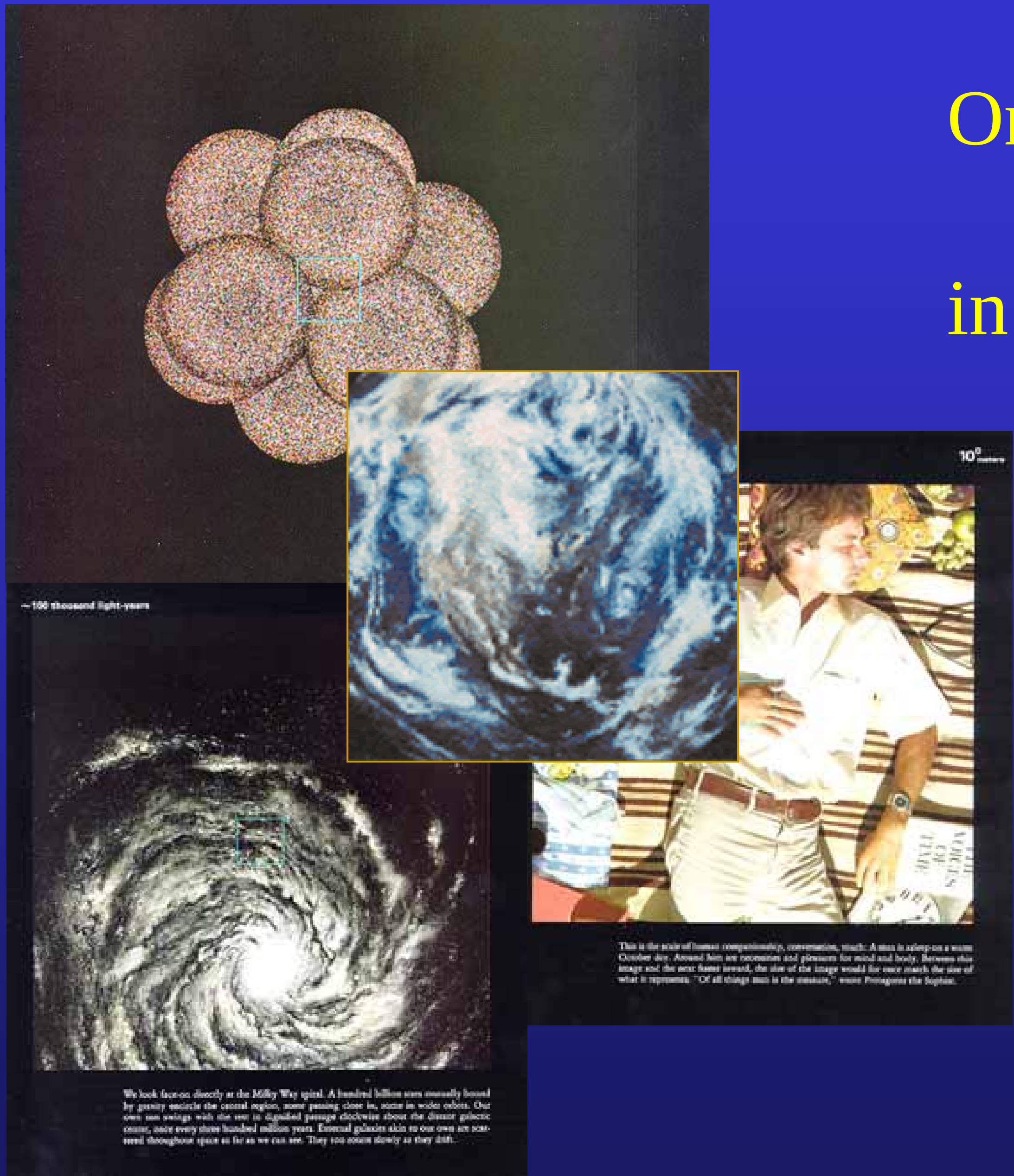
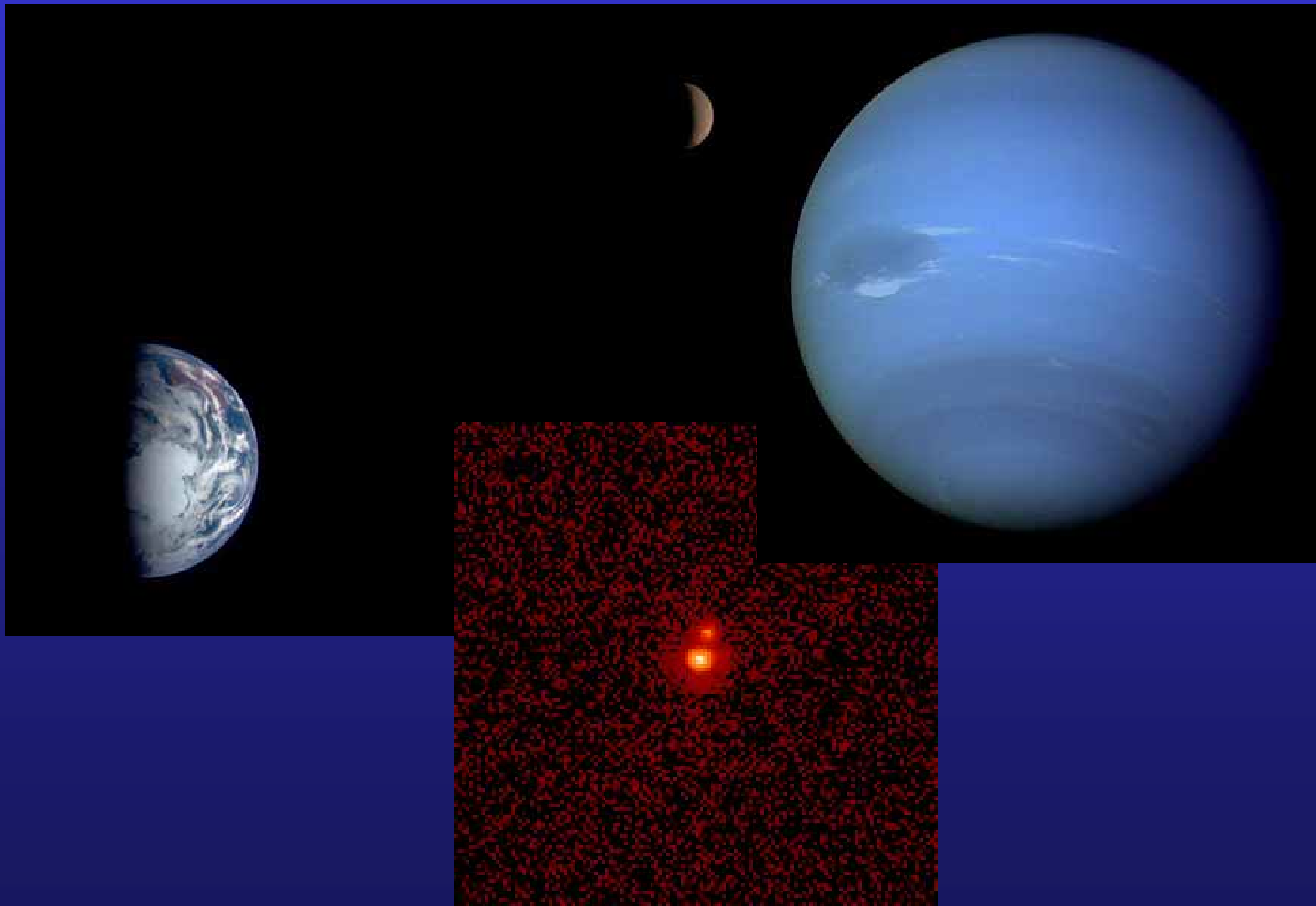


