

Jovian Planets and Interiors

11-7-2005

Opening Discussion

Have you seen anything interesting in the news?
How will life end? Pessimists Optimists

Venus Weather

Venus has no significant weather at ground level. There aren't significant winds or precipitation.

Sulfuric acid clouds are blown about by strong winds in the upper atmosphere. The presence of sulfuric acid indicates that there must be some fairly recent volcanism as the sulfur dioxide needed to produce it isn't stable over geological timescales.

Venus is extremely dry, even the upper atmosphere lacks water. Venus should have had as much water as the Earth, but photo dissociation effectively removed it.

How Venus Got This Way

So why is Venus so different from Earth given the similar size and distance from the Sun? The answer lies in the minor difference in distance to the Sun.

When a planet warms more water evaporates. Since water is a greenhouse gas, having more in the atmosphere warms the planet further. This positive feedback loop can lead to a runaway greenhouse effect if the planet is a bit closer to the Sun than the Earth. Because the Sun was dimmer in the past Venus might have been habitable though we are unlikely to ever know.

Implications for the Earth

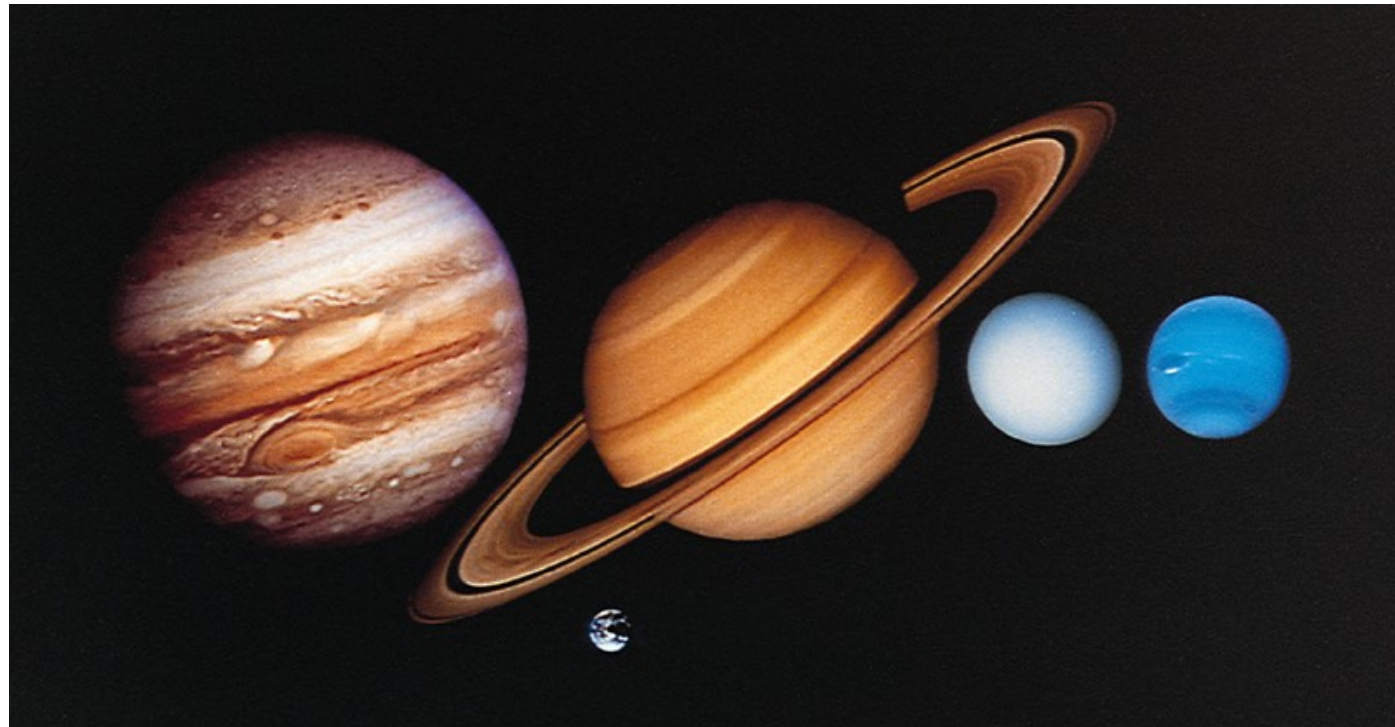
The Earth's atmosphere has been remarkably stable over the age of the Solar System. We owe this to the stabilizing influence of our Moon, the size of our planet, and our distance from the Sun.

