

# Astronomers detect hydrogen corona of Jupiter's moon Europa

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Jupiter's icy moon Europa. Credit: NASA/JPL-Caltech/SETI Institute

(Phys.org)—Using the Hubble Space Telescope (HST), astronomers have spotted an atomic hydrogen corona around Jupiter's icy moon Europa. The discovery which could improve our understanding of Europa's tenuous atmosphere was published Jan. 13 in the *Astronomical Journal*.

Europa has a thin atmosphere composed mostly of molecular oxygen which is generated from sputtering and radiolysis of the moon's surface ice by impacting magnetospheric ions. While molecular oxygen is the densest component of Europa's atmosphere, the surface sputtering also produces water and molecular [hydrogen](#) at similar rates to molecular oxygen. However, it is known that only the noncondensable [molecular oxygen](#) builds up a near-surface bound atmosphere, while the other sputtering products like water freeze upon surface contact or quickly escape the moon's gravity—which is the case with [molecular hydrogen](#).

In order to reveal more insights on the nature of Europa's atmosphere, a team of astronomers led by Lorenz Roth of KTH Royal Institute of Technology in Stockholm, Sweden, observed this moon in [ultraviolet light](#) with HST between December 2014 and March 2015. Due to the fact that most of the ultraviolet light gets absorbed in the atmosphere, such observations are not possible with ground-based telescopes and must be carried out by space observatories like Hubble.

The far-ultraviolet observational campaign utilizing HST allowed them to obtain images of Europa during its six transits of Jupiter and was focused on detecting localized signals from [water vapor](#). However, the results of these observations turned out to be even more promising than expected.

"The main goal of the observing campaign was actually finding localized signals from water vapor in the ultraviolet hydrogen emission. Yet we found a widely extended and homogeneous cloud of hydrogen around Europa," Lorenz told Phys.org.

The new research confirms the abundance of hydrogen in Europa's global [atmosphere](#) that was predicted in previous studies. In particular, the scientist's analyzed the images constraining atmospheric absorption of Jupiter's Lyman-alpha dayglow above the limb of Europa during the transit. They managed to constrain the abundances of atomic hydrogen in the moon's extended corona and derive upper limits for local water vapor abundances from plume activity.

"The amount of hydrogen we observed was actually expected to exist and ultimately originates from the erosion of Europa water ice surface," Lorenz said.

Although the researchers derived the global abundance of hydrogen, they cannot yet confirm whether the hydrogen corona changes with time or location. They suggest that an uncertainty of about 20 percent of the derived coronal hydrogen density

is based on the differences in the fitted spatial profile of the background dayglow.

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"The fitted densities for the six visits vary by about 20 percent around the average of  $1.85 \times 10^3 \text{ cm}^{-3}$  and the variation exceeds the obtained uncertainties, suggesting an intrinsic variability of the hydrogen corona. We have searched for possible connections of the density variability to changes in either the magnetospheric environment or the orbital true anomaly, but do not find an apparent correlation," the team concluded.

**More information:** Lorenz Roth et al. DETECTION OF A HYDROGEN CORONA IN Ly $\alpha$  IMAGES OF EUROPA IN TRANSIT OF JUPITER, *The Astronomical Journal* (2017). DOI: [10.3847/1538-3881/153/2/67](https://doi.org/10.3847/1538-3881/153/2/67)

### Abstract

We report far-ultraviolet observations of Europa in transit of Jupiter obtained with the Space Telescope Imaging Spectrograph of the Hubble Space Telescope on six occasions between 2014 December and 2015 March. Absorption of Jupiter's bright hydrogen Ly $\alpha$  dayglow is detected in a region several moon radii above the limb in all observations. The observed extended absorption provides the first detection of an atomic hydrogen corona around Europa. Molecular constituents in Europa's global sputtered atmosphere are shown to be optically thin to Ly $\alpha$ . The observations are consistent with a radially escaping H corona with maximum densities at the surface in the range of  $(1.5\text{--}2.2) \times 10^3 \text{ cm}^{-3}$ , confirming the abundances predicted by Monte Carlo simulations. In addition, we search for anomalies around the limb of Europa from absorption by localized high H<sub>2</sub>O abundances from active plumes. No significant local absorption features are detected. We find that an H<sub>2</sub>O plume with line-of-sight column density in the order of  $10^{16} \text{ cm}^{-2}$ , as inferred by Roth et al. would not be detectable based on the statistical fluctuations of the transit measurements, and hence is not excluded or further constrained. The presence of plumes with line-of-sight column densities of  $>2 \times 10^{17} \text{ cm}^{-2}$  can be excluded at a 3- $\sigma$  level during five of our six observations.

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