Homework 5 Due ~~TODAY~~

Readings: Ch. 3, p 60-69
Chap. 4 p. 75-79, 85-89
Ch. 5 (all)

RINGS, GLORIOUS RINGS!

Quick survey of ring systems: Figure 3-14

1- Saturn - broad, bright rings out to ~ 2.4 R_{Sat}.
- gaps!
- thin (<< 1km), not solid (bright in transmission at ring plane crossings)

2- Uranus - narrow, dark rings discovered via occultation
- non circular & ring, rocky
- out to ~ 2 R_{Uranus}

3 Jupiter - single dusky ring
- sharp outer edge @ ~ 1.8 R_{Jup}.

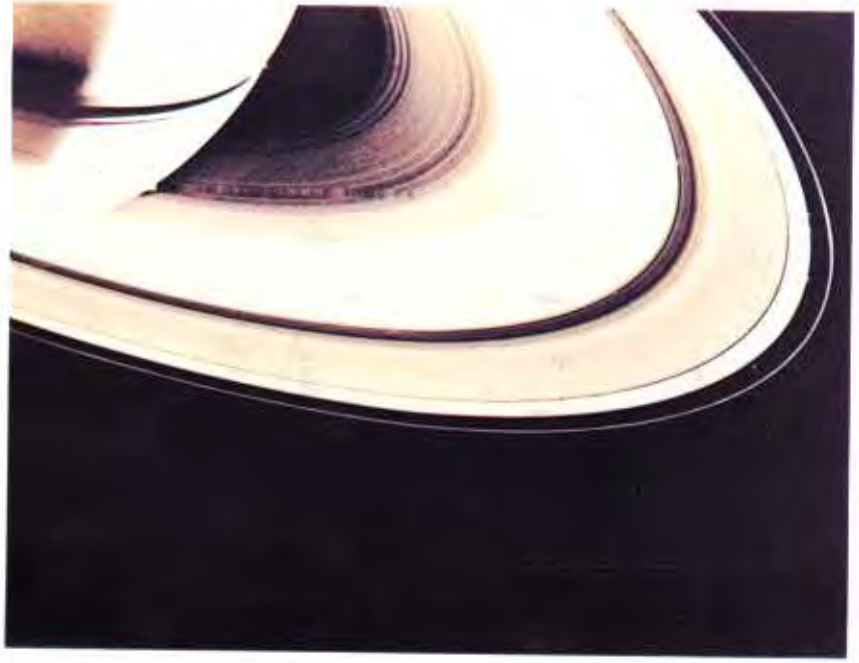
4. Neptune - (mostly) ring arcs out to ~ 2.6 R_{Nep}
- icy

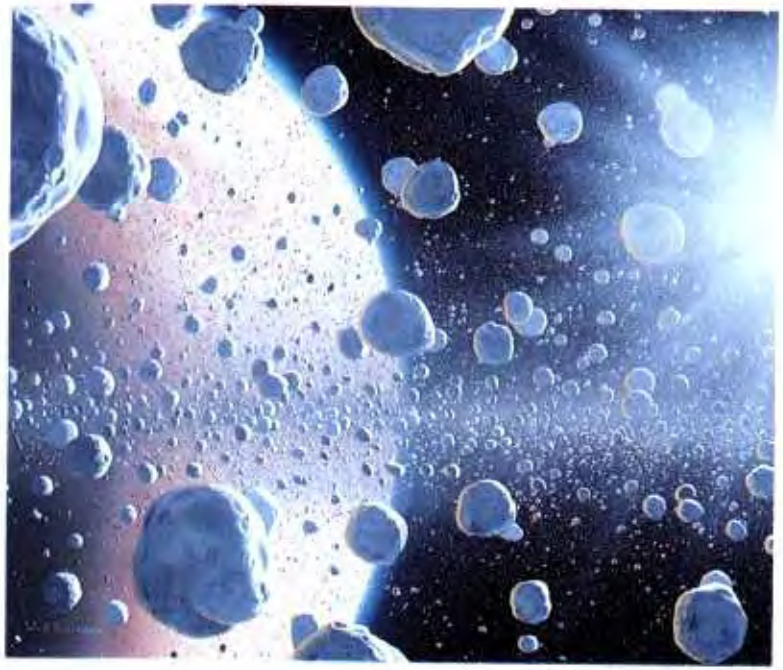
Recall the ROCHE LIMIT

$r_{Roche} \approx 2.44 R_{planet} (\rho_{planet}/\rho_{moon})^{1/3}$ low ρ "moon" $\Rightarrow$ bigger r_{Roche}

- material within cannot gravitationally congeal;
- modestly dep. on mass; $R \lesssim 40$ km might survive if already formed.