Order-of-Magnitude Problems in Planetary Science

Kobe 2005
E. Chiang
UC Berkeley

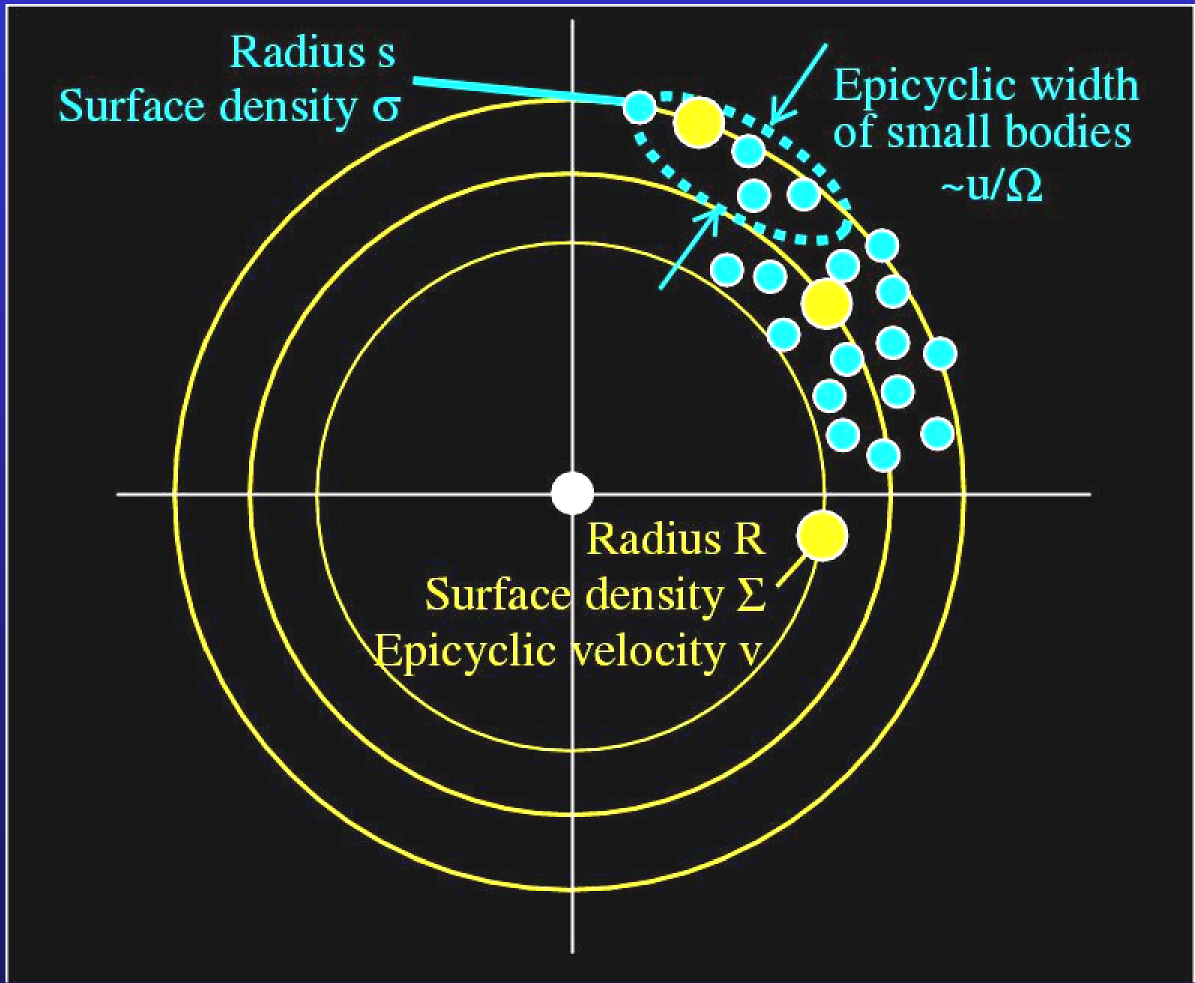
I. Planet Formation
II. Planet-Disk Interaction
III. Debris Disks
IV. Mass Loss from Hot Jupiters

