U.R.S.I.

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K.R. RAMANATHAN
1893-1984

It is with deep regret that we announce the death of Professor K.R. Ramanathan, the doyen of geophysical sciences, on 31 December 1984 in Ahmedabad, India. Prof. Ramanathan was 92.

He became the Founder-Director of the Physical Research Laboratory at Ahmedabad in 1947, after his retirement from the India Meteorological Department. In his research career spanning more than six decades, he had contributed actively in the areas of meteorology, ozone, airglow, ionosphere, space physics, geomagnetism and radio astronomy.

Prof. Ramanathan started his research career with Prof. C.V. Raman, the Nobel Laureate, when they published in 1923 the pioneering paper on X-ray diffraction of liquids. One of his outstanding contributions came in the field of ozone, especially the vertical distribution of ozone at low latitudes. Prof. Ramanathan's work relating ozone distribution to jet stream, tropopause discontinuities and inter-latitudinal phenomena and his discovery of quasi-biennial oscillation of total ozone in the tropics attracted international attention in the early stages of the ozone era. In addition to ozone, his work on airglow enriched our knowledge of the middle atmoshere. His major contribution on airglow was the estimation of the secondary and higher order scattering in twilight.

The late Sir K.S. Krishnan and Professor Ramanathan were the personalities behind the remarkable success of the Indian programmes for the IGY and the IQSY. Prof. Ramanathan took up the chairmanship of the Indian National Committee for the IGY after Dr. Krishnan's death.

Professor Ramanathan was the Chairman of the Radio Research Committee (which was then the URSI Committee in India) from 1963 till 1973. During his leadership a large number of new programmes in radio science were initiated.

Prof. Ramanathan was Foundation Fellow of the Indian Academy of Sciences, Honorary Fellow of the Royal Meteorological Society in London, President of the Indian Association of Meteorology (1951-54) and of the International Ozone Commission

(1960-1963) and Honorary Member of this Commission until his death.

Prof. Ramanathan was President of the Mathematics and Physics Section of the Indian Science Congress Association (1939), Member of the Council of ISCA (1942-44), and Vice-President of INSA (1955-56). He was awarded the International Meteorological Organization Prize in 1961 and was elected President of the International Union of Geodesy and Geophysics in 1957.

In recognition of his eminent work, the Government of India honoured him with the Padma Bhushan in 1965 and the Padma Vibhushan in 1976. He was also awarded the Aryabhatta Medal of the Indian National Science Academy in 1977.

ERNST-AUGUST LAUTER
1920-1984

With deep sorrow we announce the untimely death of Professor Dr. Ernst-August Lauter, Ordinary Member of the Academy of Sciences of the German Democratic Republic, on 21 October 1984 after a fatal illness at the age of 64.

Professor Lauter was a member of the URSI Committee in the German Democratic Republic, and a member of the former URSI Committee for solar-terrestrial physics.

Prof. Lauter started his scientific career in 1947 with observations of the ionospheric D region. In 1951, he initiated the Observatory of Ionosphere Research at Kühlungsborn, which in the sequel bore the stamp of his scientific activity.Always devoting much energy to advocating and fostering the development of interdisciplinary solar-terrestrial research and international collaboration in this field, he became the first Director of the Central Institute of Solar-Terrestrial Physics of the GDR Academy of Sciences, founded in 1969.

Prof. Lauter was one of the first to promote, in the early 70-ies, the idea of an international cooperative programme for the study of the stratosphere, mesosphere, and lower ionosphere, which later on took shape in the present Middle

Atmosphere Programme, MAP.

Of his numerous significant contributions to middle atmosphere sciences, we should mention here

- the development of diagnostics of structure and dynamics of the mesopause region by means of ground-based radio techniques (absorption and phase-heights);

- extensive studies, based on these methods, of the relations between mesospheric and stratospheric dynamics, especially in winter and during the seasonal transition periods, and

- his discovery, already in 1950, of the post-geomagnetic storm after-effects (PSE) in the D region, which he took up again in the late 70-ies with a comprehensive analysis and study of the PSE mechanisms, related to high energy particle precipitation from the magnetosphere. He also first recognized the control of PSE effects by the interplanetary magnetic sector structure.

Prof. Lauter's vivid personality was characterized by his enthusiasm in science and abundance in ideas, much stimulating his studies and collaborators, always setting an example by his own restless work. Until his last days he was still busy with studies of solar forcing of atmospheric changes, and coupling between middle and lower atmosphere.

His memory will be kept alive by a large number of colleagues in his country and abroad.

J. Taubenheim

URSI FACTUAL STATEMENT ON NUCLEAR ELECTROMAGNETIC PULSE (EMP) AND ASSOCIATED EFFECTS

This Statement was prepared by a Committee chaired by Mr. Manuel Wik, and consisting, in addition, of Dr. W. Ross Stone (Secretary), Prof. D. T. Gjessing, Dr. F. Lefeuvre, Mr. P.O. Lundbom, Prof. V. Migulin, Prof. S. Schwartz and Prof. F.L. Stumpers. Mr. Wik's address is:

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DISCLAIMER

All material in this document is based on what is available in the open literature. Participation in the preparation of this document does not constitute more than an affirmation that the material in the document is consistent with what is in the open scientific literature. Such participation and the information neither confirm nor deny the validity of such information.

PREFACE AND ACKNOWLEDGMENTS

This factual statement on nuclear EMP and associated effects was prepared by URSI (International Union of Radio Science) during the URSI XXI General Assembly in Florence, August 1984. The Statement was requested by SCOPE - ENUWAR (Scientific Committee on Problems of the Environment - Environmental Consequences of Nuclear War) within ICSU (International Council of Scientific Unions) and should be unemotional, non political, authoritative and readily understandable.

The Statement was unanimously approved (in principle) by the URSI Council meeting on 6 September 1984.

Due to the limited time available during the URSI General Assembly some editorial work, including some remarks at the Council meeting, was left to be done.

For better clarity headings have been added and some paragraphs rearranged. In the conclusions the most important statements have been repeated. New paragraphs have been added concerning:

- "Low altitude EMP" (in accordance with discussion at the Council meeting);
- "Transient radiation effects (TRE)" (which was referred to in the Introduction);
- the Argus effect (under "Radio wave propagation and long-term radiation effects");
- the objectivity of assessments (under "Testing and assessments").

