“Observational” Signposts of Brown Dwarf Formation Mechanisms

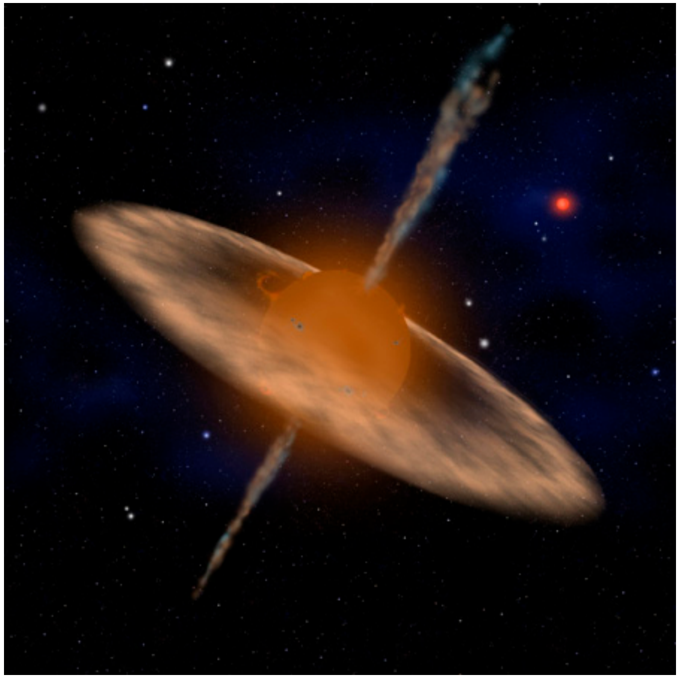


Image: David Aguilar

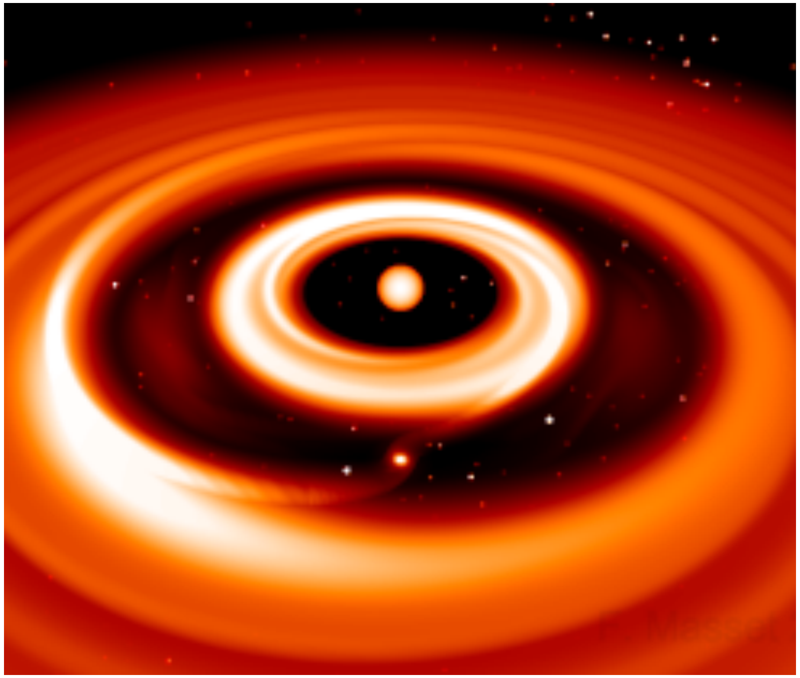
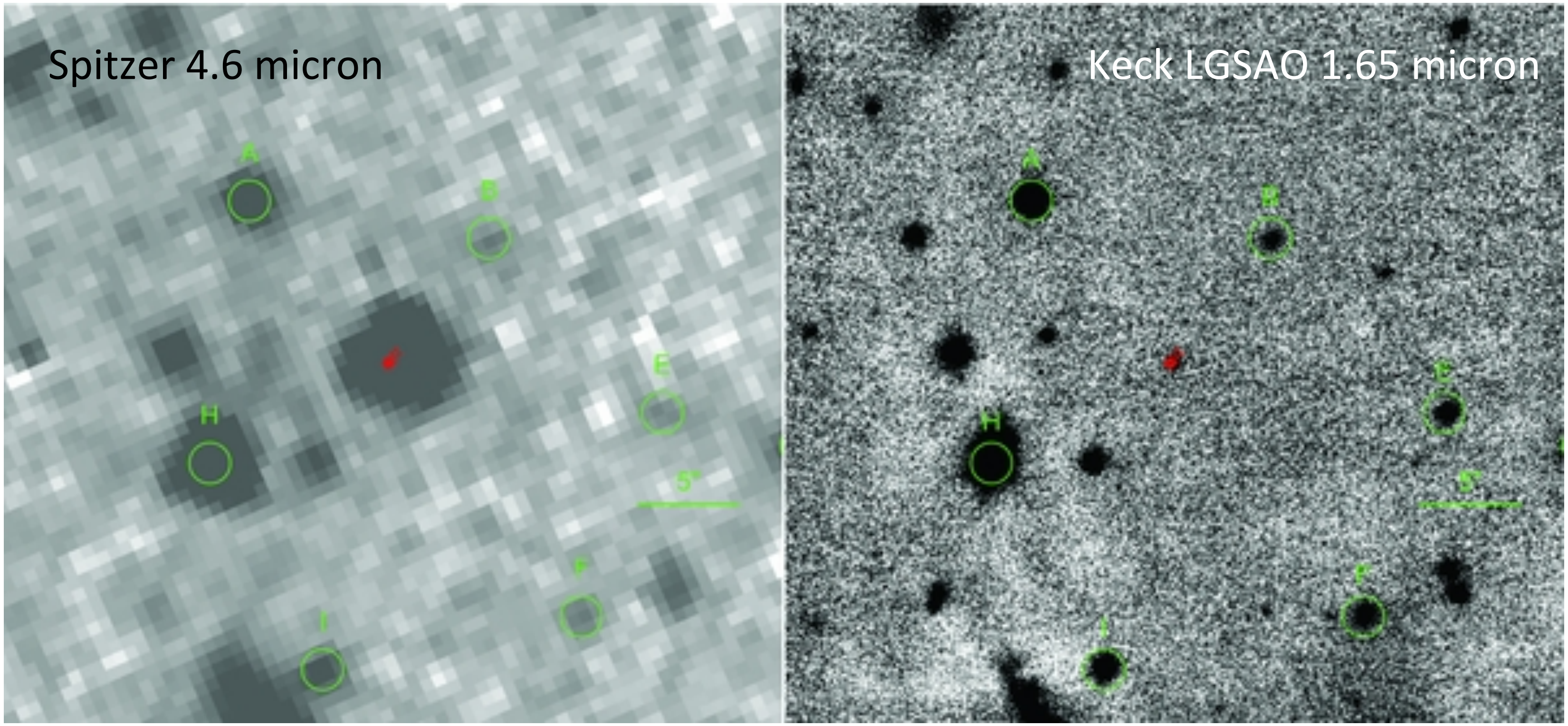


