EPSC Abstracts
Vol. 12, EPSC2018-756, 2018
European Planetary Science Congress 2018

Hydrodynamic Simulations of Asymmetric Propeller Structures in the Saturnian Ring System

Michael Seiler, Martin Seiß, Holger Hoffmann and Frank Spahn
Institute of Physics and Astronomy, University of Potsdam, Germany (miseiler@uni-potsdam.de)

Abstract

Small sub-kilometer sized objects (called moonlets) embedded in the dense rings of Saturn cause density structures due to their gravitational interaction with the surrounding ring material which resemble a propeller, giving the structure its name in this way. The prediction of the existence of propeller structures within Saturn's rings [1, 2] led to their detection [3, 4, 5]. The recurrent observation of the large outer A ring propellers in Cassini ISS images allowed the reconstruction of their orbits. This analysis yielded that the observed propellers are deviating considerably from their expected Keplerian orbit [6]. The offset motion of the largest propeller structure called *Blériot* can be astonishingly well composed by a three-mode harmonic fit [7]. The origin of this offset motion still is on debate. Two hypotheses are in discussion: Whether the moonlet is perturbed resonantly by one or several of the large outer moons [7] or whether it is stochastically migrating [8, 9, 10]. Independent which of these hypotheses is finally correct, the changed orbital motion of the moonlet is effecting the shape of its created propeller structure. Here, we perform hydrodynamic simulations to study the changes of the propeller structure due to a disk-embedded moonlet which is librating around its mean orbital position. We present results showing how the induced propeller structure changes because of the libration of the moonlet and if these changes might be visible in Cassini images. Further, we apply our results to the propeller structures Blériot and Santos Dumont.

Acknowledgements

This work has been supported by the Deutsche Forschungsgemeinschaft (Sp 384/28-2, Ho 5720/1-1) and the Deutsches Zentrum für Luft- und Raumfahrt (OH 1401).

References

[1] Spahn, F., Sremčević, M., Density patterns induced by small moonlets in Saturn's rings?, Astronomy and Astrophysics , 358, 368–372, 2000.

[2] Sremčević, M. et al., Density structures in perturbed thin cold discs, Monthly Notices Royal Astron. Soc. , 337, 1139–1152, 2002.

[3] Tiscareno, M. S. et al., 100-metre-diameter moonlets in Saturn's A ring from observations of 'propeller' structures, Nature , 440, 648–650, 2006.

[4] Sremčević, M. et al., A belt of moonlets in Saturn's A ring, Nature , 449, 1019–1021, 2007.

[5] Tiscareno, M. S. et al., The Population of Propellers in Saturn's A Ring, Astronomical Journal , 135, 1083–1091, 2008.

[6] Tiscareno, M. S. et al., Physical Characteristics and Non-Keplerian Orbital Motion of 'Propeller' Moons Embedded in Saturn's Rings. Astrophysical Journal Letters , 718, L92–L96, 2010.

[7] Seiler, M. et al., A Librational Model for the Propeller Blériot in the Saturnian Ring System, Astrophysical Journal Letters 840, L16, 2017.

[8] Rein, H., Papaloizou, J. C. B., Stochastic orbital migration of small bodies in Saturn's rings, Astronomy and Astrophysics , 524, A22, 2010.

[9] Pan, M. et al., Stochastic flights of propellers, Monthly Notices Royal Astron. Soc. , 427, 2788–2796, 2012.

[10] Tiscareno, M. S., A modified "Type I migration" model for propeller moons in Saturn's rings, Planetary and Space Science 77, 136–142, 2013.