The Nuclear EMP ad hoc Committee and the URSI Council delegates have not had time to comment on this editorial work. Such comments are encouraged.

The Committee is grateful to those URSI delegates who have taken active part in the preparation of this factual statement during the URSI General Assembly in Florence.

FACTUAL STATEMENT

1. INTRODUCTION

Communications, electronic control and electric power systems are fundamental to modern society. Without them there would be risk of widespread chaos if outages were to last for many hours or days. Nuclear explosions can create blast,ground shock, thermal and nuclear radiation and electromagnetic pulse (EMP) effects. In this document emphasis is given to widely distributed environmental consequences on electric and electronic systems due to EMP rather than to the more local effects. EMP from exoatmospheric or high altitude bursts and associated electromagnetic effects, transient radiation effects (TRE), and radio propagation changes are described. Further information and technical and scientific reports can be found in the open literature, and even more has been classified for military and other reasons.

2. HIGH ALTITUDE EMP

2.1 Phenomenology

Early Time EMP Environment

High altitude nuclear explosions can cause disruption of communications and electric power systems *even though other* *nuclear effects such as shock, heat, and radioactive fallout are not present at ground level.*

The electromagnetic pulse generated by a single high altitude explosion could have a devastating effect on communications and power systems over the whole area of the earth, that can be viewed from the burst location, covering a country or a continent, and cause more or less widespread communication and/or power black-outs.

The explosion emits gamma rays with times of the order of nanoseconds. The gamma rays that travel downward will reach denser atmospheric layers at a height of 20-40 km and at this pancake-shaped zone, known as the deposition region, the gamma rays strip electrons from air molecules. This process is called the Compton effect. The free electrons initially move in an average radial direction (from the detonation point). In the presence of the earth's magnetic field these electrons are deflected to give a transverse component to the current, which in turn produces a radially directed (and therefore directed toward the earth's surface) high-amplitude pulse of electromagnetic energy.

This EMP interacts with all sorts of metallic conductors which by design or by accident act as resonant antennas. The energy induced in conductors will find its way to connected objects where it is dissipated as heat, in some cases in combination with flashhovers. The electric field-strength of the pulse can be millions of times greater than those normally used for radio communications, e.g. some 10^{11} times larger than radio fields that could be received by an FM radio receiver. The rise-time of the pulse is less than 10 nanoseconds and its duration is of the order of a few 100 nanoseconds. The rise-time and duration of the EMP field differ significantly from those of lightning and power transients. Thus, protection against these effects will not necessarily protect against EMP.

In a widespread network, pulses might be able to destroy or interfere with connected devices almost simultaneously in a number of places. Lightning and power transient stress levels are thought to exceed those for EMP for many situations. However, the simultaneous appearance of EMP induced pulses in most parts of complex networks is a completely new situation that under some circumstances can affect network stability and performance in a serious way. There may be additional, quite significant effects on synchronous (e.g. power) networks.

Instability and accumulated stress could also be the result of several EMP's.

Late Time EMP Environment

A nuclear explosion also causes a disruption of the earth's magnetic field. This can result in a second type of damaging electromagnetic pulse of much lower magnitude but longer duration (hundreds of seconds). This is known as the magnetohydrodynamic EMP (MHD-EMP), in some way comparable to auroral geomagnetic storms. The MHD-EMP fields can disrupt very long landlines and submarine cables, including telephone cables and power distribution cables.

2.2 Environmental Consequences

Society has entered the information age and is more dependent on electronic systems that work with components that are very susceptible to small but excessive electric currents and voltages. For example, telecommunication networks, high voltage power supply networks, railway networks, air traffic, water supplies and process industries are all controlled and regulated by equipment which usually contains semiconductor components which are susceptible to EMP effects.

High altitude nuclear explosions could thus "knock out" radio receivers and other communication, electronic and electric equipment temporarily, if not permanently, by overloading and damaging the front ends, various cable terminations and internal circuitry, both by coming through intentional antennas and other paths that are unintended. However, whether or not this occurs depends strongly on the design and configuration of the system.

EMP and associated effects will vary considerably due to a number of factors, including the following: burst location and observation points; type of weapon; yield; number of bursts; type of exposed system and its topology; direction and length of exposed conductors; susceptibility of subsystems; and protective measures taken.

Several questions can be raised concerning the impact of high altitude EMP and associated effects on communications and power systems in case of nuclear exchange. Can people still use their radios? Do the nationwide telecommunication networks still function so that information about the radioactive fallout situation and weather forecasts can be distributed? Do the communication systems needed to re-establish electric power, water and food supplies and other vital requirements work? Can electric power for light, heat, water, and gasoline pumps be obtained? Which transportation systems can be used? Do the hotlines between the political leaders still function, so that the conflicts can be solved politically and not militarily? Are the command, control and communication systems intact so that defence systems are under control?

It is clear that current landline and satellite communication systems and domestic power grids may be at a serious risk. As an example there have been various recent incidents in several countries where regional and national power grids have failed totally because a few elements of the system failed and a cascade effect resulted. Any practical assessment must anticipate massive failures of communication systems, power supplies and electronic equipment. The effects of this on the civilian population could cause chaos, and the possible disruption of communication grids could have major significance for the development of a nuclear exchange.

Electric power grids often use nationwide overhead power lines that act as unintentional antennas and collect EMP energy. Many power stations are computer controlled and involve components that are very sensitive to electromagnetic transient overstress. However, the most serious situation are possible long time outages that could arise if damage occurs to any unique high voltage equipment, such as some larger, specially designed transformers. If there is not enough redundancy and flexibility in the power system, this might result in a power outage until new equipment has been manufactured and installed.

2.3 Protection

Today EMP analysis, testing, and protective design is a discipline in which there is much scientific work done. Yet, additional research on many aspects of EMP is necessary. For decision-makers and for those responsible for civil defense, telecommunications, and electric power administrations awareness of these effects is a must if protective measures are to be taken in order to reduce system susceptibility.

Protection against EMP commonly includes shielding, filtering, transient protection using surge arresters and other more specialized techniques. However, the protection (usually termed "hardening") of a power or telephone network is vastly different from the hardening of a radio receiver. As one example, a rapid changeover to optical fibre cables is occurring in telecommunication networks. This provides a unique opportunity for planning exclusive EMP-protected communication channels superposed on the ordinary networks. Nevertheless, one must then also be prepared to spend the additional amount of money for these less vulnerable communication networks.

