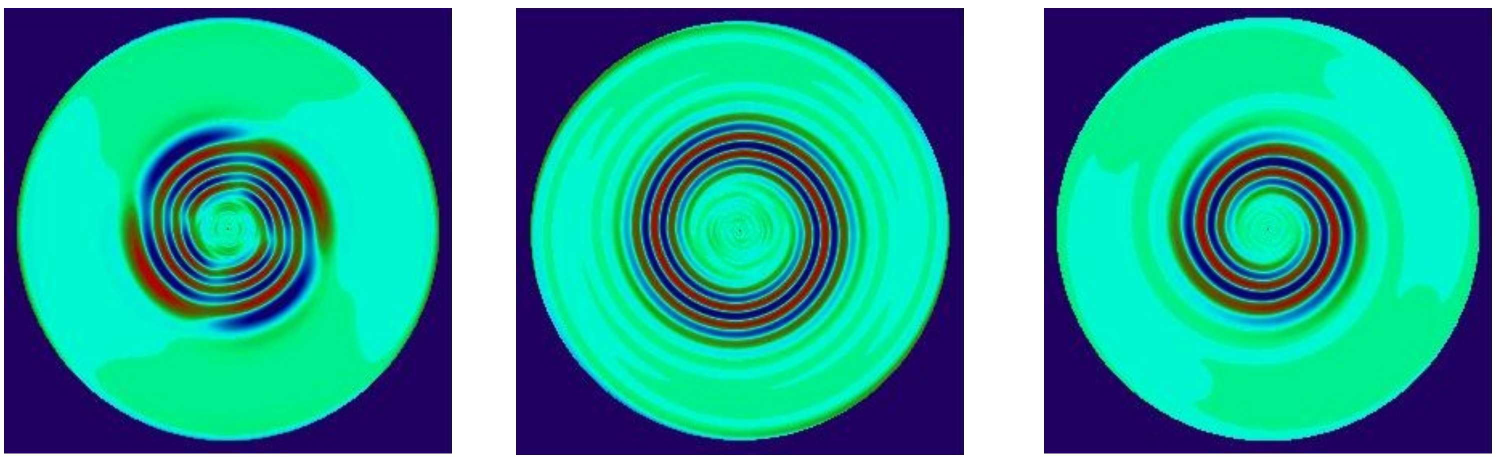
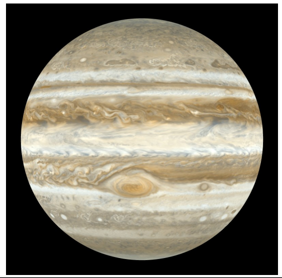
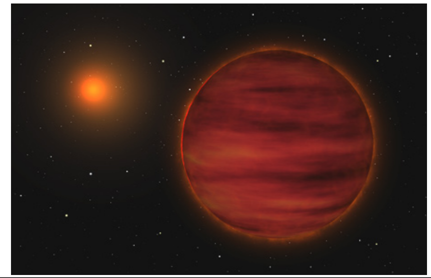
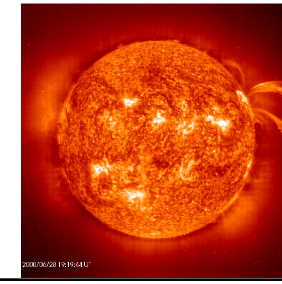
Gravitational Instability:

