

COMMISSION 21 : LIGHT OF THE NIGHT SKY (LUMIERE DU CIEL NOCTURNE)

Report of Meetings, 16, 18 and 21 August 1979

PRESIDENT : R. Dumont.

SECRETARY : D.W. Schuerman.

16 August 1979

ADMINISTRATIVE SESSION

1. Welcome address

Dans son allocution de bienvenue, en français puis en anglais, le président évoqua la mémoire de ses prédécesseurs disparus Jean Dufay et Daniel Barbier, et se félicita de la présence à l'Assemblée Générale de tous les anciens présidents vivants de la Commission : F.E. Roach, M. Huruhata, H. Elsässer et J.L. Weinberg. Une minute de silence fut observée en souvenir des membres ou consultants décédés depuis trois ans : Takao Tohmatsu et John R. Roach.

In a comment on language difficulties, the president urged those participants whose mother tongue is English, to fully realize how privileged their situation is in international meetings. In return, they ought to consider a clear and not too fast diction as being a matter of courtesy towards other participants.

2. Commission membership

The names of the new officers for the triennium 1979-1982, nominated by the Executive Committee on proposal by the current officers, were given with a few comments on the activities of these scientists :

President : H. Tanabe

Vice-President : R.H. Glese.

The president-elect was recognized as one of the very few colleagues whose experience extends over practically all of the various components of the night skylight.

The new Organizing Committee recommended by the current officers was accepted by the members attending the session, and therefore transmitted for approval by the Executive Committee : R. Dumont, M. Harwit, C. Leinert, A.C. Levasseur-Regourd, K. Mattila, Yu. L. Trutse, J.L. Weinberg.

The following existing IAU members were co-opted for Commission 21 membership : A.L. Broadfoot, H. Fechtig, L.M. Fishkova, I. Halliday, T. Matsumoto, D.H. Morgan, S. Mukai. The following applicants were found admissible to Commission 21 membership under the condition (fulfilled a few days later) that they are admitted into the Union : W.J. Baggaley, P.D. Feldman, M.S. Hanner, Ph. Lamy, M. Maucherat-Joubert, N.Y. Misconi, S. Nawar, M. Rapaport, D.W. Schuerman, H.J. Staude, T.I. Toroshelidze, J.A. Tyson. Two members resigned from Commission 21 membership : D.M. Hunten and W.R. Steiger.

A new list of 26 consultants was approved for the next triennium.

3. Reports on Astronomy 1979, and the scientific interests of the Commission

The president expressed his thanks to all who provided him with information on their activities, results and aims, allowing him to improve the quality of the

Report. Whether or not some components have to be included in Commission 21 field was then discussed ; due to the 8-page limitation to the Report, priorities on the topics could not be avoided. Most of the participants agreed to exclude general airglow studies from the field of the IAU, unless they are operationally related to astronomical problems, e.g. when the knowledge of the brightness of an astronomical component directly depends on the knowledge of a telluric one.

4. The Newsletter of the Commission

Approval and satisfaction was expressed to the president with the three issues of the newsletter that he edited. The president-elect, with the help of the vice-president and the Organizing Committee, plans to continue this service. At least one issue per year is contemplated, possibly more. Members are instructed that the only useful size for the information that they are requested to send to Dr. Tanabe is of the order of half a page ; and that preprints or reprints have interest only in addition to such precise and concise summaries of their results and projects.

5. Relationship with other Commissions

Commission 50 is charged with the protection of observing sites. One of its major concerns is the ratio of artificial light to the natural light of the night sky. In this regard, our Commission has been requested to provide standard levels. H. Tanabe and R. Dumont handled most of this correspondence, from which the average figures 250 S₁₀ or 11 R/nm, and 30 R, for visible continuum and NaI radiation respectively, can be pointed out. F.E. Roach and the president emphasized that the Report of Commission 50 is a document of the highest interest.

Relationship with Commission 22 mainly dealt with preparation of the IAU Symposium n° 90 "Solid particles in the solar system", held in Ottawa immediately after the General Assembly, and dedicated to our distinguished colleague Peter M. Millman. This meeting was co-sponsored by our Commission, having deputed 3 persons in the Organizing Committee and approximately 25 in the attendance. 5 invited papers and 22 contributions were given by members of our Commission.

6. Other topics

The report of the Background Starlight Working Group of the Commission was mentioned, to be given during the last scientific session (see below).

The administrative session came to an end with a short address of the incoming president, H. Tanabe, who thanked the retiring one, R. Dumont, for his efforts during the triennium, especially to improve the circulation of information - in both of the official languages of the Union - between night skylight people.

