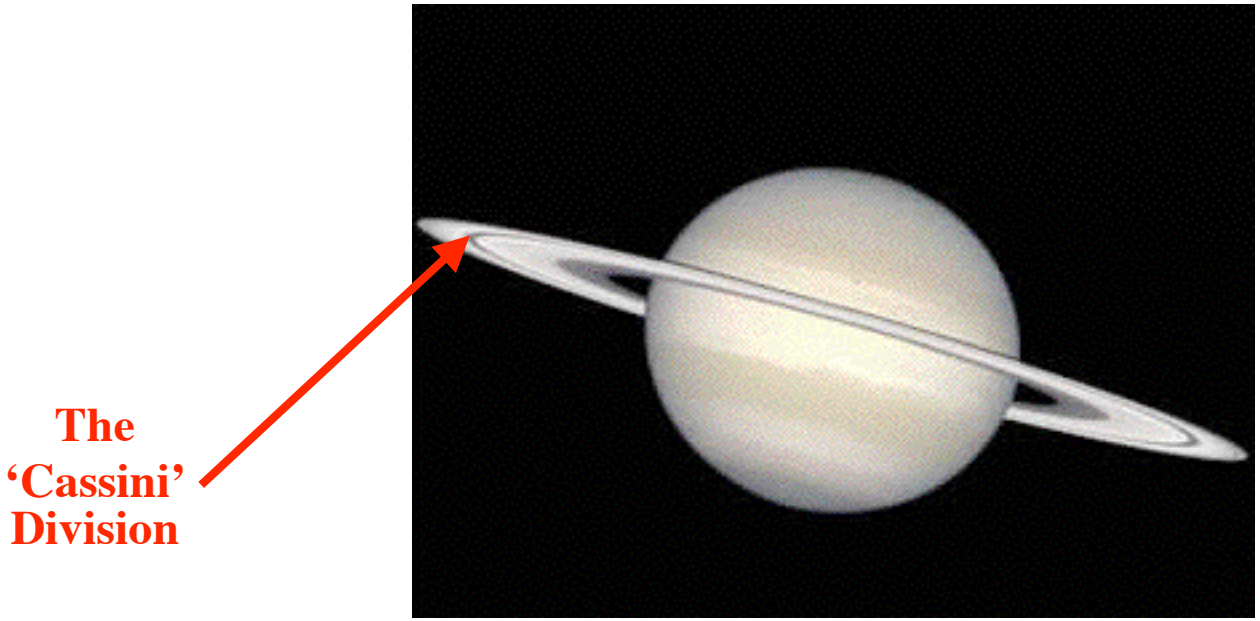
PLANETARY RINGS

All 4 of the Gas Giant planets in our Solar System possess a system of orbiting rings

Saturn of course provides the best example



What are the physical characteristics of Saturn's rings?

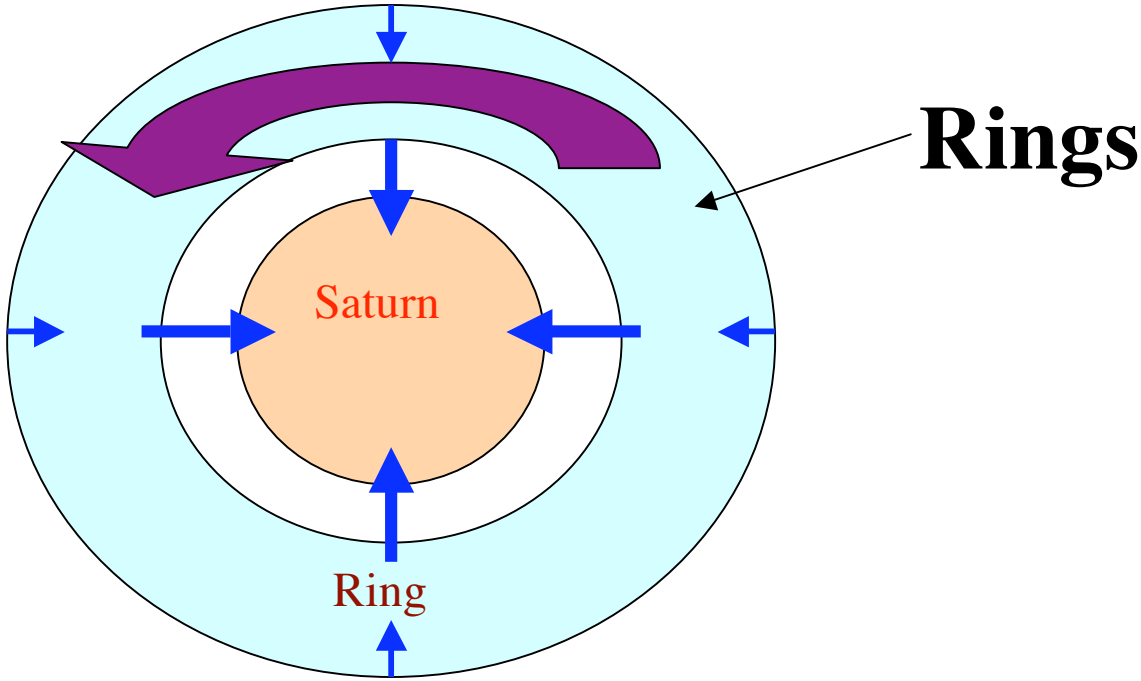
Is the ring a solid disk, like a CD or DVD ?

How thick is the ring?

What material(s) comprise the ring?

If the ring was a solid disk, Saturn's gravity would tidally 'rip' the ring apart in to 'small' pieces

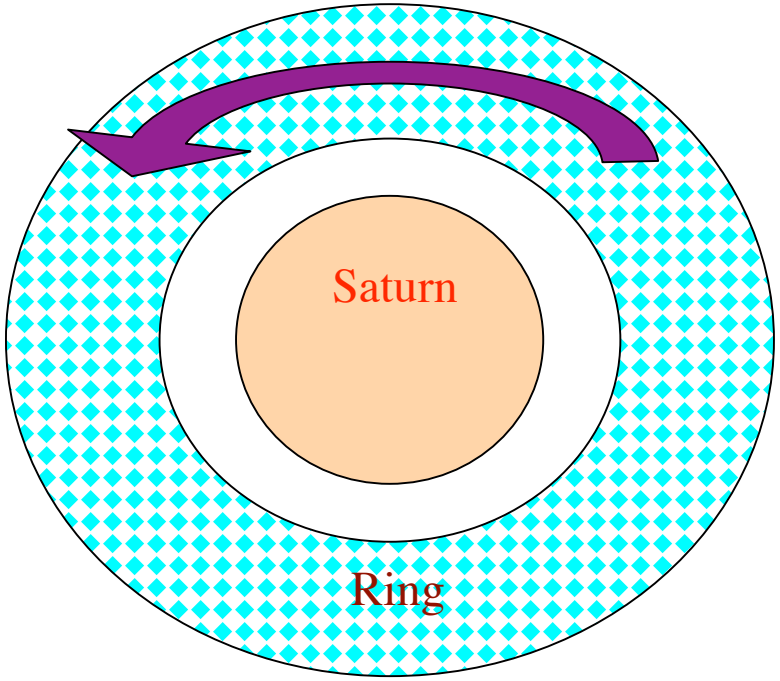
(looking down upon Saturn and its rings from above)