It is unlikely that complex systems can be completely protected against EMP. However, just as a given level of reliability can be attained for a given effort and cost in design and engineering, so is the degree of hardening achievable dependent on the amount one is willing to spend on the hardening process.

It is vital to be aware that hardening can be accomplished much more economically in almost every case if it is brought in at the planning and design stages, rather than if an attempt is made to add it at some later time.

2.4 Testing and Assessments

The understanding of EMP simulation and system testing is important to achieving protection and to measuring the degree of protection achieved. The complexity of the phenomena and the inability to test them with actual EMPs make fully verified assessments impossible although sophisticated analysis and testing techniques exist and are widely used.

It is important to maintain a sound scientific basis for the assessments of the effects. This implies that there be a certain objectivity in any assessment. In particular it is important that highly qualified scientists and engineers and their organisations be utilised which have nothing to gain by hiding deficiencies, for this task. As in any good scientific discipline the results of such assessments must be subjected to peer review and must be fundamentally based on experimental data (testing), if one is to have confidence in the accuracy of the results.

3. OTHER RELATED EFFECTS

3.1 Low Altitude EMP

Low altitude nuclear explosions create blast, ground shock, thermal radiation, prompt nuclear radiation, fallout and electromagnetic pulse (EMP) effects. Electric power grids and communication networks are vulnerable to most of the effects. It is possible that in some cases because of EMP failures will extend far outside the region where most objects are damaged by the usual blast and thermal effects. However, at least for civil systems this EMP effect does not appear to be nearly as significant as the widespread effects of high altitude EMP effects.

3.2 Radio Wave Propagation and Long-term Radiation Effects

Depending upon the scenario, nuclear bursts can also modify the atmosphere and ionosphere and affect radio wave propagation at all frequencies from a few Hertz through tens of Gigahertz.

They also create intense radio-frequency noise. The bursts increase the electron and ion densities, and there are large- and small-scale structural modifications, and long-term chemical changes. The actual propagation disruption patterns depend on many factors, and are very complicated. The propagation effects can cause block-outs for at least several hours, especially for shortwave communications. Questions also remain about whether satellite signals would be able to penetrate the ionospheric disruptions from high-altitude bursts.

An additional radiation effect that can disturb terrestrial radio wave propagation and communication satellite functioning is the Argus effect. By this phenomena charged particles spiral around the paths of the earth's magnetic field.

The nuclear explosions can also produce artificial electron belts that can persist for months. The ionizing dose to electronic components in space installations can reduce performance and lifetime. Other effects could result from different scenarios.

3.3 Transient Radiation Effects (TRE)

Transient radiation effects (TRE) are primarily caused by the prompt gamma, neutron and X-radiation. Transient and sometimes permanent changes in the performance of semiconductor components and other sensitive components and material can occur. These effects are of special concern in space for communication satellites where the atmosphere is not present to filter out the radiation environment.

3.4 System Generated EMP (SGEMP)

In outer space, communication satellites can be exposed to gamma and X-rays at considerable distances from a nuclear burst. The interaction of this radiation with the system also produces what is termed system generated EMP (SGEMP). This SGEMP can be a significant threat to many satellite systems.

4. CONCLUSIONS

Nuclear EMP is one of the effects of nuclear weapons. The awareness of the high altitude EMP threat in different scenarios and the protection problems should be widely spread and taken seriously. This brief document touches only on a small portion of the known effects of EMP and associated effects. It is intended to make workers outside this field aware of:

1) The existence of nuclear EMP phenomena.

2) The fact that high altitude EMP effects can occur even though other nuclear effects such as shock, heat, and radioactive fallout are not present at ground level.

3) The fact that these effects can cover the whole area of the earth, that can be viewed from the burst location, e.g. a country or even a continent.

4) The potentially serious nature of the effects of high altitude bursts to telecommunications and power systems.

5) That in consequence, the possible disruption of communication grids could have a major significance for the development of a nuclear exchange.

6) That the possible disruption of power grids in large areas could cause chaos and lead to the collapse of the infrastructure of modern society if outages were to last for a longer time.

7) The various serious effects on satellite communications.

8) The techniques for protection against EMP and associated effects.

9) The necessity for valid testing and assessments of system performance in EMP environment.

It is hoped that the information presented in this statement and its scientific basis will emphasize the need to recognize the seriousness of nuclear EMP and associated effects.

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NEWS FROM MEMBER COMMITTEES

NATIONAL URSI SYMPOSIUM IN CAIRO

A National URSI Symposium was held in Cairo from 10 to 12 March 1984. The meeting was organized by the URSI Committee in Egypt and supported by the Academy of Scientific Research and Technology. It was hosted by the Military Technical College. Ten sessions were organized, during which 41 papers were presented, mainly in the areas of Commissions B, C and F. Three papers originated from foreign countries.

RADIO SCIENCE IN INDIA - SIR J.C. BOSE TO PRESENT DAY

The following lecture has been delivered on 26 November 1984 by Dr. A.P. Mitra, President of URSI, as the Acharya Jagadish Chandra Bose Memorial Lecture of the Institution of Instrumentation Scientists and Technologists of India.

Radio science in India, now quite vigorous and internationally competitive, really started with the pioneering work of Sir J.C. Bose. The period 1888-90, known as the "period of the Hertzians", saw the beginning of microwave devices and microwave optics, later, unfortunately, to be forgotten for several decades after Marconi's spectacular experiment on radio communication with longer wavelengths. This was a period of radio science giants: Hertz, Oliver Lodge, Righi and his student Marconi from Italy, and Sir J.C. Bose from India. The starting event was the first launching of electromagnetic waves (66 cm) by Hertz in 1888 with a parabolic reflector fed by a dipole excited by spark discharge. Bose's contributions to microwave generation and detectors and in microwave optics were of the highest quality, using materials that were easily available, and in that process introducing several new concepts.

Bose used frequencies between 5 mm and 2.5 cm. Some of his ideas and inventions were:

- "Shielded lens" concept: by putting circular cylinder at end of tube.
- Microwave absorbers: blotting paper dipped in electrolyte.

- Hollow tube "waveguide" radiator: with or without a lens. At lower frequencies, tube behaved as slightly oversized waveguide; at 5 mm, behaved as a shield, producing higher order modes.
- Microwave optics: in 1897, brought to Royal Institution of London a "microwave optics" set up, in which Bose used for the firstline a "pyramidal horn" (first flared waveguide arrangement).
- Microwave analog physics: macroscopic models of molecules of twisted jute fibres with lefthanded and righthanded twist.

