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The
RADIOSCIENTIST

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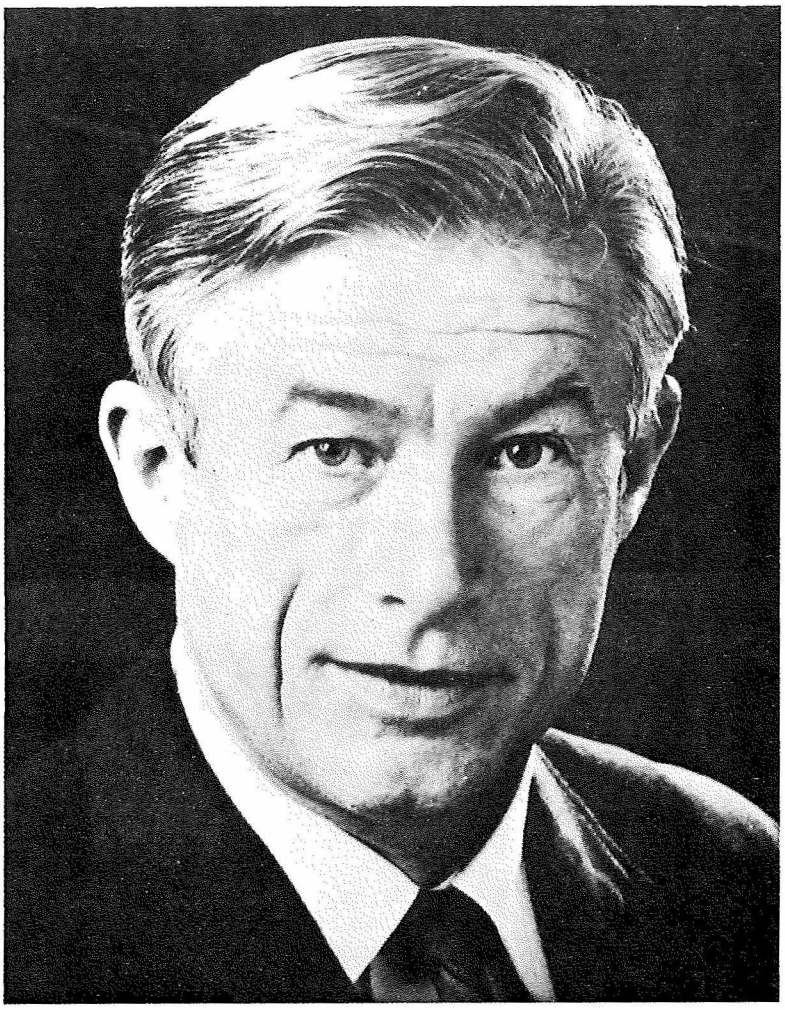

Edward Jull
URSI President, 1990-93

The new URSI Board elected at Prague

URSI in verse by Felsen

NORAM URSI

Cosmic μwave back ground

X-Rays on ROSAT

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APOLOGY

Prof. A. D. Olver, one of the Regional Editors of *URSI NEWS*, was listed on the editorial staff of the *Radioscientist* without his permission. Our apologies for the inconvenience and embarrassment this caused.

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All material should be mailed direct to the Editor, preferably on Word 4 (Mac) on diskette. "Flat" or pure ASCII text files on diskette or email are acceptable, as is paper. Deadline is six weeks before issue date but contributions are welcome at any time. The Editor reserves the right to to accept, reject, defer and/or edit any material and all material submitted.

Scanning the *Radioscientist* — from the Editor

The first issue of the *Radioscientist* was an experiment. It was produced independently of URSI for evaluation at the Prague General Assembly. There were three options for URSI Council — (i) to leave the *Radioscientist* as an independent magazine, (ii) to leave it independent but with URSI sponsorship like the journal, *Radio Science*, or (iii) to take it over as an URSI publication. Rather beyond my hopes and expectations, the decision was (iii).

This means that the *Radioscientist* is now the successor of *URSI NEWS*, so the latter will not continue. It leaves the *Radioscientist* without the safety net I envisaged last time, so we had better catch the trapeze! If this magazine still appears amateurish it is because the editor, copy editor, type setter, page designer, and advertising manager is combined in one person and an amateur at that. But he's learning.

This issue, the first as URSI's own magazine, is mainly about the Prague General Assembly. As one of the Young Scientists said (see *LETTERS*), the senior figures of URSI seem to have no past, so the first article is a *Who's Who* of the newly elected Board. As you will see, Dr. Okoshi could be another Borodin.

Prof. Peter Clarricoats (left), on behalf of the Royal Society of London, presents the Appleton Prize to Dr. V. Gurevich at URSI XXIII.

There has been a tradition — really just a habit — in URSI that, since the Statutes allow Vice Presidents to be re-elected for a second term, such re-election happens. So for the last two or three decades (I haven't checked) at each GA, two "Senior" Vice Presidents retired after having served two terms, the two "Junior" ones were re-elected for a second term and two new Vice Presidents were elected. In addition one of the two retiring Vice Presidents was elected President. This just happened. It is not and never was in the Statutes, but it was sometimes mentioned by an old hand to a new chum as an unwritten tradition (it took me several years to discover it!).

At Prague the tradition ended. It had to happen eventually but it caused disappointment to many that neither of the retiring Vice Presidents, to whom URSI owes so much, was elected to the Presidency. That office went to Edward Jull to whom we extend our congratulations and whose address on taking office is printed here.

Another tradition, kept this time
Was Leo Felsen's speech in rhyme

Banquet conditions were none too good
Conversation won out and so did the food

With pilsner beer and Becherovka to drink
How could one hear, let alone think?

So instead of the Banquet to read Leo's lay
Sid Bowhill presented it on the last day

We print it in full to read at your leisure
With his picture as well to add to your pleasure.

Next follows three *LETTERS*, all from Young Scientists. They were not written to the Radioscientist as such but I would like to launch a *LETTERS* page or two. Anyone for *LETTERS*?

It is not always appreciated that most of URSI's scientific activity takes place at specialist or regional meetings between General Assemblies. Edward Jull describes how the North American Radio Science meetings are alive and well.

Two articles follow on the ionosphere, one historical, one on studies by NEED.

The three following articles were supplied by Rudolf Treumann — the first written by his colleague, Laurent Muschietti and the other two by himself. He has written the introduction (following paragraph) for Dr Muschietti's paper, but first I would like to commend Rudolf to all my other regional editors. Get material like this in quality and quantity and we will have no trouble making the *Radioscientist* a monthly magazine.

The following article by Laurent Muschietti should be of vital interest to all those radioscientists who are involved into the generation of nonthermal radiation in natural plasmas of different origin in the universe. Nonthermal radiation is known to be excited in the solar atmosphere during solar radio bursts and has recently been detected from radio flare stars using the VLBI. The oldest known way of exciting nonthermal radiation is via the merging of two Langmuir waves. Adding up their frequencies one finds that the resulting radio emission has a frequency of about twice the plasma frequency of the region where the waves have been generated, while the wave vectors of the two waves nearly cancel to produce a long wavelength transverse radio wave. The Langmuir waves required in this mechanism are in most cases the result of the instability of a fast electron beam traversing the plasma. But serious problems have been encountered during the investigation of the stability and life time of such beams. Theoretically they should exist only over very short spatial distances and not lead to extended radio wave emissions as those observed during solar type III radio bursts. This problem has long been attacked by theoreticians in many ways, proposing that the inhomogeneity of the beams, as well as of the medium, or complicated nonlinear effects, are responsible for the observed long life time of the beam. The work reported on by Muschietti focuses on this problem and shows that recent simulations taking into account the deformation of the wave dispersion relation due to the presence of the beam modify the details of beam propagation and wave generation and lead to a new insight into the process.

These calculations may have strong influence on the future understanding of nonthermal beam-generated radio radiation.

This is as good a place as any to bring up the question: should articles in the Radioscientist be refereed? So far they are not. Ross Stone, the Editor-in-Chief of the IEEE Antennas and Propagation Magazine, tells me the articles in his magazine (some of which you will see reprinted in the *Radioscientist* from time to time) **are** refereed. My feeling is that we already have *Radio Science* as an international, refereed journal in this field and now sponsored by URSI (see advertisement displayed free of charge to AGU). Should we compete? Getting papers refereed is a lengthy process. Maybe something gets lost in the process. Maybe the very things we need in a magazine like this which would be inappropriate in a Journal. What do **you** think?

Finally we have a paper on experimental thermodynamics. We do a lot of experimental physics down here in a fun way — elasticity by way of bungy jumping and mechanics in jet boats. We have yet to find a way to do radioscience like this, so you will have to make do with John Campbell's article. If URSI eventually comes to NZ, compulsory firewalking will be on the programme.

The New Team — the Board Elected at URSI XXIII

Alexander Cullen was born in London, England in 1920. He married is to Margaret, and they have two sons and a daughter, and six grandchildren. He attended Imperial College London (1938-40; B.Sc. (Eng) 1941).

Prof. Cullen gives Presidential Report.

He worked on radar at the Royal Aircraft Establishment in Farnborough, Hampshire (1940-1946). From 1946 to 1955 he was a lecturer at University College London (UCL) where he worked on microwave measurements, surface waves, and space-charge waves in electron beams. In 1955 he was professor of electrical engineering at Sheffield University, where he worked on millimetre-wave measurements, including plasma diagnostics, returning to UCL in 1967 to succeed Professor Harold Barlow as Head of Department. He became a Science Research Council Senior Fellow in 1980, and since 1983 he has been an Honorary Research Fellow at UCL.

He has been on URSI's Board of Officers since 1981, for two terms as a Vice President (1981-87), the second as Treasurer (1984-87), then as President (1987-90) and now as **URSI Past President**. He and Professor **Van Bladel** (Secretary General since 1979) provide the essential experience and wisdom for a relatively young and new Board.

His hobby is music of all sorts — from jazz to classics. He has a desk at one end of his study, and a set of drums and a clarinet at the other. He enjoys reading detective stories, and imagining that one day he might even write one!