The formation mechanism of gas giants on wide orbits

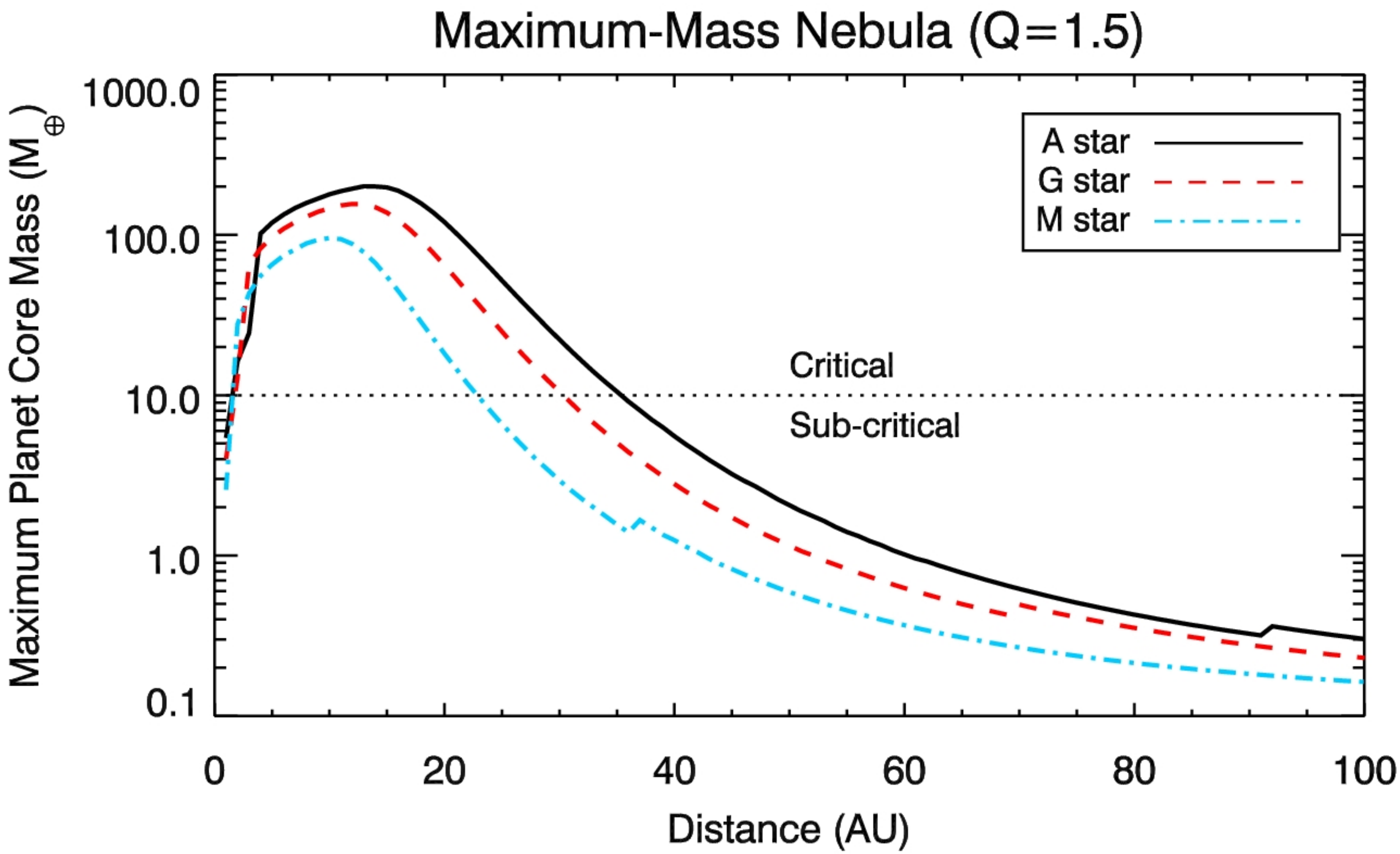


Sally Dodson-Robinson
University of Texas

Spherical, Self-Gravitating Objects

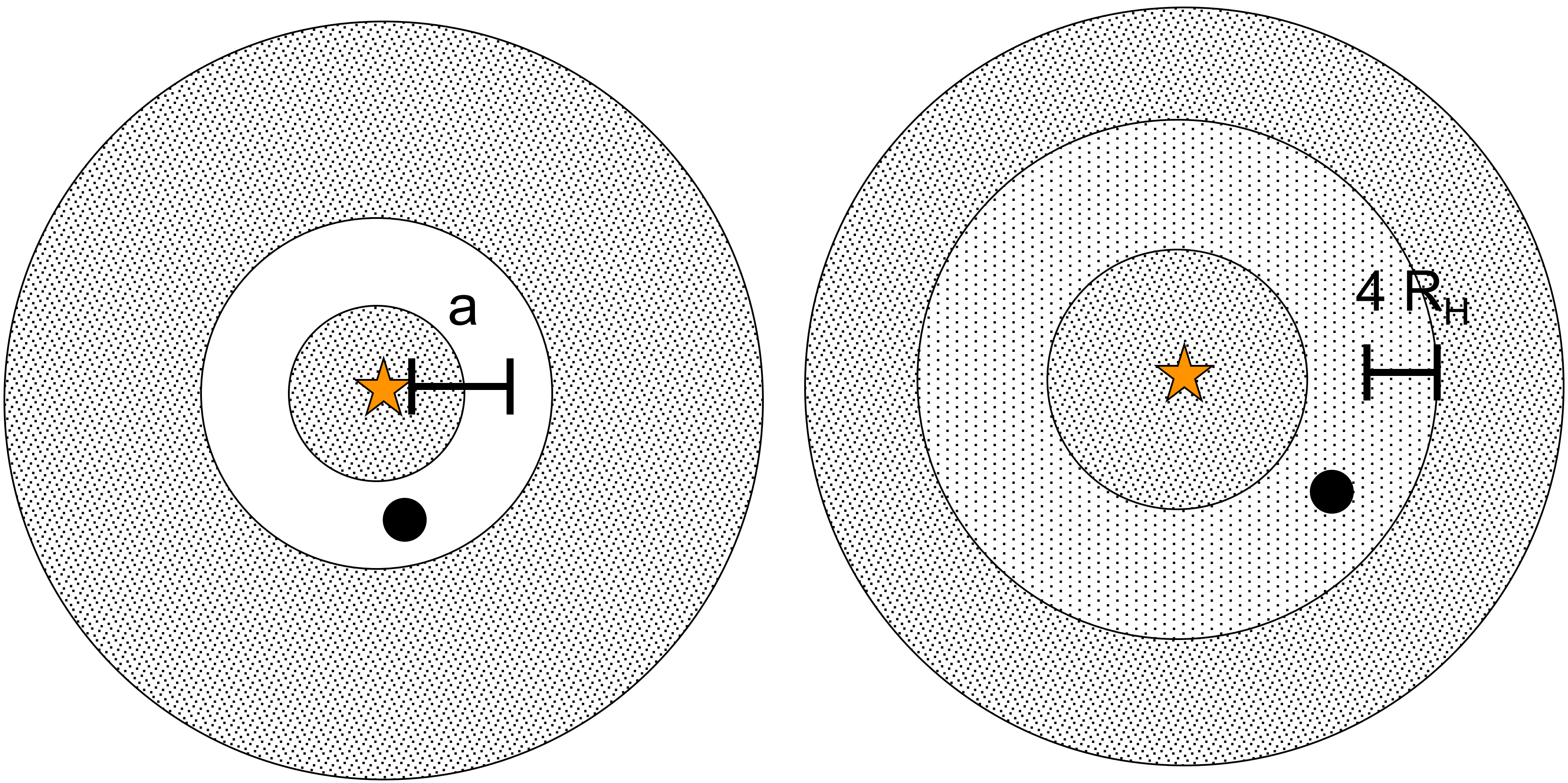
Picture			
Mass Scale	Jupiter	10 Jupiters	100 Jupiters
Formation Efficiency	~10%	Unknown (being measured)	10-30% in local clouds
Formation Mechanism	Bottom-up	Intermediate (possibly triggered)	Top-down
Multiplicity	N planets orbit 1 star	Unknown	Singles or binaries with M_1/M_2~1

Core accretion location



Dodson-Robinson et al. (2009)