The next major step was taken some 30 years later with the installation in Calcutta in 1923 of the first broadcast transmitter by a private firm called The Indian States and Eastern Agency. Shortly after the discovery of the ionosphere, Prof. S.K. Mitra and his students initiated the first ionospheric measurements in India in 1930 by utilizing the Calcutta transmitter and a simple receiving equipment at a distance of 70 miles from Calcutta. An interesting observation was the detection of echoes from very low altitudes around 55 km which S.K. Mitra referred to as the "C layer". The Calcutta group also participated in the annular solar eclipse of 21 August 1933. Critical frequencies were measured for both the E and F layers for the eclipse (21 August) and control days (20 and 22 August 1933). E region ionized reached a minimum 20 minutes after the time of maximum obscuration which made him conclude that ultraviolet radiation must be the principal ionizing source for the E layer.

In 1935 Prof. Mitra presented a "Report on the Present State of our Knowledge of the Ionosphere" at a meeting of the National Institute of Sciences. This, with revisions carried out over a period of 10 years, came out as the book "The Upper Atmosphere" in 1947 (and a revised edition in 1954). In this, he projected the ionosphere as a part of the upper atmosphere. Even at that time he had an entire chapter on the Earth's thermal structure and developed model profiles of the atmospheric temperature and density which happened to be one of the few that Soviet scientists could use when Sputnik I was launched.

In the 30's another school of ionospheric research was also developing in the Allahabad University which M.N. Saha had joined. Jointly with G.R. Toshniwal investigations were started on the third and fourth conditions of reflection of radio waves and on fundamental studies of ionospheric layer formation. With the departure of Saha to Calcutta in 1939,this activity gradually tapered off. Research schools in ionospheric investigations were also set up by the All India Radio, in Dacca by S.R. Khastgir and at Banaras by S.S. Banerjee.

Both Saha and Mitra felt the need of setting up a National Radio Research Board to support, monitor and encourage Radio Research Centres in the country. For this purpose on 5 May 1936 Mitra invited a number of distinguished British scientists to a dinner to discuss the desirability of creating a Radio Research Board in India. The guests included Sir Edward Appleton, Prof. Sydney Chapman, Sir Robert Watson Watt, Dr. R.L. Smith-Rose, Prof. E.N. Endrade. However it was not until 1942 that the Radio Research Committee was formed with S.K. Mitra as its first Chairman.

The formation of the Radio Research Committee in India was a turning point in radio science in India. For the first time funds and support couldbe provided to several groups in Universities. Research began to be supported in a wide range of areas: atmospherics, measurement of radio noise, indigenous systems of radio components, ionospheric investigations. An ultrasound and microwave panel was set up. Several research schemes on the manufacture of radio components were carried out with the support of this Committee in areas such as carbon microphones, loudspeakers, volume controls, carbon resistances, vitreous resistances, microwave condensors and general utility condensors. A survey was made of the possibility of starting a radio industry in this country as also a document on the existing facilities for testing and standardization work.

When the IGY came, a very sound base on radio science had been created. The Physical Research Laboratory had been established at Ahmedabad under the leadership of Sarabhai and Ramanathan and the Radio Propagation Unit had been formed at the National Physical Laboratory. The latter started the job of coordinating the ionospheric data in India and also the work of prediction of solar activity needed for radio communication predictions. Recognising that the use of radio frequencies must in future extend beyond the limited range of 500 KHz to 20 MHz, a new technique which had been developed a few years earlier by Mitra and Shain in Australia was introduced in India. This was the use of radio noise from our Galaxy - the so-called cosmic radio noise - at a frequency exceeding, but close to, the critical frequency of the F region of the ionosphere. This was later extensively used during the IGY and became a major tool for the study of the ionosphere and the sun and, in particular, in the detection of solar proton events in the high latitudes (the PCA's). Another important technique introduced in which Indian scientists played an important role was the use of 3-station ionospheric drift technique. Radio techniques of a wide variety were commissioned for the detection of solar flares: use of atmospherics, cosmic radio noise, ionosondes, radio emission from the Sun. India's special position near the geomagnetic equator was utilised. A network of 11 ionospheric stations was organised ranging over latitudes from 28° 38'N to 08° 29'N. As many as five were in the anomalous equatorial zone. Trivandrum was located almost exactly on the magnetic equator, Kodaikanal on the fringe of the electrojet and Tiruchirapally in the middle of it. They were (excepting Calcutta) all nearly around the same longitude: 75° E - an unusual advantage that was immediately recognised.

In the 50's the NPL had already organised a Time and Frequency research activity, using the "Essen" ring crystals developed by the British Post Office and by broadcasting the time signals under the call sign ATA at 10 MHz from 1959.

In the early 60's whistler observations were undertaken at Banaras Hindu University under Khastgir and Tantry, and some pioneering work on whistlers was conducted, first in Gulmarg and later in the low latitude station at Varanasi. In fact the early low latitude whistler observations were reported from that place.

Space radio research began as early as 1957. When the first satellite was launched radio scientists at NPL and elsewhere started recording the telemetry transmission from the satellite. Serious radio beacon observations, however, began later with the satellite COSMOS 5 at frequencies of 20, 40 and 41 MHz. A rocket launching facility was set up at Thumba on the geomagnetic equator in 1963. Although the first experiment was the release of sodium vapour for the measurement of upper atmospheric drifts, subsequent experiments included techniques of radio science interest.

In 1963 the Government of India appointed, under the chairmanship of H.J. Bhabha, an Electronics Committee to prepare a 10-year development plan for electronics. The Bhabha Committee Report marks another landmark in the development of radio science in the country. It covered recommendations in many areas of development of radio interest in India, including (1) raw materials, (2) components, (3) servo and control systems, (4) electronic test instruments, equipments and components, (5) radio and TV broadcast, entertainment electronics, (6) telecommunication system, radio, VHF, (7) microwave systems, radar.