Edward Jull was born in Calgary, Canada in 1934. He is married to Anne Kjellberg from Uppsala, Sweden and they have two daughters and two sons. He received the BSc degree in engineering physics from Queen's University, Kingston, Canada in 1956, the PhD degree in electrical engineering from the University of London (University College) in 1960 and the DSc (Eng) from the University of London in 1979. He was with the Division of Radio and Electrical Engineering of the National Research Council in Ottawa in 1955 as a summer student, in 1956-57 as a junior research officer, in 1961-72 as an assistant and associate research officer and in 1979-80 as a visiting research officer. He was a guest researcher in the Laboratory of Electromagnetic Theory of the Technical University of Denmark and the microwave Institute of the Royal Institute of Technology, Stockholm in 1963-65. In 1972 he joined the electrical engineering department of the University of British Columbia, Vancouver, where he is now a professor.

Edward Jull was a joint winner of the 1964 IEEE Antennas and Propagation Society best paper award. He was chairman (1973-75) of Canadian Commission VI (now B) of the International Union of Radio Science (URSI), Chairman of the Canadian member Committee for URSI (1980-86), editor of the Commission B chapter of the Review of Radio Science 1984-86, was elected a Vice President of URSI in 1987, and is now **URSI President**. He has also been an associate editor of Radio Science (1980-83) and an international director of the Electromagnetics Society (1981-86) as well as a member of the IEEE Antennas and Propagation Society administrative committee (1986-89). He is a fellow of the IEEE. His research interests include aperture antennas and diffraction theory and he is the author of a book (Peter Peregrinus, 1981) so titled.

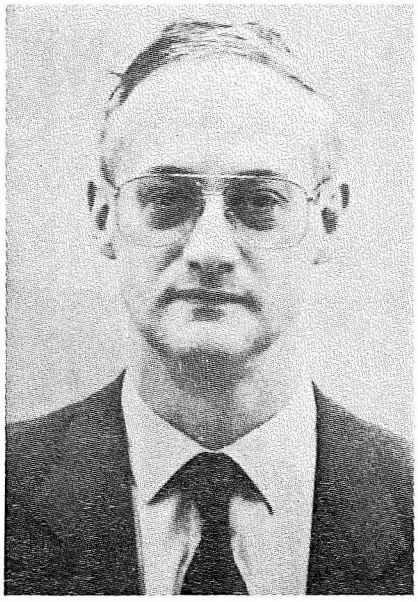
His hobbies are reading, walking, occasional hiking and skiing, and cycling to work. For recreation his family have a forest clearing on an island some 3 km off the W. Coast with a small cabin which they built. They use a 14-foot inflatable boat (Zodiac) to get there.

Jean Van Bladel was born in Antwerp, Belgium, in 1922. His first degrees in electromechanical engineering (1947) and radio engineering (1948) were taken at Brussels University. In 1948-50 he was a Graduate Fellow of the Belgian-American Educational Foundation at the University of Wisconsin where he was awarded PhD in electrical engineering in 1950. He returned to Brussels as Head of the Radar Department, MBLE (part of Philips) in 1950. In 1954 he returned to USA and became Professor of Electrical Engineering, first at Washington University, St Louis (1954-56) and then the University of Wisconsin

(1956-64). He returned once more to Belgium in 1964 to the University of Ghent as Professor and Director of the Laboratory for Electromagnetism and Acoustics until he retired in 1987.

Prof Jean Van Bladel

He was awarded the International Montefiore Prize in 1965 and an Honorary Doctorate, University of Liège, in 1987. He was elected Fellow of both the IEEE (USA) in 1975 and the IEE (UK) in 1974. He served as Vice-President of the Belgian Acoustical Society during 1967-77. He was Chairman of URSI Commission B in 1975-78, and became **Secretary General of URSI** in 1979, the position he still holds.



Paul Lagasse was born in Gent, Belgium on April 19th, 1947. At the University of Gent he obtained a degree in Electronic Engineering in 1969 and a PhD degree under the supervision of Prof. Van Bladel in 1973. After joining the Laboratory of Electromagnetism and Acoustics directed by Prof. Van Bladel at the University of Gent, Paul Lagasse did research in the field of surface acoustic waves. This work was done in close cooperation with the Department of Electronic Engineering of University College London, where he was a frequent visitor. At the end of the seventies he started research in the area of optical communications and integrated optics. After becoming Professor of electronic engineering at the University of Gent, he built up a group in that research area. In 1988 he succeeded Prof. J. Van Bladel as director of the Laboratory of Electromagnetism and Acoustics, which consists of 70 persons working in the fields of high frequency, high speed electronics and optoelectronics. He is author or coauthor of over 100 papers and is currently active in a number of EEC collaborative research projects.

In 1989 he became President of the Belgian URSI Committee and at the Prague URSI General Assembly he was appointed by the Board as **URSI Assistant Secretary General**. In this capacity he hopes to assist the Secretary General and the URSI Board, and more specifically, to contribute to the work of the Committee on the Future of URSI. His longstanding collaboration and friendship with Jean Van Bladel will ensure a smooth working relationship with the Secretary General.

Paul Lagasse is married and has two teenage daughters. In his spare time he enjoys photography and woodworking.

Jørgen Bach Andersen was born in Randers, Denmark in 1935. After a year in a Teachers College in Pennsylvania, USA, he returned to Denmark and took his degrees at the Technical University of Denmark at the Electromagnetics Institute. Since 1974 he has been with Aalborg University in Northern Jutland, a new institution with a rather unique project-oriented and problem-oriented teaching system. Being back in Jutland includes the pleasure of being close to beautiful beaches at the North Sea, where he enjoys the fresh water and wind with his wife Dorte. Two sons are professionals in microwaves and computers, but the small grandson is until now mainly interested in toy cars.

Prof. Jørgen Bach Andersen

His research activities are diverse, but they are all related to various applications of Maxwell's equations. They include HF propagation over mixed land-sea boundaries, dielectric and helix antennas, inverse problems, and for the last ten years interaction between biological tissue and electromagnetic waves, especially in the field of hyperthermia. More recently, mobile communications has been a favourite, especially diversity, microwave propagation and the relevant statistics of the phenomena. He enjoys the present excitement of a new, open and cooperating Europe and is chairman of a European working group for UHF propagation for future personal communications (COST 231). In Europe he is also a member of the management committee for the ESPRIT programme. He enjoys travelling and finding out how radiowaves find their way around interesting old European cities like Rome, Paris, and Aalborg.

In URSI connections he is a former chairman of the Danish URSI committee, and a former chairman of Commission B. He kicked off the birth of Commission K (after a gestation of 20 years!) and is its interim chairman until a new chairman is democratically elected. He helped **Pierre Bauer** organize the Prague General Assembly and the Bioelectromagnetics Symposium, and is an **URSI Vice President responsible for the Scientific Programme for the Kyoto GA.**

Jørgen sees URSI as a truly international body, in contrast to regional

and national societies, and as such it has a responsibility for supporting radio scientists all over the world and for stimulating international cooperation, especially in this changing world. The interdisciplinarity in URSI is also a great potential strength, and he feels that more activities, meetings, working groups, cooperation etc. should occur between General Assemblies, in order to involve more individuals in URSI.

Pierre Bauer was born in 1941. He is married to Daniéle and they have three children: Sylvie, Isabelle and Jérôme. He received the Licence ès Sciences from the Engineer Institut National Polytechnique de Grenoble in 1964, the MS (1965) and PhD (1968) in electrical engineering from the University of Michigan. He was an ESRO/NASA Fellow at the University of Michigan in 1964-66 and later Research Assistant and Teaching Fellow (1966-67). He was appointed Charge du Recherche of CNRS at CNES/CRPE in 1982 and (his present position) Director of Service d' Aéronomie du CNRS in 1985. During 1974-75 he was Senior Postdoctoral Fellow of the National Academy of Sciences at NASA/GSFC.

He was Chairman of URSI Commission G (1981-84) and was the Scientific Programme Coordinator of the Prague General Assembly. He is currently an **URSI Vice President and Treasurer of URSI**, and is also President of the French Committee. Positions on other bodies include the Presidency of Division II of IAGA (1979-83), Chairmanship of the Scientific Advisory Committee of EISCAT (1979-85) and Vice-Presidency of the European Geophysical Society (1986-90).

Richard Dowden was born in Boorowa, NSW, Australia in 1932. He is married to Eleanor Widdicombe from Tasmania and they have four sons and four daughters (in order sds-dsdsd). He received his BSc from the University of Sydney in 1955, but his MSc (1959), PhD (1963) and DSc (1975) are all from the University of Tasmania. Early interests at CSIRO (as a summer student), and again while on the faculty of at the University of Tasmania (Physics Department, 1963-66), were in radio astronomy, particularly HF radiation from Jupiter. Upper atmosphere physics took over while with the Australian National Antarctic Research Expedition to Macquarie Island (1956) and then with the Ionospheric Prediction Service (1957-63), his particular interest being VLF propagation, amplification and generation in the magnetosphere.

In 1966 he was appointed Professor of Physics (later Beverly Professor) at the University of Otago, NZ, the position he still holds. His present interest is in VLF remote sensing, location and imaging of electron precipitation into the lower ionosphere.

He was awarded the Mechaelis Memorial Gold Medal and Prize in 1984 for upper atmosphere research, was elected Fellow of the Institute of Physics (UK) in 1968 and Fellow of the Royal Society of New Zealand in 1983. He has served as NZ National Chairman of the Institute of Physics (1974-75) and as President of the NZ Institute of Physics (1983-84).

He was Chairman of URSI Commission H (1984-87) and has been an **URSI Vice President** since 1987. He is currently **responsible for publications** and is editor-in-chief of the *Radioscientist.*. His main hobby at present is desk-top publishing (the *Radioscientist.*). He and his family live on a small (5 hectare) farmlet in a rural atmosphere only 2 km from the University. He sometimes enjoys aggressive gardening with a chain saw.

Takanori Okoshi was born in Tokyo, Japan in 1932. He received the BS, MS and PhD degrees in electrical engineering from the University of Tokyo in 1955, 1957 and 1960 respectively and became a Professor in the Department of Electronic Engineering, University of Tokyo in 1977. In 1987 he was elected to be the Founding Director of the Research Center for Advanced Science and Technology (RCAST), a newly established research institute of the University of Tokyo, featuring the promotion of interdisciplinary research as well as international academic cooperation.