Core accretion on wide orbits



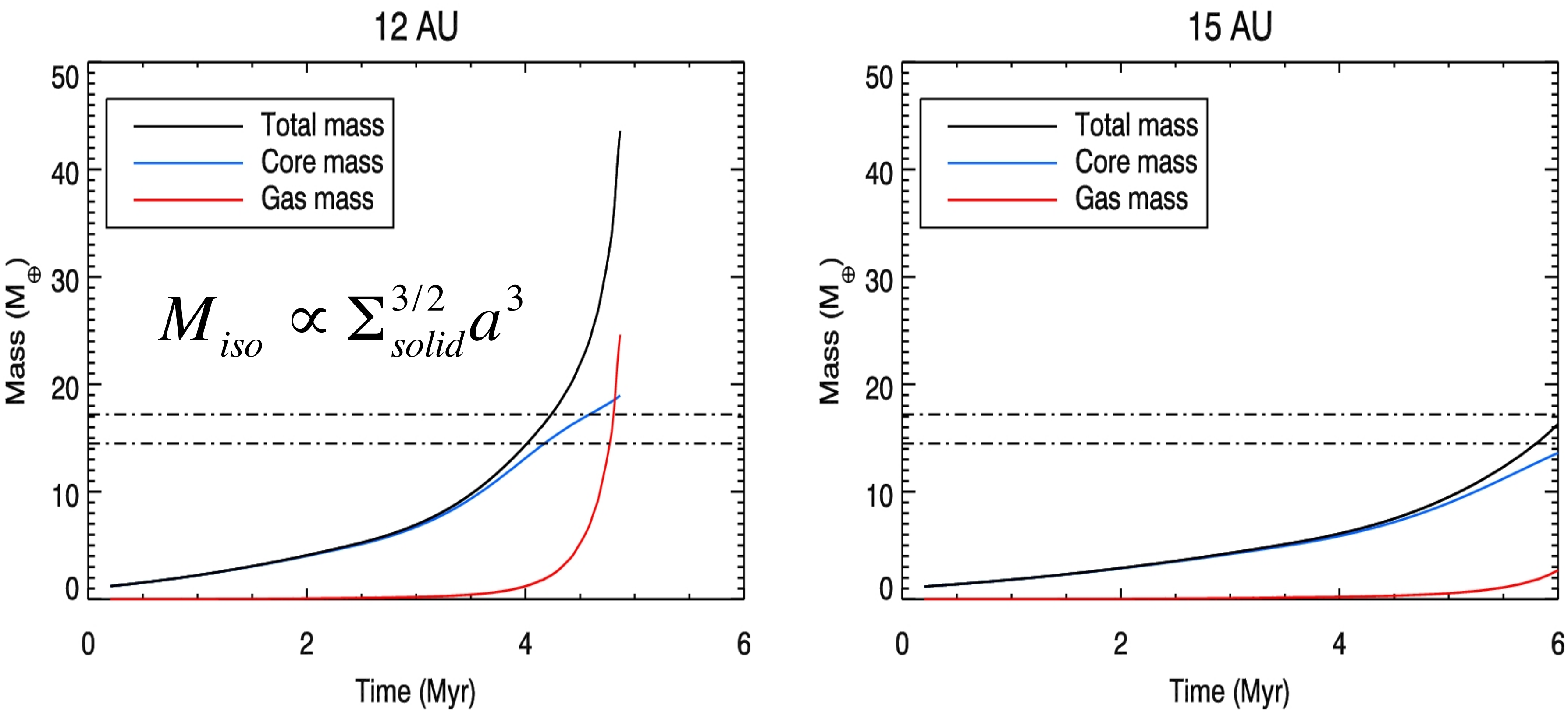
Needs to grow by gas accretion

Continues to accrete planetesimals

The power of dirt

Lake Mills, Wisconsin
Image: National Park Service

Planetesimal sabotage

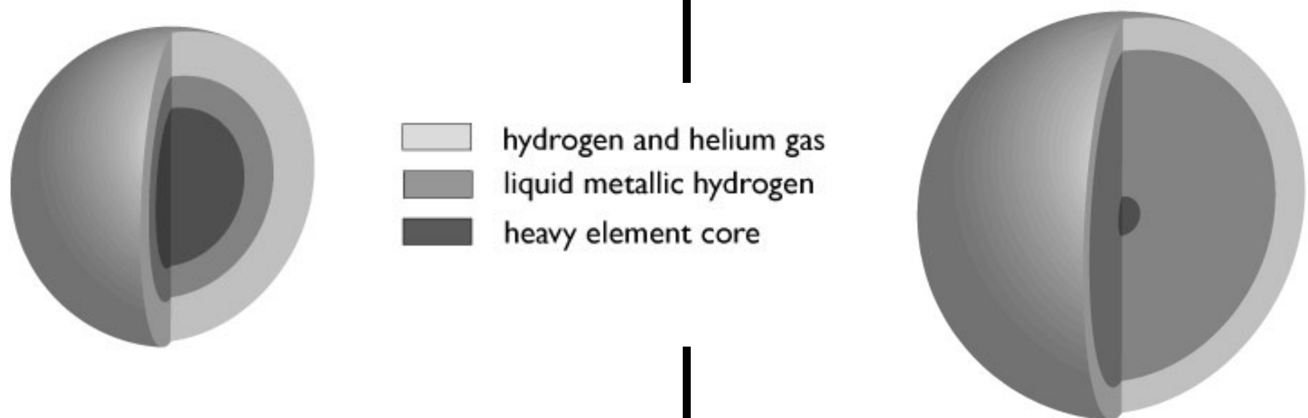


$$M_{iso} \propto \Sigma_{solid}^{3/2} a^3$$

Dodson-Robinson and Bodenheimer (2010)

