EPSC Abstracts
Vol. 6, EPSC-DPS2011-1452, 2011
EPSC-DPS Joint Meeting 2011


# Rotation Periods of Irregular Satellites of Saturn

T. Denk (1), S. Mottola (2), Th. Roatsch (2), H. Rosenberg (1), and G. Neukum (1)
(1) FU Berlin, Germany (Tilmann.Denk@fu-berlin.de), (2) DLR Berlin, Germany

## Abstract

**Rotation periods of six irregular moons of Saturn have been measured as follows: Siarnaq ~06:40 h; Ymir ~07:20 h; Albiorix 13:19±0:08 h; Bebhionn ~16 h; Paaliaq ~19 h; Kiviuq 21:49±0:13 h (*Tab. 1*).**

## 1. Introduction

We observe irregular moons of Saturn with the Imaging Experiment (ISS) of the Cassini spacecraft [1]. Motivation is the determination of basic properties of these objects like rotation periods, polar axes orientations, object sizes and shapes, phase curves, colors, or the search for binaries. This might allow a better understanding of the impact history in the saturnian system including the question about the origin of the irregular moons. Furthermore, a comparison to other solar system objects like asteroids, comets, and KBOs might be done, and the role of the irregular moons related to the color and albedo dichotomies of Iapetus [2] and the reddish color of Hyperion might be constrained in a better way.

The saturnian system harbors at least 62 moons. 38 of these objects are so-called irregular or outer moons of Saturn with semi-major axes of ~11 to ~25 million km. 9 of these move in prograde orbits, 29 are retrograde moons. As seen from the Cassini spacecraft, these moons show best apparent magnitudes of ~10 mag (Albiorix, Paaliaq, Siarnaq) to ~17 mag (Fenrir) (*Fig. 1*). Only Phoebe is significantly brighter (~6 mag). From Earth, again except for Phoebe, these moons are never brighter than ~20 to 24 mag. It would require the use of ~10-m-sized telescopes to obtain data of similar quality.

Observing the irregular moons of Saturn with Cassini ISS offers multiple advantages in comparison to ground-based observations: In most cases, there is no straylight from nearby Saturn, there are no problems with seeing, clouds or other weather effects, and the phase angle range is (in principle) from 0° to 165° (Earth: < 6° only). In addition, the ISS camera is ~60x to ~240x closer to the objects than the Earth is, and long duration observations are possible because there is no 24-h day/night cycle at Cassini. Disadvantages are the relatively small telescope mirror of the Cassini ISS camera (0.17 m), the smaller field-of-view of the ISS resulting in a significantly higher pointing accuracy requirement, and the inability of doing image quality checks and exposure parameter adaptations during data acquisition.

## 2. Results

Measured rotation periods for seven satellites are shown in *Tab. 1*. The values vary significantly: While Siarnaq, with a period of ~6 h 40 min., rotates relatively fast, Kiviuq needs almost 22 h for one day/night cycle.

The quality of the data is very different. It depends on the actual magnitude of the object and the accuracy of the pre-determination of the exposure parameters. Best data sets exist for Albiorix (*Fig. 2*) and Kiviuq, covering full rotations at high signal-to-noise ratios. For Siarnaq, the SNR is relatively low, resulting in a more scattered appearance of the light curve with a less accurate rotation-period determination. For Paaliaq and Bebhionn, the observation times were shorter than the rotation periods, and the derived values are extrapolations from the incomplete light curves. For Ymir, the data look good, but the light curve is not perfectly closed, more data are needed here. For Phoebe, the light curve gives a result consistent to the Bauer *et al.* value [3].

*Fig. 3* shows a plot of the spin rates vs. diameters of the saturnian moons in comparison with ~4000 asteroids. Although the rotation periods of the saturnian moons lie within the values of the asteroids, there is a slight tenendcy that unusually long periods are relatively more common among the saturnian satellites. More observations are needed to get a better idea if this is a real trend. Work is underway to integrate these into the Cassini observation timelines, and more observations are expected to be performed until 2016.

