WARS02

Workshop on the Applications of Radio Science

CONFERENCE

This Conference was proudly supported by the Australian Academy of Science through the National Committee for Radio Science.

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- CSIRO for underwriting the Conference
- UTS for hosting the WARS02 website
- IPS for producing and funding the Proceedings.

WARS02

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WARS 2002 (WARS02) is the fourth in a series of conferences of national significance organised by the National Committee for Radio Science. It brings together Australian and International scientists and engineers conducting research in areas relevant to the various Commissions of URSI (Union Radio Science International) with which Australia is affiliated through the work of the National Committee for Radio Science. Through the invited speakers program, Australian scientists of international standing review a number of new developments in international radio science in which Australia is a leading player. Submitted papers provided an opportunity for Australian scientists and postgraduate students to present their work to their national peers and in particular, to provide an important opportunity for cross-fertilisation of ideas between the wide range of sub-areas that make up radio science in Australia and internationally.

Each paper was reviewed by at least two independent reviewers. Authors were required to respond to reviewer comments and papers undergoing major revision were sent to referees a second time. Reviewers were issued with guidelines and criteria for publication consistent with those issued by several international journals, premier in their field. For a paper to be accepted for publication, two referees had to be satisfied that it met these guidelines and criteria.

An editorial panel that carried out these tasks was:

- Technical Editor - Phil Wilkinson
- Commission A Editor - Peter Fisk
- Commission B Editor - Geoffrey James
- Commission C Editor - Robin Braun
- Commission D Editor - Le Nguyen Binh
- Commission F Editor - David Noon
- Commission G Editor - Peter Dyson
- Commission H Editor - Brian Fraser
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- Commission K Editor - Ken Joyner

Local Organising Committee (LOC)

- Prof. Robin Braun, Telecommunications Engineering, University of Technology Sydney
- Dr. Geoffrey James, CSIRO Telecommunications and Industrial Physics
- Dr. Phil Wilkinson, IPS Radio and Space Services, Sydney

The National Committee for Radio Science (NCRS) has a moderated electronic mailing list.

- Go to http://www.ips.gov.au/mailman/listinfo to enroll in **ncrs-general,**
- If you want to send a message to other radio scientists in Australia, use the mailing list.

Note: the membership of the mailing list is not intentionally disclosed to anybody outside the NCRS.

Wednesday 20th February			Start	Length	End
Registration			11:00	2:00	13:00
Lunch (Light - sandwiches)			12:30	1:30	14:00
Opening Address	Dr. Phil Wilkinson		14:00	0:15	14:15
Poster Session 1 (plus afternoon Tea)			14:15	1:45	16:00
Discussion Session	Convenor: Dr. Graeme James CSIRO	The Square Kilometre Array (SKA)	16:00	2:00	18:00
Complimentary Drinks			18:00	1:00	19:00
Dinner			19:00	3:00	22:00
Thursday 21st February					
Invited Speaker 1	Professor Brenton Watkins, University of Alaska	A review of the HAARP facility and research program	9:00	0:45	9:45
Invited Speaker 2	Professor Jim Schroeder, University of Queensland	Automatic target recognition using synthetic aperture radar imagery.	9:45	0:45	10:30
Poster Session 2 (plus morning Tea)			10:30	2:00	12:30
Lunch (Barbecue)			12:30	1:30	14:00
Invited Speaker 3:	Prof. Paul Edwards,	The Telstra Tower / University of Canberra Quantum Cryptographic Telecommunications Link	14:00	0:45	14:45
Poster Session 3 (plus afternoon Tea)			14:45	2:00	16:45
Complimentary Drinks			18:00	1:00	19:00
Dinner			19:00	3:00	22:00
Friday 22nd February					
Invited Speaker 4	Dr. Colin Waters, University of Newcastle	Using Commercial Satellite Data for Space Weather Studies	9:00	0:45	9:45
Invited Speaker 5	Dr.Mike Tobar, The University of Western Australia	Microwave Frequency Standards: Tools for Testing the Foundations of Physics in the Laboratory and on board the International Space Station	9:45	0:45	10:30
Poster Session 4 (plus morning Tea)			10:30	2:00	12:30
Lunch			12:30	1:30	14:00

Abstracts for Invited Speakers

Aural Session on The Square Kilometre Array (SKA)

Convenor: Graeme James (CSIRO)

The Square Kilometre Array (SKA) is a proposed centimetre-wavelength radio telescope for studying the early universe with the intention of commencing operations around 2015. It will be enormous in size having an effective collecting area of one square kilometre at 1.4 GHz to give 100 times more sensitivity than any existing radio telescope. As a minimum, the frequency coverage will range from 0.3 GHz to 5 GHz. Multi-beaming is a key factor in the design with many independent dual-polarised beams on the sky at any one time. This momentous challenge requires the expertise of an international consortium in which Australia is playing a significant role. In this session we present an overview of the SKA project and, in particular, show where Australia is making important contributions. Delegates will be given a booklet 'from cogs to connectivity' (which is also to be found on the CD of WARS'02) outlining the engineering aspects of the project.

Further information is available at the web site 'http://www.atnf.csiro.au/ska'.

Topics and Speakers

4.00 - 4.30pm: The Astronomers' View (Dr Carole Jackson, ANU)
4.30 - 5.00pm: A Technological Overview (Aaron Chippendale, CSIRO)
5.00 – 5.15pm: Antenna Options (Dr Graeme James, CSIRO)
5.15 – 5.30pm: Signal Processing Role (Dr Colin Jacka, CSIRO)
5.30 – 5.45pm: The Correlator Challenge (Dr Warwick Wilson, CSIRO)
5.45 – 6.00pm: Interference Mitigation (Daniel Mitchell, CSIRO/USYD)

Speaker 1: A Review of the HAARP Facility and Research Program

Professor Brenton Watkins (ffbjw@uaf.edu), Geophysical Institute, University of Alaska, Fairbanks

The HAARP (**H**igh frequency **A**ctive **A**uroral **R**esearch **P**rogram) facility is a major new observatory for upper atmospheric and ionospheric research. It is located at Gakona, Alaska that provides a wide variety of geophysical conditions, viz auroral, sub-auroral ionospheric trough structures, and mid-latitude type ionosphere. The primary instrument is a high-power, high frequency (2.8 - 10 MHz) phased-array radio transmitter that is used to stimulate well-defined overhead volumes of the ionosphere. The existing HF array consists of 48 crossed dipoles and transmits a total maximum power of 960 kW. Long-term plans call for a final array configuration expanded to a maximum size of 180 antenna elements, arranged in 15 columns by 12 rows with a maximum power of 3.6 MW.

