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ADRESSE TÉLÉGRAPHIQUE : *GOLDKUNST-BRUXELLES*

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HAYEZ, IMPRIMEUR DE L'ACADÉMIE ROYALE DE BELGIQUE
112, Rue de Louvain, 112

1914

URSI HQ to Ghent

COBE

ROSAT recovers

EISCAT

Heating at Gor'kiy

ELBBO

Ringberg workshop

VIKING

EDITORIAL STAFF

Richard L. Dowden
Editor-in-Chief
Physics Department
University of Otago
Dunedin New Zealand
fax: +64 3 4790964

EMAIL addresses:
dowden@otago.ac.nz or
psi%0530124000016::dowden
or via SPAN:
ssl::psi%otago::dowden

W. Ross Stone
Associate Editor
McDonnel Douglas
Technologies, Inc.
1446 Vista Claridad
La Jolla, CA 92037
U.S.A.
Ph: +1 619 4598305 (24 hrs)

Rudolf A. Treumann
Associate Editor
MPI für Physik und
Astrophysik
Institut für Extraterrestrische
Physik
D-8046 Garching
Germany
Email via SPAN:
mpe::tre

Carl-Gunne Fälthammar
Dept. of Plasma Physics
Kungl. Tekniska Högskolan
S-100 44
Stockholm
Sweden
fax:+46 8 7907685
Email :
falthammar@plasma.kth.se

Per Høeg
Dept. of Geophysics
Danish Meteorological
Institute
Lyngbyvej 100
DK-2100
Copenhagen Ø
Denmark
fax: + 45 1 271080
hoeg@os1100.uni-c.dk

J. H. Cloete
Department of Electrical and
Electronic Engineering
University of Stellenbosch
Stellenbosch 7600
Rep. South Africa
fax: +27 2231 774981

Ari Sihvola
Electromagnetics Laboratory
Helsinki University of
Technology
Otakaari 5 A
SF-02150 Espoo
Finland
fax: +358 0 46022

Hiroshi Matsumoto
Radio Atmos Science Center
Kyoto University
Uji Kyoto 611
Japan
fax:+81 774 318463

Pavel Tríska
Geophysical Institute
Czechoslovak Academy of
Sciences
Bocni II. cp. 1401-14131
Praha 4
Czechoslovakia
fax: +42 2 762528

D. J. Skellern
School of Electrical
Engineering
University of Sydney
Sydney
NSW 2006
Australia

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Scanning the *Radioscientist* — from the Editor

The editorial policy of the *Radioscientist,* though ultimately determined by URSI, is largely based on that of the "house" magazines of other scientific

Secretary-General Jean Van Bladel in his new office watched over by his predecessors and a few past presidents on the wall behind him.

societies. As these vary between themselves and I am only slowly becoming aware of all of these, there will be several modifications to policy from time to time over the next few issues. Suggestions from readers on this are welcome. The only response to the question of refereeing papers in the *Radioscientist* which I raised last time was negative. This was from a prospective Regional Editor who said he would not consider the position if it involved refereeing. However, articles in the *Radioscientist* can be cited so pagination is now made continuous during each volume (one year) for easy citation. As a result, this issue starts with page 21.

On the suggestion of Ross Stone, Associate Editor of the *Radioscientist,* a general copyright statement appears (and will continue to do so) on the inside cover page. Not withstanding, an arrangement exists for the *IEEE Antennas and Propagation Magazine* to reprint any such articles covered by such copyright. A reciprocal arrangement reprinting by the *Radioscientist* of *AP-Magazine* articles. Both parties will acknowledge such reprinting with a source statement.

I am loathe to introduce payment for articles in the *Radioscientist* (including "negative payment" or page charges). This has meant passing up an interesting tit bit I found in a secular magazine because the original author, a professional freelance journalist, required payment. The substantial and probably marketable review of software in this issue has been written for, and at no cost to, the *Radioscientist.* In recompense, or as a substitute for it, the copyright is retained by the author to allow him to offer his work for republication elsewhere and so is

Administrative Secretary Inge Heleu at her Macintosh. In addition to her administrative and computing expertise she has a teaching degree in Germanic languages.

not included in the arrangement outlined above. This review is only the first of a series by Alan McCord to be published in the *Radioscientist* this year.

One of our editors has suggested that the by line of articles written by editors use only initials. I feel they deserve better than this so, following a custom used in another magazine, I will use their full names but use "the

Radioscientist" as their address since their full addresses are given on the inside cover.

We show on our cover this issue a reproduction of the cover of issue N° 1 (1914) of the *Bulletin* of the *Commission Internationale de Télégraphie Sans Fil Scientifique* to note the end of 77 years of the General Secretariat at Brussels. Since TSFS was an international body from the beginning, its transformation into URSI in 1919 when it and other International Unions were set up under the auspices of ICSU (then known as the *International Research Council*) could be regarded as only a change in name (even the executive officers carried over). In fact the English version of the name "URSI" was at first the *International Union of Scientific Radio Telegraphy,* then the *International Scientific Radio Union* (1928) and now the *International Union of Radio Science.* URSI is the only International Union known by a French acronym, an acronym more widely known than either the French or English versions of the full title.

The new General Secretariat office is housed in the Laboratory of Electromagnetism of the University of Ghent with modern equipment (computer, laser printer, fax) for desktop publishing and rapid communication. The new site is not new to Professor Van Bladel for he was Director of this Laboratory from 1964 until his retirement in 1987. For much of this time (since becoming URSI Secretary General in 1979) he had to commute

Another joint experiment in the radio-science field, involving scientists from USA, Brazil and NZ, began only a few days ago (as I write this) with the launching of the prototype ELBBO (extended lifetime balloon borne observatory). A further five or six ELBBOs will be launched in 9-12 months time.

Rudolf Treumann gives us an excellent description of a workshop at Ringberg Castle to discuss everything related to the large scale structure in the universe. But can the paintings described still be seen at the castle?

The discovery of radio emission from Jupiter over 30 years ago led to speculation, and later discovery, that the Earth is also an intense, and natural, radio emitter. Viking results confirm this.

At this point I would like to introduce articles about exciting discoveries or even just speculation in fields of URSI other than those geophysical and astrophysical. Where are they?

The final item concerns the award of the Montefiore Prize to Drs De Zutter and Faché. Their photograph appears on this page for typesetting reasons (which I have to do myself!). At the risk of embarrassing the author of this item, I would like to add that not only are both Drs De Zutter and Faché from his former Laboratory but also that he was himself awarded this Prize in 1965.

between the Laboratory in Ghent and the Secretariat in Brussels to carry out two jobs at once. In his "retirement" (to only one full time job!) he is bringing the URSI Secretariate fully up to the speed of the 1990s for handing over to the present Director (and his previous PhD student), Professor Paul Lagasse.

Following the article about the microwave background radiation in the last issue, Rudolf Treumann describes recent results from COBE, the first satellite devoted to the study of the infrared and microwave background. The next article, also by Rudolf, is further news about ROSAT.

The maintenance of the magnetospheric plasma by ionospheric plasma has been known for a quarter century.

But does the plasma "boil off" the ionosphere or do electric fields of magnetosphere origin suck it up? Opgenoorth and Wahlund use EISCAT to investigate this.

Using the ionosphere as a "laboratory" plasma without walls has become possible over the last decade or so with very high power (megawatt) HF transmitters and high gain antennas. Recent advances owe much also to the increasing sophistication in on-line data analysis and experimental control of the RF and modulation. The Soviet and Swedish groups came together to combine their complementary techniques and resources very successfully.

Computing without Programming ?

A Review: *MathCAD* version 2.0 and *Igor* version 1.2

What will radioscientists be doing at their computers during the 1990's?

It used to be that about the *only* thing you could do in front of a computer was write programs, but we could write FORTRAN programs to do just about everything: gather data from experiments, generate it from simulations, process it and plot it. Occasionally we would also need to solve or integrate some obscure function which wasn't already buried somewhere in a mathematical handbook.

By writing a program to do everything we did get correct answers, but it was tedious and much of our time was spent unproductively. We had to translate natural mathematical expressions into FORTRAN-speak; the "γ"s became GAMMAS and i became (0.,1.). Not only did we have to

correct any mistakes in the FORTRAN representation of our mathematics, but we also had to debug other parts of our programs as well. Our FORTRAN programs had to be linked with large mathematical and graphical libraries but, worst of all, a lot of our programs were actually almost the same -- only the prompts, variable names and mathematical statements were different. Wouldn't it have been nice if somehow, all that structuring and control had been done for us, and all we had to do was type in the mathematical definition or maybe the name of a data file.

