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First ground observations of Saturn's spokes around 2009 equinox

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Abstract

Since 1980, only spacecraft or space telescope have been able to image spokes (intermittently appearing radial or elongated dark markings in Saturn's B-ring) around the planet equinoxes. Amateur astronomers' observations from Earth have been increasing in quality and coverage since a few years, leading around the 2009 equinox to the first ground observations, with a good coverage of Saturn's rings. Combining these with amateur observations of white spots associated to storms (cf. [1]) can give some hints if the two kinds of events are related.

1. Introduction

Voyager fly-by (cf. [2]), HST sporadic Saturn's observations (cf. [3]) and Cassini limited target time for Saturn B-ring (cf. [4]) provided high-resolution but sparse observations of spokes around 1979, 1994 and 2009 Saturn's equinoxes. Here many amateur astronomers provided a better coverage for the latest equinox, which can be useful for spokes studies.

2. Spokes observations

2.1 Amateur observations

Amateurs use mostly reflectors with an aperture from 15 to 40 cm. Since 2001, their image coverage has been very good 6 months around Saturn's opposition. Images taken by more than 180 observers since mid-2007 have been studied, yielding to 67 candidate observations of possible spokes, usually in visual wavelengths (more often in red), or in near infrared (not more than 830nm long-pass filters).

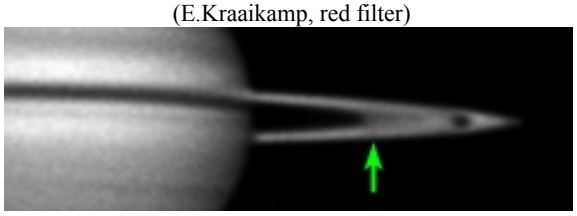
2.2 Measurements

Winjupos software (cf. [5]), used by amateur astronomer associations to measure positions, calculate drifts and produce reports on features evolutions on Jupiter and Saturn (cf. [1]), evolved in 2011 to be able to measure the position of features in Saturn's rings (LIII, longitude in system III and R_s, distance from planet center in Saturn radius).

Candidates observations for spokes have been selected by identifying possible dark features in B-rings turning with the planet on animations made by the observers, excluding over-processed images as artifacts appear rapidly during the processing phase due to high contrasts visible in the rings. These observations have been considered as confirmed if, after measurement, the center of the suspected spoke in at least 2 different images satisfies the following two conditions:
- R_s is between 1.65 and 1.95 R_s (Cassini division) as co-rotation with magnetic field is in B-ring at 1.86 R_s
- LIII between the measures is the same +/-5°

2.3 First spoke ground images

Figure 1: First spoke observation (green arrow)
(E.Kraaikamp, red filter)



A single candidate observation has been found from mid 2007 to end of 2009, but failed the R_s constraints defined above. The first confirmed observations by Emil Kraaikamp on March 3rd 2010, occurred with a small ring tilt (from Earth) of 3,6°.

3. Results

3.1 Spokes

During the 2009-2010 apparition, spokes have been identified at three occasions, with two different spokes on March 10rh, one on April 9th and 22nd.

Table 1: First ground-based spokes observations

Date (UT)	No. of positions	Position / std dev.
2010.03.10	7	59° +/-2° LIII
01h11.1-02h06.5		1,85 +/-0,01 Rs
02h05.0-02h24.5	2	47° +/-1° LIII
		1,82 +/-0,01 Rs
2010.04.09	5	251° +/-5° LIII
22h17-22h58		1,83 +/- 0,06 Rs
2010.04.22	2	340° +/-8° LIII
22h05-23h44		1,75 +/- 0,03 Rs

During the 2010-2011 apparition, from Dec. 23rd 2010 to mid-May 2011, 62 candidate spoke observations (with a ring-tilt between 10.3 and 7.8°) have been identified, from 22 observers. There was also on two occasions simultaneous observations. This data has not yet been measured and studied to confirm the observations, but one finding is that only 4 of them show spokes candidates in the evening B-ring ansae, 59 in the morning ansae.

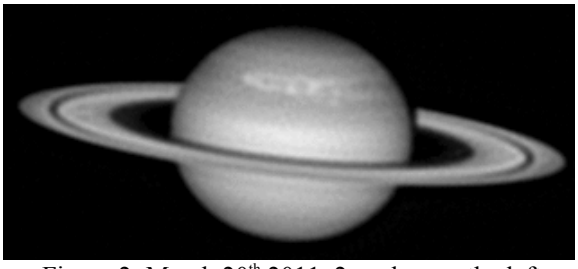


Figure 2: March 20th 2011, 2 spokes on the left (E. Kraaikamp, red filter)

3.2 Storms

During the 2009-2010 apparition, starting on March 4th a white spot, located in Storm Alley (35°S planetocentric latitude) has been observed by amateurs. It rapidly evolved into several bright spots over an extended zone, observed till June 28th, summing up to 107 observations in total.

During the 2010-2011 apparition, a Great White Spot, a one per 30 years event (see [6]), started on Dec. 5th 2010 in the North hemisphere (lying at the equivalent latitude as Storm Alley) and raged during all apparition, covered continuously by amateurs.

4. Possible relation of spokes and storms observation

The first spoke observations beginning in 2010 occurred 6 days after the apparition of a new storm which was then becoming brighter. The other spokes were observed when the storm was separated clearly into two spots. These spokes observations occurred only when the storm was active, with a phase angle around 55°, 45° -125° and -45° LIII.

End of 2010 and in 2011, an extremely high number of spokes candidates have been detected starting when the GWS started to be active. There could be a relation between the exceptional planet-scale event in Saturn atmosphere and the large number of spoke candidates detection.

5. Summary and Conclusions

Around 2009 equinox, amateurs images showed for the first time spokes in B-ring, in the zone co-rotating with the planet's magnetic field, only when white spots related to storm activity in Saturn's atmosphere were observed by amateurs. This shows that the amateur coverage of Saturn atmosphere and ring can have an interest for professional studies of spokes, and their relation to Saturn's atmospheric events.

Acknowledgements

We would like to thank all amateurs who have been providing their images for their time and dedication.

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