Solid body formation by coagulation

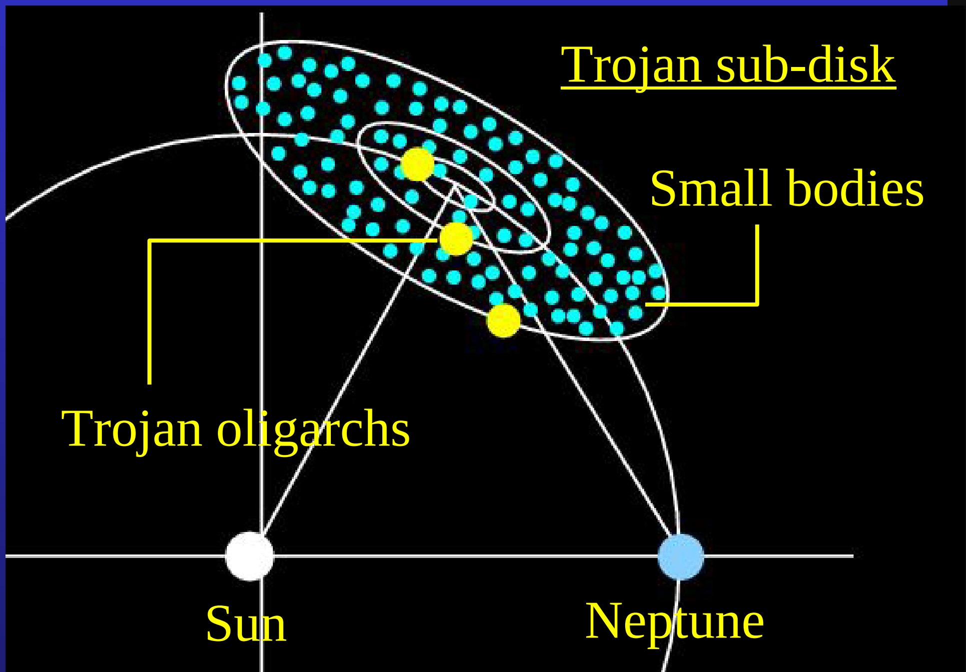


Goldreich et al. 04

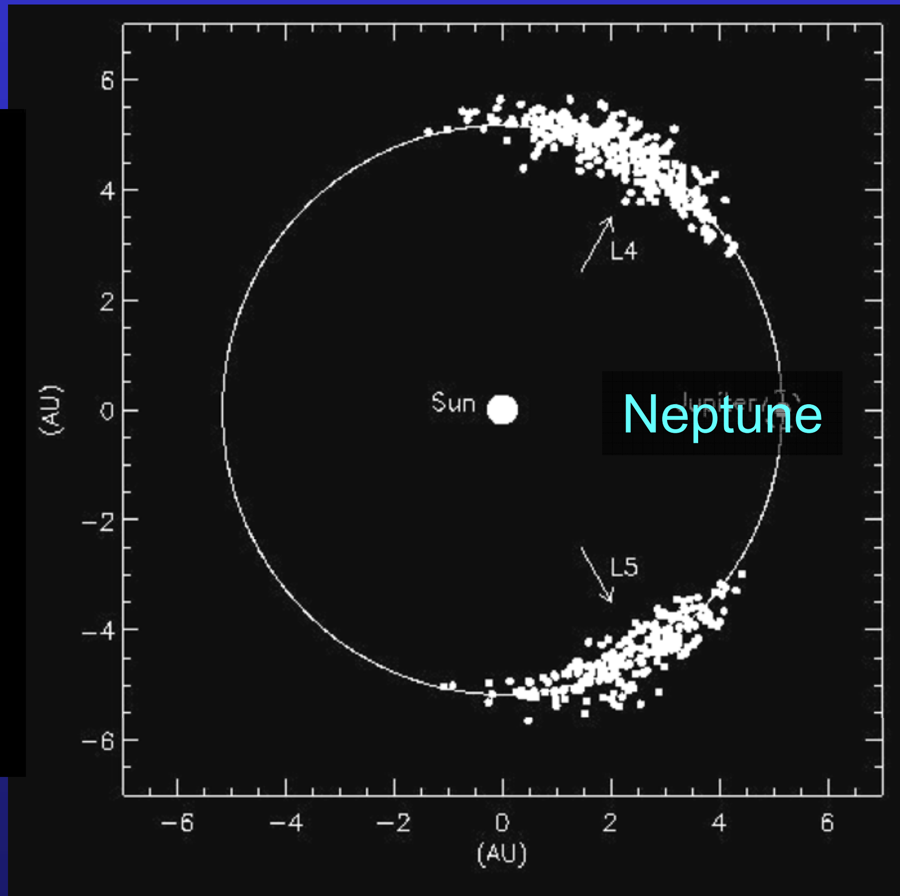
Dispersion-dominated Oligarchy



Neptune Trojans as Dispersion-Dominated Oligarchs

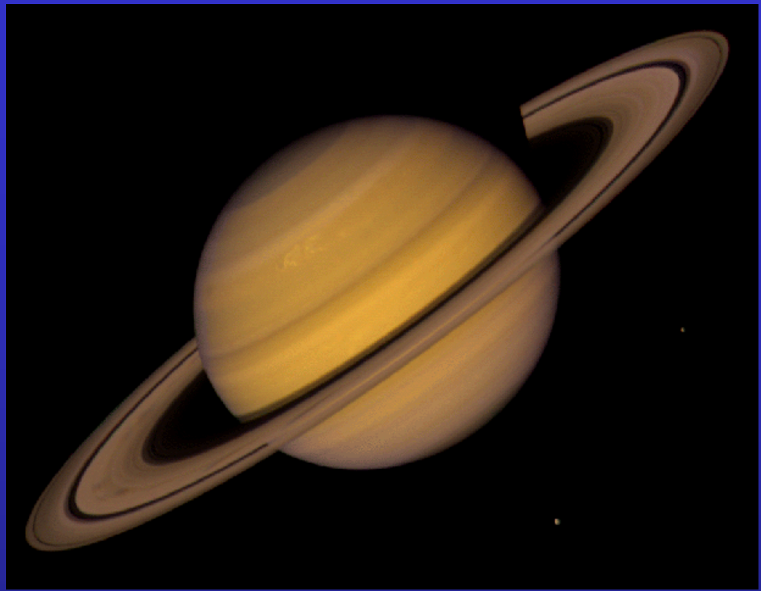


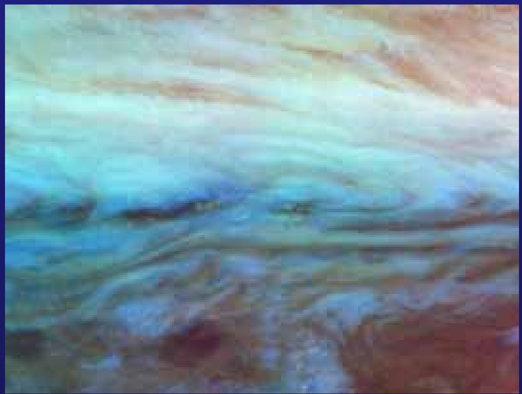
"Move over Jupiter"