Fortunately, times have changed. In this article we'll review two programs which enable you to spend much more time doing physics on your personal computer and much less time getting your hands dirty. *MathCAD* from MathSoft Inc., and *Igor* from WaveMetrics are two pro

s_i

6

-6

0   i   127

Take its discrete Fourier transform:

$f := fft(s)$ $j := 0 .. 64$

$\alpha := 2.5$ ...define threshold for spectral noise rejection.

$\left| f_j \right|, \alpha$

8

0

0   j   64

<-- Signal

<-- Noise

Filter, and take the inverse transform:

$g_j := f_j \cdot \Phi\left[\left| f_j \right| - \alpha \right]$ $h := ifft(g)$

h_i

6

-6

0   i   127

α	β	γ	δ	ϵ	ζ
η	θ	ι	κ	λ	μ
ν	ξ	o	π	ρ	σ
τ	υ	ϕ	χ	ψ	ω

A	B	Γ	Δ	E	Z
H	Θ	I	K	Λ	M
N	Ξ	O	Π	P	Σ
		Φ	X	Ψ	Ω

:= ≡ =? (Calc)
+ − × ÷
$\frac{x...}{+y}$ −x x^y ()
√ x! $\bar{x}$ |x|
∫ $\frac{dy}{dx}$ ∑ ∏
> < ≈ ≠
≥ ≤ Given Find
v_i $M^{\langle i \rangle}$ $\vec{v}$
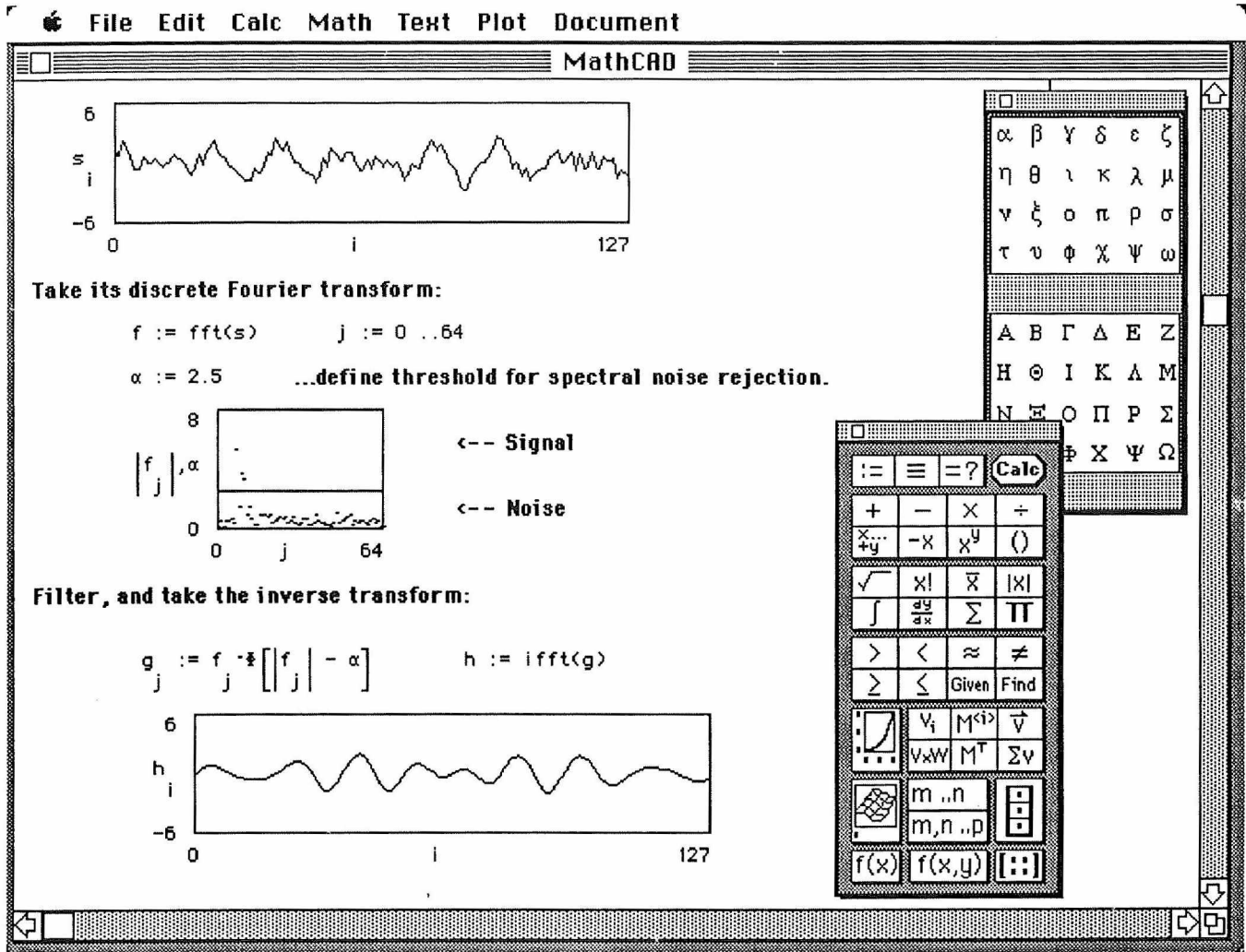VxW M^T Σv
m..n ·
m,n..p ·
f(x) f(x,y) [::]

Fig.1. Screen dump within a typical MathCAD document.

grams especially oriented for technical and scientific users of Macintosh computers. *MathCAD* is also available for other platforms, including PCs. Many tasks can be performed equally well by both packages but the style of operation is quite different even though both programs conform to the usual mac menu interface.

Hardware Requirements

To run *MathCAD 2.0* you'll need a Mac Plus, Mac SE or a Mac II with at least 1Mb of RAM and Mac System Software version 6.0.2 or later. *Igor 1.24* requires at least 800kb of RAM available to it, a hard disk, and version 4.1 or later of the Mac System Software. Our evaluation copy of *MathCAD* came on two 800kb diskettes, one containing a version for machines without a math coprocessor. *Igor* comes on three diskettes and will use a math coprocessor if one is present. Installation poses no problems with either program. *MathCAD* has the advantage of being able to be installed on a Mac Plus with only two floppy drives and no hard disk. It's refreshing to see software companies catering for the lower end user as well. The PC version of *MathCAD* supports the usual graphics adapters and can be run with as little as 512kb RAM and two floppy disks and will support LIM EMS and an 80x87 math coprocessor chip if present.

What is MathCAD?

Using *MathCAD* is like having a dialogue between you and the computer. When *MathCAD* starts up it presents you with a blank screen much as if you have just entered a word processing program. This is in fact a good way of thinking about *MathCAD*. In *MathCAD* your final document *is* your program. *MathCAD* is not a symbolic math program and the only results it produces are graphics, (possibly complex) numbers (with optional units attached), arrays of numbers, and tables. But *MathCAD* enables you to rapidly enter natural-looking symbolic *expressions* which it then evaluates numerically.

To begin entering expressions into *MathCAD* you just move the mouse to any point on the screen and click it. A flashing insertion cursor appears at that point and you are ready to type in an expression. You can build up your expressions using the familiar computer-style operators like / but don't expect to have to type in operators like SQRT() etc. Instead you can pop up an *operator palette* which contains common math symbols like √ and ∫ etc. When you select a symbol from the palette, it is automatically inserted into your expression with its own "placeholders" attached to it. These "placeholders" (black blank slots) indicate where you must enter additional information necessary for the evaluation of that symbol. For example, the ∫ symbol has placeholder slots on the upper and lower limits

of the integration, a placeholder slot for the integrand, and one for the variable of integration.

You can also pop up a palette of Greek letters and one click inserts the symbol you want into your expression. Fig. 1 shows these two palettes onscreen within a *MathCAD* document — all symbols can also be obtained directly via keystrokes. You can also cut and paste subparts of an expression. It is important to remember that, just like your brain and all the math teachers you've ever had, *MathCAD does* distinguish between upper and lower case letters for variable names!

You continue to build up your mathematical expression until you type an "=" sign. At this point the expression is evaluated and the result is returned on the right hand side of the equals sign. Assignments to a variable (without screen output) are made using ":=". While *MathCAD* is busy evaluating an expression, a light bulb icon appears immediately to the right of the expression but a calculation can be interrupted at any point. An excellent feature of MathCAD is that any errors due to bad syntax or undefined variables in your expressions are precisely indicated for you by an arrow and a labelled box.