Image: Frederic Masset

Sally Dodson-Robinson

A Sample Population

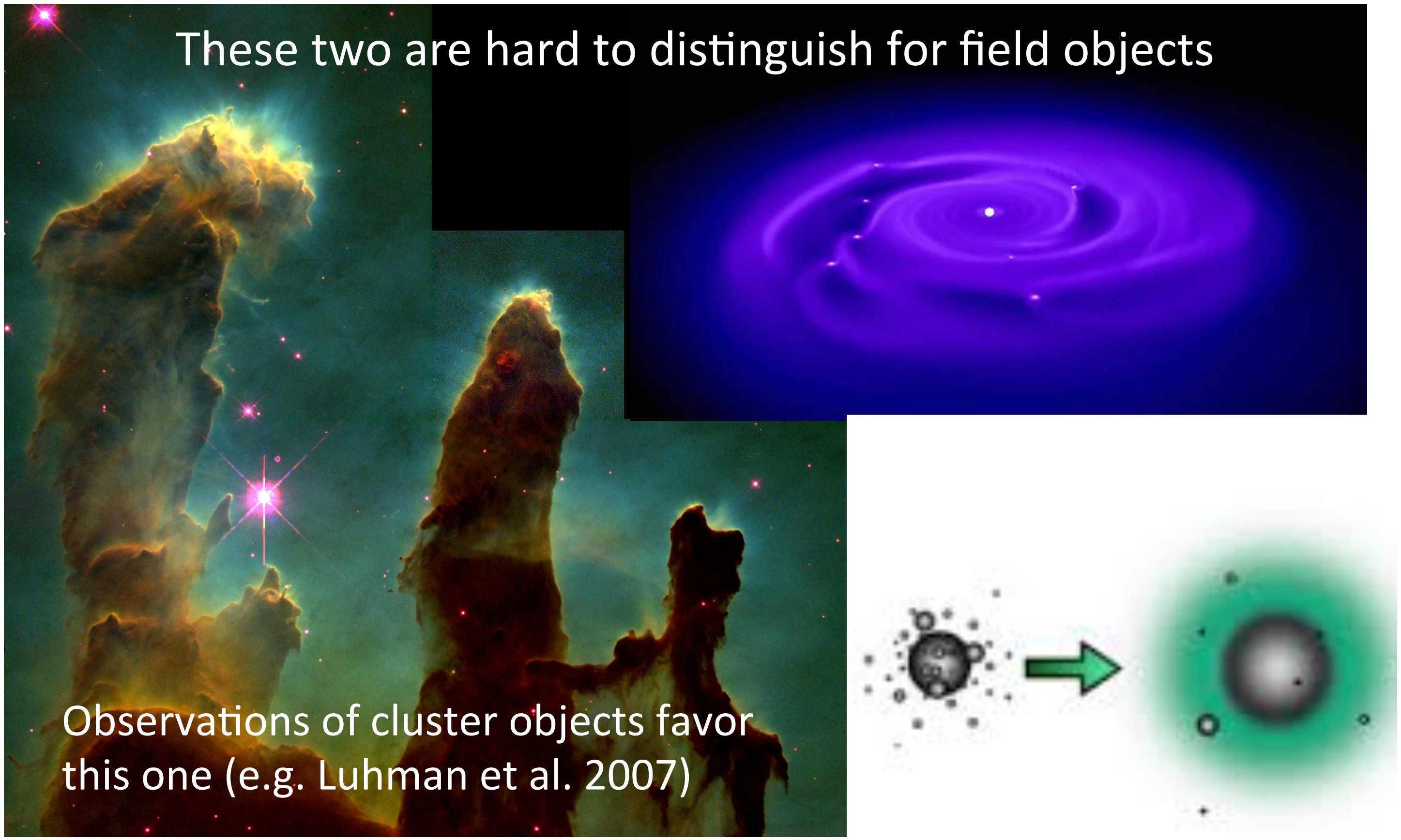


Beichman, Gelino, Kirkpatrick, Cushing, Dodson-Robinson, Marley, Morley & Wright 2014

15 field WISE sources of spectral type T8 and later:

How did they form?

