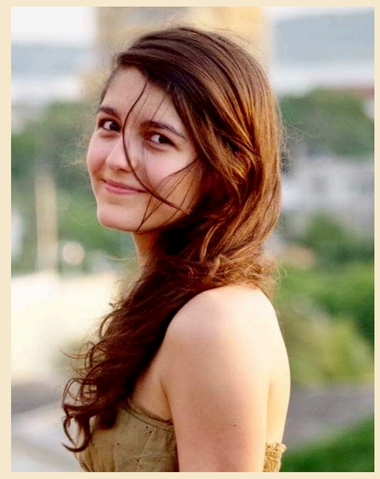
ARE URANUS AND NEPTUNE REALLY ICE GIANTS?



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ABSTRACT

Recent studies challenge the idea that Uranus and Neptune are primarily icy, proposing a rock-dominated composition [1]. We model their interiors to assess ice-to-rock ratios and analyze their influence on the planet's Pressure-Temperature profile. We find that Neptune's envelope is rock-enriched, with a maximum ice/rock of 0.5, while its mantle contains more ice. Moreover, higher ice-to-rock ratios correlate with hotter interiors.

3-LAYER MODELS

Interior models are built to match the planet's gravity data. MCMC simulations are used to explore a wide range of interior configurations, assuming the structure shown in Fig. 1.

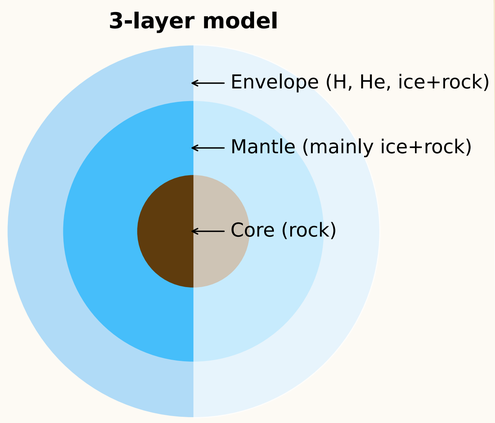

Fig. 1: Internal structure assumed for both planets.

POSSIBLE INTERIORS

Our solutions comprise models that fit observational data. Fig. 2 displays representative interior solutions. Neptune is denser than Uranus, as can be deduced from their Mass-Radius relation.

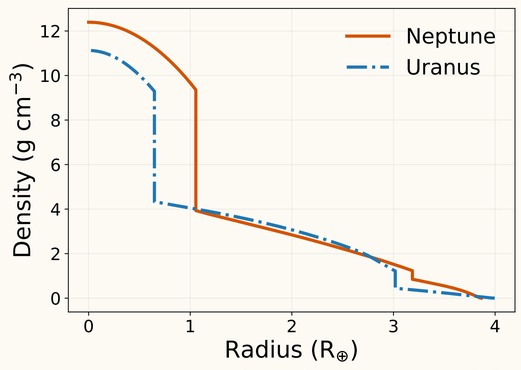

Fig. 2: Example of one possible density profile per planet.