What actually happens when you type in a *MathCAD* expression is that an invisible box or "region" is created around the expression. This region continues to grow as you build up your expression. To put another expression somewhere else on the page you simply click the mouse at the new point and start typing. You can rearrange existing expressions by dragging them to another place on the page using the mouse. The same applies for graphs and tables. Normally the rectangular borders of an expression are invisible, but a menu option is provided to make them visible which is sometimes necessary when there are a lot of closely spaced expressions on a page.

As well as regions containing mathematical expressions, you can also create text-only regions into which you can type any text using any font (building up expressions using symbols from the palette doesn't work in text-only regions though). One of the strengths of *MathCAD* is this ability to create a free-form page of mixed calculations, graphs, tables and descriptive text.

When *MathCAD* is evaluating a whole page, the order in which it evaluates expressions is determined by their position on the page, starting at the top and working downwards, and going from left to right if there is more than one expression on the same line.

When you save a *MathCAD* document to disk, you are only saving the expressions you have typed plus the results of the evaluation of those expressions. If you wish to open an old *MathCAD* document and extend or alter some expressions in it, all expressions above the one you are working on will need to be evaluated again. This is done automatically for you by MathCAD.

MathCAD Graphics

The operator palette also contains icons representing a two dimensional graph, and a "three dimensional" surface plot of a function of two variables. Generating a plot on the page is simple. After you have evaluated the desired func-

tion over a range of the independent variable, you click the graph icon on the palette and a dummy graph appears on the page with placeholders on the axis labels. You then use the mouse and keyboard to enter the names of the axis variables in the placeholder slots. *MathCAD* then uses these names to automatically draw the graph. Zooming in on a subrange of x or y values is easily achieved by directly changing the numeric labels at the ends of an axis and instructing *MathCAD* to evaluate the plot again.

A plot can be resized interactively as well as dragged around the page by the mouse. There is a wide choice of possible line types and to put multiple traces on the same graph you simply put a list of functions names in the placeholder slot for the vertical axis label. Logarithmic axis scales can be chosen, and grid lines can be added. It is not possible to add tickmarks to the axes however. An example of generating a simple graph using *MathCAD* is given in Fig. 2.

MathCAD can also produce surface plots of data as a function of two variables. As for ordinary plots, you can select the surface plot icon from the palette and fill in the single placeholder on the vertical axis. (You can only create surface plots from matrices). As well as being able to change your point of view of the surface, you can also produce a *shaded* surface plot. The degree of shading can be determined either by the elevation (vertical coordinate), or by the location of a light source which you can also move around in space. Monochrome or colour shading is possible but no facility for axis labelling is provided for surface plots. It is a little disappointing that *MathCAD* doesn't also provide a contour drawing capability to complement this excellent surface drawing facility.

Who is Igor?

Nowhere in the manual does it explain why this program is called *Igor* or who Igor actually is. However, you do get a momentary glimpse of the guy (I assume it's Igor) when you click on the *Igor* icon on the Mac desktop. So if I can't tell you exactly who Igor is, I can at least try to describe what *Igor* can do.

Igor is essentially a high level graphing and data analysis system which can either be menu driven, or driven by commands typed into its command line Interface. It is possible to use Igor via the menus only, but use of the facilities based around *Igor's* command line is really the key to unlocking the full power of *Igor*.

In fact, as you use *Igor* via the menus and dialogue boxes in the usual mac way, it echos for you the *Igor command* to do the same thing via its command line. As each command is performed it is also stored in a window called the "history area". Fig 3 shows an example of an *Igor* session with the history region near the bottom of the screen and the command line at the very bottom.

You can assign an arbitrary name to any sequence of these Igor commands (called a "macro") enabling you to automate repetitive tasks.

The basic object that you work with in Igor is called a "wave". A wave is basically a variable containing a vector of floating point numbers with scaling information in

Here is an example of a *MathCAD* dialog. All text here is produced using *MathCAD*.
Let's define a variable called t

$t := 10$ and define a function of that variable $f(t) := \sin(t)$

To evalulate f(t) you just type in $f(t) =$ and you get

$$f(t) = -0.544$$

The default precision for displayed results is 3 significant figures but you can change this to a maximum of 15 using the Global Result Format menu item.

Another important MathCAD concept is defining a range variable. For example by redefining t as

$t := 0 \ ..4$

means that t will take on the range of values 0 through to 4 in steps of 1 (by default). Typing in $f(t) =$ as before now automatically produces a table of values of f(t) for each value of the range variable t.
To graph f(t) you select the graph icon and label the axes.

f(t)
0
0.841
0.909
0.141
-0.757
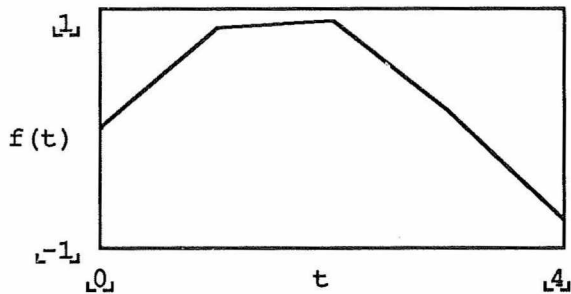
To provide better resolution in the plot, we can specify the range variable t to be incremented by an amount smaller than the default value of 1. To do this you provide the starting value, the *second* value, and then the ending value in the definition of the range variable. For example

$t := 0, 0.1 \ ..4$

This defines 41 t values and now the plot looks like
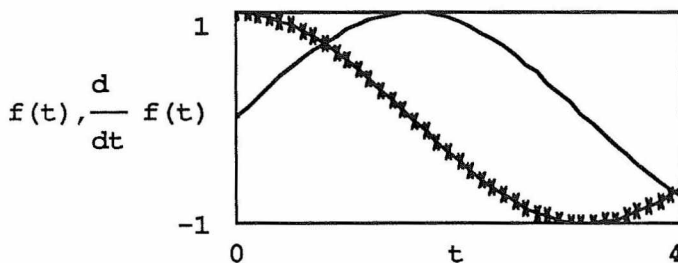
Also plotted on this graph is the value of the numerical derivative of f(t) calculated automatically by MathCAD.

Here's a slightly more complicated example where we have built up an expression directly within the placeholder slot on the axis. We first define a range variable w which is the upper limit of the integral

$w := 0, .1 \ ..10$

then build up the expression for the integral on the axis label using the operator palette, then plot it as a function of w.

