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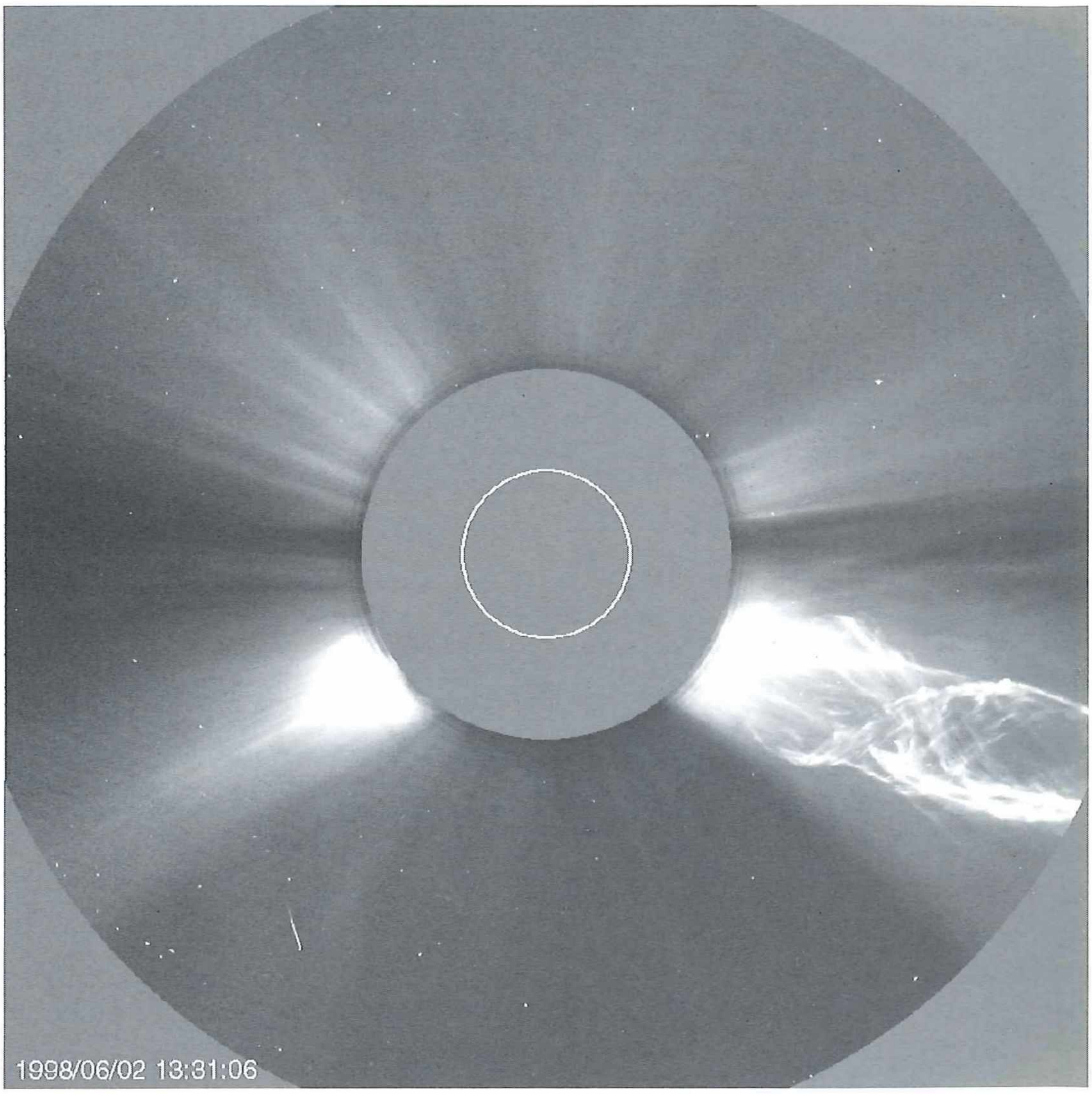
U.R.S.I.



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Contents

Front cover: *The coronal-mass ejection recorded with the coronagraph LASCO onboard SOHO on June 2, 1998. This ESA-NASA space observatory is positioned at the Lagrangian point between the Earth and Sun, and has observed the solar corona since 1996. The Sun's diameter is indicated by the white circle on the diagram (more on pp. 4-10).*

The International Union of Radio Science (URSI) is a foundation Union (1919) of the International Council of Scientific Unions as direct and immediate successor of the Commission Internationale de Télégraphie Sans Fil which dates from 1913.

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URSI Commission B

INTERNATIONAL ELECTROMAGNETICS PRIZE

URSI Commission B with the approval of the URSI Board of Officers has established the International Electromagnetics Prize to be awarded annually. The prize is $10,000 US plus a commemorative plaque and is sponsored by the Summa Foundation. It is awarded for an accurate approximate solution of a designated scattering or related problem in electromagnetics and is presented at an appropriate URSI meeting. The first prize will be awarded in Spring 2003.

General Information

The last 30 years have seen enormous advances in the application of numerical techniques in electromagnetics, but there have not been comparable advances in our knowledge of the scattering from simple geometric shapes. It is hoped that the prize will encourage the development of accurate physically based approximate analytical expressions for the solution of canonical and similar problems.

On 15 September of each year the designated problem will be announced on the URSI web page (http://www.intec.rug.ac.be/ursi) and elsewhere, and solutions are due by 15 January, 16 months after the announcement date. Entries must be in English in the format of a paper submission to the journal *Radio Science* and not exceed 25 pages in length, including tables, figures and references. Hard copy or electronic submission is acceptable. Entries will be judged by a panel appointed by the chair of URSI Commission B and the Summa Foundation. Factors taken into account in the judging will be the simplicity and elegance of the expressions, their conformity with the known physical properties of the solution, and their accuracy for all values of the parameters involved in the problem. The winner will be announced on 15 April of the year of submission. There is the right to withhold the award if, in the opinion of the panel, no worthy entry is received.

All scientists are eligible for the prize apart from an officer or director of the Summa Foundation, a member of the panel, or one of their immediate working associates.

Since the prize is awarded for the best paper submitted, multiple authorship is allowed.

2003 Prize Topic (Announced 15 September 2001)

The topic is the scattering of a uniform plane wave by a perfectly conducting right circular cone of semi-infinite extent. In terms of spherical coordinates with the cone axis coincident with the polar (z) axis and the tip of the cone at the origin, the conical surface is $\theta = \theta_c$ with $0 < \theta_c < \pi/2$. The objective is the determination of the scattering matrix for the exterior problem for either time harmonic or time dependent excitation.

There is a sizable body of literature on this problem but it is incomplete in that solutions are not known for all ranges of the problem parameters, nor are there accuracy bounds known for the solutions that are available. A solution should be in the form of analytical expression(s) accompanied by conditions indicating the ranges of validity and an inclusive specification of the accuracy. A minimally acceptable solution might be one for which either the incident or scattered wave (but not both) is axial. Contestants are encouraged to submit a solution which is as general as feasible for which the accuracy is specified. A solution whose specified range of validity is limited but whose accuracy is tightly bounded will be looked upon more favorably than one which holds over a greater range but whose accuracy is not proved or tightly bound.

Submission

The members of the interim panel are C.E. Baum, C.M. Butler, and T.B.A. Senior.

Entries in the format described above must be received by 15 January 2003 and submitted to:

Professor Thomas B.A. Senior
Electrical Engineering and Computer Science Department
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Editorial

Thank You

At the URSI Board meeting in May, I was given the honor of being named Assistant Secretary General (Publications). As part of my responsibilities, I have been asked to take over as Editor of the technical section of the *Radio Science Bulletin* (*RSB*). I want to begin by thanking the outgoing Editor, Piotr Sobieski, for the very significant contributions he has made to the *RSB* and, thereby, to URSI. He deserves our great appreciation and respect for what he has accomplished in this position.

What's in this Issue

When an ejection of material from the Sun's corona occurs, it interacts with the Earth's magnetosphere and ionosphere, via the solar wind. If this is sufficiently violent and properly oriented, it can cause a shock wave to hit the magnetosphere. This, combined with dynamo effects of the interaction of the solar wind and the Earth's magnetic field, can lead to distortions of the Earth's magnetic field that are called magnetic storms. In this issue, Kristian Schlegel has given us a paper that describes these magnetic storms, and focuses on some of the strongest such storms of the last century. He explains how these occur, and some of their consequences, including changes to the ionosphere and thermosphere, auroral effects, and effects on electronic systems. The paper is written in such a manner that it should be of interest to and understandable by all of our readers.

Beginning in this issue is a column by James Lin, entitled "Radio-Frequency Radiation Safety and Health." Jim has agreed to provide this on a regular basis. It deals with a topic that is of broad and current interest to many radio scientists, and I appreciate his willingness to do this. For this issue, he looks at the risk of human exposure to RF radiation from mobile communications. If you have suggestions for specific topics you would like to see discussed, or if you have contributions or comments, please send them to Jim.

The URSI Young Scientist Awards are a critical part of URSI's involvement in the furtherance of radio science, and in URSI's own future, as well. The Conditions for applicants, and an application form, appear in this issue. The deadline for *receipt* of the form at the URSI Secretariat is **15 November 2001**. If you are eligible, please apply; if you know of a good candidate, please encourage him or her to apply. Do it for the candidate, *and* for URSI!

Kevin Hughes has provided us with news of the activities of several ITU-R Study Groups in this issue. If you have any interest in the work of the Spectrum Management, Radiowave Propagation, or Science Services Groups, you should read his report. Reports on several conferences, and conference announcements and a call for papers are also in these pages.

Goals, and Requests for Help

I believe that URSI's goal should be to have the *RSB* become the central mechanism of communication and community among radio scientists. To do this, it is absolutely critical that we expand the technical and general-interest content of the *RSB*. There are several ways we can do this, and your help – the help of our Correspondents, and of radio scientists around the world – is central to the success of this effort. If we are successful, the *RSB* can help to insure that URSI will survive, grow, and prosper. If we are not successful, then we are largely relying on our General Assembly, other conferences, and our Young Scientist program to ensure the long-term future of URSI – and most of these only bring us into contact with each other and with those who represent our future every three years. I want to share with you my hopes and plans for trying to achieve this goal. I am also asking for your help.

As approved by the Council at the Toronto General Assembly, we will have the General and Tutorial Lectures from the Maastricht General Assembly as featured papers in the *RSB* (instead of their being published in the previous *Modern Radio Science* book). The plan is to publish the first of these papers next year, and perhaps sooner. Ideally, the papers from these Lectures will be published over a two-to-three-year period, spanning 2002-2004. However, these Lectures need to be just the starting point.

We need all of you to consider the *RSB* as a forum for publishing. It is a peer-reviewed, archival publication. If you have interesting work that falls within the field(s) of one or more URSI Commissions or that would otherwise be of interest to radio scientists, please submit a paper on it. If you are aware of interesting work being done by others, please either solicit a paper from the person or group doing the work, or let me or the appropriate Commission Associate Editor know. Ultimately, we would like to have at least three or four technical papers in each quarterly issue of the RSB. This is a unique opportunity for radio scientists to share their work with the premier group in their field.