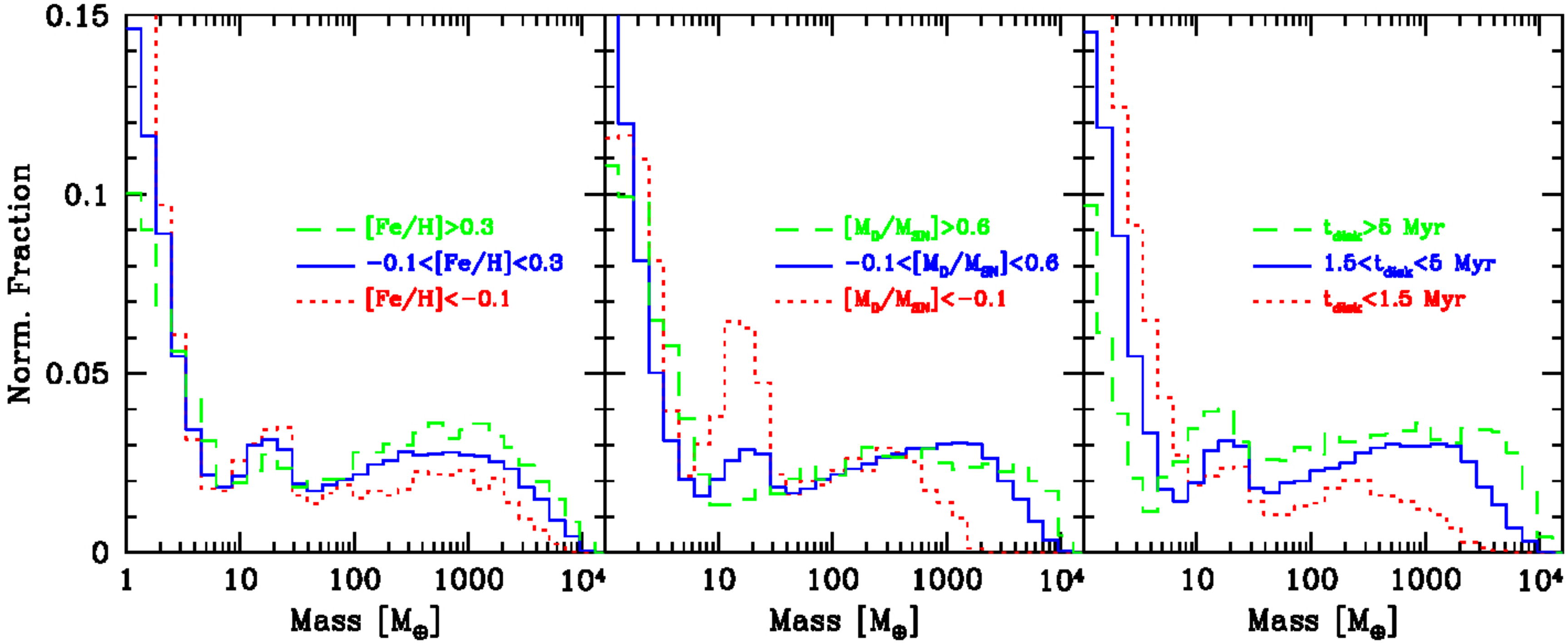
Formation Mechanisms



From left: star formation, disk instability, core