A number of complementary instruments enable the facility to be used as a general ionospheric research observatory as well as supporting ionospheric modification experiments. Scientific instruments currently operating at the site are: a flux-gate magnetometer, induction magnetometer, all-sky riometer, imaging riometer, digital ionosonde, a GPS-based total electron content monitor, VLF/UHF scintillation monitors, broadband VLF receiver, a 139 MHz turbulence-scatter radar, and an optical imager. These on-site instruments are supplemented by (a) an HF backscatter radar at Kodiak, Alaska that obtains data on the occurrence of ionospheric irregularities over a large region of Alaska, including Gakona , and (b) a 50 MHz auroral back-scatter radar at Anchorage, Alaska that may be used to monitor the auroral boundary and its movements.

This presentation reviews the current status of the existing facility and instruments, recent science projects, and future plans for a UHF incoherent-scatter radar that is planned for installation at Gakona.

Speaker 2: Automatic Target Recognition Using Synthetic Aperture Radar Imagery.

Professor Jim Schroeder (schroeder@cssip.edu.au), Cooperative Research Centre for Sensor Signal and Information processing (CSSIP) SPRI building, Mawson Lakes Boulevard Mawson Lakes, SA 5095

Radar imagery enjoys the advantage of independence from a passive illumination source, such as sunlight or starlight, thus offers imaging capability at night and through clouds. Modern day radar imaging systems are capable of comparatively high resolution by utilising synthetic aperture processing methods. The defence requirement is to employ SAR imagery as an aid in finding comparatively small mobile or relocatable targets; the requirement is of course an all-weather one. The need is to detect targets, cue the analyst, classify/recognise targets, and identify targets if possible.

This presentation will address four areas: (i) Target Detection, (ii) Target Discrimination, (iii) Target Classification/Recognition, and (iv) Performance predictions. Examples from several funded R&D studies at CSSIP will be used to illustrate the basic concepts and performance of Automatic Target Detection and Recognition systems.

Speaker 3: The Telstra Tower / University of Canberra Quantum Cryptographic Telecommunications Link

Prof. Paul Edwards, paule@ise.canberra.edu.au, Centre for Advanced Telecommunications and Quantum Electronics Research, University of Canberra

The University of Canberra Free-Space Quantum Cryptographic Key Link (UNCCKL), the first Australian free-space quantum crypto-key distribution facility, was officially opened in Canberra on Marconi Centenary Day, December 12 2001.

The 4.2 km link between Black Mountain Telstra Tower and the University of Canberra campus is the longest in the world. It is being set up as a testbed to investigate and develop high bit rate technologies for the global distribution of quantum crypto-keys by means of low earth orbit satellites.

UNC^{2}KL is a joint venture between the UNSW at ADFA, the Canberra Institute of Technology and the University of Canberra. It is part of a multinational quantum cryptography project involving US, UK and Australian participants.

Speaker 4: Using Commercial Satellite Data for Space Weather Studies

Dr. Colin Waters (colin.waters@newcastle.edu.au), University of Newcastle

Field aligned currents (FACs) flowing into and out of the polar ionosphere and the high-latitude electric potential pattern are important features of magnetosphere-ionosphere coupling. The associated Poynting flux leads to Joule heating of the high-latitude atmosphere and ionosphere. Estimating the global Poynting flux is challenging as it requires knowledge of both the electric and magnetic perturbation fields over a large area. By combining data from the Super Dual Auroral Radar Network (SuperDARN) and the Iridium satellite constellation, global maps of Poynting flux from in situ data are obtained. SuperDARN provides Doppler velocity measurements that allow the ionospheric electric field to be estimated. The engineering magnetometers on the Iridium satellite constellation provide FAC induced, magnetic perturbation data. Using experimental data driven, spherical harmonic expansion methods, the electric and magnetic perturbations are combined to give the global Poynting flux for any magnetic local time and any latitude down to 60 degrees geomagnetic. The time resolution is limited by the Iridium data and is about one hour. A number of examples show the spatially integrated power to be around 50 GW into the polar ionosphere for average conditions. Both afternoon and early morning enhancements in Poynting flux are seen to be localized around 70° geomagnetic latitude, close to maxima of the region 1 FAC system.

Speaker 5: Microwave Frequency Standards: Tools for Testing the Foundations of Physics in the Laboratory and on board the International Space Station

M. E. Tobar[1] (mike@physics.uwa.edu.au, www.physics.uwa.edu.au/~mike/, www.fsm.physics.uwa.edu.au/), J. G. Hartnett[1], E. N. Ivanov[1], C. R. Locke[1], A. N. Luiten[1], Ch. Salomon[2] , N. Dimarcq[3] , M. Abgrall[4] ,A.Clairon[4], P. Laurent[4], P. Lemonde[4], G. Santarelli[4],P.Uhrich[4], L.G. Bernier[5], G. Busca[5], A. Jornod[5], P. Thomann[5], E. Samain[6],P.Wolf[7], F. Gonzalez[8], Ph. Guillemot[8], S. Leon[8], F. Nouel[8], Ch. Sirmain[8], S. Feltham[9]

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[4]Laboratoire primaire du temps et des fréquences, observatoire de Paris, 61, avenue de l'Observatoire, 75014 Paris, France.
[5]Observatoire cantonal de Neuchâtel, rue de l'Observatoire 58, 2000 Neuchâtel, Switzerland.
[6]Observatoire de la Côte d'Azur, 2130, route de l'Observatoire, 06460 Caussols, France.
[7]Bureau international des poids et mesures, pavillon de Breteuil, 92312 Sèvres cedex, France.
[8]Centre national d'études spatiales, 18, avenue Edouard-Belin, 31402 Toulouse, France.
[9]European space agency/ESTEC, Keplerlaan, 2200 AG Noordwijk, The Netherlands.

Two major tasks in fundamental physics are the quantization of gravity and the unification of all interactions. All approaches to achieve these tasks lead to deviations from present day physics. For example, violations of the Einstein's Equivalence Principle are possible. Some violations may manifest as spatial and/or time variations of the fundamental physical constants, and recently attempts to measure these effects have gained considerable attention. One of the most precise tools for testing these theories is the time or frequency standard (clock). This paper discusses the application of microwave frequency standards to testing the foundations of physics. This includes start-of-the-art experiments proposed for both the laboratory and in space. For example, the Atomic Clock Ensemble in Space (ACES) mission, will be launched in 2005 to perform experiments in the micro-gravity environment of the International Space Station. Current plans and future possibilities for Australian participation will be presented.

