

COMMISSION 44: ASTRONOMICAL OBSERVATIONS FROM
OUTSIDE THE TERRESTRIAL ATMOSPHERE
(OBSERVATIONS ASTRONOMIQUES AU-DEHORS DE
L'ATMOSPHÈRE TERRESTRE)

Report of Meetings, 19, 20, 22, 25 and 26 August 1970

PRESIDENT: R. Wilson.
SECRETARY: C. Jordan.

Business Meeting

The President announced that the Joint IAU/COSPAR Symposium on 'New Techniques in Space Astronomy,' proposed by Commission 44, had been held in Munich at the Max-Planck Institute from 10–14 August, 1970. The Commission 44 proposal that an IAU Symposium on 'UV and X-Ray Spectroscopy of Astrophysical and Laboratory Plasmas' should be held at Utrecht in 1971 has been accepted.

The President described how the Commission 44 report for 1967–70 had been split into sections according to several topics and thanked the authors of the different sections for their collaboration. The sections were on Solar Physics, The Interplanetary Medium, Cosmic X and γ -ray Sources, the Cosmic X and γ -ray Background, UV Stellar Astronomy and Radio Astronomy. They were written by Dr R. Tousey, Dr M. Neugebauer, Professor L. Gratton, Dr W. Kraushaar, Dr H. E. Butler and Professor F. G. Smith respectively.

The President explained that the scientific sessions of Commission 44 would follow the plan of the Report, with each session being introduced by a review paper, given where possible by the author of the relevant section.

Each Commission is free to arrange its own system of operation and make its own By-laws, but the President pointed out that the General Secretary and Executive Committee wished to know how each Commission intended to organize itself, preferably by the end of the General Assembly. Following a description of how the Commission had been run in the past three years, with the Organizing Committee consulted on executive matters and the full commission membership consulted on scientific matters, Professor Gratton proposed that the present system seemed satisfactory and that it was unnecessary to define any specific rules of operation.

The President listed the proposals received for the new President, Vice-President and Organizing Committee and invited further proposals.

The membership of the Commission has been reduced by removing the names of those members regularly failing to reply to circulars.

The President invited those who wished to join the Commission to add their names to the list posted on the main notice-board.

Representation of the IAU on other international organizations was discussed. Professor C. W. Allen was proposed as the IAU representative on the Solar Particles and Radiations Monitoring Organization. Professor Dollfus agreed on representing Commission 44 as well as Commission 17 on the Intercommission Committee on the Exploration of the Moon.

Commission 44 wishes to note the letter of Professor F. Zwicky, which draws attention to the importance of astronomers taking an active interest in the work leading to an International Treaty on the Use of Outer Space.

The relationship between Commissions 44, 47 and 48 and between Commissions 44, 10 and 12 was discussed. It was agreed that overlap between commissions should be minimized, but no clear way of dividing interests between the above commissions was apparent. There was a general feeling, expressed particularly by Professor L. Gratton and the President, that Commission 44 should limit

itself to techniques and observations rather than include theoretical analyses of data. The President thought that the Executive Committee of the IAU should examine the role of all the commissions to avoid proliferation.

Regarding future symposia, Dr Giacconi pointed out that by 1972 many data are expected from new satellites devoted to X and γ -ray Astronomy. He suggested that an IAU symposium on Cosmic X and γ -ray Astronomy should be held in the eastern United States in 1972 or 1973 and that this should be similar to the 1969 Rome Symposium. It was agreed that such a meeting should be held jointly with Commission 48 and that the President should initiate a joint proposal.

Scientific Meetings

The first solar meeting opened with R. Tousey reporting some of the highlights of the past year. The eclipse of 7 March 1970, during which two rockets were launched from Wallops Island, West Virginia, to reach apogee at totality and so record the flash spectrum in the ultraviolet, was considered as the main event.

C. Jordan then reported results obtained from a recent Skylark rocket flight instrumented by the Culham group. These have been used to derive the temperature structure of the chromosphere-corona transition region.

K. Evans presented results from recent rocket-borne crystal spectrometers. Models of active regions were constructed and abundances of elements in the corona were determined.

L. Goldberg presented results from a multigroup experiment designed to observe the XUV flash spectrum of 7 March 1970. H- $L\alpha$ was observed between 1 and 1.3 solar radii and it has been suggested that this is due to scattering of H- $L\alpha$ by neutral hydrogen.

The meeting concluded with G. S. Vaiana presenting X-ray images of the Sun obtained by the A.S. and E. group over the last two years. The images have a resolution of 5 arc sec for active regions and 1 arc sec for flares.

Further results were reported during the second solar session.

K. Frost presented results from the GSFC hard X-ray experiment on OSO 5. Various flare profiles were presented and their correlation with Type III radio bursts was discussed.