Judging from the other terrestrial planets in our Solar System, this stability is the exception, not the rule.

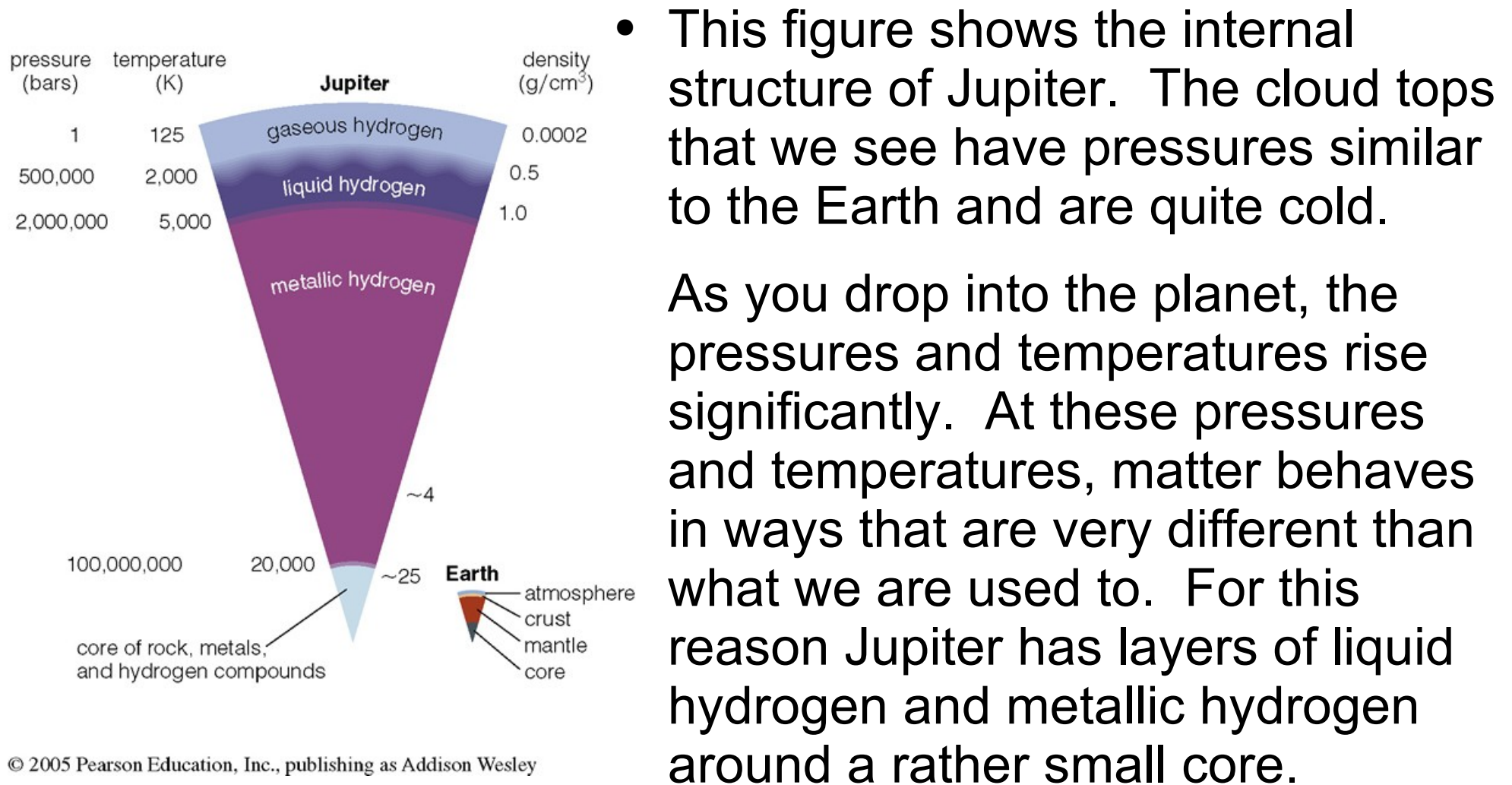
The greatest fear of those who worry about global warming is the possibility of a runaway greenhouse on Earth. It is almost inevitable in 1 billion years as the Sun gets brighter. Our current activities could speed up the process.