$$\int_0^w \frac{\sin(u)}{\sqrt{(1+u)}} \, du$$

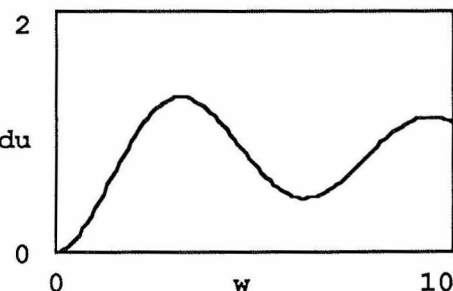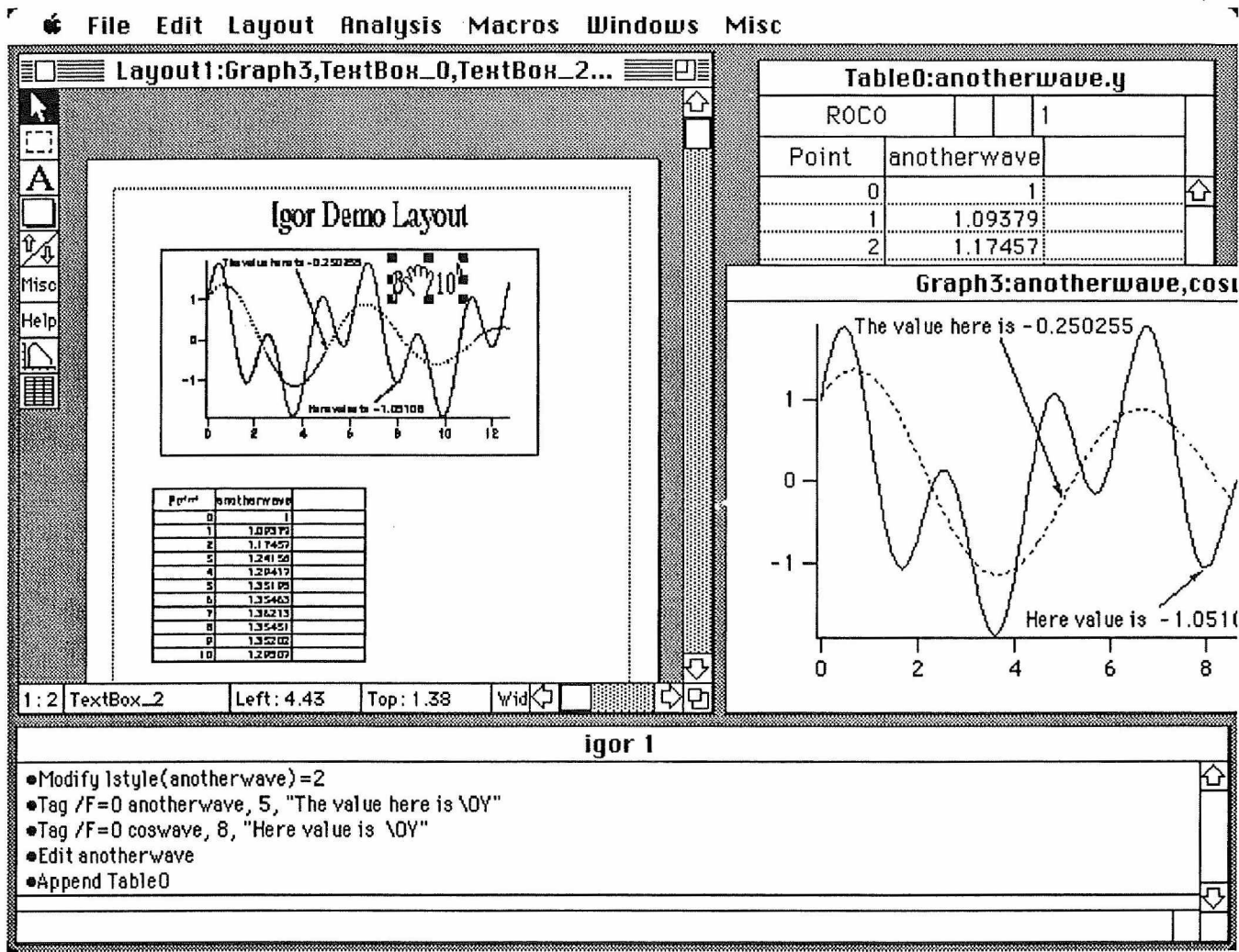Fig. 2. An example of a document created using MathCAD.

Fig. 3. Screen dump during an *Igor* session.

cluded. The numbers can be real or complex, single or double precision, and can be nonuniformly spaced. When you create a wave you must specify its length, and whether it is single precision, double precision, or complex. By default, a newly created wave has all elements zero. You can place values into a wave by reading numbers from a file or providing *Igor* with a "wave equation" (sic) which is an assignment statement involving zero or more previously defined waves or mathematical expressions. The name "wave equation" has nothing to do with real wave equations but is just Igor-speak for assigning values to a vector (a "wave").

You can also define your own numeric functions to extend Igor's built-in set. As well as vector variables (waves), you can also define your own scalar numeric and string variables using statements in the command line like:
variable myvar = 7.24
string mystring = "Who is Igor?"

In *Igor*, a wave can be displayed in a table form which can also be edited interactively and cut and paste between waves.

Igor Graphics

Once you have defined a wave, you can "Display" the wave on a graph of its own, or with other waves. If the numeric data in a wave is changed, then the graph is updated automatically. You have a great deal of control over the ap-

pearance of the graph including line and marker thickness, coordinate offsets and excellent control of axis labelling and tick marks. Axis labels can include changes of fonts, font size, super- and subscripting. Sophisticated plot annotation features are available including "tags" containing "dynamic text" which changes when the values associated with its attached data point changes. Fig 3 demonstrates the use of two dynamic tags.

Finally, *Igor* has "layout pages" which show graphs, text boxes or tables of selected waves as they will appear when printed out. You can also move and resize all of these quantities (including annotation text) interactively on the layout page and also click on places on the page where you want to add further annotations. Fig 3 shows the "hand" dragging a piece of annotation text to a different position on the page. You can also add PICTs generated from other macintosh applications onto your layout pages.

Collectively, all your waves, graphs tables, layout pages, macros and variables comprise an Igor "experiment". Igor does not save your work as a single document, but rather as a main "experiment" file (the one you can double click on to relaunch Igor) plus an associated folder which contains the contents of your "procedure window" (containing your macros and user-defined functions), the system and user variables, and the history.

Special Math Functions

In *MathCAD* all the usual trigonometric and logarithmic functions are defined for complex arguments as well as real. Special functions include Bessel, Error functions and the Gamma function. Several interpolation functions are provided, as well as FFT and inverse FFT operations, and some statistical functions.

Igor has a similar set of special math functions to those provided in *MathCAD*, including taking the FFT of a wave. Some functions of complex arguments are not built in to *Igor*, and you have to define them yourself. (Examples of how to do this plus many other pointers are given in the *Igor Technical Notes* which are provided on one of the *Igor* diskettes).

Equation Solving

MathCAD can numerically find real or complex roots to single and simultaneous equations and inequalities. The documentation with MathCAD also provides some description of the algorithms used to solve these problems, so this kind of information is there if you really need it. This makes a welcome change from the "black box" approach to routines of many other packages.

Igor has no built-in equation solving features.

Data Files

MathCAD reads and writes to the outside world using plain ASCII files, so it can be used to read in, process and plot experimental data. Built-in file access routines enable you to read, write and append scalars and matrices to and from external files. The *MathCAD* file itself is not an ASCII file but it can be swapped between the mac and PC versions of *MathCAD* with some restrictions.

Igor also reads and writes ASCII files, and has the useful feature of being able to read in numbers from a file automatically ignoring any line of non-numeric data. A wave of 100,000 points (column of 100,000 entries) can be handled. The maximum number of characters per row is 5000, and the maximum number of columns per row is 250. Missing values can be indicated by the presence of the "NaN" (not a number) symbol within the data. To read this kind of "general text file" into Igor you first specify the file and provide names for the new waves to be read. If the columns are separated by tabs, as is usual for spreadsheets, and are headed by names, these names will be automatically used as the wave names.

Igor can also import "Igor tex files" which have a simple format already containing the wave names, scaling and precision information. Igor can also read and write waves using its own binary file format.

Vector and Array Operations

Vector and array operations are incorporated nicely into *MathCAD*. You can globally change whether *MathCAD* labels the first element in a vector as the 0th or the 1st. Like standard mathematical notation, you reference vector or matrix elements via subscripts, e.g., $M_{i,j}$. The dot symbol "·" is used for multiplication of two scalars, multiplication of a matrix by a scalar, dot product of two vectors, and general matrix multiplication. The nth power of a matrix is A^n, and A^{-1} returns the inverse of the matrix. You can also "vectorize" an expression by placing an arrow "$\rightarrow$" over it. Vectorize really means "interpret all operations as scalar and then perform them element by element". For example, C := cos(A) is illegal if A is a matrix. However putting an arrow over the cos(A) will result in a matrix whose elements are the cosine of the elements of A. Similarly, the "vectorized" form of C := A·B produces a vector C whose elements are the products of the respective elements of A and B instead of normal matrix product.

There are limitations on the size of individual arrays in *MathCAD*. No array can have more than 6400 elements, so the maximum size of a vector is 6400 elements, the maximum size of a square matrix is 80x80, and the maximum size of a three dimensional array is 18x18x18.

Expandability

MathSoft also sells several application packs for use with *MathCAD* including packs for statistics, Numerical Methods (including ODEs), Electrical, Mechanical, Civil and Chemical Engineering.

As well as user-defined functions, the functionality of *Igor* can also be extended through External Operation (XOP) of C programs. WaveMetrics offers the *Igor XOP Toolkit*, which includes MPW C 3.0 and THINK C 4.0 sample source codes for several XOPs. Two hours of free technical assistance are included in the price of the toolkit. There is also an *Igor Filter Design Lab* available.

MathCAD is also available in a French or German version. As a registered *MathCAD* user you are provided with free telephone support, upgrade information and a quarterly Users Journal. MathSoft have also released a program called *MathStation* for use on Sun unix machines. As well as improved graphics, it also provides menu driven symbolic computing using the MAPLE symbolic algebra program.

