16. PHYSICAL STUDY OF PLANETS AND SATELLITES (ETUDE PHYSIQUE DE PLANETES ET SATELLITES)

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I. INTRODUCTION

The past triennium has seen an unprecidented increase in our knowledge and understanding of the solar system and, in particular, of the planets and satellites of the outer solar system. This epoch - 1 January 1979 to 31 December 1981 - has witnessed major spacecraft missions to Venus, Jupiter and Saturn by the United States and the launch of further missions to Venus by the Soviet Union.

In following the format used in the preceding Commission 16 report (1976-1979), it seems appropriate to simply review the highlights of the past three years and to provide a short list of comprehensive references, rather than to attempt the customary abbreviated summary. Most of the work cited has been published in ICARUS or in SPACE SCIENCE REVIEWS, which contain most of the papers published in the field of planetary science in the English language. In an attempt to broaden the coverage, however, a review by V G Tejfel' of research carried out in the Soviet Union is included. Also included is a report by M E Davies on the IAU Joint Working Group on Cartographic Coordinates and Rotational Elements of the Planets and Satellites.

II. SOLAR SYSTEM RESEARCH

The following summary of accomplishments in planetary science over the past three years is necessarily incomplete. Most of the results which do appear are based on data obtained by American and Soviet spacecraft; nevertheless, any review of the current literature will underscore the importance of groundbased telescopic observations and will emphasize the need to continue these useful observing programs.

a) Moon

A new radar mapping of the Moon at 70cm wavelength using the 430 Mhz radar at the Arecibo Observatory is being undertaken by T W Thompson. These new radar measurements will have better surface resolution (2-3km) and better radarmetric control than the existing 70cm maps obtained in the late 1960's (T Thompson et al. *Moon Vol 9*, 89-96, 1974).

b) Mercury

A comprehensive review, presented as a post-Mariner 10 assessment of Mercury, was published by R G Strom in *Space Sci Rev 24*, 3-70 (1979).

c) Venus

Summaries of the results of the Pioneer-Venus mission have been published in *Science 203*, 743-808 (1979); *Science 205*, 41-121 (1979) and *J Geophys Res 85*, 7575-8337 (1980). These results include the composition and abundances of major, minor and noble gas species in the mixed lower atmosphere and the diffusely separated upper atmosphere. Isotopic ratios were determined for certain selected species. State properties of the atmosphere and the structure, particle size distribution, composition and optical properties of the clouds have been reported. Radar surface images and altimetry have indicated many tectonically-produced features and, when combined with gravity measurements, they indicate that the surface and interior of Venus is more like the earth than Mars or the Moon.

Analyses of Venera 9, 10 and 11 results have continued. Thermal radiometric studies have been published by L V Ksanformality in *Icarus 41*, 36-64 (1980); the clouds of Venus have been discussed by M Ya Marov et al in *Icarus 44*, 608-639 (1980).

A comprehensive review of the Venus atmosphere has been published by V I Moroz in *Space Sci Rev 29*, 3-127 (1981).

d) Mars

As of 31 December 1981, only the Viking 2 lander remains in operation, the two orbiters and the Viking 1 lander having ceased functioning during the reporting period. Analysis of Viking data has continued, however; an excellent summary of results appears in *Icarus 45*, 1-494 (1981). In *Space Sci Rev 25*, 231-284 (1980), M H Carr has reviewed the morphology of the martian surface.

e) Outer Planets

The results of the Pioneer and Voyager missions to Jupiter and Saturn have been widely published. Voyager results for Jupiter are found in *Science 204*, 913-921 and 945-1008 (1979); *Nature 280*, 725-806 (1979); *Science 206*, 925-996 (1979); *Icarus 44*, 225-510 (1980) and *J Geophys Res 86*, 8123-8841 (1981). Pioneer and Voyager results for Saturn are found in *Science 207*, 400-453 (1980) and *Science 212*, 159-243 (1981). An excellent summary of current knowledge of the Jovian satellites will shortly be available in the book: *Satellites of Jupiter*, edited by D Morrison (Tucson: University of Arizona Press) 1982. A geological summary of the surface of Io has been published by G G Schaber in *Icarus 43*, 302-333 (1980).