Commission A

A.1 Microwave Properties of Ultra-Low Loss Chromium-Doped YAG

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The microwave properties of a cylindrically cut single crystal of chromium-doped yttrium aluminum garnet ($Y_3Al_5O_{12}$:YAG) were determined between 6 K and room temperature. It exhibited very strong microwave losses near 15.3 GHz at room temperature and 15.5 GHz at 77 K. The mechanism producing the losses was found to follow standard Curie law behaviour below 30 K. In combination with the thermal expansion of the material the magnetic characteristics produced turning points in the mode frequency-temperature dependence at 60 K. Analysis showed that the Cr^{3+} doping into the dielectric lattice resulted in an anisotropic static paramagnetic susceptibility, which was resolvable at temperatures below 77 K. Two excited state energy levels were confirmed, equivalent to 0.76 K and 29 K above the ground state. The lifetime of the excited state was found to be very temperature dependent and below 100 K was dominated by Raman scattering.

A.2 Split Post Dielectric Resonators for Measurements of the Complex Permittivity of Laminar Dielectric Materials at Microwave Frequencies

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Split-post dielectric resonators operating at frequencies 1.4-30 GHz were used to measure complex permittivity of standard reference dielectric materials with known dielectric properties previously measured by other techniques. It was proved experimentally that using split post resonators it is possible to measure permittivity with uncertainty of 0.3% and dielectric loss tangent with resolution of $2x10^{-5}$ for well-machined laminar specimens. Applications of split post dielectric resonators for measurements of ferroelectrics and thin film materials were highlighted

A.3 Michelson Morley Experiment using Spherical Resonators

Michael E. Tobar (mike@physics.uwa.edu.au), James D. Anstie, and John G. Hartnett (john@physics.uwa.edu.au)

Spherical resonators are proposed for new highly sensitive Michelson-Morley experiments. Two modes with orthogonal propagation directions are identified for this purpose: 1. Whispering Gallery modes, which propagates like a ray along the equator of the sphere: 2. Whispering Longitude modes, which propagates as azimuthal wave fronts in the longitudinal direction. If the beat frequency between the modes is measured as the experiment is rotated, we show how to choose the axis of rotation in the laboratory frame to obtain maximum sensitivity to violations of Special Relativity.

A.4 RF and Microwave Power Calibrations at the National Measurement Laboratory (NML), CSIRO

Tim Zhang, (Tieren.Zhang@csiro.au)
CSIRO Division of Telecommunications and Industrial Physics, P O Box 218, Lindfield, NSW 2070

The RF and Microwave Group at CSIRO, National Measurement Laboratory, has responsibility to maintain and disseminate RF and Microwave standards. The RF and microwave power calibration service will be briefly described in this poster.

A coaxial microcalorimeter has been established at NML to provide a national primary standard measurement facility, which is used for calibrating RF and microwave reference power sensors.

The six-port measurement technique has diverse applications such as reflectometer, automatic S-parameter network analysis, and power measurement. Power sensor calibrations are mainly conducted using automated six-port networks.

Three six-port networks have been implemented to provide power calibrations from 1 GHz up to 40 GHz.

New automated power calibration procedures using splitters are being developed.

Commission B

B.1 A Broadband Singly-Fed Electromagnetically Coupled Patch Antenna for Circular Polarisation

Kwok L. Chung (klchung@ieee.org) and Ananda S. Mohan (ananda@eng.uts.edu.au), Faculty of Engineering, Telecommunications Group Cooperative Research Centre for Satellite Systems University of Technology, Sydney1 Broadway, Sydney, NSW 2007, Australia

Traditional single layer singly-fed circularly polarised (SFCP) microstrip patch elements are classified as Type-A and Type-B in the literature according to the polarity of perturbation. SFCP antenna has the advantage of low cost and high efficiency, but achieves narrow bandwidths at lower microwave frequencies. Circularly polarised electromagnetically coupled patch (EMCP) antennas have also been the focus of many studies owing to the extra degrees of freedom. In this paper, we present a novel 2.4 GHz SFCP patch antenna, which is an evolution of Type-A element, is based on the EMCP concept. The optimum impedance (VSWR≤2), axial ratio (≤3dB) and gain (≥8dBic) bandwidth are measured as 22%, 4.6% and 24% respectively. The peak gain is recorded as high as 10.5 dBic at 2.55 GHz whilst the mean gain level as 9.2 dBic over the gain bandwidth. These measured results show that the proposed antenna has significant improvements over the existing designs in the literature.

B.2 Double Ridged Orthogonal Mode Transducer for the 16-26GHz Microwave Band

Alex Dunning (alex.dunning@csiro.au)

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The design, construction and performance of a double ridged Orthogonal Mode Transducer is described. The factors influencing the design are discussed, in particular the excitation of the TE11 mode and the effect it has on broadband performance. The OMT is shown to exhibit low insertion loss and good isolation across the full 16-26GHz band.

B.3 Optimization of corrugated horns radiation patterns via a spline-profile

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Corrugated horns are widely used as feeds for reflector antennas or as direct radiators, as in global earth illumination from a satellite or source antenna in an anechoic chamber. Shaping the radiation pattern of a corrugated horn is mainly done by shaping the profile, and to a lesser extent, for wide-band applications, by using a mode-converter tuned to the design frequency.

In the literature, the profile of corrugated horns is optimised either by using known information on the effect of conventional profiles or by combining some of these profiles. Some authors report successful optimisation using as parameters the profile and/or slot-depths of each corrugation.

In this paper, we define the profile of a corrugated horn as a spline and optimise the radiation pattern by shaping the profile. A computer program has been written to optimise the profile to meet a specified radiation pattern.

B.4 The fundamental limit of small antenna bandwidth - how it affects small GPR antennas

C.J. Leat, leat@cssip.uq.edu

University of Queensland, Queensland

A numerical implementation of the Chu fundamental limit for small antennas was used to reveal that above typical ground materials, GPR antennas may be reduced to 65% of the size of free space antennas before the small size seriously constrains the bandwidth or efficiency.

B.5 The design and simulation of wire antennas using Ansoft's High Frequency Structure Simulation (HFSS) software

M. Ozerova, (marina.ozerova@dsto.defence.gov.au)

Wire antennas, required for specific defence applications, have been modelled using Ansoft's High Frequency Structure Simulation (HFSS), a new interactive software package based on the finite element method (FEM). The simulated electromagnetic response of these structures is presented and discussed. It is demonstrated that HFSS is a powerful software package that has widespread application in antenna design.