Something needs to be said about the type of papers for which we are looking. We want contributions that will be of interest to a wide range of radio scientists. These can be of a tutorial or review nature, and/or they can also report on new, original work in a particular area of radio science. Where the work is significant and of reasonably broad interest, papers describing past and current research of a particular group or organization may also be appropriate. Contributions on the history of some aspect of radio science are certainly of interest. Reports of original "breakthroughs" can be appropriate, but these should be written in such a manner as to be understandable by as broad a cross section of URSI readers as possible (the focused paper on original work written for the technical specialist belongs in *Radio Science* or *Wireless Networks*!). The guideline that I suggest for determining whether or not a contribution is of sufficiently broad interest is a "20% rule:" if at least 20% of the readership is likely to be interested in the topic, then it should be of sufficiently broad interest. Of course, we would like to find papers that will appeal to a much larger percentage of our URSI family.

I am also looking for individuals who want to become an active part of the *RSB*. Regular columns are contributions that can significantly enhance the *RSB*, and they can be a lot of fun to write or edit: the column Jim Lin has begun with this issue is an excellent example. If you have a topic area that you think might be an appropriate basis for such a column, please contact me. If you would be interested in editing such a column, or can suggest a possible editor, please let me know. Columns can be authored by the person responsible, and/or they can consist of edited contributions from others. Examples of possible topic areas include wireless telecommunications; book reviews; radio science education; reports on the major activities of other scientific unions and related organizations (e.g., the AGU, the ITU, etc.); a column devoted to ways in which the Web and technology are being used to further radio science and radio science education; a summary of new standards and standards-related activities that affect radio science around the world; and a column on the art and science of successful proposal writing and project administration for radio science research. I'm sure you can think of even better examples: please share them! I am also looking for editorial staff help: If you are interested in becoming an Associate Editor, with specific responsibilities related to publishing the *RSB*, please contact me. I need help in several areas. This is an excellent way to get to know – and to become known by – our radio science community.

Reports on activities and new results of interest to a specific URSI Commission are also welcome. We have individual Associate Editors for most of the URSI Commissions: please communicate such reports to the appropriate Commission Associate Editor. Hopefully, we will be hearing from each Commission in these pages on a regular basis.

It's that Time!

Every three years, URSI holds its General Assembly. This is the "core" meeting for radio scientists, and a chance for you to share your most important results of the last triennium, and to find out what has happened both in your area of radio science, and in the fields of all of the Commissions. The Web site for the Maastricht General Assembly (17 to 24 August, 2002) is up, and all of the information you need to submit a paper to the General Assembly is there. The URL is http://www.URSI-GA2002.nl/; the deadline for receipt of abstracts is **January 15, 2002**. However, *please* read the call for papers and the instructions for submitting abstracts carefully! We are using a new procedure this time. For most Commissions, a review abstract is required, and there are provisions for online submission. Successful applicants will be invited to submit one - to four- page full papers that will be published in the *Proceedings*. You should also begin to make your plans to attend the meeting *now*. I've visited the Maastricht site, as well as the historic town of Maastricht, and I've seen the excellent arrangements that the Scientific Program Coordinator, Martin Hall, has led the Commissions in making. This is going to be an outstanding General Assembly, and I think you're really going to enjoy it!

In most parts of the world, this issue should reach you about the time that many schools are starting their academic years, that people are returning from holidays, and that many new projects are getting underway. As part of the "getting started" process, plan on sharing what you are doing with your colleagues, through these pages.

Ross

The Strongest Geomagnetic Storms of the last Century

K. Schlegel

Abstract

Geomagnetic storms are interesting and important for several aspects of URSI-related work, ranging from ionospheric disturbances and communication problems to microchip-production failures. This article gives a brief overview of the mechanisms and consequences of geomagnetic storms, and reviews some major storms between 1900 and 2000. It is intended for casual readers who are not specialists in this field. An extended reference list and several relevant Internet URLs provide more in-depth information.

Introduction

Magnetic storms are the reaction of the terrestrial magnetosphere-ionosphere system to disturbances in the solar wind. During violent explosions in the Sun's outer atmosphere, so-called coronal-mass ejections [1] – clouds of billions of tons of hot gas – are hurled into the interplanetary space (Figure 1). These compress the solar wind, thereby causing shocks, i.e., abrupt changes in the particle density and velocity [2]. If travelling in the proper direction, these shocks hit the terrestrial magnetosphere (Figure 2), compressing and shaking it. Simultaneously, the streaming solar wind and the terrestrial magnetic field form a dynamo, causing electric potentials within the magnetosphere that drive several current systems [3]. The direction of the magnetic field in the gas clouds is very important. If it is directed southward, i.e., opposite to the direction of the terrestrial field, field-line merging is possible. This enables a very effective transfer of energy from the solar wind into the magnetosphere, which is of the order of 10^{12} to 10^{13} watts [4]. In case of a northward-

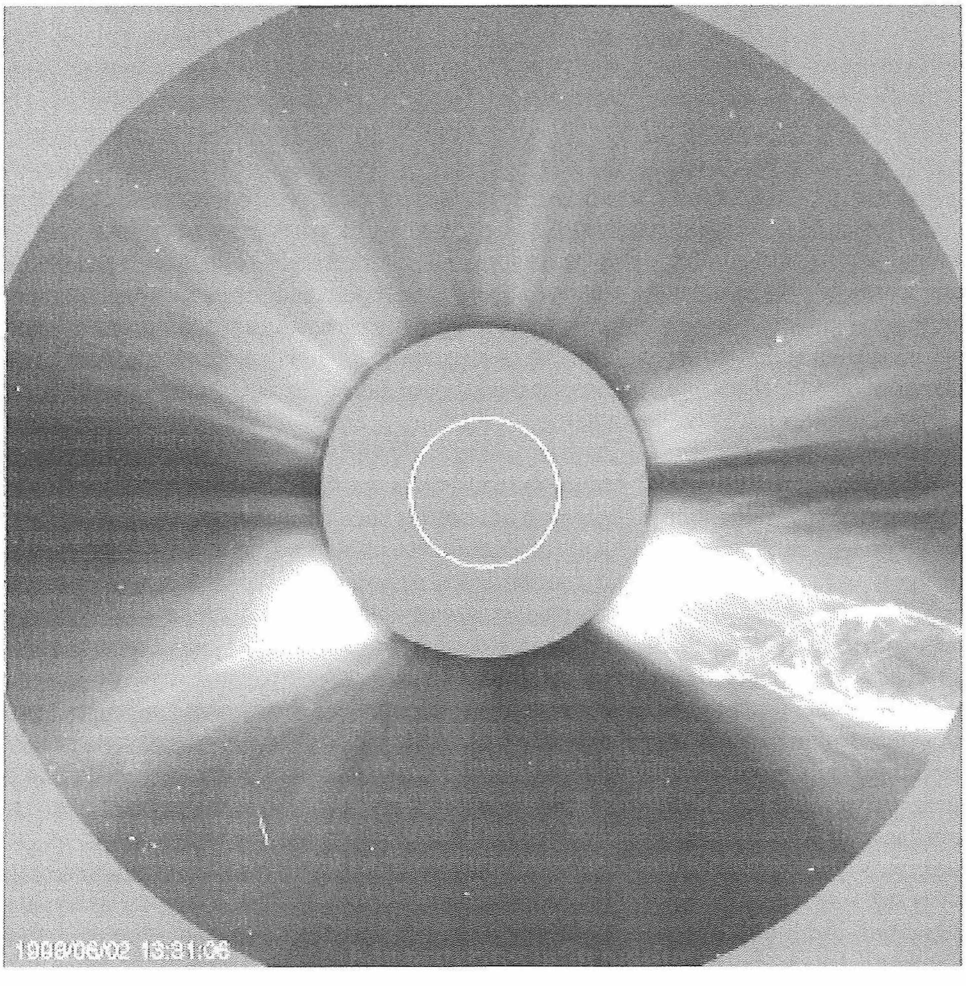

Figure 1: The coronal-mass ejection recorded with the coronagraph LASCO onboard SOHO on June 2, 1998. This ESA-NASA space observatory is positioned at the Lagrangian point between the Earth and Sun, and has observed the solar corona since 1996. The Sun's diameter is indicated by the white circle on the diagram (Max-Planck-Institut für Aeronomie).

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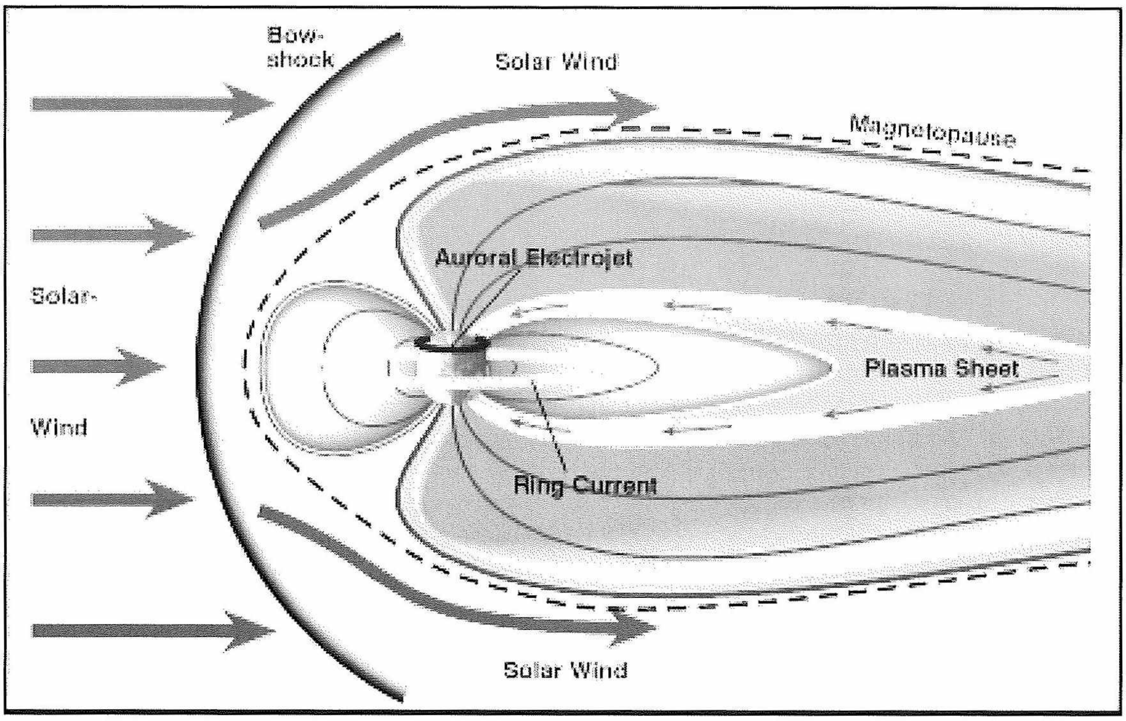

Figure 2: The Earth's magnetosphere and the solar wind streaming by it. In the bow shock, the solar wind is decelerated from super-sonic to sub-sonic velocities. The two current systems that eventually cause geomagnetic disturbances are the auroral electrojet (only plotted above the northern hemisphere, but flowing above the southern hemisphere, as well), and the ring current. The arrows characterise the flow of particles from the plasma sheet that precipitate into the upper atmosphere, causing aurora and an increase in ionospheric electron density.

directed magnetic field, field-line merging is inhibited, and, consequently, this energy transfer is very low, even in the case of strong shocks.

