Collisional History of Saturn's Largest Ring

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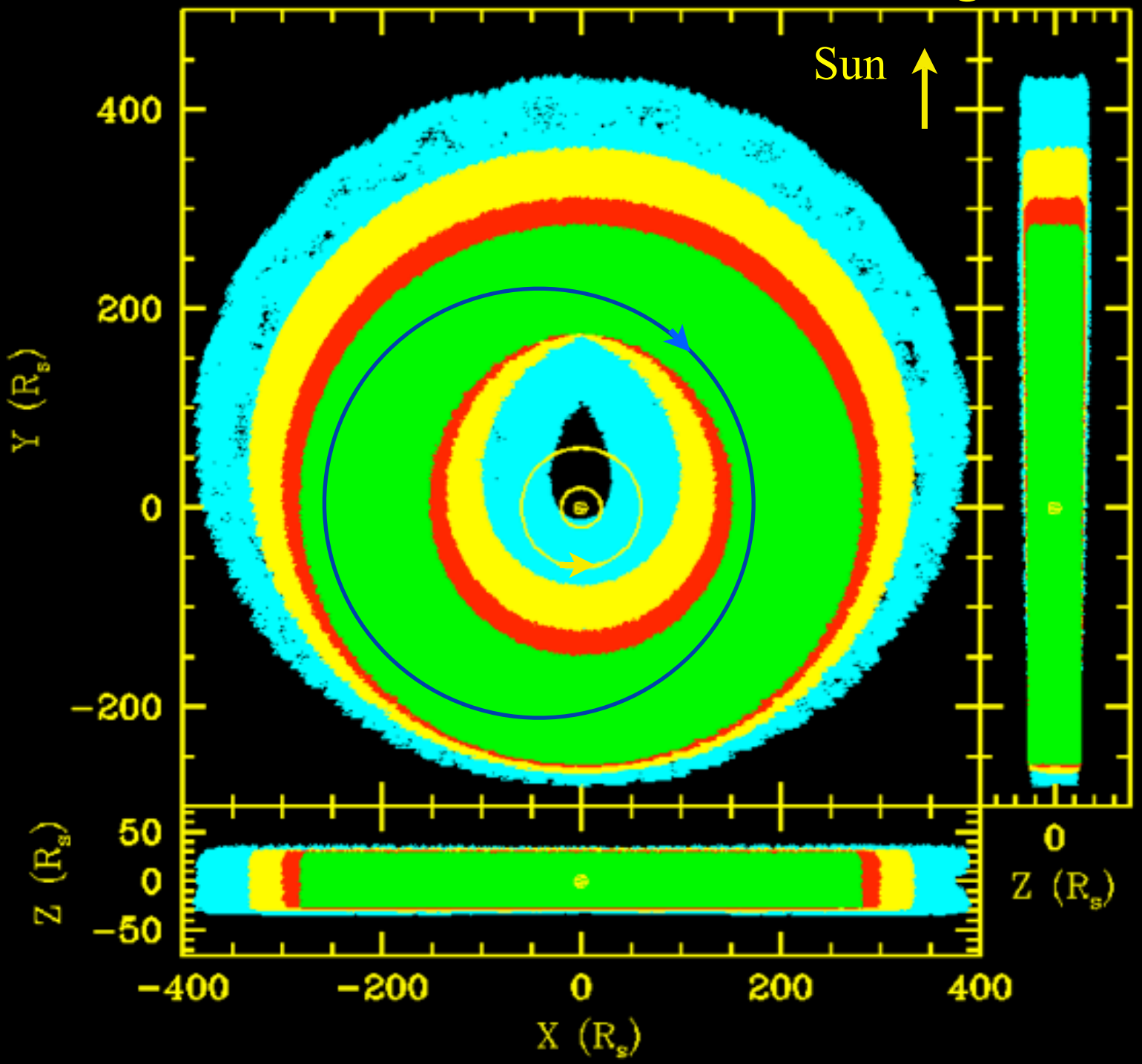
- Structure of the Phoebe Ring
- Importance of Collisions

The Phoebe Ring

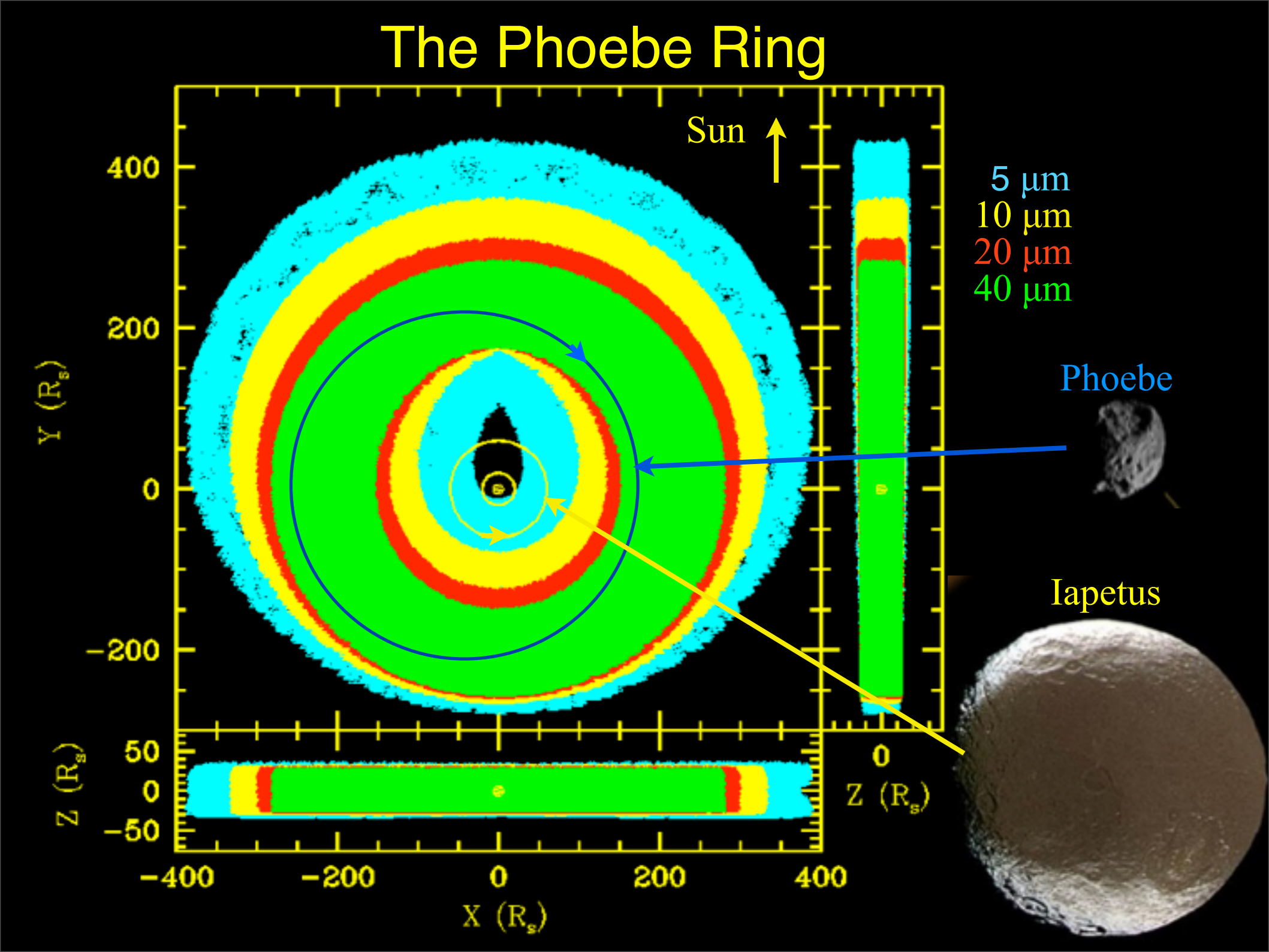


5 μm
10 μm
20 μm
40 μm

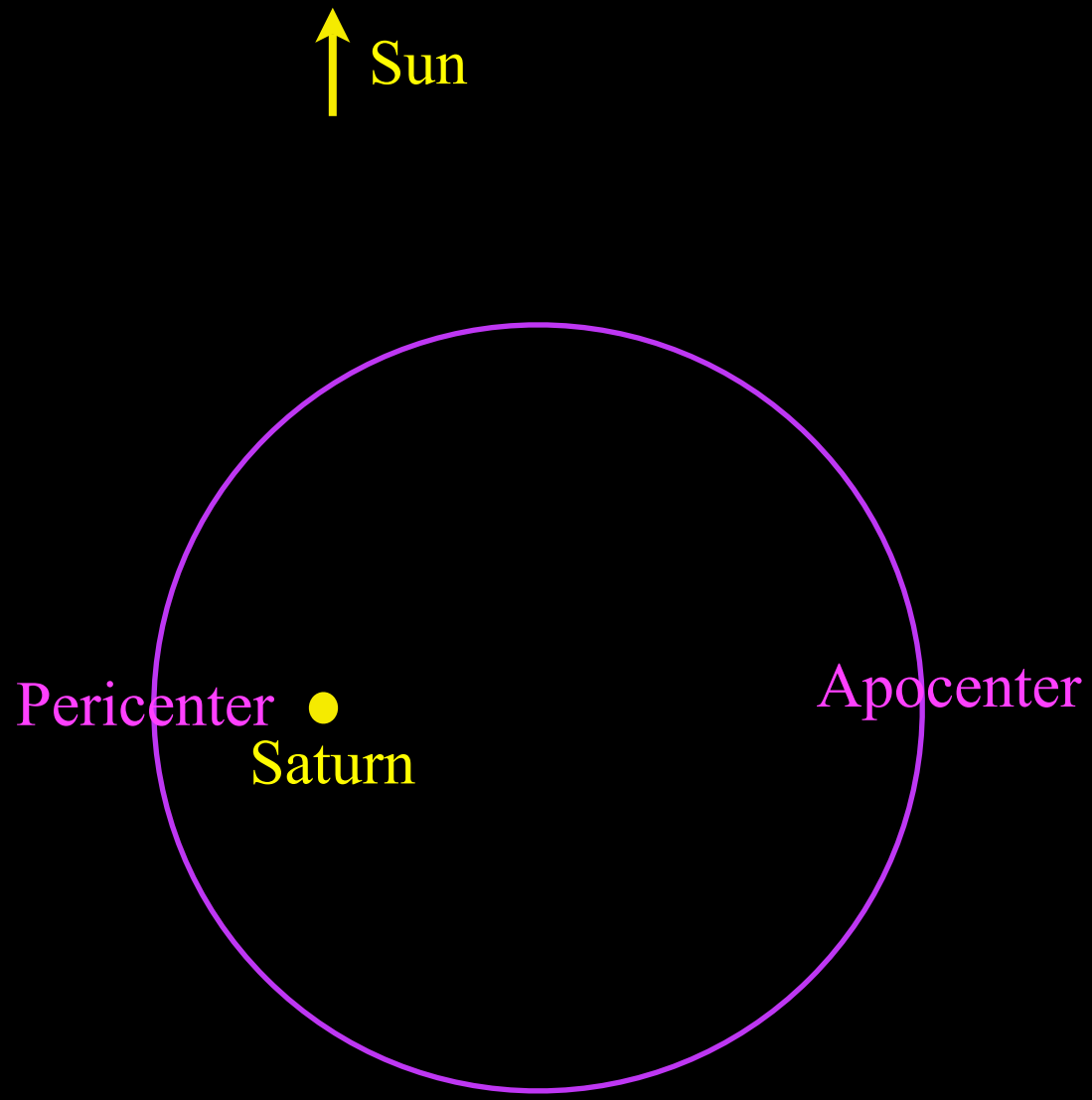
Radiation Pressure Sizes Segregate
Scale: 300 R_S
Retrograde Orbits Offset toward Sun

