Transactions IAU, Volume XXVIIA
Reports on Astronomy 2006–2009
Karel A. van der Hucht, ed.

doi:10.1017/S1743921308025337

DIVISIONS I-III / WORKING GROUP NATURAL PLANETARY SATELLITES

CHAIR **Jean-Eudes Arlot**
MEMBERS **Kaare Aksnes, Carlo Blanco, Nikolaj V. Emelianov, Robert A. Jacobson, George A. Krasinsky, Jay H. Lieske, Dan Pascu, Michel Rapaport, Mitsuru Sôma, P. Kenneth Seidelmann, Donald B. Taylor, Roberto Viera-Martins, Gareth V. Williams**

TRIENNIAL REPORT 2006 - 2009

1. Activities of the Working Group on Natural Planetary Satellites

The main goal of the Working Group was to gather astrometric observations made during the triennum as well as old observations not yet published in the data base. The WG encouraged the making of new observations. A Spring School was organized in China in order to teach the observational techniques of natural satellites to students and young astronomers. New theoretical models of the motion of the satellites and fit of the current models to new observations were used in order to make ephemerides of all the planetary satellites with tools useful for observations such as configurations. These ephemerides named MULTISAT are available at `<www.imcce.fr/sat>` or at `<lnfm1.sai.msu.ru/neb/nss/nssephme.htm>`.

Original ephemerides are also available on JPL's Horizons ephemerides and on MPC ephemerides for irregular satellites. A workshop has been held in Paris in November 2006 for organizing campaigns of observations. The problem of a standard format for the astrometric observations of the natural satellites raised and will have to be solved during the next triennum.

2. Selected works performed during the triennum

2.1. *The Martian satellites*

The data from MEX and MGS were analysed and information on the tidal dissipation within Mars were deduced from observation of the shadow of Phobos on Mars (Bills *et al.*, *J. Geophys. Res.*, 110, E7, 7004). Numerically integrated orbits for Phobos and Deimos were produced from fits to all observations including MEX and MGS (Lainey *et al.*, *A&A*, 465, 1075; Jacobson, LPI Contribution 1377). Jacobson's orbits were produced in support of the MRO Project and incorporated MRO imaging observations as well.

2.2. *The Galilean satellites*

Observations of the 1997 mutual events were published (Arlot *et al.*, *A&A*, 451, 733) and astrometric data were deduced from these photometric observations (Emelyanov &

Gilbert, *A&A*, 453, 1141). A new theory was published (Lainey *et al.*, *A&A*, 456, 783) and studies have been made on the tidal dissipation in Io (Lainey & Tobie, *Icarus*, 179, 85), on the rotation of Io and Europa (Henrard, *Icarus*, 178, 144; *Cel. M&DA*, 91, 131; 93, 101) and on the free and forced obliquities of the Galileans (Bills, *Icarus*, 175, 233).

2.3. *The inner satellites of Jupiter*

Several papers were published on Amalthea after the fly-by of Galileo on the gravity field (Weinwurm, *Adv. Sp. Res.*, 38, 2125) and on the density of Amalthea (Anderson *et al.*, *Science*, 308, 1291). Results were obtained from *Cassini* observations (Cooper *et al.*, *Icarus*, 181, 223).

2.4. *The outer satellites of Jupiter*

Observations were reported (Veiga, *A&A*, 453, 349). New orbits were calculated using all observations (Emelyanov, *A&A*, 435, 1173). The mass of Himalia was determined from perturbations on other satellites using ground-based observations (Emelyanov, *A&A*, 438, L33). Theoretical works were performed on an analytical theoretical model (Beauge' *et al.*, *AJ*, 131, p. 2299) and the dynamical evolution of this family of satellites (Christou, *Icarus*, 174, 215).

2.5. *The main satellites of Saturn*

The data of the Cassini probe provide many results on the gravity field, the shape (Jacobson *et al.*, *AJ*, 132, 711; 2520). Star occultations by Titan were reported (Sicardy *et al.*, *JGR*, 111, S91) as astrometric observations by the *HST* (French *et al.*, *PASP*, 118, 246). A new analysis technique for mutual events data was published (Ramirez *et al.*, *A&A*, 448, 1197) as a new image-processing technique for astrometry (Peng, *MNRAS*, 359, 15, 97).

2.6. *The faint inner satellites of Saturn*

The hypothetical satellites seen by Cassini led to study of their stability (Mourao *et al.*, *MNRAS*, 372, 1614). New orbits of the inner satellites have been deduced from *Cassini* and old observations (Spitale *et al.*, *AJ*, 132, 692; Jacobson *et al.*, *AJ*, 135, 261). The orbit of the newly discovered satellite Anthe was fit to *Cassini* data (Cooper *et al.*, *Icarus*, 195, 765).

2.7. *The outer satellites of Saturn*

A new orbit of Phoebe was calculated using all the available observations (Emelyanov, *A&A*, 473, 343). An analysis of albedo was made using Cassini data (Porco *et al.*, *Science*, 307, 1237) as spectrophotometry, useful to characterize the families of satellites and their formation (Buratti *et al.*, *Icarus*, 175, 490).

2.8. *The satellites of Uranus*

Astrometric observations of the main satellites were performed (Izmailov *et al.*, *Solar System Res.*, 41, 42), of Puck (Veiga & Bourget, *A&A*, 454, 683), mutual events were predicted (Arlot *et al.*, *A&A*, 456, 1173; Christou, *Icarus*, 178, 171)) and observed (Hidas *et al.*, *MNRAS*, 384, 38). Satellites U-12 to 17 have been named (CBET 323, 2005). New ephemerides for the main satellites were produced from fits to all but the mutual event data (Jacobson, *BAAS*, 39(3), 453).

2.9. *The satellites of Neptune*

Astrometric observations of Triton were performed (Qiao *et al.*, *MNRAS*, 376, 1707) as predictions of eclipses of Nereide (Mallama, *Icarus*, 187, 620). Constraints on the orbital

https://doi.org/10.1017/S1743921308025337 Published online by Cambridge University Press

evolution of Triton was published (Matija & Gladman, *ApJ*, 626, 113) and a study has been made of the disturbing function on the inner satellites (Yokoyama, *Adv. Sp. Res.*, 36, 569) followed by the modelling of the precession of the equator of Neptune (Nascimento *et al.*, 35th COSPAR Scientific Assembly, 18–25 July 2004, Paris, France).

New ephemerides for Triton, Nereid, and Proteus were produced by fitting all observations through the opposition of 2007 (Jacobson, *BAAS*, 40(2), 296). NOTE: Qiao's observations contain systematic errors and are unusable.

2.10. *The satellites of asteroids*

These objects are in fact binary or triple objects, the center of mass of the system being not inside the largest object. Nowadays a lot of binary (or triple) systems have been discovered. No data base of astrometric observations is available and no ephemeris is published.

2.11. *The rings*

The rings of the giant planets have been extensively observed by the space probes *Galileo* and *Cassini* and also by the *HST*. The dynamics are studied and the systems ring-moon have also been studied. The ring-moon system of Uranus has been studied (Showalter & Lissauer, *Science*, 311, 973; Gibbard *et al.*, Icarus, 174, 253).

2.12. *Miscellaneous*

The observability of the Natural Planetary Satellites has been explored by Tanga & Mignard (Proc. *Gaia* Symposium, Paris, 2004). The capture of irregular satellites of the giant planets has been studied (Nesvorny *et al.*, *AJ*, 133, 1962) as their chaotic behaviour (Mel'Nikov & Shevchenko, *Solar System Res.*, 39, 322).

Jean-Eudes Arlot
chair of the Working Group