ICE-TO-ROCK RATIO

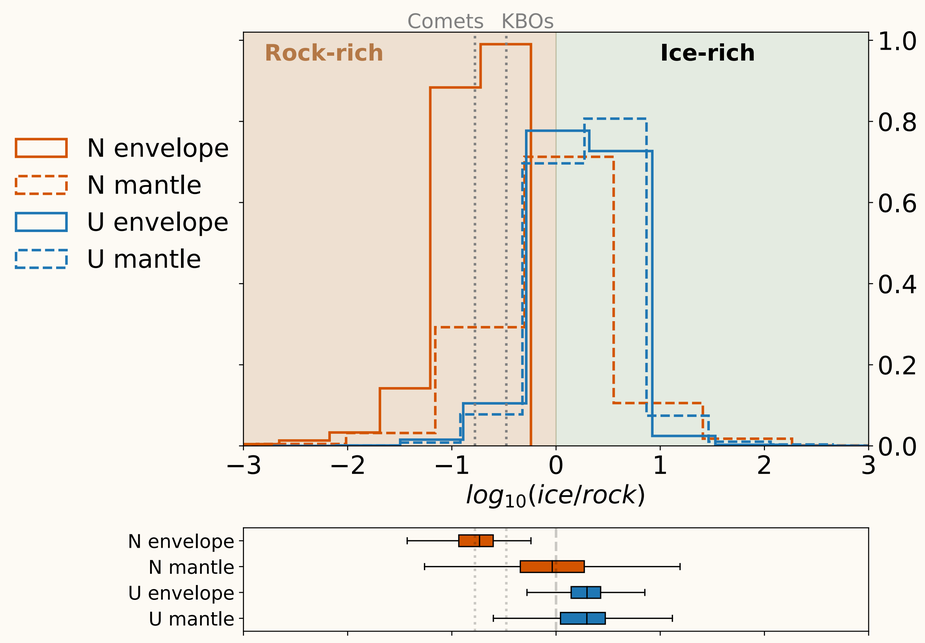

Fig. 3: Distribution of possible ice/rock values in the ice giants' envelope and mantle. Neptune's envelope is rock-dominated, similarly to outer solar system objects.

PRESSURE-TEMPERATURE PROFILE

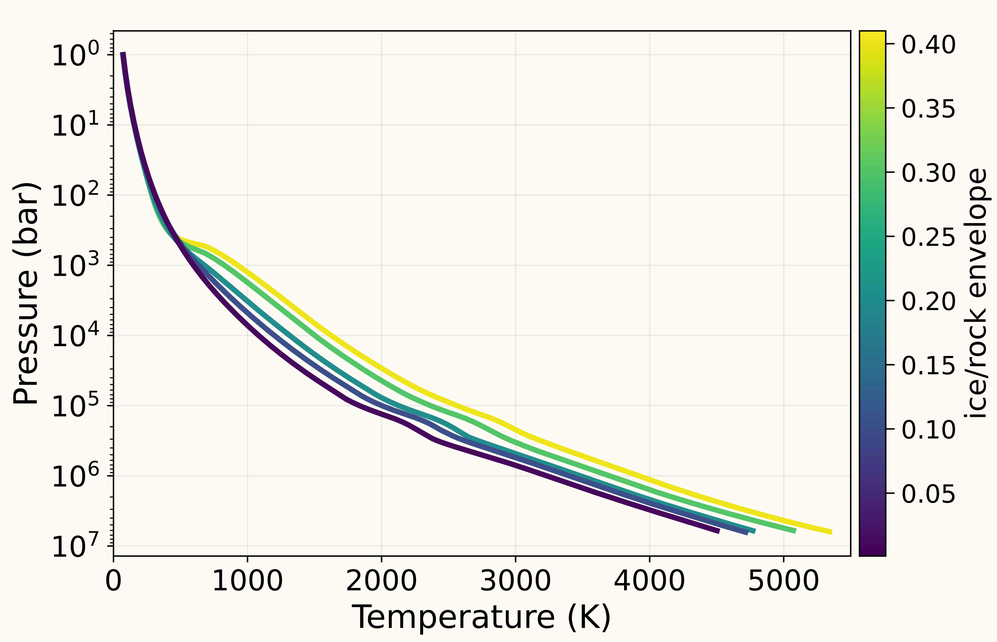

Fig. 4: Neptune's Pressure-Temperature profile for different ice-to-rock ratios in the envelope. Larger ice/rock values correlate with hotter interiors. Similar results found for Uranus.

DISCUSSION

- The rock fraction in Neptune's envelope is consistent with outer solar system objects but is significantly high compared to its mantle and to Uranus (Fig. 3). **Did Uranus and Neptune form and evolve differently? Can meteorite impacts explain the rock fraction enrichment in Neptune's envelope?**
- We find that larger ice/rock values trigger hotter interiors (Fig. 4). This is likely explained by the presence of more water in the planet's interior (greenhouse effect).

CONCLUSION

We model the interior of Uranus and Neptune. Our solutions indicate that Neptune's envelope is rock-dominated, with an ice-to-rock ratio consistent with outer solar system objects, while it's mantle has a higher ice fraction. Uranus interior seems to be ice-rich, with similar ice-to-rock values in its envelope and mantle.

A dedicated mission to the "ice" giants is needed to better constrain their interiors!

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References:
[1]: Teanby et al. 2020