If the solid ring DID NOT rotate, it would be pulled in to Saturn

If the solid ring DID rotate, the outer portion would not be able to 'keep up' with the inner portion (think Kepler's 3rd Law)

Saturn's rings ARE composed of countless SMALL (dust size **to house size**) **pieces of material, each piece independently orbiting Saturn according to Kepler's 3rd Law** *(while also feeling the gravitational pull of nearby ring particles and also moons)*



Saturn's ring particles are primarily composed of WATER ICE with some other materials mixed in

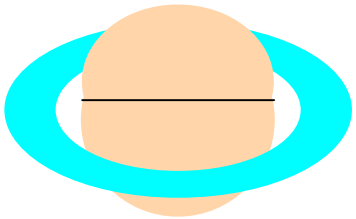
Every now and then (~ every 15 years), Saturn's rings DISAPPEAR from view…….. WHY?

Does all the ice sublime away ('melt' directly to vapor)?

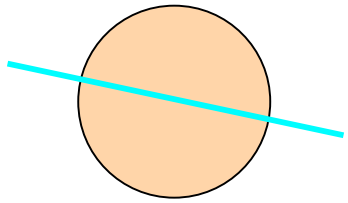
If the ice did sublime, it would be unlikely to be replenished.. so the rings would remain 'gone'
(the ring contains enough material to produce a 250 kilometer radius/'moon')

Saturn's rings are very THIN **… only ~100 meters thick (compared to their horizontal extent of 60,000 km!)**

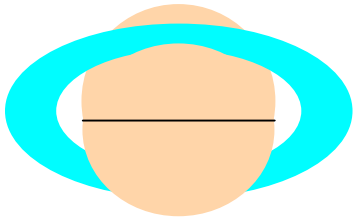
When Earth is between the Sun and Saturn AND Saturn is at its Spring or Autumn equinox (*Saturn's axis tilt is 27 degrees of angle*)**, the rings are seen EDGE-ON from Earth, and they 'disappear'** (because they are so thin….)



