TERAHERTZ MEASUREMENTS OF HOT HYDRONIUM IONS (H_3O^+) WITH AN EXTENDED NEGATIVE GLOW DISCHARGE

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Terahertz absorption spectroscopy was employed to detect the ground-state inversion transitions of the hydronium ion. The highly excited ions were created with an extended negative glow discharge through a gas mixture of 1 mtorr of H_2O, 2 mtorr of H_2, and 12 mtorr of Ar, which allowed observation of transitions with J and K up to 12. In total forty seven transitions were measured in the 0.9–2.0 THz region and twenty two of them were observed for the first time. The experimental uncertainties range from 100 to 300 kHz, which are much better than those of 0.3–1.2 MHz reported in previous work. Differences up to 25.6 MHz were found between the observed positions and the catalog values that have been used for Herschel data analysis of observations towards Sagittarius B2(N), NGC 4418 and Arp 220.[ab] The new and improved measurements were fit to experimental accuracies with an updated Hamiltonian; and better H_3O^+ predictions are reported to support the proper analysis of astronomical observations by high-resolution spectroscopy telescopes, such as Herschel,[c] SOFIA, and ALMA.

[a] Lis et al., "Hot, metastable hydronium ion in the Galactic center: formation pumping in X-ray-irradiated gas?", *Phil. Trans. R. Soc. A* **370**, 5162 (2012).

[b] González-Alfonso et al., "Excited OH^+, H_2O^+ and H_3O^+ in NGC 4418 and Arp 220", *Astrophys. Astronom* **550**, A25 (2013).

[c] Lis et al., "Widespread rotaional-hot hydronium in the Galactic Interstellar Medium", *Astrophys. J.*, submitted (2014).