SCIENTIFIC SESSION : THE OUT-OF-ECLIPTIC MISSION AND OTHER GENERAL REPORTS

1. Photopolarimetry from International Solar Polar Mission (Out-of-Ecliptic)

R.H. Giese : *Experiment objectives and description ; Observations of the Zodiacal light*. - The Principal Investigator explained the fascinating geometry of the spacecraft trajectory and the viewing directions, and gave figures for the expected brightnesses of the zodiacal light. Mapping of the sky will be detailed and frequent, enough for a satisfactory knowledge of the gradients of brightness versus viewing direction and versus spacecraft position, allowing to apply new inversion techniques to the zodiacal brightness integral.

J.L. Weinberg : *Observations of the Background Starlight*. - A brief summary was presented on the objectives of the astronomical phases of the Zodiacal Light/Background Starlight Experiment, by the Co-Principal Investigator. The Pioneer 10-11

spin-scan technique will be used to make multi-color maps of background starlight (brightness and polarization), from spacecraft positions and in viewing directions where the zodiacal light is negligible.

2. Other scientific reports of general interest

A.S. Asaad : *Zodiacal Light observations in Egypt* (no abstract available).

F. Sánchez : *Research on the night skylight in Spain*. - Two groups recently established in Spain are active in our field : one in the Instituto de Astrofísica de Andalucía (Granada) is concerned by various airglow problems, some of which are connected to astronomical components (airglow continuum ; emission of the F level at 557.7 nm) ; the second group, in Instituto de Astrofísica de Canarias (Tenerife), works on separation of atmospheric and extraterrestrial continuums, zodiacal light (visible and IR observations ; models), origin and evolution of interplanetary dust. Both existing and planned instrumentation were described.

18 August 1979

SCIENTIFIC SESSION : NIGHT SKYLIGHT GENERATED IN THE INTERPLANETARY SPACE

1. Zodiacal Light : Optical Study of the Zodiacal Cloud

D.W. Schuerman : *The general inversion and information content of the zodiacal light brightness integral*. - Optical space probes afford the only means to determine the brightness per unit-volume of interplanetary space as a function of position and scattering angle. Observations along a viewing circle, which is a unique function of the space probe's trajectory, provide the most information possible about the brightness per unit-volume of the zodiacal light (see Space Res. 19, p. 451, 1979, and Planet. Space Sci. 27, p. 551, 1979). Such observations directly relate to dust dynamics and "in situ" measurements.

A.C. Levasseur-Regourd : *Inversion of the brightness integral in zodiacal light photometry*. - While observations made tangentially to the orbit provide a direct inversion (of interest also for future cometary missions), observations made in the symmetry plane require the knowledge of the derivatives $\partial Z/\partial \epsilon$ (satisfactorily known) and $\partial Z/\partial R$ (never measured up to now inside the earth's orbit). It is shown that for $\epsilon = 90^\circ$ the latter equals $-\partial^2 Z/\partial \epsilon^2$ in the vicinity of $R = 1$ AU, leading to a new determination of the decrease of density with heliocentric distance, R . The general trend resulting from Helios measurements is confirmed, but a slight departure from the $R^{-1.3}$ law could exist close to 0.7 and to 1.0 AU.

H. Tanabe, A. Takechi and A. Miyashita : *Recent results about the False Zodiacal Light*. - Results of photographic, spectroscopic and photoelectric observations of the false zodiacal light made at Iriomote Island, Japan, in 1978-79 were presented. To interpret these data, the proposed hypothesis is that the false zodiacal light seen at low latitudes is part of the subtropical arc. However, more observations are required for a complete explanation of the phenomenon.

N.Y. Misconi : *The symmetry plane of the zodiacal cloud*. - Recent results on the location in space of the plane of maximum dust density and its possible association with the orbital planes of the planets were reviewed. It is suggested that the location of this maximum depends on heliocentric distance, varying from a position near the orbital plane of Venus, to a position approaching the invariable plane near the earth's orbit.

R. Robley : *Changes in Zodiacal Light brightness with solar activity*. - Zodiacal light brightness, although poorly correlated with solar activity as defined by sunspot number, is found strongly related to the solar corona, measured at mean

heliocentric latitudes. This behaviour is similar to that of the brightness of the eclipsed moon, and both are assumed to be governed by the solar wind ejected at various heliocentric latitudes. The gegenschein observed from 1964 to 1978 at Pic-du-Midi Observatory, the zodiacal light according to Weill (C.R. Acad. Sci. Paris 263 B, p. 943, 1966) and the eclipsed moon according to Danjon (ibid. 171, p. 1127, 1920) have their brightnesses very well related to the extension of the polar coronal holes.