XY is Saturn's Orbit Plane

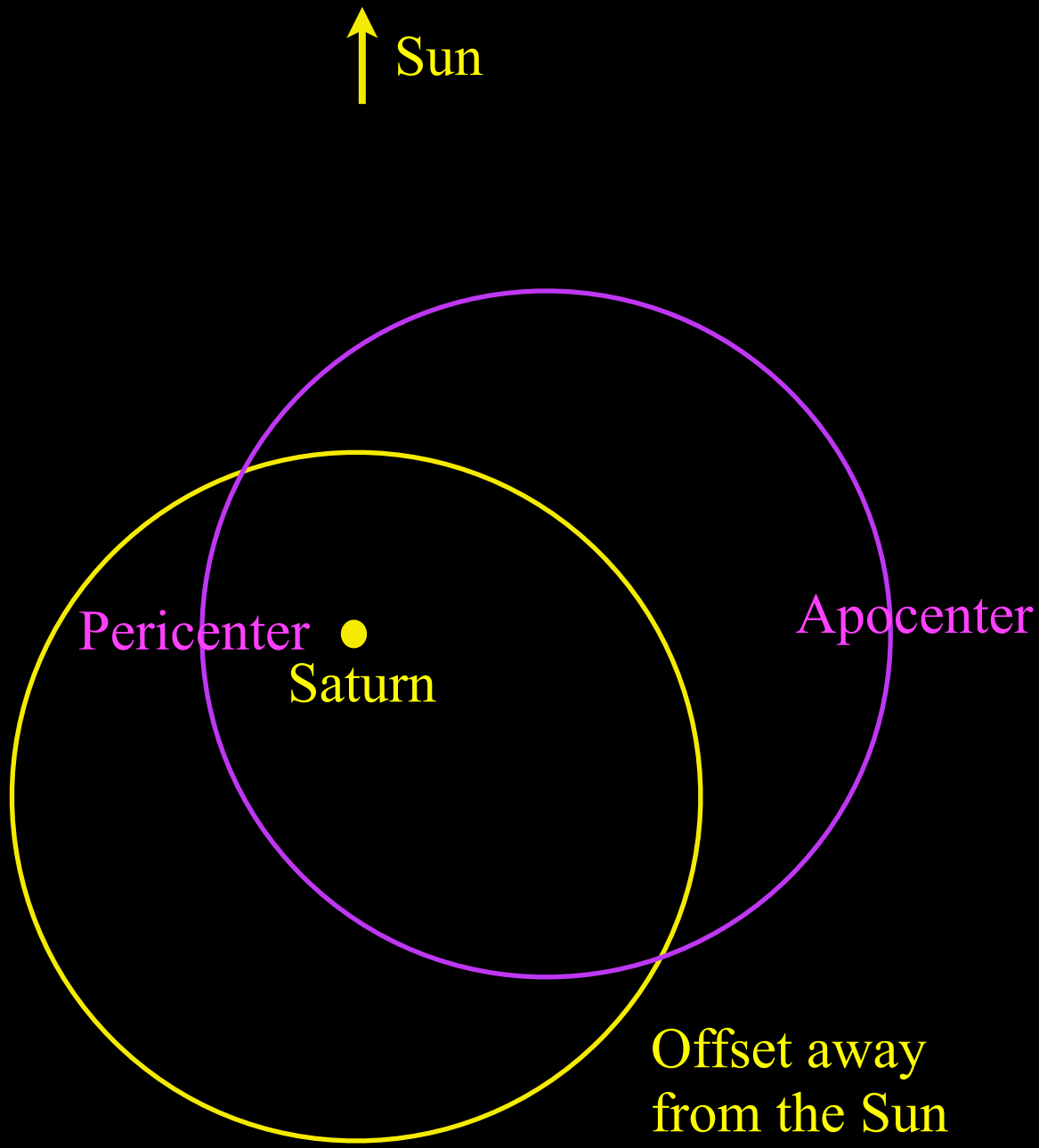
The Phoebe Ring



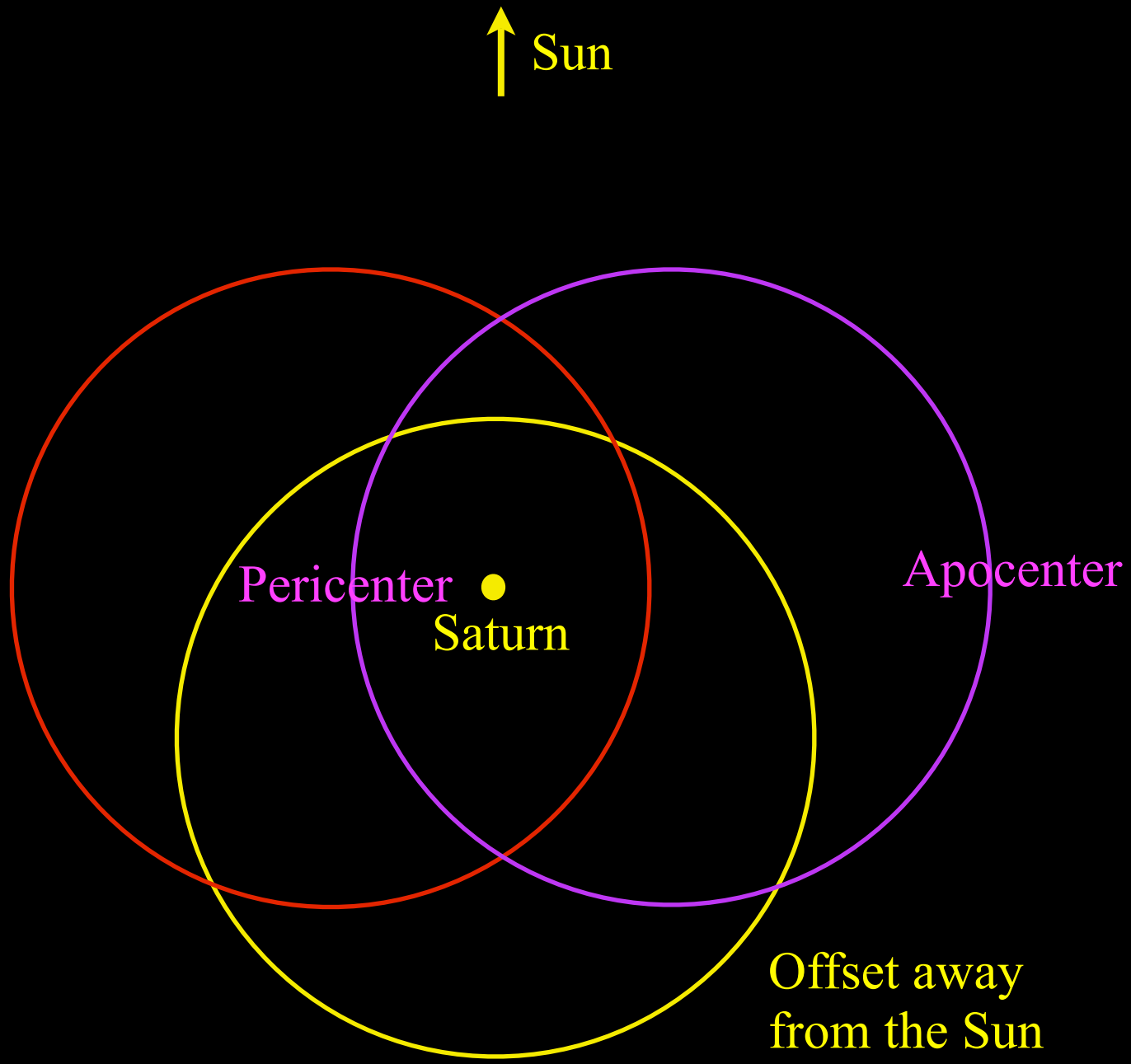
Precession of Phoebe



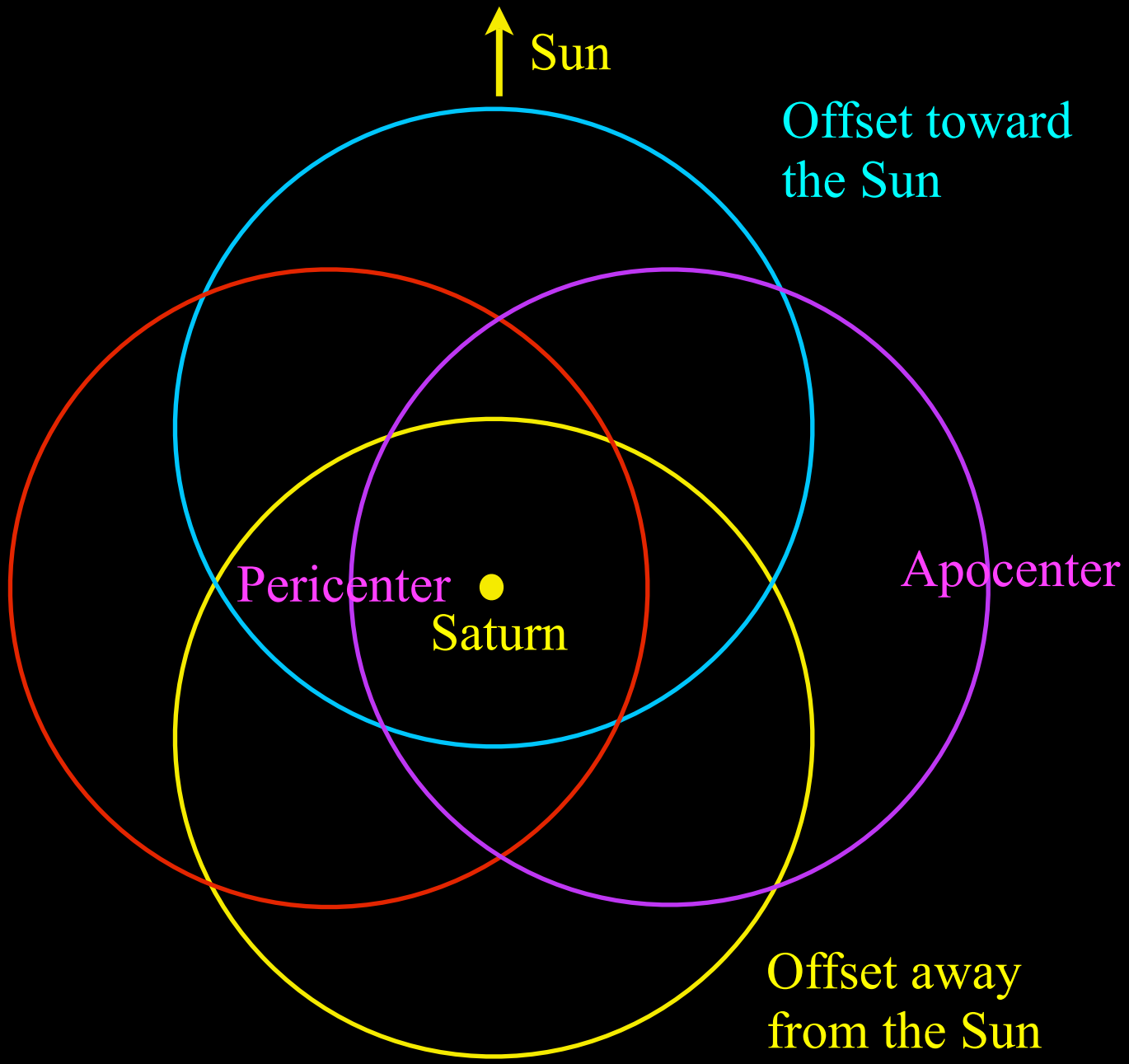
Precession of Phoebe



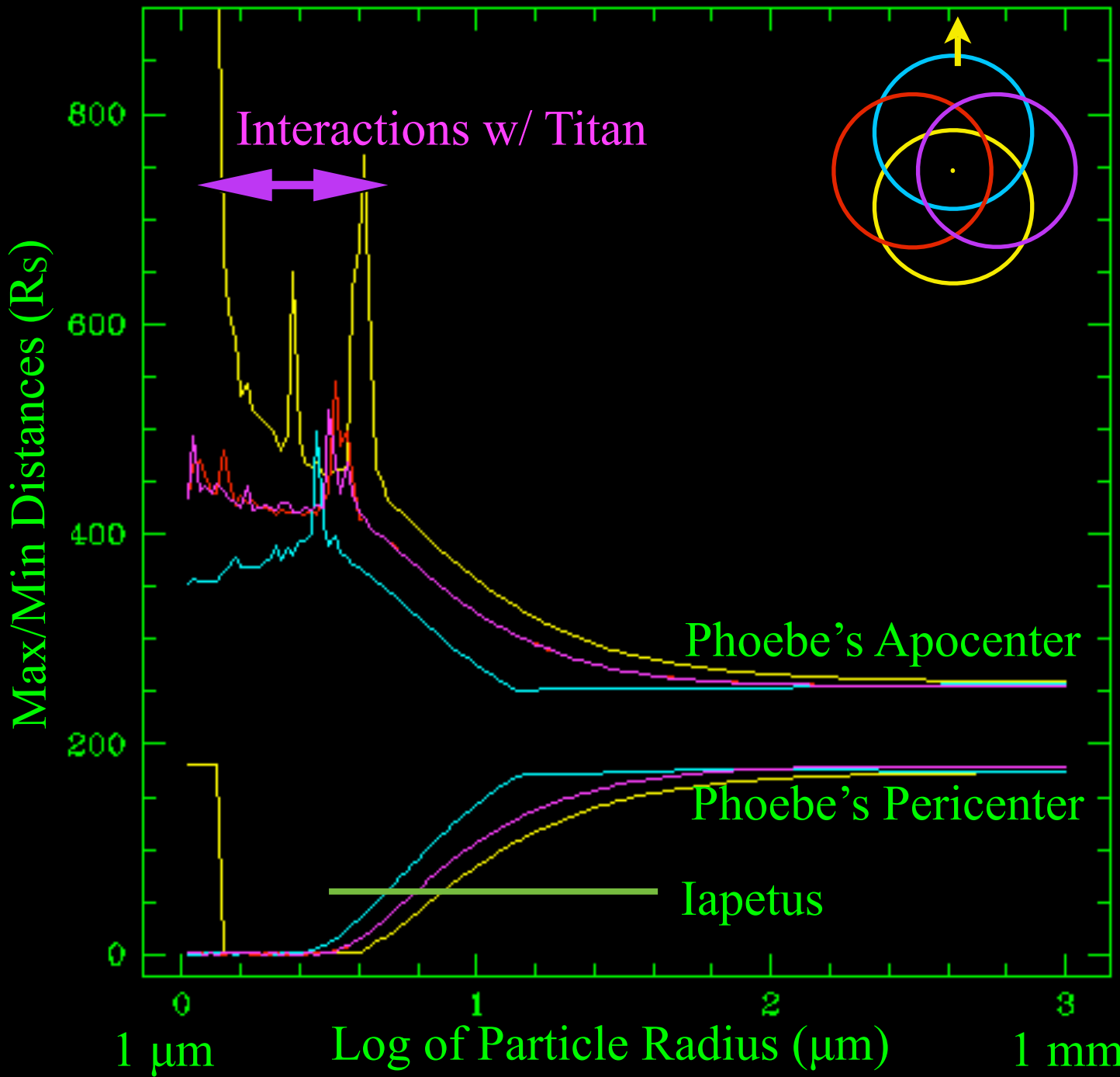
Precession of Phoebe



Precession of Phoebe

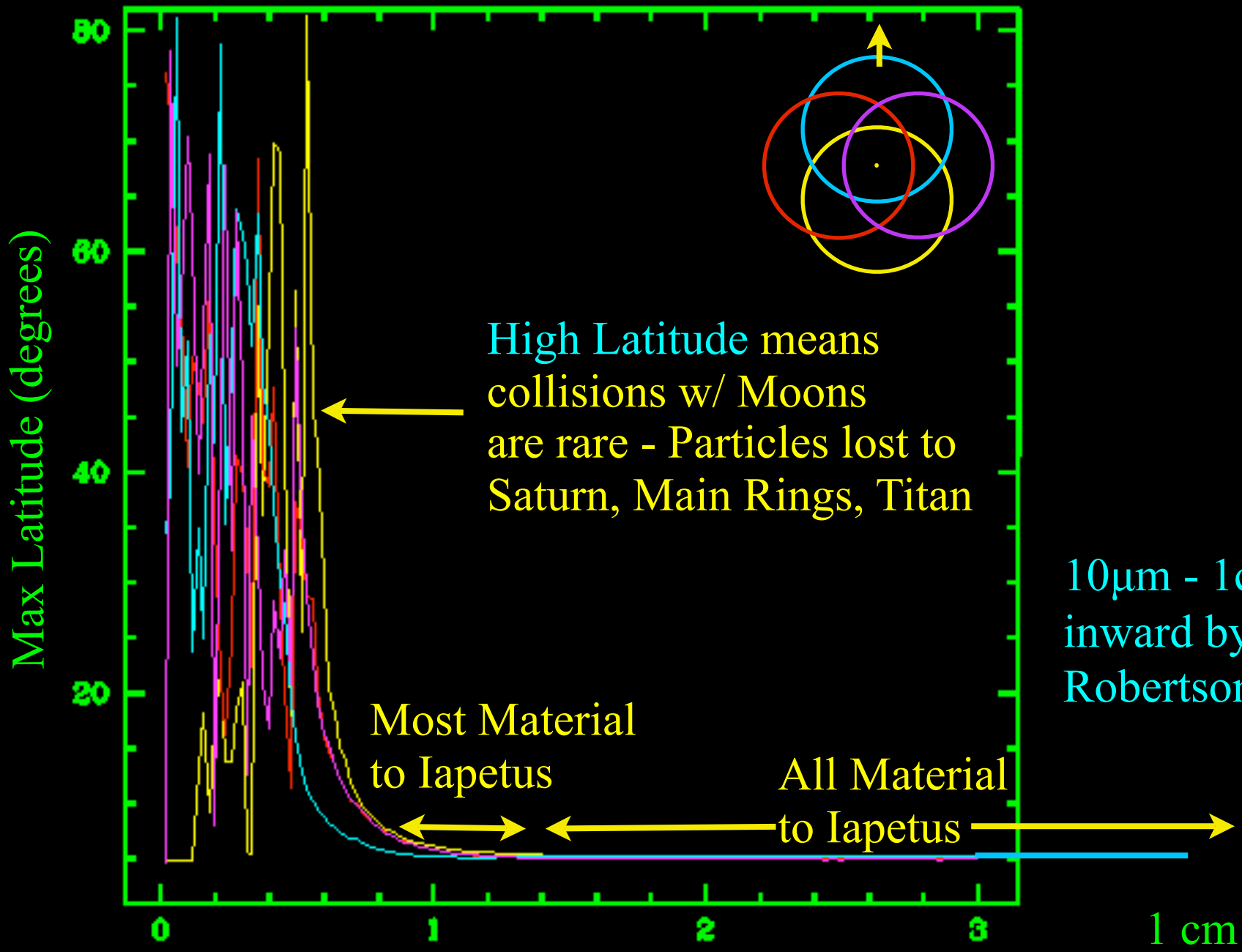


Radial Structure of the Phoebe Ring

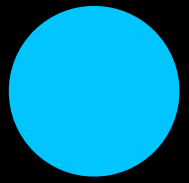


Solar Radiation Pressure drives orbital eccentricities

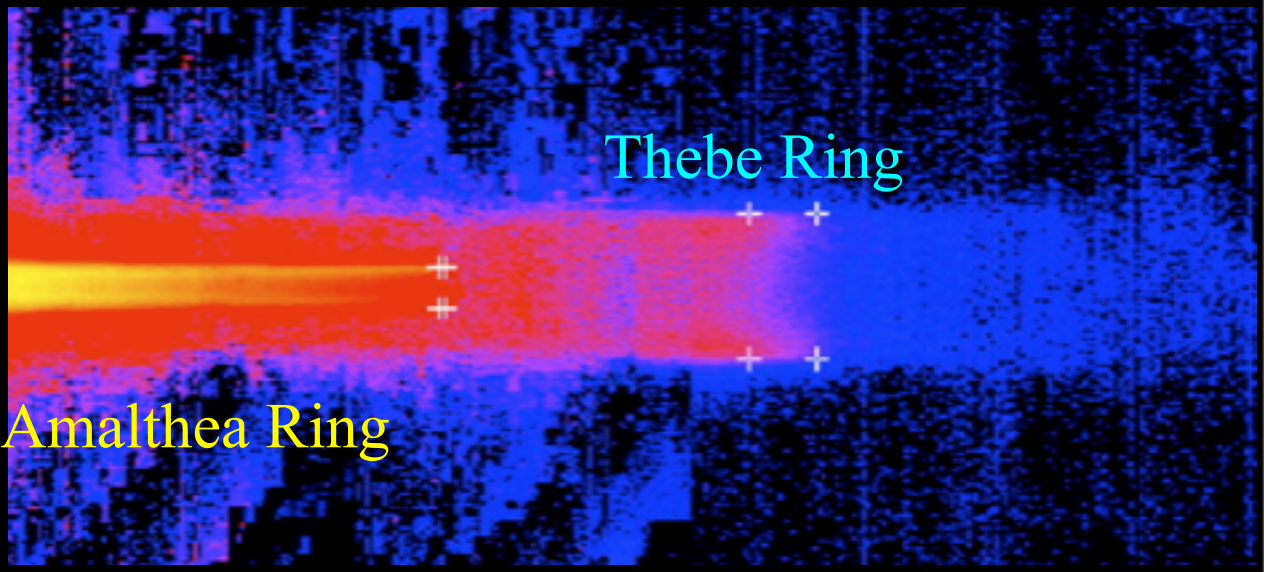
Vertical Structure of the Phoebe Ring



A Tale of Two Rings



Planet



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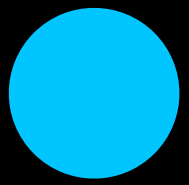
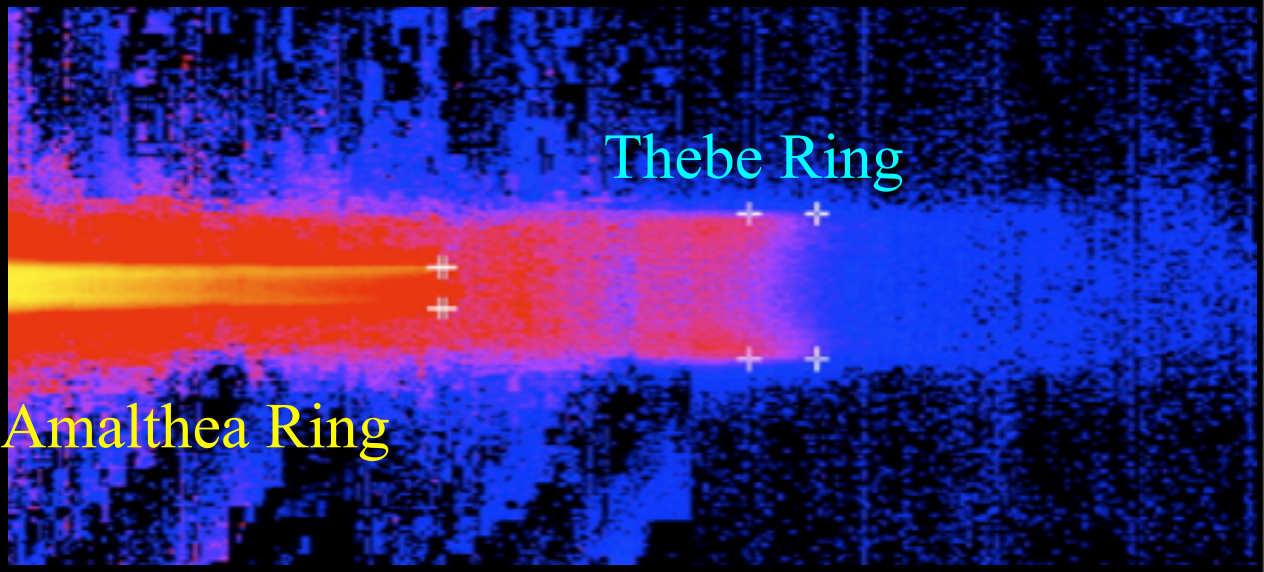




	Phoebe Ring (@Saturn) 	Thebe Ring (@Jupiter) 
Radius:	300 R_S	4 R_J
Vertical Thickness:	40 R_S	0.1 R_J
Mass:	1 km sphere	50 m sphere
Optical Depth:	10^{-8}	10^{-8}
Number Density:	20 km^{-3}	10^{4} km^{-3}

Constructive Collisions

Interplanetary Impactors

- Present in all ring systems - creates “minimal” ring

Satellite-Satellite Collisions

- High speed prograde-retrograde collisions are common
- Current lifetime of Phoebe debris is 10^{10} years
- Augments interplanetary impactors
- Almost certainly dominates dust production

Destructive Collisions

Loss of small μm dust

<1μm lost to space, <4μm strike the main rings

Collisions with satellites

10 μm - 1 cm material goes to Iapetus

Builds up a 20cm dark layer on Iapetus in 4.5 Gyr.

