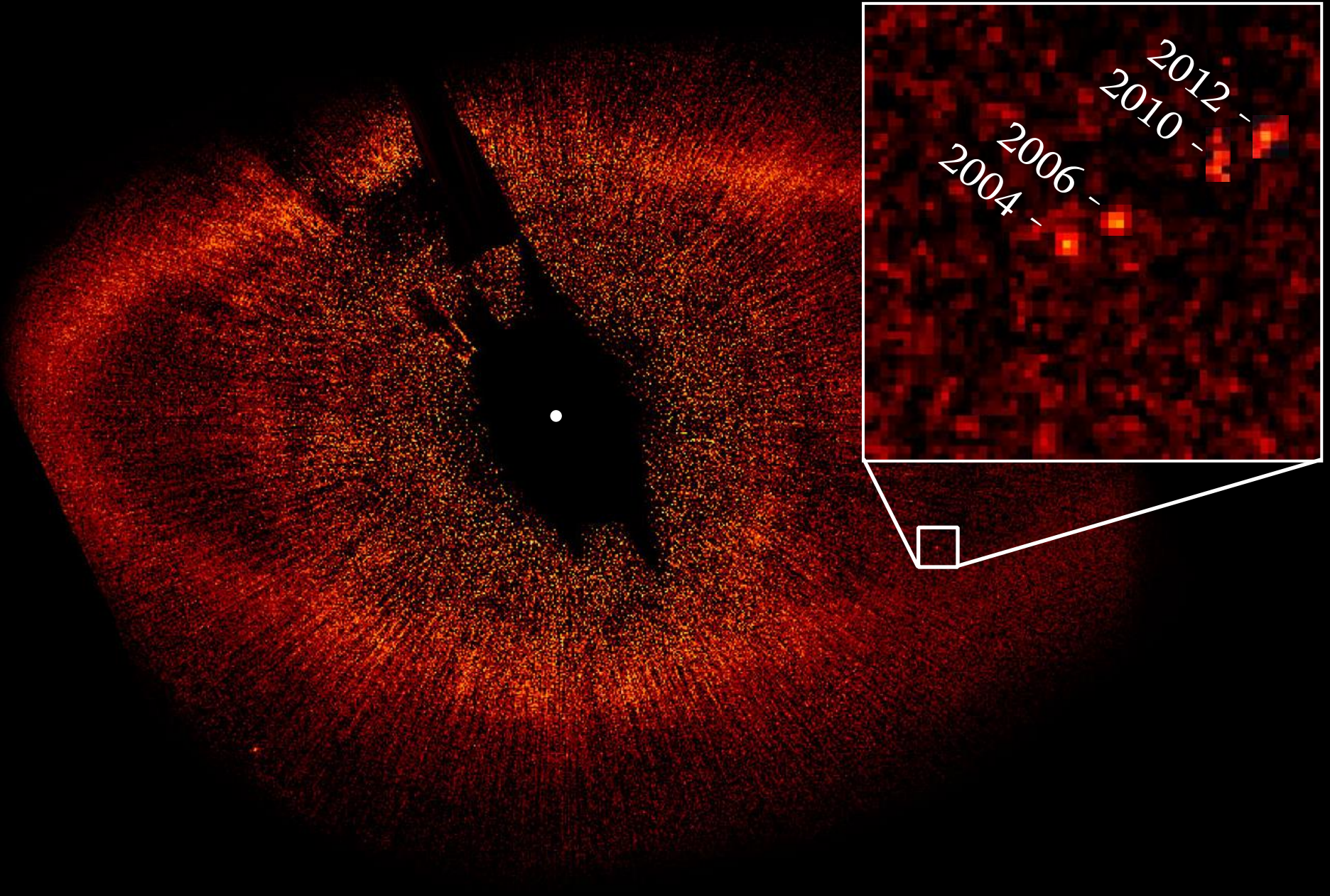
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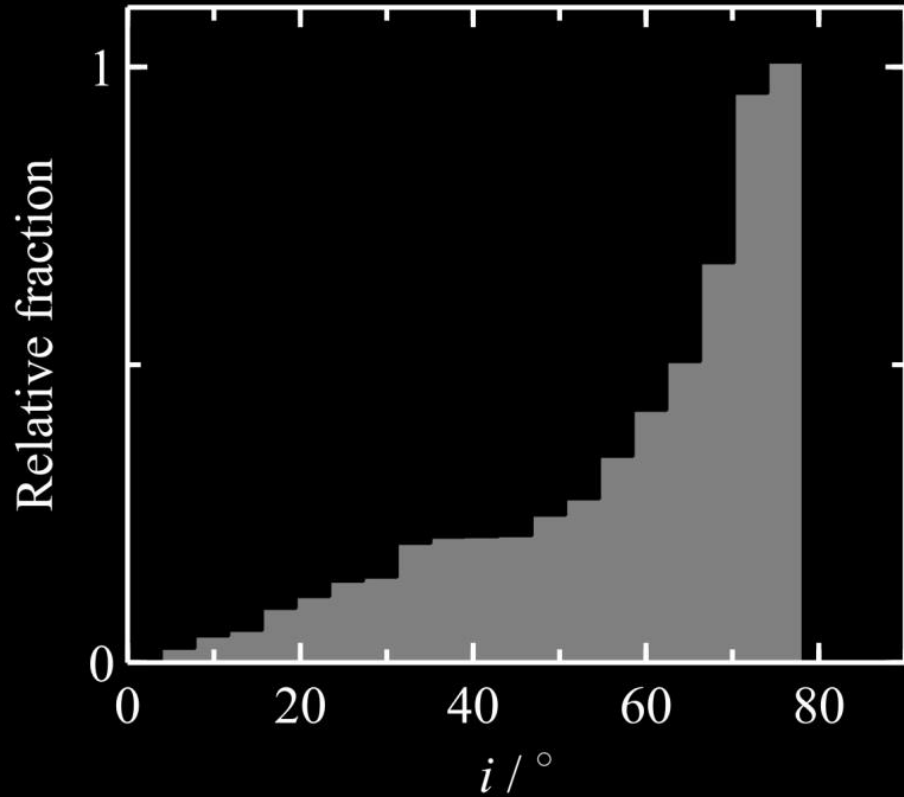
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Possible orbits are typically explored using MCMC

