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DIVISION III: PLANETARY SYSTEMS SCIENCES
(SCIENCES DES SYSTEMES PLANETAIRES)

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: Search for Extraterrestrial Life

1. Introduction

The Division III activity in the triennial period since the time of GA XXIV in Manchester run in various aspects involving both scientific and business matters. The business of IAU Division III is normally carried out by its President and a Board, which consists of the current Presidents of the Commissions in the Division plus additional individuals for a total of 12 members. It is understood that the Commission Presidents may consult the members or organizing committees of their Commissions on divisional matters as they deem appropriate. Meetings of the entire membership of the Division are held at each General Assembly. The first such meeting was held at GA XXIV in Manchester and it approved the current plan of organization. The current Board was the first to be formed under the plan of organization adopted at the 24th GA. It was elected by Division III during GA XXIV.

In the scientific area, the focus was placed in organizing through the respective divisional Commissions and supported bodies symposia and colloquia in the years 2000 through 2002, as well as planning scientific events during GA XXV. In the business area, there were discussions of some current issues with an intention to be better prepared for more thorough discussions and (when necessary) making decisions during the forthcoming Commission/Division business meetings which are scheduled to be held during GA XXV. Divisional Working Groups (CBSN, WGPSN, and WGESP) continuously performed business in their respective fields of small bodies and distant bodies naming, names assignment to the new discovered planetary satellites and planetary surface features, and collecting data on the new discovered extrasolar planets. The Board evaluated in detailed the Commission's proposals on meetings to be organized before requesting EC endorsement to have it as an IAU event, working in permanent contact with the IAU GS, AGS, and Secretariat.

It is appraised that all divisional meetings, having large numbers of supporting commissions, were a great success and confirmed the dynamic character of the Division. They were mostly interdisciplinary in their character dealing with outstanding subjects from the series that requires frequent updating. Everyone had excellent scientific rationale addressing coherently the hot problems of planetary sciences and astrophysics, and some with involvement of contemporary biology.

Below the most important issues of the Commission/WG activities are summarized, and these are described in more detail in their respective Reports.

2. Physical Studies of Comets and Minor Planets

Scientific activity in the field of the Commission responsibility has been very intense in the past three years, and led to publication of a large number of papers. This is a good indication of the activity in planetary sciences, in particular that concerning small bodies. An impressive amount of papers was published. The comprehensive list of references is available from the Commission 15 web page, which can be reached via a link from the IAU home page. The ongoing activity can be summarized as follows.

In the field of asteroid science and their connections to meteorites, a number of very important achievements were made. Space missions have produced a wealth of exciting new data. The population of near–Earth asteroids has been extensively investigated due to the increasingly wide recognition of the existence of an impact hazard. The role of thermal emission in affecting the rotational and orbital properties of small bodies has been extensively recognized. The physical properties of families and their evolution since the time of their formation has been a hotly debated subject. The discovery of hydration features in the spectra of M–class asteroids has opened exciting new problems. Radar experiments have produced excellent new results at an increasing rate, and both radar and adaptive optics have led to the discovery of many new binary systems among asteroids. Significant results were derived on the problems of: Asteroids size distributions, masses and densities; Photometry, shapes, disk–resolved images, rotations, and pole orientations; Radar, thermal infrared, and optical polarimetry; Spectra, taxonomies, and compositions; Study of binaries and dynamical families; Origins, impacts, orbital and collisional evolution; NEOs, Trojan asteroids and physical characteristics of outer objects of the solar system; The asteroid–meteorite connection and possible survival of life on asteroids and other minor bodies. Special attention was given to the main belt asteroid observations with ISO and asteroids visited (or to be visited) by spacecraft.

In the field of comet science it is emphasized that the very bright comets (C/1995 O1) Hale–Bopp and (C/1996 B2) Hyakutake still were major topics of cometary research. A second conference (IAU Colloquium 186 "5 Years after Hale–Bopp: Progress in Cometary Science", 21–25 January, 2002, Santa Cruz, Tenerife, Canary Islands, Spain) with support of Commissions 20 and 34, concentrating on Hale–Bopp, attempted to summarize these efforts. It was the main–stream cometary science involving many new results, including explanation of X–ray emission from comets, new phenomenology in the splitting of comets, a better understanding of the mixing of comets from different origin, etc. The exceptional activity and the early detection of comet Hale–Bopp as well as the coincidence with the operational phase of the Infrared Space Telescope resulted in a major step forward in the detection and observation of chemical compounds. The program was nicely coordinated to minimize the overlap with July 2002 Berlin (triennal) meeting also dealing with small bodies. Both meetings significantly advanced various challenging topics which have been discussed.