Conclusion

The two Macintosh programs *MathCAD* and *Igor* are, in a sense, complementary. *MathCAD* is more oriented toward using conventional mathematical notation to provide equal stress to the intermediate steps involved in obtaining a result (the result being a number, tables of numbers, or graphs). This makes *MathCAD* an excellent teaching tool, either as a "live" scratch pad, or as a means of preparing instructional material for later presentation as handouts or for use with overhead projectors. *Igor*, on the other hand, is designed primarily for manipulating experimental data. What you finally print out from *Igor* are annotated graphs or tables suitable for direct inclusion in a publication -- the intermediate steps to get there are not evident as part of Igor's normal output.

The axis labelling on *MathCAD* graphs is relatively poor compared to *Igor* having no tick marks and numeric labels only at the two ends of an axis. *Igor's* strength is its ability to quickly analyze data sets and produce publication quality graphics with easy mouse-controllable annotation. *Igor* can effectively be programmed by using the mouse to

do the job once, then have the sequence applied to other data sets.

In my opinion, the notation and syntax used in *MathCAD* is more consistent and elegant than *Igor's*. The "catchy" names used for quantities in Igor may not be intuitive, but they are certainly easy to remember. *Igor's* ability to ignore non-numeric text when it imports an ASCII file is a definite advantage when processing files create by data acquisition hardware.

MathCAD comes with a fold-out quick reference card, a feature fairly common with application software, which is often faster to use than either the online help or the manual. *Igor* lacks this feature though both the manual and online help are thorough.

Both packages can be used for automated data analysis, although the ability of *Igor* to interface to external C programs may ultimately provide it with more flexibility and speed in this area.

Lack of contour drawing routines in both packages is a disappointment, and *Igor* has no facilities for plotting functions of two variables. A plus on *Igor's* side is that it has a sense of humour. For example, try deleting some contents of the "history area".

MathCAD and *Igor* enable you to easily do things that previously you wouldn't even have attempted doing by computer. The two programs are especially good news for physicists with an aversion to traditional programming. I enjoyed using both programs a lot and intend to make a lot more use of them in the future.

Products Reviewed:

Cosmic Background Radiation Mapped by COBE

On November 18, 1989 NASA launched COBE, its first satellite devoted to the study of the cosmic background radiation which is most important for cosmology. This satellite carried three instruments aboard, the spectrum instrument FIRAS, the infrared experiment DIRBE, and the differential microwave radiometer DMR to measure the microwave anisotropy at different radio wavelengths. FIRAS surveyed about 98% of the sky (60% double coverage) and DIRBE 100% before the liquid helium of the cryogenic system was exhausted. DIRBE still works in the 1-5 micrometer channel; DMR, which is unaffected by cryogen depletion, continues to operate for the two year operation period and hopefully longer.

The first and already spectacular result of COBE was the finding that the spectrum of the cosmic microwave background is extremely close to a blackbody radiation spectrum. The deviations are smaller than 1% of the peak value; the temperature found was 2.735 K with error 0.06 K. The anisotropy is found to be only dipolar with amplitude 3.3 mK. The dipole direction is $\alpha, \delta = 11.2^h \pm 0.2^h$, $-7° \pm 2°$. First attempts have been made to determine the cosmic infrared background from the measurements of FIRAS and DIRBE. Analysis is still underway and depends heavily on the models of the foreground contributions by the various cosmic infrared sources: planets (Jupiter), primeval galaxies, active galactic nuclei, halo black holes, massive objects, decaying particles, exploding stars etc., but the sensitivities of the instruments allow for much more precise measurements and therefore more reliable conclusions than previous rocket measurements. DMR has produced full sky microwave maps at 31.5, 53, and 90 GHz with two independent channels at each frequency. It was found that at millimetre wavelengths the microwave background dominates the sky with intensity three orders of magnitude higher than galactic emission. The dipole anisotropy mentioned above is caused by the motion of our solar system with respect to the cosmic background frame and is consistent with a Doppler shifted thermal spectrum. Quadrupole emission is not obvious and can be placed at a limit smaller than $\Delta T/T = 4 \times 10^{-5}$ at the 95% confidence level, assuming that the fluctuations are Gaussian. The DMR limits relate directly to the large scale geometry and dynamics of the universe. Specifically, the Hubble expansion of the universe must have been uniform to one part in ten thousand, and the universe must be rotating less than one ten thousandth of a turn in the last 10 billion years. Energy density of long wavelength gravitational waves and mass per unit length of cosmic strings can be given severe upper limits. Also, scale invariant long wavelength energy

density fluctuations in the early universe must in inflationary cosmology have had normalised amplitude limits smaller than 3×10^{-5}. Future theories will have to satisfy these constraints.

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Rudolf A. Treumann
The Radioscientist

Problems with ROSAT Settled

ROSAT's survey phase during which the x-ray sky has been scanned for half a year came to an unexpected end one week before schedule due to a temporary loss of the satellite caused by some battery problem the reasons for which have not yet been clarified. The satellite was fortunately recaptured gain after a few uncontrolled revolutions around the earth during which its position was not checked. After recapturing it was found that one of the instruments was damaged due to illumination by solar UV. The extremely high sensitivity of the detector was not suited to solar radiation. Fortunately there is another redundant detector aboard the spacecraft. After some hesitation it has now been brought into position in the telescope replacing the broken one and has been switched on. It seems that it works just as well as the former detector. Hence continuation of the mission with its planned two half year pointing phases seems guarantied.

Nevertheless the reasons for the event have to be analysed. It is not clear what caused the troubles: human failure, failure in the steering systems computer, or interaction with space debris. Finding the reasons is important to prevent further damage which then would be fatal because redundancy has now been exhausted. Fortunately during the survey phase a large number of data has been collected and a number of important new results have already been found. It will take many years and much effort of a large community of scientists to analyse the available data, and we are looking forward to its results.

One breathtaking result is already among those which have been provisionally obtained. Preliminary analysis of the x-ray background in the north ecliptic pole region [*Hasinger et al.*] indicates the signature of a large scale structure in the soft x-rays comparable to that found in the optical large scale distribution of galaxies. This finding, if confirmed by later analysis, may be very important for cosmology.

Rudolf A. Treumann
The Radioscientist

Does the Ionosphere Blow out Plasma or Does the Magnetosphere Suck it Away?

Diffusive Ionospheric Plasma Escape: One Course for the Magnetospheric Particle Population

It has been known for many years that the magnetospheric particle population and its constant refilling cannot be sustained by the solar wind plasma only. The extraction of ionospheric plasma, particularly heavier ions, is considered to contribute to a large extent to the refilling of the magnetospheric plasma. The processes leading to ion loss from the ionosphere have generally been understood to be of a thermal nature. Ionospheric plasma density increases caused by precipitation, and plasma heating due to horizontal convection electric fields, can produce appropriate pressure gradients, which force ions to escape along the magnetic field-lines. This diffusive loss of plasma is particularly effective in the polar regions and has been called the "Polar Wind" [*Banks and Holzer*, 1968], describing both the unstructured character of the process and the analogy to the other major source of magnetospheric plasma, the "Solar Wind".

The incoherent scatter technique, as utilized e.g. by the EISCAT facility in northern Europe [*Folkestad et al.*, 1983], allows for a unique way of simultaneously observing the crucial parameters involved in the formation of the "Polar Wind". In a field-aligned experiment geometry an incoherent scatter radar can provide simultaneous profiles of electron density, electron and ion temperatures, and field-aligned bulk ion velocities. In the case of the EISCAT radar, two remote receiving stations even give the possibility of determining the complete ion velocity vector at one altitude along the same field-line, thus allowing for an estimation of the horizontal electric field.

Recent EISCAT results from high resolution experiments have shown that the ionospheric electric field in the auroral zone exhibits considerable structure. Both spatially and temporally limited electric field enhancements up to 1000 mV/m been observed (see e.g. *Williams et al.*, [1990]). In association with such strong electric field enhancements, *Winser et al.* [1988a] have observed localized and very

strong events of ion outflows with velocities exceeding 100 m/s. Those were the highest upward ion velocities reported in the literature. Detailed analysis resulted in an explanation for these events similar to the mechanism creating the "Polar Wind", namely extremely enhanced diffusion caused by intense frictional ion heating within such local strong perpendicular electric fields [*Winser et al.*, 1988b, 1989]. It can be concluded that one reaction of the ionosphere to magnetospheric particle precipitation and electric fields is to blow out a considerable amount of topside ions, i.e. mainly O^+, both as a more or less constant, unstructured wind and as localized shortlived bursts within regions of electric field enhancements.

