High-Contrast Imaging Orbital Constraints of the β Pic b Planet Candidate

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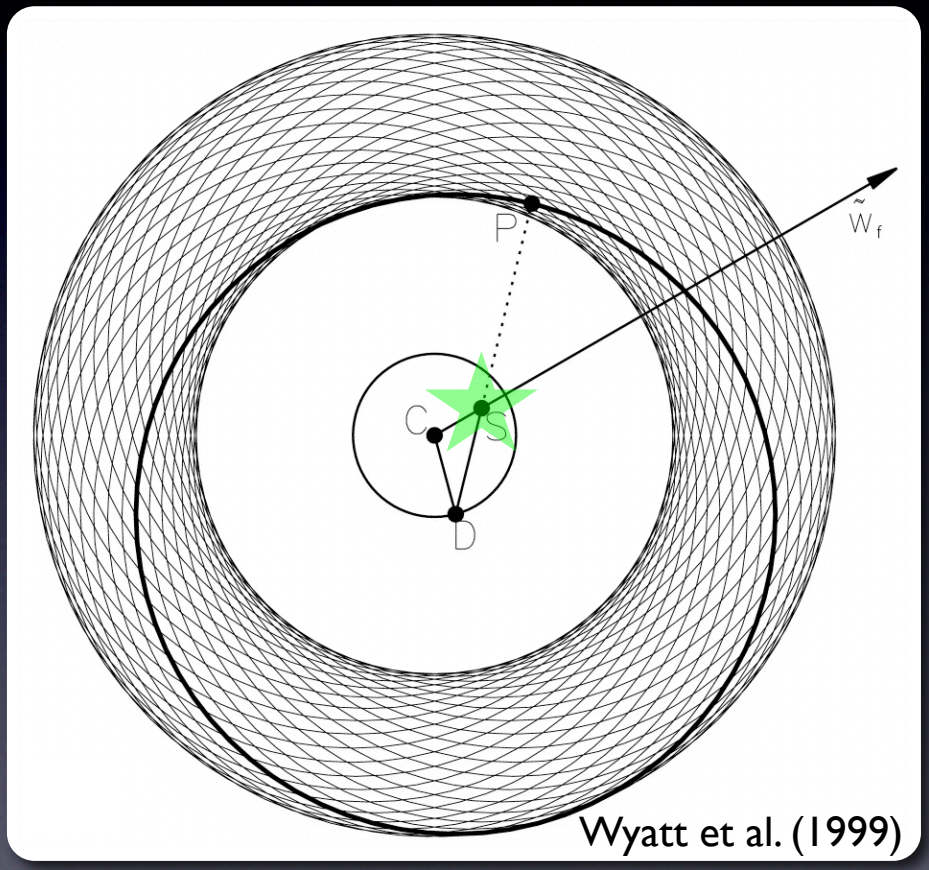
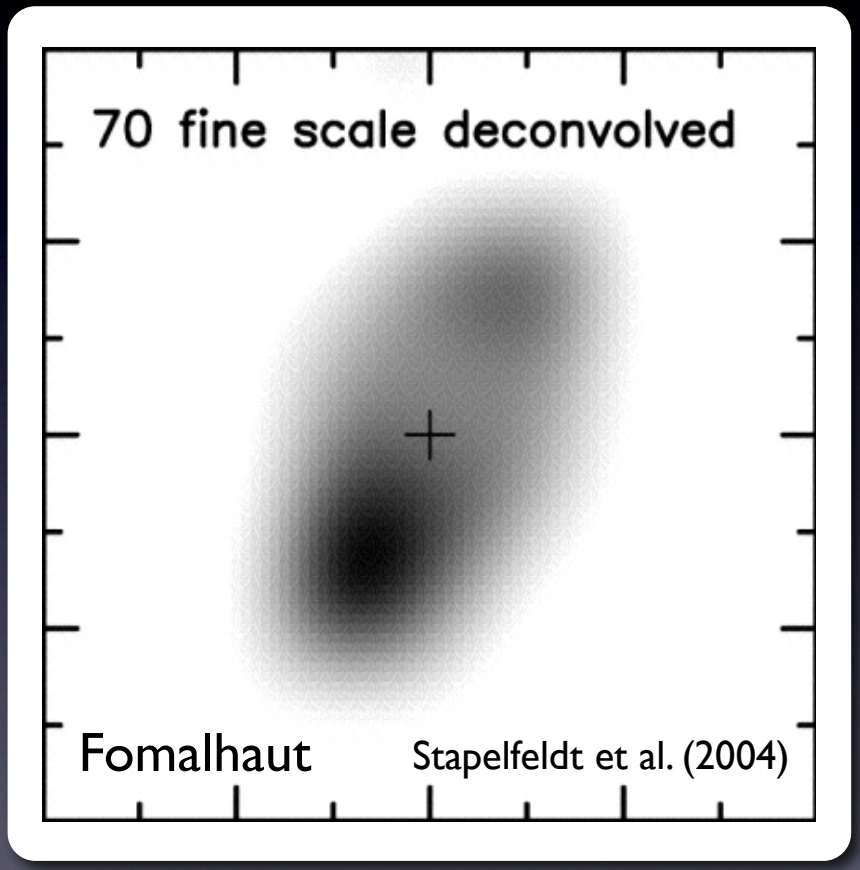
Circumstellar Debris Disks

- Asteroid and Kuiper Belts contain primitive remnant bodies
- Collisions and evaporation of these bodies create fresh dust
- Forces alter grain trajectories, creating a disk