The Deep Space 1 mission passed comet 19P/Borrelly and images were taken of an elongated, 8 km long cometary nucleus with a resolution of about 100 m over an extended range of phase angles. The Stardust mission to comet 81P/Wild 2 is on its way to collect a coma sample and to return it to Earth. The comet fly–by mission Contour failed shortly after launch and a further Deep Impact mission will drop a mass of 350 kg into the nucleus of comet 9P/Tempel 1 during a fly–by in July 2005. The ESA cornerstone mission Rosetta is to be launched in January 2003 to rendezvous with comet 46P/Wirtanen in late 2011 after passing the asteroids 140 Siwa and 4979 Otawara.

The following areas of cometary study were specially addressed: nucleus observations and modeling; cometary gas coma including high resolution spectra over the entire visible wavelength; dust coma and tail involving observations at visible and infrared wavelengths to derive dust nature and size distribution; fragmentation and splitting (breakup) of comets. Certainly, special attention was paid to comet Hale–Bopp, in particular interpretation of the dust/gas coma images, rotation and activity covering a range of heliocentric distances of 1–7 AU, and composition mainly derived through emission lines at infrared and radio

wavelengths that resulted in more than 20 molecules (neglecting ions and isotopes) detected in the coma. Another impressive finding was the 500th SOHO comet discovered in August 2002 with the Large Angle Spectrometric Coronagraph (LASCO), and most of the objects are sungrazing comets. These and other relevant results, as well as general prospects for the cometary physics and solar system origin, will be thoroughly discussed at the forthcoming two meetings accepted by the EC as the Commission/Division III proposal for the scientific program of the forthcoming GA XXV in Sydney. These are two Joint Discussions: JD 14 "Formation of Cometary Material" and JD 19 "Physical Properties and Morphology of Small Solar System Bodies".

3. Physical Study of Planets and Satellites

During the report period the web page for Commission 16 was put on line. In addition to a description of the work and list of officers of the Commission, the web site contains the minutes of the business meeting held in Manchester, the Triennial report for 1998–2000, and links to other commissions and working groups. The respective web site was established and it is maintained.

Following a pattern established earlier, the Commission has undertaken to write its triennial report for the period 2001–2003 with the contributions of a number of experts in areas in which notable progress is being made. Thirteen individuals have contributed to the triennial report in the current cycle.

Planetary exploration continues with a number of missions in progress or in an advanced state of development. The extended mission of the Galileo spacecraft in orbit around Jupiter significantly contributed to the study of the planet (atmospheric composition, circulation, lightning, and aurora) and has made many close passes of the large satellites, with new images of the surfaces (volcanic eruptions on Io, surface structures on the icy satellites, etc.) and results on their interior structure. The Cassini spacecraft made its data–collecting flyby of Jupiter in December, 2000, and will go into orbit around Saturn (July, 2004) with a probe entering the atmosphere of Titan at about the same time. Results of the flyby of Jupiter include highly detailed observations of atmospheric dynamics. These new results can be integrated with the Galileo results on the motions of Jupiter's atmosphere. Continued analysis and interpretation of the Galileo probe into Jupiter's atmosphere have yielded two different views of the composition and vertical structure of Jupiter's atmosphere. In addition, bold new models of the Jovian hot spots have been formulated.

Titan is a principal focus of the Cassini–Huygens mission, with the Huygens entry probe, extensive radar mapping, imagery, and spectroscopy forming much of the scientific program of the project. New Earth–based results on Titan, its surface and atmosphere continue to emerge from an increased pace of studies by many investigators on the eve of Cassini–Huygens.

Continued study of the results of the Magellan radar mapping mission to Venus has yielded two distinctly different views of the age of Venus' surface. This subject is of broad interest because it is intimately related with the history of Venus and evolutionary processes responsible, in particular, for the formation of its peculiar atmosphere and heat budget. The Mars Global Surveyor continues to provide high–resolution view of the planet's surface, and the Mars Odyssey spacecraft began to return significant amounts of data. Important new thinking on vital issues of recent volcanism and the presence of water on Mars' surface are among the hot topics of the planetary sciences.

A great many satellites of the outer planets have been found by extensive observational surveys in the last few years through international collaborations of astronomers in Europe, South America, and Hawaii, and a summary of the statistics and dynamical groupings that are emerging as the new discoveries continue is of great importance.

Pluto and Charon form a binary planet–satellite at the edge of the planetary zone of the Solar System. With the latest knowledge of Pluto–Charon relating these objects to the vast Kuiper disk, the New Horizons for Pluto–Kuiper Belt mission are opened that is now under

advanced study. A NASA mission to Pluto–Charon and beyond to one or more objects in the Kuiper Belt has been selected for a hoped–for launch in 2006 and arrival in 2016. Pluto–Charon are truly the gateway to the Kuiper Belt, and their surfaces are expected to record the dynamical activity of collisions in this newly discovered great geographic region of the Solar System.