New infrared groundbased studies of the satellites of Saturn and Uranus have been reported by D P Cruikshank in *Icarus 41*, 246-258 (1980). A new treatment of the structure of the Uranus atmosphere has been presented by L Wallace in *Icarus 43*, 231-259 (1980). The physics of planetary rings has been discussed by W-H Ip in *Space Sci Rev 26*, 39-109 (1980).

A meeting commemorating the 50th anniversary of the discovery of Pluto was held on 18 February 1980 in Las Cruces, New Mexico, USA. A summary of current knowledge of this remote planet was discussed at the meeting and was subsequently published in *Icarus 44*, 1-71 (1980). Results include models for the structure and composition of Pluto by M J Lupo and J S Lewis and the positive detection of a methane atmosphere by U Fink et al.

III. BRIEF REPORT ON PLANETARY RESEARCH IN THE USSR (V G TEJFEL')

a) Moon

A lunar globe at a scale of 1:10 000 000 was constructed at the Sternberg State Astronomical Institute (Moscow) and printed by "Nauka" Publishing House (Moscow). New values of the main photometric constants for the lunar surface were derived for the true full moon. The monograph "Modern selenography" was published by V V Shevchenko ("Nauka", Moscow). In the Astronomical Council of the Academy of Sciences (USSR), G A Lejkin, E V Zabalueva and L P Yaroslavskij have accomplished a granulometric analysis of the composition and structure of the lunar soil from the "Luna-24" column probe and have discovered multi-layered structure within this probe. New maps of the color distribution on the visible lunar hemisphere were constructed in the Kharkov University Astronomical Observatory (N N Evsyukov et al.). Nonlinear theory of the Moon's physical libration was developed in the Kazan University Astronomical Observatory. B Yu Levin (Moscow) has showed that the Moon must have a small core of melted iron, perhaps with a moderate abundance of the iron sulfide.

b) Mercury

The global regularities in the crater distributions on Mercury, Mars, and the Moon were studied by D A Kazimirov, J F Rodionova, B D Sitnikov et al. (Sternberg Astronomical Institute). A number of peculiarities in the distribution for craters with diameters more than 10 km was discovered. In particular it was noted that the density of the craters decreases from the poles to the equator on the Moon and Mercury, but increases from the north pole to south pole on Mars.

c) Venus

The spectral and temporal characteristics of the Venus clouds visible in ultraviolet were studied by O M Starodubtzeva (Astronomical Observatory of the Kharkov University). It was determined that the ultraviolet contrasts varied with a period of 4.55 ± 0.05 days.

d) Mars

The structure of two-dimensional autocorrelation functions for the mesorelief of the martian surface was studied by A M Grietskij (Astronomical Observatory of the Kharkov University). Yu V Aleksandrov and V P Tyshkovetz have obtained new estimates of dust particle sizes (about 20-25 μm) in the martian atmosphere during the great dust strom of 1971. The comprehensive monograph "Physics of the planet Mars" by V I Moroz (The Institute of Space Research of Academy of Sciences, USSR) was published in 1978 ("Nauka", Moscow).

e) Jupiter

During the 1979 apparition of Jupiter, the latitudinal and longitudinal variations of the color characteristics of the clouds were studied spectrophotometrically by V G Tejfel', G A Kharitonova, and G I Khudyaeva (Astrophysical Institute of Academy of Sciences KazSSR, Alma-Ata). They have showed that the correlation between color (spectrophotometric gradient) and the normal reflectivity of the cloud features on Jupiter is more complicated than a single-valued dependence. The spectral invariance of limb darkening for the polar regions of Jupiter at λλ 0.33-0.70 μm was obtained from new spectrographic

and spectrometric observations, consistent with the results from preceding years. This effect is connected with a presence of the high altitude aerosol layer over the Jovian polar regions.