Are There Magnetospheric Means to Extract Ions from the Ionosphere?

When browsing through the large data base from the coordinated observations between EISCAT and the first Swedish satellite Viking (see *Opgenoorth et al.*, [1989]) we recognized by pure chance some features in the topside ionospheric plasma parameters which showed up only in a few high gates at the upper observational limit of the standard EISCAT experiment modes [*Wahlund and Opgenoorth*, 1989]. During more than 50% of all intensifications of ionospheric plasma density caused by auroral precipitation we found extreme enhancements of the electron temperature (several 100 K above background) and the upward bulk ion drift more than 500 m/s) along the magnetic field-line above 300 km. In these observations there was a clear increasing tendency towards higher altitudes. We noticed that the observed effects were particularly common when narrow auroral structures moved through the radar beam. A more detailed analysis revealed a very good correlation between these topside phenomena and plasma density enhancements in the lower F region between 150 and 200 km, indicating a rather soft precipitating electron spectrum. There was no indication for enhanced ionospheric electric fields or frictional ion heating in association with these events.

We estimated that the observed ion outflow, if it occurred all around the auroral zone during about 50% of the time, would account for a total ionospheric plasma loss of 10^{25} ions sec^{-1}, which would make it one of the most effective loss processes for the earth's atmosphere. But so far we had neither a clue about the physical mechanism for the upward ion acceleration nor a proof for that the upward ion flows continued upwards further than the few gates we see them in the standard EISCAT data. We also had only indications that the outflows were a permanent feature associated with auroral structures. In our dataset they appeared as shortlived spikes, when structures were found to move through the radar beam. Consequently we designed a new EISCAT experiment, allowing for observations in extreme altitudes, i.e. up to 900 km with the EISCAT UHF system and for the first time also utilizing the VHF system for observations up to 1500 km [*Wahlund et al.*, 1990].

The results of these experiments were manifold. We could show that the topside electron heating and ion outflow continued to increase even within our new range of observations, reaching electron temperatures of 7000 K and velocities of more than 1000 m/s, resulting in an upward ion flux of almost 2×10^{14} m^{-2} s^{-1}. Still there was no sign of an associated ion heating. High altitude tri-static measurements with help of the EISCAT remote antennas gave also no indication for an ion temperature anisotropy. Since we

used the VHF antenna in a vertical position and the UHF antenna in a field-aligned mode we could show that the features were, in fact, associated with drifting auroral forms, and not shortlived as might be suspected from our earlier data. We found clear altitude dispersion features in the VHF data and a delay between the events in UHF and VHF data, which can only be explained by narrow drifting structures, aligned along the magnetic field.

Still our dataset is not complete enough to exactly determine the process leading to the upward acceleration of ions. We can definitely exclude thermal diffusion from the possible candidates, since the observed pressure gradients do not agree with the altitude dependence of the outflowing ion acceleration. Otherwise our dataset leaves room for a number of speculations. The association of the observed features with auroral structures indicates a possible causal connection to field-aligned currents and/or parallel electric fields, sucking up ionospheric plasma into the magnetosphere. Such a mechanism has, in fact, already been suggested by *Block and Fälthammar* [1968] to be responsible for topside plasma depletions. The absence of anisotropic ion heating also points rather towards an acceleration by a low altitude parallel electric field than magnetic mirror effects. Furthermore *Rietveld et al* [1991] recently found that EISCAT spectra from high altitude gates during the described events quite often exhibit extremely enhanced ion-acoustic lines instead of the normal F-layer "double humped" spectrum. Such lines can be interpreted as signatures of ion-acoustic wave turbulence, which in turn could cause the observed effects in the topside plasma parameters.

In future EISCAT experiments and additional coordinated observations aboard rockets and satellites we will continue to search for more clues about the physical mechanism behind this extremely effective, nonthermal, auroral loss process for heavy ions from the topside ionosphere. From our estimations it seems to be more important than the thermal ion loss due to ionospheric diffusion, and it involves a more direct and quite localized coupling between the ionosphere and the magnetosphere.

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Hermann J. Opgenoorth and Jan-Erik Wahlund
Swedish Institute of Space Physics
Uppsala Division
S-755 91 Uppsala, Sweden

Swedish/Soviet Heating Campaign in Gor'kiy, USSR

Most of the emphasis of the Swedish Institute of Space Physics, Uppsala (IRFU) research group in nonlinear wave interactions in space plasmas is concentrated on the stimulated electromagnetic emission (SEE) technique used in ionospheric modification experiments. First discovered in a joint Uppsala/Lindau experiment at the MPAe Tromsø Heating facility in August 1981, the SEE technique has later been used in similar experiments at Arecibo, Puerto Rico, the HIPAS facility, Fairbanks, Alaska, and various facilities in the USSR.

Through cooperation with Professor A. Gurevich, Lebedev Institute, Moscow, who helped establishing contacts between the IRFU group and Dr A. Karashtin at the Radiophysical Research Institute (NIRFI) in the city of Gor'kiy (now renamed Nizhnyi Novgorod) on the Volga, an agreement for IRFU participation in an ionospheric modification campaign at the "Sura" facility in September-October, 1990 was worked out. The experiments were undertaken by using the Soviet ground-based equipment (transmitters, antennas) together with the IRFU computer controlled digital signal analysis system that we took from Sweden. This combination of efforts turned out to be nearly optimal.

The "Sura" facility is named after the Volga tributary Sura and is located at the NIRFI field station (geographical coordinates: $56.13°$ N, $46.10°$ E), 7 km outside the village of Vasil'sursk, located at the Volga/Sura confluence about 100 km east of Gor'kiy/Nizhnyi Novgorod in the Gor'kovskiy oblast' of the RSFSR. The transmitter section of the "Sura" installation consists of three commercial "Vyuga" PKV-250 transmitters, each capable of outputting 250 kW of HF power. The antenna system is a 300×300 m^2 array consisting of three individual stearable ($\pm 40°$) subsystems with four 12 element linear arrays of wideband "turnstile" dipoles, covering the $4.5 - 9.5$ MHz band. When operated in parallel the maximum effective radiated power (ERP) is about 250 MW. The antenna is oriented so that the scanning plane of the beam (transmitted and/or received) coincides with the plane of the magnetic meridian at the F region altitude. Besides being used for ionospheric modification experiments the "Sura" facility is also utilised for magnetospheric radar and radio astronomy experiments.

Among the many important discoveries we made in these IRFU/NIRFI experiments we would like to mention the detection of a narrow (≈ 100 Hz) absorption resonance of a certain prominent feature in the nonlinearly generated SEE at the seventh harmonic of the ionospheric electron cyclotron frequency, ω_{ce}, at about 9.4 MHz. Our analysis of this particular feature has shown that the absorption resonance is a manifestation of a cyclotron damping in the upper hybrid layer, i.e. the layer in the plasma where the local plasma frequency, ω_p, and the pump frequency, ω_0, fulfil the relation $\omega_0^2 = \omega_p^2 + \omega_{cc}^2$. This discovery demonstrates, among many other things, that by means of *nonlinear* plasma diagnostics it is possible to determine, from the ground, the magnitude of the magnetic field in this layer with an accuracy that is much higher than with other methods. It also lends strong support for the interpretation of these emissions in terms of the decay of upper hybrid waves into lower hybrid waves and O-mode electromagnetic waves.

Another very important discovery was that the evolution of the emissions proceeds through a number of rather distinct steps. This discovery was possible because we were able, for the first time, to inject the pump *phase coherently* and control its frequency and timing from our own equipment and could therefore perform exact measurements of both the amplitude and the phase of the stimulated emissions and the reflected pump. The preliminary results show that first (about 50 - 100 µs after pump turn-on) the dominating effect is the generation of plasma irregularities near the pump reflection layer. After that, one reaches a stage of weak turbulence within a larger volume around the reflection layer which, after some tens of milliseconds, transcends into strong turbulence (creation of solitons and cavitons). A few hundreds of milliseconds after pump turn-on the processes change to parametric interactions near the upper hybrid layer, whereas after a few seconds they show a chaotic behaviour. Needless to say, this is a much more complicated scenario than predicted by present theories. We believe the rapid changes in phase are due to the nonlinearly generated irregularities that we are studying theoretically, as mentioned above.