Ring Particle-Ring Particle Collision

>10 Myr. Depends on particle size distribution

Conclusions - The Phoebe Ring

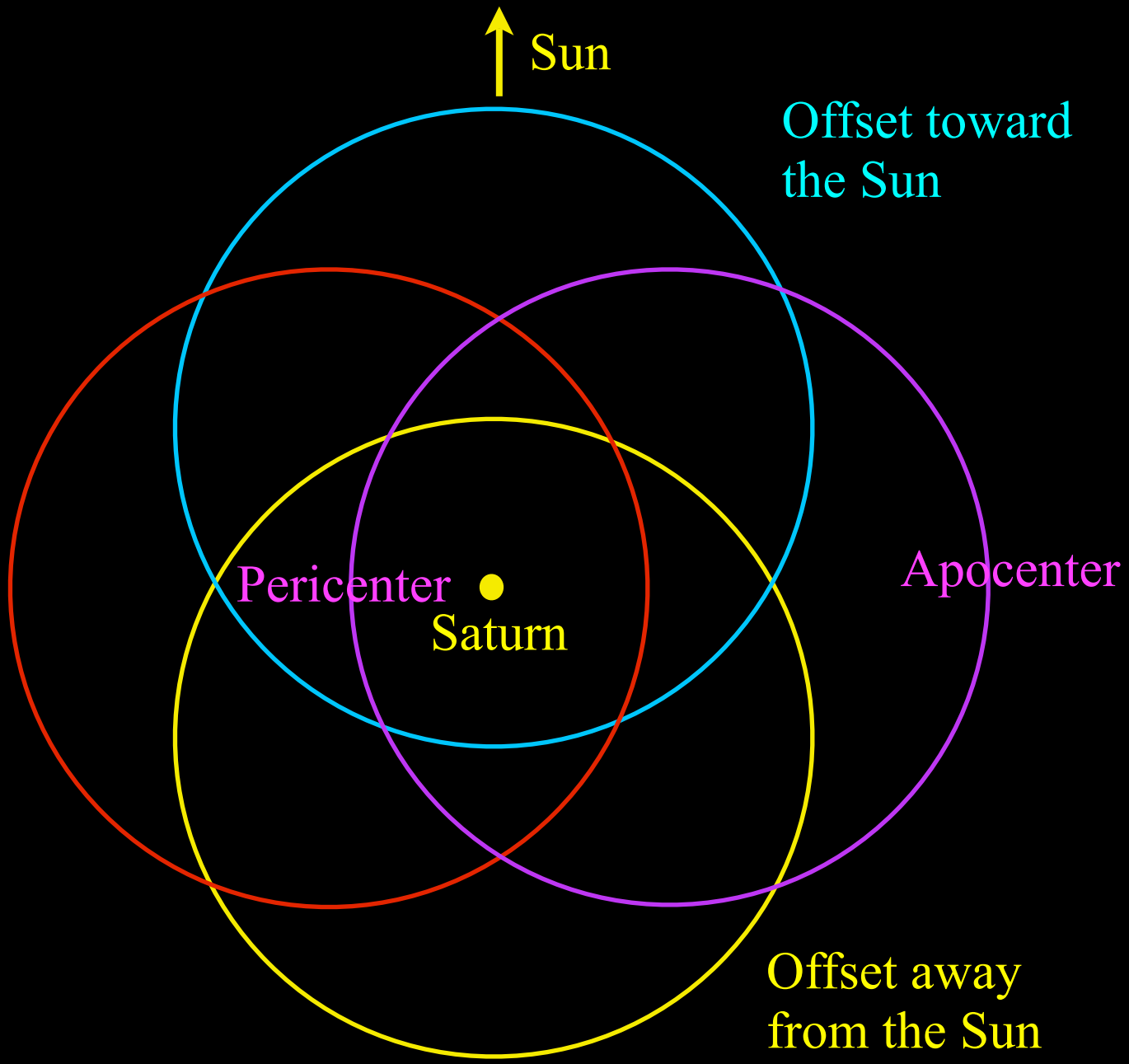
Direct Observations

Optical Depth:	10^{-8}
Vertical Thickness:	40 R_S
Dimensions:	128-207 R_S

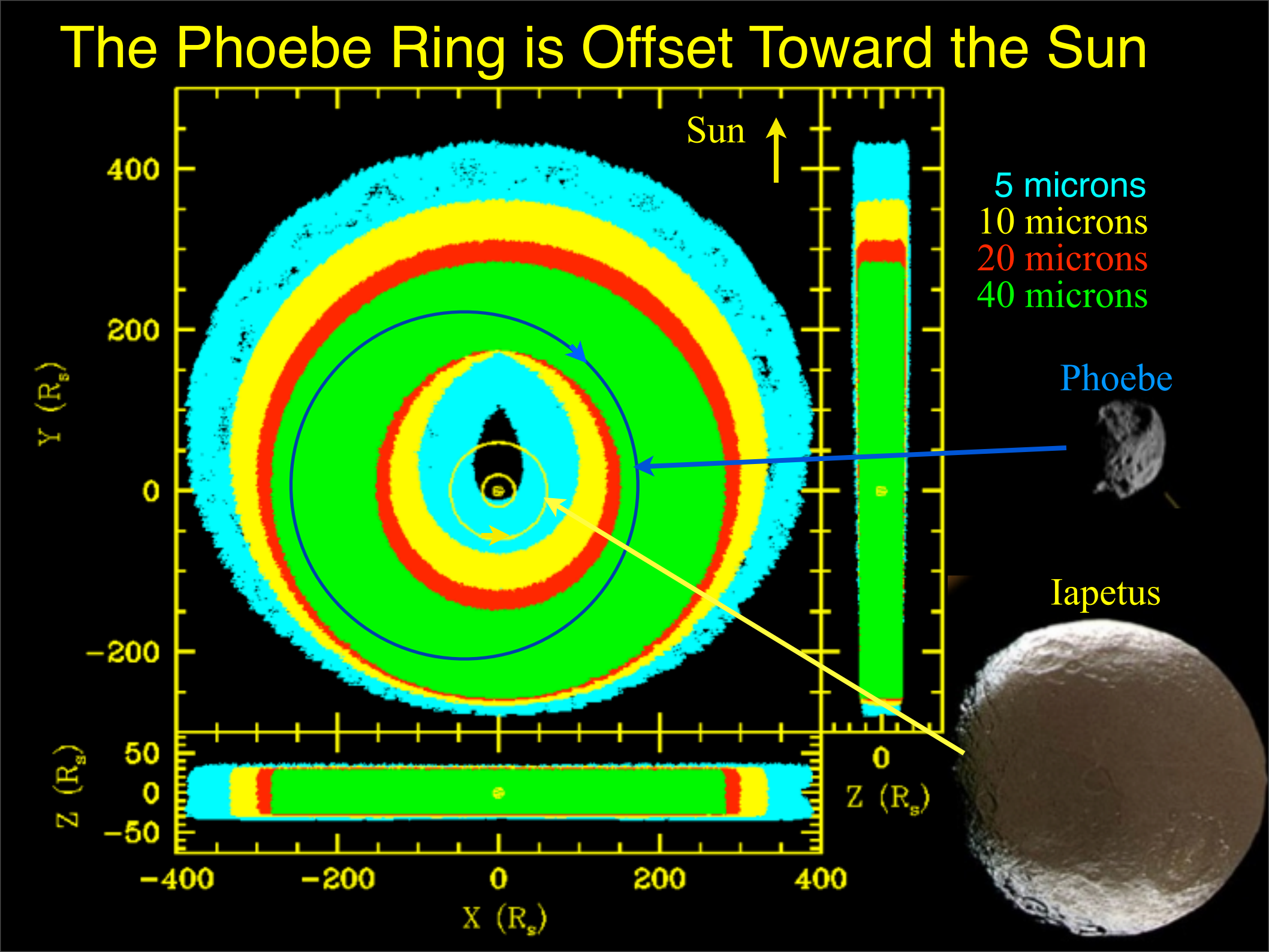
Derived Quantities

Dimensions:	60-300 R_S
Particle Size:	>10 μm
Ring Mass:	1 km sphere
Number Density:	20 km^{-3}