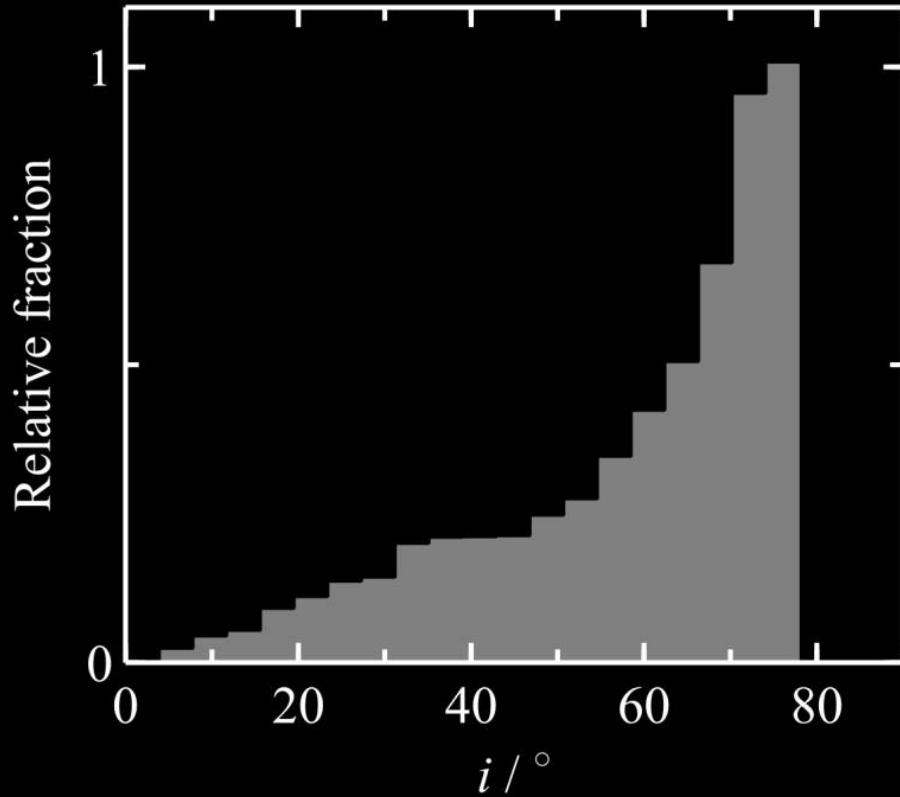
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Uniform z, \dot{z}