J. H. Parkinson described results from a joint experiment between the UCL and Leicester groups, also on OSO 5. Soft X-ray maps of the Sun were presented and models of active regions were constructed as a function of the photospheric magnetic field.

Results from a third experiment on OSO 5 were presented by W. M. Neupert. The spectra from two crystal spectrometers were discussed, with special emphasis on the feature at 1.86 Å and its resolution into several iron lines.

L. W. Acton reported the analysis of X-ray spectra above 3 keV obtained on three rocket flights. The spectra were assumed to be thermal so electron temperatures and emission measures were derived.

Finally, L. van Speybroeck considered X-ray photographs obtained on the same day as the 7 March 1970 eclipse. The relations between the white light coronagraph observations and the X-ray emitting regions on the solar disk were discussed.

Scientific Meetings, Second Session

The first meeting consisted of a series of papers concerning the physics of the interplanetary medium.

J. C. Brandt read the Draft Report prepared by Dr M. Neugerbauer who was unable to attend the meeting. Interplanetary space has been continuously monitored over the last five years from space vehicles, and important advances have been made in our understanding of the solar wind. It has been shown to be electrically neutral, for example, and to have only a small variability with solar cycle.

J. C. Brandt reported that the two-fluid model of the solar wind cannot explain the observed properties even at 1 AU from the Sun. The inclusion of viscosity as a method of heating the proton

component is essential to reduce the ratio T_e/T_p to a value near to the measured ones of between 1.5 and 5.0.

T. Gehrels reported work on polarization measurements on the atmosphere of Venus, using the polariscope balloon-borne instrument. Measurements at 2150 Å and 2800 Å show 22.8% linear polarization which can be attributed to the molecular atmosphere above the Venesian clouds.

T. Gehrels then gave a paper on the Pioneer F + G missions to Jupiter. These will carry an imaging polarimeter with which the polarization of Jupiter will be mapped, along with measurements on any asteroids to which the spacecraft may pass sufficiently close.

F. Zwicky made a plea for more widespread understanding of existing international treaties governing the peaceful uses of space, and suggested that for the purposes of future legislation, a more flexible definition of where a country's 'airspace' ends and where 'space' begins, should be made.

The second meeting of the day was concerned with recent results in the field of stellar UV spectroscopy.

Dr H. E. Butler (Edinburgh, U.K.) began the meeting with a review of progress in UV astronomy between 1967 and 1970, pointing out that many of the new observations have resulted from advances in space instrumentation technology.

Recent observations were described and the importance of reliable photometric calibration was stressed.

Dr A. D. Code (Wisconsin, U.S.A.) described the scanning spectrometer experiment carried on OAO-A2 and summarized the observed stellar spectra. Spectra have been recorded between 1100 Å and 3500 Å with a spectral resolution of about 10 Å. The observed continuum fluxes give reasonable agreement with model atmosphere calculations for spectra types earlier than AO, but departures are found for later types. Adjustments of the metal abundances help to match the observed and theoretical curves. Stars having the same spectral type and luminosity class have similar UV spectra, but the line spectra of supergiants and main sequence stars show distinct differences. The instrument intensity calibration has proved to be extremely stable throughout the first 15 months in orbit.

Dr B. D. Savage (Wisconsin, U.S.A.) described measurements of UV interstellar extinction obtained from the OAO-A2 stellar spectra. The observed extinction curves have a peak near 2200 Å and a minimum in the region 1800–1300 Å, followed by an increase in extinction at shorter wavelengths. Theoretical curves for graphite particles could not be matched with the observed extinction, some other constituent being needed to explain the peak near 2200 Å.

The results obtained by the OAO-A2 'Ceslescope' experiment were described by Dr W. A. Deuschman (Smithsonian, U.S.A.). Data analysis is now in progress and a catalogue listing the UV magnitudes (± 0.2) of 10000 stars is expected to be ready before 1971.

Mr J. W. Campbell (Edinburgh, U.K.) described results obtained using broad-band UV photometers on unstabilized 'Skylark' rockets. Measurements of 94 early-type stars had been made in wavebands centred near 1450 Å, 2150 Å and 2550 Å.

Scientific Meetings, Third Session

The meetings consisted mainly of contributed papers in the field of cosmic X-ray and γ -ray astronomy.

L. Gratton opened the first meeting with a review of cosmic X-ray sources, and listed eleven sources which have been identified with optical counterparts.

K. A. Pounds reviewed the X-ray and γ -ray background; the break in the X-ray spectrum was discussed, together with the isotropy of the general background radiation and the enhancement along the Galactic plane.

B. A. Cooke reported a new survey of the Centaurus-Norma region in the 2–16 keV range, discussing the changes in the intensities of sources observed in this region over the past few years, particularly Lupus X-1 and Cen X-3. An unusual spectrum was presented for the latter source.