Jovian Planet Basics

- Jovian planets are all giant balls of gas. They are extremely different from the terrestrial worlds. They are low density and rotate quickly causing some oblateness. They have have numerous moons and rings.

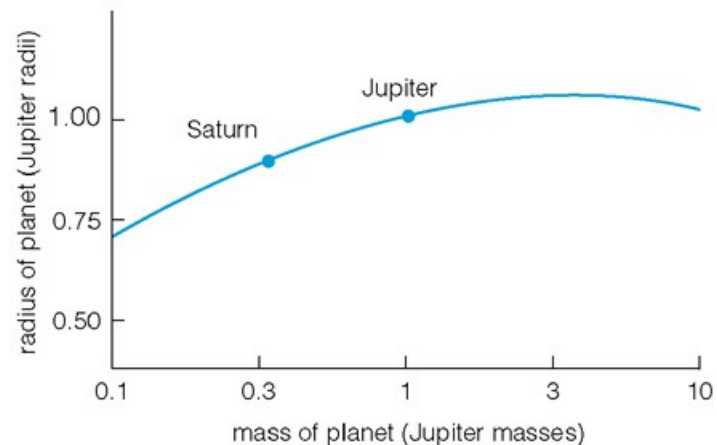
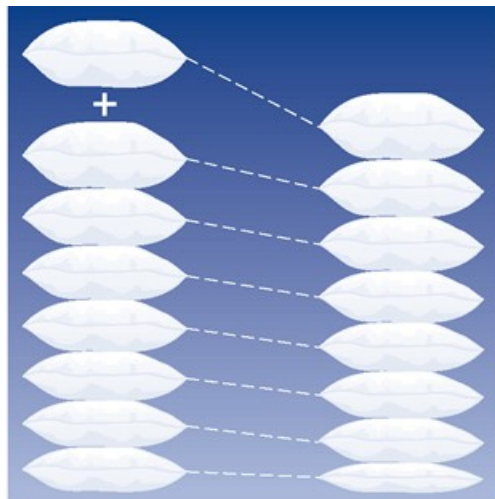