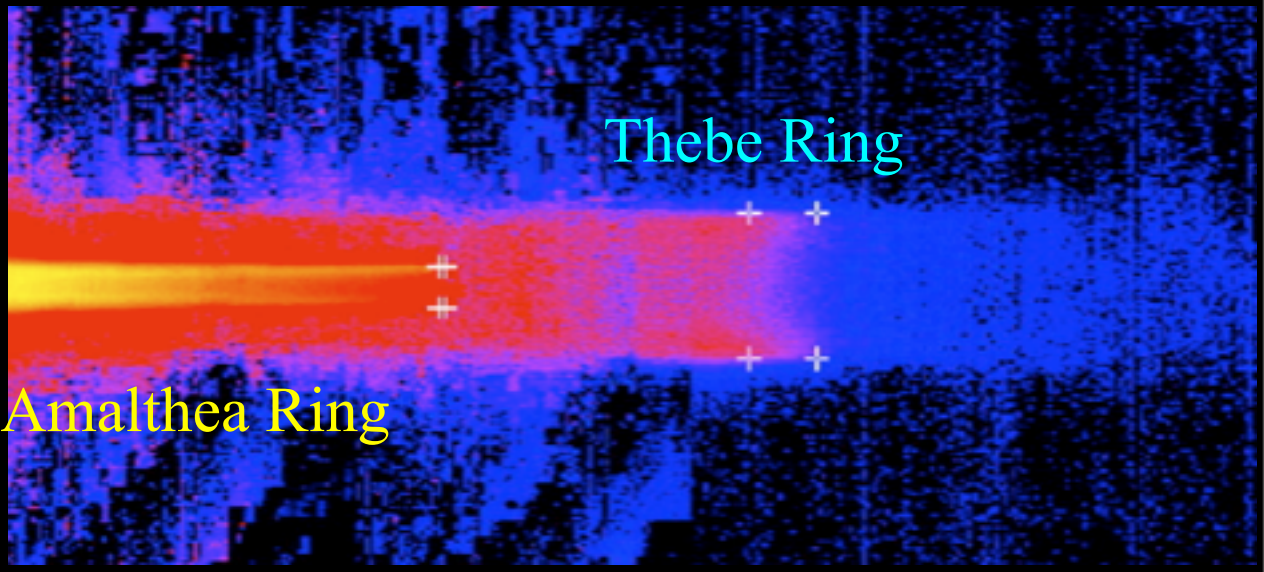
Precession of Phoebe



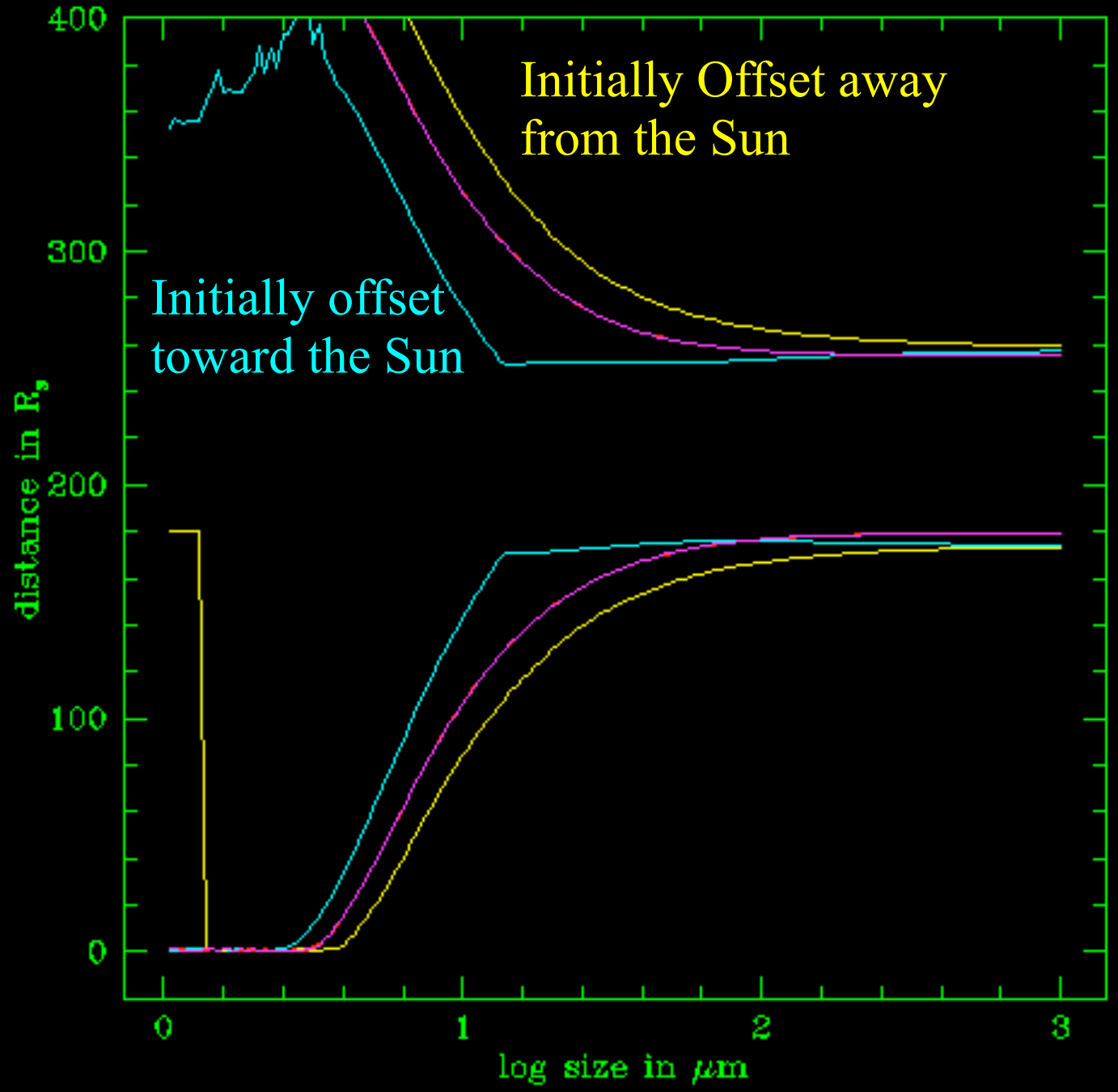
The Phoebe Ring is Offset Toward the Sun