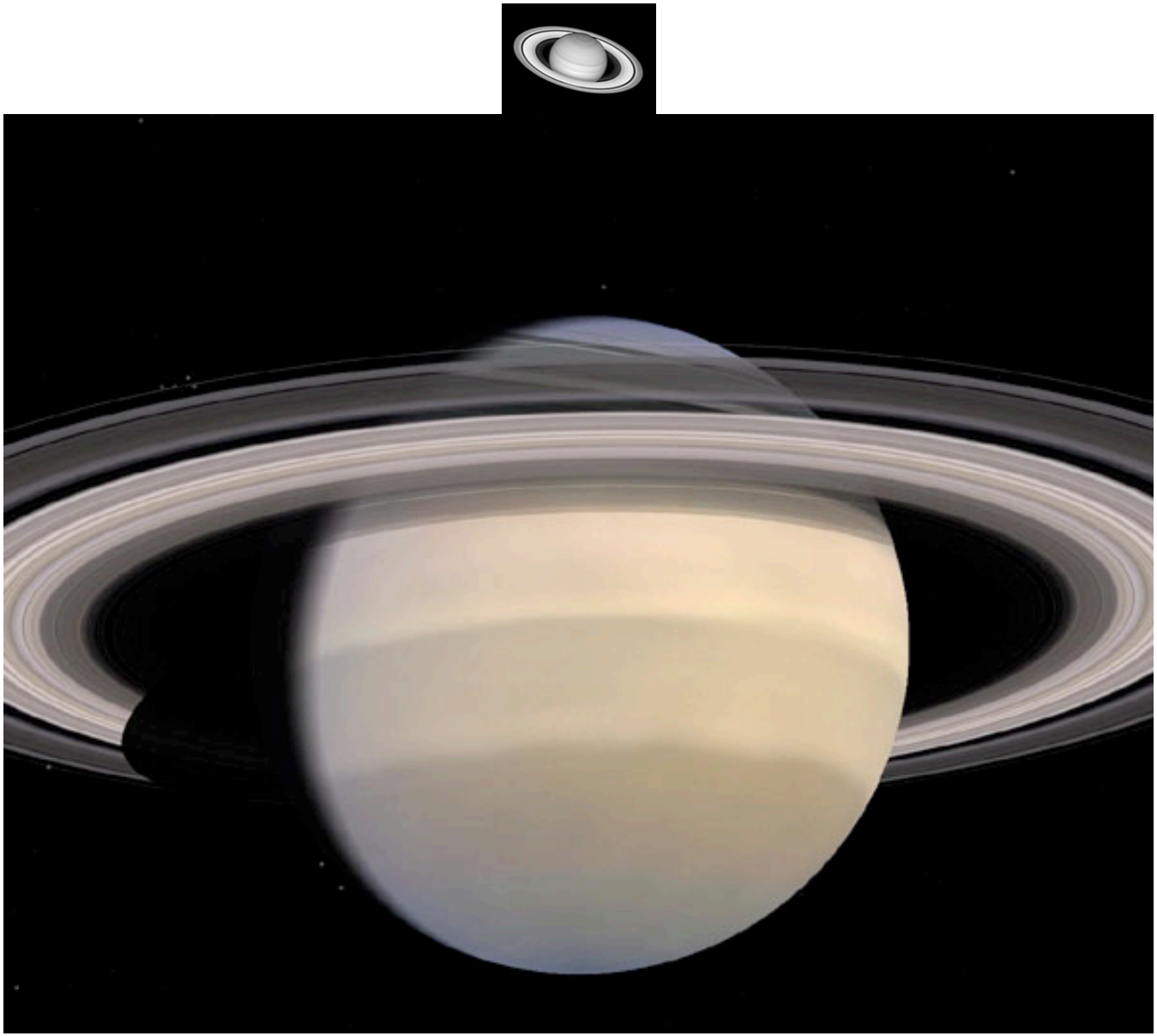
Rings tilted DOWN

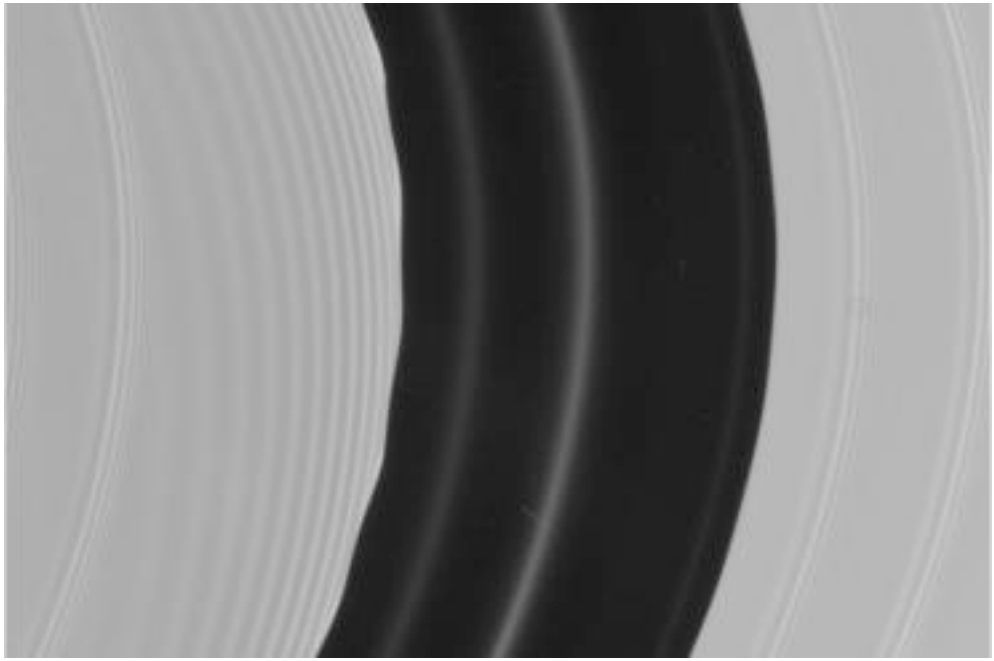


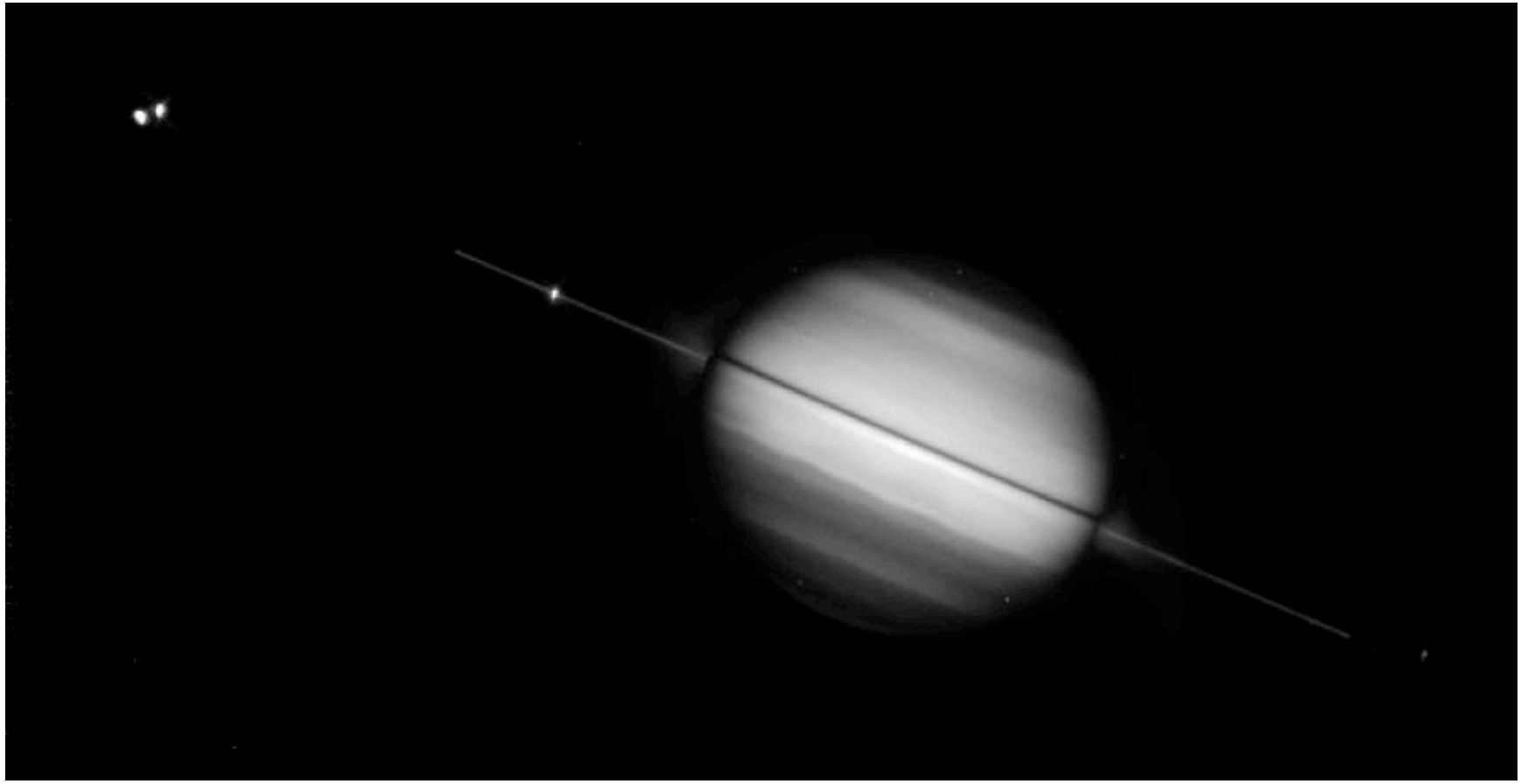
Rings edge on

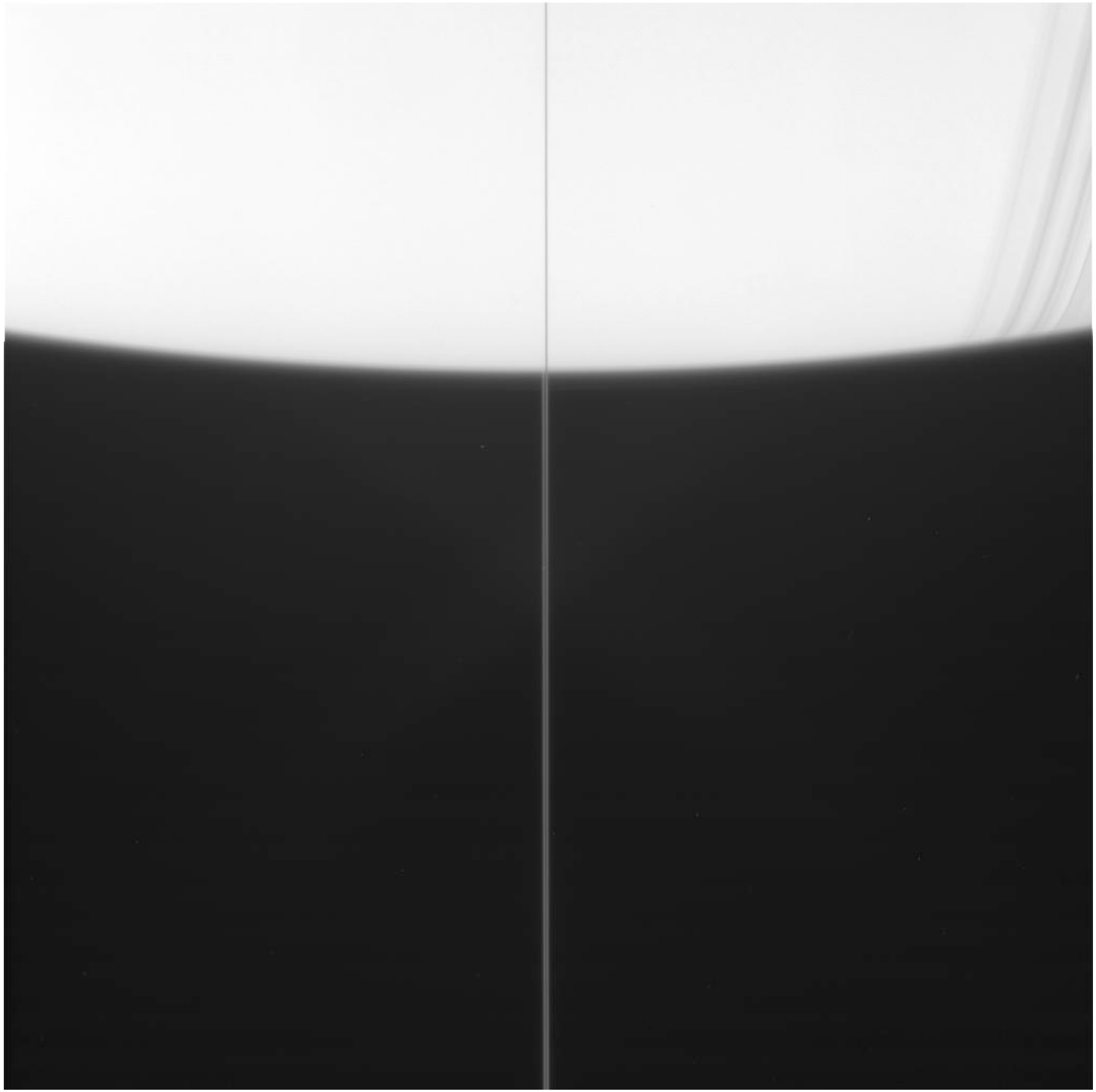


Rings tilted UP







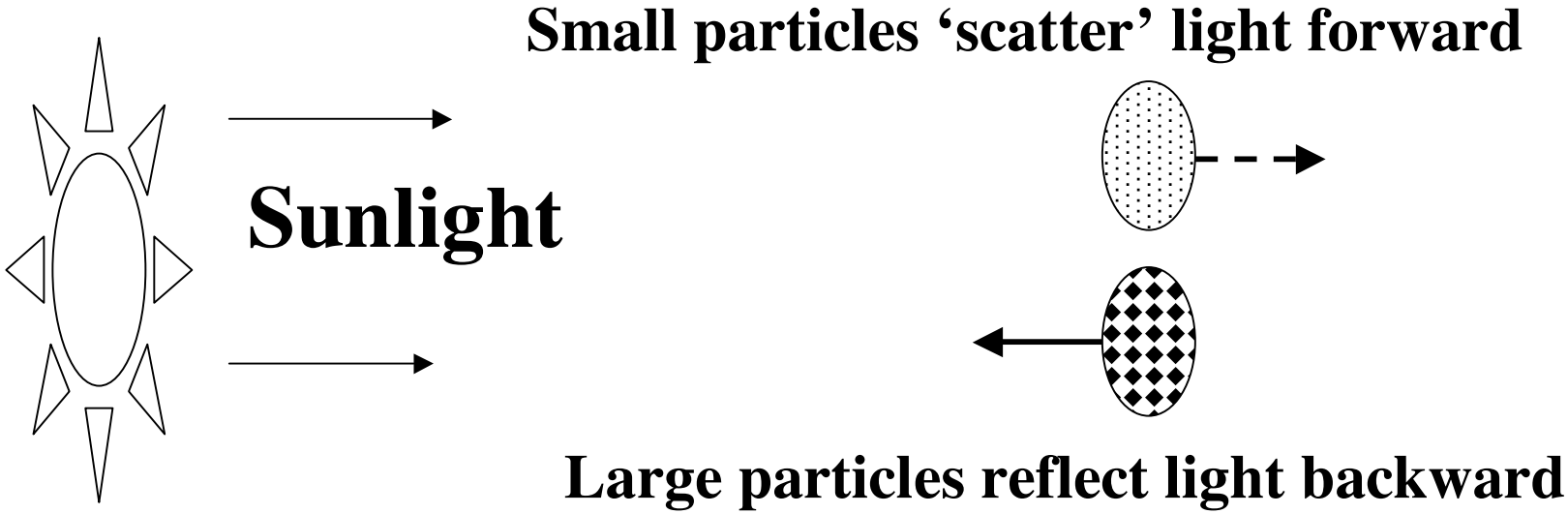


JUPITER, URANUS, and NEPTUNE