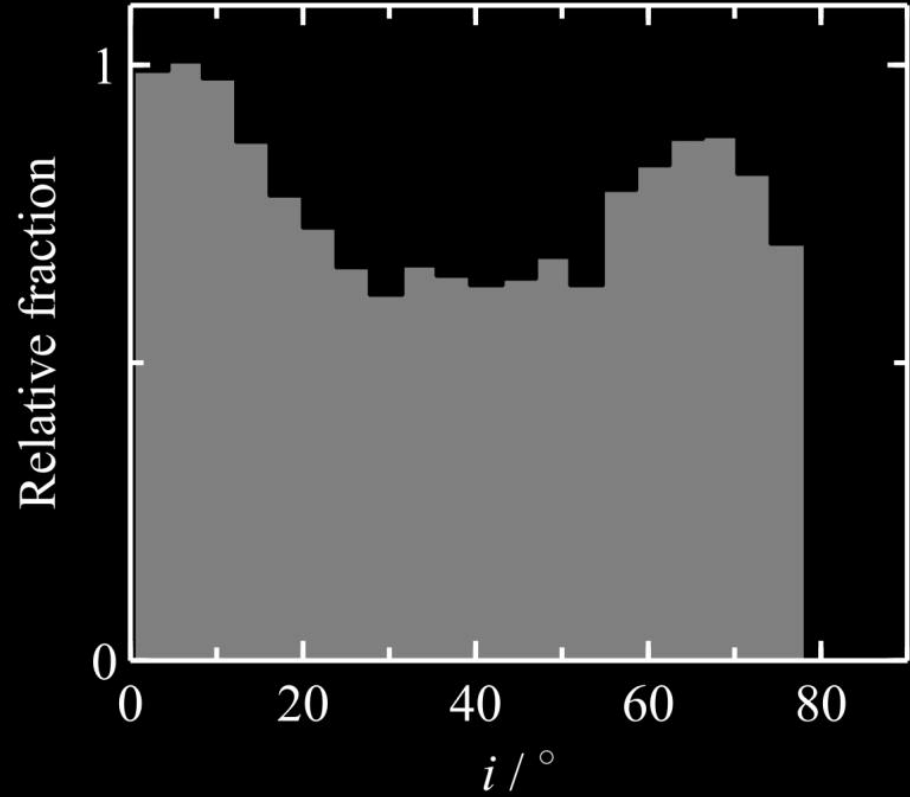


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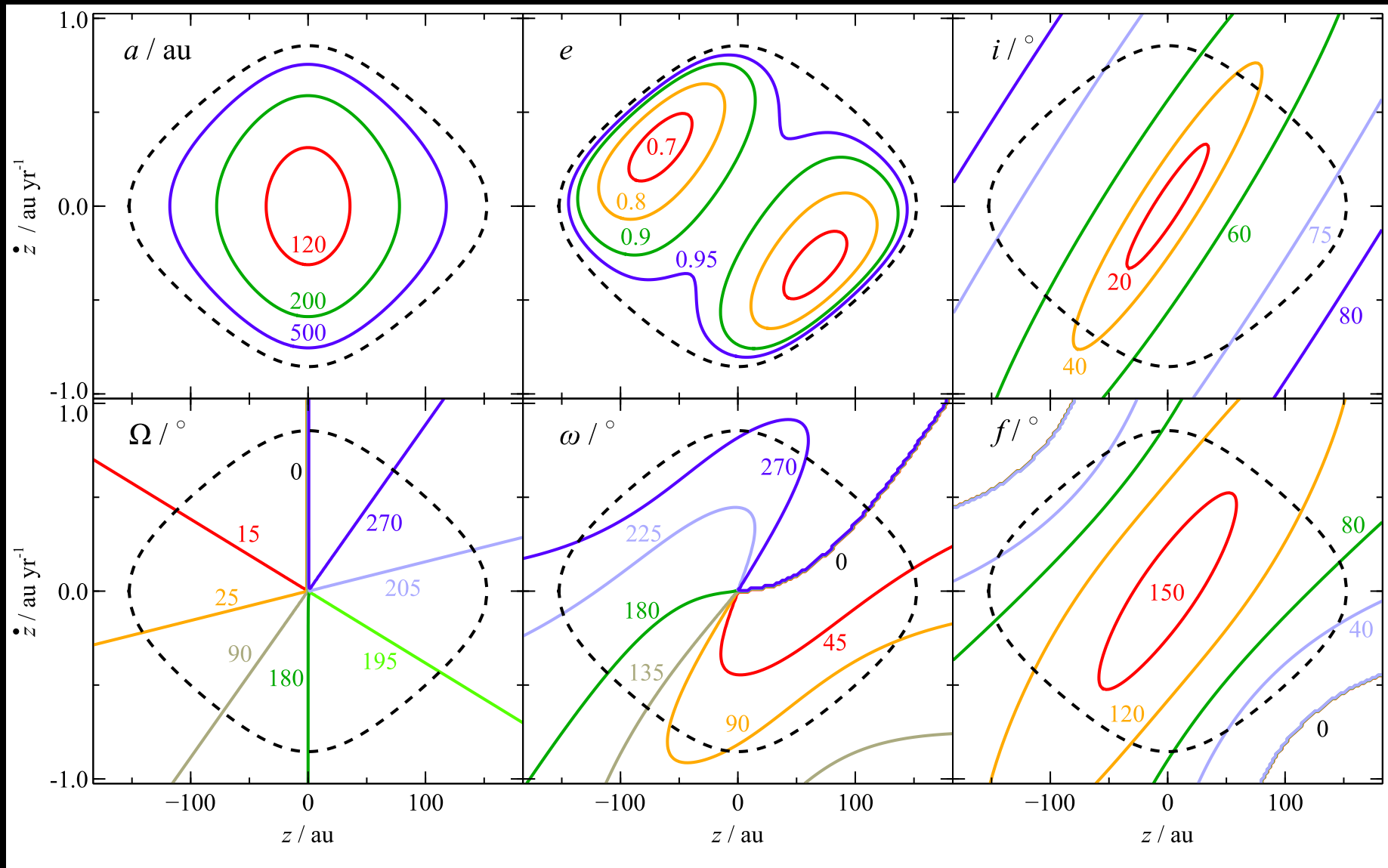