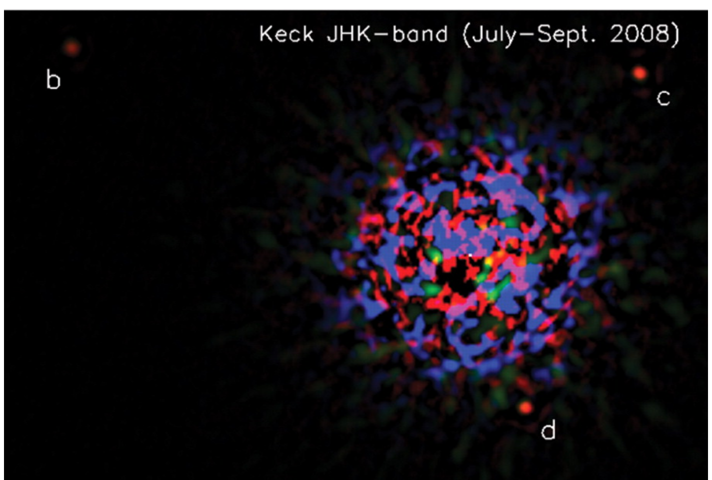
Three Species of Giant Planets

	Wide orbit	Close-in orbit
Core accretion	HD 149026 b	Jupiter
Disk instability	(Keck image, below)	Not viable*