also have RINGS,
BUT
their rings are much more difficult to see because they are **DARK** and don't contain much material

You and I can't see these rings when looking through telescopes here at NMSU
BUT
Very large diameter telescopes (which capture large quantities of light) and spacecraft near these planets CAN 'see' these planets' rings

Jupiter's ring is a DUST ring

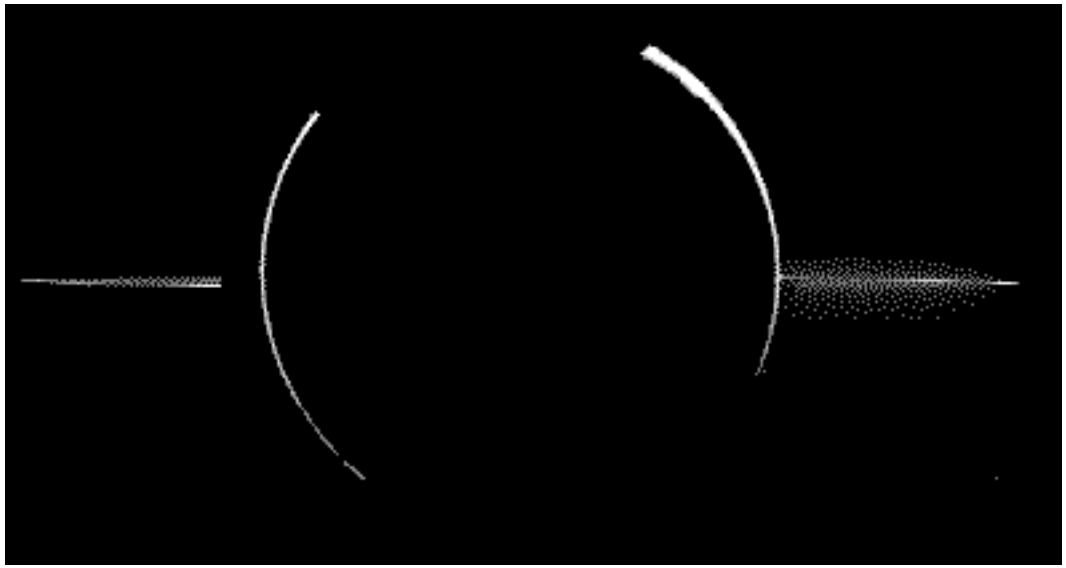
The particles are so small that they do a better job of 'reflecting light forward' [scattering] than they do reflecting light backward