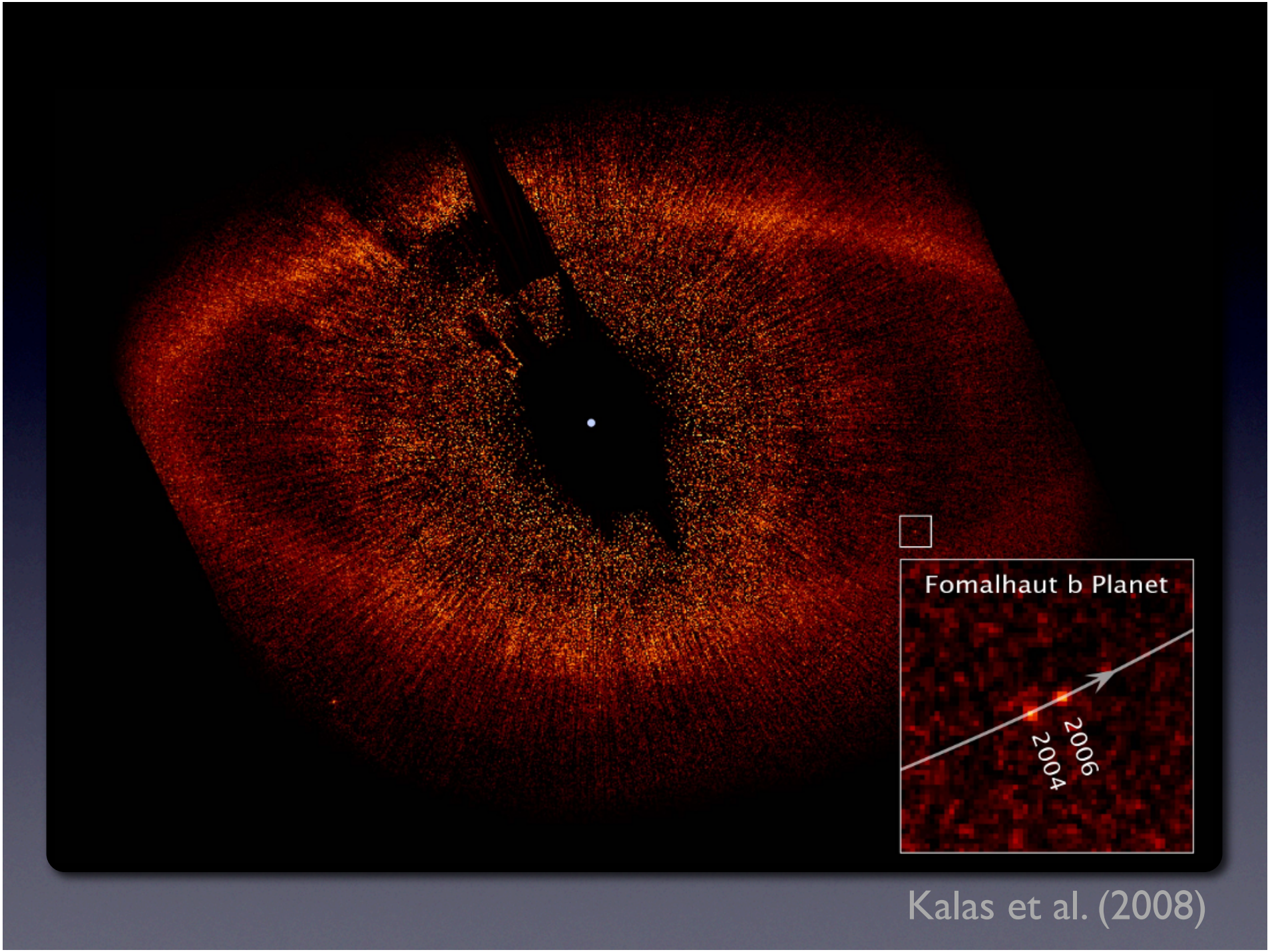
P. Kalas

Gravitational Perturbations



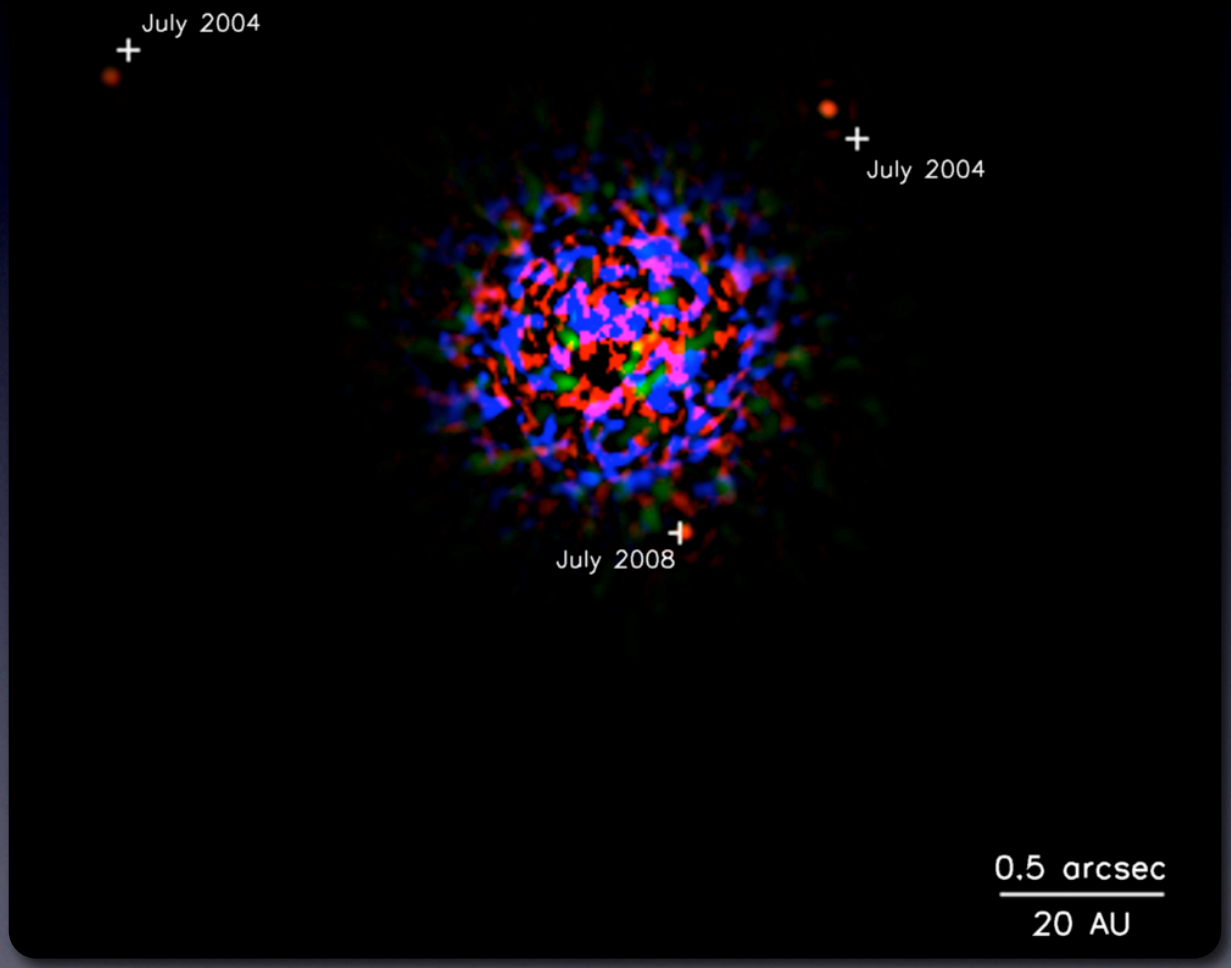


Secular perturbations by an eccentric perturber

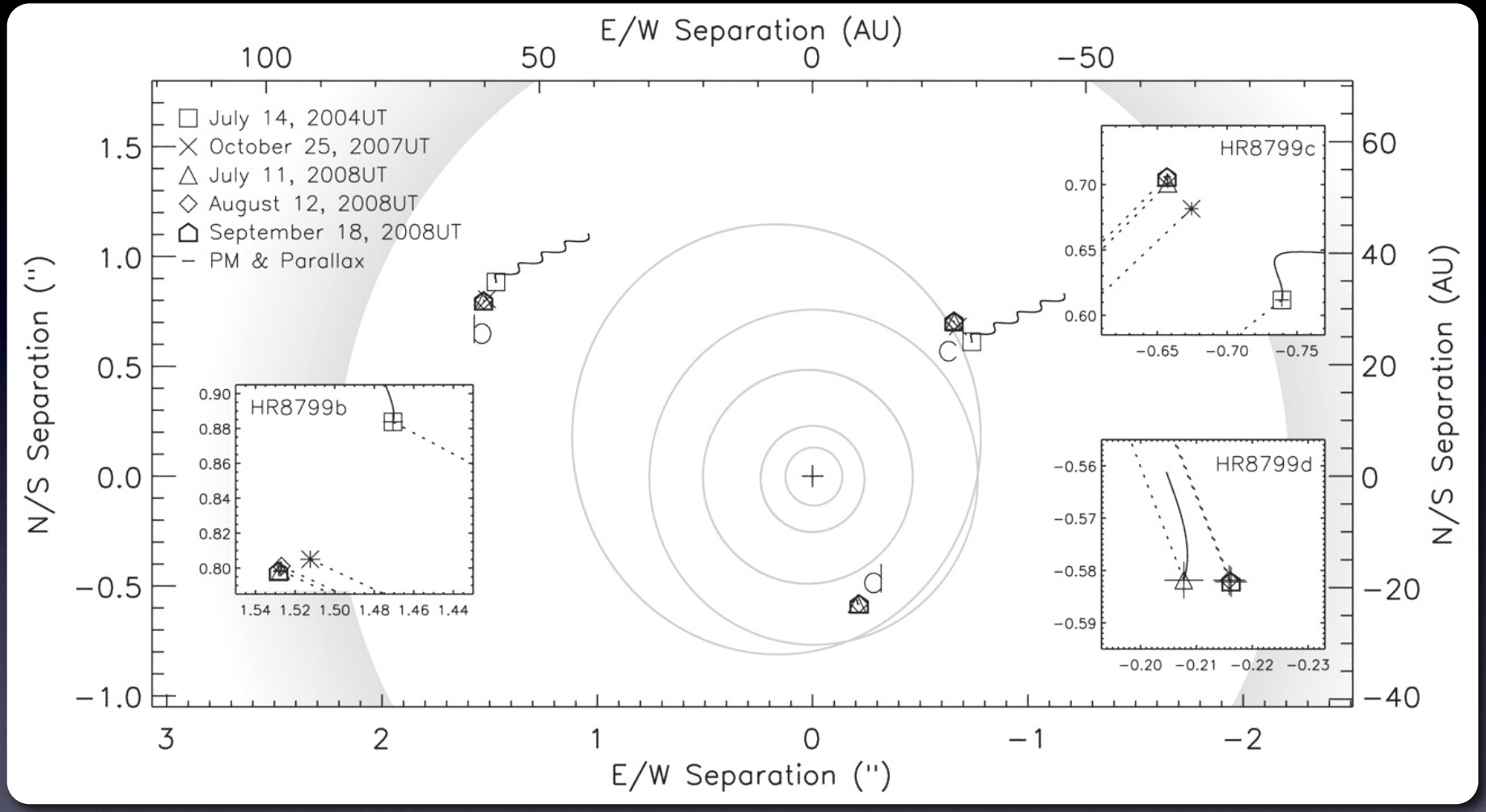