At present Dr Okoshi is also a Guest Research Fellow of the Communications Research Laboratory of the Japanese Government, President of the Japanese Committee for URSI, Chairman of the Technical Committee of NHK (Nippon Broadcasting Corporation) Research Laboratories, and a Member of the Electrical Communications Council of the Japanese Government.

Since 1955, his work has focussed on electron guns, high-efficiency electron

beam collectors, three-dimensional imaging techniques, microwave planar circuits, optical fibres, and optical communications. He has written fifteen books in these research areas, including four in English: *Three-Dimensional Imaging Techniques* (Academic Press, 1976), *Optical Fibers* (Academic Press, (1982), *Planar Circuits* (Springer, 1984) and *Coherent Optical Fiber Communications* (KTK/Kluwer, 1988, with Dr K. Kikuchi). For these works Dr Okoshi received five achievement awards, five publication (book) awards, two paper awards and three other awards from four academic institutions including IEEE and IEICE Japan.

Dr Okoshi is a Fellow of the IEEE (1983) and is an active participant in IEEE activities and IEEE-sponsored conferences. He was Chairman of the International Steering Committee for International Conferences on Optical Fibre Sensors (ISC-OFS) in 1984-1986, and is Chairman of the International Management Committee of International Conferences on Integrated Optics and Optical Fibre Communication (IMC-IOOC) for 1987-1989. He was Chairman of URSI Commission D (1987-90) and is currently President of the Japanese URSI Committee and an **URSI Vice President,** acting as liaison between the Board and the Kyoto Organising Committee and as Chairman of the Committee on Future General Assemblies.

Dr Okoshi's hobby is music composition. His debut concert as an amateur composer was held in downtown Tokyo in early 1988, where his "Ten Pieces for Flute and Piano" (1984) were performed by professional musicians. He lives with his wife, Yasuko, two daughters (Asako, Naoko) and one son (Kento) in uptown Tokyo.

Address by the Incoming President, Edward Jull

Closing Ceremony, XXIII General Assembly of URSI, Prague.

Let me first express our sincere appreciation for the contributions to URSI of the retiring members of the URSI Board:

to Dr **Mitra**, who committed URSI to a role in the developing countries;

to Dr **Albrecht**, who expertly guided URSI finances for many years, making its operations and initiatives possible;

and to Dr **Zima**, who gave us this splendid general assembly.

Prague is a magic city of surprise and change and it has cast its spell on URSI. You now have an URSI board as committed to change as surely as radio science and the world are changing.

URSI's changes have begun. We shall have a new commission on the biological effects of electromagnetic fields, a subject taking its place in the first rank of interdisciplinary research effort.

Through radio science and telecommunications URSI has quietly contributed to the dramatic changes in the world. These changes have provided us with the best opportunity ever for scientific cooperation with our colleagues from E. Europe and the Soviet Union. URSI should further encourage this global scientific cooperation by making its meetings accessible financially to as many radio scientists as possible. This means as well a larger young scientist program, particularly oriented towards those from developing and non convertible currency countries. To realize this a Young Scientist Committee is being formed.

URSI needs to find new ways to function efficiently, to interact with industry and to provide better services to radio scientists. A Long Range Planning Committee is being formed to address these issues.

URSI needs to renew and enhance its relationship with international consultative committees such as CCIR. A Telecommunications Committee is being formed for this purpose.

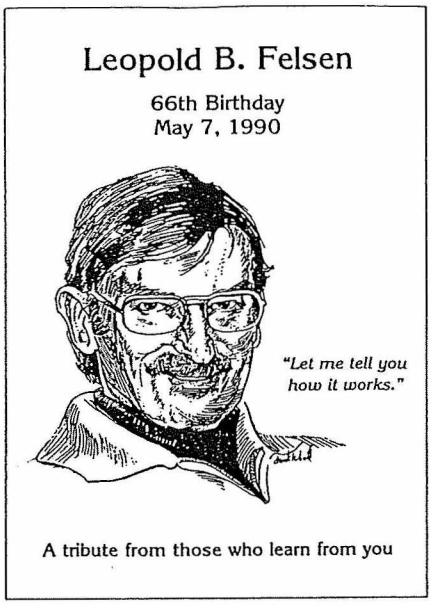
Mesdames et messieurs, chers collègues:
Au nom du nouveau bureau permettez moi de vous remercier sincèrement pour votre confiance. Nous espérons vous servir de notre mieux. Faites nous parvenir vos suggestions. Elles nous serons utiles.

Ladies and gentlemen, on behalf of the newly elected board I wish to thank you for your confidence in us. We wish to serve you well and I invite your suggestions for ways which may help us to do this.

Perspectives on the URSI XXIII General Assembly 1990.

*Prepared by **Leo Felsen** for the URSI banquet in Prague, Czechoslovakia, but not presented because of unsuitable conditions.*

No occasion such as this is complete without someone getting up to interrupt your pleasant conversation during or after a delicious meal. As you see, this tradition is being followed here, and I apologize for being the culprit who implements it. The remarks one makes usually have something to do with the occasion, and you have already heard several presentations from those whom I would broadly call the "Managers", the leading personalities both in the international and local URSI organization. Therefore, I shall try to look at the same from the perspectives of the "common man". Before getting into this, I would like to make a few very personal remarks.



Prof. Leo Felsen, as taken from a metal plaque mounted on olive wood which was presented to him by his colleagues and former students at a luncheon in his honour.

I have been in Czechoslovakia several times during the last 15 years, primarily in connection with activities pertaining to seismology. On one of these early occasions, when I was invited by the Geophysics Dept of Charles University to give a series of lectures on spectral methods and Gaussian beams, I also had the opportunity to visit Professor Zima and his research institute, give a seminar and interact with the staff and students there. Professor Zima and I have remained in personal contact ever since, and I would like to express to Professor Zima at this time my sincere appreciation for his generous concern for my personal needs, which has made it possible for me to attend this Assembly. From our first meeting and discussions, I gained an insight into the difficulties of running a high-level research activity under the restricted conditions which were then in place. That Prof Zima was able to do it obviously attests to his ingenuity, vitality and dedication, which have been in evidence as well at this Assembly.

What left a deep impression on me during my previous visits to Czechoslovakia were the various reactions to life in general, and scientific pursuit, in particular. The emerging scientists, namely the fresh PhD's or PhD candidates, were already disillusioned that they could not develop their scientific potential because of restricted flow of information, bureaucratic restrictions, and lack of access to the western world. Disillusionment in young people, who see no hope for change, was for me one of the most devastating manifestations of that period. I also had occasion to exchange views and develop friendships with members of the next generation, already mature scientists in their forties. They had learned to adapt to the system, and each had his or her own view of operating within it. We discovered that we shared the same philosophical attitudes, as expressed by two Czech writers: Franz Kafka and Jaroslav Hasek. Kafka's pessimism epitomizes the excesses and absurdities of a bureaucracy that makes life for its citizens impossible, and Hasek's humouristic-satirical vision embodied in the *Good Soldier Schweik* provides some hope for coping with the system by shrewd noncooperation. Kafka and Hasek, whom I had to read in secret because they were forbidden, were important for psychological survival in my own youth, which I spent as a Jew in Nazi Germany, thus, the Kafka and Schweik *Wetanschauung* forged a bond between my Czechoslovak colleagues and myself during the past years. We made jokes and we laughed, but the laughter was not the happy kind; instead, it was the bitter laughter associated with "gallows humour", half apologetic because of the existence of conditions one could do little about.

All that has now changed. I realized the profundity of the changes when I met one of my friends again. On recalling our Kafka-Schweik philosophical exchanges, he observed that these images are no longer relevant. The former pessimism has been replaced by hope and confidence, the passive resistance of Schweik transformed into plans for action, and the laughter is now a real expression of good feeling. Just walking the streets and observing especially the young people, one sees a friendly curiosity toward foreigners, offers of help when one needs directions, inquiries about one's country of origin — just a general atmosphere of good feeling and eagerness to exploit the openness that was so long denied. I am sure that most of the foreign participants here have noticed these things. They will be among the most important and rewarding impressions that we shall take with us, especially those among us who have taken these freedoms for granted.

After these personal preliminaries, which I hope may have struck a responsive chord at least in some of you, let me pass on to the General Assembly per se. Rather than speak in straight narrative, let me put the common man's perspective into verse.

The "Common Man's" View

Three years have quickly passed us by,
The world has changed beyond belief.
In countries where suppression reigned,
One senses hope where there was grief.

As nineteen-ninety presses on,
The world will never be the same.
No one can doubt this simple truth:
There are new rules to play the game.

URSI has not escaped the change.
Assembly plans three years ago
Did not anticipate events
That changed the rules in steady flow.

Such was the task in Prague, which had
Been chosen as Assembly site.
This task, awesome in normal times,
Now generated increased plight.

Attendance lists that grew and grew
Left organizers unprepared.
Yet, none of them threw in the sponge.
They coped, instead of running scared.

So, here we are: participants
In URSI's biggest-ever show.
The motto for the Nineties is
To break down barriers, merge and grow.

Old timers who have been around
At URSI meetings long since past,

Recall the intimacy there.
Slow was the pace that now is fast.

But new technologies demand
An interdisciplinary blend.
We may look back and reminisce
But we must follow current trends.

Whether the scope is big or small,
If one selects a place to meet,
It's hard to think of any site
That really can with Prague compete.

A city steeped in history.
Cathedrals, palaces abound.
Aesthetic beauty, culture, art ...
All blend in harmony profound.

The people complement this scene.
One senses pride, a spirit freed.
The cherished past provides the base
On which to structure future need.

The URSI-ites converged on Prague
From north and south, from east and west.
Once settled in, their remote sense
was put directly to the test.

The mailed announcement let us know
Where registration would proceed.
Yet on the map which we received
We saw a dot on unnamed street.

How to locate the building from
so sparsely framed a data set?
Use URSI's theme of Telecom,
And if you find it, win a bet.

Accordingly the local streets
With searching URSI-ites were filled.
By random walk, most did arrive,
Exhausted, but their task fulfilled.

Some may, however, still be there,
Wand'ring the streets till URSI they find.
We hope they make it in good time,
Leaving them not too far behind.

Finding the registration site
Means you are well launched in your quest
Next comes the registration line.
This constitutes the second test.