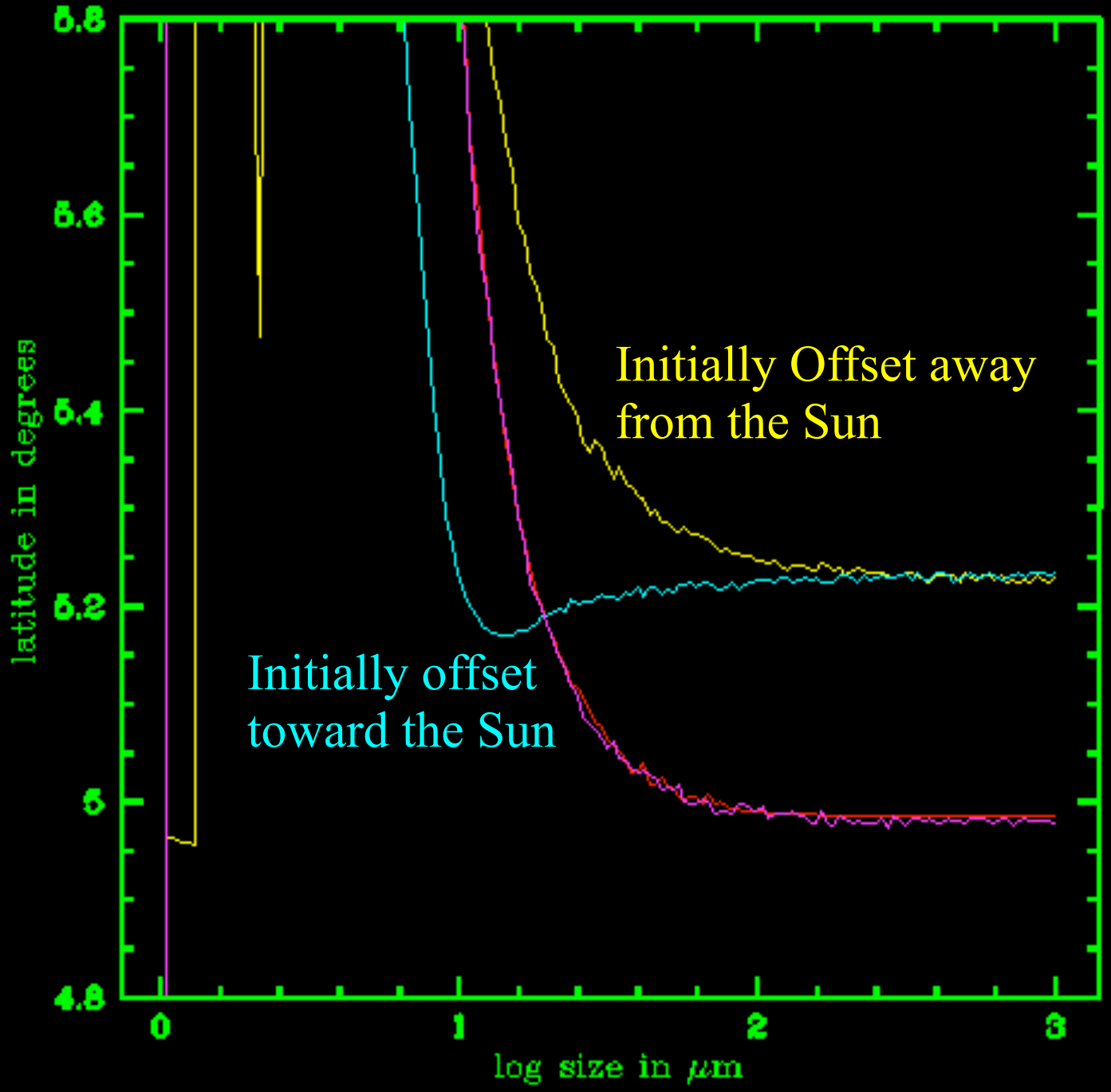
Planet



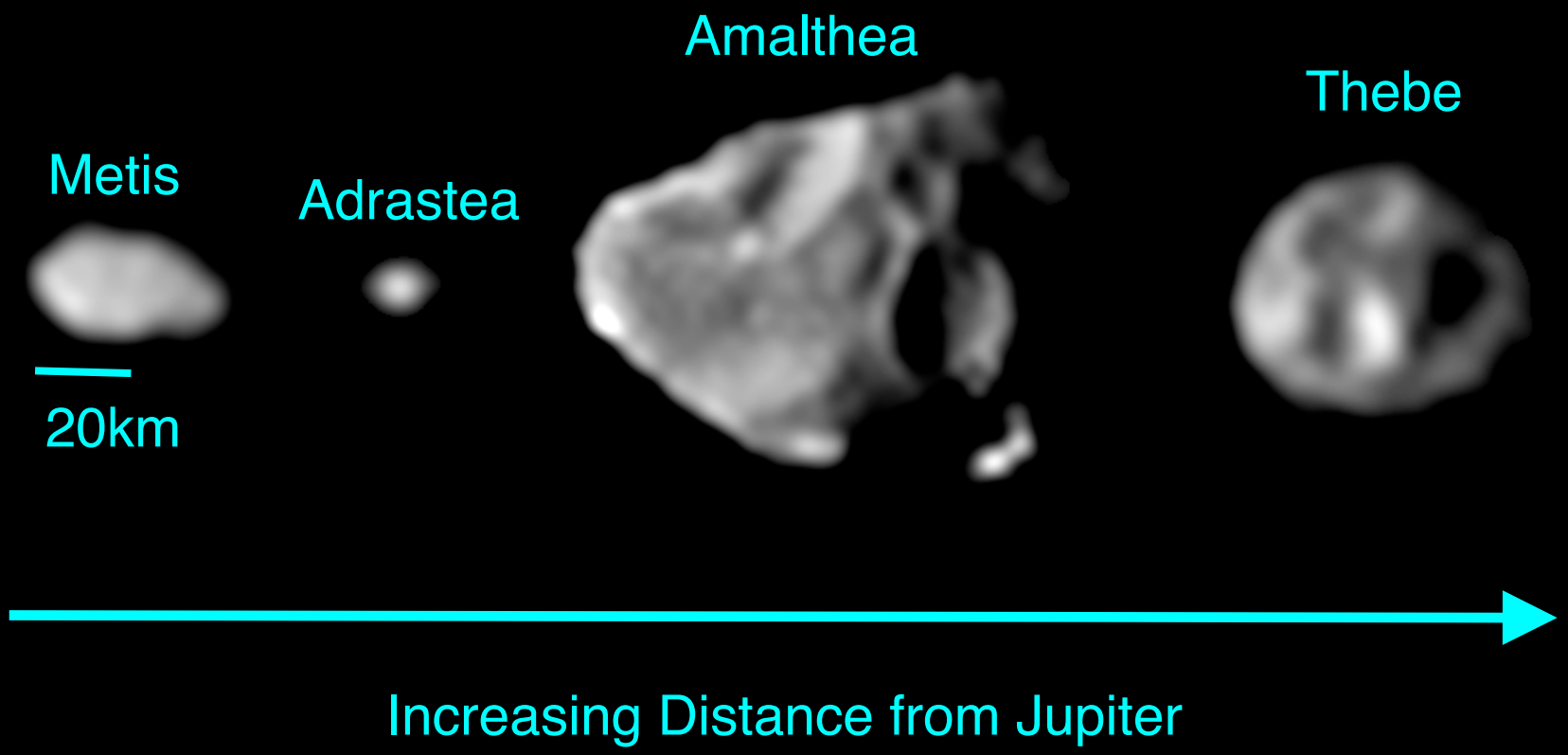
Radial Structure of the Phoebe Ring



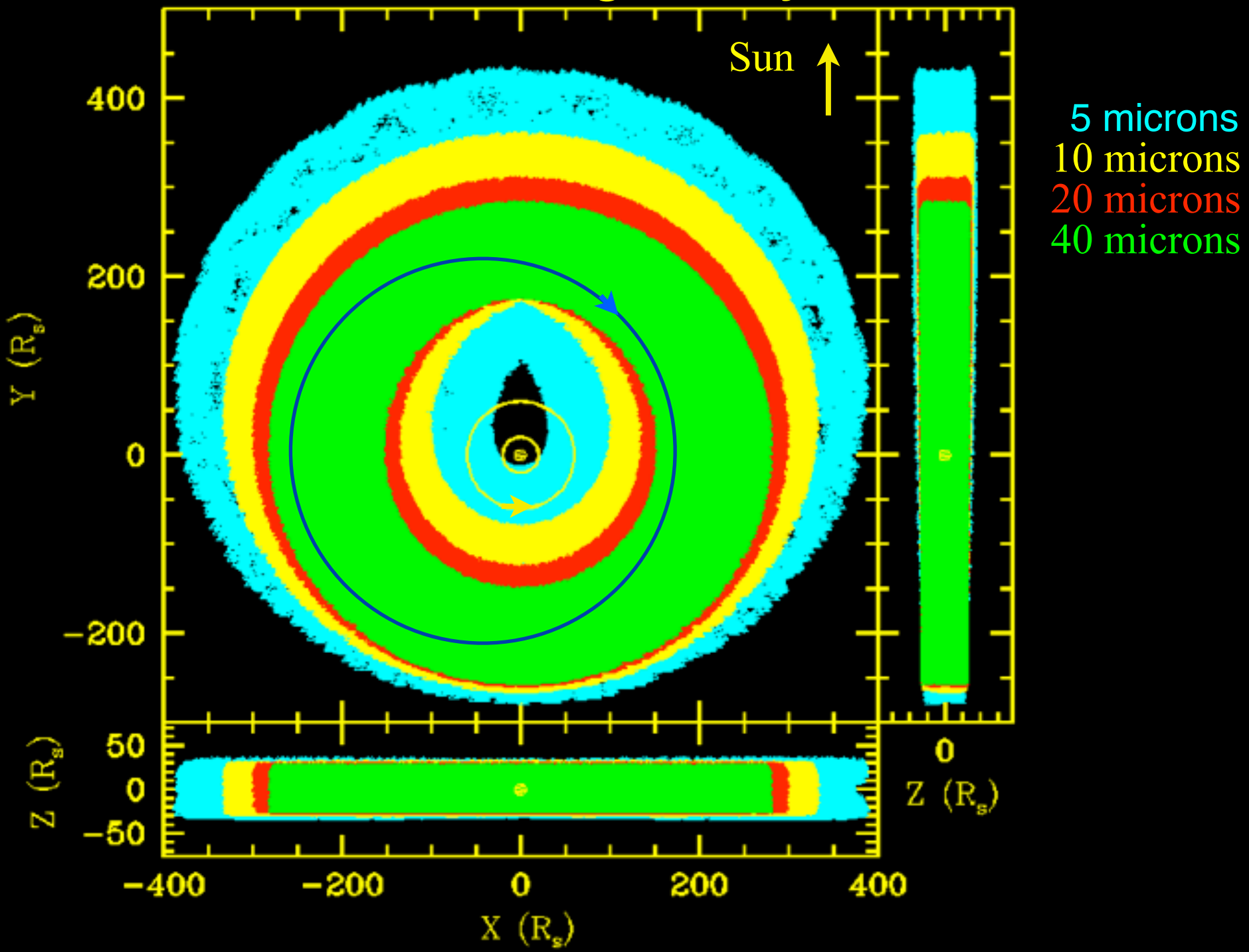
Vertical Structure of the Phoebe Ring

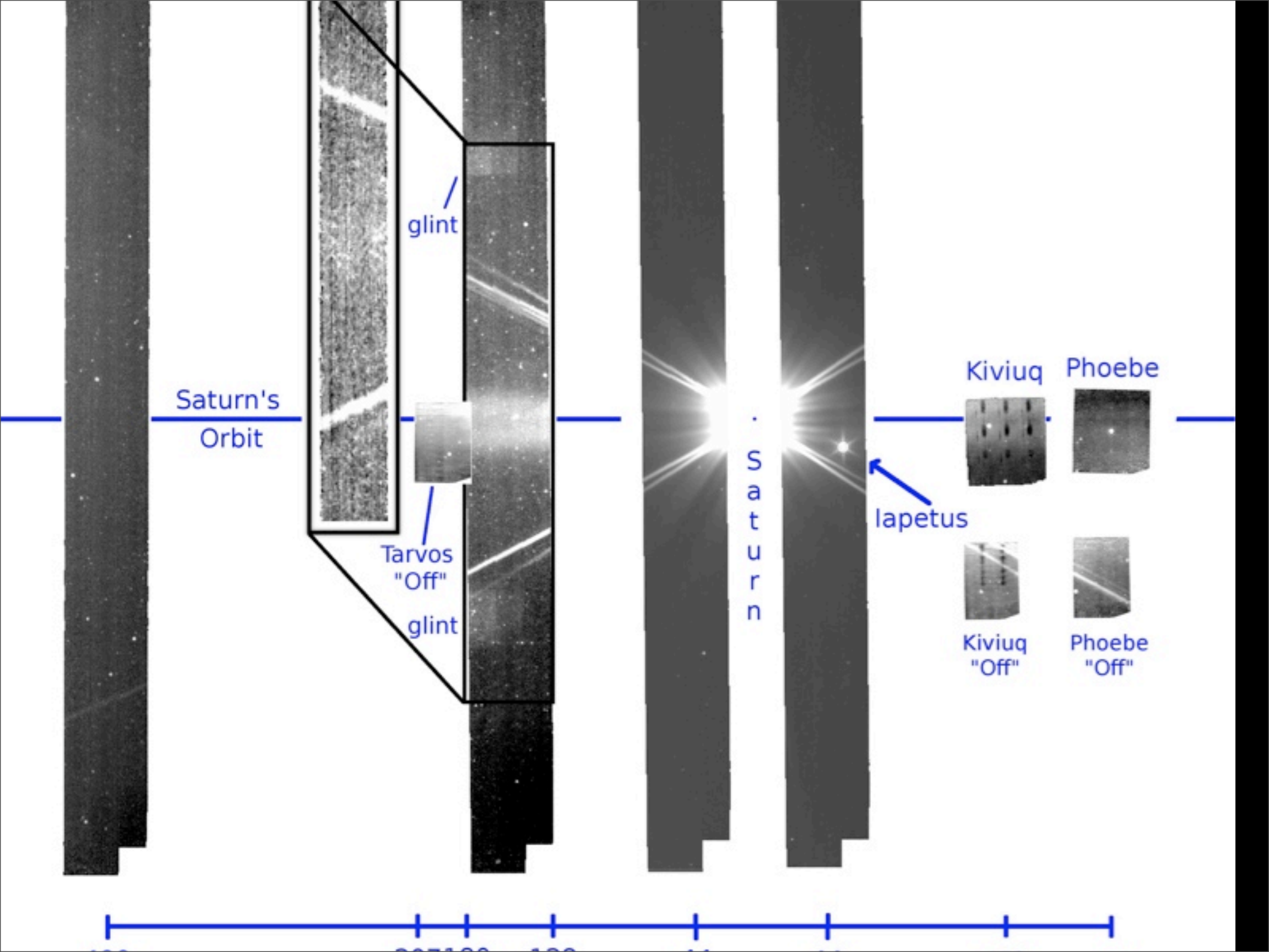