As a consequence of magnetic reconnection in the magnetospheric tail, energetic particles (mainly electrons) from the plasma sheet are accelerated towards the Earth, along magnetic field lines (see the arrows in Figure 2). They precipitate into the upper atmosphere at high latitudes, causing aurora and additional ionisation: the latter results in enhanced electron densities in the ionosphere. High electron density leads to enhanced conductivity of the ionospheric plasma, and this causes a strong increase of the current systems mentioned above. One of these systems is the auroral electrojet [5], flowing at an altitude of about 100-130 km at high northern and southern latitudes (see Figure 2). The total current can reach more than a million amperes during strong disturbances. Another important current is the ring current, formed by energetic protons and electrons drifting around the Earth at a distance of 3-6 R_E in the equatorial plane of the magnetosphere, within the so-called radiation belts [6]. This current is strongly enhanced by particles from the magnetospheric tail during disturbed conditions. Both current systems cause distortions of the quasi-constant terrestrial magnetic field, which we call a magnetic storm.

It should be stressed, however, that the processes leading to geomagnetic storms have been greatly simplified in the above description. Although our knowledge has increased tremendously through the last 30 years – mainly from the exploration of near-Earth space by satellites and space probes – some processes are still not well understood in detail. Several textbooks and reviews contain thorough treatments of magnetic storms, e.g., [7], of the solar wind; e.g., [8], of magnetosphere-ionosphere coupling; and of the historical developments in this field [9].

Magnetic Indices

Since the pioneering work of Julius Bartels (1899-1964), geomagnetic storms have been characterised by the index Kp [10]. Bartels, who introduced this index in 1949, derived it from the largest variation of the horizontal magnetic-field component during a three-hour interval from a single magnetometer station, using a quasi-logarithmic scale. This so-called K index was then averaged over 13 globally distributed stations, applying special weighting functions in order to obtain the Kp index, where p stands for "planetary." Kp runs from 0 (very quiet) to 9 (very disturbed), and is further subdivided using the subscripts –,o,+ (e.g., 1–,1o,1+,2–,...); this yields 28 steps in total.

As already mentioned, Kp is expressed in a logarithmic scale and, consequently, is not very well suited for averaging. Bartels therefore introduced the linear equivalent, Ap, where kp=9o corresponds to Ap=400 nT. This index is a mean over eight three-hour intervals, i.e., over a full day. It consequently characterises not only the strength but also the duration of the strongest phase of a storm.

Bartels was able to derive both indices back to 1932; for earlier years, not enough magnetometer stations were available. As a convenient notation, he developed a kind of musical-note diagram (Figure 4), which is still in use.

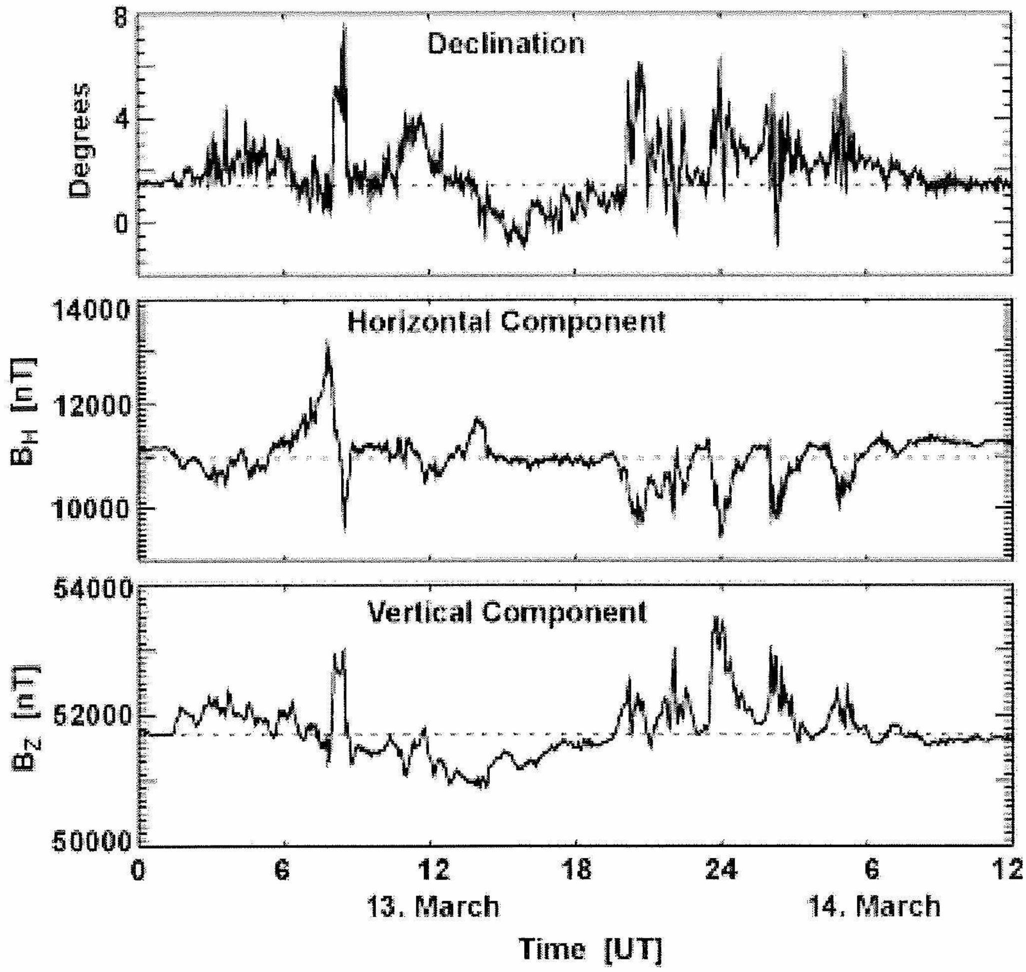

Figure 3: A magnetogram recorded at Tromsø (northern Norway) on 13 March 1989 during the strongest geomagnetic storm of the past century. This shows the three components of the geomagnetic field. The dotted horizontal lines characterise the mean values for magnetically quiet times.

For many years, the University of Göttingen issued the Kp and Ap indices, but since beginning of 1997, this task has been taken over by the Adolf-Schmidt Observatorium für Geomagnetismus in Niemegk, Germany.

If we want to regard geomagnetic storms from the entire past century (i.e., before 1932), we have to revert to a different index, the so-called AA index. It is similar to Ap, but it is derived from the magnetograms of only two stations, one in the northern hemisphere (England), and one in the southern hemisphere (Australia). Since both stations have recorded the geomagnetic field since 1868, it was possible to derive AA back to this year.

The mentioned indices so far characterise geomagnetic variations (particularly at high and mid-latitudes) that are mainly related to the auroral electrojet. The magnetic variations due to the ring current are described by the Dst index. Since 1957, it has been derived from the horizontal magnetic field component measured at four stations near the equator. The magnetic field of the ring current is directed oppositely to the main geomagnetic field; consequently, strong disturbances are characterised by large negative Dst excursions. Finally, magnetic disturbances at very high latitudes are characterised by the AE index, which is derived from magnetic records of 12 stations at auroral latitudes. Details of the derivation of all of these indices can be found in [11], and their values are accessible through the Internet [12, 13].

The Strongest Storms

Table 1 lists all of the geomagnetic storms between January 1, 1900, and December 31, 1999, with AA* > 250 nT (this is a subset of all storms listed in [14]). Slightly different from AA, the index AA* characterises the most strongly disturbed 24-hour interval, which does not necessarily coincide with a full day. Strong storms generally last longer than one day. The listed events are really "super storms," which can be realised from the following comparison. The average AA of all days of the above 100-year interval amounts to 20.4 nT as the average magnetic activity. Usually, events with AA* > 60 nT are counted as magnetic storms; in the past century, 1172 of these occurred (see the list cited above). Storms with AA* > 250 nT are therefore truly exceptional. Also included in this table are the maximal Kp and the minimal Dst index of the corresponding 24-hour interval, if available. The last column contains auroral observations that will be described in more detail in Section 5.

A magnetogram, recorded during the strongest visible, and IR), which we observe as the aurora. During quiet and weakly disturbed conditions, the aurora occurs only in an oval-shaped ring around the magnetic poles. However, during strongly disturbed conditions, this oval expands towards the equator [20]. In such events, the aurora can be observed at mid-latitudes or even at low latitudes.

For storm No. 4 of Table 1, Figure 5 shows a map with locations marked where ships and other observers have reported aurora. These show that the aurora was visible

Date	AA* [nT]	max. Kp	min. Dst [nT]	Auroral Observation nearest to the Equator (geogr. Latitude)
1989 13./14. März	441	9o	-589	A: Florida Keys, (j » 24°N)
1941 18./19. Sept.	429	9-	-	Si: Florida, (j » 29°N)
1940 24./25. März	377	9o	-	Si: Korfu, (j = 39°N)
1960 12./13. Nov.	372	9o	-339	A: Atlantic, (j = 28°N)
1959 15./16. Juli	357	9o	-429	Sch: j » 48°N
1921 14./15. Mai	356	-	-	Si: Samoa, (j = 14°S)
1909 25./26. Sept.	333	-	-	Si: Mallorca, (j = 39°N)
1946 28./29. März	329	9o	-	Si: Queensland, (j » 27°S)
1928 7./8. Juli	325	-	-	Si: Atlantic, (j = 24°N)
1903 31.10./1.11.	324	-	-	Si: Bamberg, (j = 50°N)
1958 8./9. Juli	314	9o	-330	Sch: j » 38°N
1960 31.3./1.4	312	9-	-327	Sch: j » 36°N
1941 5./6. Juli	302	9o	-	Si: New England, (j » 42°N)
1958 11./.12. Feb.	298	9o	-426	Sch: j » 25°N
1946 22./23. Sept.	295	9o	-	Si: New Zealand, (j » 40°S)
1972 4./5. Aug.	290	9o	-125	Sch: j » 48°N
1986 8./9. Feb.	287	9o	-307	Sch: j » 48-50°N
1967 25./26. Mai	279	9o	-387	Sch: j » 50°N
1982 13./14. Juli	268	9o	-325	Sch: j » 49-50°N
1946 7./8. Feb.	256	9-	-	Si: England, (j » 55°N)
1941 1./2. März	254	9o	-	Si: Tasmania, (j » 43°S)
1960 6./7. Okt.	253	9o	-287	Sch: j » 49°N

Table 1: Geomagnetic storms in the past century with AA > 250 nT in descending order. The third column gives the maximal Kp (since 1932) and the fourth the minimal Dst (since1957) in the corresponding interval. The last column shows the location of auroral observations most near to the equator during the storms. Si refers to a list of auroral observations compiled by Silverman [34] ranging from 686 BC to 1951 AD, Sch to W. Schröder (private communication), A to other sources.*

