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DIVISION III PLANETARY SYSTEMS SCIENCES

SCIENCES DES SYSTÈMES PLANETAIRES

Division III's activities focus on a broad range of astronomical research on bodies in the solar system (excluding the Sun), on extrasolar planets, and on the search for life in the Universe.

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DIVISION III COMMISSIONS

Commission 15	**Physical Study of Comets and Minor Planets**
Commission 16	**Physical Study of Planets and Satellites**
Commission 20	**Positions and Motions of Minor Planets, Comets and Satellites**
Commission 21	**Light of the Night Sky**
Commission 22	**Meteors, Meteorites and Interplanetary Dust**
Commission 51	**Bioastronomy**
Commission 53	**Extrasolar Planets**

DIVISION III SERVICE

Division III WG	**Minor Planet Center**

DIVISION III WORKING GROUPS

Division III WG	**Committee on Small Bodies Nomenclature**
Division III WG	**Planetary System Nomenclature**

INTER-DIVISION WORKING GROUPS

Division I-III WG	**Cartographic Coordinates and Rotational Elements of Planets and Satellites**
Division I-III WG	**Natural Satellites**

TRIENNIAL REPORT 2006 - 2009

1. Division III structure

There have been some changes to the structure of Division III. This triennium, Division III is pleased to welcome the new Commission 53 on *Extrasolar Planets*, formed at the Prague General Assembly. Commission 51 has changed its name to form Bio-Astronomy to *Bioastronomy*. The Division's Working Group on Near-Earth Asteroids has now become a working group of the Executive Committee, and has changed its name to *Hazards of Near-Earth Objects*. Division III's Working Group on *Natural Satellites* is now a joint working group with Division I. Note that the report of the other Division I–III joint working group (on *Cartographic Coordinates and Rotational Elements of Planets and Satellites*) is given in Division I's report. In terms of membership, Division III, with more than 1 000 members, is the third largest of the twelve IAU Divisions.

2. Division III developments within the past triennium

Much of the Division's activity has centered on the ramifications of the definition of a planet, as adopted at the IAU XXVI General Assembly in Prague. Discussion and action have mainly involved the Division's Board, the CSBN, and the WG-PSN (see also the reports of the CSBN and WG-PSN).

Of concern soon after the Prague General Assembly was the naming of dwarf planet (136199) 2003 UB_{313} and its satellite. Following requests by the discoverers, the former was named *Eris*, and the latter *Dysnomia*. Being only the third named dwarf planet, prior discussion involved the Division Board, the CSBN, and the WGPSN. An IAU press release in September 2006 led to much media coverage.

Dwarf planet terminology led to two separate discussions. Because of the grammatical inconsistency of a dwarf planet not being a planet (whereas, for example, a dwarf star *is* a star), there was an attempt to find a single word for dwarf planet. Candidate words *nanoplanet* and *subplanet* were discussed at length, but there was no consensus to approve either. The view that the term dwarf planet is now embedded in the public's consciousness appeared to win the day. The remaining discussion concerned finding another term for 'transneptunian dwarf planet'. As the CSBN's report notes, this discussion derived from the footnote to the Prague General Assembly's Resolution 6. The CSBN, after long discussion, settled on the word *plutoid*, and this word was adopted by the IAU Executive Committee at its May 2008 meeting on the recommendation of Division III's president. Unfortunately, in part because of an email miscommunication, the WG-PSN was not involved in choosing the word *plutoid*. The WG-PSN wishes to record that it did not take part in the process of accepting the term *plutoid* for a transneptunian dwarf planet. In fact, a vote taken by the WG-PSN subsequent to the Executive Committee meeting has rejected the use of that specific term. Thus, the views of its members were seriously misrepresented at the Executive Committee meeting and in the subsequent IAU press release in June 2008.

Because of perceived urgency in the naming of the large transneptunian objects (136472) 2005 FY_9 and (136108) 2003 EL_{61}, the Executive Committee decided at its May 2008 meeting to adopt the following recommendation: *Any solar system body having (a) a semimajor axis greater than that of Neptune, and (b) absolute magnitude brighter than $H = +1$ mag shall be considered for naming purposes to be a dwarf planet and named jointly by the WG-PSN and CSBN. Name(s) proposed by the discoverer(s) will be given deference.*

Note the following: An essential phrase to bear in mind is 'for naming purposes'. It is not the intention to declare that a body having $H < +1$ mag *is* a dwarf planet. The lower diameter limit of a body having $H = +1$ mag and geometric albedo $p = 1.0$ is $D = 850$ km. For $p = 0.65$ (like Pluto-Charon), $D = 1050$ km, and for very low $p \simeq 0.03$, $D \simeq 5000$ km. While it is likely that all solar system bodies having $H < +1$ mag are dwarf planets, one cannot at this time be certain (see Section 4 for remarks on quantifying the IAU definitions of planet and dwarf planet).

