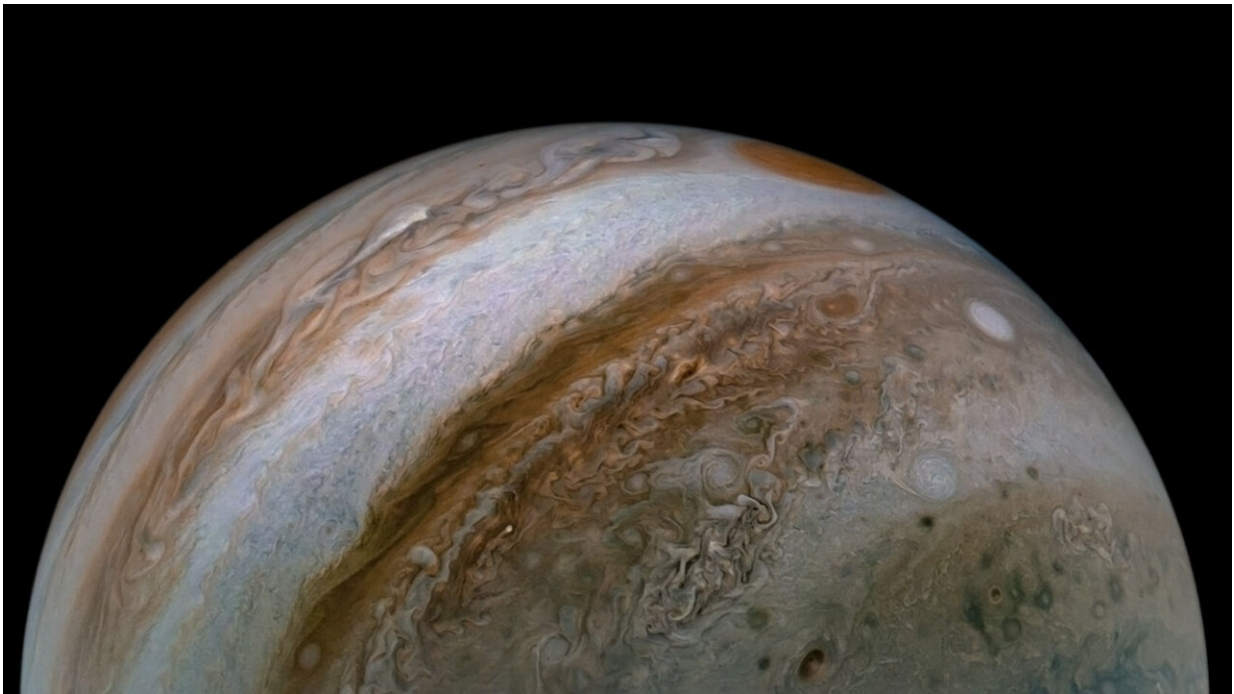


Jupiter turns out to be inhomogeneous; metallicity gives clues about origin

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Credit: NASA

An international team of astronomers, led by Yamila Miguel (SRON/Leiden Observatory), has found that Jupiter's gaseous envelope doesn't have a homogeneous distribution. The inner part has more metals than the outer parts, adding up to a total of between 11 and 30 earth masses, meaning 3–9% of Jupiter's total mass. This is a high enough metallicity to conclude that kilometer-sized

bodies—planetesimals—must have played a role in Jupiter's formation. It will be published on June 8 in *Astronomy & Astrophysics*.

When NASA's Juno space mission arrived at Jupiter in 2016, we caught a glimpse of the remarkable beauty of the biggest planet in our solar system. Besides the famous Great Red Spot, Jupiter turns out to be littered with hurricanes, almost giving it the appearance and mystique of a Van Gogh painting. The planet's envelope underneath the thin visible layer however, is not immediately apparent. Still, Juno is able to paint us a picture by sensing the [gravitational pull](#) above different locations on Jupiter. This gives astronomers information about the composition of the interior, which is not like what we see in the surface.

An international team of astronomers, led by Yamila Miguel (SRON/Leiden Observatory), now found that the [gaseous envelope](#) is not as homogenous and well-mixed as previously thought. Instead it has a higher contraction of metals—elements heavier than hydrogen and helium—toward the center of the planet. To reach their conclusions, the team built a number of theoretical models that adhere to the observational constraints measured by Juno.

The team studied the distribution of metals because it gives them information about how Jupiter was formed. The metals turn out to be not distributed homogeneously across the envelope, with more in the inner part than in the outer parts. The total adds up to between 11 and 30 Earth masses worth of metals. Miguel: "There are two mechanisms for a gas giant like Jupiter to acquire metals during its formation: through the accretion of small pebbles or larger planetesimals. We know that once a baby planet is big enough, it starts pushing out pebbles. The richness of metals inside Jupiter that we see now is impossible to achieve before that. So we can exclude the scenario with only pebbles as solids during Jupiter's formation. Planetesimals are too big to be blocked, so they must have played a role."

The finding that the inner part of the envelope has more [heavy elements](#) than the outer part, means that the abundance decreases outward with a gradient, instead of there being a homogeneous mixing across the envelope. "Earlier, we thought that Jupiter has convection, like boiling water, making it completely mixed," says Miguel. "But our finding shows differently."

More information: Y. Miguel et al, Jupiter's inhomogeneous envelope. arXiv:2203.01866v1 [astro-ph.EP], arxiv.org/abs/2203.01866 . Accepted for publication in *Astronomy & Astrophysics*

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