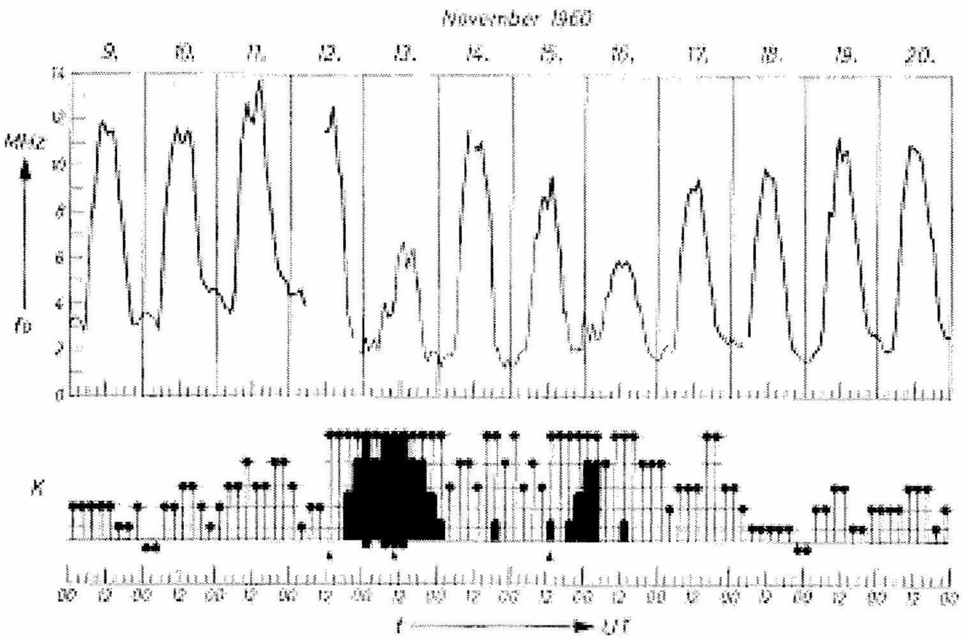

Figure 4: The ionospheric F2-region critical frequencies foF2, as recorded above Lindau/Germany during a sequence of two geomagnetic storms in November, 1960 (storm No. 4 in Table 1). foF2 is a measure of the ionospheric electron density. The negative storm effect (a decrease of electron density) is clearly seen on 13 and 16 November. The lower panel shows the local geomagnetic activity in the musical-note description, as introduced by J. Bartels in 1949. This refers to the K-value of the geomagnetic observatory Wingst, in northern Germany (from [33]).

down to a geographic latitude of 28° N (about 40° geomagnetic). The last column in Table 1 lists the most-southerly-observed auroral displays during the storms, together with the corresponding geographic latitude. From this compilation, it follows that the aurora most near to the equator was observed on 14/15 May, 1921, from Samoa (an alleged sighting from Singapore during storm No. 7, in 1909, was disputed by Silverman [21]). Today, auroral activity and the extension of the auroral oval is monitored by polar-orbiting satellites, and can be viewed on the Web [22]. An interesting review of auroral activity over the last 500 years has been published by Silverman [23].

Influences on Technical Systems

Magnetic storms have various effects on technical systems [24-26]. This topic is presently under extensive investigation, and these are called space-weather effects. It is very interesting that at beginning of the last century, only telegraphy disturbances were reported, while in 1989, when mankind relied on many more-sophisticated technical systems, the effects were much more widespread (see Table 2). Today, our life depends very strongly on satellites (communications, navigation, radio, television), and, therefore, the effects of geomagnetic storms have considerable economic consequences. Space-weather effects are therefore extensively studied by all industrial nations, to improve forecasting and to diminish the adverse effects [27-30].

Unfortunately, forecasting is difficult, and not very effective, so far. The optical observations of coronal-mass ejections from, e.g., the SOHO space observatory (Figure 1) allow a warning time of about 60 to 80 hours. This is the travel time of the gas cloud from the Sun to the Earth. Due to imperfect knowledge of the processes resulting in coronal-mass ejections, we cannot yet predict their occurrence, nor can we remotely determine the orientation of the magnetic field in the cloud, which is crucial for the energy transfer to the magnetosphere. It is a fact, however, that strong geomagnetic storms are coupled to solar activity, in general.

Solar Activity

Solar activity varies with an average cycle of 11 years, which has been known since the observations of the German pharmacist Heinrich Schwabe in the 1840s. It is characterised by the relative sunspot number; the variation in sunspot number over the last century is plotted in Figure 6 (from [13]).

Interestingly, the strongest geomagnetic storms do not occur at the maximum of the solar cycle, but during the descending phase of the activity (see Figure 6, especially after cycles 17 and 19). A detailed analysis of all 1172 storms of the 20th century shows that the highest storm frequency occurs about 16 to 24 months after the sunspot maximum. The solar physicists so far have no conclusive explanation as to why the strongest coronal-mass ejections

1903

DISTURBANCES IN TELEGRAPH LINES

... the world whole telegraph system was upset ...

... for several hours communication was almost completely interrupted ...

... 675 V of electricity – enough to kill a man – in the wires, without any battery connected to them ...

(cited from Nature, 5. Nov. 1903)

1989

DAMAGE IN 9 SATELLITES

... SMM dropped in altitude by 3 miles ... / ... episodes of uncontrolled tumbling ...

permanent and/or temporary disturbances in the electronic systems of 4 satellites

COMMUNICATION

... out of Hf-radio contact from southern U.S. to sites around the world ...

... California Highway Patrol messages wereoverpowering local transmissions in Minnesota ...

... undersea cables in Atlantic and Pacific oceans experienced large voltage swings ...

NAVIGATION

... U.S. Coast Guard reported numerous LORAN navigation problems ...

... ship navigation near Australia using signal from navigation satellites were impaired ...

POWER GRIDS

Long power break in Quebec, 6 Mill. people without electricity for 9 hours

Power failures in six 130-kV grids in Sweden

Disturbances in power grids of New York, Maryland, New Mexico, Arizona, California (*...but no general blackout ...*)

OTHER

... microchip production facilities in the northeastern U.S. out of operation two or more times ...

(cited from [26])

Table 2: Comparison of disturbances in technical systems during geomagnetic storms in November 1903 and March 1989

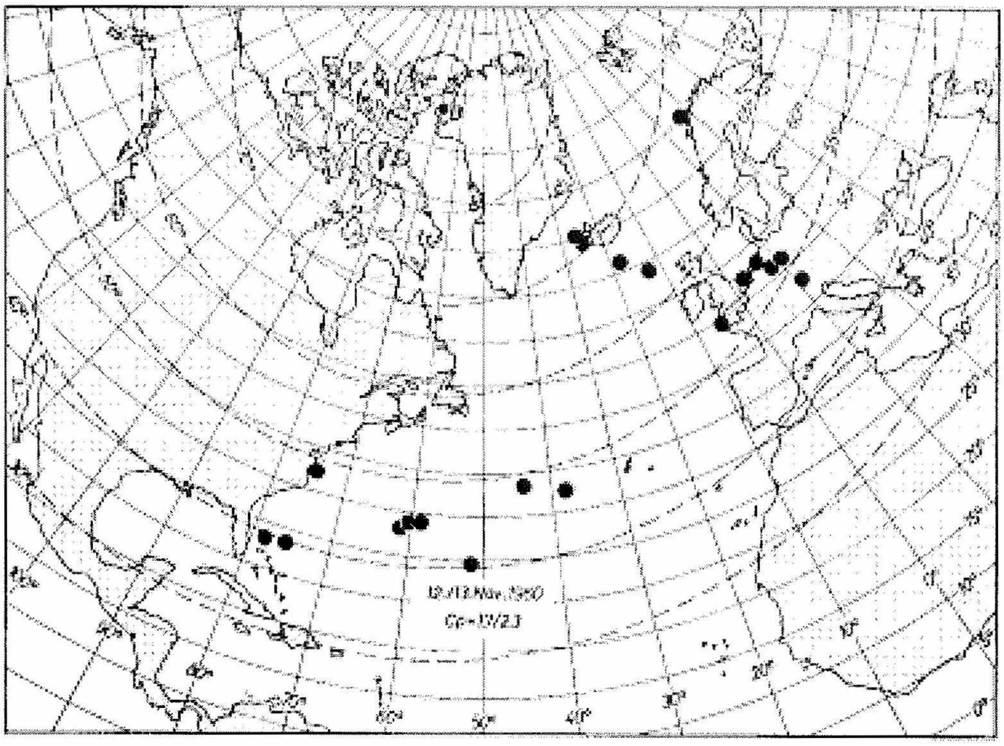

Figure 5: A map of the Atlantic, with the locations of ships reporting aurora during the November, 1960, storm (from [33]).

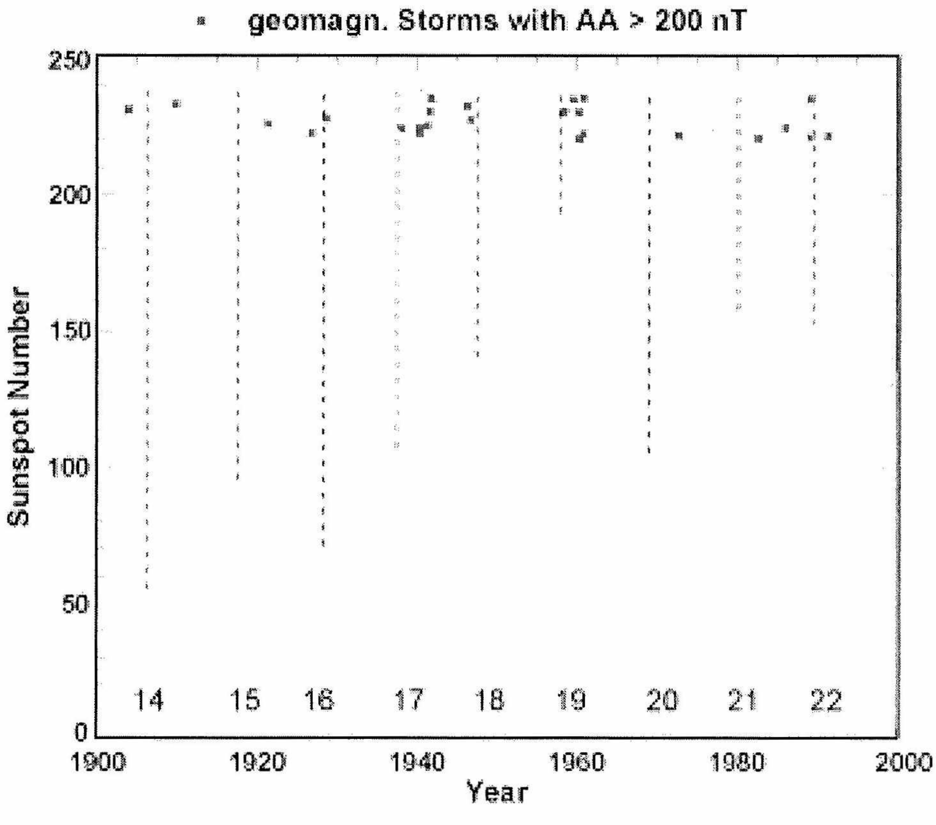

Figure 6: The solar activity in the last century, expressed in terms of the relative sunspot number. The dots in the upper part characterise the times when strong geomagnetic storms, with AA > 200 nT, occurred.

occur during this phase. The present solar cycle (23) is not particularly pronounced. Its maximum was in the middle of the year 2000, with maximal monthly sunspot numbers around 120. The strongest storm so far (the status as of July, 2001), was the one on 15 July 2000, dubbed the "Bastille Event," after the French national holiday. It had a maximal Kp of 9o, an AA* of 221 nT, and a Dst of -300 nT. If the statistical storm behaviour holds, we would have to expect more intense storms in the years 2001 and 2002.