Uniform $\log_{10}(z), \log_{10}(\dot{z})$

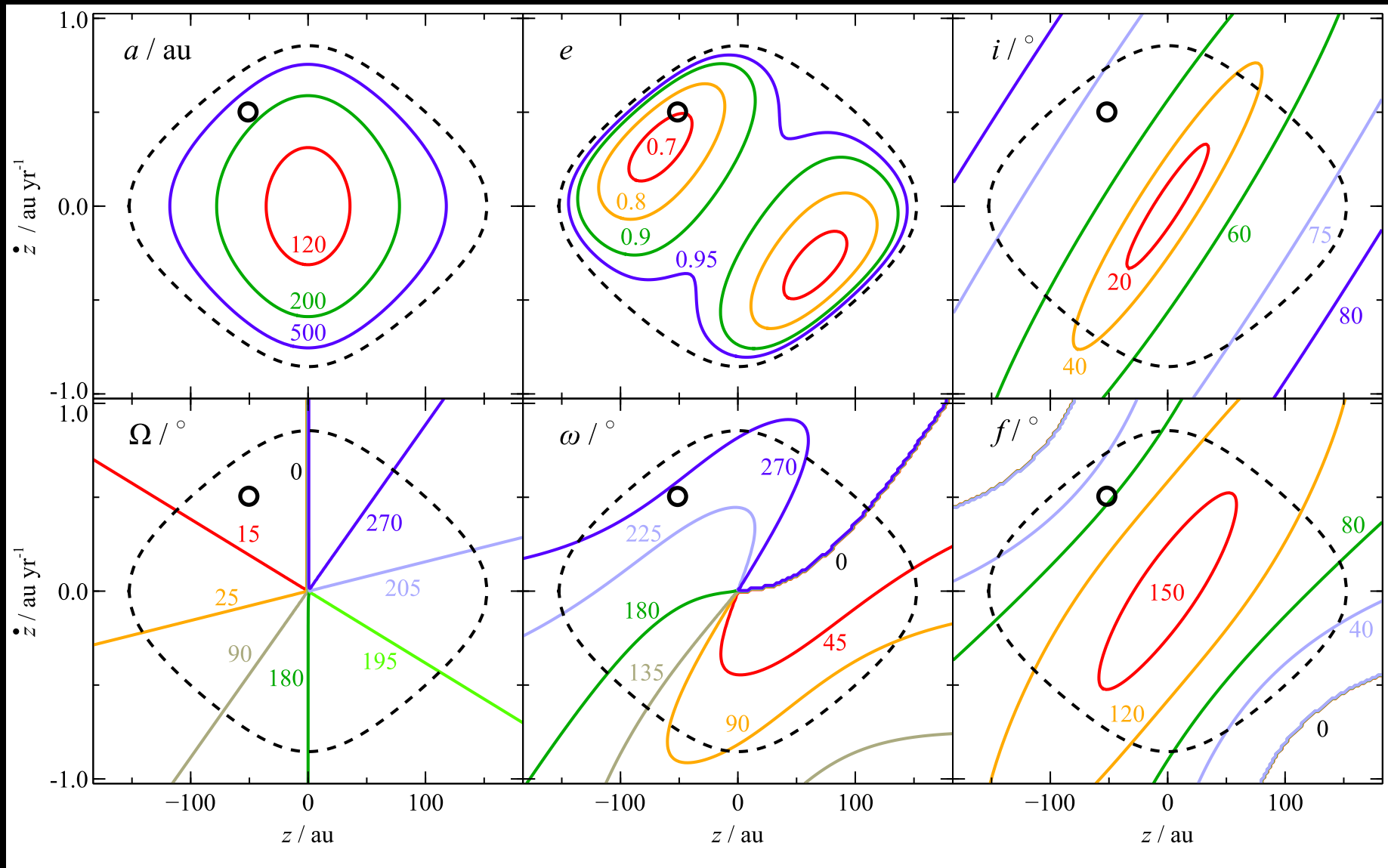


Interpreting MCMC distributions of orbital elements is difficult

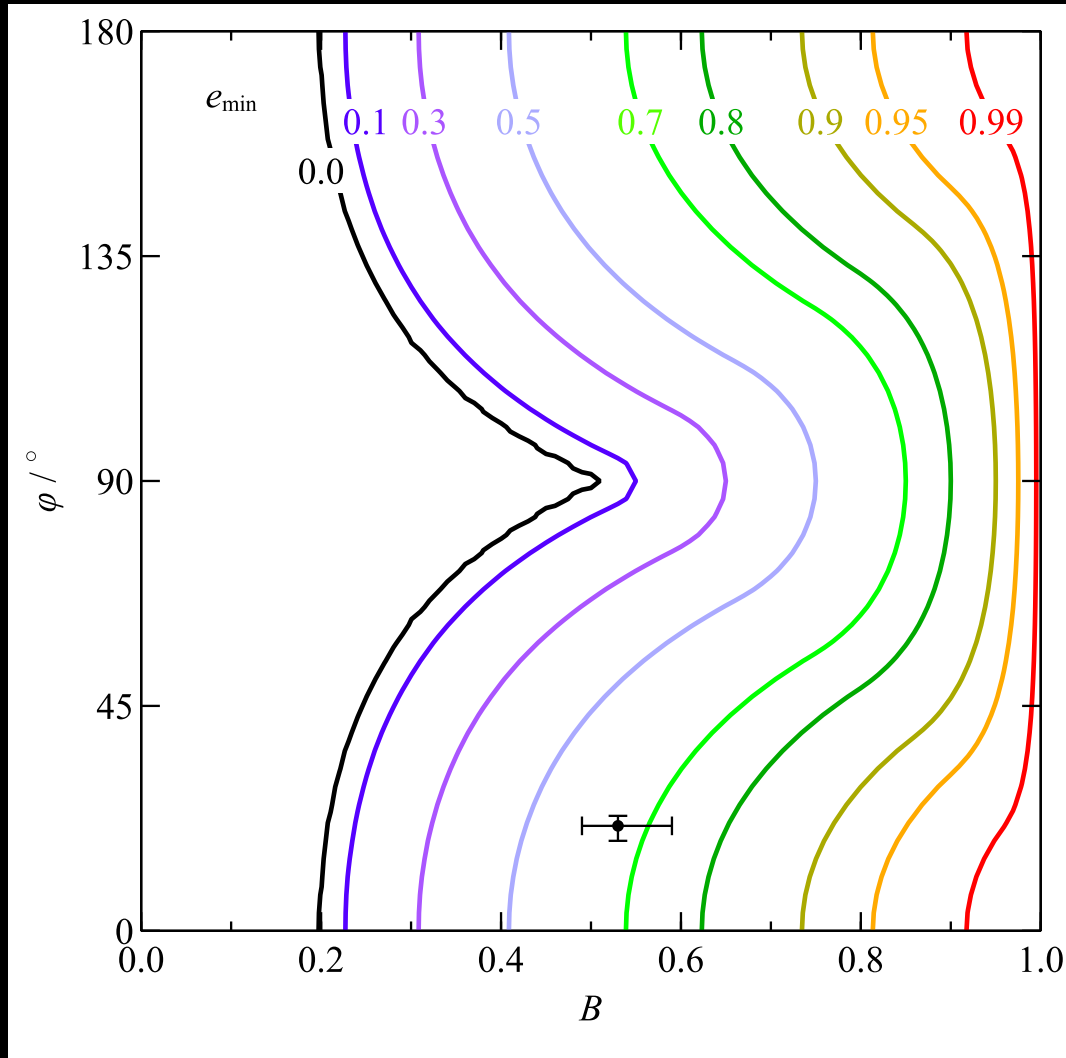
Alternative method: plot orbital elements as functions of z and \dot{z}