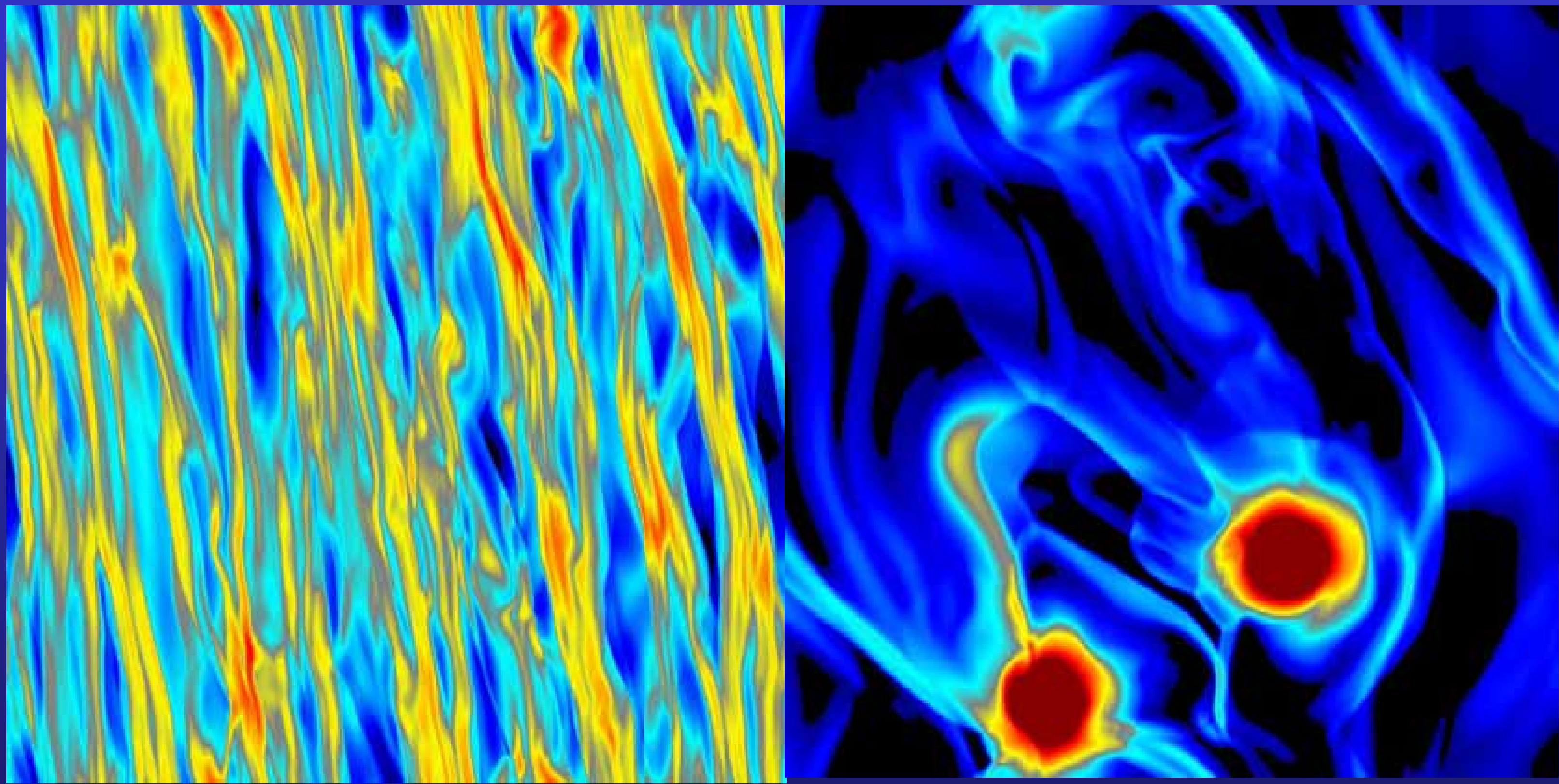
Chiang et al. 2003; Chiang & Lithwick 2005