Commission 16 served as the sponsoring Commission for IAU Colloquium 189, Astrophysical Tides in 2002 in Nanjing, China, proposed by Iwan Williams (GB) and supported also by Commissions 7, 15, 19, and 20. A tidal effect is defined to be the effect caused by variation in the gravitational field across a finite sized body and so it can play a role in a wide range of problems in astrophysics. The aim of the "Astrophysical Tides" Colloquium was to look at the applications of tidal effects within the Solar system and other planetary systems. This was an extremely important, well focused, and timely meeting on the subject that has probably seen a larger fractional growth in the last few years than any other topics. The main topics applicable in a wide range of areas included: The long–term evolution of the lunar orbit; The origin of the Moon–deductions from its orbital evolution; Motion of the Earth's pole; the effects of Tides on Nutation; The internal structure of satellites and tidally driven volcanism; the interplay of tides and resonance and orbital decay; The tidal effects on the small satellites of the outer Solar system and on rings; The role of tides in the break–up of comets, production of elongated asteroids, and in the formation of planets, involving gaseous massive planets close to the parent stars (hot Jupiters) and the known multi–planet systems. Although the existence of the tidal effect has been known for a long time, many new applications in the solar system and other planetary systems are now being recognised, and the meeting became a forum for the exchange of ideas and methodologies devoted to these important astrophysical phenomena. The program addressed the field concisely aiming to link objects and physics of considerable diversity together, such as long term lunar orbital evolution and Io volcanism, with extension to ESPs, and also help to coordinate new observational and theoretical study.

Commission 16 also endorsed the Commission 51 proposal on the Bioastronomy meeting in 2002 in Australia. In preparation for GA XXV, the Commission sponsored the proposal for JD 02 (Mercury), and co–sponsored the proposal for JD 19 "Physical Properties and Morphology of Small Solar System Bodies". Commission 16 itself successfully proposed Special Session SPS 4 "Recent Progress in Planetary Exploration" for the Sydney GA. In an effort to increase participation in IAU activities by scientists with a special interest in the Solar System, the officers of Commission 16 have issued an invitation to members of the Division for Planetary Sciences of the American Astronomical Society (DPS) to apply for IAU membership through the appropriate national committees. The DPS is the largest professional organization for scientists working on Solar System problems, and consists of about 75 percent US scientists and 25 percent from other countries.

4. Positions and Motions of Minor Planets, Comets and Satellites

The work of Commission 20 has seen a continuing upsurge during the last triennium, in large part due to the enormous number of astrometric positions of asteroids and comets generated by near–Earth objects (NEOs) search programs. Those programs, and others concerned with the search for transneptunian objects (TNOs), faint outer–planet satellites, and TNO and asteroid satellites, have greatly increased the pool of unusual solar system objects, and have engendered research in hitherto unexplored areas. Rapid maturation of the World Wide Web has also had a beneficial effect on the Commission's work, from the more frequent dissemination of data from the Minor Planet Center, to the ready availability of datasets on asteroid, comet, and satellite orbital elements and ephemerides.

Several meetings relevant to Commissions 20 and 15 work were held: during the interval since the report for Transactions XXIV: Asteroids, Comets, Meteors 1999, 26–30 July 1999, Ithaca, NY; U.S.–European Celestial Mechanics Workshop, 3–7 July 2000, Poznan, Poland; Asteroids 2001: from Piazzi to the 3rd Millennium, 11–16 June 2001, Palermo, Italy; and

Astrometry and Physics of Minor Planets from observational networks, 9–12 October 2001, Paris, France.

The NEO search programs have led to an increasing overlap between Commission 20's work and that of Commissions 7, 15, and WG on NEO in terms of an accurate evaluation of asteroid–Earth impact probability; migrations into chaotic resonance zones in the inner Main Belt and onto Earth–approaching orbits with account of the Yarkovsky effect; and a closer relationship between images of comets taken for astrometric purposes and cometary physics. The recent results on asteroid orbit determination and the ramifications of cometary orbit determination are addressed in the Commission 20 report.

In the asteroid area, there have been important developments in the computation of orbits and in identifying and linking asteroid astrometric observations. Largely, these developments have stemmed from the super–exponential growth of the number of observations being reported. Several new solutions to the inverse problem of orbit computation have been devised, including linear, semilinear, and nonlinear methods. The determination of asteroid masses through mutual perturbations of pairs of asteroids continues to advance, fueled by the accelerating accumulation of astrometric data, though their accuracy has improved only slightly. Also, estimation of asteroid profiles through the timing of the occultation of stars, continues to flourish. The computation of a greatly enlarged database of reliable asteroid proper elements has led to a startling view of the distribution of taxonomic classes in the Main asteroid belt from Sloan Digital Sky Survey colorimetry.