Figure 12.36 Saturn's rings





TA 91

The first evidence for rings around Uranus (Fig. 13-11)

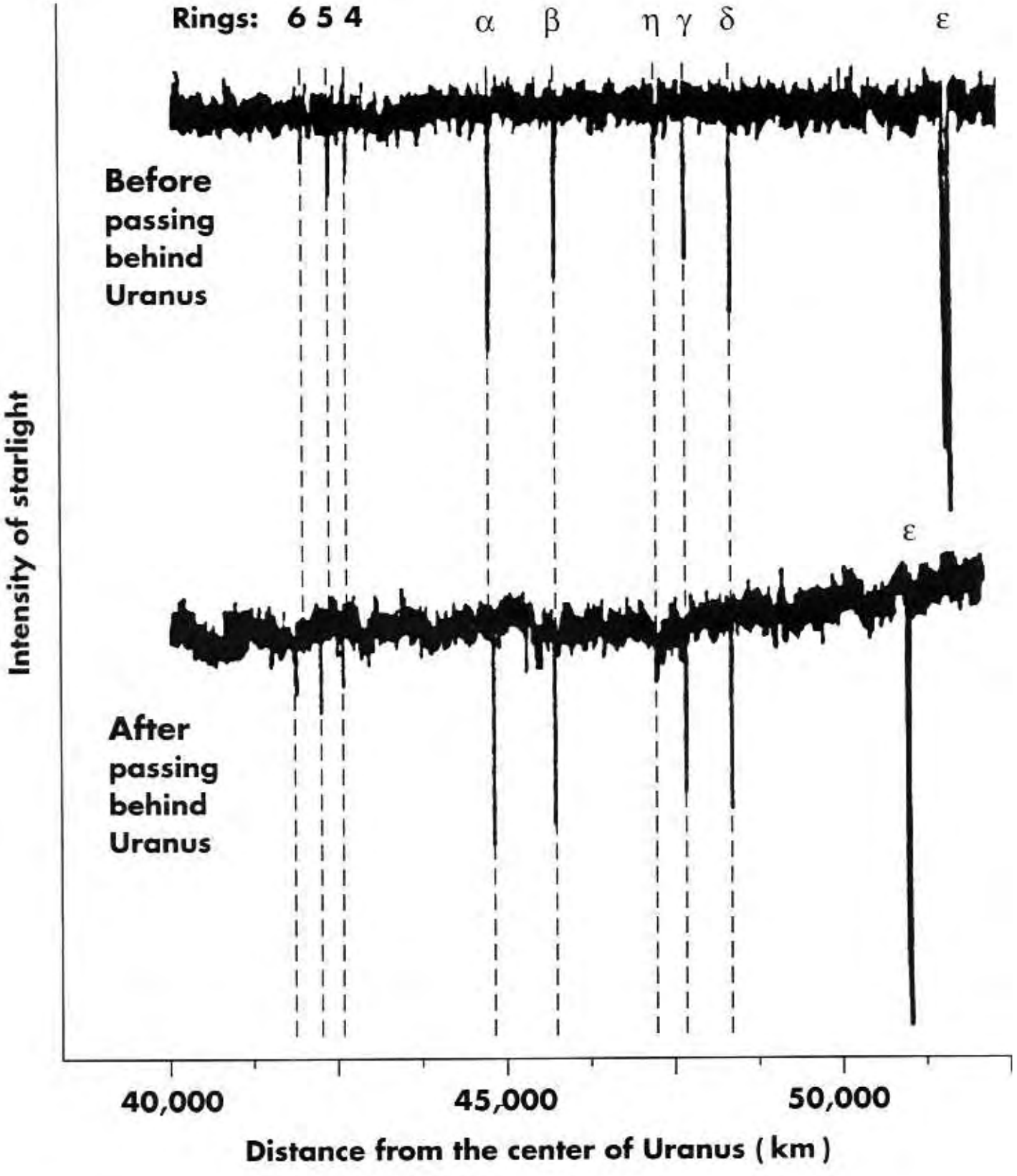
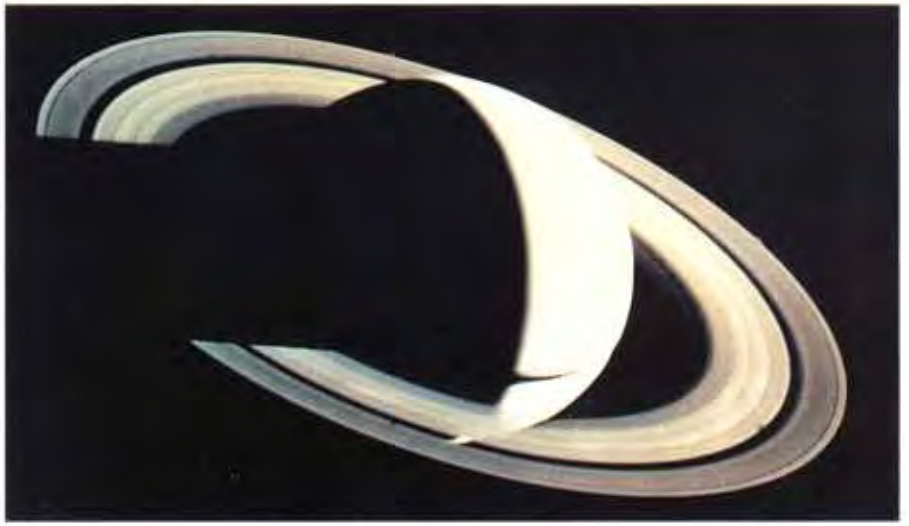
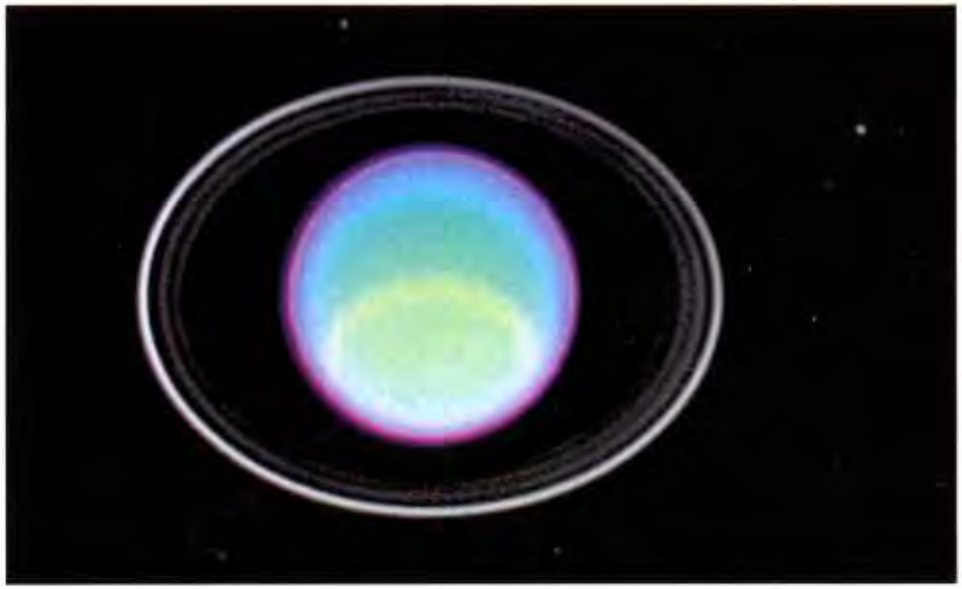