J. H. M. Bleeker described the results of a 20–80 keV search for X-rays from the Galaxy using 4 identical independent scintillation detectors. No discrete sources were observed in the Galactic

centre region. The spectrum of the Galactic enhancement, incorporating all published observations of the excess radiation in the X- and γ -ray region, was discussed in the light of theoretical considerations.

V. L. Ginzburg discussed the chemical composition of quasars in relation to the effect of γ -radiation. No chemical changes have been observed in the envelopes of quasars – the possible reasons for this were presented.

P. Gorenstein described a recent X-ray observation of the Cygnus Loop using a focusing collector. The structure of the source in X-rays was discussed, the resolution of the detector being $\frac{1}{2}^\circ$. The spectrum of the source was best fitted by thermal bremsstrahlung with line emission from O VIII contributing $\frac{1}{3}$ of the total emission in the observational energy range.

The second meeting continued with a description by R. E. Griffiths of the results of a recent rocket experiment to search for iron line emission from Sco X-1. A narrow line was not observed with the LiF crystal spectrometer, but the overall spectrum in the 4–15 keV region from proportional detectors showed an excess around the expected positions of the emission lines from Fe XXV and XXVI. It was concluded that the emission lines are broadened by the process of electron-scattering in a dense source.

L. Acton presented the results of a proportional counter experiment on Sco X-1 with the detection of iron line emission at 6.6 keV.

W. A. Hiltner reported the results of optical studies of the intensity variations of Sco X-1 and the correlation of X-ray and optical fluctuations.

H. M. Johnson discussed a programme for the optical identification of X-ray sources, using the Mount Palomar Schmidt telescope.

J. E. Grindlay considered flare stars as candidates for X-ray sources. Intensities were derived, assuming a synchrotron model, for X-rays of energies greater than 10 keV.

In the discussion following Grindlay's paper, Lovell commented on the very large energy release during the 3–4 h flaring of YZ Can. Maj.

T. A. Clark concluded the meeting with some results from the Radio Astronomy Explorer satellite on observations of the galactic background continuum radiation in the Local System, and discussed the possible H II distributions.

Scientific Meetings, Fourth Session

The second meeting on stellar UV spectroscopy began with a report by Dr D. C. Morton (Princeton, U.S.A.) on recent ultraviolet stellar spectra of high resolution (0.3 Å) obtained by an objective grating Schmidt camera flown in a stabilized rocket. Interstellar absorption lines were recorded in spectra of ζ -Oph and δ -Sco between 1100 Å and 1500 Å. The interstellar lines include H I 1216 Å, C II 1334 Å and O I 1302 Å from which an abundance ratio [O I]/[H I] of about 7×10^{-3} can be estimated. As the solar ratio is 6×10^{-4} an overabundance of O I in the interstellar cloud is implied.

The interpretation of the interstellar hydrogen absorption in these spectra was discussed by E. B. Jenkins (Princeton, U.S.A.) who also reviewed interstellar H I absorption data obtained on earlier rocket flights. Using a statistical method to determine the correct continuum level, equivalent widths were estimated for the 1216 Å line and values for the interstellar atomic hydrogen density were derived. The estimated density ($\sim 0.2 \text{ cm}^{-3}$) is significantly lower than the value obtained from 21 cm radio data or the density derived from OAO-A2 observations.

Ultra-violet spectrophotometric measurements of bright stars obtained by balloon-borne instrumentation were described by C. Navach (Geneva, Switzerland). An objective prism Schmidt camera was used to record spectra between 2000 Å and 5000 Å and the observed intensities agree well with those obtained by Stecher.

G. C. Sudbury (Edinburgh, U.K.) described spectrophotometric measurements made from unstabilized rockets using photoelectric scanning techniques. Photometric data were obtained for 100 stars in the wavelength range 1850–3000 Å. Measurements of the background sky brightness at 2425 Å have provided new data on the distribution of radiation from the galactic plane, which can be interpreted to give information about the location of dust clouds in the Galaxy.

C. M. Humphries (Edinburgh, U.K.) presented photographic spectra recently recorded using an objective prism Schmidt camera carried on a stabilized Skylark rocket. Spectra between 1700 Å and 5000 Å were recorded for stars brighter than $M_v \approx 5$ in Centaurus and Lupus.

During the third meeting on UV stellar spectroscopy Dr A. Boggess (GSFC Greenbelt, U.S.A.) described the design and operations plan for OAO-B, the second astronomical observatory satellite which will be launched late in 1970. This satellite will have a scanning spectrometer fed by a Cassegrain telescope system. The importance of detailed planning to optimize the observing programme was stressed. A Guest-observer programme will provide ten percent of the available time for observations by invited astronomers.