To solve this problem, you apply
An iterative marching scheme.
Convergence means you've realized
The analytic modeler's dream.

Although convergence may be slow,
As you approach the final goal,
The smiles accompanying each step
Becalm the most impatient soul.
The formal opening showed us all
That everything has been worthwhile.
Majestic auditorium,
Concert, reception, in grand style.

The musical selections sampled
Czechoslovak themes that showed
How ethnic motives merged with art
Have culture on this land bestowed.

If multisessions caused you grief
Those sessions that you did attend
Gave overviews that helped so that
New things you better understand.

The huge attendance also let
You meet new faces, make new friends.
The large contingent from the east
Will hopefully define new trends.

Another first, the prominence
Of scientist quite young of age.
It is refreshing to observe
New talents that appear on stage.

For all of this — the science, art,
The culture, friendliness, good grace,
Even the weather — we must thank
those who put all of this in place.

Professor Zima and his staff
Have tackled this gargantuan task.
The problems, which they must have faced,
We are embarrassed even to ask.

The spirit in which they've performed
Is worthy of our highest praise.
To show that we appreciate,
Let's rise and our glasses raise:

To our Czechoslovak hosts,
We express deepest gratitude.
May your new freedoms long survive
In solid-structured certitude.

May you continue as you are,
With humour, art, and culture's blend.
I speak a toast to all of you
In language native to your land,

Dekuji Vam a dobre zdravye

(Thank you and good health.)

L.B.Felsen
Polytechnic University
Farmingdale, NY.

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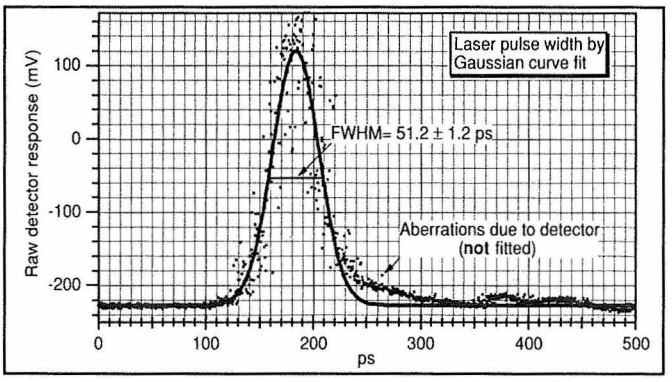

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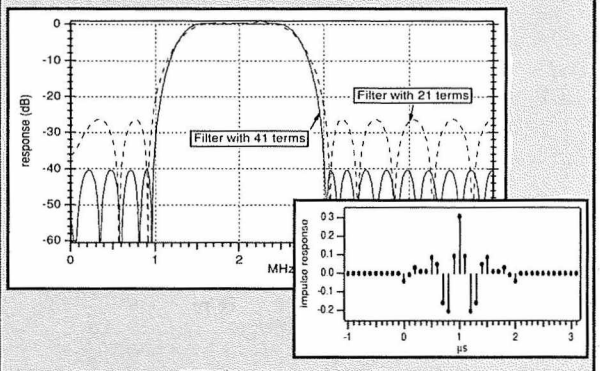

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LETTERS

Young Scientists say....

I should say firstly that I regard it as a great honour to have been able to attend the General Assembly in Prague as a Young Scientist, and I enjoyed the experience enormously. I particularly enjoyed the opportunity to meet and talk to the other Young Scientists (especially those from Eastern bloc countries), so I believe it was a good idea to accommodate all the Young Scientists together. I know that before the event there was some apprehension about the standard of accommodation, but the student Halls of Residence in which we stayed were perfectly adequate. They were in fact brand new, and were both comfortable and clean. Although the Halls of Residence were some distance away, transport to and from the General Assembly was quick and easy, thanks to the excellent Prague Metro system.

The URSI General Assembly is, of course, an unusually large conference, with an unusually diverse range of topics, and this must produce problems of its own. I occasionally found that there was more than one session of interest to me under way at once, but this is probably inevitable in an event of such a size. By the same token I welcomed the chance to attend sessions on subjects that I would not normally encounter at the conferences I usually attend.

At a technical level I felt the programme was good, with a proper balance between 'review' type presentations and more specific new work, and this obviously reflects well on the conveners of the individual sessions. The standard of the presentations themselves was extremely variable, ranging from models of clarity to virtual incomprehensibility. Part of that can be put down to the difficulty of giving a presentation in a foreign language, or to some very mathematical subjects, but by no means all. Personally I felt it would have been useful to know the required length of presentation well in advance, to give me a proper opportunity to prepare and rehearse - I don't particularly like having to modify my presentations in real time. Having said that, there are evidently presenters for whom knowing the required length of presentation before hand makes no difference to how long they want to speak! The audiovisual arrangements were a shade on the primitive side, though this didn't seem to cause major problems.

I thought the 'General Lectures' that I attended were excellent; well-chosen subjects and speakers, and well-prepared presentations.

As far as administration was concerned, I thought the registration process was perhaps rather lengthy; on the positive side, though, I was impressed by the provision of pigeonholes for all of the pre-registered delegates.

The format of the conference, with effectively seven days spaced round a weekend, gave maximum opportunity for sightseeing and social activities, but did effectively mean that the conference occupied two full weeks (particularly for participants from the USA). There were some participants who could not spare two weeks away from their work, and they came just for the day or days in which they had to participate. In discussing this with other Young Scientists, one idea that emerged was to attempt to stagger the programmes of the various Commissions so that a participant could (if required) just attend the sessions of his or her particular Commission. Personally I think this would create more problems than it would solve. Equally, I am sure it would be a mistake to try to fit the whole General Assembly into one week. However, for the next General Assembly in Kyoto, the cost of hotel accommodation — and for Europeans, of air travel — will be rather higher than in Prague, so I think the present arrangement is probably close to optimum, allowing those that wish to stay for a full two weeks with up to three weekends, and those who are in more of a hurry to limit themselves to ten days.

I felt that the social side was pretty good. The organisers had evidently made a big effort to arrange a full range of social events that reflected Czech culture, and that would be interesting to visitors from other countries. There were, admittedly, some hiccups with late arrival of transport and so on, but nothing drastic.

In summary, I am certain that the event was worthwhile. I always had the impression that the conference staff were going out of their way to be helpful and to resolve any minor difficulties as quickly as possible.

Hugh Griffiths
University College London

..thank you, but.....

I was very fortunate to attend the URSI General Assembly as a Young Scientist Award winner. It was a great opportunity meet distinguished radio scientists who came from various research centres around the world. Over 1300 scientists representing both developed and developing countries attended the General Assembly. Many of them presented their latest innovations and contributions to the field. Over 1000 papers and posters were presented in over 200 scientific sessions. Almost all the sessions I attended were very interesting and informative. The General Assembly was highlighted by the presentations by 100 young scientists.

In addition to regular presentations, there were special Tutorial Lectures, covering interesting topics in Radio Science and Bioelectromagnetics. Given by experts, these lectures helped broaden our understanding in these rapidly changing fields. I took the opportunity to meet many scientists at the two dinner parties. I will never forger the lovely opening ceremony held at the cultural centre of Czechoslovakia.

The URSI General Assembly was truly international. Frankly, I haven't been to a convention with this broad representation before. It was very interesting to meet scientists from all continents under one roof. It was a blend of many differ-

ent philosophies and ideologies. Theoreticians and mathematicians from the East were freely communicating with technology-experts and experimentalists from the West. Researchers from the Third World took the opportunity to acquire the state-of-the-art in both theory and applications of Radio Science. They will undoubtedly apply this knowledge and help develop their countries.

Attending a convention like this will be very difficult, if not impossible, after I return to Sri Lanka. Therefore, I greatly appreciate the decision of CIDA Sri Lanka Desk to sponsor this trip. The knowledge and experience gained by attending the URSI 23rd General Assembly is very helpful for my current studies. It will be more useful when I return to Sri Lanka as a faculty member.

Karu P. Eselle
University of Ottawa

...have more general GA's

I enjoyed the General Assembly in Prague very much. It was by far the biggest gathering that I have been to and at times decisions about which sessions to attend were difficult. I particularly valued exposure to the whole range of activities that make up radio science and came away feeling quite inspired by such things as non-thermal planetary emissions, fractal media and radio astronomy. It has long been my opinion that engineers and physicists do not meet enough and seem to view each other across a barrier made up of all kinds of negative feelings (e.g. physicists view engineering as being too deterministic).

I feel that the most important role of URSI is to provide this link by breaking up the inevitable specialist groupings and thrusting them together. Many of the groups seemed rather inward looking. They know each other very well already and if they are active workers they will be keeping an eye on the activities of their colleagues in any case and meeting regularly at other specialised events. My point is that a General Assembly should be seen to be a General Assembly. There should be a greater emphasis on cross fertilisation and tutorials. Specialist sessions should concentrate on reviews, accessible to initiated and non-initiated alike, and contain fewer presentations. At the end of each session the chairman/convener should clearly state his opinions on the current status of the subject and its future course. This will place greater onus on him/her but I am sure that the extra effort would be worthwhile. After all, the General Assembly only occurs once every three years.

My justifications for this are, (1) since URSI publishes no collection of papers there is no incentive to expand ones publications list and (2) more than a third of my time in sessions was spent listening to boring and badly prepared presentations. One event comes to mind and is a good example of what I am talking about and it is not untypical. It started with an expectant full house. The first speaker dismissed a large part of the subject as trivial, to the obvious disappointment of myself and other people around me. He then proceeded to display viewfoils consisting of densely packed and unreadably small equations and seemed to be assuming that we should all know what he was talking about anyway. Before the end of the first session more than half of the audience had walked out, often in the middle of presentations, and at the end, only a handful remained. The IEE publishes a booklet on how to prepare and give a talk and hold an audience, so perhaps URSI should publish similar guidelines and encourage chairmen/conveners to promote their use within the context of an interdisciplinary audience.

As for the young scientists program, I felt that its main value was to enable young people (future senior members) to attend such a diverse event and in this regard URSI succeeded admirably. I for one am most grateful for my award and actually feel part of URSI now, having met many people and placed faces to names. However, I feel that the young scientists program was compressed into early stages of the Assembly and seemed to end after the dinner. The dinner was rather static and perhaps it should be supplemented by other informal and purely social gatherings (e.g. dances, buffets, visits). One of the worst ways to get to know people on first introduction is to talk shop because ones competitive feelings (superiority, inferiority, suspicion etc) get in the way.