An analysis of the observations of several asteroids suspected of binarity was made to detect the signature of a satellite. A discovery was made of a satellite around (45) Eugenia (named S/1998 (45) 1 "Petit–Prince"). Lack of astrometric positions precluded the development of models of asteroid satellite motion, and theoretical work was restricted to the formation of such satellites.

In the comet area, the number of numbered comets (i.e., those observed at multiple perihelion passages) increased during the triennium from 140 to 152 (detailed information is contained in the Commission 6 report). Arrangements were made, starting in February 2002, to publish the comet observations preliminarily in the Minor Planet Electronic Circulars, essentially on a weekly basis.

The study of dynamical evolution of the transneptunian region was aimed to attribute some features (such as the heating of the belt in the region at 40–50 AU) to gravitational interactions with massive bodies scattered by the Jovian planets after their formation. The delivery of ice–rich bodies to the primitive Earth from the outer asteroid belt was confirmed to be the main contributor to the Earth's water, with a late veneer supplied by bodies from the Uranus–Neptune region and from the transneptunian region.

Work concerning Oort cloud dynamics has focused on possible signatures of the distribution of aphelion points of long–period comets, attributed either to close stellar passages or to a planet–sized or substellar companion, as well as on the effects of individual stellar encounters on the orbits in the cloud. The capture of Oort cloud comets into short–period orbits has been the subject of active research, involving a possible explanation of the observed population of Halley–type comets starting from an Oort cloud consisting of an isotropic outer cloud and a disklike massive inner cloud. There were also studied dynamical evolution of Oort cloud comets entering the planetary region for the first time, and the time variation of planetary impact probability of comets from Oort cloud due to modulation effects. Numerical modeling of the dynamical history of a large number of observed long–period comets showed an evolution of cometary orbits having hyperbolic original osculating elements in elliptic original orbits.

In the Distant Objects area, the number of known transneptunians rose from 135 in mid–1999 to 679 in mid–2002. The number observed at multiple oppositions rose from 61 to 333 during this time. They are divided into 22 Centaurs, 260 "basic" transneptunians, 11 hybrids and 40 scattered–disk objects (SDOs), although 11 of the SDOs have perihelia larger than the canonical 38 AU. Since the first numbered Centaur (2060) Chiron in 1978, the number of numbered Centaurs is at least 8; the 35 numbered TNOs include five

SDOs, and three are hybrid cases with mean distances greater than and perihelion distances significantly smaller than those of Neptune.

In the Satellites area, with the recent availability of large–format CCD arrays which are beyond the reach of earlier photographic surveys, small planetary outer satellite discoveries has now become a flood. 23 Jovian and 12 Saturnian outer satellites, in addition to the earlier found five new Uranian satellites, were discovered. IAU Circulars contain just a summary of the discovery, while the Minor Planet Electronic Circulars and Minor Planet Circulars would then carry the early astrometric observations and preliminary orbit computations, with later data also being archived in the latter. Three new Uranian satellites (UXVIII–UXX) had already been numbered and named; the 23 new Jovian satellites comprise the objects designated S/2000 J 1–12 and S/2001 J 1–11. Of the 2000 set, all but S/2000 J 11 have been observed at more than one opposition, S/2000 J 1 in fact being identical with the lost S/1975 J 1. The 2001 set are still single–opposition objects. The new Saturnian satellites, designated S/2000 S 1–12, were all also observed at their following opposition. The activities of the Working Group on Natural Planetary Satellites in the structure of Commission 20 are mainly concerned with maintenance of the database of astrometric observations of natural planetary satellites.

It is worth noting that Commission 20's Working Group on Comets expanded its purview in 2000 to include distant objects. While this may be logical from a physical point of view, there is a difference between how the categories (particularly for the Centaurs and transneptunian) are handled astronomically. This and some other problems (in particular, improving the definition of "magnitude" in the case of the comets, notably for predicting magnitudes in ephemerides) pose appropriate recommendations at the upcoming meetings in Sydney.

5. Light of the Night Sky

Unfortunately, there was a lack of any activity of this Commission, both during the past GA XXIV in Manchester and during the current triennium. A vast effort the Division and IAU has undertaken to enforce the formal process of the Commission reorganization in order to it make more efficient and to better reflect the evolution of astronomy and astrophysics, failed and has become the harder part of sorting out the future. While the Commission has been very active some 20 years ago, this has not been the case recently, including no transition between the past and ongoing Presidents and a turmoil with a business meeting and membership election in Manchester.