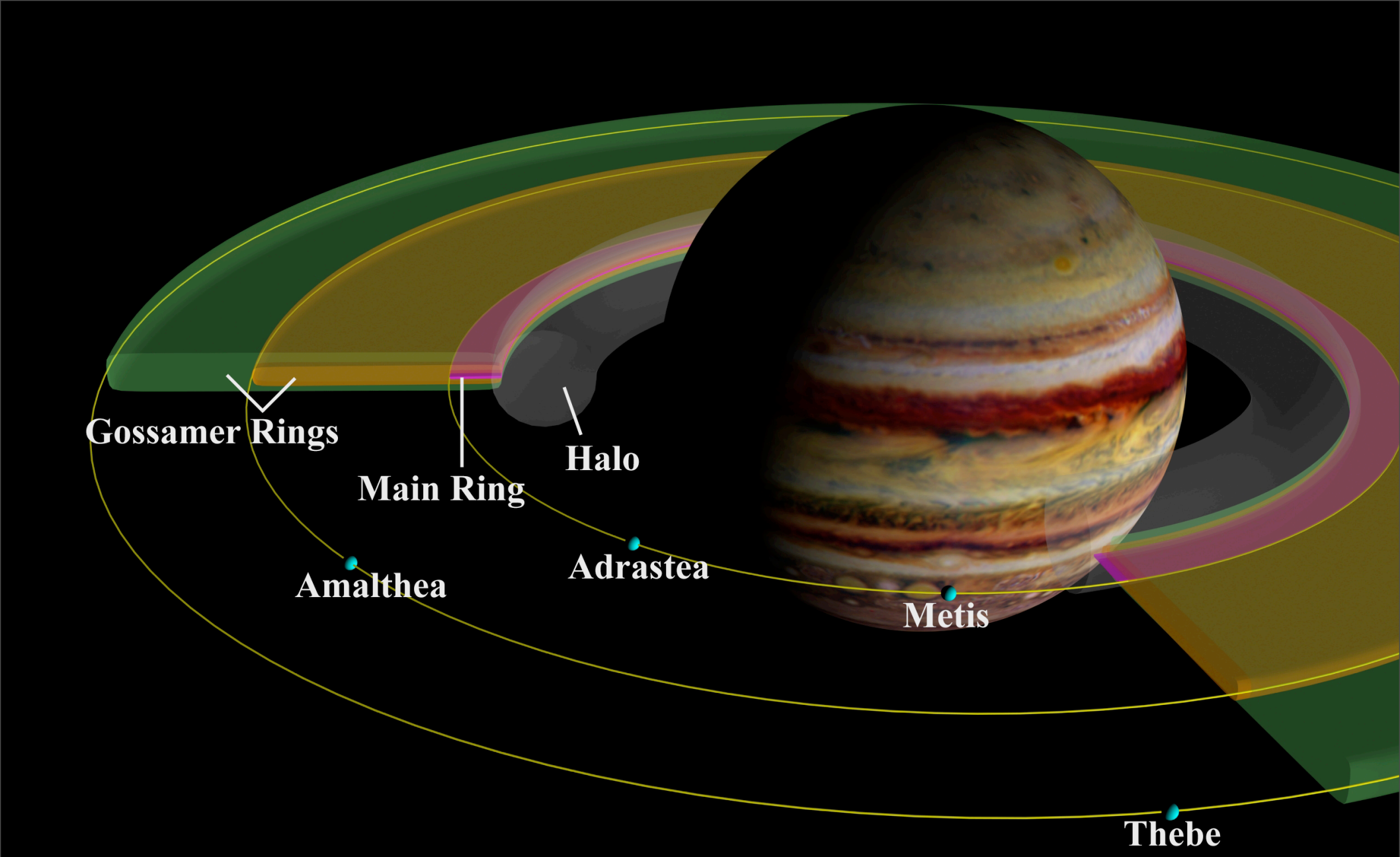
The Inner Jovian Satellites



The Phoebe Ring is Asymmetric

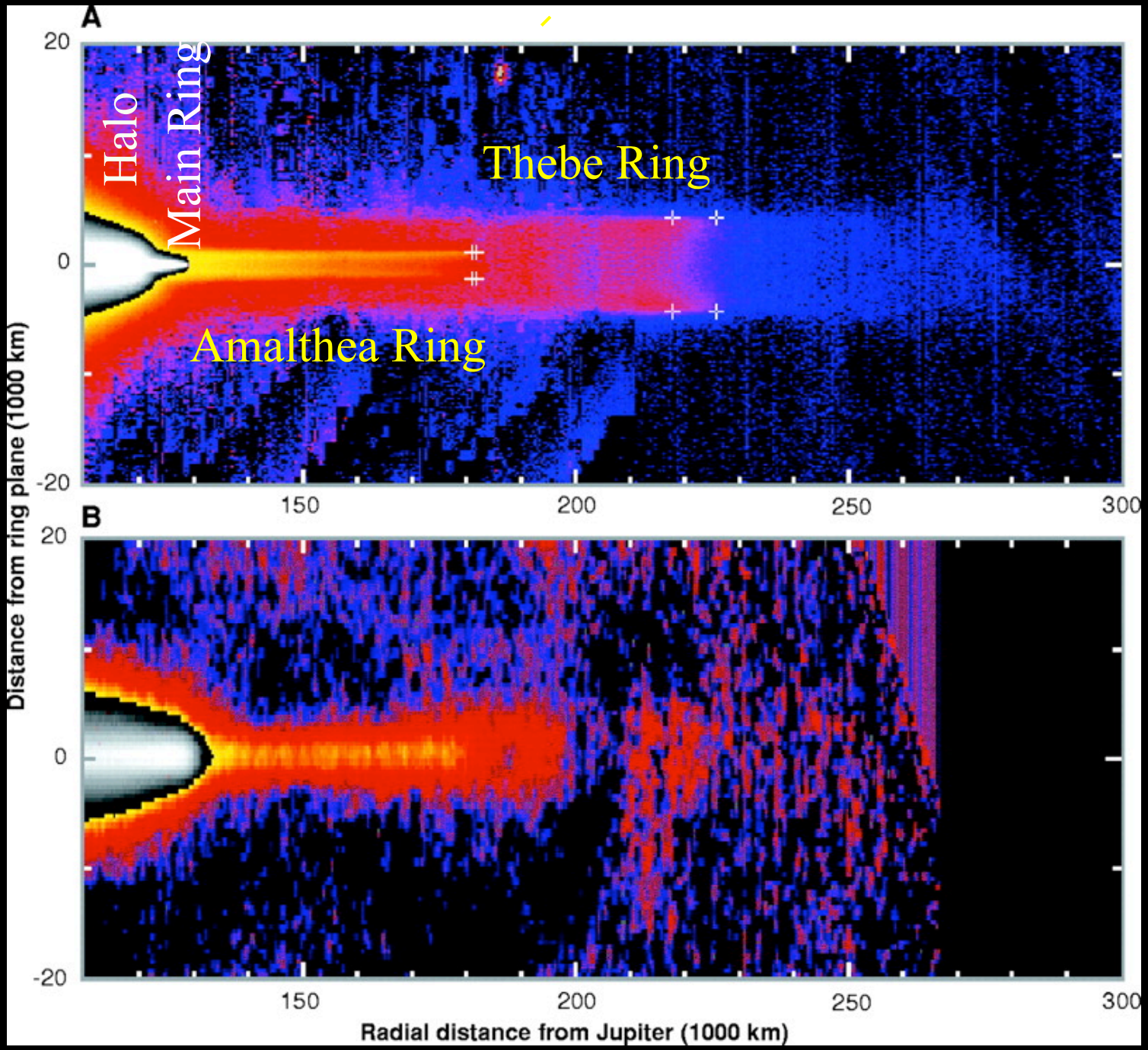



glint
Saturn's
Orbit
Tarvos
"Off"
glint
Saturn
Kiviuq
Phoebe
Iapetus
Kiviuq
"Off"
Phoebe
"Off"



Moons are Sources of Ring Material