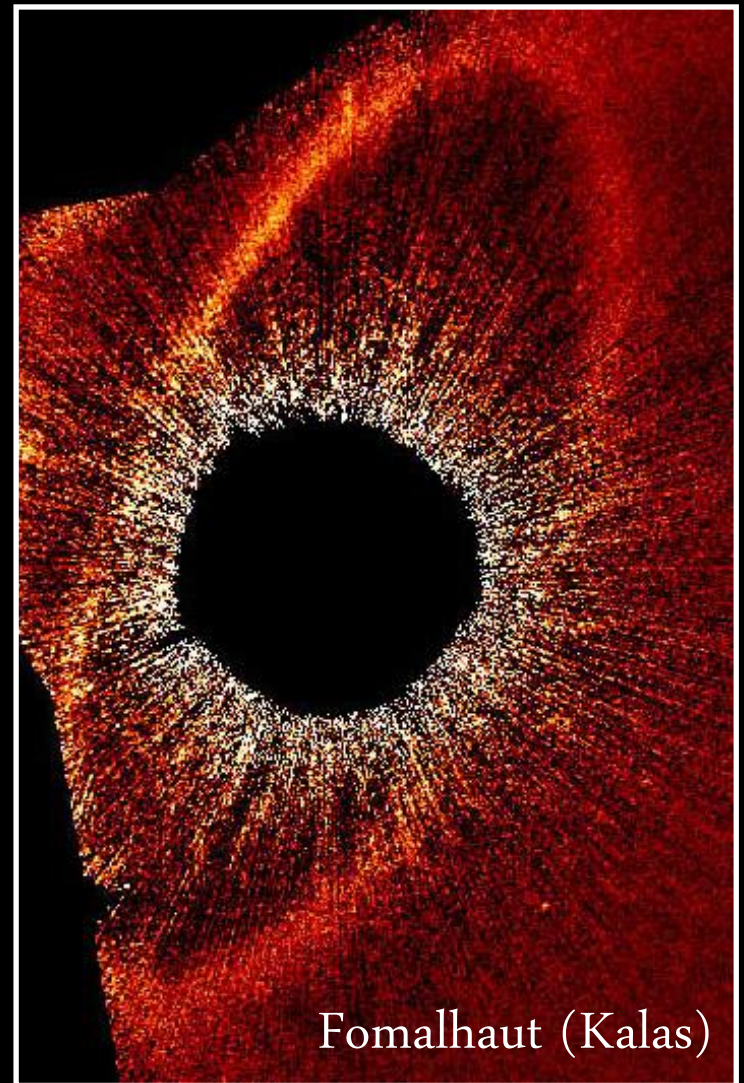
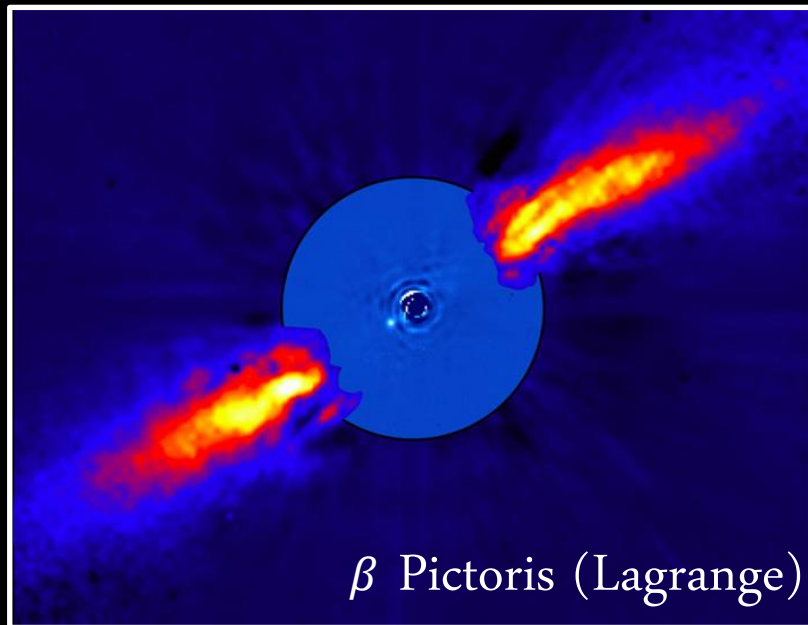
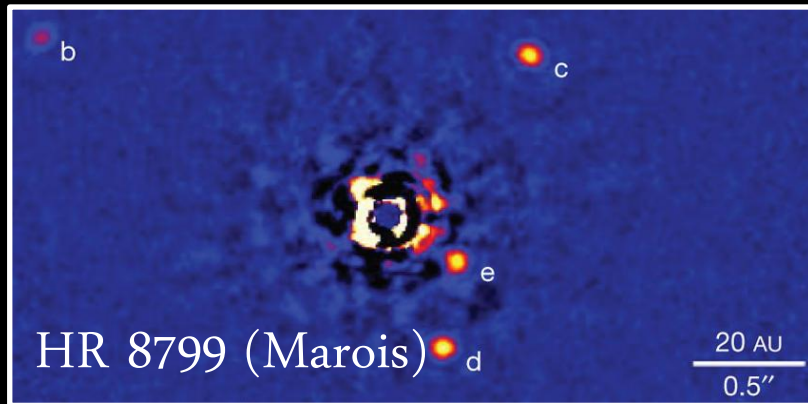
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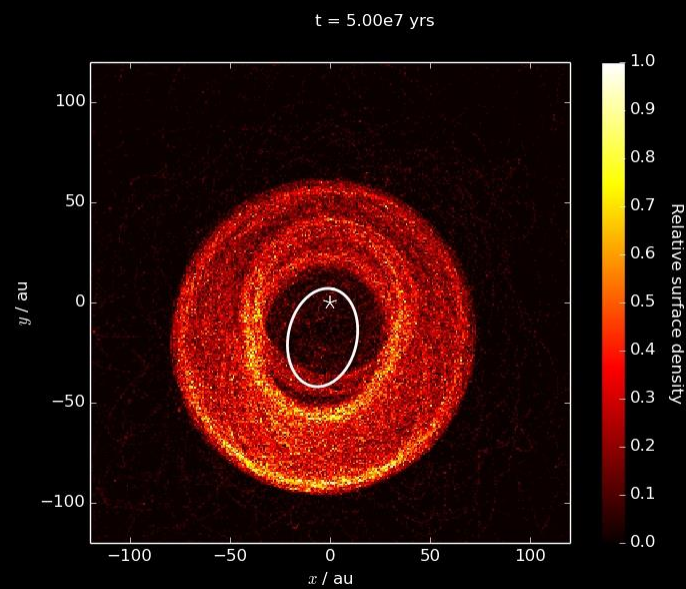