There were some informal discussions about a possible reorganization of the Commission, though further consultations are needed, involving the members, the relevant Divisions, and Executive Committee. According to the Commission President, its landscape has so much evolved that an assessment of the Commission adequacy to the current scientific situation is not shocking. A first remark is that the marriage of different topics, such as atmospheric, interplanetary, interstellar, galactic, and extragalactic lights, is less and less justified, as it is illustrated by the series of separate conferences held by these different topics. In particular, because an interplanetary dust have regrouped the remote (zodiacal light) and in–situ studies, some scientific logic exist in regrouping the interplanetary part of Commissions 21 with C22. On the other hand, the situation is entirely different for the fields of galactic and extragalactic dust which are very active and this may justify having a devoted commission.

Basically, an open attitude and a fresh view of the situation taking into account the evolution of the respective discipline must be adopted in order to make the IAU better and more efficient in fulfilling its charter and in attracting young scientists. The problem poses detailed interdisciplinary discussion during GA XXV in Sydney, and suggestions how to proceed with the Commission status should be submitted to the Division and EC for the final decision.

6. Meteors, Meteorites and Interplanetary Dust

At GA XXIV in Manchester, Commission 22 officially encompassed meteorites into its purview and its name was changed to the new one. Activities of the Commission during the triennium was focused to research in relevant fields and to organizing meetings or conferences focused on meteors and dust, as well as on the relationship of meteors to their parent bodies. This gives an opportunity for more thorough discussions, as compared to other meetings, such as ACM. The Commission's Working Group "Professional–Amateur Cooperation in meteors" worked effectively in gaining observational data, thereby promoting the improvement of cooperation between both communities.

Following the format of the three previous meteoroid conferences held in Slovakia, the new conference "Meteoroids 2001" has been organized in Kiruna, Sweden. It was a very successful meeting addressing the complex review of the meteor research, with the involvement of dynamics and manifestation of meteor streams; physics and chemistry of meteors; various techniques of the meteor observation; interaction of large meteoroids with an atmosphere; physical properties of interplanetary dust; and interstellar meteors and dust. The conference also provided an excellent opportunity for the Commission's OC to meet and discuss perspectives and other business matters. In particular, it was decided to organize meteoroid conferences regularly, every three years as the Commission official meeting. The next one "Meteoroids 2004" is to be held in Canada. The Commission served also as a co–organizer of IAU Colloquium 181 "Dust in the Solar System and other Planetary Systems" in 2000 (Canterbury, UK), and two meetings focused on the observed Leonid meteor showers: "Leonid MAC Workshop 2000" (Israel) and "Leonid MAC Workshop 2002" (Japan). Commission members also assisted some other both interdisciplinary and specialized meetings.

Recording Leonid meteor storms during the last years highlighted the Commission activity. An unexpectedly high brightness of bolides of the stream in 1998 invoked new modelling to better understand the stream structure and predict its activity. In the following years, the Leonids were observed with the use of many facilities, including the flights of two NASA airplanes with scientific instruments on board. The Leonid storms observed in 1999 and 2001, were the biggest ones since 1966 and provided important information on the stream structure and meteor physics. Since the first photographed meteorite during atmospheric entry (Příbram, 1959) and reconstruction of its orbit in space, only four meteorites were known with precise orbits until 2000. For the following two years, three additional bodies were observed and their orbits were computed (Tagish Lake, January 2000; Moravka, May 2000, and Neuschwanstein, April 2002). Moreover, the last one has an orbit identical with the Příbram meteorite, which definitely confirms the presence of meteorite streams in the near–Earth space.

Recently, long focal length systems became an important player in meteor research. A 3–m diameter liquid mirror telescope with a coupled CCD was used to study very faint meteors. These observations revealed Leonid meteors of very small masses and also provided a great opportunity to investigate in detail meteor ablation with an outstanding spatial resolution. Lidar systems have also found progressively increasing application to study physics and chemistry of the meteor ablation. The observational techniques for meteor spectroscopy gradually shifted from photography to modern electronic devices such as image intensified video cameras with CCD detectors. Most recently the first ever TV spectrum (251–384 nm) of spaceborne meteor was obtained.

7. Bioastronomy: Search for Extraterrestrial Life

During the triennium, there was a great progress in the field of the Commission activity and very important scientific meetings reviewing the main achievements were organized: IAU Symp. 211 "Brown Dwarfs" (21–25 May, 2002, Honolulu, Hawaii, USA), supported by Commissions 9, 25, 26, 30, 34, 36 and 45; the "Bioastronomy 2000" Symposium (Honolulu, Hawaii, USA), and IAU Symp. 213 "Bioastronomy 2002: Life Among the Stars" (8–12

July, 2002, Great Barrier Reef, Australia), with the support of Commissions 15, 16, 34, 40, 46 and 50.