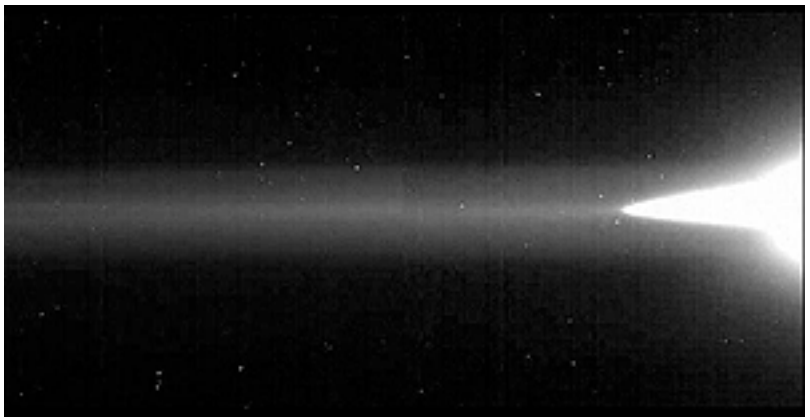


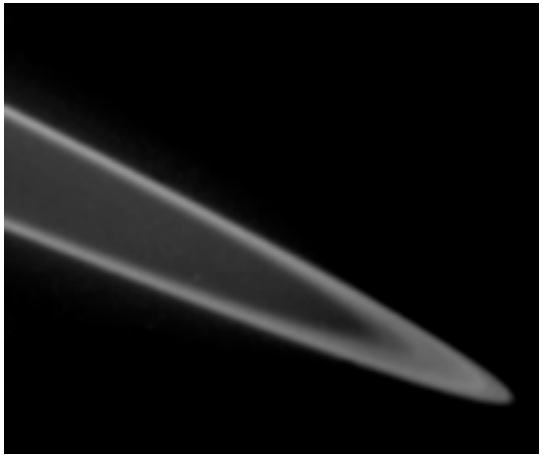
So, Jupiter's rings are best seen from the beyond the planet looking back to the Sun….this view is provided ONLY by spacecraft that we have sent to Jupiter and beyond (Pioneer 10 and 11, Voyager 1 and 2, Galileo, and Cassini)

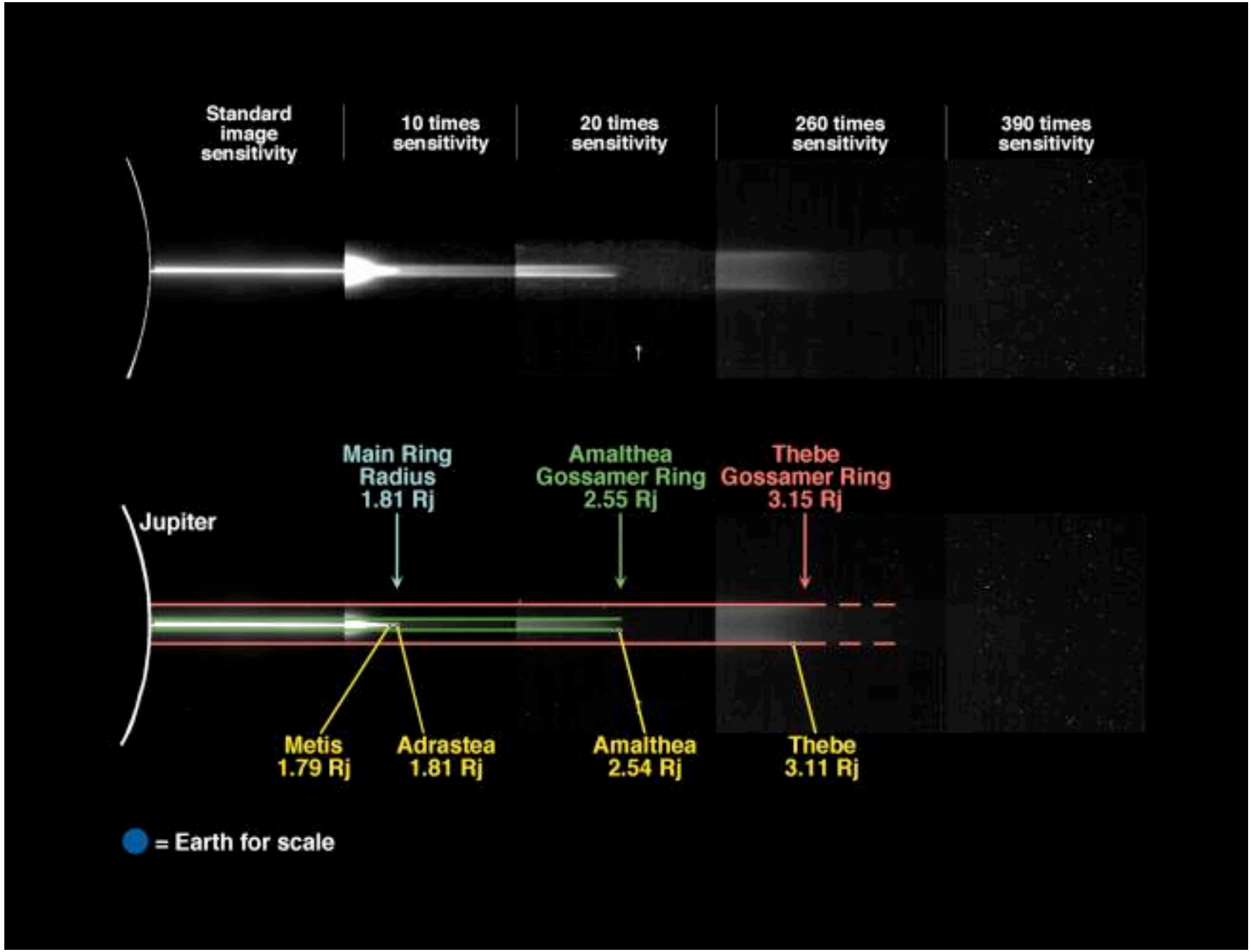
The dust in Jupiter's ring is provided by small moons which are impacted by small pieces of material; these impacts launch dust in to orbit around Jupiter

(NASA)