Radio astronomy at this time began a very rapid growth in India. A systematic programme of measurements of spectrum and polarisation at metre wavelengths and radio flux at 10.7 cm (used widely as a measure of solar activity) was undertaken. A solar radio spectroscope was set up by the PRL in the frequency range of 40-240 MHz in May 1967 for the study of solar radio bursts. The most spectacular facility was, however, the radio telescope built by TIFR at Ooty. It operates at 327 MHz and has an effective collecting area of 8000 m^2 with a 530 m long cylindrical antenna array. It was designed primarily for lunar occultation observations of weak (and thus very distant) extragalactic sources. The long N-S axis was made parallel to the Earth's axis of rotation; this was done by placing the telescope on a north-south slope equal to the latitude of the place. Since 1970, occultations of over 1000 sources have been observed; these have had an important impact on the theories regarding cosmological evolution.

Early 70's saw the beginning of intense troposcatter research in India. There was already a sizable activity in radio meteorology. Indigenously designed radiosondes for upper air meteorological observations had been in operation for more than two decades. Radars were also being extensively used: X-band radars had been introduced in the mid 50's for detection of thunderstorms and S-band radars in the mid 60's on the East and West coasts for detection of cyclonic storms. Radio refractivity computations had also begun in early 60's, on the basis of radiosonde data. Anomalies had been seen in several VHF links and in TV propagation. But the main impetus came from: (a) the desire in India to establish transhorizon troposcatter links, and (b) the increasing sophistication and requirement of radar operation. Consequently, radar and troposcatter system research was initiated at the 5 IITs, the Indian Institute of Science in Bangalore, the Roorkee University and the National Physical Laboratory. A wide variety of activities were initiated: phased array radars, establishment of troposcatter links, monitoring of tropospheric radio parameters through radiosondes, introduction of new techniques of monitoring, etc.

One of the most important work at that time was the preparation by the NPL and the IMD of an Atlas of tropospheric radio refractivity over the Indian sub-continent. The Atlas has since been used as a basic reference document for most troposcatter and radar systems in India.

Several experimental links were set up. One was the troposcatter link at 2.1 GHz set up between Nainital and Kanpur using a 1 KW transmitter located at Nainital and receiver at Kanpur. The distance between the two was 330 km. For characterising the radio refractivity conditions over the path a microwave refractometer loaned by the USA was used in an aircraft.

New techniques of tropospheric monitoring were introduced: one such technique was the sodar. The sodar is essentially an acoustic monitoring of atmospheric inhomogeneities. The sodar that was set up at the NPL operated at a frequency of 2 KHz, had a height range of about 600 metres and initially used a microwave dish and acoustic sources embedded in the ground with sandbags as shields. This improvised model had been continuously improved over the years with different antenna systems; horns, parabolic dishes and shields of various types such as polyurethene foam. The sodar provided the first detailed mapping of the ducting conditions.

Another technique that was used with advantage for tropospheric studies was the radio beacon signals from orbiting satellites at very low angles ($< 5°$). At these angles fadings can have tropospheric origin; such tropospheric disturbances were detected at Delhi by the NPL.

The third technique was the use of ground-based microwave radiometers designed and installed at 11, 18 and 22.3 GHz to monitor rain attenuation and water vapour in the atmosphere. Rain attenuation measurements were made simultaneously with rain rate measurements with an electronic rain gauge built specifically for this purpose and with time resolution of 10 seconds. By combining troposcatter specific link observations at two frequencies with initial refractivity gradients measured with the radiosondes, a new tropospheric transmission loss prediction system was worked out which has since been extensively used in the country.

One of the most important national efforts in the area of radio science in the mid 70's was the programme connected with the ATS-6 satellite. There were two major programmes: (1) relating to direct reception of TV signals from about

2330 villages in six widely separated direct reception clusters and (2) a planned network of satellite radio beacon receiving equipments operating in different parts of India at one or more designated frequencies: 40, 140, 360 and 860 MHz. The direct broadcast satellite programme (known as SITE) was a unique experiment conducted jointly by ISRO and NASA of the USA. The primary purpose was to bring TV to backward and remote villages of India through direct reception of signals from the satellite. Programmes were broadcast 4 hours every day; the subjects included family planning, agriculture, health and hygiene.

While the SITE programme was operationally an exciting adventure, the second aspect of the ATS-6 programme, the satellite beacon experiment, was also scientifically exciting. ATS-6 was the first geostationary satellite available to a wide community of Indian ionospheric scientists: its coverage of frequencies extending from 40 MHz to 860 MHz offered scope for study of the frequency effects in scintillation, including those at 860 MHz than considered too high for ionospheric effects. An extensive network of stations could be organised extending from the geomagnetic equator to about 27°N geomagnetic latitude and located mostly around 75°E longitude. It was possible to observe and study ionospheric scintillations that are known to be particularly severe in the equatorial belt. Another special feature was the availability of the Ooty telescope for measurement of scintillation of selected radio stars in the same time frame.

The late 70's also saw a major new dimension in time and frequency dissemination and calibration. This came in two ways: (a) through the replacement of old quartz clocks by caesium atomic clocks and (b) from the use of satellites. The French-German satellite Symphonie was used to synchronize: (a) two atomic clocks located in Madras and Ahmedabad, and (b) externally between NPL (India) and PTB (West Germany), the latter with a precision of better than 10 μs.

Remote sensing with the satellites BHASKARA I and II was the next major milestone in radio research in India. There were two radiometers in BHASKARA I (19.5 and 22.235 GHz) and three in BHASKARA II (19.35, 22.235 and 31.40 GHz). With these frequencies different types of information could be obtained: through the 22 GHz radiometers atmospheric water vapour content; and through all frequencies information on "sea state" and rainfall rates.

An exciting event was the occurrence of the total solar eclipse over India on 16 February 1980. Observing programmes included: optical astronomy, radio astronomy, ionosphere, atmospheric physics, geomagnetism and life sciences. Of special interest to radio science was a carefully coordinated and planned series of rocket experiments for measuring the changes of ionization during the solar eclipse in three rocket ranges - Thumba, SHAR and Balasore. In Balasore the eclipse was almost total whereas in SHAR and Trivandrum obscuration was about 90% and 80%. A network of satellite radio beacon receiving stations, spread from Patiala to Trivandrum and receiving transmission from the Japanese satellite ETS-II, looked for eclipse induced gravity waves. Radio astronomers took advantage of the sharp edge of the moon to make high resolution scanning of solar radio emitting regions at centimetre wavelengths.

In radio astronomy several new major developments are taking place. One is the development in Ooty: the big cylinder was combined with 7 other baby cylinders (26 cm x 9 m), all steerable, to produce a 4 km synthesis radio telescope sensitivity of about 15 mJys.