As a matter of fact, the storm strength has increased during the last century. The average AA index was around 13 nT in the last 30 years of the 19th century, and has almost doubled since then, to about 25 nT, at present. This increase is in line with an increase of the solar magnetic field in general [31]. It is interesting to note that there is a hypothesis that global warming may be partially related to this increase in solar magnetic activity, which modulates the cosmic-ray flux [32]. This emphasises, once more, the importance of geomagnetic storms to mankind and to the natural and technical environment.

Acknowledgement

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Radio-Frequency Radiation Safety and Health

James C. Lin

Introduction

Beginning with this issue of the *Radio Science Bulletin* (*RSB*), a new series, entitled "Radio Frequency Radiation Safety and Health," will become a regular contribution to the *RSB*. The intent of this series is to provide a source of informed discussion on a subject of considerable current interest. It is my hope that it will be of service to the URSI community. The suggestion came from Ross Stone, the Editor. His effort and thoughtfulness are greatly appreciated. At times, articles in this series may be similar to the columns I write for magazines. From time to time, I may also solicit input to the column (either actual contributions, or suggestions of topics) from the radio- science community.

The Risk of Human Exposure to Mobile Communication Radiation

Our knowledge concerning the biological effects of radio-frequency (RF) radiation from wireless communication devices has been primarily derived from investigations conducted using experimental animals, such as rats, mice, etc. When it comes to the impact of RF radiation on human health and safety, epidemiology can play a pivotal role, because it is a study of the distribution of disease and its determinants in human populations.

In recent years, there has been increasing interest in cancer induction and promotion from RF exposure. Prior to 1980, however, most epidemiological studies or medical surveillance in occupational settings did not take cancer induction into account.

To examine if exposure to wireless communication radiation is involved in cancer induction and promotion, it is necessary to collect data from people with similar backgrounds other than RF exposure. For example, some factors that should be considered when collecting the data include age, sex, race, education, occupation, personal habits, and so on. Also, when reviewing the data one has to be aware if there are any changes in diagnostic criteria, diagnostic technique, or improved reporting. This is not to suggest that RF exposure is adequately characterized in most studies: the fact is that it is far from it.

The importance of confounding factors in observational data is illustrated by age in mortality rates in the United States. (A mortality rate is the number of deaths per population at risk per unit time. It is the reciprocal of population life expectancy.) The crude mortality rate of the United States, stayed almost at the same level (1,000 per 100,000) from 1940 to 1990. A crude mortality rate does not take the effect of age into account. If age is taken into consideration – a procedure called age adjustment – the mortality rate goes dramatically down from 1940 to 1990. Age adjustment makes the outcome of observations, for which compositions of population age are different, comparable. The age-adjusted results indicate that the total number of deaths per year stayed the same. However, from 1940 to 1990, the longevity became greater, since fewer people died in the young and middle-aged groups. Therefore, when age adjustment is conducted, the mortality rate went down (to about 600).

Moreover, a false-positive relationship between exposure and disease can also exist, and it can be confusing. For instance, the association between cigarette smoking and lung cancer is well known. A positive relationship between alcohol consumption and lung cancer, which is false, can also be shown to exist. What actually happens is that smoking increases the risk of developing lung cancer. Since those who smoke tend to drink, a positive connection between alcohol consumption and lung cancer exists. However, smoking is a significant confounding factor, in this case.

In epidemiological studies, a relatively large sample size is required to detect a certain level in the difference of outcomes. If the study is conducted using a small sample size, true results cannot be drawn. In such a case, the study is nothing more than a waste of time and money. One has to be careful about sample size when conducting studies. It is customary to assess how rare the outcome is by calculating the pvalue associated with an appropriate statistical test (Chi square, Fisher's exact, Student's T, etc.). In general, if the pvalue is less than 0.05, the result of the study is usually considered to be statistically significant.

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There were two early epidemiological papers reporting cohort studies of cancer and RF exposure. Between 1953 and 1976, US personnel stationed at the Moscow Embassy were exposed to 0.015 mW/cm^2 at 600-9600 MHz for 9-18 hr/day [1]. The morbidity and mortality of the Moscow personnel were compared with those who had served at Eastern European embassies or consulates where only background levels were detectable during the same period. (Morbidity is the state of ill health produced by a given disease.) There was no evidence of higher mortality or morbidity in the exposed group. Note that the small number of cancer cases makes interpretation of this study rather limited. Another study was conducted on US Navy personnel trained in the use and maintenance of radio and radar equipment. The study did not reveal any difference in the mortality rate or cancer incidence between the high-exposure (up to 10-100 mW/cm^2) and low-exposure cohorts (<1 mW/cm^2) more than 20 years after exposure [2]. A major difficulty with these two studies is the uncertainty in assessing actual exposure to large numbers of people.

A cohort study is a prospective study, in which people who are free of the disease of interest at the time of entry into the study are classified according to their level of exposure to the putative risk factor: in this case, RF radiation. In a retrospective cohort study, a cohort is assembled by reviewing records to identify exposure in the past. Several epidemiological studies on cancer and mortality have been published within the last few years. The mortality rate of male amateur-radio operators in the Western US was compared to that of the US general population [3]. Higher mortality ratios were shown for brain tumors (1.4), acute myeloid leukemia (1.8), and cancer in some lymphatic tissues (1.6). In other words, 1.4, 1.8, or 1.6 times as many people in the study group died because of brain tumors, leukemia, or lymphatic cancer as in the reference group. The potentially significant confounding factor of soldering fumes within this hobby group presents some uncertainty.

Some studies involving children and adults living in close proximity to radio towers used distance from the tower as a surrogate for exposure measure. In a cohort of 50,000, it was found that the relative risks (RR's) of children for brain tumor, leukemia, Hodgkin's disease, and non-Hodgkin's lymphoma were not elevated if they lived within 3.5 km of an RF tower in San Francisco [4]. (Relative risk is the ratio of the risk of individuals exposed to a causal agent developing the disease to the risk of unexposed individuals developing the disease.) A small case-control study, based on a leukemia cluster around a broadcasting tower in Hawaii, gave a RR of 2.1 for children living within 4.2 km [5]. The risk of developing leukemia was 2.1 times as high for those living within 4.2 km of the broadcasting tower as for those in the control group. Also, the incidence of leukemia was found to be greater (1.58) among children living near TV towers in Sydney, Australia [6]. However, the rate for brain tumors was not increased, when comparing those who lived near and those who lived further away (12 km). A case control study is a study in which the investigator selects persons with a given disease (the cases) and persons without the given disease (the controls), and measures and compares the extent of the exposure to the hypothesized causal agent between the cases and the controls.

A small-area study of cancer incidences near the Sutton-Coldfield radio and TV towers in the UK indicated an increase in risk (1.83) of adult leukemia within 2 km. But there was a significant decline in risk with distance for leukemia, and for bladder and skin cancers [7]. A follow-up study of 20 other broadcast sites in the UK found an excess risk of no more than 15% at any distance up to 10 km, and there was no observed excess within 2 km [8].

In a case-control study of males serving in the US Air Force between 1970-1989 [9], a small increase in the RF, age, race, senior-military-rank-adjusted odds ratio (OR = 1.39) for brain tumors was detected. (The odds ratio is the ratio between the chance of exposure to a causal agent for individuals with the disease to the chance for individuals without the disease.) This result is especially interesting, in view of the negative finding for a relatively well characterized carcinogen, ionizing radiation. Exposure of the men to ionizing radiation was reported to have an age, race, senior-rank-adjusted OR of only 0.58.

Recently, a large-cohort mortality study among relatively young employees (a total of 195,775 during the 1976-1996 period) of Motorola – a manufacturer of wireless communication products – examined all major causes of mortality, with brain cancers, lymphomas, and leukemias as outcomes of interest [10]. The study classified workers into high, moderate, low, and background RF-exposure groups, using job titles. Using external comparisons, the standardized mortality ratios for RF-exposed workers were 0.53 and 0.54 for central-nervous-system/brain cancers and all lymphomas/leukemias. Rate ratios, calculated using internal comparisons, were about 1.0 for brain cancers, and below 1.0 for all lymphomas and leukemias. The findings were consistent across cumulative-, peak-, and usual-exposure classifications, and did not show higher risk with increased exposure duration or latency. Although this study is quite recent, it is limited by the use of a qualitative exposure metric.

To summarize the above epidemiological reports, the two older studies did not uncover a positive association. Among the more recent reports, there are nearly equal numbers of studies showing excess and no-excess cancer mortality. The studies that gave excess risk had reported relative risks that ranged from 1.4-2.1. Among the latter, the authors of the Sutton-Coldfield study suggested, after an enlarged study, that no more than a weak causal implication can be made. The finding by Grayson [9] was diluted by a small sample size. The highest risk ratio, 2.1, was associated with a small cluster [5]. The study by Milham [3] had soldering fumes as a confounding factor within the group.

A survey of the mortality rates of portable cellular-telephone users, who were active for three or more years including 1994, did not show any excess when compared to those using car-mounted mobile telephones [11]. Because the use of cellular telephones is a very recent event, and a large increase in mortality rates over the short term is a rare phenomenon, a difference is not expected from this preliminary study.

Since then, three case-control studies and one cohort study have appeared in the archival scientific literature. None showed an overall increase of risks of brain cancer with the use of cellular telephones.

A case-control study from Sweden did not show any overall increase in brain tumors, as compared to nonusers of cellular or mobile telephones [12]. However, there appeared to be a tendency toward greater likelihood (statistically not significant) to develop brain tumors on the side of the head where the phone was held. The authors have stated that their results were based on small numbers of cases, and must be interpreted with caution. Their cases and controls ranged from 200 to 500. The incidence rate of primary malignant brain and central-nervous-system cancers is about 6 per year per 100,000 population in the US. The other two case-control studies were conducted between 1994 and 1998 in US medical centers [13, 14]. They showed no overall increase of the risks of brain cancer compared to the use of cellular telephones, neither in duration of use nor in cumulative hours of use, except that the uncommon neuroepitheliomatous cancers had an OR of 2.1 [13]. (Neuroepitheliomatous cancers are a rare type of neuronal cell tumor, for example, gangliogliomas.) It is noteworthy that cerebral tumors were reported to occur more frequently, although not statistically significantly, on the same side of the head where cellular telephones had been used – laterality. A total of 469 men and women with primary brain cancer and 422 matched controls without brain cancer were enrolled from five medical centers. The other case-control study had enrolled 782 patients through several hospitals; 489 had histologically confirmed glioma, 197 had meningioma, and 96 had acoustic neuroma [14]. The 799 controls were patients admitted to the same hospitals as the patients with brain tumors for a variety of nonmalignant conditions. Results of this study suggest that there was a non-significant trend for cancers to be on the side of the head where the patients reported using their cellular telephones. It is interesting to note that the relative risks associated with using a cellular telephone were marginally depressed (RR = 0.7) for meningioma, and slightly elevated (RR =1.4) for acoustic neuroma, although not statistically significant. Acoustic neuromas are benign tumors attached to the auditory nerve, and are often presented with tinnitus and hearing loss.