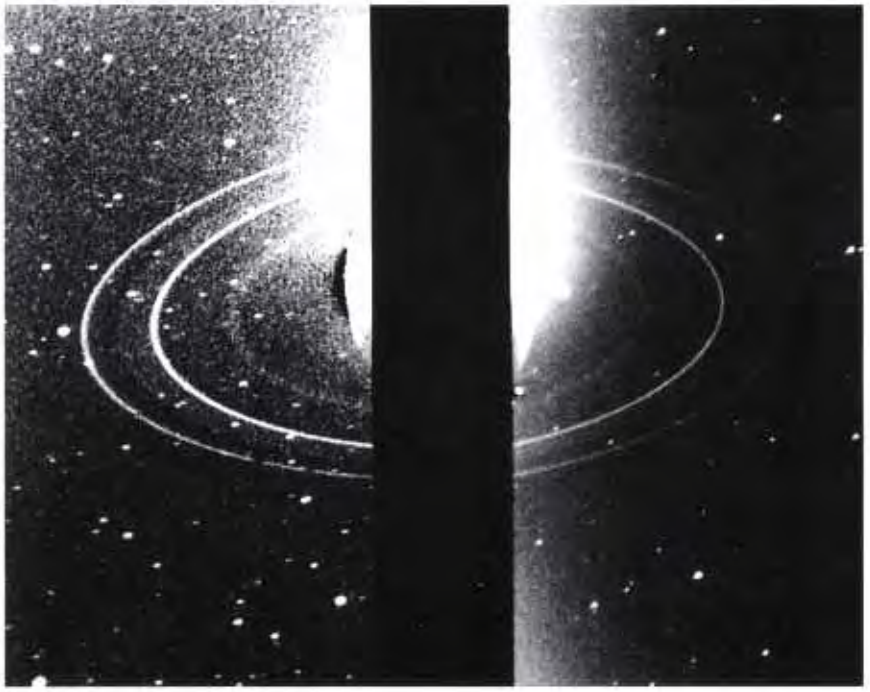
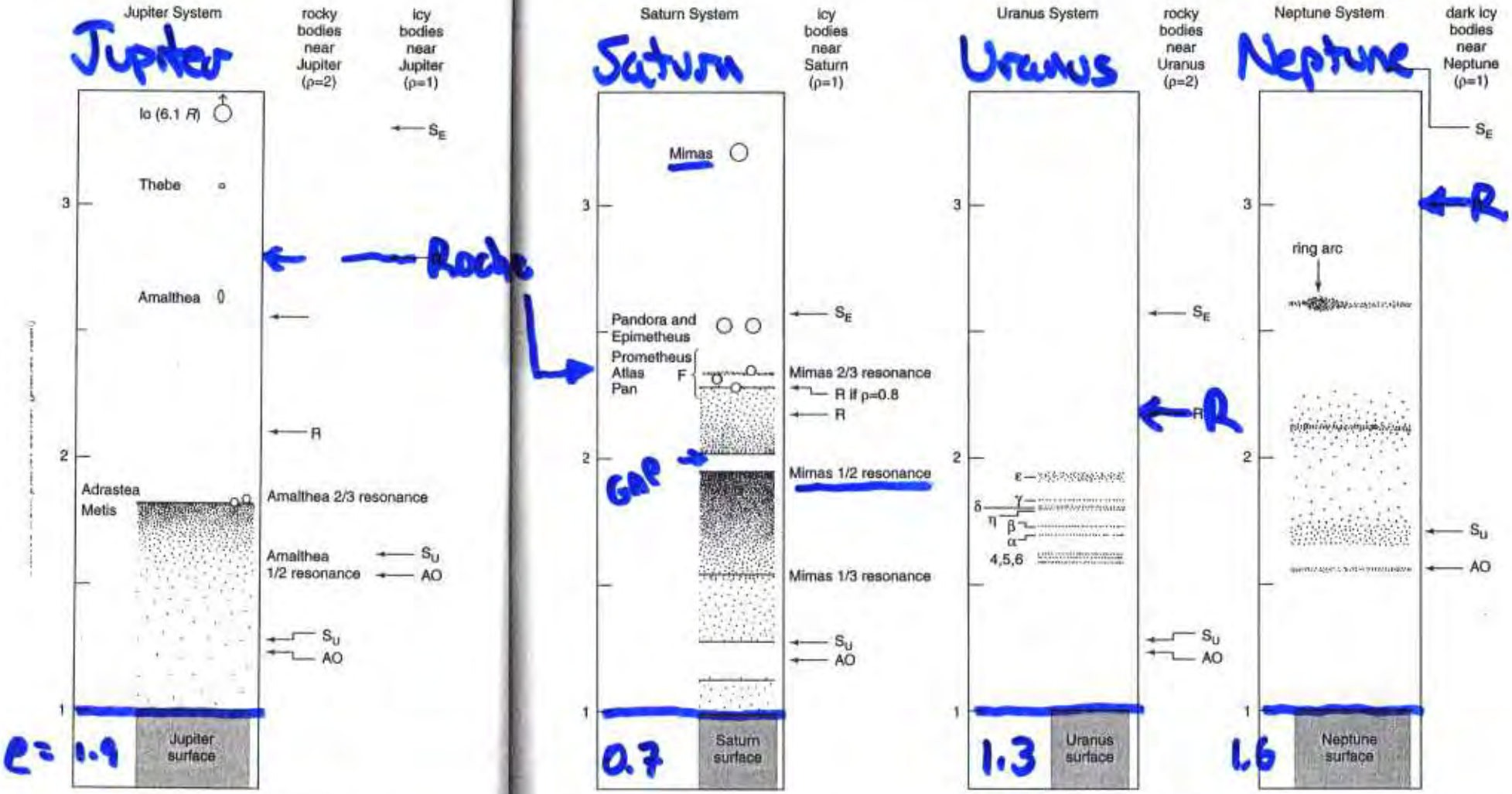