Brown dwarfs have emerged as new objects in observational astronomy in the last few years. While Brown Dwarfs have unique properties, they are also connected with other important areas of astronomy such as the missing mass, galactic structure, star formation and planet formation. Many other current problems in Brown Dwarf research are addressed including: Completing the census of objects in the solar vicinity; Investigating the scale height of Brown Dwarfs in the Milky Way; Searching for halo Brown Dwarfs which may contribute to the dark matter in the Galaxy; Classification schemes for Brown Dwarfs; Temperature, gravity and chemical composition determinations; Detailed analysis of Brown Dwarf spectra to extract physical information about their atmospheres and interiors; Activity and variability due to magnetic fields and weather (dust formation and condensation). It is understood that the progress in this new field of astrophysics will come from larger surveys for Brown Dwarfs, spectroscopic follow–up, multiwavelength campaigns to search for variability, and theoretical efforts to understand the origins, evolution and properties of these enigmatic objects. The above mentioned Symposium provided an excellent opportunity to elaborate a strategy, based on the acquired experience, to plan future surveys best fitted to fulfill the needs, and to coordinate follow–up observations with the new large ground–based and space telescopes.

The symposia on bioastronomy were the six and seventh in the series that have been organized by Commission 51 over the past 20 years, but the recent advances mean that these ones are likely to foster considerably more interdisciplinary connections than previous conferences in the series. The last few years have seen a rapid growth in the field of bioastronomy, which has grown from a minority interest to a significant area of mainstream astronomy. This revolution has included such important advances as: The discovery of extra–solar planets that has created a vigorous new field of astronomy and opened up new fields of exploration for the study of gas giant planets/brown dwarfs and their habitats; The appearance of putative nanobacteria in a meteorite from Mars, coupled with the growing appreciation of the importance of bacteria in studies of terrestrial life, that triggered a wave of studies in this area, though the significance of the "Mars nanobacteria" remains controversial; A growing awareness both of mechanisms for transferring primitive life forms between planets, and of the potential importance of very primitive organisms in the formation of life; The discovery of conditions suitable for life on other planets in our Solar System (e.g., the evidence for a near–surface global ocean on Europa, and probably on Ganymede); Rapid advances in technology, that have rapidly increased the sensitivity of SETI searches; An increasing amount of work on understanding the origins of life.

Obviously, bioastronomy is becoming more tightly integrated with other areas of astronomy. While the field of exoplanets is a prime example, there are also close links between SETI and radioastronomy, with many examples of joint technological development, such as the joint funding of the Allen Telescope Array between the SETI Institute and the astronomy department at UC Berkeley; the coupling of the "Southern Serendip" project with the Swinburne pulsar multibeam project in Australia; and the joint development of radio frequency interference mitigation techniques. One of the aim of the last meetings was to explore all these links, to foster collaboration between different groups and different fields, and to try to answer the linked questions of "Where are conditions suitable for life?" and "Are we alone in the Universe?". These and other challenging goals are at the frontiers of contemporary science. The next "Bioastronomy 2004" meeting is tentatively planned to be held in Iceland.

8. Small Body Nomenclature and Minor Planet Center

The Minor Planet Center (MPC) is operated under the auspices of Commission 20, and also closely related to the divisional CSBN, thereby supporting/expanding tremendously both Commission 20 and CSBN responsibility.

The surge in MPC activity so evident during the 1996–1999 triennium escalated to even higher levels during 1999–2002 involving numerous observations, new provisional designations given to initially unidentified objects and objects for which new orbits were computed, new permanent numberings, and new namings of minor planets. It is now believed that the positions of all of the numbered minor planets are routinely predictable to better than a very few arcsec–except presumably on those rather infrequent occasions when one passes extremely close to the Earth.

The MPC publications basically appear monthly, being currently restricted to a concise presentation of the discovery information and orbits of the newly numbered minor planets and a list of new identifications. However, beginning in April 2001, in response to requests that observations of main–belt minor planets be made available more frequently than once a month, arrangements were made to publish the "Observation Supplement" at two–week, or even one–week intervals in a simplified format, with no filing of the asteroid observational or orbital data. Now there are also "minibatches" of "Minor Planet Circulars" containing all the material that does not relate to observations and orbits of minor planets, as well as the "Minor Planet Electronic Circulars" to provide information about individual objects of particular interest, such as transneptunian and near–Earth objects.

The Committee on Small Body Nomenclature is authorized to provide the naming of small bodies on a regular basis.

A revision of the guidelines for naming comets was undertaken. After considerable discussion the revision has been completed with some changes to guidelines and more detailed history and examples. A trend worth noting in 2002 is that of 172 comets designated, 132 are named SOHO and 20 are named LINEAR.