B.6 Microstrip Circuit Analysis using the New Closed-Form Green's Functions

Yuehe Ge and Karu P. Esselle (karu@ics.mq.edu.au)

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Abstract—An efficient full-wave spatial domain numerical method is presented for the analysis of multilayer microstrip structures using new closed-form Green's functions in conjunction with the method of moment (MoM). This method solves the mixed potential integral equation (MPIE) for the surface current density on the microstrip. Using the new closed-form Green's functions and selecting roof-top functions as both basis and testing functions, one can derive closed-form expressions for the matrix elements involved in the MoM and improve the computational efficiency significantly without compromising the precision. The results from the new method agree well with the results from alternative methods.

Commission C

C.1 A frequency-scanned slotted waveguide array sensor for detecting W-band emissions

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EWD DSTO, PO Box 1500 Edindurgh 5111, South Australia

A frequency-scanned slotted waveguide array for detecting W-band thermal emissions via an acousto-optic Bragg cell receiver has been developed. This paper considers its design and fabrication.

The geometrical parameters of the slotted waveguide determine the frequency scanning characteristics of the array, These parameters are optimised for detecting a 9 GHz band centred on 94 GHz. Silicon dielectric waveguide has been considered because it allows the RF band to scan wider angular fields of view than metal WR-10 waveguide would permit. The waveguide size has been optimised for single mode (E_{11}^{y}) wave propagation and the slot spacing chosen such that broadside radiation occurs at the band's centre frequency.

A practical implementation of this design has been modelled. The electromagnetic response of this structure has been simulated using Ansoft's High Frequency Structure Simulator (HFSS), a frequency-domain Finite Element Method (FEM) software package, and the results of this analysis are discussed.

C.2 Digital Communication Filter Design by Stochastic Optimization

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The subject of this work is to analyze the behavior of high-speed digital QPSK modulated communication channels in the presence of the Additive White Gaussian Noise (AWGN) and Inter Symbol Interference (ISI). The high frequency of the carrier in this application makes digital filtering rather difficult, thus an analogue filter was suggested for the receiver. The paper deals with the problem matching the filter to the signal for best performance.

C.3 Licensing of Experimental Apparatus with Radio Emissions up to 420 Thz

ACA Presentaion, Radio Frequency Planning Group, Australian Communications Authority,
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Several flexible licensing provisions, made by the ACA under the Radiocommunications Act 1992, facilitate the use of the radiofrequency spectrum for experimental development work.

This presentation provides information targeted at scientists and engineers concerning:

- Interference management and the general requirements under the Radiocommunications Act;
- Licence Types: Apparatus versus Class versus Spectrum licensing;
- Class Licence: Low Interference Potential Devices (LIPD), Infrared Devices etc...
- Apparatus Licence: The Scientific (assigned versus non-assigned) licence types;
- If I need a radiocommunication licence, which one do I choose and how much does it cost?;
- How & where to apply. What information is needed for an application?;
- How to find further information.

C.4 Measurement of Building Shielding at 11GHz in the Australian Urban Environment.

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Radio Spectrum Research Group (RSRG), University of Canberra.

Previous RSRG work on analysing system deployment has demonstrated the sharing potential between the Fixed Service (FS) and the Fixed Satellite Service (FSS) in the 11GHz (10.7 – 11.7GHz) Band. The paper, however, assumed up to a maximum of 22dB of shielding in the study. There is then a need to conduct a measurement campaign in the 11GHz band to validate the assumptions made in this paper.

The goal of the measurement campaign is then to characterise additional attenuation introduced when an 11GHz radio wave is shielded by a building. Specifically, these shielding losses due to buildings are characterised as a function of receive angle and building material.

The findings of this measurement campaign provide a reasonable estimate of the average attenuation due to building shielding and terrain clutter in the Australian urban environment. With a range of 20 to 35dB, the measurements validate the assumptions that were made in previous work, where up to a maximum of 22dB of shielding was assumed.

C.5 THE TROUBLE WITH MICROWAVE TRANSISTORS AND HOW TO AVOID IT

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Microwave transistors, both HEMT and MESFET in either GaAs or InP, have characteristics that vary with both operating condition and frequency. A simple structure to this otherwise complicated dynamic behaviour of the FETs is revealed by large-signal pulse and small-signal RF measurements. These variations can be explained in terms of thermal effects and trap-related effects. The intrinsic gain, over frequency and bias, is proposed as an indicator of the impact on signals and distortion generation. An understanding of this is necessary in using these devices.

C.6 YOUR FINGER ON THE PULSE OF MICROWAVE TRANSISTORS

Anthony E. Parker[1] (tonyp@ieee.org), James G. Rathmell[2] (jimr@ee.usyd.edu.au) and Peter S. Blockley[2]

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Modern microwave FETs and short-channel MOSFETs are rate dependent in that their characteristics vary with bias and frequency. Without pulse testing, characterising these devices is like finding the end of a rainbow. Pulsing works by establishing a bias during long periods between pulses. Rate dependency of the device is observed during each pulse.

The Arbitrary Pulsed Semiconductor Parameter Analyser represents the state-of-the-art in pulse testing. It provides arbitrary pulse trajectories with full control over all aspects of pulse timing, utilises an unique floating current and voltage sampling system that ensures accuracy in the fine detail, and features the ability to measure and tag data in the time domain.

Rate dependence raises the issue of variations over a range of signal frequencies. How does this variation affect signal integrity? Is there an influence on distortion parameters, spectral regrowth, IP3, ACPR? Pulse testing can help answer these questions.

C.7 Evolution from GSM to 3G

Dr Kumbesan Sandrasegaran (kumbes@eng.uts.edu.au)

Telecommunication Group, Faculty of Engineering, University of Technology Sydney

In this poster, we will look at some of the important issues pertaining to the evolution of mobile communication networks from GSM (Global System for Mobile Communications) to GPRS (General Packet Radio Service) and to 3G (Third Generation). Some network operators may also choose to implement HSCSD (High Speed Circuit Switched Data) or EDGE (Enhanced Data Rate for GSM Evolution) in this evolutionary process. Other operators may choose to miss these steps.

This evolution will manifest in the form of new techniques for modulation, multi-access, multiplexing, radio resource management, mobility management, traffic management, parallel circuit and packet switched networks, compression, ciphering, authentication, handover, roaming, switching and transmission technologies, communication protocols, user terminals, services, etc.