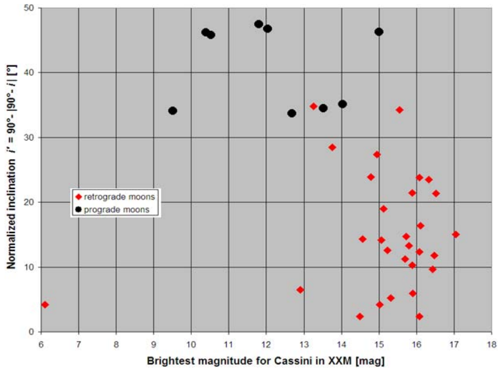


*Fig. 1:* Apparent best magnitude vs. normalized inclination of the irregular satellites as seen from Cassini for the Cassini Solstice Mission ("XXM", "extended extended mission").

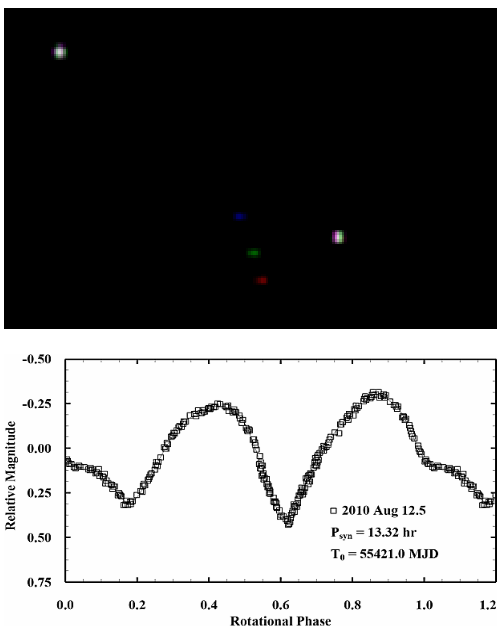


*Fig. 2:* Albiorix image data (above; the colored dots show the object's movement on 12 Aug 2010); and light curve (bottom).

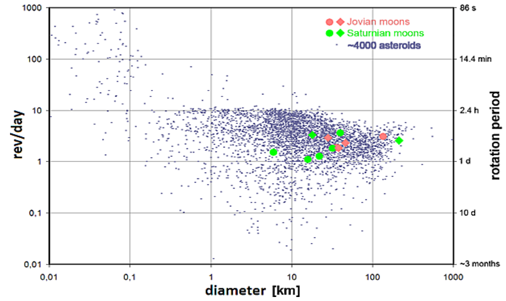


*Fig. 3:* Spin rate vs. diameter for ~4000 objects. Dots indicate prograde, diamonds retrograde moons.

| Object | ID | Size | Obs. time | Rotation period |
|---|---|---|---|---|
| | *Prograde moons* | | | |
| Paaliaq | 620 | 22 | Nov 2007 | ~19 h |
| Kiviuq | 624 | 16 | Aug 2010 | 21:49 ± 0:13 h |
| Albiorix | 626 | 32 | Aug 2010 | 13:19 ± 0:08 h |
| Siarnaq | 629 | 40 | Mar 2009 | ~06:40 h |
| Bebhionn | 637 | 6 | May 2010 | ~16 h |
| | *Retrograde moons* | | | |
| Phoebe | 609 | 213 | Dec 2005 | 09:16.4 h |
| Ymir | 619 | 18 | Apr 2008 | ~07:20 h |

*Tab. 1:* Rotation periods of irregular moons of Saturn. ID is SPICE ID. Sizes are in [km], rotation periods in [hh:mm]. The value for Phoebe is from [3].

## Acknowledgements


We gratefully acknowledge funding of this work by the German Space Agency (DLR) Bonn through grants no. 50OH0305 and 50OH1102.


## References


[1] Porco, C.C. *et al.* (2004): Cassini imaging science: Instrument characteristics and capabilities and anticipated scientific investigations at Saturn. *Space Sci. Rev.* **115**, 363-497.

[2] Denk, T. *et al.* (2010): Iapetus: Unique Surface Properties and a Global Color Dichotomy from Cassini Imaging. *Science* **327**, 435-439.

[3] Bauer, J.M. *et al.* (2004): Recovering the Rotational Light Curve of Phoebe. *Astrophys. J.* **610**, L57-L60.