More than 2800 names of minor planets have been approved and published in the Minor Planet Circulars in the period July 1999–June 2002. Before this time a total of 6730 minor planets had received names since 1801; thus nearly one third of all names have been bestowed in this triennium. Among these is the first of the transneptunian objects to be named, (20000) Varuna. The Lincoln Laboratory survey program has begun to name many of its thousands of discoveries in honor of science students and their teachers who are finalists in a series of science competitions. There are now nearly 50000 numbered minor planets, up from less than 18000 two years ago.

The CSBN has been concerned that the recent proliferation of numberings of minor planets would have an uncontrolled effect on the rate of proposals of new namings and has investigated methods of limiting the naming process and experimented with one. The bottom line is some new activity in the field, with the progressively growing involvement of astronomy magazines or even private firms in the naming process to favor general public, what in some cases becomes an equivalent of selling names. So far the namings have continued to average under 100 per month, and any significant increase in the naming rate is expected to meet with some opposition. In late 2001 the CSBN carried out, with mixed success, an experiment in which there was a vote for the "best" names.

Anyway, the situation dramatically changed in the past years when the intensive observational programs such as LINEAR (Lincoln Near Earth Asteroid Research) have been undertaken and the surplus of asteroids to be named is not properly and timely managed by the different teams. Hence, the enormous amount of work to be done by the respective IAU bodies should be somehow facilitated and/or the existing procedure must be probably changed, possibly even handed over to a commercial company. On the other hand, while amateurs no longer contribute to the asteroids discovery significantly, their rights should be sustained. The key point is to which extent the IAU should be continuously involved in this business and if yes, which constraints in (possibly revised) IAU rules and standards should be placed to minimize the abuse and/or violation from the different groups. It is recognized that even although the honor of getting asteroid names is diluted, IAU should keep its engagement and responsibility for the whole process and for development of respective guidelines (including size of objects; categories, collecting and editing of names; citations; processing fee, if any, etc.).

The most troublesome points are now addressed to Commissions/Centers dealing with the minor bodies naming business (CSBN, MPC, MPCAC) and running programs. A fresh example is the name Quaoar assigned to the new big body in the KB which was chosen by the discoverers themselves, and publicized with no involvement of CSBN, thus putting the IAU's naming rights at stake. A coherent agreement to strictly define the policy in the area is awaited before to be endorsed by EC and widely publicized, and GA XXV must be the forum to come up with a reasonable and workable solution.

9. Near–Earth Objects

The Working Group on Near–Earth Objects (WGNEO) is sponsored jointly by Division I and Division III, and it has a direct link and application of the work of Commissions 20 and 7. The charge of the WG includes (1) Liaison with SpaceGuard Foundation; (2) Advise on coordination of NEO activities worldwide; (3) Advise on reporting of NEO hazards; (4) Advise on research relevant to NEOs. The WG also maintains a standing review committee to provide a voluntary technical peer review of predicted close approaches of NEOs, where such predictions include estimates of the possibility of collision with the Earth. The IAU also provides partial sponsorship of the Minor Planet Center, with orbital and other information on all known NEOs available at

http://cfa-www.harvard.edu/iau/mpc.html

During this triennium, the WGNEO met at the IAU General Assembly in Manchester and held one additional formal meeting in Palermo, Italy, in conjunction with the conference "Asteroids 2001: From Piazzi to the Third Millennium" (June 11–16, 2001). The WGNEO reaffirmed its commitment to providing accurate, timely, and responsible information to the public on NEO impact risks. The WGNEO maintains a Technical Review Committee for the purpose of providing rapid peer review of predictions of possible impacts. However, the development of on–line computational tools at JPL and in Pisa means in practice that such reviews are automatic and practically instantaneous, so that the formal IAU procedure is unlikely to be much required in the future. A new hazard metric, called the Palermo Technical Scale, was approved to compare the risk from newly discovered NEOs

http://neo.jpl.nasa.gov/risk/doc/palermo.html

although it does not replace the Torino Scale for public communication.

The past three years have seen a tremendous growth in the study of NEOs. This period includes the one–year orbital study of 433 Eros by the NASA spacecraft NEAR–Shoemaker, followed by a landing on the asteroid surface. This mission has effectively resolved in the affirmative the long–standing issue of the association between S–type asteroids and the primitive ordinary chondrite meteorites. New radar studies have provided images of NEOs and include the discovery of several binary objects, which permit the calculation of densities. Automated orbital calculation and risk estimates are now continuously available on–line through the NEO Dynamics system at Pisa

http://newton.dm.unipi.it/cgi-bin/neodys/neoibo

and the Sentry system at JPL

http://neo.jpl.nasa.gov/risk/

The Spaceguard Survey discovery programs, led by the LINEAR MIT system

http://www.ll.mit.edu/LINEAR/

have found more than 600 of the estimated 1100 ± 100 NEOs brighter than absolute magnitude H=18 (diameter approximately 1 km). The primary Spaceguard search programs are supported by the United States government (NASA and the U.S. Air Force), with an international team for astrometric follow–up. The goal of the Spaceguard Survey is to find 90% of the NEAs larger than 1 km diameter by the end of 2008.