In addition, a retrospective cohort study of cancer incidences was conducted in Denmark of all users (420,095 in total, identified from the two Danish operating companies) of cellular mobile telephones during the period from 1982 through 1995. No excesses were observed for cancers of the brain or nervous system, or for leukemia [15]. The risk for these cancers also did not vary by duration of cellular-telephone use, the time since initial subscription, the age at initial subscription, or the type of cellular telephone (analogue or digital). Furthermore, an analysis of brain and nervous-system tumors showed no statistically significant increase in incidence ratios for any subtype or anatomic location. It is interesting to note that in this study, 3391 cancers were observed with 3825 expected, yielding a significantly decreased incidence ratio of 0.89. A sizable proportion of this decreased risk was attributed to deficits of lung cancer and other smoking-related cancers.

Taken together with the study by Hardell et al. [12], these results do provide some basis for optimism, in that they imply that the use of cellular telephones does not cause brain tumors in the short term. It is noteworthy that, although not statistically significant, two of the three case-control studies showed a trend between reported laterality of the cancer with the self-reported laterality of the use of the cellular telephone. Nevertheless, it may be possible to view these results as failing to indicate an excess of cancer mortality from RF exposure. However, it is important to recognize that these investigations do not evaluate the risks in the long run (with the possible exception of the cohort study from Denmark), or for cancers with longer latency periods of induction, especially for slow-growing tumors. Further studies are needed to account for acoustic neuromas, and for the twofold increase in uncommon neuroepitheliomatous cancers among users.

A fair assessment of the above studies would be that they all suffer from small numbers (including the early cohorts from the Danish study), and a lack of realistic measures of RF exposure. These considerations present profound uncertainties in their use for risk analysis at this stage. It is noted that some efforts are being taken to expanded the current understanding of wireless-telephone radiation and human health. In particular, a large-scale epidemiological study is underway in Europe, as part of a wide-ranging research effort on health effects of wireless-telephone use.

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Maastricht General Assembly

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The year 2002 will bring the General Assembly of URSI back to the Netherlands after more than half a century. The local Organising Committee takes great pleasure in inviting you to attend this General Assembly that will take place in Maastricht in the *Maastricht Exhibition & Congress Centre (MECC)*.

A First Announcement with a Call for Papers has been sent out. Please note that any further information concerning the 2002 General Assembly will be made available only through the conference website, i.e.

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Also abstracts of contributed papers can be submitted only through web forms that can be accessed through the above-mentioned URL. The deadline for abstract submission is January 15, 2002.

We sincerely hope that the many members of the URSI community will get together in the Summer of 2002 and will depart after the Assembly with a good and kind recollection of scientific value and an inspiring setting of URSI GA 2002.

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News from ITU-R

Some recent activities in the ITU-R Study Groups which may be of particular interest to the URSI community are summarized below.

Study Group 1 (Spectrum management)

ITU studies on unwanted emissions were initiated more than 50 years ago. In recent years, Task Groups 1/3 and 1/5 developed limits for unwanted (spurious and out-of-band) emissions, introduced the new concept of spurious and out-of-band domains for unwanted emission limits and defined the boundary between these domains.

The aim of ITU-R Task Group 1/7 is to assess the impact of unwanted emissions on passive systems, to lay the framework for band-by-band studies, and to perform such studies on a limited number of bands. The basis for these studies lies in WRC-03 Agenda Item 1.8.2, which calls for: *consideration of the results of studies, and proposal of any regulatory measures regarding the protection of passive services from unwanted emissions, in particular from space service transmissions, in response to recommends 5 and 6 of Recommendation 66 (Rev. WRC-2000).*

After two meetings TG 1/7 has prepared working documents for a new Recommendation on the methodology of compatibility analysis between a passive service and an active service allocated in different bands. The TG is also preparing suitable text for submission to the ITU-R Conference Preparatory Meeting (CPM) for WRC-03.

Study Group 3 (Radiowave propagation)

Budapest was the venue for parallel meetings of Working Parties 3J (Propagation fundamentals) and 3M (Point-to-point and Earth-space propagation), preceded by "CLIMPARA 2001". The latter was the fourth in a series of workshops, organised under the auspices of URSI Commission F, which have arisen from the need for improved parameterization of the climatic effects that drive the propagation prediction procedures used for terrestrial and space services. Concentrating on purely scientific aspects, CLIMPARA workshops serve to bridge the scientific and engineering propagation communities - this liaison being all the more effective with the workshop held at the same location and just prior to the ITU-R Working Parties. Presentations at CLIMPARA 2001 addressed both clear-air and precipitation effects, of which those concerning rain scatter, fade duration modelling and statistical representations of surface water vapour were just three examples of immediate relevance to the subsequent ITU-R meetings.

Working Parties 3J and 3M prepared material for the revision of several existing ITU-R Recommendations, (e.g. those concerning prediction methods for terrestrial line-of-sight paths, land mobile-satellite paths, determination of earth station coordination distance, obstacle diffraction, vegetation effects, specific attenuation of rain, water vapour density mapping). In addition, preliminary text was developed on new Recommendations dealing with propagation prediction methods for Earth-space optical communications, the statistics of fade duration on Earth-space paths, and the effects of building materials and structure on propagation above about 100 MHz. Propagation information was also prepared to support studies underway in other ITU-R Study Groups - topics which include ground scatter to passive sensors, rain scatter in coordination area prediction, sharing between HDFS and other services at 30-50 GHz, and satellite downlink fading.

Study Group 7 (Science services)

Working Party 7A has completed revision of Recommendation ITU-R TF.686 "Glossary and definition of time and frequency terms" harmonizing this with the ITU-R Handbook "Selection and use of precise frequency and time systems", ITU-T Recommendation G.810, and with IEEE and ISO documents on terminology.

Working Party 7D has initiated the development of a Recommendation on technical and operational characteristics of ground-based astronomical facilities operating between 10 THz and 1000 THz, in response to Question ITU-R 235/7. Within the practices of ITU, radiocommunication is typically considered to encompass only the spectrum below 3000 GHz. However, according to the ITU Constitution (CS 78) and the Convention (Note 2 of CV 1005), Study Group activities are not required to restrict their considerations to within the 3000 GHz upper limit. The Recommendation under development includes important information for possible frequency sharing studies between 10 THz and 1000 THz.

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Studying/Employed at : ....

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Department ....

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Title of abstract submitted : ....

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Type of session preferred: ☐ *in an oral session* ☐ *in a poster session*

The subject of the paper is relevant to URSI Commission .... *session (leave blank if uncertain).*

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Send this form before 15 November 2001 to the URSI Secretariat (address overleaf). Please send THREE COPIES of each of the following: (1) a completed application form, (2) a CV and list of publications, (3) an abstract of proposed paper.

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Conferences

CONFERENCE REPORTS

4TH EUROPEAN PERSONAL MOBILE COMMUNICATIONS CONFERENCE (EPMCC 2001)

Vienna, Austria, 20-22 February 2001

The Fourth European Personal Mobile Communications Conference (EPMCC 2001) was held in Vienna, Austria from 20 to 22 February 2001.

The Co-organizers of this conference were ÖVE, the Austrian Electrotechnical Society, and the Technische Universität Wien, Department of Communications and Radio-Frequency Engineering.

Attendance was satisfactory (220) from 26 countries, European and non-European, to hear some 90 papers. These papers had been selected from some 130 submissions.

The URSI support, which amounted to € 1000, was gratefully acknowledged.

The money was spent to provide travel support to three persons from less-privileged countries to enable them to attend and present their paper.

Other supporting organizations were Mobilkom Austria, the largest Austrian cellular operator, and Austrian subsidiaries of Ericsson, Siemens, Nortel and Motorola.

The Best Award Contest turned out as a surprising three-way tie. So the awards went to a Finnish and two German groups. All these concerned smart antennas and related issues of the spatial characteristics of the radio channel.

MSMW'2001

Kharkov, Ukraine, 4-9 June 2001

The Fourth International Kharkov Symposium on Physics and Engineering of Millimetre and Sub-Millimetre Waves (MSMW'2001) took place in Kharkov State University, Kharkov, Ukraine on June 4-9, 2001.

It was organised by the National Academy of Sciences of Ukraine Scientific Council on the problem "Radio Physics and Microwave Electronics", in co-operation with the following organisations:

- Institute of Radio-Physics and Electronics of the National Academy of Sciences of Ukraine (IRE NASU),
- Institute of Radio Astronomy of the National Academy of Sciences of Ukraine (IRA NASU),
- Kharkov National University (KNU),
- IEEE AES/AP/ED/EMB/GRS/MTT/NPS-Societies East Ukraine Joint Chapter,
- IEEE AP/CPMT/ED/MTT-Societies West Ukraine Joint Chapter,
- National URSI Committee of Ukraine,
- Young Scientists Council of IRE NASU.

The working days of the conference were June 5 to 8. Every day the conference started with a plenary session of four 40-min invited lectures in a large auditorium. After that, four parallel day-long sessions of 15-min contributed papers had been working. All the papers were presented in English. June 9 was filled in with social events. The number of registered participants was 248 including 192 from Ukraine, 26 from Russia, 8 from Germany, 4 from Mexico, 3 from Turkey and USA, 2 from Belarus, Japan, Great Britain, and The Netherlands, 1 from Armenia, Finland and Italy each. Totally 238 papers out of 293 in the Program were presented. Two-volume MSMW'2001 Proceedings counting totally over 970 pages had been published before the symposium. The holding of the conference became possible thanks to the support of sponsors: URSI, IEEE ED and MTT Societies, EOARD, INTAS and STCU. The next MSMW'2004 is planned to be held in Kharkov in June, 2004.

June 4

June 4 was the day of registration. On this day, a bus city tour was organised, enabling participants to get acquainted with the history of Kharkov, second-largest Ukrainian city. Remarkable historical buildings and monuments, such as Assumption Cathedral, WW II Memorial, "Gosprom" complex built in the 20's as an example of constructivism style in the architecture of the early Soviet period were visited.

