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Atmospheres on Callisto composed of sublimated water vapor and its photochemical products

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The parameter space for the very uncertain composition of sublimated H2O and its photochemical products H and H2 in Callisto's atmosphere is examined using the Direct Simulaton Monte Carlo (DSMC) method.

We focus on two significantly different versions of H2O production in which:

(1) the ice and dark, non-ice/ice-poor material are intimately mixed and H2O sublimates at Callisto's warm day-side temperatures (e.g., as in most atmospheric modeling efforts at Callisto to date [1-4]); and

(2) the ice and dark, non-ice/ice-poor material are segregated (e.g., consistent with interpretations of images of Callisto's surface taken by Voyager [5, 6] and Galileo [7]) and H2O sublimates at "ice" temperatures [8].

Our 2D molecular kinetic models track the motion H2O, whose sublimation yield varies several orders of magnitude depending on the description of Callisto's surface, its photochemical products H and H2, and a relatively dense O2 component. Whereas H is assumed to react in the regolith on return to the surface, H2 is assumed to thermalize and re-enter the atmosphere.

We compare the simulated LOS column densities of H to the detected H corona at Callisto [9], which was suggested to be produced primarily by photodissociation of sublimated H2O. Our goal is to use the corona observations to help constrain the source rate for H2O from Callisto’s complex surface.

References

[1] Liang et al., 2005. Atmosphere of Callisto. *Journal of Geophysical Research: Planets*.

[2] Vorburger et al., 2015. Monte-Carlo simulation of Callisto’s exosphere. *Icarus*.

[3] Hartkorn et al., 2017. Structure and density of Callisto’s atmosphere from a fluid-kinetic model

of its ionosphere: Comparison with Hubble Space Telescope and Galileo observations. *Icarus.*

[4] Carberry Mogan et al., 2021 (*under review*). A tenuous, collisional atmosphere on Callisto. *Icarus*.

[5] Spencer and Maloney, 1984. Mobility of water ice on Callisto: Evidence and implications. *Geophysical Research Letters*.

[6] Spencer, 1987. Thermal segregation of water ice on the Galilean satellites. *Icarus*.

[7] Moore et al., 1999. Mass movement and landform degradation on the icy Galilean satellites: Results of the Galileo nominal mission. *Icarus*.

[8] Grundy et al., 1999. Near-infrared spectra of icy outer solar system surfaces: Remote determination of H2O ice temperatures. *Icarus*.

[9] Roth et al., 2017. Detection of a hydrogen corona at Callisto. *Journal of Geophysical Research: Planets*.