C.8 An Application Of A Generalised Jakes Model For Mimo Channels

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Jakes model for frequency nonselective fading processes is often used as a channel model in wireless applications where the propagation environment is characterised by rich-scattering. The model is extended so that it can be more appropriately applied to a space-time Rayleigh fading multiple-input multiple-output (MIMO) channel. Thus the fading channel distortions can be modelled. In applying the model to a conventional four transmit and two receive (4,2) MIMO radio channel with differential space-time modulation used over the channel, general trends emerge showing the effects of frame length in rapid differential decoding. Useful engineering guidelines and insights can be developed from applying this trend.

C.9 Mass-Producible E-Plane Millimeter Wave Filters

Stephanie Smith (Stephanie.Smith@csiro.au),

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An E-plane filter has been designed for manufacture using low cost mass-producible manufacturing methods. This paper discusses the issues related to diecasting the waveguide filter halves. A filter suitable for LMDS applications was designed and optimised using a mode matching technique. Modelled results from HFSS are presented along with measurements.

Commission D

D.1 Fibre Mode-Locked Lasers at 10GHz and 40GHz Repetition Rate

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Mode-locked fibre lasers offer a number of advantages as compared with their integrated semiconductor counterparts such as high average optical output power, adjustable repetition rate, flexibility of control of pulse width etc. As ML fibre lasers are constructed from discreet optical components, it is therefore possible to integrate an optical-RF self-adaptive feedback for self-locking that would provide long-term stability and minimise amplitude and phase noises of the generated optical pulse train.

This paper gives a detailed account, for the first time, of the design, construction and characterisation of an ultra-stable mode-locked mode locked fibre ring laser proven to be practically feasible for ultra-high speed optical communications systems and networks.

The implemented ML laser structure employs in-line optical fibre amplifiers, a guided wave optical intensity Mach-Zehnder interferometric (MZI) modulator and associate optics to form a ring resonator for generating optical pulse trains of several GHz repetition rate with pulse duration whose pulse width is in order of a few pico-seconds.

Long term stability of amplitude and phase noise obtained indicates that the optical pulse source can be error-free in a self-locking mode for more than 20 hours. This would be suitable for laboratory use. Further evaluation of the stability of the mode-locked laser is needed for field deployment such as stabilisation and control of DC drift of the bias voltage of the MZI modulator. A mode-locked laser operating at 10 GHz repetition rate has been designed, constructed and packaged. The laser generates optical pulse train of 4.5 ps pulse width when the modulator is biased just below the phase-quadrature quiescent point. Preliminary experiment of a 40 GHz repetition rate mode-locked laser has also been conducted, although still unstable in long term, without an opto-electronic feedback loop, optical pulse trains have been observed.

D.2 Ultra-broadband integrated interferometric optical modulators

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Integrated optical modulators operating at multi-GHz region are critical for Tera-bps optical communications systems and networks. This paper describes a simple, efficient and accurate analysis of the travelling wave electrodes for high-speed optical modulation and the implementation of these electrodes in interferometric optical modulators for broadband operation in the microwave and mm-wave region. Such integrated optic modulators are formed with an inteferometric optical waveguide structures in which one arm of the interferometer is phase modulated with a travelling electrical electrode.

A finite difference approach is used for modelling the travelling wave electrodes for efficient electro-optic interaction in interferometric optical modulators. UV lithographically fabricated electrode configurations such as symmetric and asymmetric co-planar waveguide or strip structures can be modelled. Simulated results demonstrate the efficiency of the presented method are compared with ones obtained by other methods such as the Green's function, conformal mapping, method if images, spectral domain analysis etc.

Tilted and thick practical electro-plated electrodes are modelled and confirmed with implemented modulators operating up to 26 GHz in diffused $LiNbO_3$ optical interferometric optical waveguide structures. The fabrication of optical waveguides and travelling wave electrodes are described for implementation of the electro-optic interferometric modulators.

D.3 A Simulation Platform for Single and Multi-Channel Transmission Systems in Frequency Domain Using Volterra Series Transfer Functions

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We present a novel simulation model for optical communication systems in which single or multi- optical channels can be transmitted without divergence due to optical nonlinear effects. The Volterra Series Transfer Function (VSTF), represented by functional series, is used to obtain analytic solution of the Nonlinear Schrondinger (NLS) wave equation which represents the evolution of optical data pulses along the transmission fibre. The radius of convergence of the VSTF model is critical for the model and is described. Simulated results are compared with those using the well-known split-step Fourier method confirms the model efficiency and accuracy for optical pulse transmission.

D.4 Microwave Measurements of Dielectric Materials at Varying Temperatures

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James Cook University

While designing communications filters we need to know accurately microwave properties of dielectrics used. At James Cook University we developed a system for accurate measurements of ε_r and tanδ of low loss dielectrics using the Hakki-Coleman and Split post resonators in temperature range down to 25 K.

D.5 Transmission Mode Q-Factor Software

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Accurate measurements of Q_o-factor are necessary for characterization of materials for wireless applications. A TMQF technique, developed at James Cook University, removes effects of noise, non-calibrated cables, connectors, coupling structures, crosstalk and impedance mismatch from measurement data giving accuracy better than 1% for Q from 10^3 to 10^6.

D.6 Measurements of Surface Resistance of Superconducting Materials

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Superconducting filters exhibit low IL and NF due to low surface resistance. A Sapphire rod resonator is used for accurate measurements of R_s of YBCO on LAO and MgO at 10, 17 and 25 GHz from 13 K to room temperature at power levels from –50 dBm to +30 dBm.

D.7 Microwave Chemical Processor

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The CSIRO Division of Telecommunications and Industrial Physics in conjunction with CSIRO Division of Molecular Science has constructed and patented a device to assist in the processing of chemicals. This device called a *Microwave Chemical Processor* has the ability to reduce reaction times and improve the yield of the final product. Three prototype units have been constructed and installed in Australia, Germany and Sweden.

The unit is a stand-alone device with safety interlocks and a self-contained fume cupboard. It is built around a stainless steel cavity designed to withstand the stresses generated when heating chemicals to about 260 degrees Celsius and associated pressures of 10 MPa. Chemicals to be processes are contained in a PTFE cup and maybe stirred via a magnetic stirrer bar. Facilities to measure the temperature and pressure are provided, as is a system for sampling the contents. Rapid cooling of the contents is also possible.