Jovian Planet Interiors

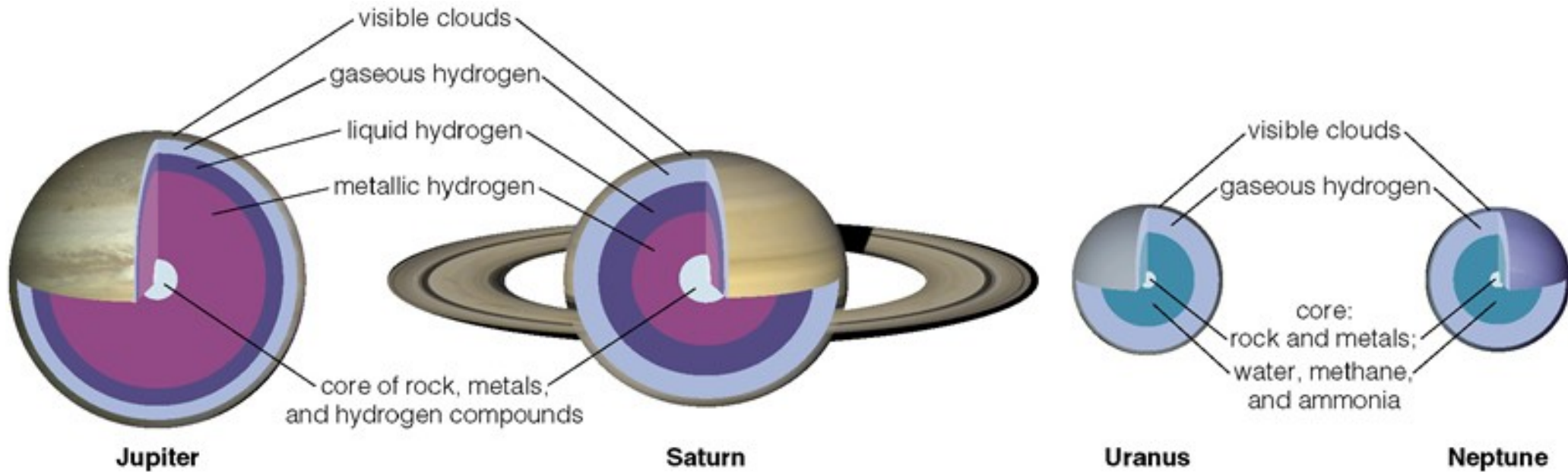


Compression

- The size of the planets does not vary with mass as one might expect. For Jupiter and Saturn this is because more mass compresses the material. At 80 Jupiter masses the object would sustain fusion and become a star.
- Uranus and Neptune have less H and He.



Comparison of Jovian Planets



Internal Heat of Jovian Planets

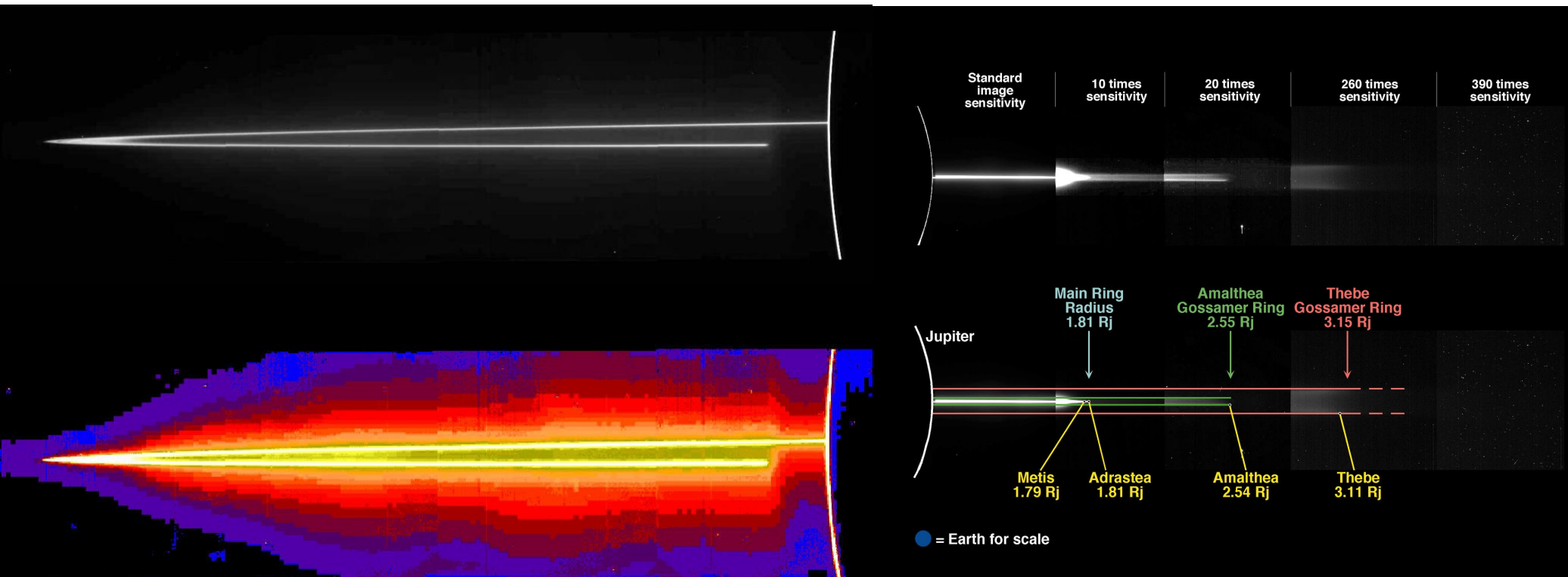
Jupiter, Saturn, and Neptune all emit roughly twice as much thermal radiation as they are hit with from the Sun.

Jupiter's heat most likely comes from continued contraction of the planet. Saturn's heat appears to come from helium rain out where helium higher up condenses to a liquid and sinks.

