ALMA's Saturn's first direct measurement of the stratospheric winds

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Résumé

The main features of Saturn's atmosphere have been observed mainly by ground and space-based telescopes. These studies include numerous observations by HST in the visible range, which allowed measuring the winds at the cloud top and studysing the tropospheric circulation of the planet. Cassini was able to reveal with a very high spatial resolution Saturn' tropospheric dynamics. As for the cloud-less stratosphere, none of these studies allowed to observe or measure its dynamics. The objective of our study is to measure the stratospheric winds in Saturn using the ALMA interferometer in the submillimeter range. It will allow us to understand the circulation of this atmospheric layer.

To do so, we observed the spectral emissions of CO at 345 GHz and HCN at 354 GHz at the planetary limb, where the emission is the strongest. The probed pressures are in the range of 0.01 to 0.4 mbar for HCN and 0.1 to 3 mbar for CO, which corresponds to stratospheric altitude levels. With the high spatial and spectral resolution of ALMA observations, we measured the Doppler shift caused by the winds in the probed layers by measuring the central frequencies of the emission lines and subtracting the rigid rotation of the planet.

The configuration of Saturn's rings in May 2018 limited our wind observations to latitudes above 20∘S. The zonal winds obtained in the eastern and western limbs are almost symmetrical with a maximum eastward mean velocity of about 340 ± 20 m/s at 10∘S. We most noticeably detected a very large eastward jet that extends from 20∘S to 20∘N with an average

*Intervenant

speed of about 240 ± 20 m/s. This large equatorial jet is perfectly correlated with one seen in the troposphere. Above 20∘N, we measured mostly westward winds with a typical speed of 50 m/s. We also detected a polar jet at 71∘N at pressure levels between 0.01 and 0.4 mbar. This polar jet seems to be correlated with the position of the northern main auroral oval of Saturn. This result reminds us the polar jets detected under the auroral ovals of Jupiter in the stratosphere and which are correlated with the main auroral ovals of this planet.