To me, it sometimes seems as if the eminent and senior figures have no past. I am sure many young people would be fascinated to hear of what life was like for them in their formative years and the ways in which yesterday's realities compare with those of today. These talks would not need to be particularly scientific, they would be pleasurable for both parties and I am sure many young scientists would derive much reassurance and encouragement from those who have found success and fulfilment in radio science.

I hope very much that you will seriously consider these rather idealistic views in the spirit in which they are intended.

Chris Hall
The University of Leeds

North American Radio Science Meetings

The 1991 North American Radio Science Meeting and International IEEE Antennas and Propagation Symposium will be held at the University of Western Ontario, London, Ontario, Canada from June 24 to 28, 1991. Following earlier meetings in Quebec (1980) and Vancouver (1985), this meeting is jointly sponsored by the Canadian and United States member committees for URSI and the IEEE Antennas and Propagation Society. All commissions of URSI plan to participate. The background to the North American URSI meetings is given here.

Canada borders on the USA only and it is the longest common border in the world. Moreover most Canadians live within 200 miles of the border and share, at least for anglophone Canadians, a common language with their much more populous southern neighbours. Consequently most aspects of Canadian culture have been very much influenced by the USA. Whatever political problems this situation has occasionally presented for Canadian governments, the economic, educational, scientific and technological benefits have been overwhelmingly positive for Canada. Science is international and for most Canadians the nearest scientific colleagues and meetings are south of the border. Consequently it has been natural for the Canadian URSI committee to organize its meetings in cooperation with URSI committees of the United States.

Cooperation between US and Canadian URSI committees began with the McGill Symposium on Microwave Optics in June 1953. It was organized by an URSI vice president, G.A.Woonton of McGill University in Montreal, assisted by Roy C. Spencer and Samuel Silver (URSI president 1966-69), both of the USA, and George Sinclair (IRE/PGAP Chairman 1951-52) of the University of Toronto. Thus began a series of meetings on microwave optics and electromagnetic theory which became the triennial URSI Commission B Symposia on Electromagnetic Theory. The last such meeting was in Stockholm in August 1989 and the next will be in Sydney, Australia, August 17-20, 1992.

Canada participated in a minor way in the 1955 Symposium on Electromagnetic Wave Theory at the University of Michigan but being outnumbered ten to one in population and more in radio scientists it has always seemed that if Canadians were going to have any real impact on joint US/Canada meetings they would have to be held in Canada. Thus the 1959 Symposium on Electromagnetic Wave Theory was held at the University of Toronto. This meeting was also cosponsored by the Institute of Radio Engineers Professional Group on Antennas and Propagation (IRE/PGAP, now IEEE/AP-S) which also published proceedings of the Michigan and Toronto symposia.

There has always been close cooperation between PGAP or AP-S and USNC/URSI. Often members of the administrative committee of AP-S are also members of USNC/URSI. For example, the president and secretary of USNC/URSI now, Sid Bowhill and David Cheng, have both been or are presidents of IEEE/AP-S. IRE/PGAP and USNC/URSI began cosponsoring annual Spring and Fall URSI meetings in 1949. These were popular forums for Canadian radio scientists and antenna and propagation specialists. The Canadian Committee for URSI cosponsored and hosted two meetings with US URSI in Ottawa in October 1961 and May 1967. These were URSI-only meetings, but with all commissions participating.

In the meantime IRE/PGAP decided to hold their own annual symposium on antennas and propagation, beginning in 1963. Later they obtained the participation of US URSI, resulting in the annual joint Radio Science Meetings and International Antennas and Propagation Symposia which began in 1966 and have continued since. At the same time US URSI has continued to hold an annual meeting in Boulder Colorado usually in January. The Boulder meetings are full URSI meetings, while those with IEEE/AP-S usually involve only commissions A, B, E and F.

The initiative for reviving Canada/US URSI meetings came in 1974 from an ex-Canadian, Jim Wait, who was then Secretary of USNC/URSI. Jules Cummins and Gilles Delisle of Laval University in Quebec expressed an interest in having the meeting, particularly if it also included IEEE/AP-S. The Canadian URSI committee proposed the meeting to US URSI and thence to IEEE/AP-S. Thus began the first North American Radio Science Meeting and International Antennas and Propagation Symposium held in Quebec in June 1980. To share the load the AP-S technical program was organized by Keith Balmain at the University of Toronto and the URSI program by Gar Yip of McGill University. All URSI commissions participated in this meeting, thus ensuring success in this first venture of an AP-S symposium outside the USA. Jules Cummins was the meeting chairman.

The 1985 North American Radio Science meeting and International AP-S Symposium was held at the University of British Columbia in Vancouver. As in 1980, the technical program was an international effort. The URSI program committee consisted of chairmen of each of the commission from the Canadian and US Committees and was organized by Tim Coyne of the Communications Research Center (CRC) in Ottawa. The AP program committee consisted almost equally of Americans and Canadians and was headed by Stan Kubina of Concordia University in Montreal. The technical program meeting was at the National Research Council (NRC) in Ottawa where we had the expertise of NRC Conference Services. The chairman of the meeting was Stan McCormick of CRC in Ottawa.

There were 896 registrants at the 1985 meeting. This was close to the record of 925 set at the 1979 IEEE AP-S/URSI Seattle meeting, also a full URSI meeting. This attendance amply demonstrated to our American colleagues that meetings north of the border need not result in reduced participation. There were 720 papers on the program with authors from 32 countries; two thirds from the USA, 20%

from overseas and the rest from Canada.

The 1991 North American Radio Science meeting and IEEE/AP-S International Symposium were held in London. Ontario will be organized similarly. Al Webster of the University of Western Ontario is general chairman, Gordon James of CRC, Ottawa is URSI scientific program chairman and Stan Kubina is again AP-S technical program chairman. NRC conference services will handle the non scientific and technical details.

Elsewhere, for example Scandinavia, where the situation is very different than that between the US and Canada, regional URSI meetings are also held. There the languages are sufficiently different and the participants sufficiently multilingual for the conference language to be English. Thus non-Scandinavians are encouraged to participate, and the conference is international, but it is most convenient for the conference organization to be regional. China and Japan seem to be similar natural partners for regional meetings and some radio science groups there have held joint meetings where the language is English. Science is international and so also should be radio science meetings.

I hope you will attend the 1991 N. American Radio Science Meeting. For information contact:

Mrs D. Ruest
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The "Ionosphere" — how it got its name

It might have become the "Balfour-Stewart-Heaviside-Kennelly-Zenneck-Schuster-Eccles-Larmor-Appleton space"!

Sixty years after the term "ionosphere" came into common use among scientists, a new piece of information has come to light on its origin. At the final meeting of the British National Committee for Radio Science, held in London on 17 October 1989, the NCRS Chairman (Professor P. J. C. Clarricoats) read extracts from old minute books of the Committee's forerunner, the National Committee for Radio-Telegraphy. The meeting of 26 October 1926, with Sir Richard Glazebrook in the chair and attended by Professor E. V. Appleton, Dr. R. L. Smith-Rose and Mr. R. A. Watson-Watt, minuted that "The nomenclature of the upper layer of the atmosphere which causes refraction of waves used in Radio-Telegraphy was discussed and it was agreed that in papers by the National Committee a scientific team should be used to describe this layer in preference to using personal names".

That discussion must have provided the inspiration for two letters written soon afterwards, apparently independently; one by E. V. Appleton to J. A. Ratcliffe, dated 2 November 1926, and the other by R. A. Watson-Watt to the Radio Research Board, dated 8 November 1926. Watson-Watt's letter was found in 1969 by G. W. Gardiner [1], during building work at the Radio and Space Research Station at Slough, while Appleton's letter was found some years later in the Edinburgh University Library archives by C. S. Gillmor [2]. Both letters proposed the term "ionosphere" to replace other terms in use at the time, such as "upper conducting layer", "Heaviside layer" and "Appleton layer". As quoted by Gillmor, Appleton wrote to Ratcliffe "For the ionized part of the upper atmosphere I think the terms *ionosphere* or *electrosphere* might be useful. Which do you prefer? Cf. *Stratosphere* and *Troposphere*". The same analogy was given by Watson-Watt in his letter of the same month.

In his 1929 Symond Memorial Lecture to the Royal Meteorological Society, Watson-Watt thought that "it might be permissible" to use the term "Balfour-Stewart-Heaviside-Kennelly-Zenneck-Schuster-Eccles-Larmor-Appleton space", but opted for "ionosphere" as he had proposed in 1926. The printed version of this lecture [3] was probably the first use of the term "ionosphere" in a scientific journal, and the name appeared to come into general use around that time, though the letters by Appleton and Watson-Watt were apparently forgotten for forty years. We now know the context in which they came to be written.

[1] Gardiner, G.W., *Nature 224*, 1096 (1969).
[2] Gillmor, C.S., *Nature 262*, 347 (1976).
[3] Watson-Watt, R.A., *Q. J. Royal Met.Soc. 55*, 273 (1929).

Henry Rishbeth,
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Investigations of Nonlinear Processes in the Ionosphere

The ionospheric F-region has often been regarded as a reasonably well understood part of geospace. Ever since its detection it has been common practice to describe this region by fluid theories. This is still the case in recent standard text books on the subject.

However, these models are really supposed to cover regions of a highly different nature. As is well known the F-layer extends through both the quiet mid-latitude regions and the very active auroral regions. In the latter regions the ambient plasma is of course disturbed both by variations of the geomagnetic field and by precipitating charged particles. In recent years therefore, doubts have been more frequently raised as to whether our description of the F-region is really adequate to fully cover such dynamic phenomena.

Previously the fluid theories have been successful in describing the overall features of the global ionosphere. This means that gross transport prop-

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erties, ionization and loss processes are described to the extent that it is possible to understand the main features of large scale interactions of the magnetosphere/ionosphere system with the solar wind. In fact, quite impressive computer simulations, using an MHD code, to show the formation of all the main features of the magnetosphere have recently been carried out [*Watanabe and Sato*, JGR p75, 1990].