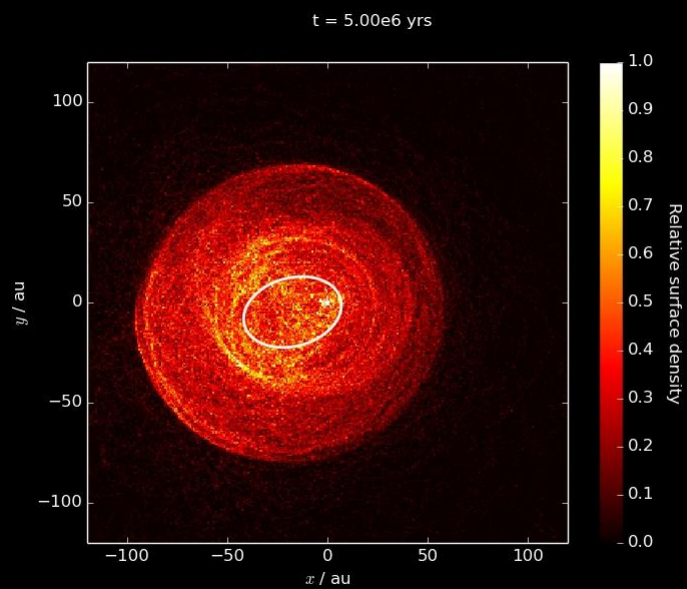
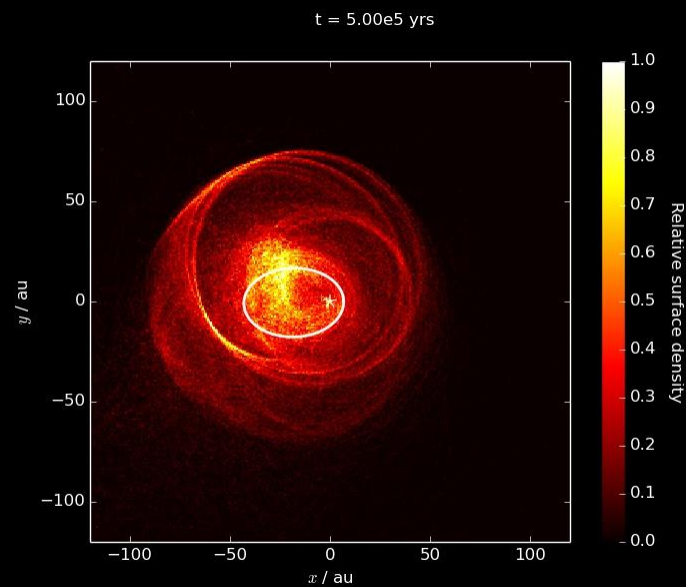
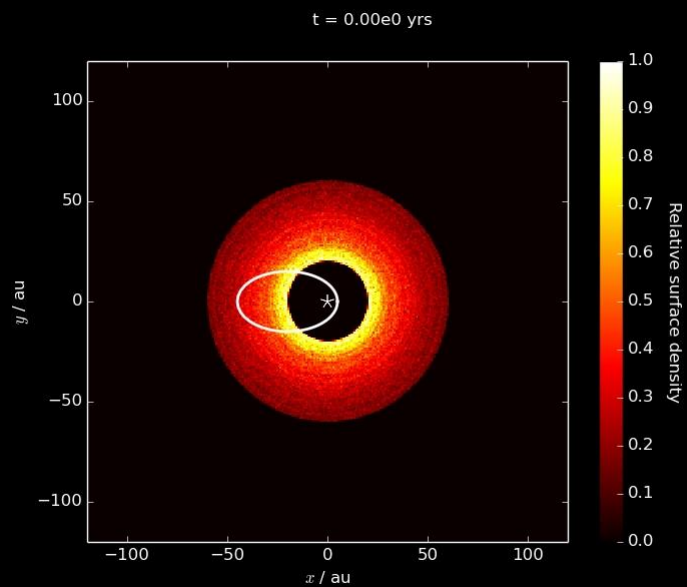
We find analytic solutions for the allowed ranges of orbital elements (e.g. a general companion's minimum eccentricity)