Standard image sensitivity
10 times sensitivity
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260 times sensitivity
390 times sensitivity
Main Ring Radius 1.81 Rj
Amalthea Gossamer Ring 2.55 Rj
Thebe Gossamer Ring 3.15 Rj
Jupiter
Metis 1.79 Rj
Adrastea 1.81 Rj
Amalthea 2.54 Rj
Thebe 3.11 Rj
= Earth for scale

Uranus' and Neptune's rings contain larger particles than does Jupiter's rings (so Uranus' and Neptune's rings are better 'backward' reflectors)

BUT

These particles are VERY DARK (and not icy) and do not reflect much sunlight at all

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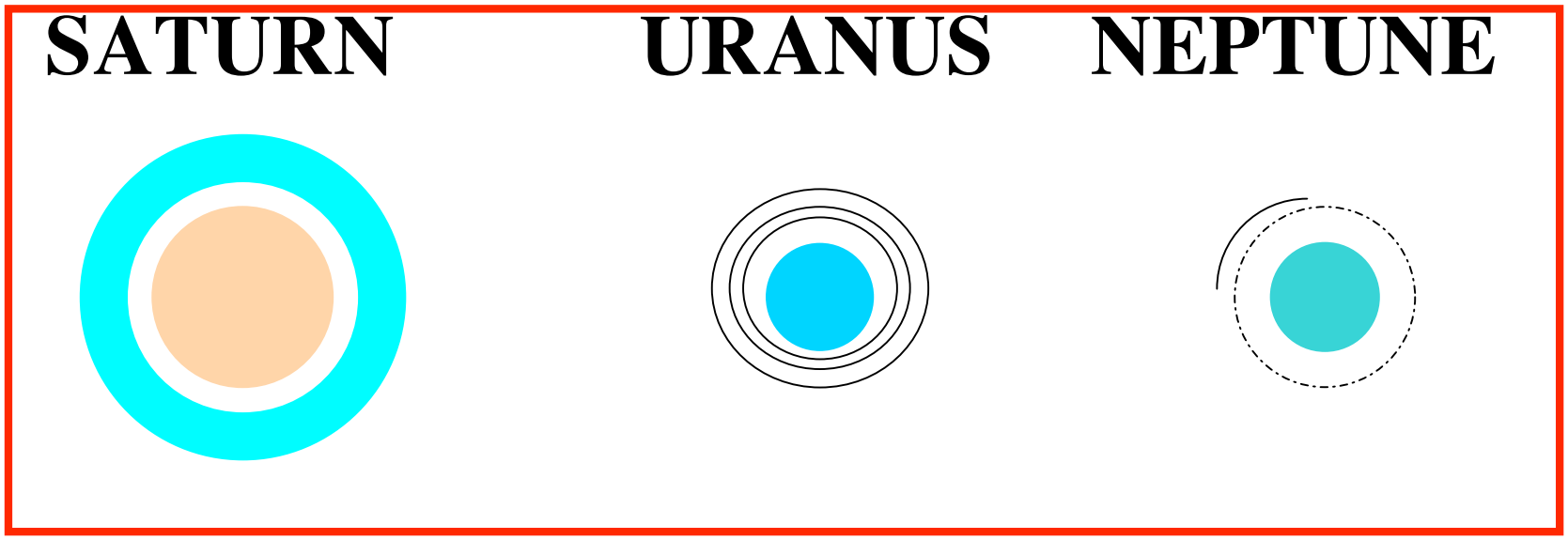
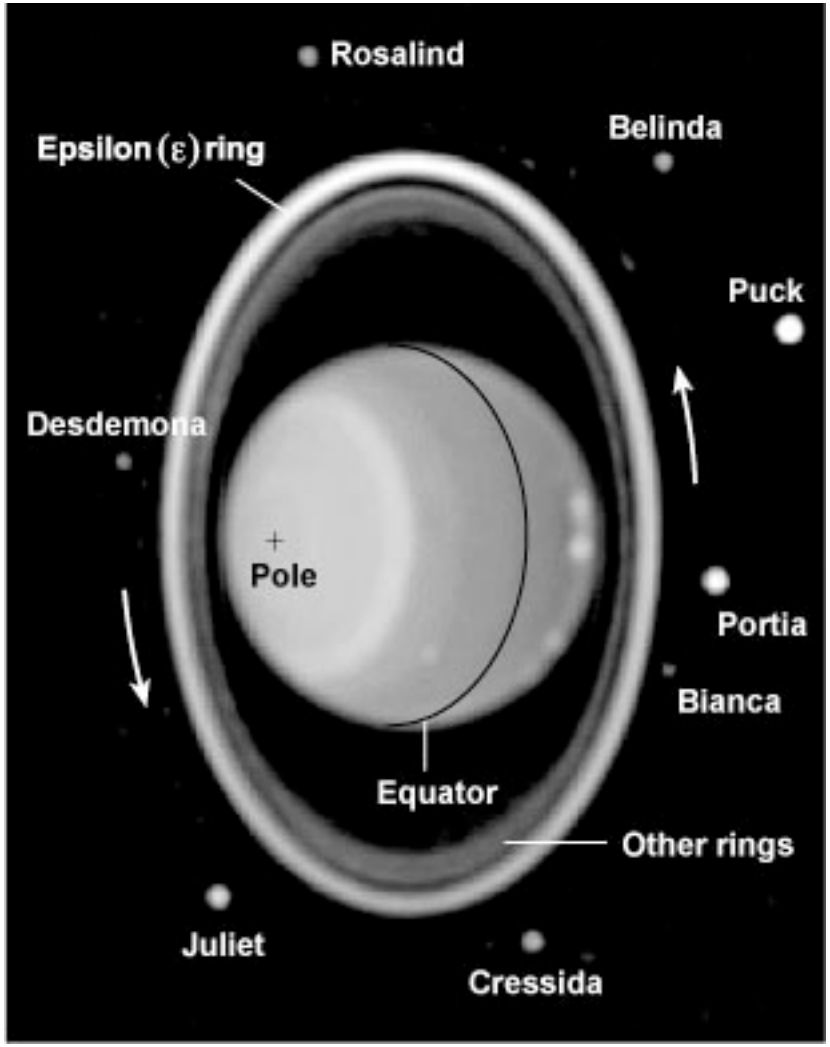
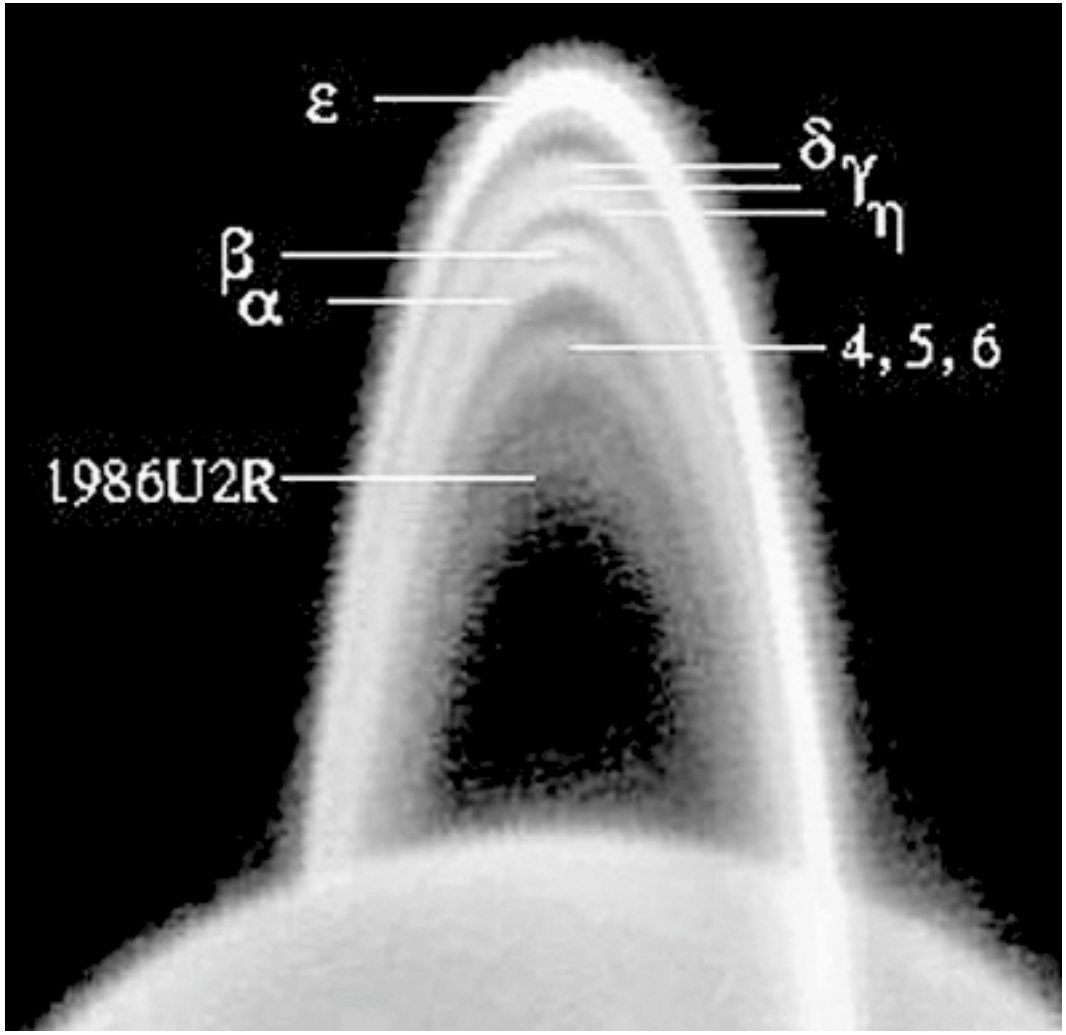
These rings are visible from Earth, but very long time-exposure images are required to 'build up' enough light to make the rings visible