Kalas et al. (2008)

HR 8799



Marois et al. (2008)

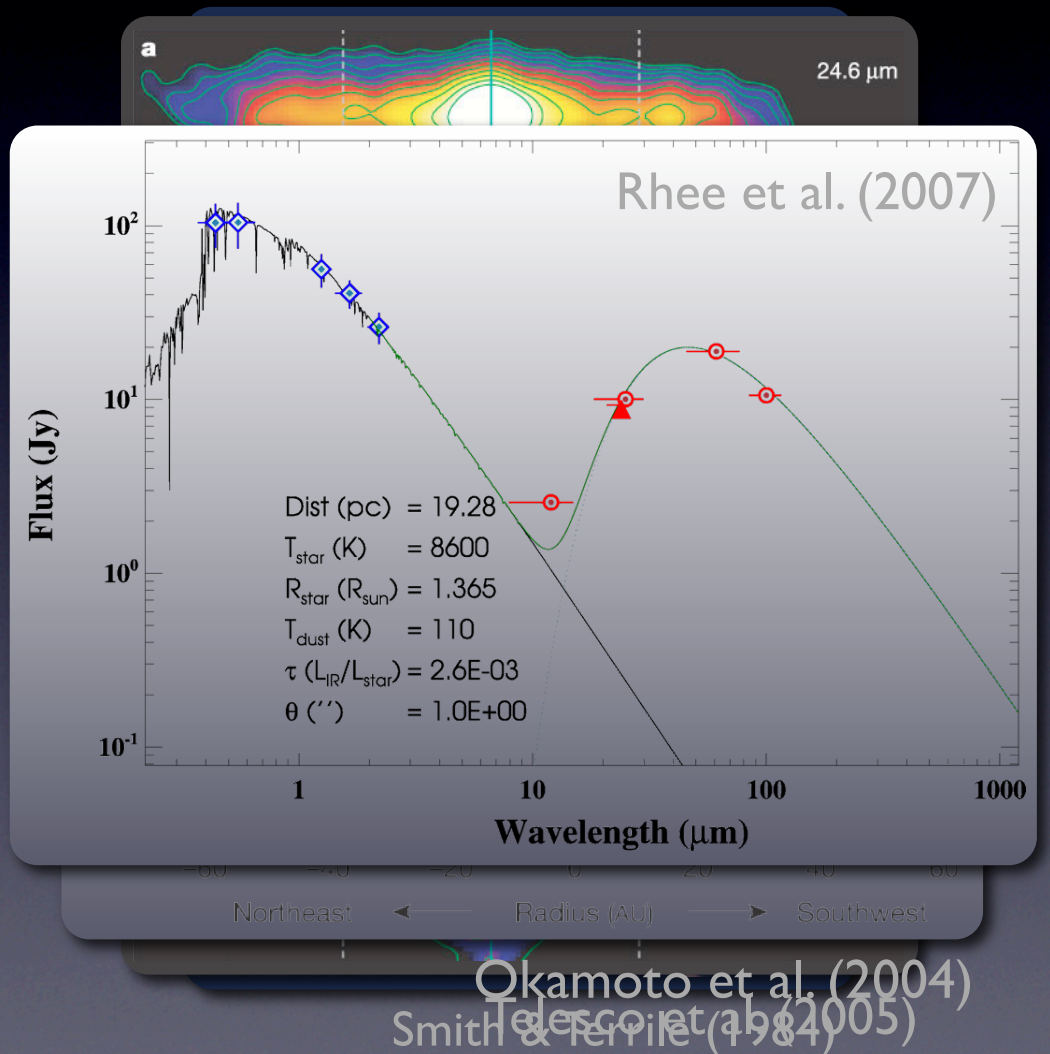


Marois et al. (2008)

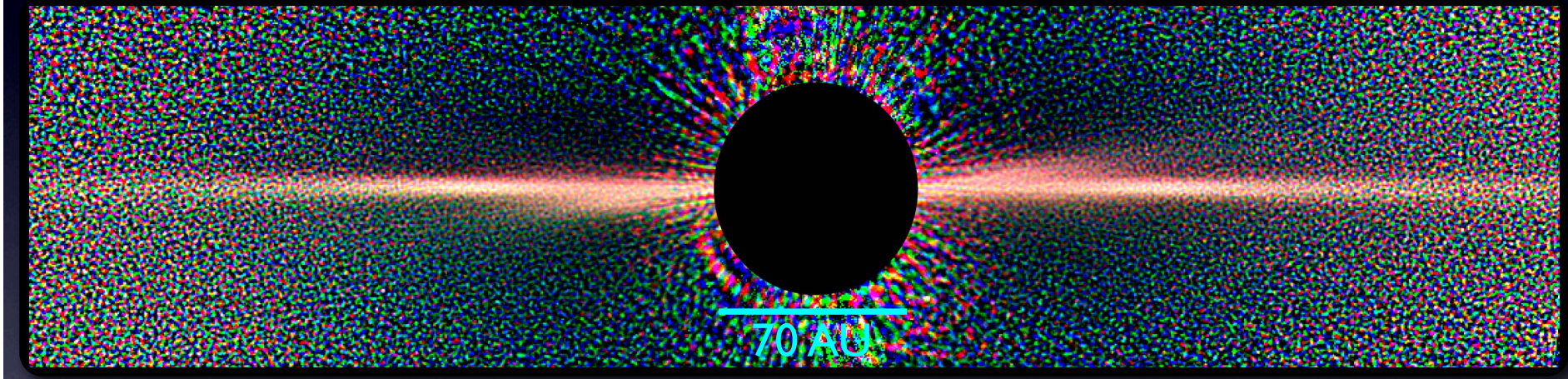
Outer disk recently resolved by Su et al. (2009)