So far though, the model predictions have seldom been used for quantitative comparisons with specific experiments. Therefore a coordinated ionospheric study, using both satellites and ground stations world wide, have recently been initiated by Eastern European scientists [*Wagner*, EOS No. 25, p 757, 1990]. The purpose of this campaign is to gather an as extensive data set as possible to describe the ionospheric situation in specific periods of time during different levels of geomagnetic activity. Based on such a data set it should then be possible to refine the prevailing physical models to more accurately predict the ionospheric response to various imposed conditions.

From the few such attempts already carried out it seems likely that this is a worthwhile undertaking. For example, during the lifetime of the Swedish VIKING-satellite efforts were made to compare a theoretically estimated energy budget for the high-latitude ionosphere with measurements obtained from both the satellite and the European Incoherent Scatter radar outside Tromsø, Norway. This resulted in a discrepancy in the F-region which could not be explained by uncertainties in the measurements [*Lilensten et al.*, JGR p6081, 1990].

Other observations, notably of ion-conics and some non-thermal features in the auroral spectra, have called for kinetic treatment of the ionospheric plasma in order to be explained. This has been further supported by the interpretation of several active experiments carried out in the F-region both at mid-and high latitudes. Very often the result of injection of energetic charged particles into the ionosphere is a heating of the ambient plasma and the creation of a wide variety of waves (from VLF to HF) but little or no plasma density enhancement (e.g., Jakobsen in *Artificial Particle Beams in Space Plasma Studies* [ed. Grandal], p175, 1982 or *Svenes et al.* to be published in Adv. Space Res.). Since the collisional cross section between the beam and ambient plasma is rather small at these altitudes this strongly suggests that wave-particle interactions are occurring.

In contrast to fluid theories, kinetic theory is able to treat models containing particles distributed in velocity space. This of course is a much better approximation of naturally occurring plasma. Simulations, utilizing such particle codes, have succeeded in explaining some of the above mentioned observations, but since any plasma seems capable of supporting a bewildering range of waves there are still many questions left open in this field.

In order to address some of these questions the NEED (**N**on-Maxwellian **E**lectron **E**nergy **D**istributions) rocket project was initiated. This is a collaboration between groups of scientists in Norway, Sweden and USA. The concept of this project is to use the EISCAT facilities to monitor the ionosphere for conditions believed to be indicative of wave-particle interactions in the F-layer. Upon the detection of such an event a sounding rocket will be launched into the region in order to make in situ measurements of the local plasma conditions.

One such attempt has already been made, but due to a malfunction in the rocket it was only partly successful. However, the indications are that such an experiment could throw more light on the complicated plasma dynamics that at times may occur in the ionospheric F-region. Another rocket campaign is planned for October 1990, and it is hoped that it will be possible to announce new results at scientific meetings next spring.

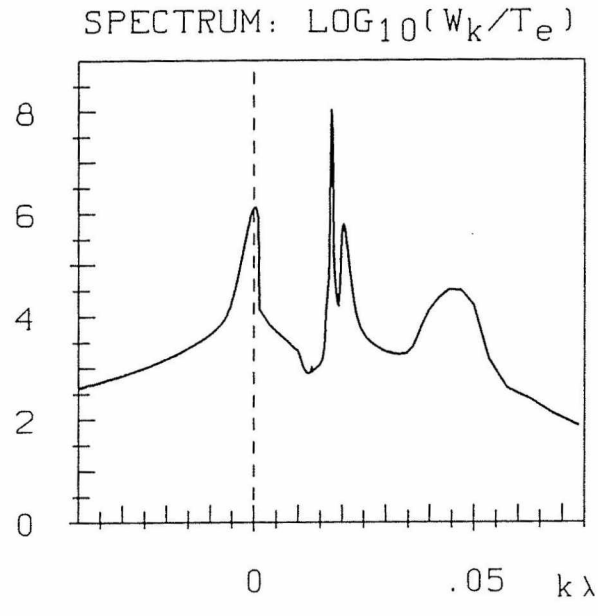
Bernt Mæhlum, Knut Svenes
Norwegian Defense Research Establishment
P.O. Box 25
2007 Kjeller, Norway

MORE INSIGHTS ABOUT BEAMS AND RADIATION

The electron beam plasma instability is a very old problem in plasma physics. It is discussed in textbooks for it represents the simplest illustration of kinetic theory. For the radioscientist the question of the Langmuir spectrum resulting from the instability is of special interest. It is indeed often believed that the radio-emission observed, e.g. from the Sun, is in fact the product of Langmuir waves excited by a beam instability which are in turn converted into radiowaves at the fundamental and the second harmonic of the plasma frequency ω_p. Now, the conversion process follows some kinematic constraint relations between frequencies ω and wavenumbers k and therefore depends on the shape of the Langmuir spectrum.

Up to now several nonlinear saturation mechanisms have been proposed which lead to different spectra. Besides quasilinear effects which are of the lowest order and so should not be a priori dismissed, there is the modulational or oscillating two-stream instability [1] and the nonlinear scattering off ion clouds [2]. A distinctive feature of the former is that wave energy is transferred from the linearly unstable modes in resonance with the positive slope of the beam toward larger wavenumbers while in the latter it is transferred toward smaller wavenumbers. Only very recently [3] particle simulations were carried out with a long enough system to avoid the artificial restriction of the linearly unstable modes to more than a few. The nonlinear scattering toward larger wavelengths was thus no more *a priori* precluded. It was found that the quasilinear wave-electron interaction and the wave-wave scattering off ion clouds were playing the main roles in the shaping of the Langmuir spectrum. However it was also noted that the mere presence of the beam affects the frequency of the beam resonant modes. From a comparison of the results of the particle simulations with the predictions of a set of kinetic equations the following picture emerges [4]. Besides the usual condition for a kinetic instability, $n_b \ll (v_b/U)^3$, where n_b is the beam to background density ratio, U the drift velocity and v_b the velocity spread of the beam; there is a more stringent criterion, $n_b \ll (v_b/U)^3(v_e/U)^2$, where v_e is the thermal spread of the electron bulk. If the beam is extremely weak, i.e., it satisfies the second criterion, the Langmuir wave energy accumulates into a condensate about $k \sim 0$. If the second criterion is not satisfied, the classic condensate about $k \sim 0$ is depleted in a late phase of the

spectrum evolution with the formation of another condensate about $k \sim \omega_p/U$, i.e., near synchronism with the beam. This can be understood simply: the beam creates a minimum in the frequency–wavenumber relation and the energy accumulates at wavenumbers for which the frequency is minimum. For strong and slow beams where complete plateau formation occurs before any substantial wave scattering, the new condensate is in resonance with the high velocity end of the plateau. For weaker and faster beams, the wave scattering intervenes before their complete relaxation; the wave energy accumulates in one of the two condensates depending on how weak the beam is (second criterion). A typical nonlinear Langmuir spectrum is displayed in the accompanying figure. The spectral energy



density W_k peaks in a narrow condensate near synchronism with the beam, $k\lambda_d \approx 1.7 \times 10^{-2} \sim v_e/U$; the level is two orders of magnitude higher than in the $k \sim 0$ condensate and 10^8 times higher than thermal. Now, in many applications the criterion for a very weak beam is not met. For example, with the weak electron beams associated to type III solar bursts [5], one finds that the event of March 11, 1979, ($n_b = 3.5 \times 10^{-5}$, $v_b/U = 0.1$ and $U/v_e = 20$) cannot be considered as a very weak beam, while the event of February 8, 1979, ($n_b = 3 \times 10^{-6}$, $v_b/U = 0.1$ and $U/v_e = 21$) can.

It is not the point to develop here a theory of radio emission. However I would like to draw the reader's attention to the following. Kinematic constraints on fundamental emission impose a minimum wavenumber to the Langmuir waves, $k\lambda_d > C_s/v_e$, where C_s is the ion sound velocity. Hence fundamental emission is impossible with the classic Langmuir condensate at $k = 0$. Quite the contrary, the new condensate allows it. On the other hand for harmonic emission, the kinematic constraints impose $(k_1+k_2)\lambda_d \leq \sqrt{3}v_e/c$. This condition is most likely to be satisfied by two waves chosen from the classic condensate about $k \sim 0$ Thus models for plasma emission should be revised in light of the new developments which have occurred in the theory of the beam-plasma instability.

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The Cosmic Microwave Background and the Case of the Missing Dark Matter

The discovery of the 3 K Cosmic Microwave Background Radiation (CMBR) in the mid sixties has obtained wide publicity in the past as the irrefutable proof of the origin of the universe in a giant Big Bang. However this radiation has still its surprises. First, it has recently been discovered that its spectrum at long wave lengths greater than 1 mm — after subtracting the proper motion of our galaxy and their companion galaxies — is practically an ideal blackbody spectrum with temperature 2.74 K, very much in favour of the Big Bang hypothesis. On the other hand, more recent measurements at shorter wave lengths below 1 mm show an excess in the flux in this regime which cannot be easily explained by effects such as the thermal radiation from primordial dust in the universe or by scattering of hot electron streams from the CMBR as proposed long ago by the late Zeldovich and Sunyaev. At the same time, the spatial homogeneity and isotropy of the CMBR poses serious problems in view of the otherwise observed hierarchical structuring of matter in the universe on scales of galaxies, groups of galaxies, clusters of galaxies and even clusters of clusters of galaxies, the superclusters. It is not yet clear how all these structures have formed, and even worse, why they have formed at the same time when the CMBR is so isotropically and homogeneously distributed throughout the universe.