In a second paper, Dr A. Boggess gave details of a geosynchronous astronomical satellite which is currently being studied for a possible launch in 1974. This satellite would use a Cassegrain telescope and a spectrometer with crossed echelle and grating dispersion, followed by image storage tube detection with T.V. data read-out. The high efficiency data-collection system and the geosynchronous orbit would provide a space observatory with virtually direct ground control.

The complete list of papers presented during the Commission 44 sessions is as follows:

Thursday, 20 August 1970

SOLAR MEETING I

R. Tousey, 'Solar Astronomy, Some Highlights from the Past Year'.

W. M. Burton, C. Jordan, A. Ridgeley and R. Wilson. 'The Structure of the Chromosphere - Corona Transition Region from Limb and Disk Intensities'.

R. M. Batstone, K. Evans, J. H. Parkinson and K. A. Pounds, 'New X-Ray Spectral Data on Solar Active Regions from a Recent Rocket Experiment'.

L. Goldberg, 'XUV Flash Spectrum of the 1970 Eclipse'.

G. S. Vaiana, 'Quiescent and Active X-Ray Corona; Observations and Results'.

SOLAR MEETING II

K. J. Frost: 'Observations of Hard Solar X-Rays by OSO 5'.

J. H. Parkinson, K. A. Pounds, and J. R. Herring: 'Time Variations in the Solar X-Ray Flux from the OSO 5 Data'.

W. M. Neupert: 'X-Ray Spectra Associated with Solar Activity'.

L. W. Acton, R. C. Catura, J. L. Culhane, P. C. Fisher, and A. J. Meyeropp: 'High Resolution Measurements of Solar X-Ray Spectra above 3 keV'.

L. P. van Speybroeck, A. S. Krieger, and G. S. Vaiana: 'X-Ray Observations of the 1970 Eclipse'.

Saturday, 22 August 1970

INTERPLANETARY MEETING

M. Neugebauer: IAU Draft Report "The Interplanetary Medium", read by J. C. Brandt.

J. C. Brandt: 'The Mean Free Path in the Solar Wind Plasma'.

T. Gehrels: 'Results from Polariscope Balloon Flights'.

T. Gehrels: 'The Pioneer F + G Missions to Jupiter'.

STELLAR MEETING I

H. E. Butler: 'Review of Ultra-Violet Stellar Astronomy'.

- A. D. Code: 'Ultra-Violet Stellar Spectra from OAO II Observations'.
B. D. Savage: 'Interstellar Extinction Measurements Based on OAO II Observations'.
W. A. Deutschman: 'Status Report on Project Celestcope'.
J. W. Campbell: 'Photoelectric UV Observations'.

Tuesday, 25 August 1970

COSMIC X AND γ -RAY MEETING I

- L. Gratton: 'X-Ray Sources'.
K. A. Pounds: 'The X and Gamma Ray Background Radiation'.
B. A. Cooke: 'A New X-Ray Survey of the Centaurus-Norma Region'.
J. H. M. Bleeker: 'A Search for Hard X-Ray Emission from the Galaxy'.
V. L. Ginzburg: 'The Effect of Gamma Radiation on the Chemical Composition of Quasars'.
P. Gorenstein: 'X-Ray Observations of the Cygnus Loop'.

COSMIC X AND γ -RAY MEETING II

- R. E. Griffiths: 'X-Ray Line Emission from Sco X-1'.
L. Acton: 'X-Ray Line Emission from Sco X-1'.
W. A. Hiltner: 'Optical Variations of Sco X-1'.
H. M. Johnson: 'A Programme for the Optical Identification of X-Ray Sources'.
J. E. Grindlay: 'Flare Stars as X-Ray Sources'.
T. A. Clark: 'Observations of the Galactic Background Continuum Radiation in the Local System'.

Wednesday, 26 August 1975

STELLAR MEETING II

- D. Morton: 'Results of Recent Rocket Experiments'.
E. B. Jenkins: 'Results of Recent Rocket Experiments'.
C. Navach: 'Ultra-Violet Spectrophotometry of Stars Based on Balloon Borne Observations'.
G. C. Sudbury: 'Low Resolution Photoelectric UV Stellar Observations'.
C. M. Humphries: 'Objective Prism Spectrophotometry from a Stabilized Rocket'.

STELLAR MEETING III

- A. Boggess: 'The Observing Programme for OAO-III'.
A. Boggess: 'Proposed Astronomical Satellite in Geosynchronous Orbit'.

Additional Solar Papers

- V. A. Krat: 'Recent Balloon Observations of the Sun'.
R. M. Bonnet: 'Balloon Observations of the Solar Mg II Lines'.
J. F. Vesecky: 'The Cooling of Solar Flare Plasmas, as Observed by OSO 4'.