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Water masers in the Kronian system

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Abstract

We report a statistically significant detection of 22 GHz water vapour maser emission from the Kronian system [1]. A possibility of molecular masers and lasers in planetary environments was first discussed in [2], and the first detection of the planetary 22 GHz water maser line was made during the Shoemaker-Levy comet collision with Jupiter [3]. Prompted by the recent discovery of a water vapour plume of Enceladus by the Cassini spacecraft [4], we started an observational programme of search for possible 22 GHz water vapour maser emission associated with different objects in the Kronian system. The observations were conducted with the 32 m Medicina radio telescope (INAF-IRA, Italy) and the 14 m Metsähovi radio telescope (HUT-TKK-MRO, Finland) during the 2006-2008 campaign. Approximately 300 hours of observational data were collected using a direct-FFT Spectrometer at Medicina [5] and a locally developed software spectrometer at Metsähovi. The collected spectra were Doppler corrected before accumulation for a multitude of targets presented in the telescope beam. Statistically significant detections were found associated with several Kronian satellites – Titan, Hyperion, Enceladus and Atlas. In this work several maser pumping models, based on water-hydrogen, water-water and water - low energy electrons [5-7] are discussed. They show the consistency of the detected radio lines with the volume and column densities of water molecules in the Enceladus plume [8] and with low-energy electron density in the Kronian environment [9]. We note that the amount of the observational material does not allow us to fully decipher the complexity and richness of the physical processes in the Kronian system and to resolve residual ambiguities concerning the association of the detected lines with certain bodies, especially in potentially transient episodes of the water maser emission. A follow-up observing campaign has already started in order to improve the time coverage, detection levels and ultimately – the corresponding physical models.

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