June 5

MSMW"2001 started at 8:30 on June 5, 2001 by the opening ceremony at the " New Physical" auditorium of the Kharkov National University. The first to address the participants was MSMW'2001 Chairman, Director of the IRE NASU, Vice-Chairman of the Ukrainian National URSI Committee Prof. Vladimir M. Yakovenko. He was followed by the welcome words from MSMW'2001 Co-Chairman, Director of the IRA NASU, Vice-Chairman of the Ukrainian National URSI Committee Prof. Leonid M. Lytvynenko. The next to make a welcoming speech was Prof. Anatoly A. Kirilenko of IRE NASU, who spoke in the name of the IEEE AES/AP/ED/EMB/GRS/MTT/NPS Societies East Ukraine Joint Chapter. He emphasised very important contribution of the Chapter to the success of MSMW2001. Prof. Alexander I. Nosich of IRE NASU addressed the participants on behalf of the MSMW'2001 Organising Committee.

That morning the first plenary session was held, consisting of four invited talks:

- G. Galati, et al., "A Novel W-Band Radar for Airport Traffic Monitoring: Implementation, First Operational Results, Perspectives" (Tor Vergata University, Roma, Italy)
- J. Moreira, et al., "Range of Applications of a Ka-Band Interferometric Synthetic Aperture Radar" (Aero-Sensing Radarsysteme GmbH, Oberpfaffenhofen, Germany)
- A. Kirilenko, et al., "The mode-matching technique as a basis of automatic solvers for complicated waveguide problems" (IRE NASU, Kharkov, Ukraine)
- R. W. McMillan, et al., "Angle of Arrival of a Focused Gaussian Beam in Atmospheric Turbulence" (US Army, Alabama, USA)

Further, after a lunch, the symposium continued working with four simultaneous sessions:

- Session C: Wave Phenomena In Finite-size Semiconductors And Solid-state Structures
- Session E: Wave Propagation And Radar
- Session I: Waveguide Devices And Integrated Circuits
- Session K: Radio Astronomy

In these sessions, the following invited papers were presented:

- E.M. Ganapolsky, "Fundamental Microwave Absorption of Millimetre Wave Band in Perfect Dielectric Crystal. Physical Basics and Applications (IRE NASU, Kharkiv, Ukraine)
- B.G. Kutuza, "Fluctuations of Microwave Emission of the Atmosphere at the Millimetre Wavelengths" (IRE RAS, Moscow, Russia)
- N.I. Herscovici, et al., "A Microstrip Array Fed by a Non-Homogeneous Stripline Feeding Network" (Cushcraft Corp., Manchester, USA)
- I.I. Zinchenko* and V.M. Shulga**, Some Results and Prospectives of the Millimetre and Sub-Millimetre Wave Interstellar Spectroscopy" (* IAP RAS, Nizhny Novgorod, Russia, ** IRA NASU, Kharkov, Ukraine)

The same evening, at 7:30 p.m., a welcome party was organised at the university restaurant. At the welcome party, Ukrainian champagne was served. This event created a perfect atmosphere to relax and shake off the troubles of long and sometimes tiring journeys that participants had to undertake to reach MSMW'2001.

June 6

At the symposium morning plenary session, the following invited papers were presented:

- H. Rohling, et al., "Research activities in automotive radar" (Technical University of Hamburg-Harburg, Germany)
- Y. Y. Kulikov, "Microwave Diagnostics of Ozone Layer at the Polar Latitude" (IAP RAS, Nizhny Novgorod, Russia)
- V. Räisänen, et al., "Experimental studies on radio holograms at millimetre and sub-millimetre wavelengths" (Helsinki University of Technology, Finland)
- N.T.Cherpak, "MM Wave Resonant and Non-Resonant Structures with High-Tc Superconductors" (IRE NASU, Kharkov, Ukraine)

This day regular sessions of contributed papers consisted of:

- Session A: Electromagnetic Theory And Numerical Simulation
- Session B: Atomic Functions, Wavelets And Fractals
- Session G: Vacuum electronics, gyrotrons and free electron lasers
- Session M: Scientific And Industrial Applications

In these sessions, the following invited papers were presented:

- K. Yasumoto, et al., "Reflection and Transmission from Periodic Composite Structures of Circular Cylinders - Refinement of Reflectance and Transmittance" (Kyushu University, Fukuoka, Japan),
- V.F. Kravchenko, et al., "New Class of Atomic-Fractal Functions and Their Applications" (IRE RAS, Moscow, Russia),
- V.E. Zapevalov, "Problems and Advances of High Power Gyrotrons" (IAP RAS, Nizhny Novgorod, Russia),
- G.I. Khlopov and A.A. Kostenko. "Application of Focused Beams in Millimetre Wave Super-Near Technological Radars" (IRE NASU, Kharkov, Ukraine).

The same evening participants visited the City Hall of Organ Music, booked by the organisers. The Hall occupies the ground floor of the bell-tower of the Assumption Church in the older part of Kharkov. The concert was performed by the famous Ukrainian musicians and singers.

June 7

On the third day, the morning plenary session looked as follows:

- K. A. Lukin, "Millimetre Wave Noise Radar Applications: Theory and Experiment" (IRE NASU, Kharkov, Ukraine),
- L.P. Lightart. "Millimetre Wave Facilities at IRCTR, Delft University Of Technology" (Delft, The Netherlands),
- V.V. Parshin, "Modern Technique for Absorption Investigation in Atmosphere and Condensed Media in the MM Wavelength Range" (IAP RAS, Nizhny Novgorod, Russia),
- D. M. Vavriv, "Cloud Radar Activities at the Institute of Radio Astronomy of the NAS of Ukraine" (IRA NASU, Kharkov, Ukraine)

Parallel sessions of regular papers that day went along the following topics:
- Session D: High- And Low-Temperature Superconductors
- Session H: Quasioptical Techniques And Antennas
- Session J: Solid State Devices
- Session O: Biomedical Applications

In the session J the following invited paper was presented:
- V.G. Bozhkov, et al., "Monolithic and Quasi-Monolithic MM-Wave Modules and Devices" (Research Institute of Semiconductor Devices, Tomsk, Russia).

That evening, the symposium banquet was held at the university restaurant. This was a lovely event accompanied with live music, dancing and informal speeches. The dominant tone, however, was the joy of meeting the old friends and colleagues and making new ones.

June 8

On the last working day of the symposium, the morning plenary session consisted of one invited paper:
- S. Vitusevich, et al., "Frequency Stable Oscillators Based on Cryogenic Whispering Gallery Mode Resonators" (Institute of Thin Films and Interfaces, Juelich, Germany)

Parallel sessions of that day covered three topical areas as:
- Session F: Remote sensing
- Session L: Spectroscopy And New Materials
- Session N: Electromagnetic metrology

The closing ceremony of MSMW'2001 took place in the "New Physical" auditorium of KNU at 5:30 p.m. At first, several awards of the conference were announced and handed to the awardees. Eight traditional MSMW awards bearing citations, "In recognition of the remarkable presentation at the young scientist paper competition", went to the following young scientists:
- A.F. Rusanov (IRE NASU, Kharkov, Ukraine),
- A.V. Antuyfeyev (IRE NASU, Kharkov, Ukraine),
- A.V. Kozmin (A. Bauman Moscow State Technical University, Russia),
- J. V. Rassokhina (Donetsk National University, Ukraine),
- A.N. Rudiakova (Donetsk National University, Ukraine),
- S. Hirsch (Technical University of Hamburg-Harburg, Germany),
- K. Duwe (Technical University of Hamburg-Harburg, Germany),
- A. O. Salman (Turkish-Ukrainian Joint Research Laboratory, MAM, Gebze, Turkey).

Each MSMW'2001 award consisted of a colourful certificate signed by the Symposium Chairman and an original Ukrainian souvenir.

The final closing address was done by Prof. Vladimir M. Yakovenko. He announced that the next Symposium, MSMW"2004, will be held again in Kharkov in 2004, thanked the participants and organisers for creating unprecedented forum for scientific discussions and expressed a hope that the MSMW symposia series will be continued. He also expressed gratitude to international institutions such as IEEE, URSI, INTAS, EOARD and STCU, which rendered valuable and timely support.

June 9

On the weekend after Symposium, the participants were proposed a social program in order to get relaxed after four days of intensive work and strengthen the links originated at the symposium. On Sunday June 9, a full-day bus tour was organised from Kharkov to the "Gaidary" Ionospheric Radio-Physical Observatory of KNU. It is located in the natural reserve about 50 km southwards from Kharkov, at the bank of the Seversky Donets River. After visiting observatory buildings a barbecue party was held.

Prof. V.M. Yakovenko
Official representative of URSI at the Symposium
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E-mail: yakovenko@ire.kharkov.ua

CONFERENCE ANNOUNCEMENT

TELECOM'2001 & 2$^{\text{èmes}}$ JFMMA

Casablanca, Morocco, 17-19 October 2001

The third meeting on telecommunications "TELECOM'2001 & 2$^{\text{èmes}}$ JFMMA" will be held at the Hassan II University in Casablanca, Morocco from 17 to 19 October 2001. The meeting will consist of invited and submitted papers, covered by the URSI Commissions A, B, C, E, F and K

Topics

The technical programme concerns all subjects related to the Technologies of Information and Communications:

- Telecommunications & Multimedia
- Electromagnetic Compatibility
- Micro waves
- Image Processing

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URSI CONFERENCE CALENDAR

URSI cannot be held responsible for any errors contained in this list of meetings.
Do you wish to announce your meeting in this Calendar? More information about URSI-sponsored meetings can be found on our Homepage at : http://www.intec.rug.ac.be/ursi/Rules.html

October 2001

School on analysis techniques for space plasma data
La Londe - Les Maures, France, 8-13 October 2001
Contact: Prof. Thierry Dudok de Wit, Laboratoire de Physique et Chimie de l'Environnement, LPCE-CNRS, 3A, Avenue de la Recherche Scientifique, 45071 Orleans cedex 2, France, Fax: +33-238-255277, E-mail: ddwit@cnrs-orleans.fr, http://www.tu-bs.de/institute/geophysik/la-londe/

November 2001

Specialist Meeting on Microwave Remote Sensing 2001
Boulder, Colorado, USA, 6-8 November 2001
Contact: Dr. Ed R. Westwater, CIRES, University of Colorado/NOAA, Environmental Technology Laboratory, 325 Broadway MS R/E/ET1, Boulder, CO 80305 USA, Tel: 303-497-6527, Fax: 303-497-3577, Email: Ed.R.Westwater@noaa.gov, http://www.etl.noaa.gov/mrs01/May 2002

May 2002

Third URSI International Commission G High Latitude Ionosphere Symposium
Fairbanks, Alaska, USA, 15-19 May 2002
Contact : Dr. Robert Hunsucker, Oregon Institute of Technology, Electronic Engineering Technology, 3201 Campus Drive, Purvine Building, Room PV282, Klamath Falls, OR 97601, USA, Tel: +1 541-885-1515, Fax: +1 541-885-1666, E-mail: hunsuckr@oit.edu@aol.com

EMC 2002
Beijing, China, 21-24 May 2002
Contact: Prof. L. Dayong, EMC 2002 Secretary, Chinese Institute of Electronics, P.O. Box 165, Beijing 100036, China, Tel: +8610 68283463, Fax: +861068283458, E-mail: dyliu@public.bta.net.cn, http://www.cie-china.org/emc2002