A decameter radio telescope operating on 34.5 MHz was set up at Gauribidanur as a joint project of the Raman Research Institute and the Indian Institute of Astrophysics. The telescope has a resolution of 28 arc sec x 40 arc sec and has a sensitivity of 30 Jansky.

A mm radio telescope with a 10-metre antenna is under construction at the Raman Research Institute. Two types of programmes are planned: the first to determine the continuum flux from quasars and compact nuclei of distant galaxies; the second objective is molecular lines spectroscopy.

An interesting work concerns the study of interplanetary scintillations (IPS); these occur when radio waves from a distant compact radio source (such as a quasar) propagate through the interplanetary medium where these are scattered by irregularities in plasma density of scale sizes 100 km. The PRL is constructing a three-station array on a frequency of 103 MHz at Thaltej (near Ahmedabad), Surat and Rajkot.

An interesting experiment performed in December 1983 involved very long baseline interferometry (VLBI) in which the participating observatories were Ooty (India), Jodrell Bank (UK), Westerbork (Holland), Torun (Poland) and Crimea (USSR).

The observations continued for 10 days and tens of sources (galaxies, quasars, etc.) were monitored. A crucial component of the experiment was a high level clock synchronization. This was achieved with two rubidium clocks provided by the NPL and the P and T. The clocks were linked to the primary NPL caesium clock, with a synchronization of 10/us.

In addition, there have been several new developments in radio metrology: establishment of Josephson voltage as a standard, farad and ohm have been linked with length standard through a specially designed calculable capacitor, so that second-metre-ohm ampere-volt have now become interlinked.

In 1982, the Indian Middle Atmosphere Programme (IMAP) was taken up, as a part of the International Programme, to study the region between 15 and 85 km with a multiplicity of techniques: optical, radio, acoustic and with sensors on the ground, in balloons and in rockets. A number of major radio techniques have been commissioned: meteorological radar at 50 MHz at Thumba monitoring winds around 80-100 km; a partial reflection radar at metre wavelengths at Ahmedabad for mesospheric ionization; a pulsed Doppler VHF backscatter radar at Thumba operating on 54.95 MHz to obtain signal strength and Doppler frequency spectrum of electrojet echoes; rocket and balloon borne systems to monitor middle atmospheric ionization and electric field; ground-based microwave radiometers to monitor atmospheric water vapour and its role in microwave propagation problems; and most importantly, the effort to establish in India, preferably within a latitude range of 10-14°, an MST radar. The radar, for which the design and feasibility studies have been completed, and the construction work is to start soon, will operate at a frequency around 45-55 MHz, with transmitter peak pulse power around 2.4 MW (24 modules of 100 KW peak power each), coaxial collinear antenna arrays of aperture 2.1×10^4 m^2, a beamwidth of 3 degrees. When this radar is set up, it would be possible to monitor continuously atmospheric winds from close to ground to 90 km with a gap around 35-55 km. Even before the entire facility is operational an ST system (Stratospheric-Tropospheric system) will be available, since the system is modular in concept.

A new and exciting chapter on radio science began as the M.V. POLAR CIRCLE reached the Antarctica on 9 January 1982 with an Indian group of scientists and engineers. Amongst the wide variety of experiments planned and successfully conducted there were several of them relating to ionospheric physics and radio propagation. Subsequently in the second and third expeditions other experiments were added: those relating to subsidence layers over the cruise path and at the base camp as inputs to tropospheric communication, and the use of riometers. The basic philosophy of these experiments has been twofold: (a) improvement of the International Reference Ionosphere, and (b) looking for radio evidence of low latitude - high latitude coupling.

BUREAU INTERNATIONAL DE L'HEURE
(BIH)

NOTE ON THE ORGANIZATION
OF THE BUREAU INTERNATIONAL DE L'HEURE

On 1 March, the activities on Time (atomic time and related matters) of the Bureau International de l'Heure (BIH) have been transferred from the Paris Observatory to the Bureau International des Poids et Mesures (BIPM), while the activities on the Rotation of the Earth remain at the Paris Observatory.

The organization of BIH is henceforward as follows:

Director: Mr. B. Guinot, BIPM

Section of Time

Head: Mr. B. Guinot
Direction et Section du temps
Bureau International des Poids et Mesures
Pavillon de Breteuil
F-92310 Sèvres (France)
Tel. (1)534.00.51 - Telex BIPM 201067 F.

Section of the Rotation of the Earth

Head: Mrs M. Feissel
Section de la rotation terrestre
Observatoire de Paris
61 avenue de l'Observatoire
F-75014 Paris (France)
Tel. (1)320.12.10 - Telex OBS PARIS 270776 F.

The correspondence of administrative and general character should be sent to the Director of BIH.

The correspondence of scientific and technical character should be sent to the Heads of the appropriate sections.

This new organization brings no changes to the services provided by the BIH.

4 March 1985 B. GUINOT

UTC TIME STEP
on 1 July 1985

A positive leap second will be introduced at the end of June 1985. The sequence of dates of the UTC second markers will be:

1985 June 30, $23^h\ 59^m\ 59^s$

1985 June 30, $23^h\ 59^m\ 60^s$

1985 July 1 , $0^h\ 0^m\ 0^s$

The difference between UTC and the International Atomic Time TAI is:

from 1983 July 1, 0h UTC, to 1985 July 1, 0h UTC:

UTC-TAI = - 22 s

from 1985 July 1, 0h UTC, until further notice:

UTC-TAI = - 23 s.

B. Guinot

THE INTERNATIONAL COUNCIL FOR SCIENTIFIC AND TECHNICAL INFORMATION (ICSTI)

The International Council for Scientific and Technical Information (ICSTI) was established in June 1984 as the successor to the International Council of Scientific Unions Abstracting Board (ICSU AB). Like its predecessor, it is an international, not-for-profit organization.

The purposes of ICSTI are to increase accessibility to, and awareness of scientific and technical information, and to foster communication and interaction among all participants in the information transfer chain, in order to develop appropriate tools better to meet the information requirements of the world community of scientists and technologists.

In its new technical programme, ICSTI has retained current activities of ICSU AB relating to improvement of abstracting and indexing activities in the various disciplines, document delivery, copyright issues, and has introduced a number of new activities dealing with data handling, new information technology and legal aspects of information transfer.