Gaseous (Liquid) Planet Formation





Cooling time vs. Collapse time

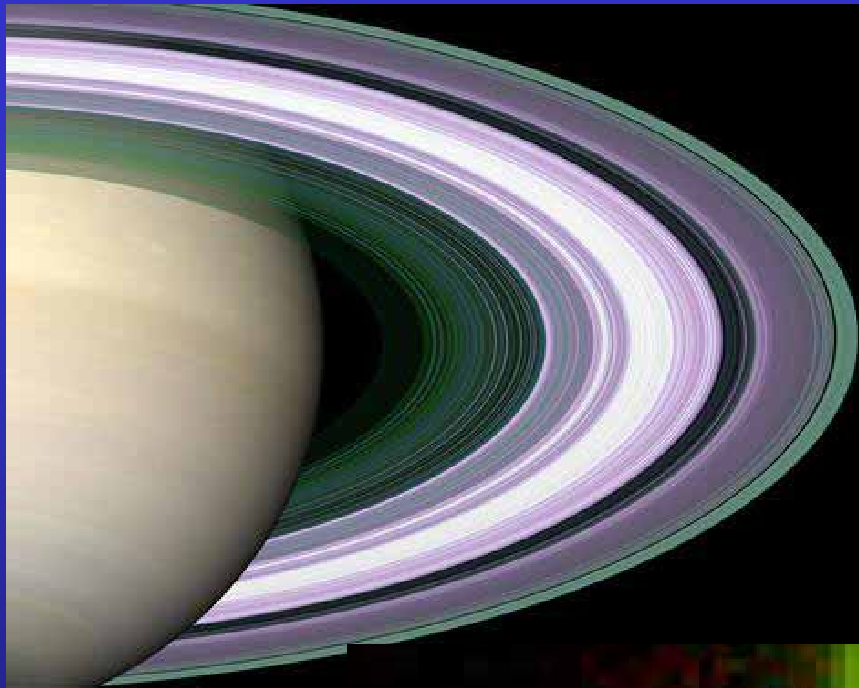


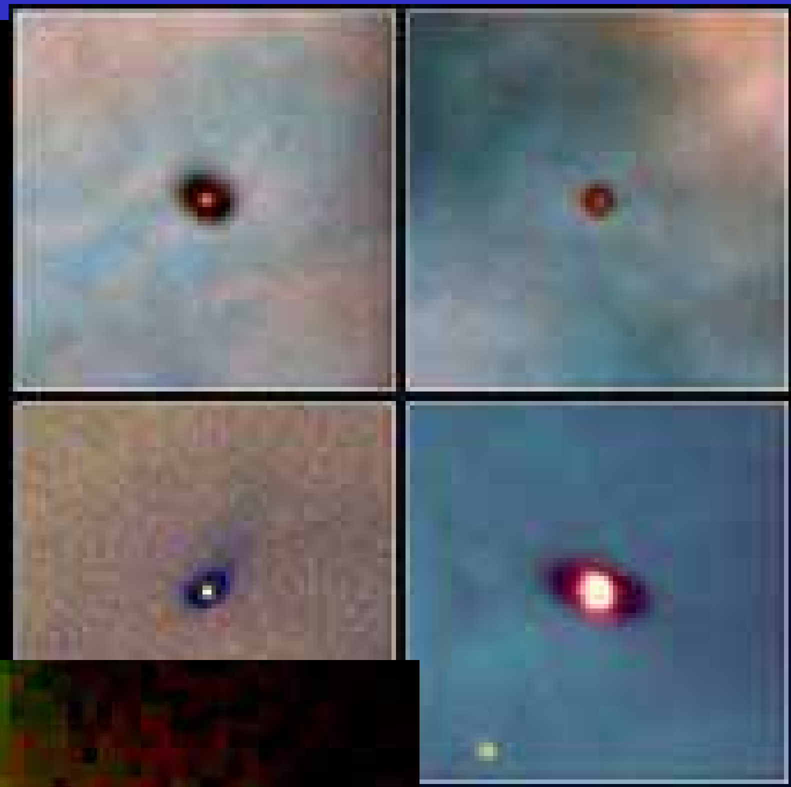
$t_{cool} \sim 50/\Omega$

$t_{cool} \sim 2/\Omega$

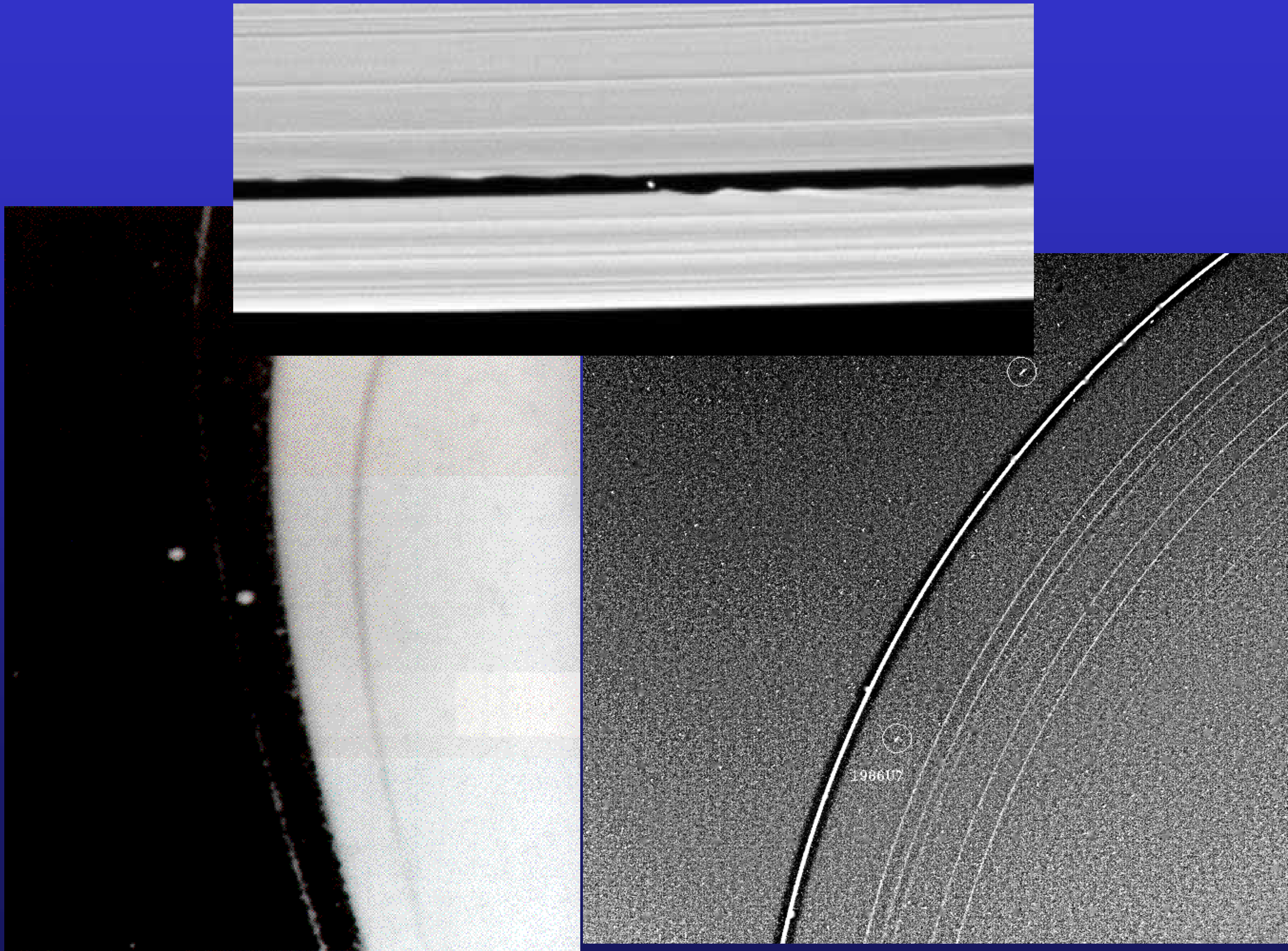
Gammie 2001

Viscous Disks



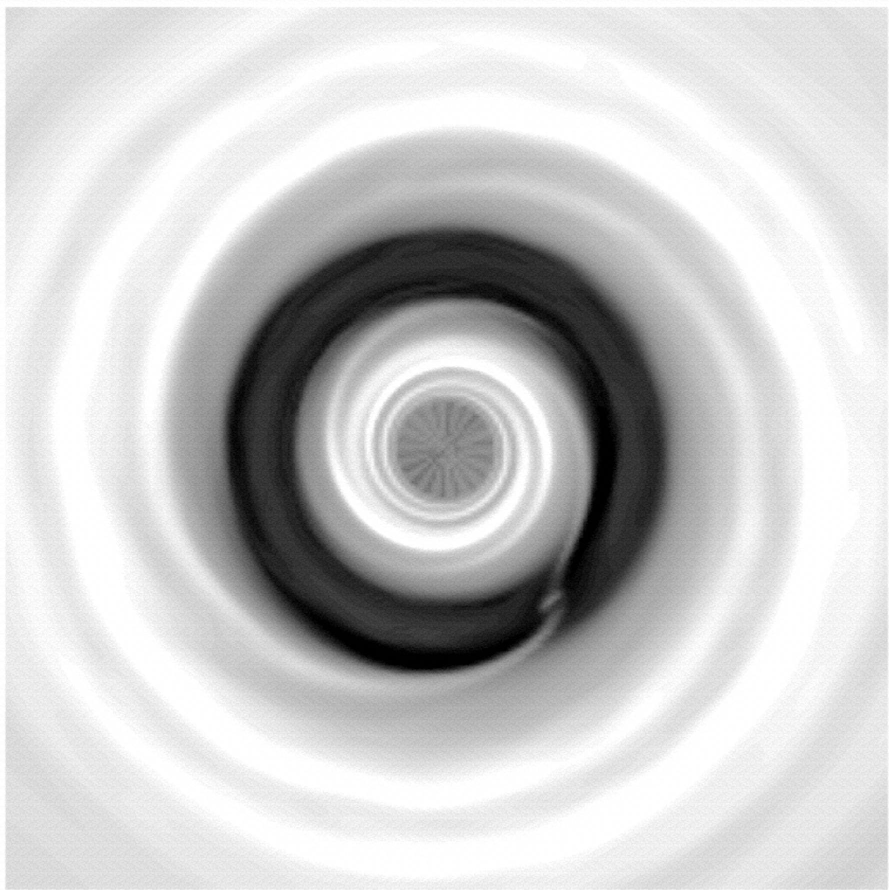