M.S. Hanner : *On the albedo of the interplanetary dust.* - The albedo of the interplanetary dust can in principle be obtained directly from a comparison of the zodiacal light brightness with in-situ measurements of particle size distribution and spatial concentration. This comparison yields a geometric albedo of ~ 0.2 , based on the lunar microcrater flux curve (Fechtig, Lect. Notes Phys. 48, p. 143, 1976), with $\rho = 3 \text{ g cm}^{-3}$. The composition of collected micrometeorites and IR observations suggest an albedo ~ 0.1 , which would indicate that the microcrater flux curve is too low by a factor of ~ 2 . The very low albedo derived by Cook (Icarus 33, p. 349, 1978) results mainly from his choice of $\rho = 0.18 \text{ g cm}^{-3}$ in converting in situ data to particle size.

2. Interstellar Wind : Influx of Gas and Dust from the Interstellar Medium

A. Lyle Broadfoot and S. Kumar : *Remote sensing of Solar wind/Interstellar wind interaction.* - On the basis of the weak emissions observed by Voyager from jovian magnetosphere/solar wind interaction, were described the optical signatures one might expect to detect from the solar wind/interstellar wind interaction. Results provided by the UV spectrometer on Voyager 2 in interplanetary cruise, especially the first detection of interplanetary Ly β resonance scattering, were discussed.

J.M. Greenberg : *Interstellar dust component in the solar system.* - The Zodiacal Light-Background Starlight experiment aboard ISPM was reported to afford a possibility of distinguishing between interplanetary and local interstellar dust (see Nature, 275, p. 39, 1978). These prospects were presented in connection with the author's current conjecture that those zodiacal light particles from comets which survive close to the sun may be similar to silicate particles forming the cores of interstellar core-mantle particles.

21 August 1979

SCIENTIFIC SESSION : NIGHT SKYLIGHT OF STELLAR, INTERSTELLAR OR EXTRAGALACTIC ORIGIN

J.L. Weinberg : *Report of the Commission 21 Working Group on Background Starlight.* - This group, which was reactivated at the preceding General Assembly in Grenoble, includes K. Mattila, M. Maucherat-Joubert, F.E. Roach, H. Tanabe, H.C. Van de Hulst, J.L. Weinberg and R.D. Wolstencroft. Theoretical studies and existing or anticipated data bases (star counts and photometries, including sky surveys and polarimetric studies) were discussed briefly in terms of timing, standardization and availability, and their use to evaluate the individual components of the background starlight. The recommendation was made that Commission 21 organize an IAU Colloquium on background starlight during the next triennium.

R.D. Wolstencroft : *Wide field polarimetry of the Diffuse Galactic Light.* - The state of polarization of the total light from the Milky Way at 5300 \AA , corrected for foreground zodiacal light, has been derived at $|b| \leq 33^\circ$ and $l = 0^\circ$ to 240° . The polarization is oriented predominantly normal to the galactic plane, consistent with an origin in the Diffuse Galactic Light. The degree of polarization is lowest ($p \sim 2\%$) close to the galactic plane ($b = 0^\circ$ to -10°) and increases to $p \sim 5\%$ at $|b| = 30^\circ$. Modelling of these data is in progress.

R.C. Henry : *A search for Far-UV starlight scattered from high galactic lati-*

tude interstellar dust. - The Apollo 17 wide field ($12^\circ \times 12^\circ$) far-UV (1180-1680 Å) spectrometer was used to scan six large bands of the sky during transearth coast. After accounting for internal scattered light and the light expected from stars in the field of view, no significant residual flux remains. This imposes important constraints on the scattering properties of the interstellar dust grains : either they are extremely strongly forward scattering ($g > 0.9$), or their albedo is low ($a < 0.2$). The work of Jenkins and Shaya (1979) suggests that the latter is the case. The absence of a scattered light signal from dusty moderate-galactic-latitude regions indicates that the high-galactic-latitude flux reported by Henry *et al.* (1979) and by Anderson *et al.* (1979) is extragalactic in origin.

M. Maucherat-Joubert and J.M. Deharveng : *Far-UV integrated sky background.* - The discrepancy between recent measurements of the far-UV diffuse radiation leads to different interpretations as to its dominant contributor, either extragalactic light or galactic plane light scattered off by dust grains. From the ELZ measurements (D2B satellite), (i) a correlation is found between 1690 Å brightness and hydrogen column density, (ii) a spectrum of the diffuse radiation in the range 1690-3100 Å is obtained and is strikingly similar to that of the Coalsack dark nebula. These results suggest a significant contribution of Diffuse Galactic Light in the UV observed, but do not rule out an extragalactic component.

