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Ground-based measurements of Jupiter and Saturn submillimeter spectrum

Juan R Pardo
Consejo Superior de Investigaciones Científicas, Spain

The importance of Solar System planets as possible calibration references at submillimeter wavelengths is obvious due to the rarity of sufficiently strong and well-characterized sources in this region of the electromagnetic spectrum. However, up to date the brightness of the Solar System planets at submillimeter wavelengths has only been measured at a few frequencies with different telescopes either in very narrow bands (typically less than 1 GHz wide) but with high spectral resolution, or in wider bands (several tens of GHz) but without any spectral resolution. For narrow-band observations, accurate absolute calibration is quite often problematic. In order to get large spectral coverage across the millimeter/submillimeter range and enough resolution to reveal spectral features of interest in the atmospheres of the Solar System Giant Planets, a ground-based Fourier Transform Spectrometer (FTS) mounted on the 10.4 m dish of the Caltech Submillimeter Observatory has been used. Using a 1.1 THz low-pass filter for this FTS has allowed the simultaneous observation at all frequencies within the 250-980 GHz range where the spectrum of Jupiter and Saturn was expected to be dominated by the planets' thermal continuum emission and by H2 collision induced continuum-like mechanisms. Three broad rotational lines of phosphine and one rotational line of ammonia should be superimposed on this smooth component, and seen in absorption. The line center of the latter is so close to a strong atmospheric line of ortho-H2O so that it cannot be seen from the ground. However, the wings of this line extend across sufficiently transparent atmospheric windows. Frequency resolutions of the order of 1 to 5 GHz, which are ideal to explore these broad planetary spectral features, are easy to obtain with differential paths l ~2–10 cm in the FTS configuration. The drawback of the experiment is that the calibration is very challenging over such a large frequency band. Several things change significantly over the target frequency range: The convolution of the telescope's beam with the source, the atmospheric transmission curve, and the losses due to imperfections in the telescope's primary dish surface. In this contribution, I will present our work during several years to achieve and reduce all the necessary observations that finally led to first spectra of both Jupiter and Saturn fully calibrated in the 250-980 GHz range, and will compare them with existing radiative transfer models.

Biography

Juan R Pardo has his expertise in millimeter and submillimeter astronomy. He completed his PhD at 28 from Pierre-and-Marie-Curie University. He is a research scientist at the Spanish National Research Council (CSIC) focusing his work on the interstellar and circumstellar media, as well as the Earth and other Solar System Planets' atmospheres. He works at CSIC central headquarters in Madrid.

jr.pardo@csic.es

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