Figure 12.40 ring comparison








Jupiter System
rocky bodies near Jupiter (ρ=2)
icy bodies near Jupiter (ρ=1)
Jupiter
Io (6.1 R)
Thebe
Amalthea
Roche
R
Adrastea
Metis
Amalthea 2/3 resonance
Amalthea 1/2 resonance
S_E
S_U
AO
3
2
1
ρ= 1.9
Jupiter surface
Saturn System
icy bodies near Saturn (ρ=1)
Saturn
Mimas
Pandora and Epimetheus
Prometheus
Atlas
Pan
F
Mimas 2/3 resonance
R if ρ=0.8
R
Gap
Mimas 1/2 resonance
Mimas 1/3 resonance
S_E
S_U
AO
0.7
Saturn surface
Uranus System
rocky bodies near Uranus (ρ=2)
Uranus
ε
γ
δ
η
β
α
4,5,6
R
S_E
S_U
AO
1.3
Uranus surface
Neptune System
dark icy bodies near Neptune (ρ=1)
Neptune
ring arc
R
S_E
S_U
AO
1.6
Neptune surface

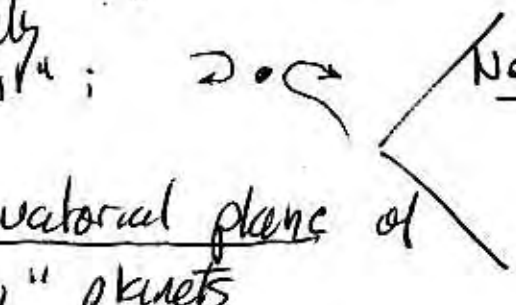
What about edges and gaps? And ring thickness?

Gaps: unstable orbits?

- Resonance w/ inner satellites.
- i.e. Cassini Division in Saturn ring system:
  2:1 resonance w/ Mimas
  - every 2 orbits, test particle "sees" Mimas
  - pumped "out" of increasing e, colliding w/ other particles, etc.

(see attached diagram)

Edges (sharp)

- Secondary resonances (5:3, etc.)
- 1:1 Resonance: shepherding satellites
  - predicted theoretically
  - recall "horshoe orbits"; 