D.H. Morgan : *Diffuse Galactic Light observed by the S2-68 Survey Telescope.* - Results at 2740, 2350, 1950 and 1550 Å were given. Detailed maps of the whole sky were presented. The analysis of part of their data was described and the resulting albedo values quoted. More detailed maps of the Orion region were presented, showing the large scale UV nebulosity and Barnard's loop superimposed. Similar maps around λ Ori were described and the data interpreted in terms of a model of the dust distribution around λ Ori. Asymmetry parameter values $g > 0.75$ are ruled out; the albedo is found to be higher at 2740 Å than at the other wavelengths; these results are similar to those obtained for the DGL. Also described are the geocoronal Ly α radiation, and the charged particle background at 550 km as a function of geographic coordinates.

A.N. Witt : *Diffuse Galactic Light and the scattering properties of interstellar grains.* - A re-assessment of the DGL observations of Lillie and Witt (Ap. J. 208, p. 64, 1976) reveals good agreement with more recent UV surveys by Paresce *et al.* (Ap. J. 230, p. 304, 1979) and by Maucherat-Joubert *et al.* (A. & A. 70, p. 467, 1978) who used similarly small fields of view. There is evidence in all these studies for a moderately high diffuse intensity of 1000 to 1500 photons $\text{cm}^{-2}\text{s}^{-1}\text{\AA}^{-1}\text{sr}^{-1}$ in the 1400-1600 Å range at high galactic latitudes, consistent with the presence of high-albedo interstellar dust with a more isotropic phase function than found in the visible. There is growing evidence that the product $a \cdot g$ (albedo \times phase function asymmetry factor) is ≤ 0.2 in the far-UV.

C.T. Hua : *Far-UV observation of the sky background by "Galactika" aboard Prognoz-6.* - Results from more than 4000 spectra obtained with the French-Soviet experiment aboard the Prognoz-6 satellite (1977) were presented. The highly elongated orbit (495 to 2.10^5 km) offers the ability to measure the far-UV sky background intensity for three dark regions : Pisces, Aries and Gemini-Cancer. Contamination by the geocoronal Ly α radiation is taken into account. A detailed analysis is planned for publication.

R. Dumont : *A suggested new clue to disentangle Zodiacal Light from Diffuse Galactic Light.* - In DGL studies, ZL is often subtracted under the assumption that its brightness at high ecliptic latitude is nearly independent of the longitude. Recent photometric surveys of the ZL do not support this assumption; along the ecliptic parallels $\pm 60^\circ$, the zodiacal brightness oscillates during the year from ~ 50 to $\sim 100 S_{10}$. A safer process would consist in pointing less than 15° away from the ecliptic directions $\lambda = \lambda_{\odot} + 180^\circ$, $\beta = \pm 75^\circ$. Within these two circles,

the zodiacal brightness is the dimmest over the sky, and practically uniform. The annual relative motion of the helioecliptic vs. galactic spheres allows observations of the DGL with the lowest uncertainty due to the ZL, in a range of galactic latitudes from -60° to $+60^\circ$.

F.E. Roach and J.R. Roach † : *Cosmic Light and galaxy statistics with the Space Telescope*. - The plans for the Space Telescope include the observation of discrete astronomical objects as faint as apparent magnitude 28. The several components of the Light of the Night Sky will be variously affected. The atmospheric nightglow will be below the telescope and observable only if grazing traverses of the earth's limb are made. The starlight will not be integrated as is required for many ground-based observations made with telescopes of small aperture and large field. In the direction of the galactic poles individual stars will be outnumbered by discrete galaxies. The integrated cosmic light due to galaxies will actually be obtained by galaxy counts. The background light on exposures with the camera arrangements will be a combination of the zodiacal light and the diffuse galactic light, and will compete with light from discrete sources near apparent photographic magnitude 26.

En conclusion à l'ensemble des réunions de la Commission 21 pendant cette Assemblée Générale, Franklin E. Roach, doyen des anciens présidents de la Commission, souligna l'intérêt des sessions scientifiques, et notamment du présent échange sur l'un des problèmes les plus difficiles de notre domaine d'investigation : les contributions stellaire, interstellaire et extragalactique à la lumière du ciel nocturne. Il remercia enfin le président sortant, R. Dumont, et souhaita la bienvenue aux nouveaux officiers, H. Tanabe et R.H. Giese.