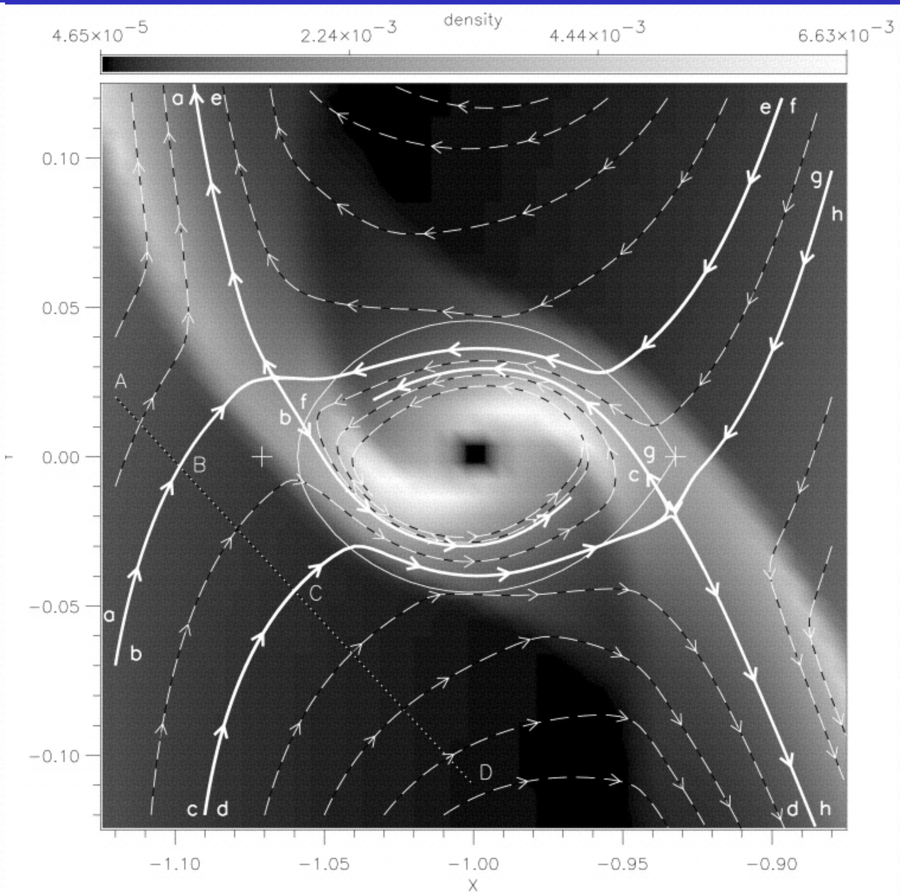
Gap Formation and Ring Confinement



Unclean Gap Formation by Jovian Mass Planets

$x \sim R_{Hill}$

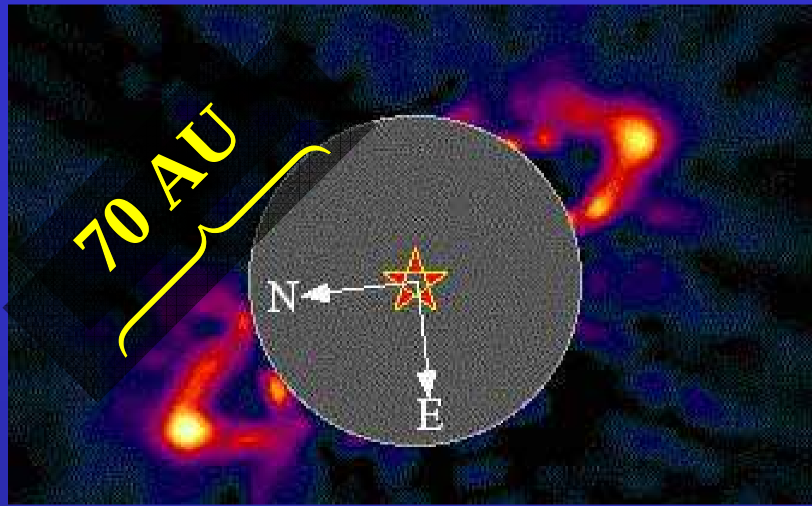


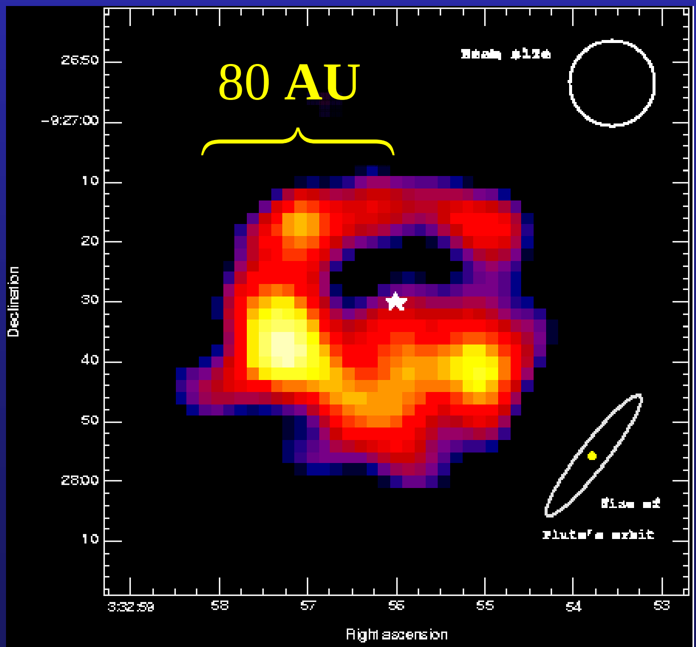


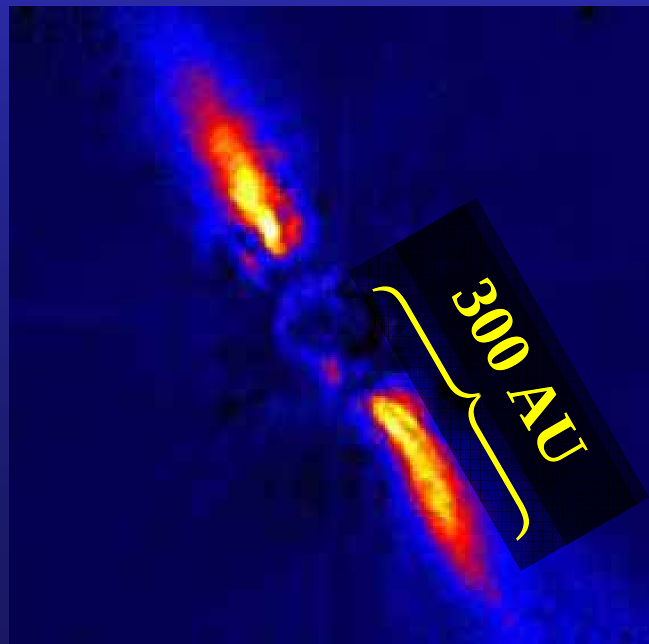
Bryden et al. 1999

Lubow et al. 1999

Debris Disks
(Extrasolar Kuiper Belts)