Thinness: Rings track equatorial plane of "rapidly rotating" planets

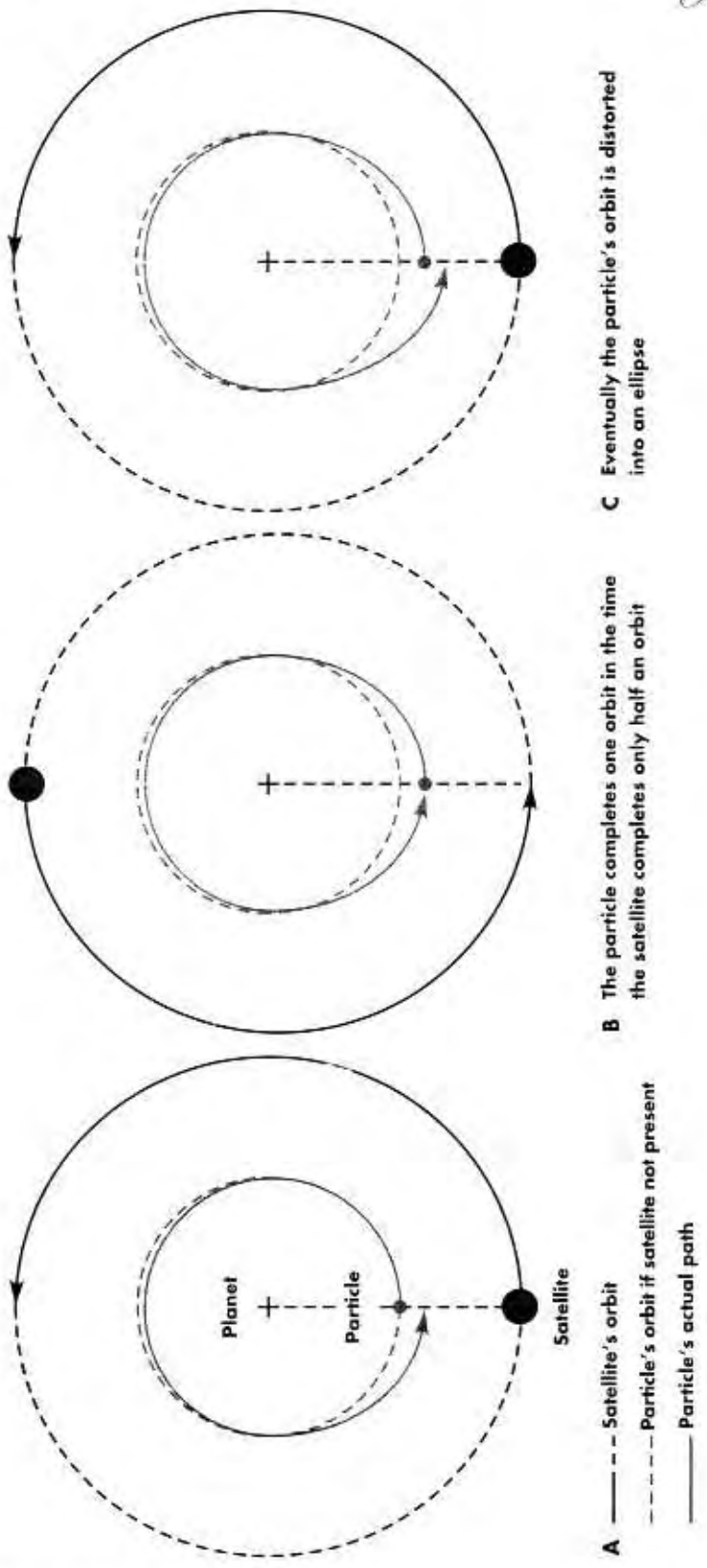
Gap	Planet	Oblateness (J_2)
0.098	Saturn	0.0163
0.065	Jupiter	0.0147
0.017	Neptune	0.0034
0.023	Uranus	0.0033
	Mars	0.0019

- Beyond planet, ↔ causes non-spherical potential favors equatorial plane
- motion out of plane causes plane crossing; ∴ collision ptcl. removes vertical component
- limit → 0 thickness ring

TA 86

A ring particle and a satellite in a 2:1 resonance orbit about a planet (Fig. 12-31)

DRAW ON BOARD



Ring Composition via optical properties

- large particles → ~~dark rings~~ →
  bright(er) rings in reflection
- small particles →
  bright(er) rings in transmission
  (ie Uranus, gaps in Saturn rings,
  E ring from Enceladus ice
  fountain, etc.)