accretion

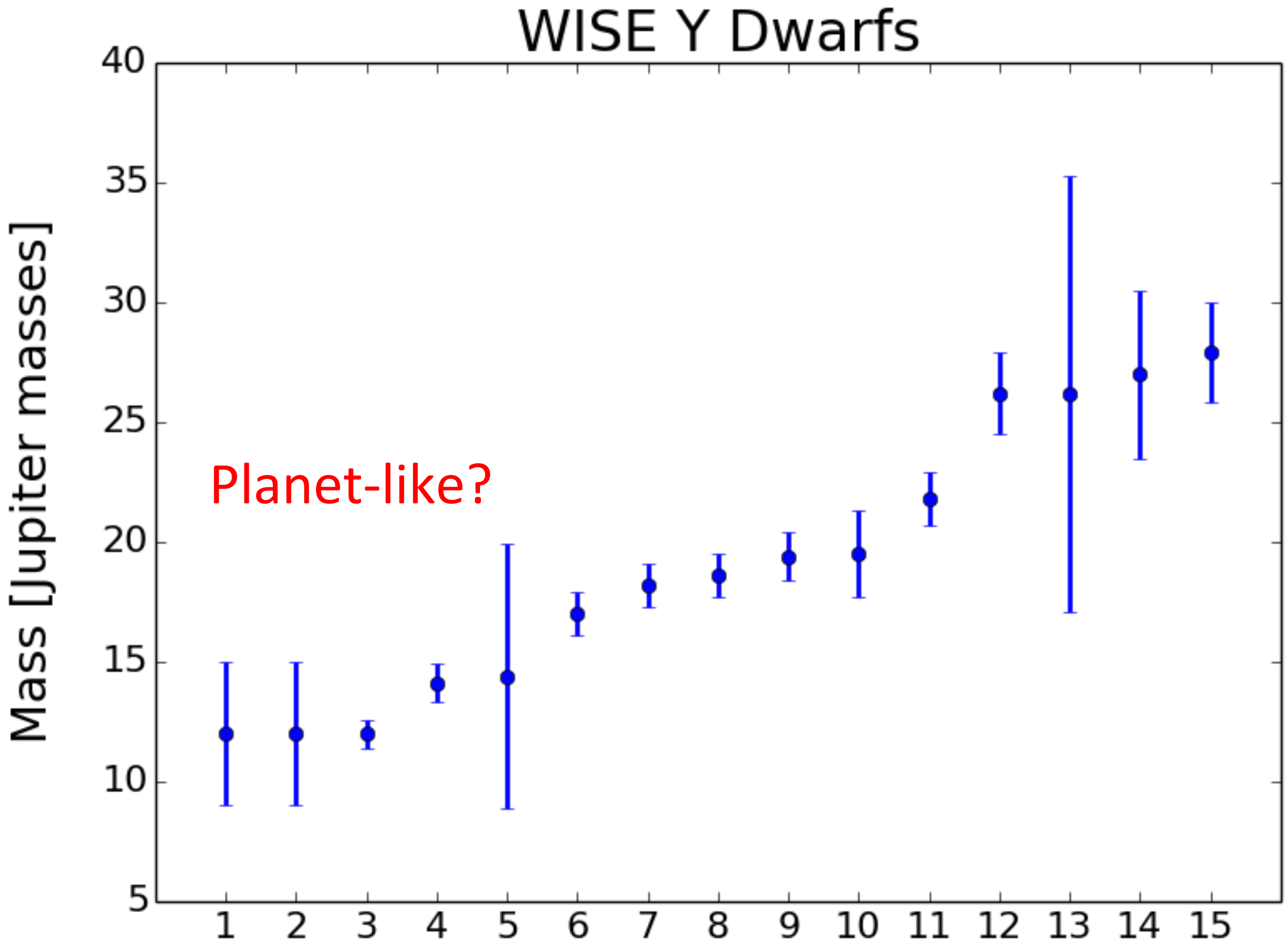
Images: NASA/STScI, Thomas Quinn, Greg Laughlin