Strength vs. size

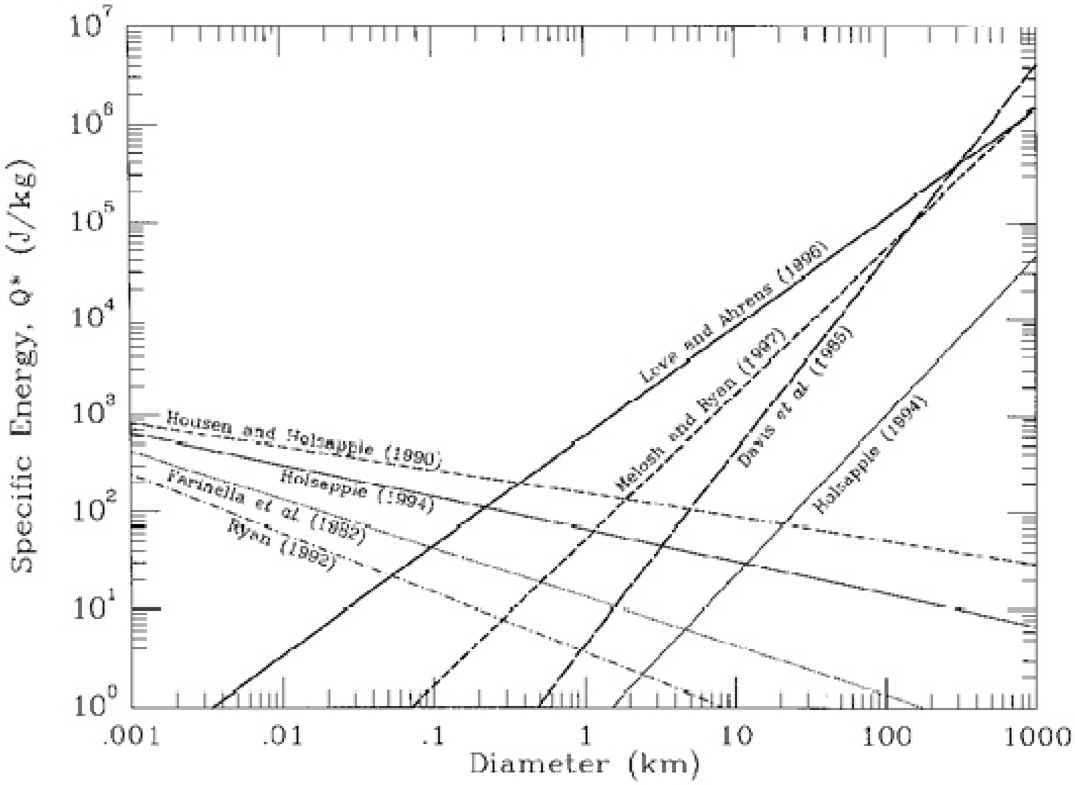
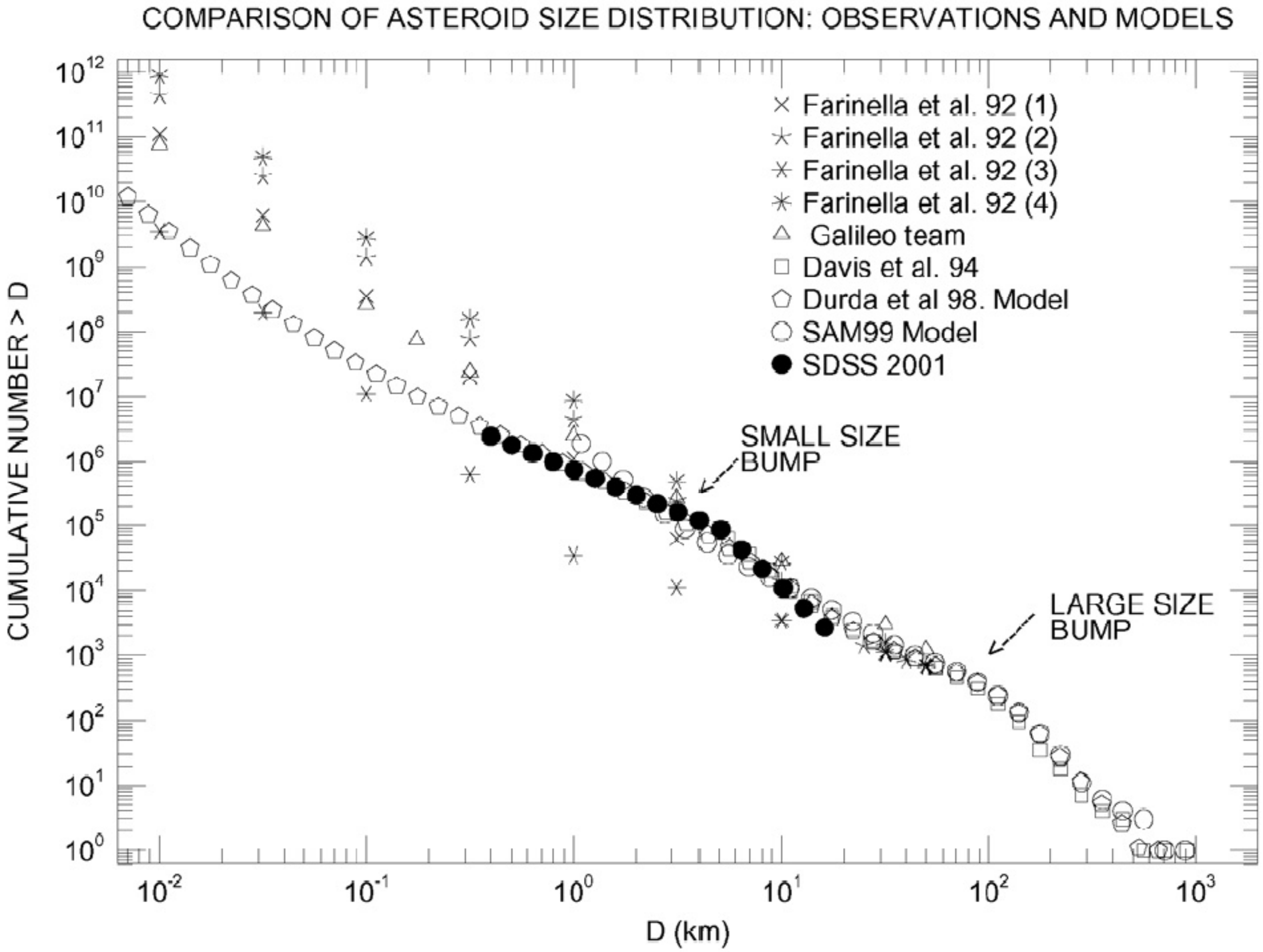


FIG. 1. Representative scaling laws in the strength- and gravity-scaling regimes. Critical specific energies in the strength-scaling regime are loosely constrained by laboratory impact experiments to values near 1500 J kg^{-1} (for solid, competent silicates) for target diameters of ~8 cm. Strength-scaled specific energies decrease with target diameter as $D^{-0.24}$ (Housen and Holsapple 1990), $D^{-0.33}$ (Holsapple 1994), $D^{-0.5}$ (Farinella *et al.* 1982), or $D^{-0.61}$ (Ryan 1992). In the gravity-scaling regime the specific energy increases with increasing target size, scaling as $D^{1.13}$ (Love and Ahrens 1996), $D^{1.5}$ (Melosh and Ryan 1997), $D^{1.65}$ (Holsapple 1994), or $D^{2.0}$ (Davis *et al.* 1985; nominal parameters, including fragment dispersal).