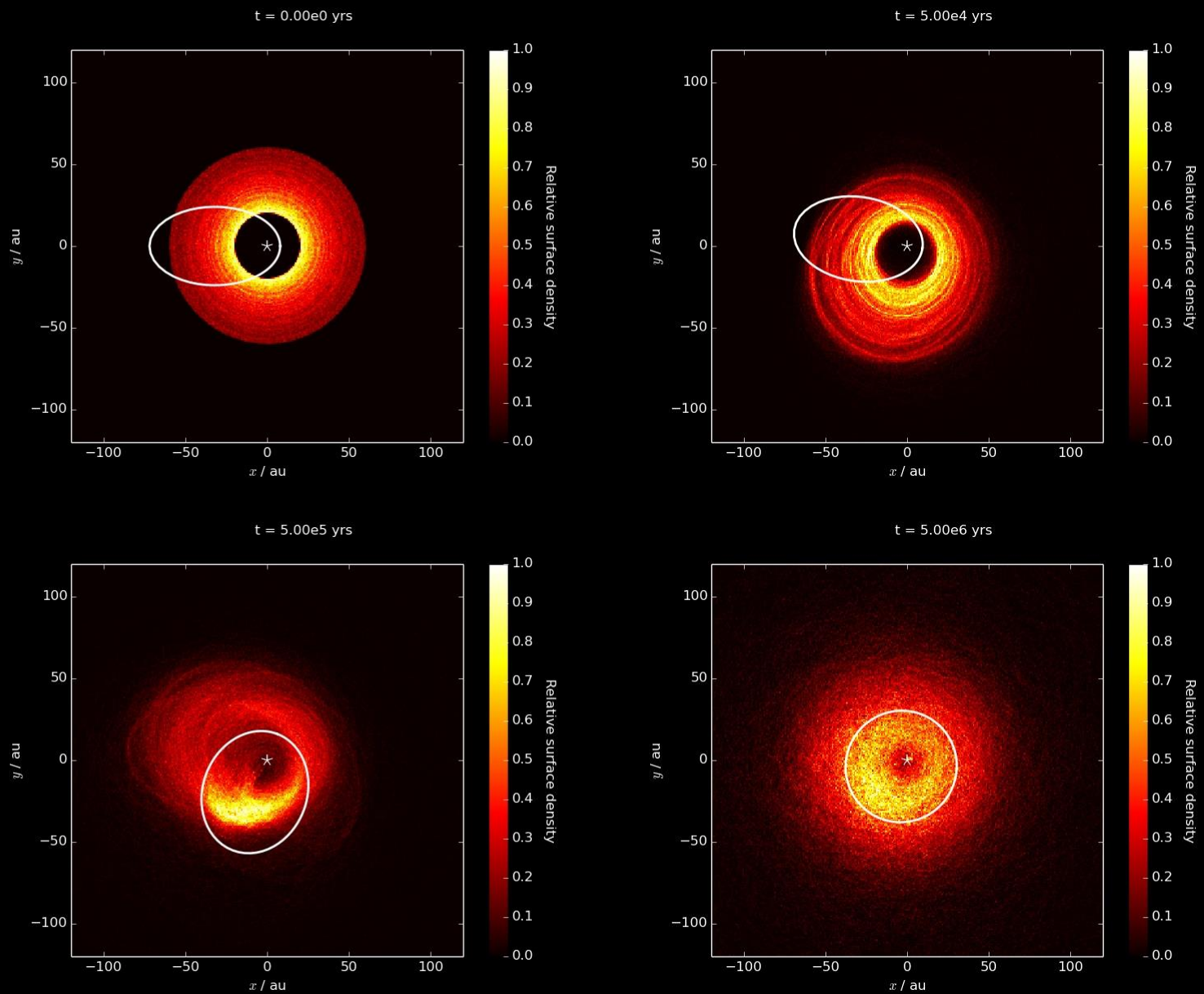
Question 2: How would a long-period companion interact with other bodies in the system?