D.8 Unbounded solitonic channels in media with competing third- and fifth-order nonlinearities

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This paper summarizes the theoretical studies on the dynamic propagation, in particular the scenario for stability, of spatial solitonic channels, both types of "grey" and bright with non-zero background intensity (unbounded), in optical media in which the third- (Kerr) and fifth-order nonlinear effects are significant and compatible. The stability of the channels depends on both the initial launched solitonic channels and the relative strength between these nonlinear effects. It has been demonstrated, as usually observed for solitary waves, that the initial amplitude and phase of the launched solitons dictate the splitting, diffraction and oscillation of the propagated "grey" or unbounded bright nonlinear beams. The nonlinear Schrödinger wave equation and the specific initial conditions for the spatial propagation of the two cases are outlined and graphical illustrations of the evolutions of the unbounded solitonic channels are presented.

Commission F

F.1 THE ITU-R AND RADIOWAVE PROPAGATION

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The growing demand for new services and higher data rates in existing services, the trend towards ubiquitous mobile voice and data systems, and the convergence of communications and computing networks are placing unprecedented demands on the use of radio frequencies. The research community should ensure that the management and regulation of the spectrum is based on sound technical advice, not only to provide adequate spectrum for radio science interests, but more generally to guarantee that radio remains an efficient and viable communications medium. This poster describes the International Telecommunication Union (ITU-R), and its technical work which depends upon research studies. New telecommunication techniques and systems require new radio propagation information, especially for non-geostationary satellite-to-Earth paths, short-range propagation within buildings, long-range propagation into buildings and vehicles, atmospheric ducts, and the influence of climate and ionospheric parameters on propagation modelling in general. Please contact local ITU-R representatives if you have such data.

F.2 Impact of elevated atmospheric structures upon radio-refractivity and propagation

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Analysis of radiosonde data simultaneously acquired from widely separated Australian ground stations on 13 March 2001 indicates that a typical subsidence duct created by the motion of a high pressure cell might possess a lateral spread of hundreds of kilometers and could persist for a time interval exceeding 24 hours. Propagation simulations utilizing the two-dimensional parabolic equation model have predicted that radio propagation from a transmitter located within the core of such a duct will exhibit substantial spatial regions of signal depletion (radio holes) of magnitude 20dB or greater, as well as possible regions of signal enhancement. These effects are manifested at ranges from the transmitter of tens of kilometers.

F.3 Implications of the evaporation duct for microwave radio path design over tropical oceans in Northern Australia elevated atmospheric structures upon radio-refractivity and propagation

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Examples of evaporation duct height statistics for coastal and oceanic waters in the North of Australia are presented. The range in duct height variation measured in coastal waters beckons further investigation of the effects of the evaporation duct on fixed link performance. Fixed link design issues are addressed in the context of the tropical evaporation duct and a suggestion made so that designers may avoid interference problems resulting from anomalous propagation inside the duct.

F.4 Propagation at 10.6 GHz over a long path in the tropical evaporation duct.

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Much work is being undertaken on the characterisation of the evaporation duct above warm tropical oceans in Australia. This work is being carried out jointly by the University of Canberra's Radio Systems Research Group (RSRG), The Defence Science and Technology Organisation (DSTO) and James Cook University.

Previous work has established the average height of the duct and diurnal changes in the duct in various climatic conditions and seasons. Propagation at 10.6 GHz over a 20-km path has also been measured. This paper describes an experiment over a very long path of 72.2 km using a very low transmit antenna height (4 meters) and a receiving array ranging from 3.6 m AMSL to 11.7 m AMSL.

Analysis of received signal strength along with weather conditions is presented along with an analysis of anomalous received signal strengths and suggestions for causal effects. This data is compared to the AREPS model produced by the US Navy SPAWAR Centre and conclusions are drawn for this path and for further work.

F.5 SLOPE STABILITY RADAR FOR MONITORING MINE WALLS

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Slope stability is a critical safety and production issue for coal mines. A common technique to determine slope stability is to monitor the small precursory movements, which occur prior to collapse. The "slope stability radar" has been developed to remotely scan a rock slope to continuously monitor the spatial deformation of the face. Using differential radar interferometry, the system can detect deformation movements of a rough wall with sub-millimeter accuracy, and with high spatial and temporal resolution. The effects of atmospheric variations and spurious signals can be reduced via signal processing means. The advantage of the slope stability radar over other monitoring techniques is that it provides full area coverage without the need for mounted reflectors or equipment on the wall. In addition, the radar waves adequately penetrate through rain, dust and smoke to give reliable measurements, twenty-four hours a day.

Commission G

G.1 Scintillation Response of Global Positioning System Signals During Storm Time Conditions.

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A principal method of studying low latitude ionospheric irregularities is through the observation of radio wave scintillation. The Global Positioning System (GPS) provides an ideal way of measuring scintillation effects as the signals are continuously available and can be measured along many paths through the atmosphere simultaneously. A single frequency GPS receiver utilizing the L1 (1.57542 GHz) signal was used to measure both amplitude and phase variations during the geomagnetic storm of 22 September 1999. The receiver was based at the southern equatorial anomaly station Vanimo (2.4^0S geographic latitude) in Papua New Guinea. Suppression of scintillation was observed prior to maximum excursion of Dst, while enhanced activity occurred during the recovery phase of the storm.

G.2 Ionospheric Propagation Modes Identified using the TIGER HF Radar

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The Tasman International Geospace Environment Radar (TIGER) is a High-Frequency (HF) radar that probes the ionosphere between Tasmania and Antarctica. Its main purpose is to detect direct backscatter from ionospheric irregularities, but it also detects echoes from signals that are reflected from the ionosphere down to the sea, and backscattered so they return to the radar again via the ionosphere. The occurrence characteristics of these sea echoes can be used to study the HF propagation modes being supported by the ionosphere. This information can then be used to examine the accuracy of ionospheric models used to predict HF propagation characteristics for HF users. This paper describes observations made by TIGER during Spring 2000, and compares them with ray-tracing simulations based on the International Reference Ionosphere.

G.3 The Buckland Park Meteor Radar – Description And Initial Results

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A new all-sky interferometric broadband radar system has been developed and installed at the Buckland Park field site of Adelaide University. A description of the radar system is presented, along with the details of the experiment and analysis techniques. Initial results are presented, indicating the radar produces count rates between 5000 and 6000 per day.

G.4 A Real-time Ionospheric Model

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An accurate real-time model of the ionosphere is needed for coordinate registration of targets in an over-the-horizon radar. Day to day variability can be tracked both spatially and temporally. This is useful, not only for locating targets in ground coordinates, but for looking at real-time phenomena such as ionospheric storms and TIDs. A method for constructing a stable, accurate, real-time model of the ionosphere is presented. Ionograms were collected through a network of Vertical Incidence Sounders in the Northern Australian region in early December. This data was used as input for the model, creating a 4-dimensional map of ionospheric plasma frequency. Its accuracy can be gauged by comparing real oblique ionograms with synthetic obliques derived from the map. An animation of a selection of data from the real-time model is shown.