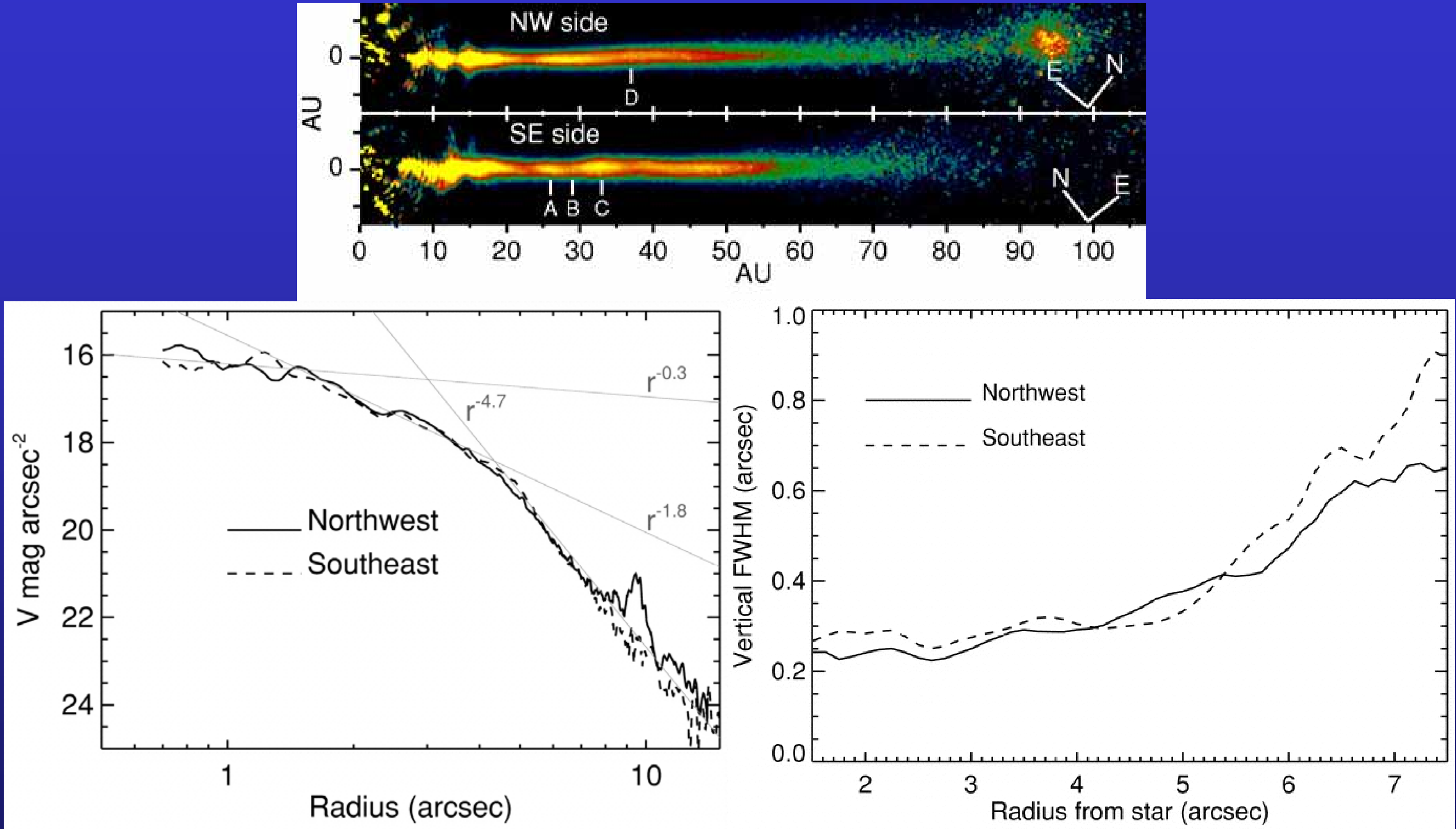
Durda & Dermott 1998

Observed Main Belt Asteroid Size Distribution



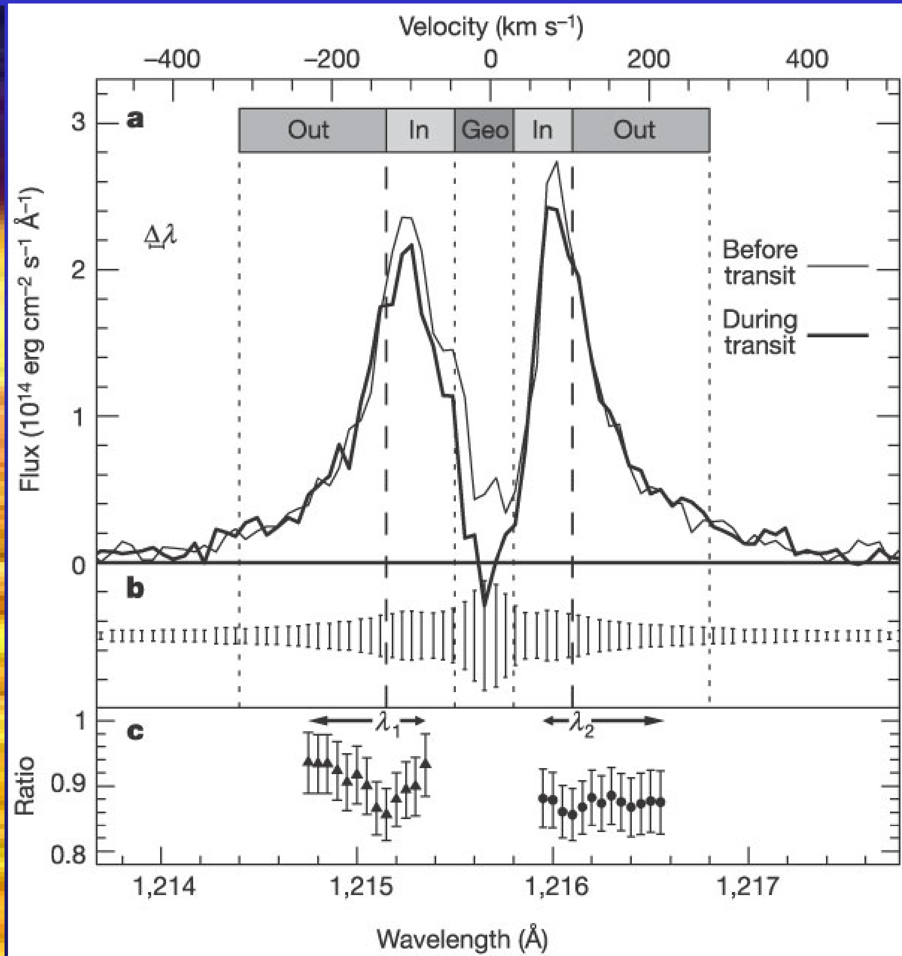
The asteroid size distribution (Davis 2002, in Asteroids III).

The Case of AU Microscopii



Krist et al. 2005

Photo-evaporating Hot Jupiters



Vidal-Madjar et al. 2003