Further experiments carried out during the campaign involved very high-altitude, scatter radar investigations of magnetospheric turbulence, the analysis of the dynamic change of the SEE associated with short probing HF pulses in the presence and absence of a continuous heating wave, a detailed analysis of the so called "Broad Upshifted Maximum" at different pump power levels, and measurement of SEE for various oblique angles of pump wave incidence in the F region.

Bo Thidé
Swedish Institute of Space Physics, Uppsala, Sweden.

Prototype ELBBO launched at Christchurch

The prototype "ELBBO" (extended lifetime balloon borne observatory) was launched just before sunrise (0655 NZST) at Christchurch on Thursday, 21st February, 1991.

The ELBBO project is an major international experiment designed to learn more about the electrodynamics of the upper atmosphere and ionosphere. The experiment involves a series of six long duration balloon flights from Christchurch, New Zealand. Scientists from the United States, New Zealand and Brazil have come together to build balloon payloads with instruments which measure the electric field, electric conductivity, VLF wave propagation, X-ray flux, magnetic field, optical lightning and many other parameters. These measurements will be applied to problems of understanding the electric coupling between the solar wind, magnetosphere, ionosphere and atmosphere.

The measurements are being made now because high altitude effects on these parameters are expected to be more easily visible at this time near sun spot maximum than at other times. The ELBBO project is part of STEP (Solar Terrestrial Energy Program) which is sponsored by SCOSTEP. The scientific institutions involved with ELBBO include the University of Washington in Seattle, Washington, the University of Otago in Dunedin, N.Z., the Jet Propulsion Laboratory, Pasadena, California and the Instituto de Pesquisas Espaciais, San Jose dos Campos, Brazil. Flight logistic support including all phases of balloon systems fabrication and the actual balloon launches will be provided by the National Scientific Balloon Facility (NSBF) in Palestine, Texas. The United States part of the ELBBO experiment is jointly supported by both the National Science Foundation (NSF) and by the National Aeronautics and Space Administration (NASA). In Christchurch the launch preparation is being hosted by the NSF Antarctic Program.

The ELBBO project is a direct descendent of an earlier, but similar experiment called EMA — Electrodynamics of the Middle Atmosphere. The EMA experiment involved the launch of a total of eight of the same type balloon to be used for ELBBO. The EMA balloons, as will be the case for the ELBBO balloons, were inflated in the Air New Zealand hangar and launched from the adjacent runway. These flights were conducted in 1983 and 1984 with funding by the same organizations (NASA and NSF) and also included strong participation by the University of Otago.

The ELBBO project is being directed by Robert Holzworth of the Geophysics Program at the University of Washington. The Washington experiment measures three component electric fields ("DC" to ULF) and currents. These will be used to study the effects of solar flares and magnetic storms on atmospheric and ionospheric electrodynamics, of thunderstorms and lightning on the upper atmosphere and ionosphere, and to study the large scale electric current systems in the atmosphere and ionosphere.

Responsibility for the HF telemetry system as well as ELBBO location and velocity measurement (using the VLF Omega network) lies with the Otago team lead by Richard Dowden of the Physics Department at the University of Otago. The Otago wave experiment uses a multichannel VLF receiver to measure the phase and amplitude of ten VLF stations at six frequencies, all simultaneously. These measurements will be used to locate lightning–induced ionisation enhancements (LIEs) of the lower ionosphere. The X-ray detector and magnetic search coil instruments are being provided by Walter Gonzalez and Osmar Pinto of INPE, Brazil.

The extended lifetimes are achieved by using so called superpressure balloons. Unlike most high altitude scientific ballooning (such as recently launched by NASA from McMurdo, Antarctica), superpressure balloons can float in the stratosphere for many weeks or months at a time. This allows the balloons to drift around the world, perhaps several times. While this improves the data sampling, it complicates the logistics of data recovery. We therefore have a dual telemetry system involving data collection by the ARGOS data collection platforms on the Tiros weather satellites in low altitude polar orbit as well as a newly developed high frequency (HF) telemetry system (14 MHz). These systems will allow continuous contact with the balloons anywhere in the southern hemisphere, even over the pole.

When fully inflated at its operating altitude, 26 km, the ELBBO balloon is about 21 m in diameter. The 50 kg payload hangs about 30 m below this and is rotated about the vertical axis at 2 rev per minute. The gondola housing most of the electronic equipment is a 1-m cube made of 75 mm polyfoam, at the centre of the 3-axis E-field dipoles each 3 m long ending in 300 mm diameter spheres. Hanging 16 m below the bottom sphere is the "Zeppelin" fed (quarter-wave line into end-fed half-wave dipole) antenna for HF (13.45 MHz) telemetry. This antenna is also used (even during HF transmission) for VLF reception. The ELBBO is powered by silver-zinc batteries charged by a 1-m^2 array of solar cells. The gondola temperature is designed to be maintained in the range 5° - 25° C using "waste" electrical heat and a non-linear heat diode which can conduct heat from the outside panel to the inside only, and only then if the inside temperature is below 25° C.

The balloons are expected to wander over a wide range of latitudes during the course of a normal lifetime. This makes the experiment politically more sensitive to conduct in the northern hemisphere (because of overflight permissions) and more attractive for the southern hemisphere where there are only a small number of countries expected to be under the balloon trajectories. The balloons are expected to float at an altitude of about 26 km (near 85,000 ft, well above commercial aircraft traffic). The balloon payloads will not be recovered.

Following this prototype launch, the main sequence of the ELBBO project will begin in about 9 to 12 months time when at least five more balloons will be launched within a few weeks so that many will be aloft simultaneously for several weeks.

Traces of the Primordial structure of the Universe—

A workshop held at the Ringberg Castle in Bavaria, FRG

The most widely accepted theory of the origin of the universe is the Big Bang theory coupled with a subsequent inflation of the universe to account for the observed isotropy and homogeneity in the radio background radiation, the so-called 3 K radiation. On the other hand, the mass distribution in the universe is definitely not homogeneous, neither on small nor on large scales. Stars, galaxies, clusters of galaxies and possibly even superclusters of galaxies exist which are not evenly distributed throughout the universe but form distinct structures which so far have not been explored or understood sufficiently.

In even the mere investigation of these structures by simple optical, radio or X-ray observation, one is confronted with the enormous difficulty of overcoming the vast distances in the universe, taking into account its expansion and aging, and getting rid of projection effects which are the result of observing a three dimensional space from one point only. Clearly, measuring redshifts helps distinguish between nearby and far objects, but this is a time consuming and laborious work and has by far not yet been completed for the millions of millions of galaxies in the universe. Yet it is just this kind of work which has recently demonstrated that on the large scale the structure of the universe might be very different from that which is described by the simple inflation model. The nearly perfect and recently established planckian nature of the background radio spectrum on the one hand, and this complicated structure of the universe on the other, are difficult to bring together into one satisfactory picture.

To discuss some of the relevant questions we organized a little workshop, generously supported by the Max-Planck-Society, in early October at the Ringberg Castle in Bavaria. This was the best place we could have chosen for a conference dealing with a subject like the nearly esoteric early structure of the universe: a castle lying at the northern edge of the Alps near the beautiful lake of Tegernsee which formerly was owned by a member of the family of the Bavarian Duke, a rather eccentric man, hunter, lover, supporter of the arts -- not always the best arts -- especially one artist who spent his life with him at this castle painting a huge number of paintings of strange contents: fairy tales, German sagas, erotic scenes. The model we have been told was one of the girls which served at the castle at that time. The castle was finished right during the First World War.

Its style reflects the crazy mind of its owner: romantic, eclectic, mixed together, almost nothing left out. Towers and chapels, large rooms with wooden walls and at the same time carpets hanging from the walls, old huge stoves, wooden ceilings and marble floors, one broad stairs and a couple of hidden stairs etc. About ten years ago when the owner died, the Max-Planck-Society leased the castle and runs it now as its congress centre. It has been reconstructed, a whole new floor has been built. There is room for about forty attendants, the more prominent of which have to sleep in the few but giant and high rooms the former owner used, where the bed can be reached only stepping up two stairs. But the Max-Planck-Society built a very convenient large conference room and added two more discussion rooms. This headshaking atmosphere -- for those who were in Ringberg for the first time -- remote from the work-a-day world, was the environment where about 35 scientists came together to discuss the questions concerning the evolution of the early universe.