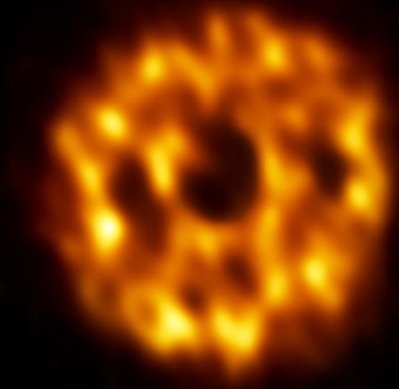
Planet mass \gg disc mass



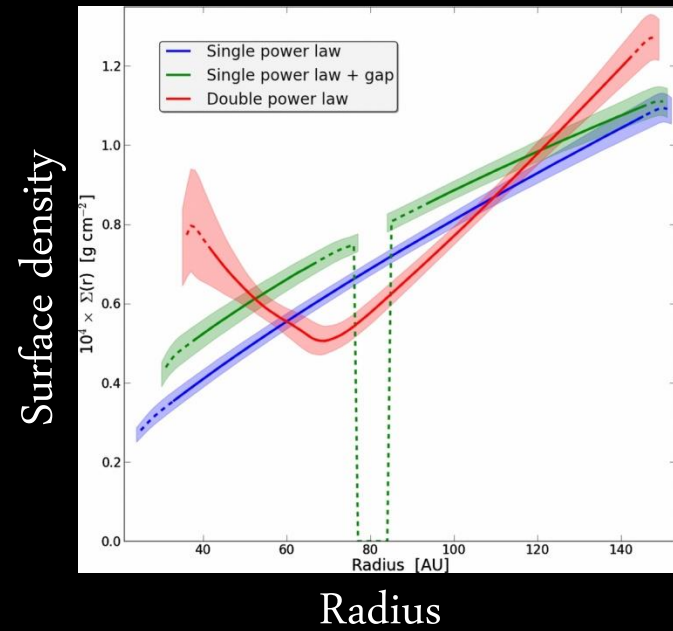
Planet mass \sim disc mass



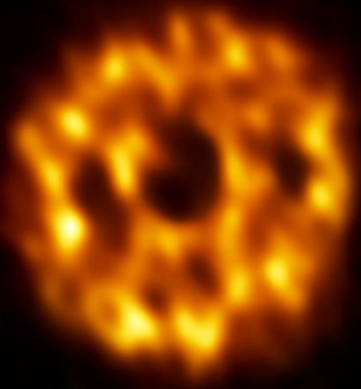
Application to HD 107146



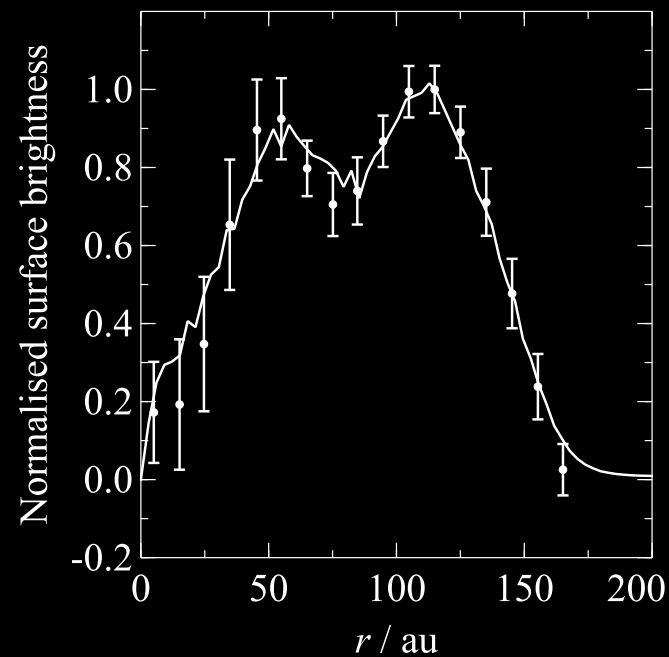
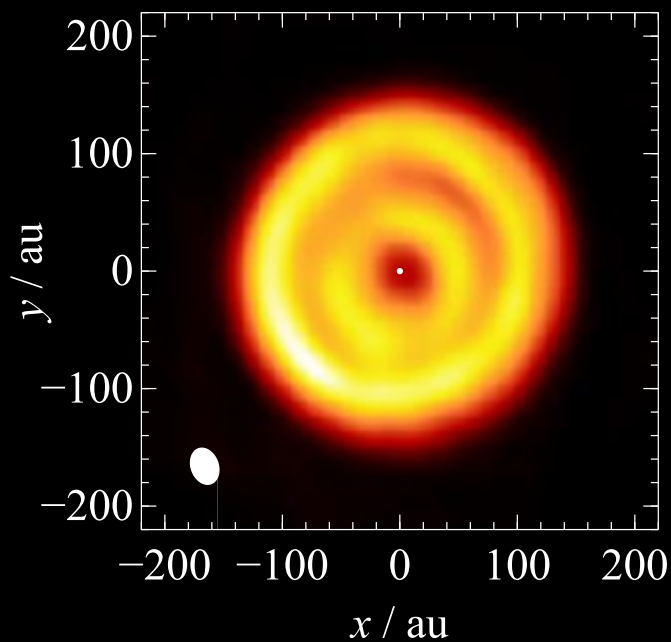
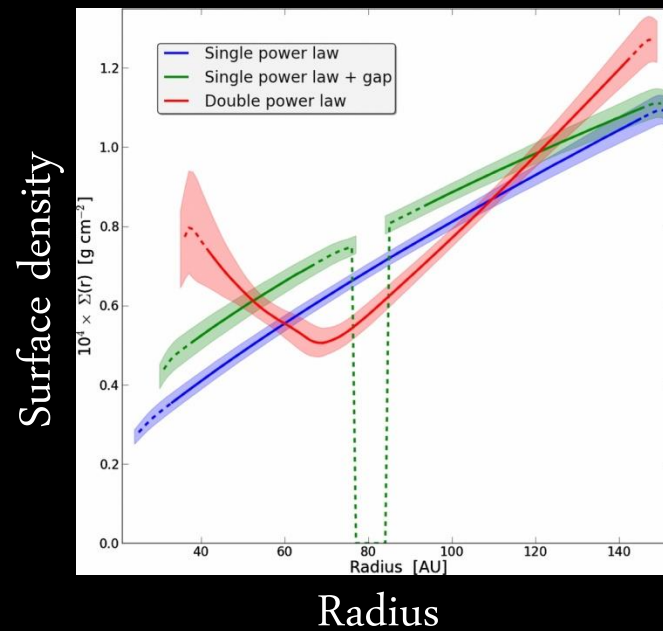
ALMA 1.25mm data: Ricci et al. 2015



Application to HD 107146



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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