S M Gajsin (Alma-Ata) has obtained estimates of some optical parameters of the cloud cover and overcloud atmosphere from observations in the near ultraviolet using a scanning spectrometer; V D Vdovichenko, with the same spectrometer, has studied the brightness distribution on the Jovian disk along both the central meridian and the light and dark belts within the near-IR methane absorption bands (from 7250 to 9900 Å). He has analyzed the results in terms of a two-layer model of the absorption-band formation. A new analysis of these bands in terms of a two-layer model also was carried out by L A Bugaenko, L M Kislyuk and A V Morozhenko in the Main Astronomical Observatory of the Ukrainian Academy of Sciences (Kiev). New estimates of the Jovian spectral reflectivity at λλ 0.32-1.00 μm were obtained at Alma-Ata and Kiev. Polarimetric maps of Jupiter were constructed by O R Bolkvadze at the Abastuman Astrophysical Observatory.

f) Saturn

O I Bugaenko and A V Morozhenko (Kiev) have analyzed polarimetric measurements of Saturn and have interpreted the discovered peculiarities in the polarization properties of the equatorial region; these result from the occurence of oriented aerosol particles, which may be injected into the Saturnian atmosphere from inner rings. New measurements of the brightness distribution on Saturn's disk and the limb darkening coefficients within the methane absorption bands and the nearby continuum were accomplished by Z N Grigorieva, V G Tejfel', K S Kuratov, and G A Kharitonova (Alma-Ata) and A P Vidmachenko (Kiev). The structure of the methane absorption band at 6800 A in the Saturn spectrum was analyzed by A A Atai (Shemakha) and V V Avramchuk (Kiev). More than 30 components of this band were detected. Variations of polarization with phase angle on Saturn's disk were studied by L A Sigua (Abastuman Astrophysical Observatory). The mean radius of the cloud particles was estimated to be about 1 μm from this study.

g) Uranus

The known data pertaining to the wavelength dependence of the geometric albedo of Uranus were analyzed in terms of some models of atmospheric structure by A A Atai (Shemakha), K S Kuratov, V G Tejfel', and V D Vdovichenko (Alma-Ata). The best fit between the theoretical calculations and observed data was obtained for a model with an optically thick, pure gaseous atmosphere combined with a Rayleigh scattering and optically thin aerosol haze layer over the tropopause. The methane abundance over this layer must be very low - about 240 cm-amagat, and in the lower atmosphere the abundance ratio CH_4/H_2 is about 3.10^{-3} (V G Tejfel').

h) Satellites

The brightness and color variations of the Galilean satellites of Jupiter and the bright, icy satellites of Saturn versus orbital and solar phase angles were measured by V V Avramchuk, L R Lisina, and V I Shavlovskij (Kiev). A F Steklov has analyzed a diurnal thermal regime for the surfaces of the Galilean satellites, Triton and Pluto from theoretical considerations. G A Lejkin (Moscow) has noted that 7 of 9 known volcanic centers on Io are lying near a great circle which may be a global crack on the satellite surface.

f) Pluto

V V Avramchuk and L R Lisina have measured the geometric albedo of Pluto in the UBV system and have confirmed both the decrease of Pluto's brightness and the changes in color.

5. JOINT WORKING GROUP ON CARTOGRAPHIC COORDINATES AND ROTATIONAL ELEMENTS OF THE PLANETS AND SATELLITES

(M E Davies)

The Commissions 4 and 16 Joint Working Group on Cartographic Coordinates and Rotational Elements of the Planets and Satellites is updating its 1979 report. The principal source of new information has come from the Voyager encounters with Jupiter and Saturn. Craters have been selected to define the longitude systems on the Jovian satellites Europa, Ganymede, and Callisto. For Io the rate of volcanic resurfacing appears to be so high that a chosen landmark might not be recognized on pictures taken by future spacecraft, so the current (IAU, 1973) longitude definiton is retained. Suitable surface features will be selected to define the longitude systems on the major Saturnian satellites (except Titan, which is cloud covered). The system III (radio) rotation period and longitude systems are recommended for use on Jupiter and Saturn. The current membership of this committee is M E Davies, Chairman, V K Abalakin, J H Lieske, P K Seidelmann, A T Sinclair, Y S Tjuflin (consultant), A M Sinzi (ex officio), and B A Smith (ex officio).

B A SMITH
President of the Commission

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