Communication with the international scientific community and with the interested public represents an important part of the WG efforts. One tool for public communication is the Torino Impact Scale, which has been adopted by the WG and other NEO scientists for this purpose. The Torino Scale is a "Richter Scale" for categorizing the Earth impact hazard associated with newly discovered asteroids and comets. The scale is described at

http://impact.arc.nasa.gov

Other websites, although not formally endorsed by the IAU, also provide valuable communication functions. These include the NASA NEO Program Office

http://neo.jpl.nasa.gov

the NASA impact hazard website

http://impact.arc.nasa.gov

the UK NEO Information Centre

http://www.neareathobjects.co.uk

and the Spaceguard Foundation and its on–line magazine Tumbling Stone

http://spaceguard.ias.rm.cnr.it/SGF/

10. Planetary System Nomenclature

Since the IAU General Assembly in Manchester in 2000, the Working Group on Planetary System Nomenclature (WGPSN) has conducted its business through numerous e-mail exchanges between the members. A nomenclature workshop was held in Birmingham, Alabama on October 6, 2002 in connection with the annual meeting of the AAS Division for Planetary Sciences.

Some 140 provisional names have been assigned to surface features on Mars, Venus, the Galilean satellites and the asteroid Eros. These and subsequent names will be published in IAU Transactions XXVB after endorsement of Division III and final approval by the IAU GA in Sydney in 2003. Also, the provisional names on 11 recently discovered satellites of Jupiter (ten of them in retrograde orbits) were given. The source of these new satellite names is the entourage of Zeus or Jupiter in Greco–Roman mythology. The names follow the tradition of the names on the other satellites of Jupiter. An expected discovery of additional satellites of the outer planets at ever increasing rates has caused concern that the traditional sources of satellite names may get exhausted. Nonetheless, the WG decided to avoid any radical solution, but, for example for Saturn's satellites, to start using the names of the many descendants of the principal Greco–Roman mythological characters after whom most satellites have been named so far.

Following the Division III meeting recommendation in Manchester to bring new expertise to the nomenclature teams, to rejuvenate them and make them more international in composition, two new members from Germany and the USA have been added to the WG, and four new members from the Netherlands, Hungary and the USA have been added to the Mercury, Mars and the Small Bodies Task Groups since the last IAU GA.

11. Extrasolar Planets

The Working Group on Extrasolar Planets (WGESP) has agreed to restrict itself to developing a working definition of a planet applicable to the cases where there already are claimed detections, e.g., the radial velocity surveys of companions to (mostly) solar–type stars, and the imaging surveys for free–floating objects in young star clusters. As new claims are made in the future, the WGESP weigh their individual merits and circumstances and revise this working definition as necessary. It has been currently agreed that objects of solar metallicity orbiting around solar–type stars with true masses above the limiting mass for thermonuclear fusion of deuterium ($13 M_J$) are "brown dwarfs" while objects with true masses below this limiting mass are "planets". In turn, free–floating objects in young star clusters with masses below ($13 M_J$) are not "planets", but are "sub–brown dwarfs".

As of September 2002, roughly 100 claims have been made for the detection of planetary companions to solar–type stars. The WGESP is presently discussing how best to decide upon a list of planetary candidates. Once decided upon, this list will be available from the WGESP web pages, which may be found at the following web page:

http://www.ciw.edu/boss/IAU/div3/wgesp/

Since the field of extrasolar planets continues to enjoy a preponderance of meetings, the WGESP decided not to organize any further meetings on the subject after the very success-

ful IAU Symposium 202 "Planetary Systems in the Universe" that was held in Manchester. However, research on extrasolar planets will be included in several meetings at GA XXV in Sydney, specifically Symposium 218 ("Stars as Suns: Activity, Evolution, and Planets"), SPS 3 ("A New Classification Scheme for Double Stars"), and JD 02 ("Mercury"), for which the WGESP is a co-organizer.

The sensitive issue of the proper place of the WGESP in the IAU structure continues to be discussed. A majority of the WGESP members argue that the broad research areas encompassed by the new field of extrasolar planet research demands the creation of a new Commission under Division III, while some others maintain the viewpoint that the proper place for this research is under the existing Commission 51 on Bioastronomy. This key question is pending more elaborative discussions during GA XXV before any decision is made.

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Mikhail Ya. Marov
President of the Division

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