1. Mass

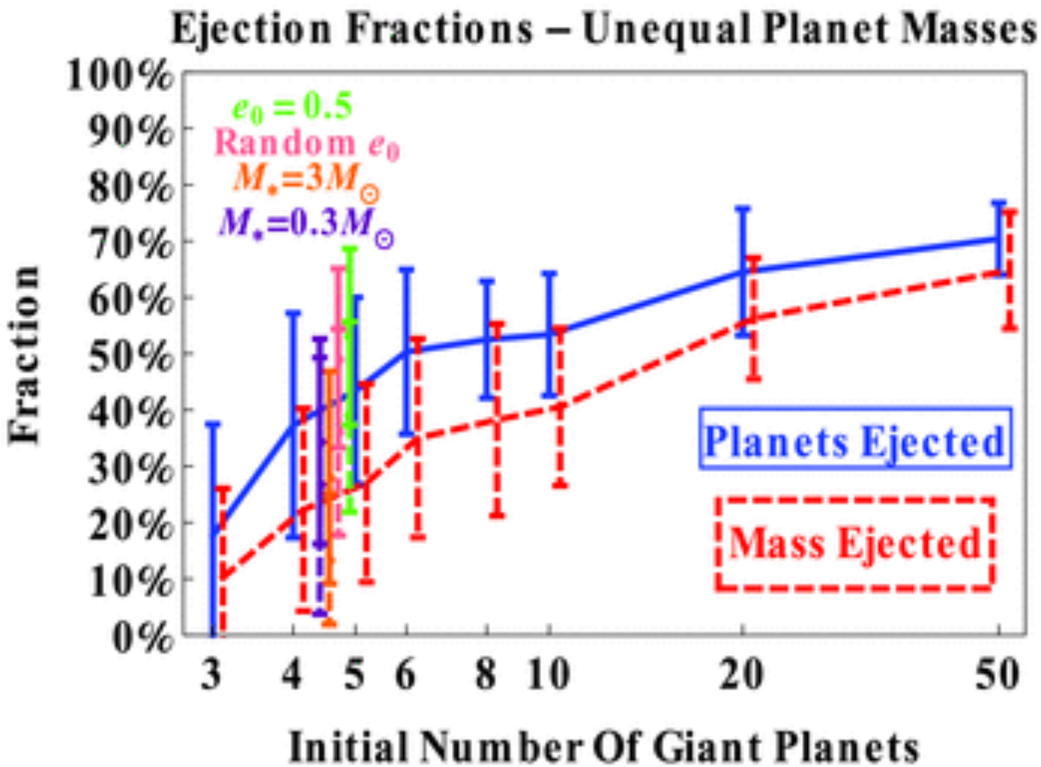


- Core accretion is extremely unlikely for objects > 3 Jupiter masses (**Mordasini et al. 2012, my work**)
- Fewer than 10% of RV planets are > 5 Jupiter masses
- Fewer than 3% of RV planets are > 10 Jupiter masses

Our Masses


WISE Y Dwarfs
Mass [Jupiter masses]
40
35
30
25
20
15
10
5
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Planet-like?