The issue of merging two pairs of Commissions (Commissions 15 and 20; and Commissions 21 and 22), mooted at the Prague General Assembly, has been discussed, but no recommendations have been developed at this time (July 2008).

3. Division III science highlights

In this section, we give thumbnail sketches of the Commissions and Working Groups that comprise Division III, and we highlight the principal scientific advances since 2006.

3.1. *Commission 15 on Physical Study of Comets and Minor Planets*

The Commission's work concerns asteroids, transneptunian objects, and comets. The *Deep Impact* and *StardustNExT* missions have returned results concerning mixing in precursor materials that formed small bodies. An unprecedented international coordination resulted in many of the world's telescopes being focused on the *Deep Impact* event. The impact showed the nucleus of 9P/Tempel 1 to be extremely porous, with a density of about 350 kg/m^3. Ice is close to the surface, but below a devolatilized layer of dust. Another notable event was the disintegration of P/Schwassmann-Wachmann 3 in 2006, the huge brightness outburst of 17P/Holmes in 2007, and a close approach of comet Tuttle, which allowed Doppler radar imaging of the nucleus. The Japanese spacecraft *Hyabusa* found the surface of asteroid (25143) Itokawa to be covered in boulders without regolith.

3.2. *Commission 16 on Physical Study of Planets and Satellites*

A broad array of observational and theoretical work, from both groundbased and space-based observations, constitutes the Commission's interest. Mercury *Messenger* flew by Mercury in January 2008. The spacecraft sampled the rich plasma environment, and found that many of the species represent the first look at Mercury's surface chemistry. Mercury's magnetic field is produced by an active dynamo in the outer core. Further, the dominant tectonic landforms, lobate scarps, indicate that cooling of the core was 1/3 greater than previously believed. Groundbased explorations of new terrains on Mercury have been made, especially at the planet's north pole. A new measurement of Mercury's libration parameters has resulted from radar speckle displacement interferometry, and implies a liquid phase in the planet's core. The *Cassini-Huygens* mission to the Saturn system (currently in extended mission mode) has greatly increased our knowledge of Saturn's atmosphere, and of the surfaces and atmospheres of some of its satellites. Titan's surface morphology has been mapped in detail, and water-vapor vents on Enceladus have been discovered.

3.3. *Commission 20 on Positions and Motions of Minor Planets, Comets and Satellites*

Dynamics and ephemerides of asteroids and comets are the purview of Commission 20. The exponential increase of asteroid astrometry has led to the continued growth in number and quality of asteroid orbits, both osculating orbits and proper elements. There are now more than 189 000 numbered asteroids. Research on the Yarkovsky effect continues apace, and a particularly elegant application of the effect led to the hypothesis that collisional disruption of the parent body of (298) Baptistina 160 My ago led to a long-term

enhancement in Earth's asteroid impact flux and to the source of the Cretaceous-Tertiary impactor 65 My ago.

3.4. *Commission 21 on Light of the Night Sky*

The Commission's work concerns the study of the various components making up the light of the night sky, as seen from both Earth and space. These components include airglow and tropospheric scattering in Earth's atmosphere, the zodiacal light, the Milky Way's integrated starlight, scattered light from the diffuse interstellar medium, and the cosmic microwave background. Since 2006, the most significant research has concerned continued analysis of sky maps from the *Cosmic Background Explorer* - Diffuse Infrared Background Experiment (*COBE*-sc dirbe) and cosmic microwave background data from the *Wilkinson Microwave Anisotropy Probe* (*WMAP*). Thanks to such data, our understanding of the time since the big bang, the Hubble parameter, and the space-time geometry of the universe has made unprecedented leaps.