Membership in ICSTI includes all previous members of ICSU AB, i.e. the world leading abstracting and indexing services in the natural and physical sciences, mathematics and technology, International Scientific Unions in various disciplines, and national members. All participants in the information transfer chain - generators, processors and users - are now welcome as members.

ICSTI is a Scientific Associate of the International Council of Scientific Unions (ICSU), which is its sponsoring body.

Further details are available from:

Marthe Orfus
Executive Secretary, ICSTI
51 boulevard de Montmorency
F - 75016 Paris, France.

Telephone: (33) (1) 525 65 92
Telex: ICSU 630553 F.

SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY

Tokyo, 16-18 October 1984

Increasing interest in electromagnetic compatibility (EMC) science and technology is confirmed by the steadily growing number of EMC conferences. For a long time the American yearly EMC meeting was the sole one. In 1972 the Wrocław EMC biannual Symposium was started in Poland, three years later the Swiss Conference was launched, and than similar meetings took place in France, in the United Kingdom and elsewhere. The Tokyo EMC 84 was the first symposium on electromagnetic compatibility organized in the Far East; it gathered more than 500 participants.

The Symposium was organized in cooperation with three Departments of State (Ministry of Posts and Telecommunications, Ministry of Education, Ministry of International Trade and Industry); three international or transnational organizations (URSI Commission E, CISPR, IEEE EMCS); eleven Japanese organizations (Science Council of Japan, Institute of Electronics and Communication Engineers, Institute of Electrostatics, Institute of Electrical Engineers, Institute of Television Engineers, Information Processing Society, Society of Instrument and Control Engineers, Society of Medical Electronics and Biological Engineering, Society of Applied Physics, Society of Automotive Engineers, and Commemorative Association for the Japan World Expo 70). The large number of various bodies collaborating can serve as a good indicator of how wide is the nature of EMC discipline, and of how great is Japanese ability to work collectively.

The Symposium Chairman was Prof. R. Sato, the Secretary Prof. T. Takagi. The technical programme featured 26 sessions, technical excursions, and a technical exhibition. 193 papers were given in the sessions entitled: "Historical Reviews, Radio Noise Interference Activities in Japan", "EMI/EMC Test", "Noise", "EM Sensor and Antenna", "EM Interference", "EMC in Mobile Communication", "Immunity", "EMP, ESD and Simulation", "Biological Interactions of EM Energy", "EMI Measurement", "EMI/EMC in Device and Equipment", "EM Wave Propagation", "EM Shield and Absorber", "Filter and Signal Processing", "Scattering and Ghost", "Lightning Surge (URSI)", "Standard and

Measurement", "EMC in Communication Systems", "EL Coupling and Crosstalk", and "Electromagnetic Environment".

31 exhibitors used the opportunity to introduce their products and to discuss applications with the participants.

The Conference Proceedings: "1984 International Symposium on Electromagnetic Compatibility - EMC '84 Tokyo" (2 volumes, 960 pages) are available from IEEE Service Center, 445 Hoes Lane, Piscataway, New Jersey 08854, USA (1984 International EMC Record Number: 84-CH2097-4).

R.G. Strużak

International Workshop on Nonlinear and Environmental Electromagnetics

The Workshop, sponsored by URSI Commission E, was held in Tokyo on 19 October 1984. This was a response to a growing interest in the electromagnetic environment in general, and in the impact of electromagnetic pulses, nuclear and of natural origin, on man-made systems. For large pulses, propagation media including transmission lines may exhibit nonlinear behaviour leading to a variety of novel phenomena. Similarly, a concentration of a large number of devices radiating electromagnetic energy may change the electromagnetic environment.

The aim of the meeting was to highlight the state of the art and to bring together those interested in these problems from both the physical and mathematical points of view. About fifty participants from eleven countries (Canada, France, German Dem. Rep., Fed. Rep. of Germany, India, Japan, Poland, Sweden, Switzerland, UK, USA) took part.

Seventeen invited papers were presented at six sessions dealing with: nonlinear waves, quasi-particles, and solitons; atmospheric and nuclear electromagnetic pulse; environmental effects of electromagnetic pulse; environmental electromagnetics; nonlinear and chaotic oscillations; ponderomotive forces in an electromagnetic environment. In addition there were three special invited lectures by Profs A. Kimpara, N. Marcuvitz, and M. Goto, celebrating the anniversaries of the authors.

Prof. Kimpara (82, well known as former Chairman of URSI Commission IV) presented results of fifty years of Japanese studies on electrical phenomena in the atmosphere. Prof. Marcuvitz (70) described similarities between particle mechanics and electromagnetic wave packets propagation with application to inhomogeneous, time-varying, linear, nonlinear, or turbulent media. His lecture was presented by Prof. Kikuchi. Prof. Goto (80) recalled the early Japanese studies on nonlinear oscillations in power transmission systems.

Kikuchi and Hirota discussed selected problems of nonlinear electromagnetics in terms of quasi-particles and solitons. Nakamura dealt with solitons observed experimentally in plasma. Pavlasek reviewed the Canadian studies of atmospheric electromagnetic pulse phenomena and electromagnetic environment measurements. Hayakawa et al. gave an interpretation of VLF emissions in terms of quasi-linear electron cyclotron instability. Okada et al. presented variations of whistler intensities. Ondoh and Nakamura dealt with riser emissions observed at altitudes 4000-7000 km. Maginu reviewed chaotic oscillations in Josephson Junction Line. Noguchi presented studies on solitons in one- and two-dimensional transmission line. Degauque and Fontaine reviewed French basic research in the field of electromagnetic pulse and electromagnetic compatibility. Stružak dealt with unintentional radiation from industrial, scientific, and medical radio frequency generators. Behari et al. presented investigations of ELF electric field influence on rats. Akama, as well as Sugai, discussed ponderomotive forces exerted by high frequency electromagnetic waves on plasma. Netwig reviewed electromagnetic pulse and electromagnetic compatibility activity in the Federal Republic of Germany. Ianovici did the same for Switzerland. Tharby discussed electromagnetic surge problems on telecommunication plants. Wik reviewed problems connected with a hardening of telecommunication networks against electromagnetic pulses. A reception and common photograph completed the technical programme.

Results of the Workshop create a sound base for further studies and applications in radio science and technology. The Workshop dealt with a wide range of problems of current interestand gathered people representing various specialities, various approaches, and various regions. This success should be attributed mainly to the international nature of URSI.