June 2002

EUSAR 2002
Cologne, Germany, 4-6 June 2002
Contact: Dr. Richard Klemm, FFM-FGAN, Neuenahrer Strasse 20, D-53343 Wachtberg, Germany, Fax: +49 229 9435 618, Email: r.klemm@fgan.de, http://www.fhr.fgan.de/eusar/

EMC Wroclaw 2002
Wroclaw, Poland, 27-30 June 2002
Contact: Mr. W. Moron, EMC Symposium, Box 2141, 51-645, Wroclaw 12, Poland, Tel: +4871-348-3051, Fax: +4871-372-8878, Email: emc@il.wroc.pl

August 2002

URSI General Assembly 2002
Maastricht, The Netherlands, 17-24 August 2002
Contact: Dr. Leon P.J. Kamp, Eindhoven University of Technology, Department of Applied Physics, P.O. Box 513, NL-5600 MB Eindhoven, The Netherlands, Tel: +31 40-2474292, Fax: +31 40-2445253, Email: URSI2002@tue.nl

September 2002

EMC Europe 2002 - International Symposium on Electromagnetic Compatibility
Sorrentino, Italy, 9-13 September 2002
Contact: EMC Europe 2002 Secretariat, AEI Ufficio Centrale, Piazzale R. Morandi 2, 20121 Milano, Italy, Phone: +39-02-77790-205/218, Fax: +39-02-798817, E-mail: emceurope2002@aei.it, http://www.aei.it/emceurope2002.html

November 2002

ISAP-i02, 2002 Intermediate International Symposium on Antennas and Propagation
Yokosuka, Japan, 26-28 November 2002
Contact: Prof. Kenichi Kagoshima, Chairperson, ISAP i-02, Ibaraki University, 4-12-1 Nakanarusawa, Hitachi, 316-8511 Japan, Internet: http://www.ieice.org/cs/ap/ISAP2002/

APMC2002, Asia-Pacific microwave Conference
Kyoto, Japan, 19-22 November 2002
Contact: Prof. Shozo Komaki, Chair, Steering Committee, c/o Realize Inc., 4-1-4 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, Tel: +81-3-3815-8590, Fax: +81-3-3815-8529, Email: mweap mc@bleu.ocn.ne.jp, http://www.apmc-mwe.org

XXVIIth GENERAL ASSEMBLY

17-24 August 2001, Maastricht Exhibition and Congress Centre, The Netherlands

Announcement and Call for Papers Now Available

The announcement and call for papers for the XXVIIth General Assembly of the International Union of Radio Science is now available on the Web. This includes the schedule for the sessions of the 10 URSI Commissions, as well as the instructions and format for submitting papers. *Web-based submission is mandatory.* A review abstract must be submitted first, followed by a full paper, after acceptance. There is also information on the **Young Scientists Program**. The information in this announcement is *essential* for anyone wishing to submit a paper to be presented at the General Assembly. The deadline for *receipt* of abstracts is **January 15, 2002.**

http://www.URSI-GA2002.nl/

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Tel: +31 40 2474292; Fax: + 31 40 2445253; E-mail: URSI2002@tue.nl

News from the URSI Community

NEWS FROM A MEMBER COMMITTEE

POLAND

Tenth National Symposium of Radio Science

The Tenth National Symposium of Radio Science will be held at the Poznan Center of Science in Poznan from 14 to 15 March 2002. The Chairman of Honour is Prof. Jerzy Dembczyñski, Rector Magnificus of Poznan University of Technology.

Program Committee

Chairman: Stefan Hahn
Members: Daniel J. Bem, Andrzej Dobrogowski ,MarekDomañski, Stanislaw Gorgolewski, Jolanta Karpowicz, Tomasz Kosilo, Bohdan Mroziewicz, Józef Pawelec, Wiktor Pawlowski, Marian Piekarski, Karol Radecki, Iwona Stanislawska, Andrzej Turski, Andrzej Wernik, Krzysztof Wesolowski

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Pawel Szulakiewicz, Zbigniew Szymañski, Krzysztof Wesolowski
Scientific Secretary: Hanna Bogucka
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Call for Papers

A rapid proliferation of wireless communications has resulted in the increased demand for cellular phone services, and the building of new cellular networks using TDMA and CDMA techniques, to accomodate the growing number of users. New wireless data transmission networks, the concept of PCS, radio access to ATM networks, have been intensively developing.

The process of implementing the third generation wireless communication system UMTS will soon begin in Poland. We all witness a substantial progress in radio astronomy and radar technology.

Therefore, research in the area of radio science is finding growing use in electromagnetic field and wave propagation theories, radio channel modelling, electromagnetic noise and interference cancellation, metrology, medicine and biology, as well as in the field of radio communication systems design.

Topics

Topics of interest include but are not limited to the following:
- Electromagnetic Metrology
- Radio Wave Propagation
- Electromagnetic Field Theory
- Signals and Systems
- Electromagnetic Fields in Biology and Medicine
- Radio Astronomy
- Wireless Information Networks
- Satellite Systems
- Electromagnetic Noise and Interference
- Mobile Communications
- Radio and TV Broadcasting
- Radar and Navigation Systems

An international session in English is also planned.

Submission of Papers

Three copies should be submitted by November 30, 2001 to the following address:

URSI 2002 Office
Poznan University of Technology
Institute of Electronics and Telecommunications
ul. Piotrowo 3A
60-965 Poznan, POLAND

Contact

All inquiries concerning the URSI 2002 Symposium should be addressed to:

The Institute of Electronics and Telecommunications
Poznan University of Technology
ul. Piotrowo 3a
60-965 Poznan
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Phone: + 48 61-6652290
Fax: + 48 61-6652572
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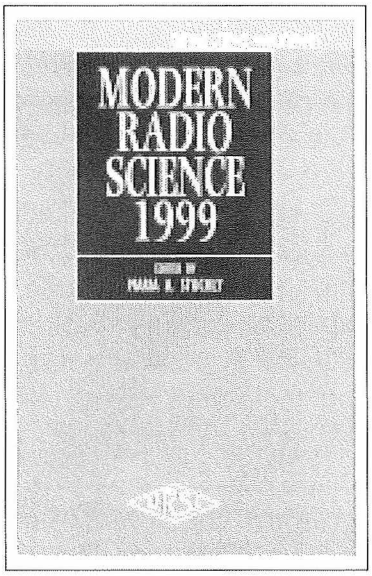
URSI Publications



Modern Radio Science 1999

Editor: Maria Stuchly
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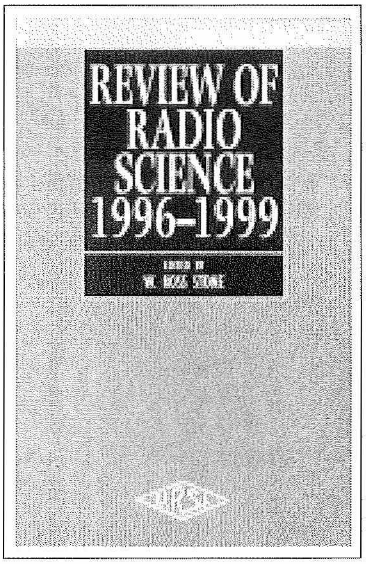

Review of Radio Science 1996-1999

Editor: W. Ross Stone
August 1999/Hardcover/1044 pp
ISBN 0-7803-6003-6
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Handbook on Radiopropagation Related to Satellite Communications in Tropical and Subtropical Countries

Editor: G.O. Ajayi
with the collaboration of :
S. Feng, S.M. Radicella, B.M. Reddy

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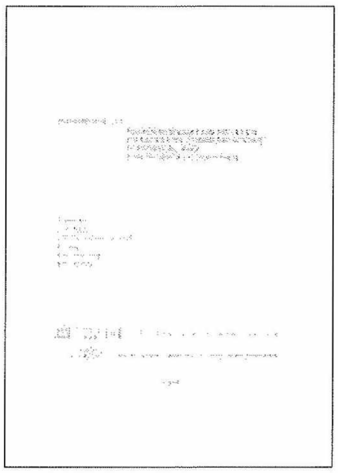

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RADIO SCIENCE

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ODUR

The Journal of Atmospheric and Solar-Terrestrial Physics

SPECIAL OFFER TO URSI CORRESPONDENTS

AIMS AND SCOPE

The *Journal of Atmospheric and Terrestrial Physics* (JASTP) first appeared in print in 1951, at the very start of what is termed the "Space Age". The first papers grappled with such novel subjects as the Earth's ionosphere and photographic studies of the aurora. Since that early, seminal work, the Journal has continuously evolved and expanded its scope in concert with - and in support of - the exciting evolution of a dynamic, rapidly growing field of scientific endeavour: the Earth and Space Sciences. At its Golden Anniversary, the now re-named *Journal of Atmospheric and Solar-Terrestrial Physics* (JASTP) continues its development as the premier international journal dedicated to the physics of the Earth's atmospheric and space environment, especially the highly varied and highly variable physical phenomena that occur in this natural laboratory and the processes that couple them. The *Journal of Atmospheric and Solar-Terrestrial Physics* is an international journal concerned with the inter-disciplinary science of the Sun-Earth connection, defined very broadly. The journal referees and publishes original research papers, using rigorous standards of review, and focusing on the following: The results of experiments and their interpretations and results of theoretical or modelling studies, papers dealing with remote sensing carried out from the ground or space and with in situ studies made from rockets or from satellites orbiting the Earth, plans for future research, often carried out within programs of international scope.The Journal also encourages papers involving: Large scale collaborations, especially those with an international perspective, rapid communications, papers dealing with novel techniques or methodologies, commissioned review papers on topical subjects and special issues arising from chosen scientific symposia or workshops. The journal covers the physical processes operating in the troposphere, stratosphere, mesosphere, thermosphere, ionosphere, magnetosphere, the Sun, interplanetary medium, and heliosphere. Phenomena occurring in other "spheres", solar influences on climate, and supporting laboratory measurements are also considered. The journal deals especially with the coupling between the different regions. Solar flares, coronal mass ejections, and other energetic events on the Sun create interesting and important perturbations in the near-Earth space environment. The physics of this subject, now termed "space weather", is central to the Journal of Atmospheric and Solar-Terrestrial Physics and the journal welcomes papers that lead in the direction of a predictive understanding of the coupled system. Regarding the upper atmosphere, the subjects of aeronomy, geomagnetism and geoelectricity, auroral phenomena, radio wave propagation, and plasma instabilities, are examples within the broad field of solar-terrestrial physics which emphasise the energy exchange between the solar wind, the magnetospheric and ionospheric plasmas, and the neutral gas. In the lower atmosphere, topics covered range from mesoscale to global scale dynamics, to atmospheric electricity, lightning and its effects, and to anthropogenic changes. Helpful, novel schematic diagrams are encouraged. Short animations and ancillary data sets can also be accommodated. Prospective authors should review the *Instructions to Authors* at the back of each issue.

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Audience

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T.L. Killeen, National Centre for Atmospheric Research, Boulder, Colorado, 80307 USA

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