G.5 Medium-Scale Travelling Ionospheric Disturbances Studied With The TIGER HF Superdarn Radar

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A cross-spectral Fourier transform method has been applied to TIGER HF radar observations to determine propagation velocities of medium-scale travelling ionospheric disturbances (MSTIDs). Observations of numerous MSTIDS during a 12-day winter interval showed consistent MSTID propagation directions during the day which changed from northeast to northwest around 0500 UT (~1500 Magnetic Local Time). It is suggested that this change was related to fore- and after-noon maxima in the distribution of field-aligned currents flowing from the magnetosphere to the ionosphere, and that these two regions were sources of atmospheric gravity waves (AGWs) due to Joule heating caused by the subsequent horizontal currents flowing in the E region. It is speculated the change in propagation direction was also controlled by thermospheric neutral winds Doppler-shifting the AGWs in proximity to the source regions.

G.6 Doppler Ionosonde Observations of Ionospheric Movement

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The KEL IPS71 ionosonde has the ability to record rapid high-resolution Doppler ionograms. Observations of three types of ionospheric phenomena made possible with this ionosonde are shown. The first is a virtual velocity map of vertical motion in the ionosphere derived from 5 minute sampling and associated values h'F1, hpF2, foE, foF1 and foF2. The second is the occurrence of sporadic E with non-spread and spread Doppler characteristics with associated fxEs and h'E. The third consists of snapshots of short-period TIDs observed simultaneously in Doppler as well in the usual h'/ frequency plots.

G.7 Investigation of different digital implementation methods for the TIGER radar receiver

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This paper compares different techniques for digital implementation of the receiver section of the TIGER radar. Three methods are compared: the normal Direct Conversion method, the IF under sampling method and the RF sampling method. Differences in performance, required resources and noise effects are presented. The number of significant bits required by each method is also considered. Some simulation results using SPW are provided.

G.8 Application Of Riometers In Space Weather

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The application of riometry in HF radio communication and radio science has been reviewed in this presentation. Basic principles of riometry are discussed along with a brief description about the operation of riometers. The superiority of riometry over pulse reflection method under high absorption conditions has been established by analyzing a Polar Cap Absorption event. New applications of riometers have been suggested at the end of the presentation.

G.9 Diurnal, Seasonal, And Geomagnetic Activity Variations In The Occurrence Of Decametre-Scale Irregularities In The Auroral And Subauroral Ionosphere

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The Tasman International Geospace Environment Radar (TIGER) is a SuperDARN HF backscatter radar located on Bruny Island, Tasmania (147.2°E, 43.4°S geographic; –54.6°Λ). HF backscatter radars obtain echoes when the obliquely propagating radio waves achieve normal incidence with magnetic field-aligned irregularities of decametre scale size forming in association with irregularities of scale size 100 m to 1 km. We report the occurrence statistics of nightside auroral and subauroral ionospheric echoes derived from all the normal scan beam 15 soundings made during the one-year interval December 1999 to November, 2000. These sunspot maximum results were sorted into bins of universal time, range, season, and K_p index. The observed variations can be explained by the combined effects of changes in radar operation, changes in the prevailing propagation conditions (including *D*-region absorption and the preferred ranges for backscatter from field-aligned irregularities), and changes in the production and movement of decameter-scale irregularities in the nightside auroral oval controlled by geomagnetic activity and ionospheric conductivity in the radar field-of-view and conjugate ionosphere.

G.10 Evaluation of Heterodyning And Interpolation For Signal Generation Of TIGER Transmitter

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The Tasman International Geospace Environment Radar (TIGER) is a high latitude ionospheric radar monitoring a region of the ionosphere south of Australia. Currently we are designing a second radar using the digital technology and reconfigureable devices as replacement for the traditionally analogue transmitter, phasing matrix and receiver of the radar. A method for the digital generation of a Gaussian modulated signal using multirate techniques has previously been presented [1]. In this paper, two implementations of the digital signal generation is discussed, one using FIR implementation and the other using polyphase interpolation. These methods differ from conventional analog heterodyning techniques through the use of time variant signal processing for frequency translation. We compare these two techniques, considering different performance parameters including computations and non-linear effects on system performance

G.11 Synoptic measurements of GPS link behaviour in the equatorial region

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We describe synoptic measurements of the effects of ionospheric scintillation on GPS links in the equatorial region during solar maximum years, paying particular attention to the number of links affected at different threshold levels of amplitude scintillation, and to the number of links remaining below each scintillation threshold. The daily occurrence of loss-of-lock events throughout the year is also examined. Data from Ionospheric Scintillation Monitors located at a selection of receiving stations in the South East Asia and Oceania regions are employed in the analysis.

G.12 Evaluation of Digital Generation and Phasing Techniques for Transmitter Signals of the TIGER N.Z. Radar

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In this paper we present a proposal for the digital evolution of the TIGER SuperDARN radar. Just as the digitisation of consumer products, such as mobile phones, has lead to enhanced features and flexibility, a digital SuperDARN radar will offer improved performance, greater adaptability and new features providing benefits to ionospheric research. The system we propose for the next generation TIGER transmitter signal generation chain uses fully digital technology to produce sixteen Gaussian shaped, RF, phase referenced pulses, for delivery to a sixteen-antenna array, using only a single clock reference. Different techniques using a variety of DSP structures, including a variable RF generator, and multi-rate processing and shaping filters, have been investigated for their appropriateness for implementation in FPGA technology. The system offers many cost and manufacturing advantages over current techniques which use a separate frequency synthesiser, delay lines and complex control circuitry to generate the phased pulses for the antenna arrays.

G.13 Use Of GPS Signals To Study Total Electron Content Of The Ionosphere During The Geomagnetic Storm On 22 September 1999.