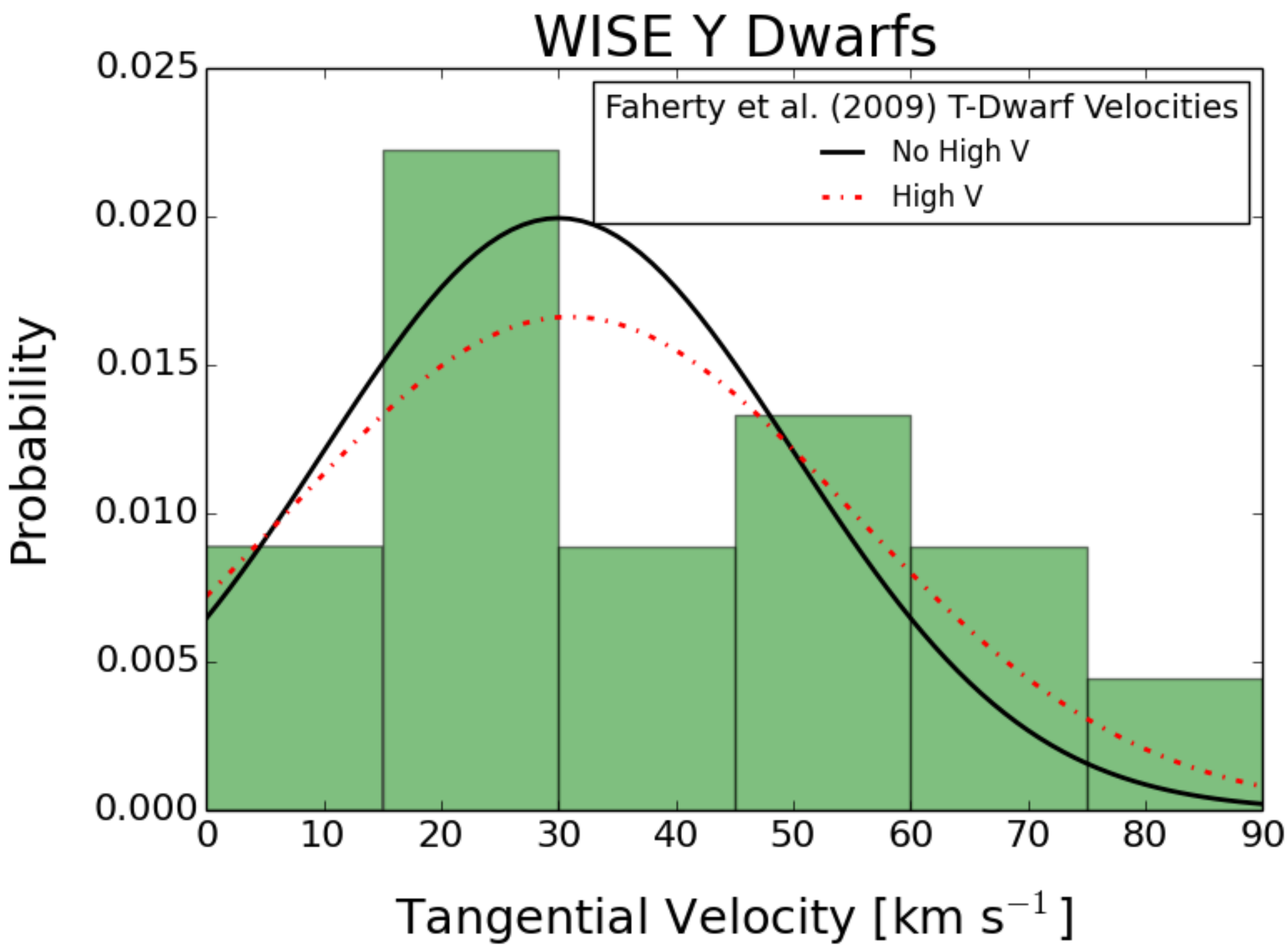
2. Tangential Velocity



*Veras & Raymond (2012): Free-floaters of Sumi et al. (2011) UNEXPLAINED by scattering
*My opinion: many "free-floaters" are bound