The organizer of the Workshop, Prof. Kikuchi, will edit the full texts of the lectures in a separate volume. Until this is done, a booklet (64 pages) containing the programme and abstracts is available from:

Prof. Hirochi Kikuchi
Nihon University
Kanda Surugadai
Chiyoda-ku, Tokyo 101
Japan.

R.G. Strużak

INTERNATIONAL MAP SYMPOSIUM

Kyoto 1984

The main purpose of this Symposium was to discuss some of the results which were obtained so far since the Middle Atmosphere Programme started in 1982. The Symposium would thus be useful for coordinating our future efforts in MAP and beyond it, i.e. Middle Atmosphere Cooperation (MAC).

The meeting was held from 26 to 30 November 1984 at New Miyako Hotel in Kyoto. Prior to the Symposium the MU radar Ribbon Cutting Ceremony took place on 24 November and, after the Symposium on 1 December, there was an excursion to the Shigaraki district where the MU radar Observatory is located.

The number of participants in the Symposium was approximately 180 from 12 countries. The number of contributions was approximately 150, of which 90 papers were presented in five oral sessions as follows: Climatology of the Middle Atmosphere; Large-scale Wave Dynamics; Gravity Wave and Turbulence; Transport Processes of Trace Species and Aerosols; and MAP in the Antarctica.

The Symposium was organized to put an equal emphasis on poster sessions and on oral sessions. The poster sessions, accommodating 60 papers, was given 2.5 hrs with no parallel oral session. The greatest attendance and interest seemed to be for the session on Gravity Wave and Turbulence of the middle atmosphere. Novel observations by MST radars and stimulating ideas were presented and discussed.

In addition to these successful scientific sessions, the participants enjoyed the social programme including a reception, a banquet and the special Accompanying persons programme.

S. Kato

Announcements of Meetings and Symposia

INTERNATIONAL SYMPOSIUM ON ANTENNAS AND ELECTROMAGNETIC THEORY (ISAE '85)

The 1985 International Symposium on Antennas and EM Theory will be held in Beijing, China, from 26 to 29 August. It is organized by the Chinese Institute of Electronics Antenna Society (CIEAS) and sponsored by the China Association for Science and Technology (CAST) and URSI.

The Symposium Chairman is Prof. Mao Yukuan, Chairman of CIEAS, and the Technical Programme Committee is co-chaired by Prof. Ren Lang, Vice-Chairman of CIEAS and Prof. J. Bach Andersen, Chairman of URSI Commission B.

The address of the Symposium Secretariat is as follows:

Mr. Fang Jun
China Association for Science and Technology
Beijing, China.
Telex: 20035 CAST CN.

COMPARATIVE STUDY OF MAGNETOSPHERIC SYSTEMS

The International Conference on Comparative Study of Magnetospheric Systems will be held from 9 to 14 September 1985 in La Londe des Maures, France. It is organized by the Centre National d'Etudes Spatiales (CNES) and co-sponsored by IAU, EGS, IAGA, SCOSTEP and URSI.

The Conference will cover the following topics:

Session I - General presentation of "individual" objects

- Plasma jetting from active galaxies
- Magnetized binary stars
- Magnetospheres of pulsars
- Magnetospheres of magnetized planets
- Plasma environment of intrinsically unmagnetized bodies.

Session II - Interaction between magnetospheres and external plasma sources

- Particle energization by collisionless shock waves
- Transfer through magnetopauses (magnetized bodies)
- Transfer through ionopauses (unmagnetized bodies)
- Magnetospheres as sources of plasma

Session III - Large scale equilibria and general circulation

- Magnetic configuration of planetary obstacles
- Plasma circulation within "magnetospheric" cavities
- Equilibria of hot plasma reservoirs (magnetodiscs, plasma sheet,..)

Session IV - Instabilities of plasma reservoirs

- Dynamics of plasma reservoirs
- Dissipation of magnetic energy via collisionless tearing modes
- Instabilities at plasma interfaces (Rayleigh-Taylor; Kelvin -Helmholtz)
- Magnetic reconnection in laboratory plasmas

Session V - Particle energization driven by microscopic processes

- Electron accelerations via laminar structures
- Electron acceleration via turbulent Alfven waves
- Ion acceleration via turbulence

Session VI - Radio emissions and plasma waves

- Electromagnetic emission from pulsars
- Radio emissions from binary stars
- A comparative study of planetary radio emissions
- Plasma waves and their role in magnetospheric dynamics.

The number of participants is limited to 100.

Proposals for papers should be sent before 15 May 1985 to:

Centre National d'Etudes Spatiales
Département des Affaires Universitaires
18 avenue Edouard-Belin
F- 31055 Toulouse Cedex (France).

26TH COSPAR PLENARY MEETING

The dates of the 26th COSPAR Plenary Meeting and Associated Activities were 23 June - 5 July 1986. These have been changed to 30 June - 12 July 1986.

6TH INTERNATIONAL SYMPOSIUM ON SOLAR-TERRESTRIAL PHYSICS

The sixth of the International Symposia on Solar-Terrestrial Physics which are organized by SCOSTEP in collaboration with COSPAR every four years will take place during the first week of the 1986 COSPAR Meeting in Toulouse, France. It is sponsored also by IAGA, IAMAP, IAU, URSI and IUPAP.

The Symposium programme will cover the entire solar-terrestrial physical system, from the solar emissions to the Earth's middle atmosphere, including solar wind, magnetosphere, ionosphere and thermosphere, and their interactions.

The Programme Committee consists of an executive group, chaired by B. Hultqvist, and of representatives of the above mentioned sponsoring bodies.

Additional information can be obtained from

B. Hultqvist
Kiruna Geophysical Institute
P.O. Box 704
S - 981 27 Kiruna, Sweden.

ADDENDUM TO LIST OF FUTURE SYMPOSIA AND MEETINGS

as published in *URSI Information Bulletin* No 231

The Contact addresses for the following meetings have been received at the URSI Secretariat:

17th International Conference on Phenomena in Ionized Gases
Budapest, Hungary, 8-12 July 1985.

Contact Address: Dr. J.S. Bakos
Central Research Institute for Physics
P.O.B. 49
H - 1525 Budapest, Hungary.
Telex: 22-4722.

8th Colloquium on Microwave Communication (MICROCOLL)
Budapest, Hungary, August 1986.

Contact Address: Secretariat of 8th MICROCOLL
P.O.B. 15
H - 1525 Budapest, 114 Hungary.
Telex: 224338.