β Pictoris

- A5V 19.3 pc 12 Myr
- *IRAS* $L_{IR}/L_* \sim 3 \times 10^{-3}$
- edge-on disk



“Warp” in the disk



NASA/ESA/D. Golimowski (JHU)

- Warp or secondary disk?

Belt Modeling

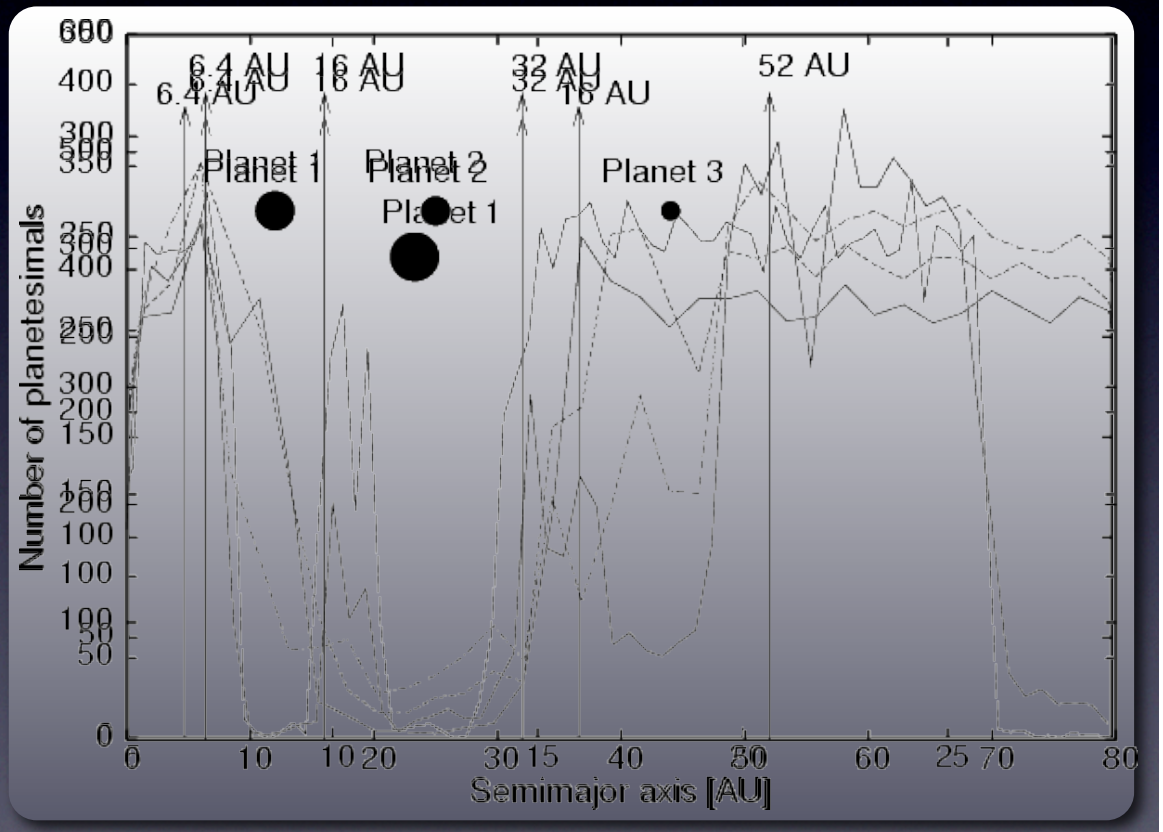
- Belt locations
- One planet:

$$a \approx 12\,\mathrm{AU}$$

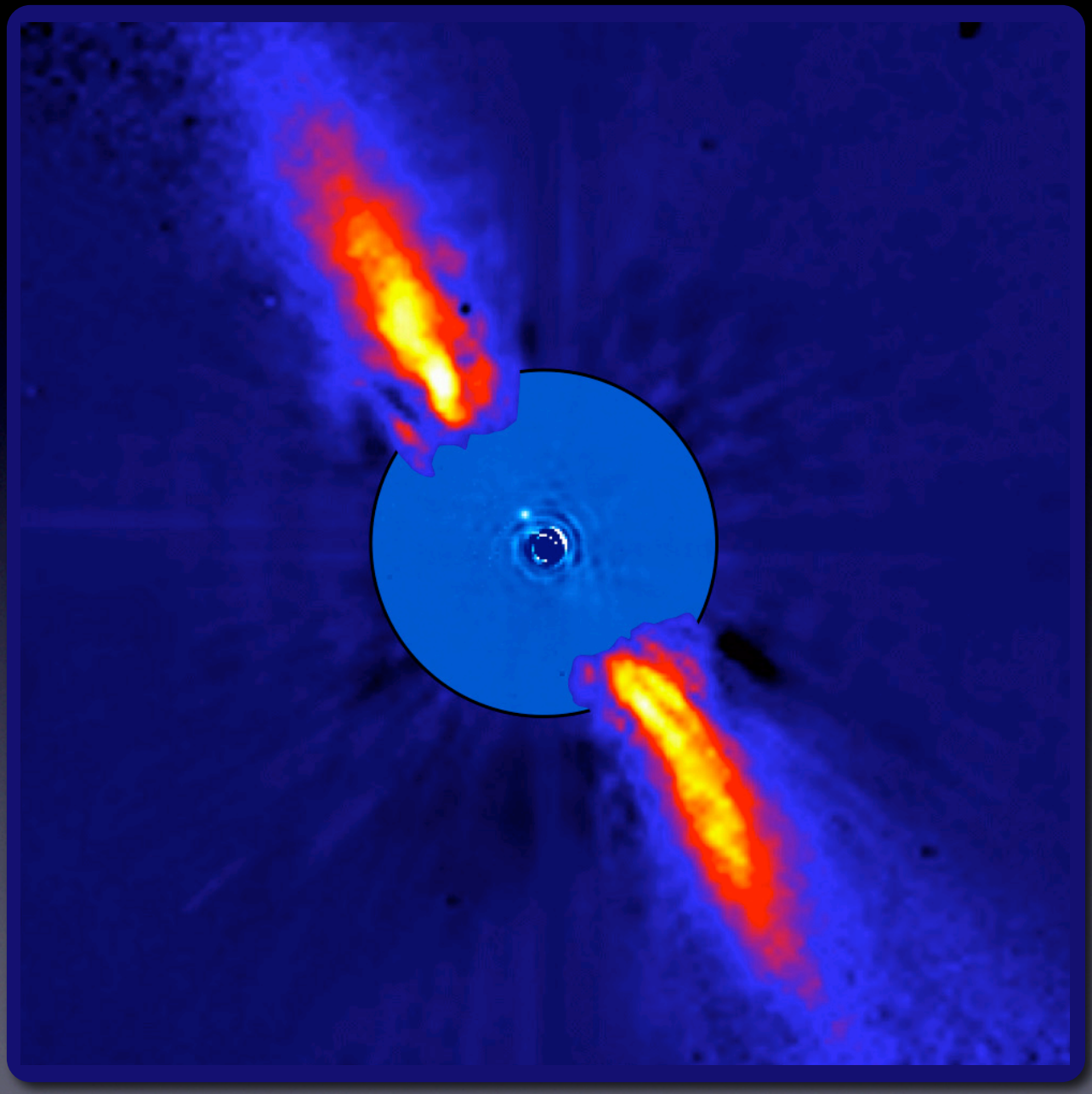
$$m \approx 2\,M_J$$

$$e \lesssim 0.1$$

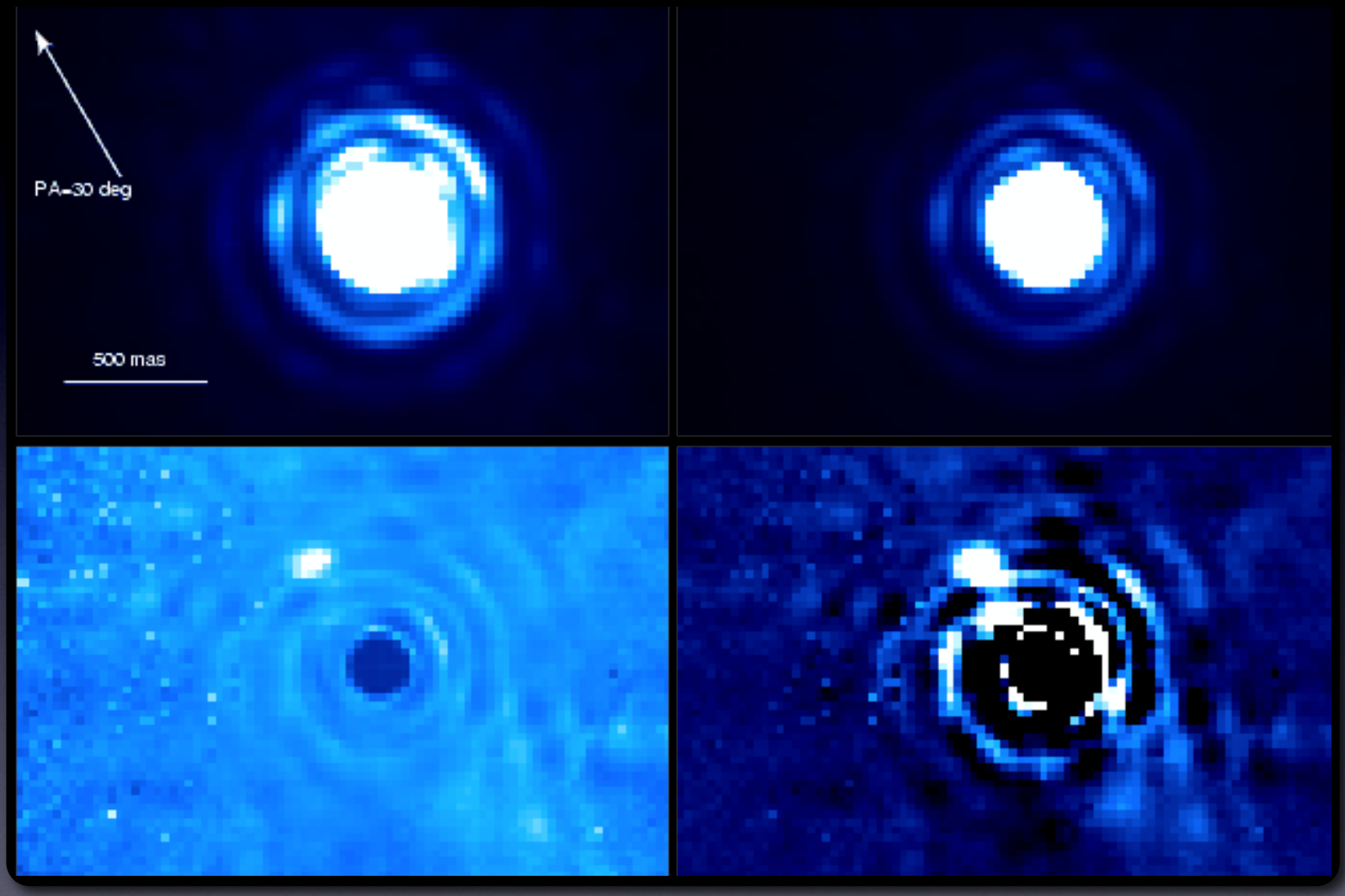
- Additional planets for outer belts



Freistetter et al. (2007)