Closer investigation of the galaxies and the galaxy clusters, however, uncovers a further big problem. It has turned out that the matter visible in these structures does not account for the velocities of their constituents, stars in the case of galaxies, galaxies in the case of clusters. Following Newton, these velocities should decrease as the reciprocal square root of their distances from the centre, as the planets do on their orbits around the sun. In galaxies and clusters,

however, the objects turn out to have nearly constant velocities beyond a certain distance from the centre, indicating the presence of large amounts of invisible or dark matter. Calculating the amount of matter required to account for the velocity discrepancies, one finds that only 1 to 10% of matter in the universe is visible. What is the other matter made of? There is a general consensus about the presence of this kind of matter, but why is it invisible? No agreement exists so far about its nature. If one believes it is normal baryonic matter, one immediately runs into great difficulties in explaining why the CMBR is homogeneous and isotropic. But nevertheless, there exists an ever growing percentage of astrophysicists who are inclined to believe that the question of the CMBR can be answered in some way, while the dark matter is simply some form of normal cold matter, dust, planets, brown dwarfs, undetected white dwarfs, mini black holes, or even some invisible very heavy black holes. The trouble about these assumptions is that these kinds of matter have never been detected in the required amounts and, worse, that if they exist, there are troubles with both the CMBR and the present cosmological theories which assume that shortly after the Big Bang explosion the universe inflated, thereby smoothing out all the CMBR anisotropies and inhomogeneities. This theory requires that the mass density in the universe is very close to the critical one at which the universe is closed, a point which can hardly be satisfied with baryonic dark matter. But the traditionalists don't care for these problems and believe in the validity of the well known conventional kinds of matter and physical laws.

Contrary to these conservative traditionalists there is another group of astrophysicists who abandon the baryonic form of dark matter and tend to favour unconventional kinds of unknown matter: either hot dark matter as massive neutrinos or massive cold dark matter of some kind which nobody has ever observed so far but which may not be in disagreement with several exotic theories particle physicists have proposed in the last few years. Both of these kinds of matter have the advantage that they only very weakly interact with baryons, that is, with conventional matter and therefore they are invisible optically or in other parts of the electromagnetic spectrum. On the other hand, because of their masses they contribute to gravitation and hence cluster around heavy objects or by themselves, so that the visible matter in the universe is nothing but a simple tracer of the gravitational clustering properties of the dark matter. Hot dark matter (heavy neutrinos) seems however not have been excluded owing to the impossibility of measuring their masses. It seems that they are still massless. However, there have recently been several proposals that some kinds of vector neutrinos could have masses heavier than 20 keV/c^2 and that would become important. If they are to account for the dark matter, the formation of structure in the universe would turn upside down because then the large scale structures, clusters of galaxies or even superclusters would have formed first and subsequently would have cascaded down to the now known scales of galaxies and stellar globular clusters — a scenario which looks strange though not impossible.

The remaining group of avantgardists abandons this possibility and believes in unknown types of dark matter. They justify their belief by the vast possibilities in the elementary particle theories where many new kinds of particles could be imagined and imagination has a wide field of activity. The most recent proposal is that massive cold dark matter is provided by tachyons, particles that travel faster than light and are therefore invisible to us. These particles have strange properties, as for instance imaginary rest masses, which is logical because they never come to rest. Their energy decreases with velocity approaching infinity, etc. Since they are spacelike particles, they do not interact with normal matter, but nevertheless they may contribute to gravitation. As a consequence, normal matter is attracted by the gravitational potential of this kind of matter. Moreover, if tachyons would carry electric charge, they could radiate electromagnetic waves which would be detectable.

Some kind of unexplained cosmic radiation in the x-ray band, the cosmic x-ray background radiation, could be interpreted as resulting from a thermal tachyonic component of matter. But none of these particles can be observed so far, and the conservative conventionalists are rather sceptical about all these proposals even though they have no difficulties either with the Big Bang and inflation scenarios or with the isotropy and homogeneity of the CMBR.

The problem is still unresolved, undecided and floating, but one observes that time is working for the traditionalists who believe in nothing else but the known forms of matter — baryons. Why? Isn't just the vast space of the universe the ideal field to provide us with new surprises? CMBR will all the time serve as a deciding razor either to prove or to dismiss some new model of dark matter.

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The German X-ray Satellite ROSAT — a Successful and Promising Experiment

On June 1, 1990 at 22:48 UT the German X-ray satellite ROSAT was launched successfully from Cape Canaveral into its nearly circular orbit with perigee of about 580 km, inclination of 53° and period of 96 min around the Earth. After a preparation and construction phase of about 15 years this launch was the climax of the work of a large group of scientists and engineers cooperating on the project.

ROSAT is a German mission with participation from NASA and the British Research Council, SERC. In addition to the launch site and the carrier — a reconstructed Delta II rocket — NASA contributed the High Resolution Imager (HRI) from the Smithonian Astrophysical Observatory which has already been flown on the Einstein Observatory. SERC contributed the Wide Field Camera (WFC) of the University of Leicester. Data from these instruments collected during each orbit are dumped down to the German satellite observing site Weilheim near Munich within the 6–8 min passes above this station. The data flux amounts to about 400 Mbit per day.

The primary instrumental advance of ROSAT over the earlier missions Einstein and EXOSAT is the use of the Wolter X-ray telescope in the wave length domains 0.6–10 nm of the proportional counters (PSPCs) and 6–30 nm of the WFC. The Wolter telescope is a grazing incidence instrument consisting of a sequence of parabolic and hyperbolic mirrors invented in 1951 by Hans Wolter. The resolution of such a telescope is not determined by the wavelength but by the smoothness of the mirror surface. The four mirrors have been provided by Carl Zeiss Oberkochen who developed new technology to polish and gold coat the mirror with an unprecedented precision. A micro roughness of only 0.3 nm has been reached. Counters and telescope give ROSAT a sensitivity about two orders of magnitude better than Einstein and Exosat and provide it with a spatial resolution of 3 arcsec.

For the first two months after launch ROSAT was operated in the calibration and verification mode. It turned out that all the instruments worked perfectly well and the calibration in space precisely reproduced the ground based calibration. On July 30 this phase ended and ROSAT was switched for six months into a sky scanning mode. During this period the X-ray sky will be scanned continuously in 2° wide overlapping strips per orbit providing a full coverage of the observable sky. After this period the instrumentation will be used to observe selected objects in pointed observations and with variable exposure times. The full life time of the satellite is scheduled for 1.5 years, restricted mainly by the finite life time of the gas counters.

ROSAT is expected to find a large number of new X-ray sources. The estimated number of X-ray sources observed may reach more than 100,000. Some of these sources will be identical with previously observed and known catalogued sources, but the majority will be new and unidentified X-ray emitting regions in the sky which will have to be identified using other catalogues of stars, galaxies, and clusters of galaxies. Since X-ray emission depends on the density and temperature of the object, all types of dense hot sources will be observed: X-ray stars as well as flare stars, T-Tauri stars, white dwarfs and their accretion disks, neutron stars, supernova remnants, galaxies, active galactic nuclei and black hole candidates, clusters of galaxies, and the diffuse X-ray background the source of which is not yet identified.

The verification phase of ROSAT has already been used to observe several well known objects. One of the targets was the Large Magellanic Cloud which was the site of the most spectacular Supernova 1987A observed in early 1987 by eye from the ground. The X-ray picture of this region showed a large number of previously undetected sources in the LMC including an extended inhomogeneous diffuse emitting region indicating the presence of very hot gas in the LMC. However, at the position of SN1987A no radiation could be found. This absence of soft X-rays from the Supernova remnant around SN1987A should have consequences for the physics of supernovae.

Among others, further targets have been Cassiopeia A, an old supernova remnant, the galaxy cluster Abell 2256, and the backscatter and scintillation of the Moon in the X-ray light of the Sun. Cas-A was observed in several energy bands showing a distinct temperature structure of the remnant. The galaxy cluster could be resolved much better than before showing interesting substructure. The Moon was found to be a strong scatterer for solar X-rays also emitting fluorescent radiation in the X-ray energy band. As a by-product it was found that the moon occults the cosmic X-ray background, a fact which allows absolute measurement of its intensity.

The data expected from ROSAT will deeply influence our knowledge of the distribution of X-ray emitters in the Universe. Radio–X-ray correlations will be performed for many of the newly detected or better resolved sources to investigate the relation between radio- and X-ray sources and to better determine the luminosity function. Of special interest is the relation between X-ray emitting galaxies and radio galaxies. Optical and X-ray observations together will yield better information about the spatial distribution of the sources. Since the X-ray observations identify sources which belong together, it will be possible to separate sources which are related from those which are merely projected onto the same region, as is important for identifying the members of galaxy clusters. There is a large number of questions which will be attacked with the help of the new and powerful facilities of the ROSAT observatory.

During the one year of pointed observations following the scanning phase, selected objects will be observed. 165 proposals have been accepted from different fields of research to be worked on during the first half year of pointed observations, and several key programs have been agreed upon to be performed in cooperation with other ground based observatories as for instance ESO. The next years will be a time of busy activity in ROSAT and related data analysis and interpretation. Already the first few tentative observations were so exciting that we can look forward to a large number of new discoveries in the field of X-ray astronomy which will fertilize all other fields including radio astronomy and possibly help answering some of the open questions in these fields as well as bringing up new ones.

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The Physics of Firewalking — The N.Z. Experiments

The sceptics were coming to town. What better opportunity to run a firewalk to debunk the mystique enshrouding this act.

Dennis Dutton, the organiser of the Annual Conference of the New Zealand Skeptics (officially *The New Zealand Committee for the Scientific Investigation of Claims of the Paranormal Inc*) does a fantastic job debunking pseudoscience, quack medicine, clairvoyancy, the occult etc; stepping in where scientists fear to tread? We owe him a lot. How better to repay him than for myself and the third year physics class to lay on a firewalk during the conference dinner?

First a few parameters needed sorting out. How long should the walk be? How much firewood? How long will it take to burn to charcoal? Many other queries flocked through the mind. Obviously a sly trial was called for.

If I was going to do this again next year for the Science Teachers Conference (SCICON90) why not make a portable pit? Hell, what if someone tripped on the edge and pitched face down in the coals? Better stick with a hole in the ground. What if some coals stick to peoples feet? Better come out into longish, wet grass. The first major lesson had been learned. The organizer of a firewalk cannot be a fussbudget – just get on with it.

The third year physics students were intrigued. Keen. A couple of second year students clamoured to be involved too. Why not? They can form the nucleus of next year's walk. Where to hold the event? It had to be near the Conference dinner at the Students' Union. Why not the small, tiered, so-called amphitheatre right outside? Te creek was less than 10 paces away – instant first aid. Hang on – what if it rains – really belts down. Better shift to the other side among trees where a tarpaulin can be rigged. The pre–event publicity creates phenomenal interest. Now there are 80 attending the dinner, 100, 120, 130 – the limit. We cannot fit them around one pit. Back to the tiered amphitheatre. **Lesson two** – A spectacular event attracts customers to a conference.