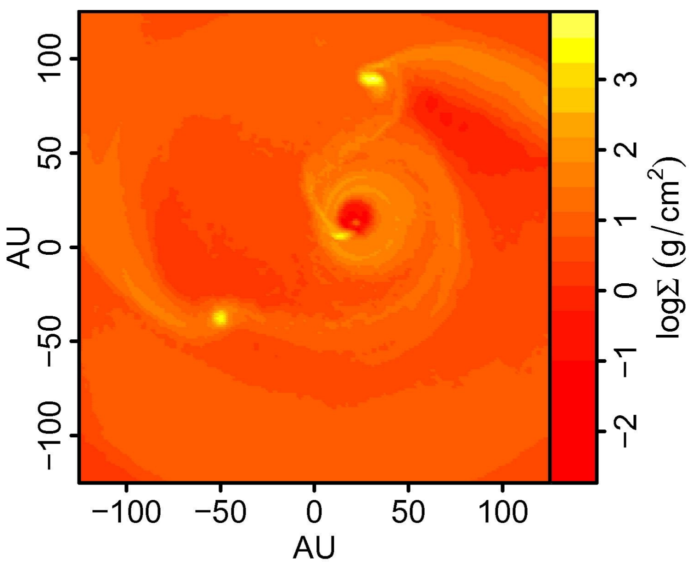


HD 149026 b

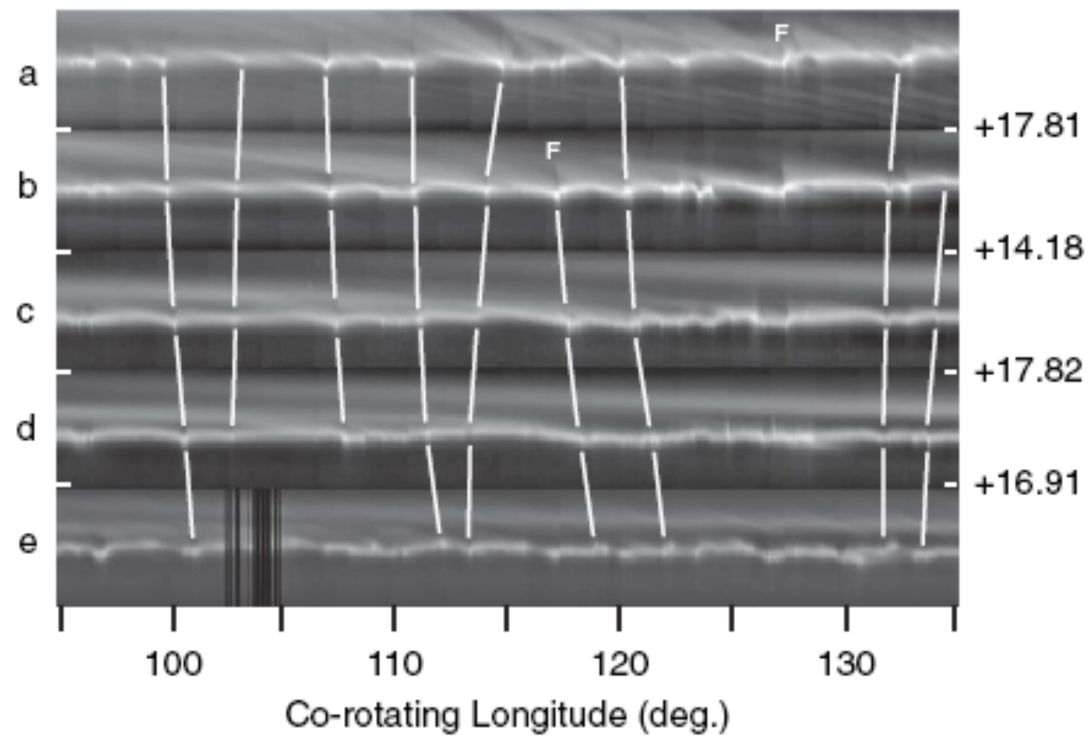
Jupiter



Evidence for low-mass fragments

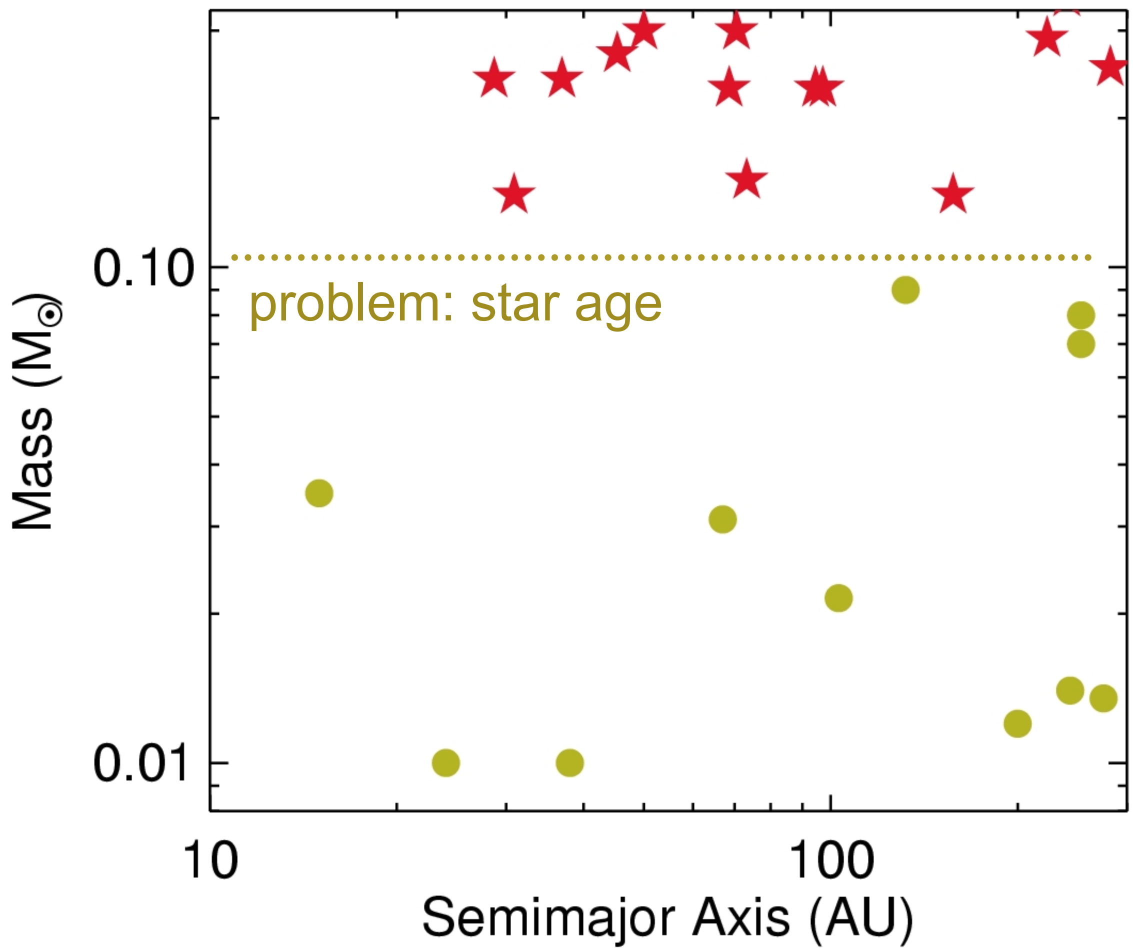


Boley et al. (2010)



Saturn's F ring
Beurle et al. (2010)

Evidence for medium-mass fragments



Likely disk fragments:

$M_2/M_1 < 0.3$
10 AU < a < 300 AU
Detection rate = 7%
Compare to RV planets!

Star data:
Eggenberger et al. (2007)