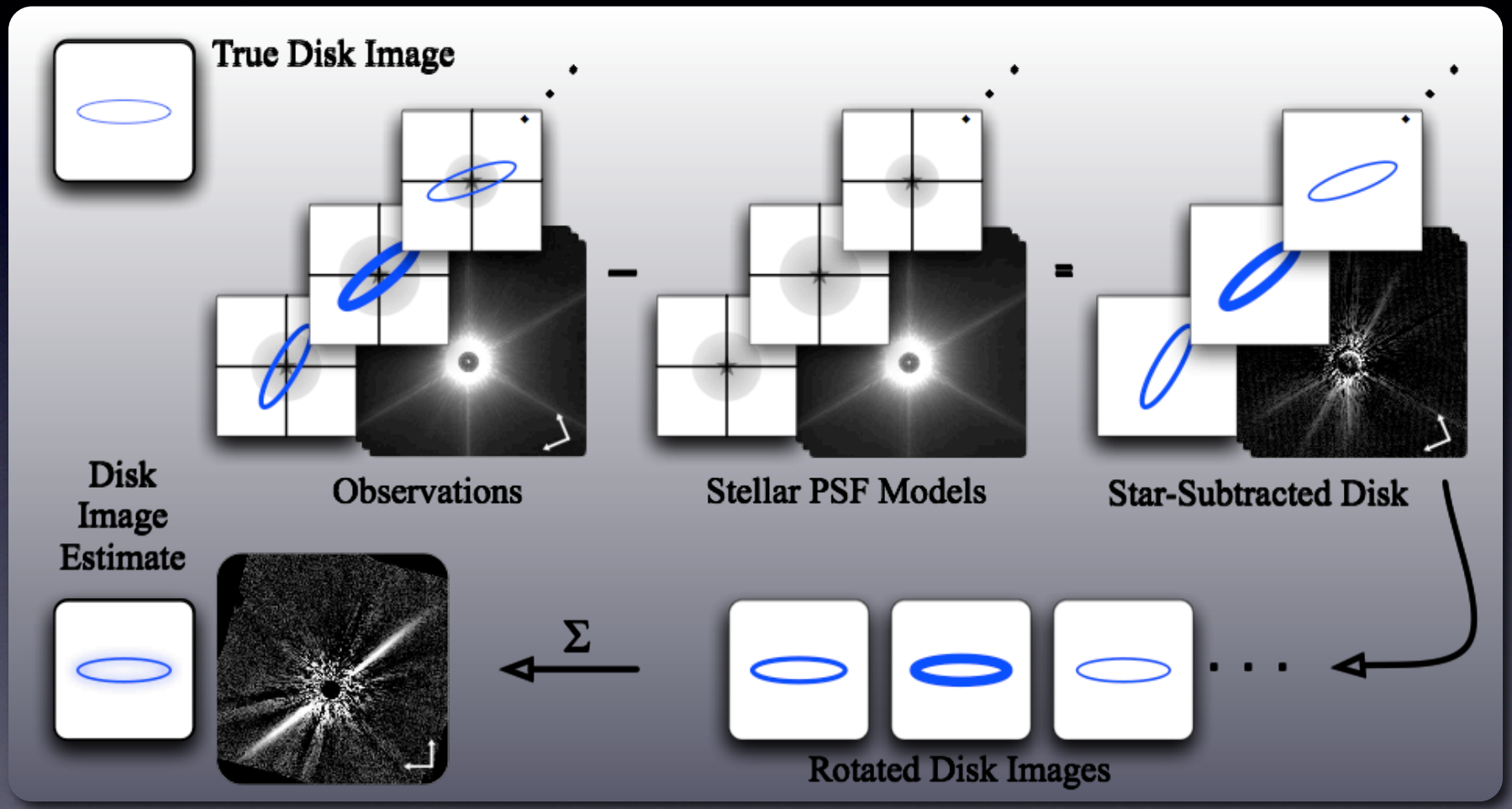


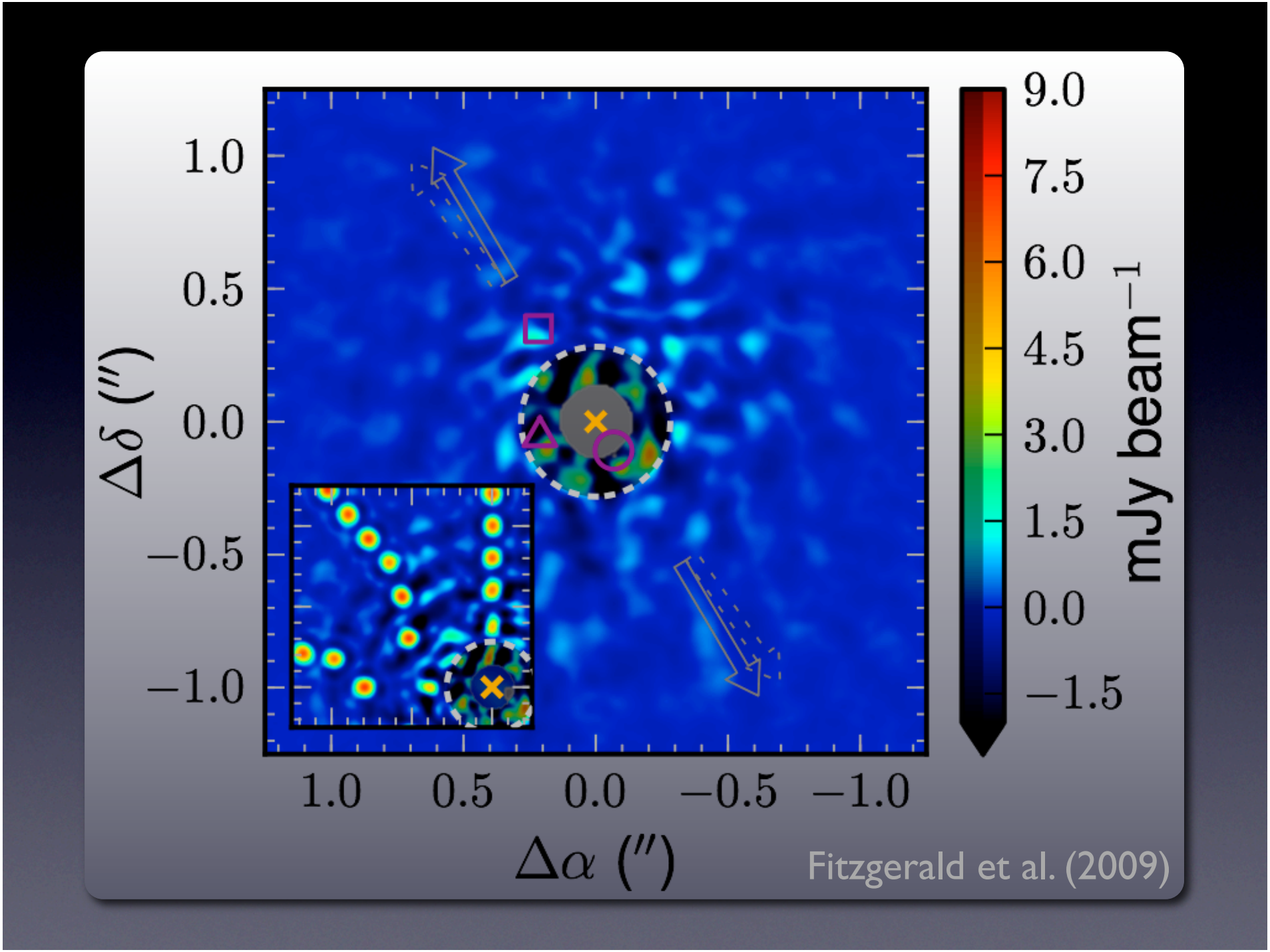
ESO/A.-M. Lagrange et al.