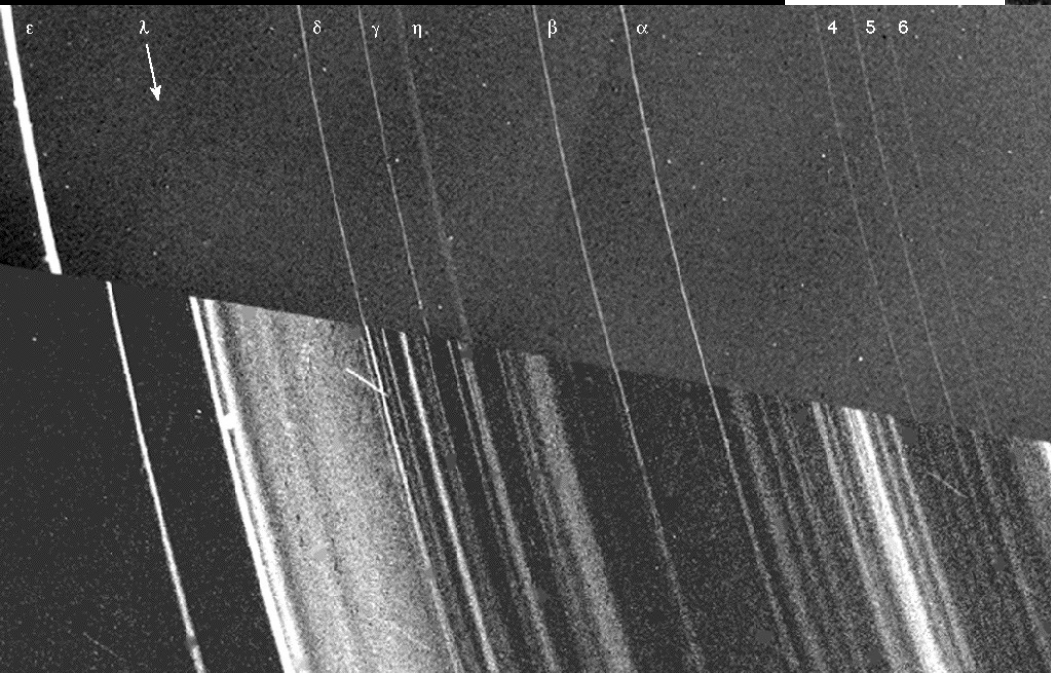
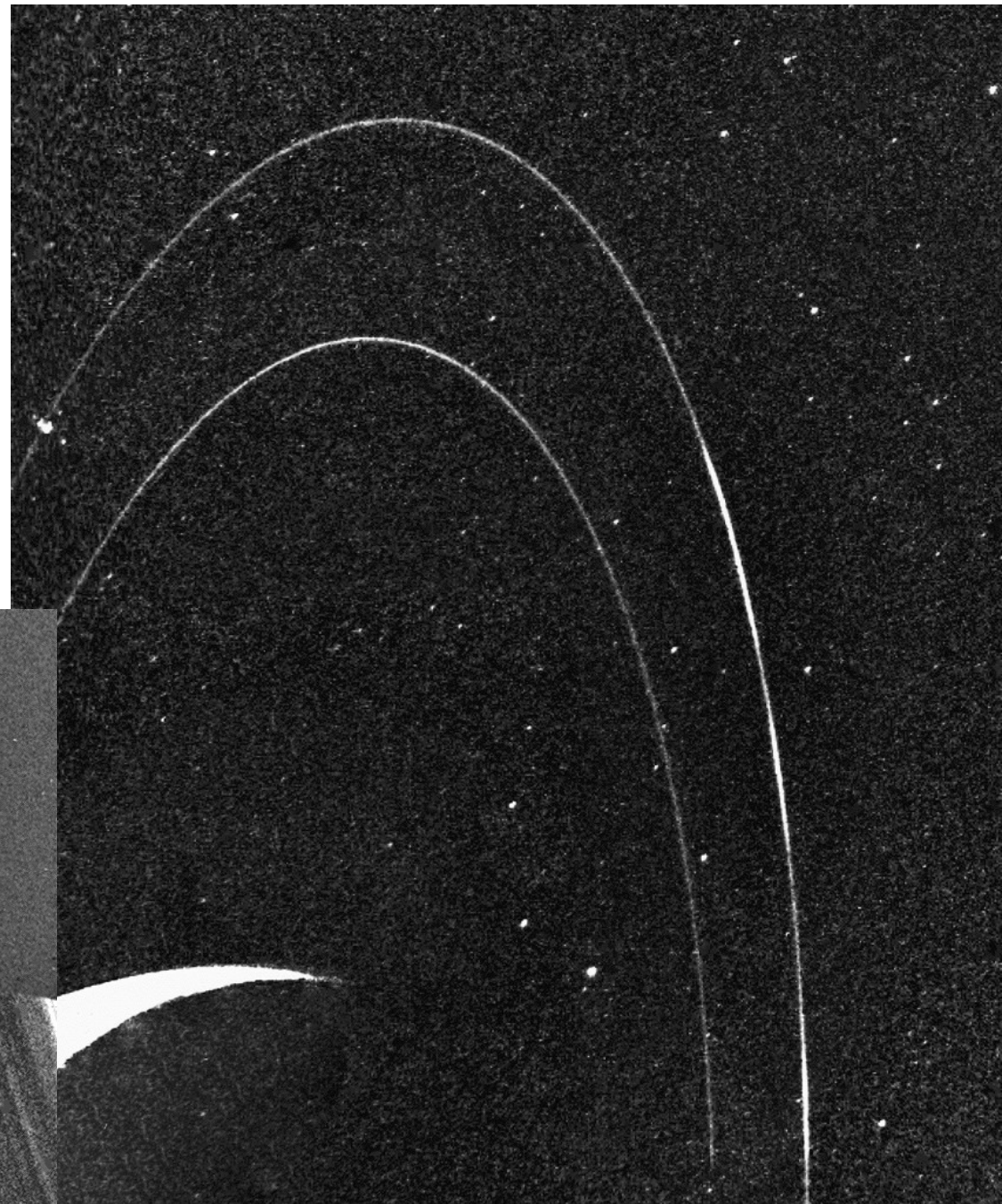
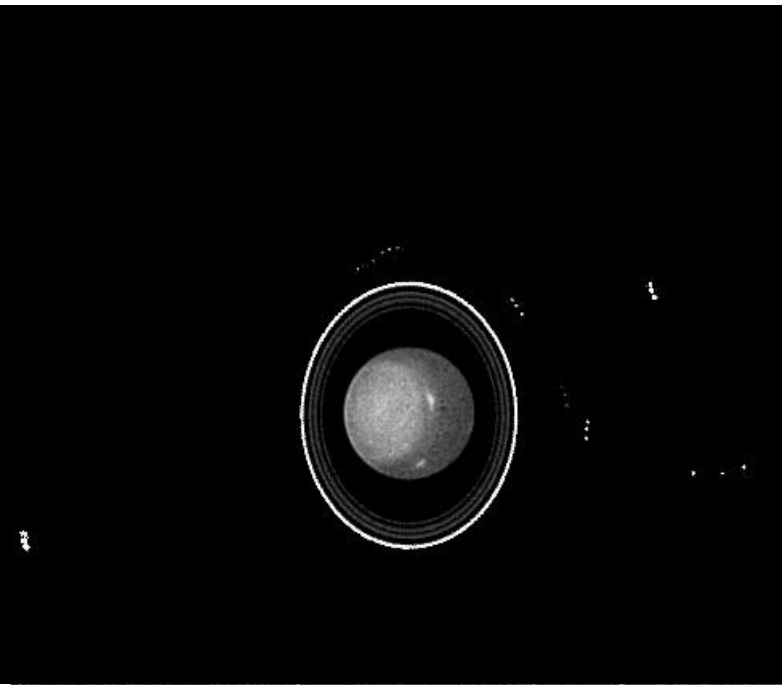
Neptune's extra heat energy isn't well explained. The only decent option would be continued contraction, but it isn't clear why that should be.

Planetary Rings

- All the Jovian planets have rings of some sort. Those of Saturn happen to be the most visible.
- Jupiter's rings are thin and dusty. They are formed by particles that have been knocked off some of the smaller, inner moons.



Rings of Uranus and Neptune



Minute Essay

Do you understand what a runaway greenhouse effect is and how it would happen?