Uranus and Neptune's rings are MUCH LESS continuous than Saturn's rings



None of the terrestrial planets possess ring systems (and none has been detected at Pluto)


Rosalind
Belinda
Epsilon (ε) ring
Puck
Desdemona
Pole
Portia
Bianca
Equator
Other rings
Juliet
Cressida


ε
δ
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4, 5, 6
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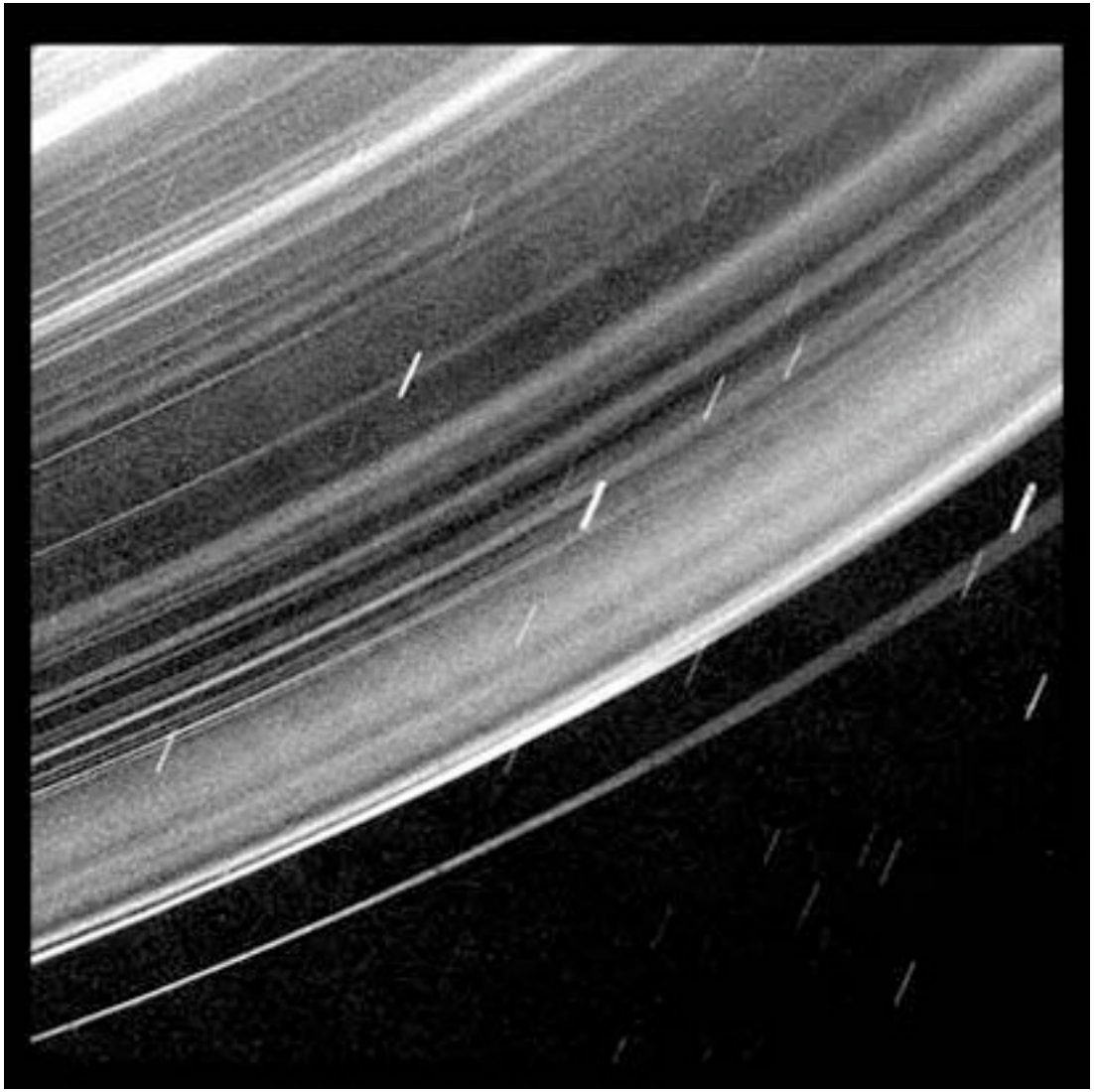
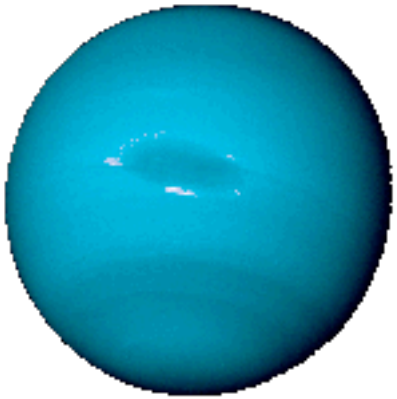
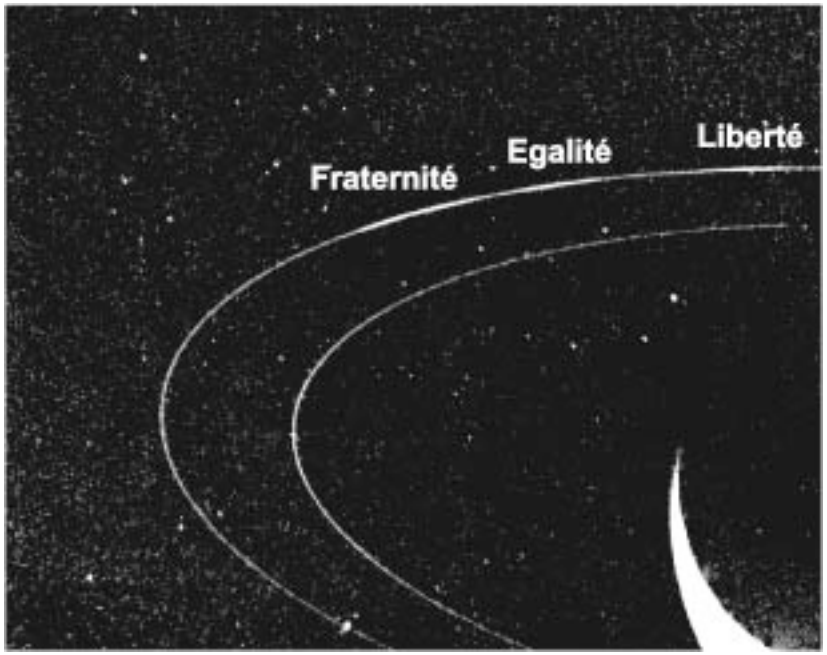
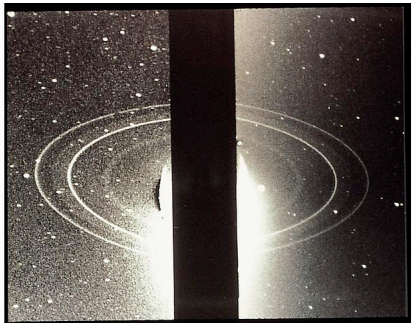
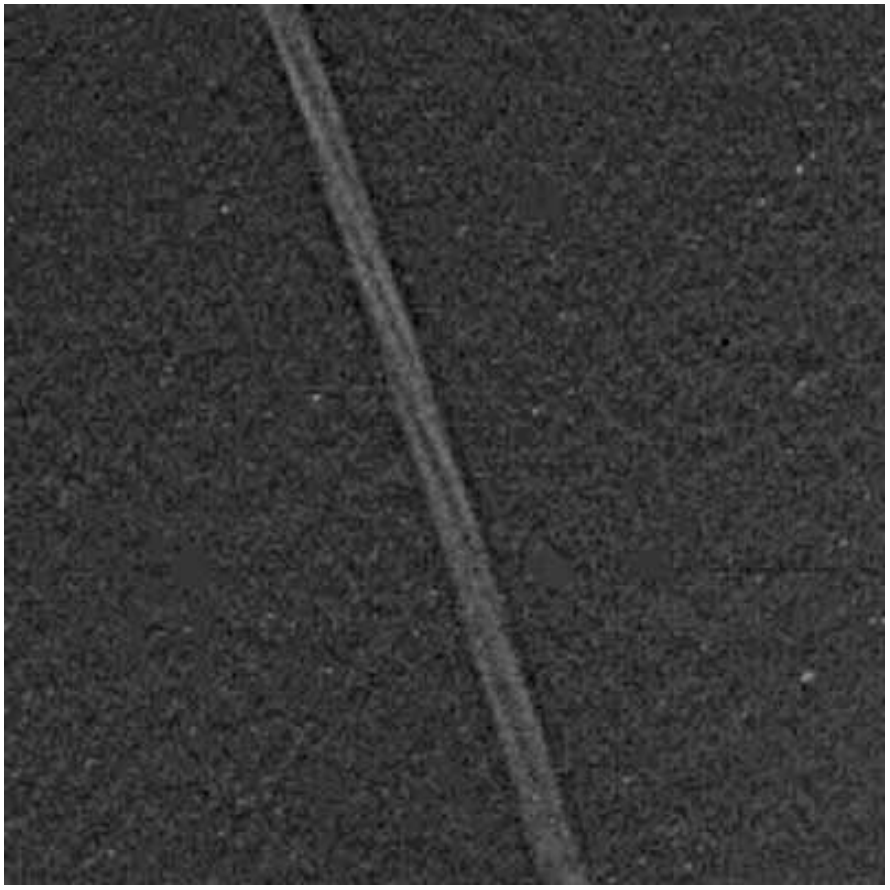





Fraternité
Egalité
Liberté





WHAT MIGHT BE THE PHYSICAL CAUSE OF RINGS AROUND THE GIANT PLANETS ?

Let's think about Jupiter's moon IO…. and all of its volcanism

What causes Io's volcanism?

Gravity tides from Jupiter

If Io was CLOSER to Jupiter, the tides would be STRONGER, and they could get strong enough to RIP Io APART !

If this happened, what would happen to the 'pieces' of Io?

Those pieces would form in to a RING, and if they DID NOT move farther away from Jupiter, they would not be able to 'group back together' to reform a moon

The distance from a planet at which a moon would be RIPPED APART by the planet's tidal forces is known as the:

ROCHE Distance
(which depends upon the planet's mass)

For the 4 Gas Giant planets, all of their rings are CLOSER to the planet than that planet's ROCHE distance

Earth's ROCHE distance is ~20,000 kilometers
(Mercury, Venus, and Mars have even smaller values)

The Moon's OSA is 384,000 kilometers
(so the Moon is not in danger of being ripped apart)

PLANETARY RINGS are scientifically interesting in part because the interactions among the ring particles (bumping in to each other, etc.) is probably somewhat similar to the planet's forming in the

SOLAR NEBULA DISK

4.5 billion years ago