EPSC Abstracts
Vol. 6, EPSC-DPS2011-972-1, 2011
EPSC-DPS Joint Meeting 2011

Dynamics of the small moons perturbed by Mimas

M. El Moutamid (1,2), S. Renner (2,3) and B. Sicardy (1,4,5)
(1) LESIA, Observatoire de Paris, UMR 8109 du CNRS, 5 place Jules Janssen, 92195 Meudon, France
(2) IMCCE, Observatoire de Paris, UMR 8028 du CNRS, 77 avenue Denfert-Rochereau, 75014 Paris, France
(3) Université Lille 1, Laboratoire d'Astronomie de Lille, 1 impasse de l'observatoire, 59000 Lille, France
(4) Institut Universitaire de France, 103 boulevard Saint-Michel, 75005 Paris, France
(5) Université Pierre et Marie Curie, 4 place Jussieu, 75005 Paris, France

Abstract

Images from the Cassini spacecraft recently revealed in the vicinity of the orbit of Mimas the existence of several very small satellites: Aegaeon, Methone, Anthe, Pallene [1, 2, 3]. Pallene shares its orbit with a continuous tenuous ring, and is probably in a third-order 19:16 resonance with Enceladus. By contrast, Methone and Anthe are embedded in arcs, and Aegaeon also orbits within an arc of material near the inner edge of Saturn's G ring. The presence of these three arcs/moons are consistent with their confinement by corotation eccentricity mean motion resonances with Mimas, and recalls the arc's system observed around Neptune interacting through corotation resonances with the satellite Galatea [4]: Aegaeon is trapped in a 7:6 resonance inside the orbit of Mimas, whereas Methone and Anthe are respectively in a 14:15 and a 10:11 resonance outside it [1, 2, 5]. Furthermore, the investigation of the long-term evolution of these satellites shows chaotic motions [6].

Here we study in details the dynamics of Methone, Anthe and Aegaeon, which are also involved in Lindblad and/or secondary resonances with Mimas. Averaged equations are used to analyze the coupling between the resonances. We also perform numerical integrations, using an integrator [7] that takes into account the effects of Saturn's oblateness (up to J_6), modified to compute the variation of geometric orbital elements [8].

We estimate the probabilities of capturing a satellite into one of the corotation eccentricity resonances with Mimas as the orbit of the latter evolves through tidal effects. This follows earlier results concerning the capture into spin-orbit resonances [9].

We will discuss the potential implications of this work, in particular the constraints it may provide on Mimas' orbital evolution.

References

[1] Cooper, N.J., Murray, C.D., Evans, M.W., et al.: Astrometry and dynamics of Anthe (S/2007 S4), a new satellite of Saturn, Icarus 195, 765-777, 2008.

[2] Hedman, M.M., Cooper, N.J., Murray, C.D., et al.: Aegaeon (Saturn LIII), a G-ring object, Icarus 207, 433-447, 2010.

[3] Porco, C.C., and 24 colleagues: Cassini Imaging Science: Initial results on Saturn's rings and small satellites, Science 307, 1226-1236, 2005.

[4] de Pater, I., Gibbard, S.G., Chiang, E., et al.: The dynamic neptunian ring arcs: evidence for a gradual disappearance of Liberté and resonant jump of Courage. Icarus 174, 263-272, 2005.

[5] Hedman, M.M., Murray, C.D., Cooper, N.J., et al.: Three tenuous rings/arcs for three tiny moons, Icarus 199, 378-386, 2009.

[6] Callegari, N. and Yokoyama, T.: Long-term dynamics of Methone, Anthe and Pallene, Proceedings of the International Astronomical Union, IAU Symposium, Volume 263, 161-166, 2010.

[7] Chambers, J.E.: A hybrid symplectic integrator that permits close encounters between massive bodies. Mon. Not. R. Astron. Soc. 304, 793-799, 1999.

[8] Renner, S. and Sicardy, B.: Use of the geometric elements in numerical simulations, Celest. Mech. 94, 237-248, 2006.

[9] Goldreich, P. and Peale, S.: Spin-orbit coupling in the solar system, Astron. J. 71, 425-438, 1966.