Components of the Jovian Ring

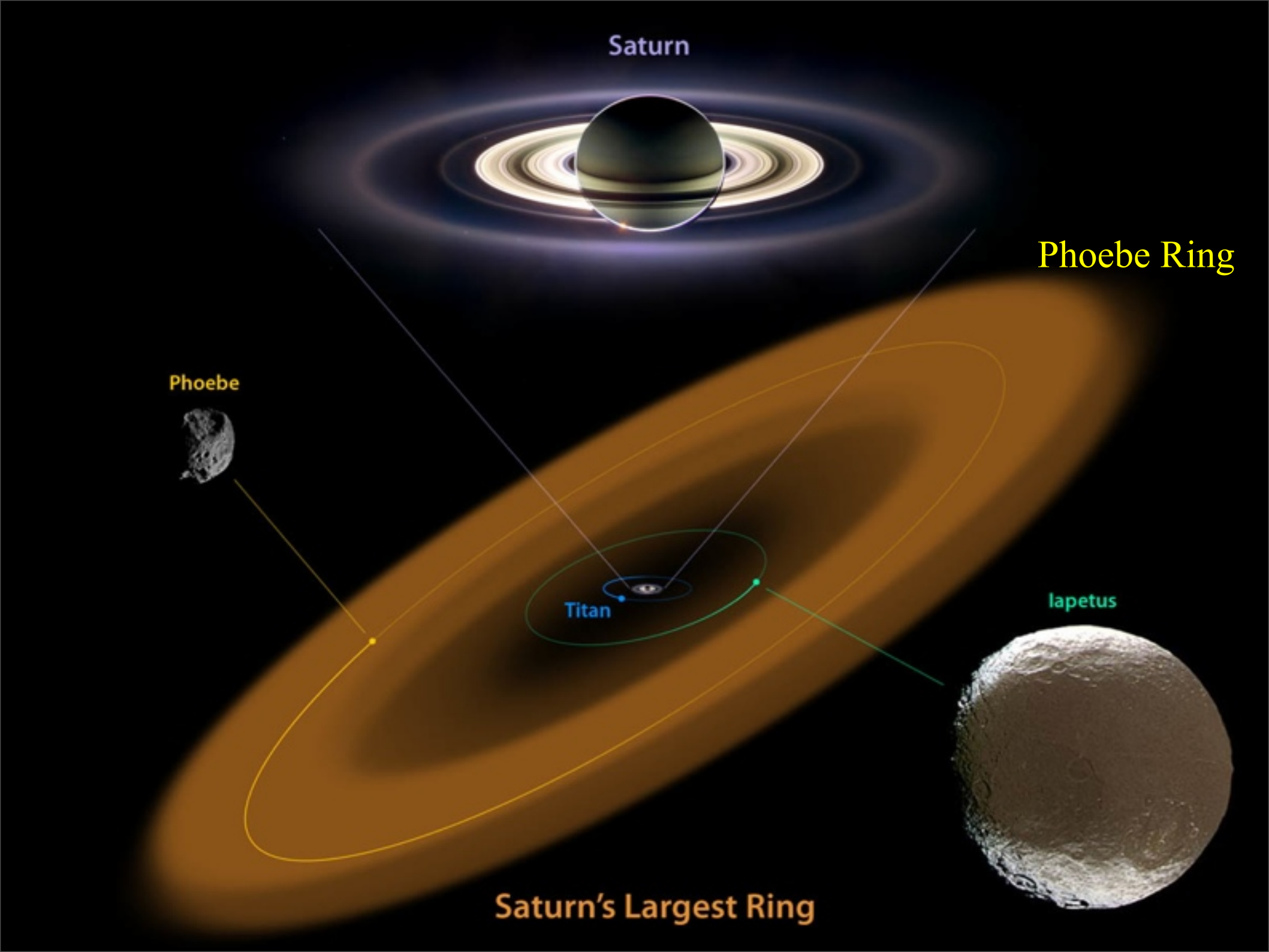


Galileo Data
Burns
et al. 1999

Forward Scatter
(small dust)

Keck Data
de Pater
et al. 1999

Back Scatter
(larger dust)


Saturn
Phoebe Ring
Phoebe
Titan
Iapetus
Saturn's Largest Ring