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A Y-like structure in Jupiter's equator

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Abstract

In this work we are presenting a study of peculiar Y-shaped structures that appeared in the equatorial zone of Jupiter between September and December 2012. These low albedo structures (named Y1 and Y2) were oriented along the equator and centered on it (at latitude 0.5ºto 1ºN). By using images acquired by a worldwide network of observers contributing to the PVOL-IOPW database [3] and operating small telescopes, we have analyzed the morphology of the structures and the surrounding area as well as the dynamical evolution during their lifetime 90 and 60 days respectively. In this period of time convective activity was registered near the vertex of these structures. We have complemented the study with a set of images in ultraviolet and near infrared wavelengths obtained by the Hubble Space Telescope (HST) for this epoch. The features were not visible at 255 nm wavelengths which indicate that they were vertically thin and placed in altitude between the upper Equatorial hazes and the main cloud deck. In addition, they move faster than their surroundings. Finally, we interpret the phenomenon as the manifestation of a transient equatorially trapped Kelvin wave.

1. Introduction

The equatorial region of Jupiter is dominated by an intense and broad eastward jet about 30º wide in latitude (from 15ºN to 15ºS), with two permanent velocity maximums at the north and south boundaries of the Equatorial zone (at 6º) and a central minimum with a velocity of around 60 to 80 ms^{-1} at 0º latitude and a parabolic shape between the north and south jets [1,3 ,5]. Globally, Jupiter's equatorial jet can be seen as a symmetric double jet with maximum velocities peaks of ~ 150 ms^{-1} and a central minimum with a velocity of -70 ms^{-1} (wetsward) relative to the two jets peaks. This structure of the jet was proposed to be the result of a mixture of meridional motions related to Hadley cells and a Kelvin wave [6].

In this paper go over the detection and study of two features appeared in Jupiter's equatorial zone in the last months of 2012 ground-based and HST images. The features had a Y-like shape approximately symmetric with respect to the equator with their vertices aligned and centered on it.

2. Observations

The PVOL-IOPW database is a repository of giant planets observations contributed by an international network of amateur astronomers in the framework of the International Outer Planets Watch Atmospheres node. It stores a large number of images and it allows web-base queries with several criteria [3]. These observations allow a wide temporal coverage of Jupiter and Saturn. The quality of the observations is very variable but some observers obtain images with spatial resolutions down to 0.5'' (1500 km over the Jovian disk at opposition). They provide almost a dayly coverage around the opposition. We complement these observations with a set of images taken by the HST the 19-20 September when the Y1 was present in the atmosphere. This set contains two wavelengths', UV and NIR, images.

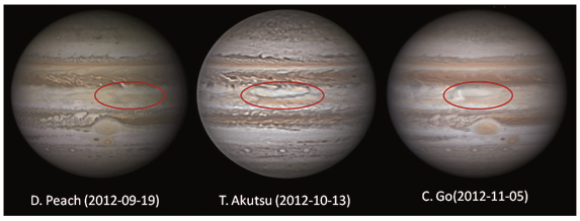

Figure 1: Visual aspect of the "Y" in three IOPW-PVOL data base images. The orientation of the planet is North up East at right.

3. Morphology, evolution and motions

Two Y-shaped structures formed and survived for months in the last quarter of 2012 at Jupiter's EZ. But contrarily to would be expected, turned over, i.e. with the open side of the 'Y' facing the minimum of

the equatorial eastward jet. The first Y feature, Y1, formed in September at 300º of longitude survived for 90 days and traveled with a longitudinal velocity of 99.4 ± 0.1 ms^{-1}. Similarly the second one appeared in October at 100º traveling with a 101.4 ± 0.6 ms^{-1} velocity for 60 days (see Figure 2).

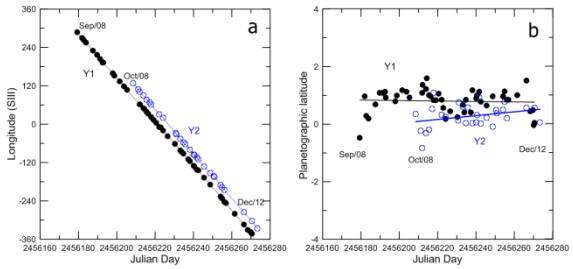

Figure 2: On the right panel we represent the drift of both features during 2012. Left panel shows the small variations suffered by Y1 and Y2 in latitude.

The Y-like structures appeared as a low albedo feature in the RGB compositions and in the HST 763 nm red wavelength images, where we observed that apparently they are moving above the ammonia cloud tops. However, in the HST UV images (255 nm wavelength) there was no evidence of the structures and only a dark patch was observed in the methane absorption band images from PVOL. These two wavelengths are sensitive to the upper atmospheric haze and high features are bright in the methane; therefore these features must be at a lower altitude. Consequently the dark clouds forming the Y-structure must be thin and located somewhere between the lower ammonia cloud and the upper ultraviolet absorbing hazes.

In November some bright spots were detected near to the vertices of Y1 and Y2. It is difficult to establish the lifetime of these spots but it must be of the order of 2-4 days. We were able to measure the area of one of those and noticed that it grew rapidly.

4. Kelvin wave hypothesis

With the aim of clarify the origin of the phenomenon we have explored the hypothesis of explaining this phenomenon as a Kelvin wave. We have used a two layer "shallow water" model [2]. The simulations that we obtain reproduce the main morphology observed in the cloud top and the properties of the Y structures, like its phase velocity when the excited layer is thin. These results suggest the manifestation of an equatorially confined Kelvin wave and its interaction with a Rossby wave.

Acknowledgements

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http://www.pvol.ehu.es/pvol/index.jsp?action=iopw.

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