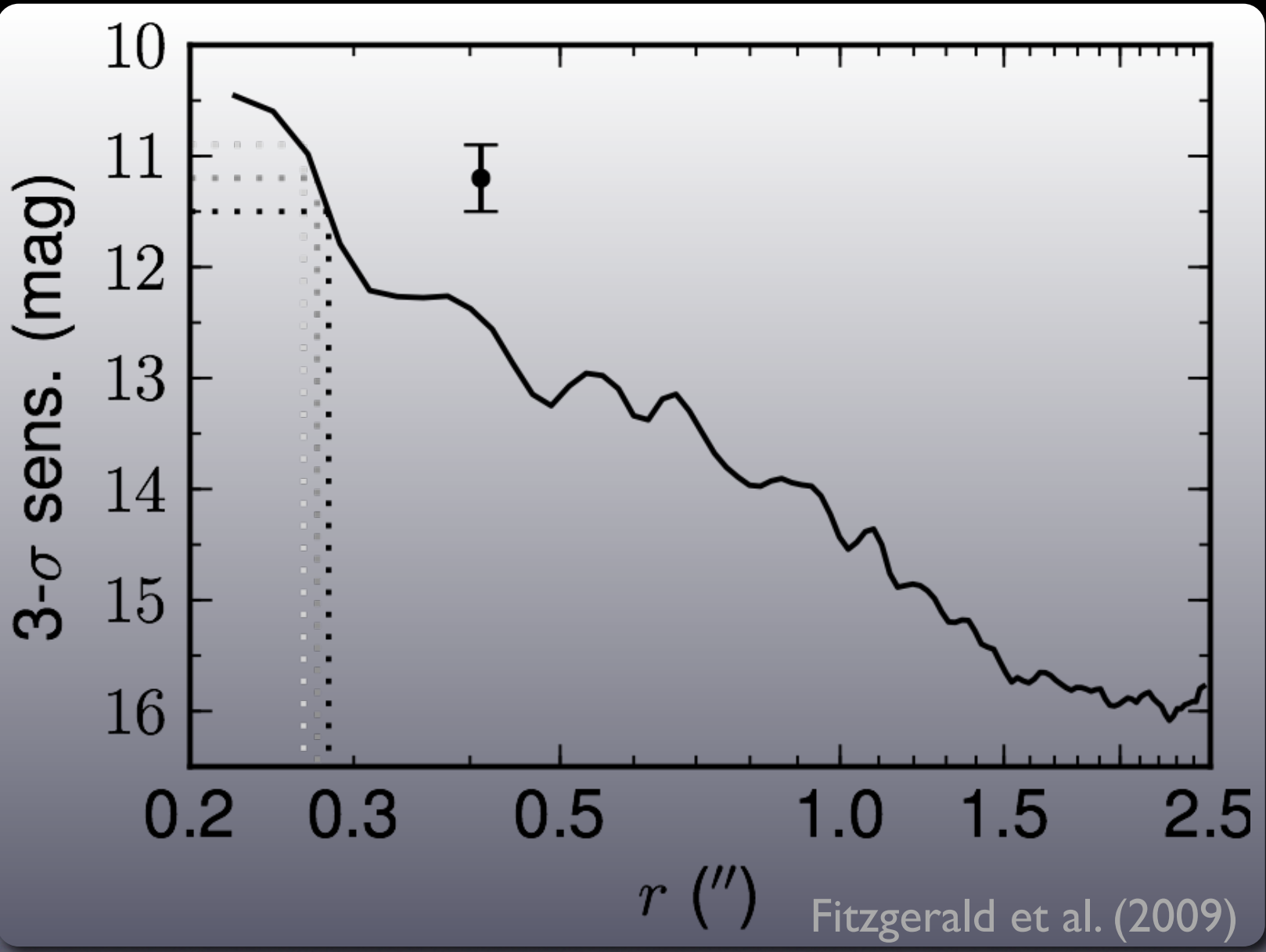


Lagrange et al. (2009)

