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Europa's neutral and plasma environment investigated through FUV aurora imaging

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Abstract

Within two recent Hubble Space Telescope (HST) campaigns, Europa's FUV aurora was imaged by Hubble's Space Telescope Imaging Spectrograph (STIS) on 16 days between January 2014 and April 2015. On each day several images of the hydrogen and oxygen emissions were obtained to follow up on the STIS detection of water vapor aurora in December 2012 [1]. We investigate the emission brightness, morphology and time-variability in all images to systematically characterize Europa's FUV aurora. Thereby, we search for influences of the magnetospheric environment on the emission and for potential atmospheric asymmetries like localized water vapor plumes.

1. Introduction

With its subsurface water ocean [2] and relatively young icy surface [3] Europa is generally considered a prime candidate in the search for present-day habitable environments in our solar system. Spectral UV images taken by STIS taken in 2012 revealed first signs of active water vapor plumes at Europa's south pole. The UV images are, however, not only a tool to study the atmosphere and plumes, but also to investigate the plasma environment that significantly affects the electron-excited aurora.

2. Technique

The observations of atomic FUV emissions near Europa provide an excellent opportunity to investigate both the neutral and plasma environment [4,5]. Neutral hydrogen and oxygen in Europa's environment can be observed through electron-excited emissions and solar fluorescence at HI 1216 Å (Lyman-α), OI 1304 Å and OI 1356 Å. In Europa's sputtering-generated global atmosphere that consists mainly of molecular oxygen O_2, electron excited OI 1356 Å emissions are brighter than the OI 1304 Å aurora. Because electron impact on H_2O yields Lyman-α and OI 1304 Å but relatively little OI 1356 Å [6], enhanced emission at Lyman-α and OI 1304 Å are diagnostic for H_2O abundance.

3. Observations

Spatial-spectral observations of Europa were taken by STIS on 16 occasions simultaneously imaging the moon at the HI 1216 Å (Lyman-α), OI 1304 Å and OI 135.6 Å lines. First follow-up HST observations after the plume detection [1] from January and February 2014 were timed to observe Europa near orbital apocenter to test the hypothesis that the plume activity is correlated with the orbital position. No local H and O emissions were detected in these images [7]. Between November 2014 and April 2015 Europa was observed again during 14 visits by Hubble. On four of these occasions Europa was imaged in eclipse, allowing to measure H and O auroral brightnesses in the absence of sunlight.

4. Analysis

We systematically analyze the total brightness of the oxygen emissions and the spatial morphology across the disk. In order to determine the influence of the highly variable plasma environment, which co-rotates with Jupiter's ~10 hour period, we study the

time-variability within the several hour long observing visits. The relative brightness of the two oxygen lines at 1356 Å and 1304 Å will allow to constrain relative abundances of molecular and atomic oxygen. Furthermore, we determine the atmospheric H Lyman-α brightnesses and thereby constrain local H_2O plume abundances in all images.

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References

[1] Roth, L., et al. "Transient water vapor at Europa's south pole." Science 343.6167 (2014): 171-174.

[2] Khurana, K. K., et al. "Induced magnetic fields as evidence for subsurface oceans in Europa and Callisto." Nature 395.6704 (1998): 777-780.

[3] Greeley, Ronald, et al. "Geology of Europa." Jupiter: The Planet, Satellites and Magnetosphere (2004): 329-362.

[4] McGrath, M. A., C. J. Hansen, and A. R. Hendrix. "Observations of Europa's tenuous atmosphere." Chapter in Europa. University of Arizona Press, Tucson 85 (2009).

[5] Saur, J., et al. "Hubble space telescope/advanced camera for surveys observations of Europa's atmospheric ultraviolet emission at eastern elongation." The Astrophysical Journal 738.2 (2011): 153.

[6] Makarov, Oleg P., et al. "Kinetic energy distributions and line profile measurements of dissociation products of water upon electron impact." J. of Geophysical Res.: Space Physics (1978–2012) 109.A9 (2004).

[7] Roth, L., et al. "Orbital apocenter is not a sufficient condition for HST/STIS detection of Europa's water vapor aurora." Proceedings of the National Academy of Sciences 111.48 (2014): E5123-E5132.