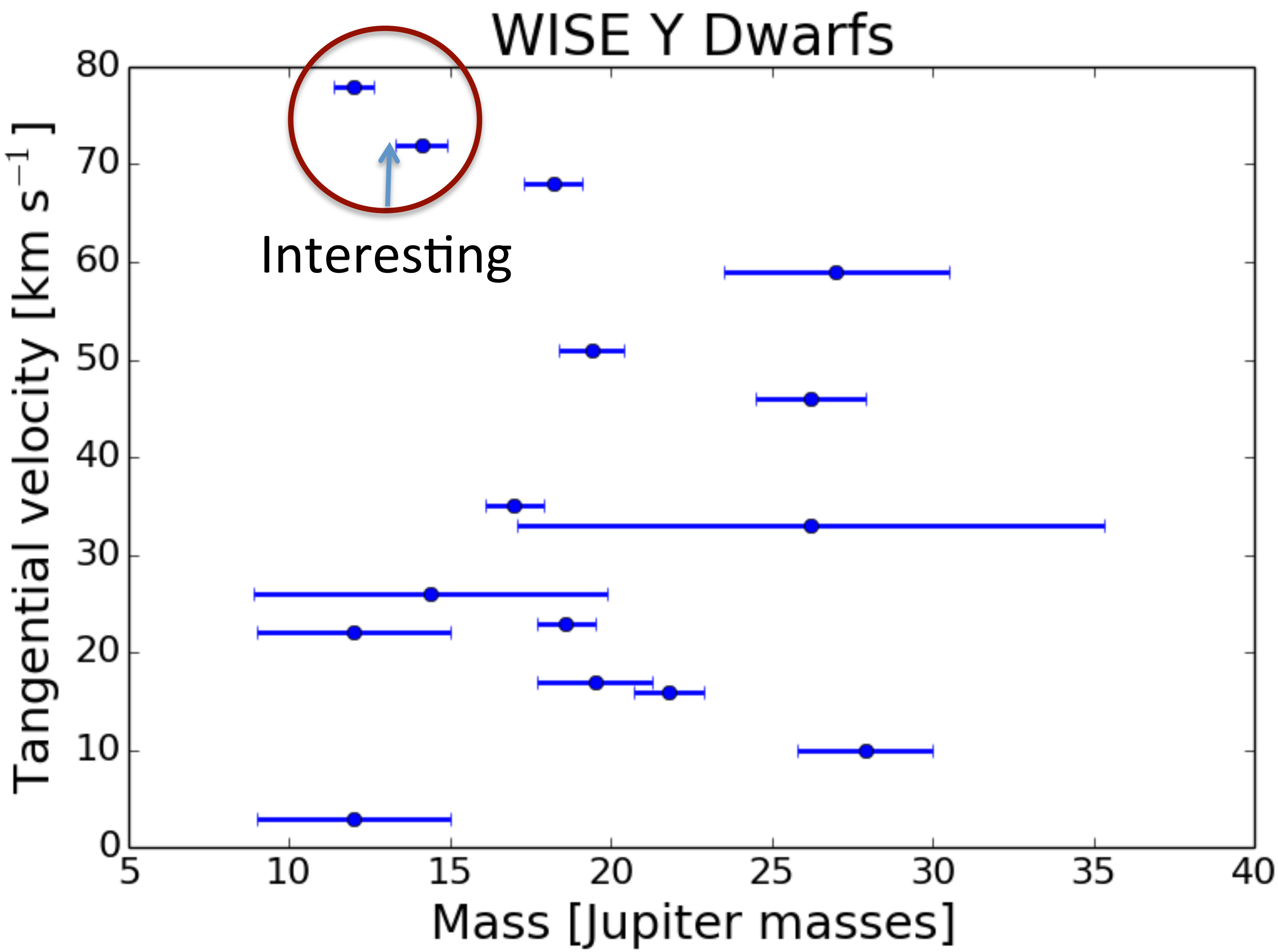
- In a three-body interaction, the smallest body is usually the one ejected (e.g. Adams & Laughlin 2003, Veras & Raymond 2012)
- High-velocity, low-mass object may have been ejected from a planetary system

Our Velocities

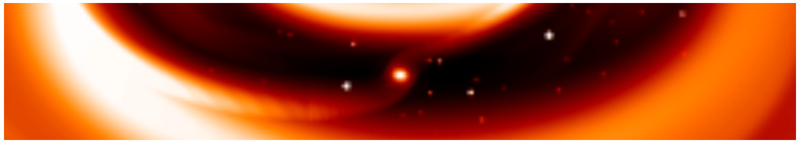


- Small sample: can't verify difference between Y and T
- BUT this is something to watch for in future

Mass vs. Velocity



Conclusions



- Statistics aren't robust enough to separate Y dwarf velocities from T dwarf velocities
- However – we do have some fast-moving, low-mass objects
- Remember that ejecting a 5 Jupiter-mass object requires something LARGER in the system
- We had no reason to reject starlike formation – but there is room to revisit the issue