3.5. *Commission 22 on Meteors, meteorites and Interplanetary Dust*

The very smallest bodies in the solar system, along with their interactions with planets, are the focus of the Commission's work. The most important recent scientific highlight concerned the Carancas meteorite impact in Peru in September 2007. During the present triennium, advances have been reported at several international meetings. Topics have included the formation of meteoroid streams by active or dormant comets and asteroids, the dynamics of meteoroids, meteoroids as a space hazard, the coming of age of the techniques of infrasound and radar detection of meteors, and the discovery of new meteor streams. In addition, there has been good progress made on professional-amateur cooperation in meteors, and on meteor shower nomenclature.

3.6. *Commission 51 on Bioastronomy.*

The Commission focuses on the search for planets orbiting extrasolar stars, the search for extraterrestrial technological signals, the search for biologically relevant interstellar molecules and an investigation of the chemical pathways for their formation, the investigation of detection methods for evidence of biological activity, and means of defining habitability and habitable environments within our solar system.

3.7. *Commission 53 on Extrasolar Planets.*

This newly established Commission focuses on the search for and characterization of extrasolar planets, their formation and evolution, and the study of individual extrasolar planets' internal structure and atmospheres. Recently, a number of extrasolar planets in the Earth-Neptune mass range have been found. Transit search observations, both from the ground (for example, the HAT Network and WASP) and space (*COROT*, *Spitzer*) have matured greatly. There now exist a number of accurate mean density determinations, direct measurement of a few surface temperatures, and first results on exoplanet spectra. A working definition of exoplanets has been proposed.

3.8. *Committee for Small Body Nomenclature (CSBN).*

The Committee continued its work of naming comets (701 newly named in the past three years), asteroids (2228), and asteroid satellites (4). The CSBN has also been working to refine its guidelines for naming asteroids.

3.9. *Working Group on Planetary System Nomenclature (WG-PSN).*

The Working Group approves names of natural planetary satellites and surface features on all solar system bodies except Earth. Through a *Gazetteer of Planetary Nomenclature*,

it establishes and maintains a list of new names, based on established guidelines. In the current triennium, the WG-PSN has approved 22 new satellite names and 259 new surface feature names. The Working Group has also clarified the definition of divisions and gaps in planetary rings.

3.10. *Working Group on Cartographic Coordinates and Rotational Elements of Planets and Satellites.*

The Working Group is responsible for recommending models of the orientations and shapes of the Sun, planets, natural planetary satellites, asteroids, and comets. The Working Group's report is given in full under Division I.

3.11. *Working Group on Natural Satellites.*

The Working Group's main goal is to encourage and gather astrometric observations, old and current, of planets, their natural satellites, and planetary rings; and to model those observations so as to provide accurate ephemerides and, where possible, to interpret orbital evolution. This triennium, significant progress has been made in almost all aspects of the WG's work. The *Galileo* and *Cassini-Huygens* missions have proved a rich source of data.

4. Anticipated Division III activity (2008 – 2009)

Two Division III Task Groups will be established. Their goal will be to quantify two of the components of the Prague GA's definition of a planet, as given in Resolution 5A; namely, that a planet has 'cleared the neighborhood around its orbit'; and that both planets and dwarf planets are sufficiently massive that their self gravity has overcome rigid body forces so they assume near-spherical shapes (are in near-hydrostatic equilibrium). At the time of the Prague GA, there were no (known) refereed publications that centrally addressed the above two criteria. Since then, Soter (2006, *AJ*, 132, 2513) has discussed planetary orbit clearing by accretion and ejection of lesser bodies; and Tancredi & Favre (2008, *Icarus*, 195, 851) have quantified the lower diameter limits for icy and rocky dwarf planets. The two TGs need to work in concert so they can try to agree on the lower mass limit for planets and the upper mass limit for dwarf planets. It is anticipated that the TGs will present their reports to Division III at the IAU XXVII General Assembly in August 2009.

5. Division III meetings at the IAU XXVII General Assembly

We are pleased to report that Division III's interests will be served by an Invited Discourse at the IAU XXVII Genaral Asembly in Rio de Janeiro, 2009. The tentative title is 'Water on planets'.

One of six 2009 IAU GA Symposia has been proposed by Division III members: IAU Symposium No. 263 on *Icy bodies of the solar system* is supported by Commisions 7, 15, 20, 22, and 51; and is to be co-chaired by H. Campins (USA), S. Ferraz-Mello (Brazil) and R. M. Schulz (Netherlands).

One of eight 2009 GA Special Sessions was jointly proposed by Divisions III and XII and supported by Commissions 16, 51, 53, and 55. The working title is *Planetary systems as sites for other life.*

Edward L. G. Bowell
president of the Division