OH* prompt emission and near-infrared searches for HDO in the moderately bright comets C/2007 N3 Lulin and 103P/Hartley 2

B. Bonev[1,2], E. Gibb[1,3], G. Villanueva[1,2], M. DiSanti[1,4], L. Paganini[1,2], M. Mumma[1,4], J. Keane[5], K. Meech[5], K. Wright[1,3], E. Sudholt[1,3], and M. Besic[3]

[1]Goddard Center for Astrobiology, NASA GSFC, MS 690, Greenbelt, MD 20771, USA
[2]Department of Physics, Catholic University of America, Washington, DC 20064, USA
[3]Department of Physics & Astronomy, University of Missouri, St. Louis, MO 63121, USA
[4]Solar System Exploration Division, NASA GSFC, Greenbelt, MD 20771, USA
[5]Institute for Astronomy, University of Hawaii, NASA Astrobiology Institute, Honolulu, HI 96822, USA

We report high-resolution spectroscopic searches for deuterated water (HDO) conducted on two comets of moderate brightness: C/2007 N3 Lulin and 103P/Hartley 2. Using the Near InfraRed echelle SPECtrograph (NIRSPEC) at the Keck-2 telescope on Mauna Kea (Hawaii), we targeted some of the strongest HDO transitions at near-infrared wavelengths. Within the free spectral range optimized for the HDO search, we sampled simultaneously a number of lines from OH* vibrational prompt emission, which results from dissociative excitation of H_2O. In contrast to fluorescent emission from OH, which shows a relatively flat spatial distribution, the prompt emission spatial profile peaks at the nucleus and tracks the distribution of water.

Applying improved routines for spectral analysis, we measured line-by- line quantitative emission intensities for OH* simultaneously with HDO, and used them as a proxy for H_2O production, thereby minimizing systematic uncertainties introduced by absolute flux calibration, atmospheric seeing, and temporal variability when the H_2O production is measured separately from HDO. This improved the accuracy of the upper limits for the ratio HDO/H_2O. The H_2O production was also measured directly, using a separate instrument setting. We discuss both the significance and the limitations of our upper limits and compare them to results from astrochemical models that predict the D/H ratio in water at the midplane of the protoplanetary disk from which the solar system formed. Based on the measured instrument performance, we make predictions for the sensitivity of D/H measurements in future infrared searches and parameterize them with the cometary "Figure of Merit" (a measure of IR line brightness) and time on source. Finally, we discuss the relevance of OH* as a proxy for H_2O production, as applied to the searches for HDO (and organics) using the upcoming cross- dispersed high-resolution spectrometer iSHELL at NASA's Infrared Telescope Facility.

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