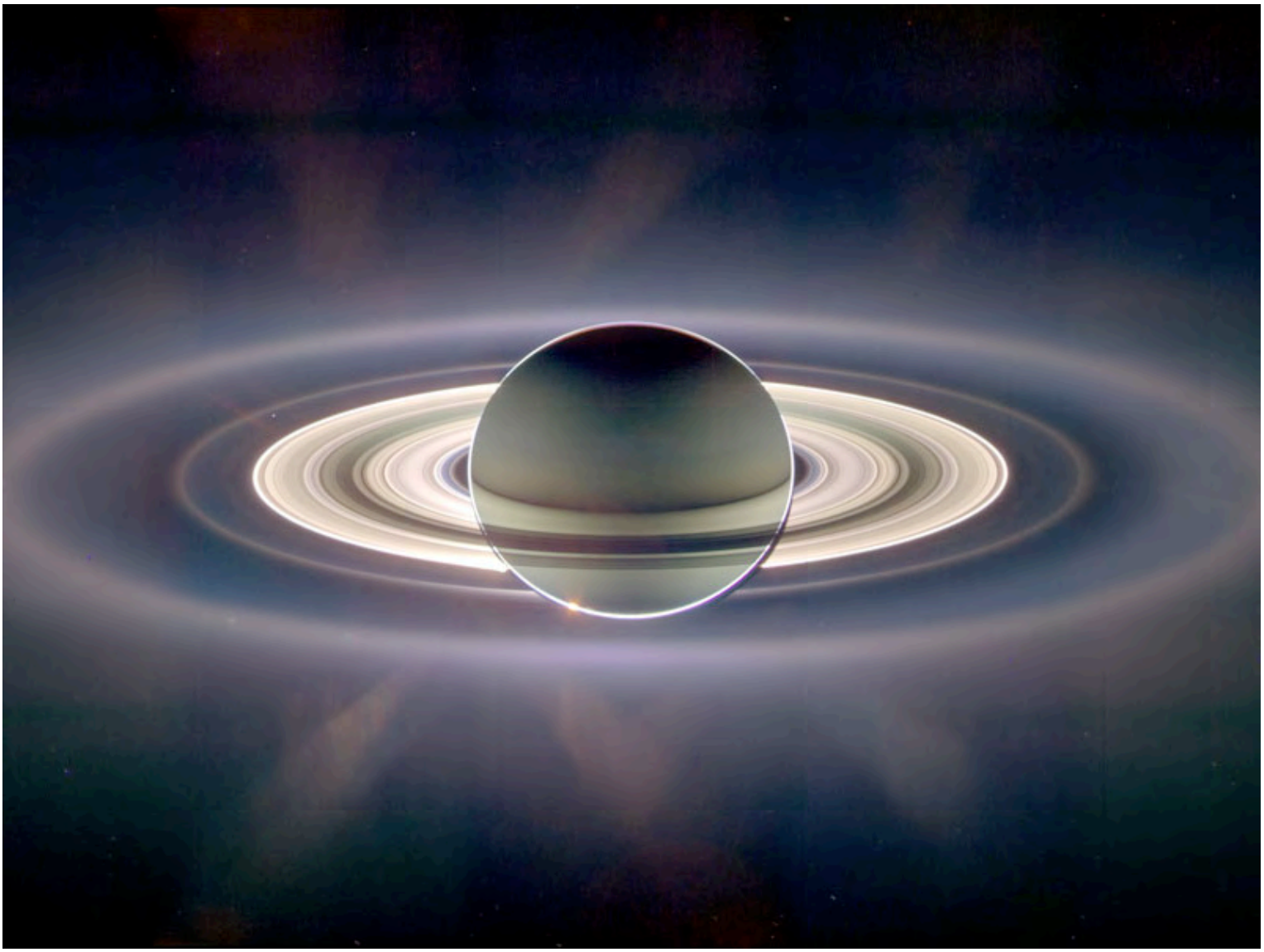
High albedo rings: And A&E

- Fresh icy particles
  (as they age, they darken from swept-up
  micrometeorites etc.)
- Suggests that Saturn rings are relatively
  young (100s of Myr)
- Perturbations by moons, etc steal J
  from rings; finite lifetime?

Astronomy Picture of the Day

Discover the cosmos! Each day a different image or photograph of our fascinating universe is featured, along with a brief explanation written by a professional astronomer.

2006 October 16



In the Shadow of Saturn
Credit: CICLOPS, JPL, ESA, NASA

Explanation: In the shadow of Saturn, unexpected wonders appear. The robotic Cassini spacecraft now orbiting Saturn recently drifted in giant planet's shadow for about 12 hours and looked back toward the eclipsed Sun. Cassini saw a view unlike any other. First, the night side of Saturn is seen to be partly lit by light reflected from its own majestic ring system. Next, the rings themselves appear dark when silhouetted against Saturn, but quite bright when viewed away from Saturn and slightly scattering sunlight, in the above exaggerated color image. Saturn's rings light up so much that new rings were discovered, although they are hard to see in the above image. Visible in spectacular detail, however, is Saturn's E ring, the ring created by the newly discovered ice-fountains of the moon Enceladus, and the outermost ring visible above. Far in the distance, visible on the image left just above the bright main rings, is the almost ignorable pale blue dot of Earth.