The Sly Trial

The trial run was carried out in great secrecy? Just me, Dennis, 15 students, the University's information officer, the University's photographer, a Sunday Times reporter and photographer (their paper was next due out a day after the main event), half the Physics Department, my wife and kids .... well almost secret. Only tell those you can trust.

Three days before the dinner the trial fire was lit. **Lesson three** – next time use more turps – want an impressive conflagration at the start. Just before the Sunday Times photographer arrived, Dennis, the arch-publicist, went and changed into a snappy blazer and tie combination. I was in shorts, boots and rough shirt – working clothes. **Lesson four** – dress for the occasion.

The roaring inferno subsided to a bed of hot coals. Time for the off. Dennis insisted that as chief shebang of the sceptics he had to be first. Who was I to stand in his way? A few nervous approaches to the edge.

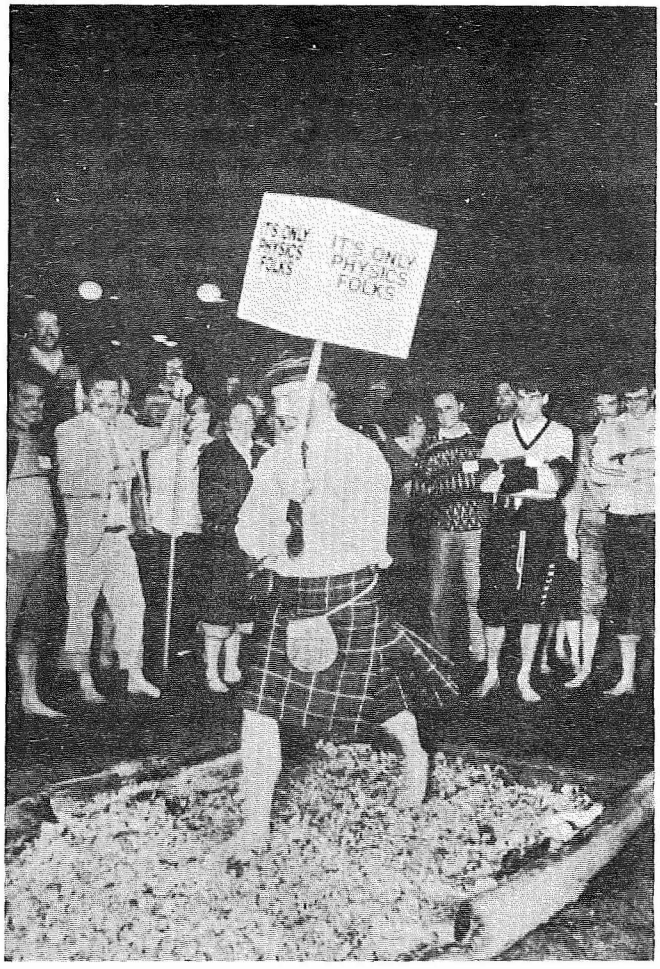
"Do you think it's ready?"

"Sure, get on with it".

He knew the principles as well as I did. Although the coals were glowing at around 700° C the parts in contact with the foot would go out and the surface quickly cool. Charcoal has low heat capacity so the first contact is hardly felt. The inside of charcoal is not burning and its thermal diffusivity is poor so that heat transfer to the foot is far slower than when standing on hot metal. One second of contact per foot is OK so there is no trouble getting in two paces per foot during this time.

A tentative touch of one foot on the coals. A nervous hop across the pit and he was ready. Carefully posing and waiting for all camerawomen to get focussed he stepped off into the front page of the Sunday Times. As a physicist I was quite confident about the principles so had no hesitation about stepping off carrying a small placard. Damn? I had caught the camerawomen unaware and missed photographic frame. **Lesson five** – pay attention to the media.

The students went across in various degrees of haste, then the kids, various strays and repeats. Archie Ross walked confidently, for the second time in 40 or so years. (The first time had been on a beach in Ireland, after taking Scottish anaesthetic and tuition from an African Prince no less!) I walked three times for no burns. Dennis stood on something sharp which he mistook at the time for a burn. A few received small burns which blistered but had gone by the next day. We had determined the parameters to run a successful firewalk that looked effortless and well planned.



Dr. John Campbell on the night of the Conference Dinner (not the walk described on this page).

The Conference Talk

The Conference opened on Saturday, September 2nd and I was scheduled for the last talk of the day. At the outset I asked who was going to walk that night. Of the 150 or so present only six tentatively raised a hand. For this talk, the highlight of my show business career, I dressed carefully in white trousers, red and black blazer and boater. That got me onto Holmes' TV show.

During the talk I discussed pub tricks, baked a cake, passed burning charcoal around for people to touch and showed video examples of the hype that accompanies commercial firewalks. At the end of the talk the audience were again asked, "Who will walk tonight? Half raised a hand. **Lesson six** – an illustrated talk is definitely needed.

A quick interview with the Holmes' team and then home to change into working clothes and prepare the pyre.

The Walk

A pit 3 metres long, 1 metre wide and 5 centimetres deep suffices for a novice walk. This allows 4 paces in all, each foot contacting the coals twice. The turf is carefully stacked well away from the fire. Turfing another 20 cm on each long side helps to minimise the scorching of the surrounding grass. Burning logs placed here during the walk add to the effect. Planks or split logs laid all around the pit help protect the grass as does an occasional spray with a hose which has to be present as a safety measure anyway. Make sure there is longish (a few cm) grass at the exit end of the pit and keep it soaked but not muddy and slippery. This takes care of the odd coal which sticks to an unlucky foot.

Two cubic metres of pine were carefully stacked (three would do a regiment, two a conference of a hundred or so and one a class of twenty). Five or so litres of turps ensure a start to gladden the heart of any pyromaniac. It will be two and a half hours before the fires burn down to a usable bed of charcoal.

The sceptics emerged out of the darkness to view the frightening pyre prior to going upstairs for their dinner and liquid courage. Finally there is just me, the students and two TV crews. TWO? So, a firewalk rates higher than a serial murder. Damn, and here is me in my work clothes. Back home to change.

The students and I have to stay sober. Discrete safety instructions are issued – half are to have their shoes on at all times in case someone trips – one on either side, run them to the creek and throw them in. Dennis, between courses, pokes his head out of an upstairs window. The fire looks awesome. "What time will it be ready, John". "When we arranged". The students and I cook our sausages on the fire. The time between nervous consultations decreases as F–hour approaches. 30 or so stray spectators had gathered for the festivities. On cue the sceptics troop out.

The coals are raked and all large burning lumps removed. At night the sight is scaring. Dennis is apprehensive. I don't blame him. Small jets of flame are still visible. We stall for time. The jets subside.

"Should we wait a bit longer?" asks martyr No.1.

As a loyal lieutenant it is my duty to give him encouragement. "Stop mucking about – get on". I know I don't have to go until he is safely across. He tries a foot in one corner. Physics works.

Dennis stands at the far end of the glowing red bed. A student and I tamp it down using flat shovels. We can only spend 5 seconds or so near the bed because it is so hot. Sweat pours off us. Dennis fights off a potential laundry problem and is ready. So are all the cameras. I surreptitiously drop a firework into the coals. It lands on its side, wick uppermost and does not go off. I quietly delay Dennis, not wanting to give him a vasectomy in mid–stride. The banger goes bang.

Dennis psychs up again, poised ready. A student (Graeme Plank) with 80 watts of stereo in his van opens up both barrels with the ritual fire dance. Dennis loses concentration. Finally all is ready. We spray some hot logs with water to produce ghostly steam for the TV cameramen. Dennis steps off the grass verge and into the Holmes show.

He has no burns. Me next. I hoist the icon, a large placard (see photo this page) and adjust my tie, bonnet and kilt. Holy cow, if this doesn't get me on TV I will streak next time. For the glory of physics I stride off to obscurity.

The students were organized to follow, to use the lemming effect to entice the sceptics onto the coals. Amazingly they are elbowed aside by people fighting to get on while the TV cameras are rolling. Ladies first. A student and I pack the bed down after every ten or so people. In the dark those embers sticking to feet show clearly. Dennis dashes across to brush one off one oblivious person. This only goes to show how poor the thermal diffusivity and heat capacity of charcoal are.

Around 100 people walk that night, some up to five times. Eventually, satiated, the spectators drift off until finally just the students, the Holmes TV crew and me are left. We cook some potatoes and we yarn. After midnight we flood the fire, tidy up and go home.

At nine on Sunday morning the conference re-convenes. Of those present, 63 walked and 11 received a small burn. But as one said, "I walked four times but had only one small blister". The first session of the morning on "Homeopathic Treatment for Minor Burns and Blisters" is cancelled.

Dennis is elated. Never before have the sceptics received such publicity. In the following 3 days he goes on some six radio programmes. Reuters interview him. The Press sort through all their photos and illuminate their front page with a large, colour one of 11–year old Benjamin Dutton in mid–stride and with a look of agony on his face. This is crummy as Benjamin walked fearlessly and without injury both days. Two radio–stations phone him. "Did your Dad force you to walk?"

So what are the final lessons? **Lesson seven** – nothing beats a spectacular stunt to attract customers and publicity. A firewalk is a must for the next SCICON and NZIP conferences. Or maybe a compulsory bungy jump. Back in the 1890's staged, head–on collisions between railways locos packed them in. Hmmm.

Lesson eight – What whimps academics are — giving away for free what scam artists charge $300 per head for. Hmmm. 100 people at, say, $250. That's umm.....

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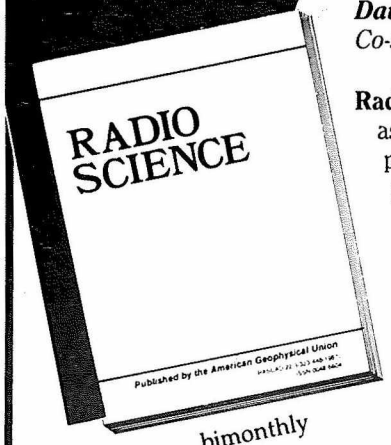
RADIO SCIENCE



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