Weather in October was gracious: cool but sunny, providing us with the most beautiful view at lake and mountains. Some of the attendees took the opportunity to run up and down the hill to recover from work and the excellent but rich food.

We had planned one week of work and left much time for discussion giving each speaker about one hour of time. This is unusual in workshops and conferences which are normally densely packed with short communications leaving little time for discussion. So a rather relaxed atmosphere was quickly reached, and the participants did not hesitate to present even instantaneous thoughts. In the end everybody was very pleased by the common understanding and left with a luggage full of new ideas and enthusiasm to start new work.

The main subjects of discussion were the relations of redshift and observation of galaxies, clusters of galaxies, and active galactic nuclei — almost everything related to large scale structure in the universe. The extremely precise new measurements of the cosmic radiation background were one of the most acknowledged inputs [Ed: see report elsewhere in this issue]. The other was the prospect of *Rosat*, the German X-ray satellite which promised to observe a large number of remote X-ray sources during the survey phase. Its measurements should enable one to properly determine the X-ray luminosity function of the cluster distribution in the sky, hopefully to allow for insight into the formation of the large scale structure. Correlations with radio sources in the sky should provide some clues for the evolution of clusters.

Theory centred around simulation of the formation of clusters and large scale structure including the dark matter and intracluster gas. Dark matter was shown to provide the basic structure where the galaxies subsequently tend to cluster. But other investigations, mainly redshift measurements for *Iras* clusters, the group of clusters catalogued by the infrared satellite *Iras*, have some excess at large scales which obviously contradicts the cold dark matter model. Cold dark matter therefore seems to be becoming out of fashion. The question was then: What's after cold dark matter? Hot? Baryonic? No baryonic and instead a non-vanishing cosmological constant? Theorists are not very pleased by these prospects, especially not the inflation theorists. Should inflation become obsolete? Wouldn't this make the universe rather boring? How can radio astromomy help? These and other questions remained open. We will have to wait for new and more precise observations as is always the case in a situation like the present one. But it was the general feeling that the new observations might complicate the picture even more and that a really fertilizing new idea is missing.

The workshop ended at the same time as the gracious weather. Next year or so we will have to organize a new and similar workshop to find out the progress achieved in the meantime.

Rudolf A. Treumann
The Radioscientist

Highlights from the *VIKING* Wave Experiment

The high-altitude auroral plasma is collisionless, so that waves produced by plasma instabilities provide the necessary interactions to transfer energy and momentum between particles. The high-time resolution of the wave experiment on board the Swedish auroral satellite *Viking* has revealed the extreme time variability of the wave phenomena taking place in this region. A rich variety of plasma waves has been detected by *Viking* in the key regions of the high-latitude magnetosphere such as the dayside cleft and cusp, and the nightside auroral oval.

These waves include low frequency electrostatic turbulence, electrostatic ion cyclotron waves, lower hybrid waves, VLF waves of various modes (hiss and sporadic broadband noise), electron acoustic waves, Langmuir, upper hybrid, electron cyclotron waves, and auroral kilometric radiation. The waves play an important role in modifying the ion and electron distributions. Indeed, the waves grow by taking energy from the particles and decay by deposing energy into the particles.

Moreover, from the characteristics of the measured waves, it is possible to infer something about the different plasma parameters such as densities of different electron components. For instance, the simultaneous observation of Langmuir waves and electron acoustic waves in the cusp allows one to differentiate the cold and hot plasma components, the latter of ionospheric, the former of magnetosheath origin. It has been possible to demonstrate that during disturbed times with a strongly southward interplanetary field, the density of the magnetosheath-like plasma dominates in the cusp and can reach 500 cm^{-3} at geocentric altitude of 3 R_e. Large magnetic depressions are recorded at the same times.

The *Viking* measurements have shown the importance of localized low frequency (about 1 Hz) electric field fluctuations for energization of both ions and electrons in the dayside cleft and nightside auroral oval. The amplitude of the perpendicular components of these fields can reach several hundred mV/m. In close correlation with the low frequency field fluctuations and on the same time scale (about 1 s), intense and sporadic broadband electrostatic noise (BEN) emissions are recorded. The electric field amplitude of the BEN emissions reaches a few hundred mV/m around the lower hybrid frequency in the 1-kHz range. In addition, sporadic AKR bursts are associated with these structures in the nightside auroral oval. How such structures are produced is not well understood. However, they are common in disturbed regions and may play an important role in accelerating the charged particle component, feeding the magnetosphere with ionospheric warm plasma. These turbulent structures may evolve into double layers. Within the acceleration region it has been possible for the first time to obtain information about the properties of solitary rarefractive structures which appear to be identical with double layers. These solitary waves are propagating upward and are associated with plasma density depressions (up to 50%) and potential changes (of order of 1 V).

Viking observations have also confirmed that the Earth is an intense radio source in the kilometre wave length range and that the generation of this radiation is clearly correlated with the auroral acceleration processes. The maser cyclotron instability is generally acknowledged as the most promising generation mechanism. However, the discovery in the source regions of the AKR by *Viking* of the presence of intense bursts of electrostatic waves associated with electromagnetic bursts on the same time scale may also argue for a mechanism based on the nonlinear conversion of this turbulence into electromagnetic radiation.

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Raymond Pottelette
Centre de Recherches en Physique de l'Environnement, Saint-Maur, France

URSI Scientists Awarded Montefiore Prize

Every five years the AIM (Society of Electrical Engineers graduated from the Montefiore Institute) of the University of Liège, Belgium, organises an international competition for the best recent work in electrical engineering. The topics covered by the competition range from electrical machines to microwave engineering.

The laureates of the 1990 Competition were Dr D. De Zutter and Dr N. Faché from the University of Ghent, Belgium for their general work in "Research in Microstrip Lines" and Dr P. Vas, University of Aberdeen, for his book *Vector Control of AC Machines.*

The work presented by the research team from Ghent consisted of recently published papers in the IEEE *Microwave Theory and Techniques* jour-

nal and in the *Journal of Electromagnetic Waves and Applications*. These papers deal with the full-wave modelling of multiconductor transmission lines in multilayered media. The authors are currently preparing a book on the same topic. This book will be published by Oxford University Press.
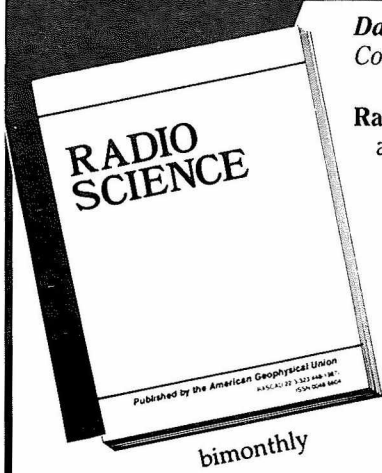
The work of P. Vas has already been published by the same publication house.

Dr De Zutter is Assistant Secretary General of the URSI Committee in Belgium. It is interesting to note that both Belgian laureates are former Young Scientists at URSI General Assemblies, Dr De Zutter in Florence in 1984, Dr Faché in Prague in 1990.

J. Van Bladel
URSI General Secretariate, Ghent.

LETTER

The Future of URSI

One of the great merits of URSI is the relatively unstructured basis upon which it operates. I do not see any reason to make any major changes in its complexion. If anything needs to be done, it is to enhance the international aspects of the union. Thus it may be a mistake to get too close to national societies such as IEEE which are much larger in size and have distinctly different goals.

Personally I believe the URSI role in helping third world countries is most worthwhile. For example, here it would be nice if URSI could publish a third world edition of *RADIO SCIENCE* in say India which would be for sale only in those countries. The present publisher, the American Geophysical Union, might be willing to cooperate on such a venture if it would not undermine their main source of revenue for the journal which is library subscriptions. Another possibility is to encourage bids from third world countries to sponsor specialist meetings such as the open symposia. Individual Soviet republics such as Estonia might fall in this category. Something along these lines occurred in Tbilisi in Georgia in 1971 which was the site for Electromagnetic Theory Symposium as one of the tri-ennial sequence.

One thing I might question is the *Review of Radio Science*, at least in its present format. It seems more bibliographic than informative. Current Contents does almost the same job at very much less effort. If there is a good review paper (e.g. on Fractals in Radioscience), it should be published in *RADIO SCIENCE*. Also the quote system currently adopted for the length of reports per country for the tri-ennial period gives a very lop-sided viewpoint of progress throughout the world.

James R. Wait
2210 East Waverly
Tucson, Arizona 85719 USA

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