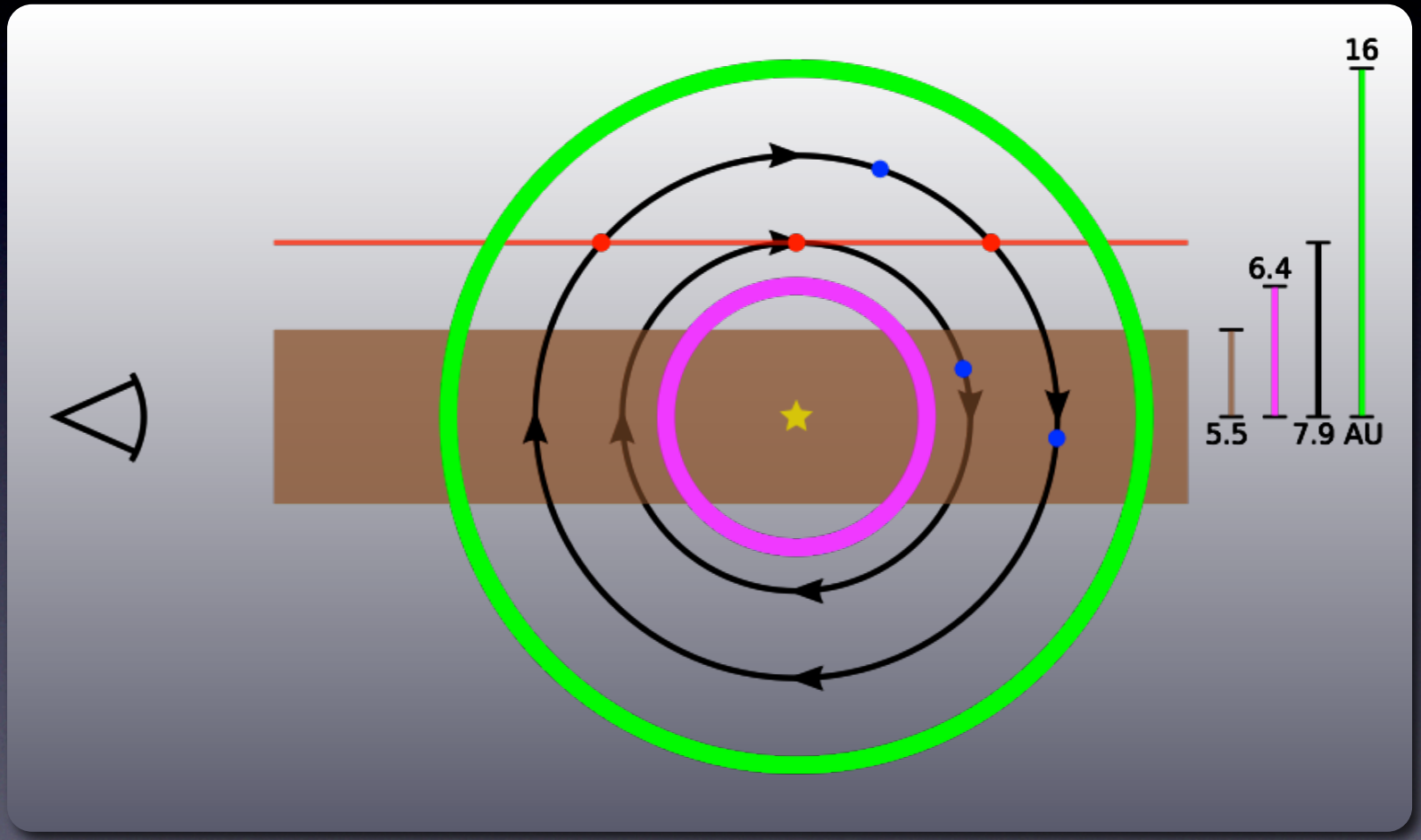
AO Roll Subtraction

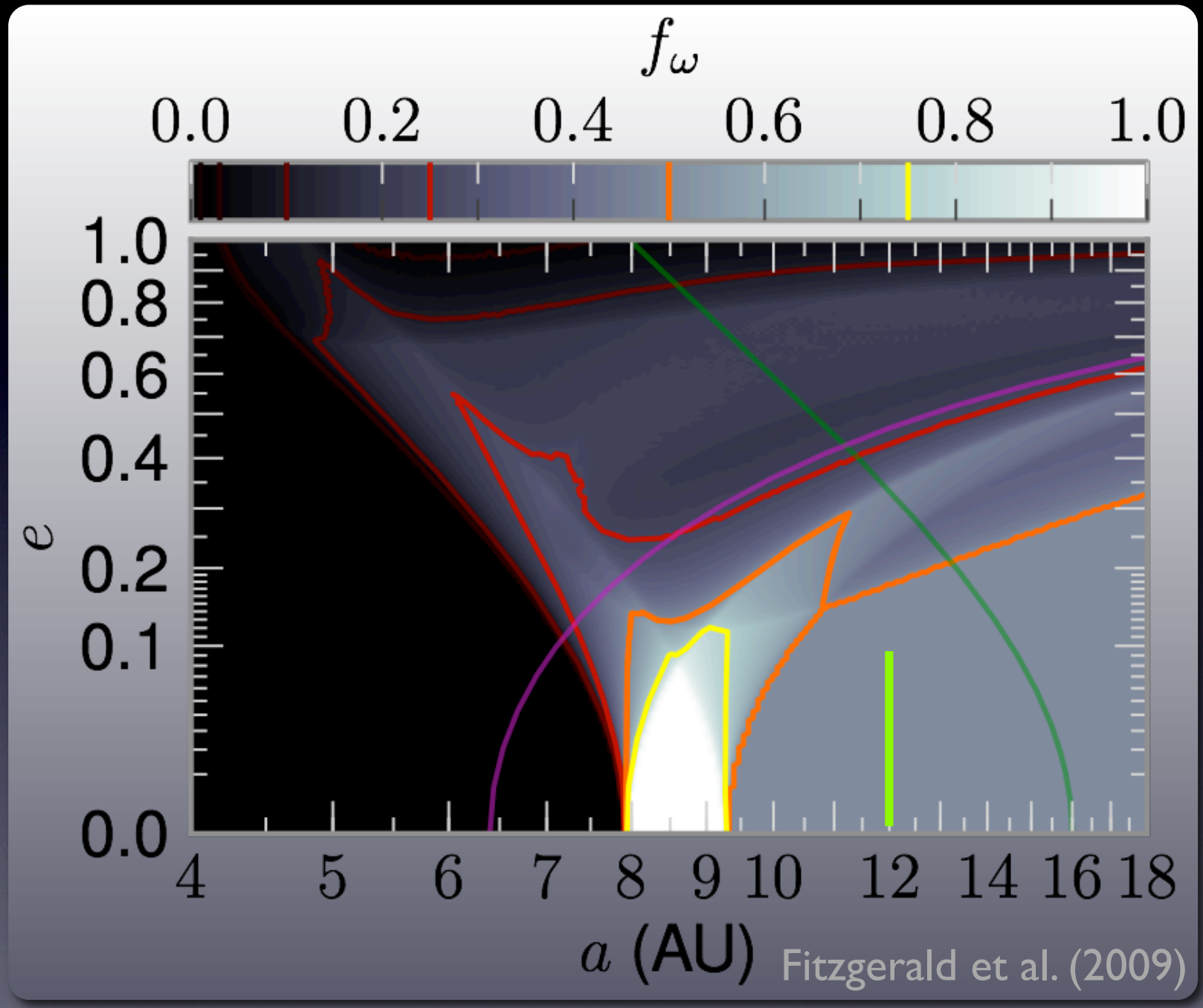


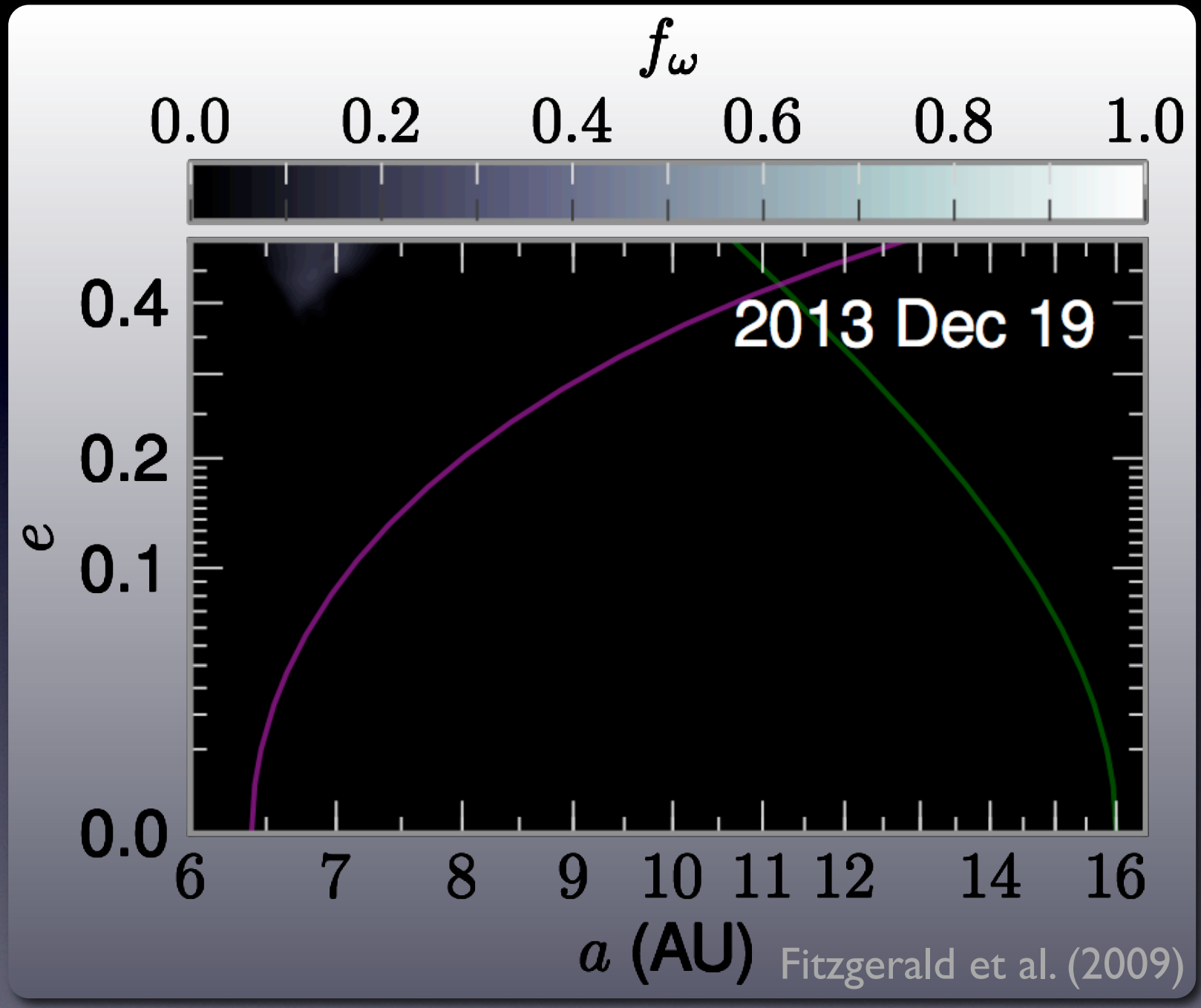

1.0
0.5
0.0
−0.5
−1.0
Δδ (″)
1.0
0.5
0.0
−0.5
−1.0
Δα (″)
9.0
7.5
6.0
4.5
3.0
1.5
0.0
−1.5
mJy beam^{-1}
Fitzgerald et al. (2009)


10
11
12
13
14
15
16
3-σ sens. (mag)
0.2
0.3
0.5
1.0
1.5
2.5
r (″)
Fitzgerald et al. (2009)

Orbital Geometry




f_ω
0.0
0.2
0.4
0.6
0.8
1.0
e
1.0
0.8
0.6
0.4
0.2
0.1
0.0
4
5
6
7
8
9
10
12
14
16
18
a (AU)
Fitzgerald et al. (2009)



Fitzgerald et al. (2009)

Summary

- β Pic b planet candidate not recovered in 2008 Dec. Keck AO *L´* band outside 0.29″ = 5.5 AU
- Require non-detections at similar sensitivity through 2013 to rule out inner planet