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The ionospheric storm evolution process was monitored during the September 22-24, 1999 magnetic storm over the Australian region, through measurements of the ionospheric total electron content (TEC) from five GPS stations. The spatial and temporal variations of the ionosphere were analysed as a time series of TEC maps. All the maps presented in this paper are 15-minute averages of TEC. Storm positive and negative effects on temporal and latitudinal changes in TEC were investigated. Possible error sources in GPS measurements such as satellite and receiver biases were removed. A comparison of storm-time behaviour of experimental TEC GPS and values derived from ionosonde measured f_oF_2 at a range of latitudes was made. Comparison of the experimental TEC GPS data with the TEC values derived from the International Reference Ionosphere model (IRI2000) was also undertaken

G.14 Comparison of WBMOD scintillation predictions with GPS scintillation observations during solar maximum conditions

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In this paper we compare predictions of ionospheric scintillation from the climatological model WBMOD with data obtained from Ionospheric Scintillation Monitors (ISM) based on GPS receivers in the southeast Asian region during the solar maximum contidions. Results using data from each of our sites located at Marak Parak (Malaysia), Parepare (Indonesia), Pontianak (Indonesia), Vanimo (PNG), Chiang-Rai (Thailand) and Darwin (Australia) will be presented. We found that WBMOD tends to concentrate the scintillation activity in the anomaly regions to a greater degree than that displayed by the data with it significantly underpredicting the level of scintillation activity at the geomagnetic equator. In addition we observed that the scintillation activity predicted by WBMOD cut off too early in night. These results and their implications will be discussed in detail.

Commission H

H.1 Are ULF Wave Observations affected by the Plasmapause in the Presence of Heavy Ion Mass Loading of the Geomagnetic Field?

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The plasmapause discontinuity in the radial plasma density profile of the magnetopause at L ≈ 3 – 6 has often been considered a boundary region for the propagation of ULF hydromagnetic waves and a possible source of boundary layer waves. Typically, plasma density gradient measurements have been based on electron and H^+ density profiles, with the contribution of mass loading through heavy ions (He^+, O^+ etc) neglected. The simplest way to investigate the radial properties of mass loading at the plasmapause is to observe radial profile variations in the Alfven velocity $V_A = B/(\mu_0\rho)^{½}$ where $\rho = m_i n_i$ for i species of ions. The Dynamics Explorer (DE-1) magnetic field data from the fluxgate magnetometer and plasma composition data from the retarded ion mass spectrometer (RIMS) are used to calculate V_A profiles for specific days. Results show that the plasmapause gradient in ρ and V_A remain important when multiple species heavy ion mass loading is included, but the plasmapause discontinuity in ULF wave resonant frequency may be smoothed out.

H.2 Observation of ULF waves in vicinity of the plasmapause using SuperDARN TIGER radar

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Tasmanian International GeoEnvironmental Radar (TIGER) has a unique location allowing coverage of plasmapause/plasmasphere regions. In addition to mapping the global ionospheric plasma convection, an important application of HF radars is monitoring ULF waves at ionospheric heights. In this work we analyze two Pc5 events observed by TIGER near the plasmapause during local magnetic evening. For one of these events data from all 16 beams of the radar permit mapping the wave amplitude and phase over a large area of the ionosphere. For this case the wave was confined to a limited ionospheric region. For the second case, which was monitored only by three beams (special mode), the wave had a global character. This was supported by ground magnetometer data from the 210 magnetic meridional array. To clarify propagation modes of the radar echoes we performed analytical ray tracing for the given ionospheric conditions, and found that for our events they may include both half-hop ionospheric scatter and single-hop sea-scatter from the boundary of the skip zone.

H.3 Polarization of a Pc5 wave observed by Saskatoon and Kapuskasing SuperDARN radars

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In principle, pairs of SuperDARN radars with overlapping fields of view present an ideal tool for directly measuring the spatial structure of ULF wave polarization at ionospheric heights. However, ULF wave events are rarely observed in the crossed beam fields of view of two radars. This may be caused by the combined effect of HF propagation and ionospheric refraction and the aspect sensitivity of scatter from the field-aligned irregularities. In this work we analyze a rare situation on 20:00-21:00 UT 18 October, 1993, when reasonably good ionospheric echoes were observed in both radars of the Canadian pair located at Saskatoon and Kapuskasing. A high-m Pc5 wave was observed through the shared radar field of view. We were able to restore the 2-D distributions of the wave amplitude and polarization in the horizontal plane. This particular event exhibits a pronounced resonant contour, which was not exactly aligned with CGM latitude, and was almost linearly polarized along the magnetic meridian. At this stage we are continuing our search for more "simultaneous" events using specially developed software.

Commission J

J.1 Implementing Correlators for the SKA

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It is proposed that a new centimetre wavelength radiotelescope (SKA) be built in the next ten years. The astronomical requirements of this telescope require a correlator with enormous computing power. This paper examines possible options for the correlator and describes a design for a FX correlator that provides an economical implementation and satisfies all astronomical requirements.

J.2 Technology Issues for Square Kilometre Array Receiver Design

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The acquisition of low-cost, low-noise, broadband receivers will be central to the success of the Square Kilometre Array (SKA), a radio telescope array aimed at probing the early universe between 0.2 GHz and 20 GHz. These receivers will most likely be integrated closely with feed assemblies and may support optical fibre interfaces. They must also be able to operate linearly in the presence of man-made interference. Here the challenge presented by a cost limited SKA is traced through to its implications on receiver design. The state of the art of relevant technologies is reviewed and possible future directions for the newly formed Australian SKA Working Group on Integrated RF Systems are presented.

J.3 A Wideband Upgrade for the Australia Telescope Compact Array

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The available signal bandwidth on the Australia Telescope Compact Array (ATCA) is to expand from 128MHz to 2GHz. Central to this development is an FPGA-based digital filterbank correlator featuring high dynamic range and flexible configuration. Associated analog to digital conversion requirements will push the limits of high-speed sampling and quantisation techniques. These new technologies are direct candidates for signal processing on the proposed Square Kilometer Array (SKA). The correlator includes extra ports to incorporate two SKA demonstrator antenna stations into the ATCA, providing both a more powerful instrument and a mature test bed for the demonstrators.

J.4 The Square Kilometre Array Radio Telescope: Australian Directions

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The square-kilometre array (SKA) is a major next-generation radio-telescope expected to be completed in the decade 2010 - 2020. As the name implies, it has an effective collecting area of a square-kilometre, or 1 million square metres: the equivalent of more than one hundred, 100 m diameter, dish antennas. This is two orders of magnitude as great as the biggest operational telescopes, giving astronomers the factor of 100 in sensitivity they require to do critical new observations. This paper describes recent Australian SKA research and outlines projects to be undertaken during the next five years.

J.4 The Equivalence of Pre and Post Correlation Adaptive RFI Cancellation.

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Adaptive interference cancellation has been used in numerous fields for many years. The techniques utilise an additional receiver to collect a copy of the interfering environment. This reference signal is adaptively modified to best approximate the environment observed at the primary receivers. The modified signals are then subtracted from the voltage streams of the primary receivers.

Radio astronomers are usually only interested in the auto and cross correlations of the signals; not the voltages. Over the past few years it has been demonstrated that, under certain conditions, the interference cancellation can be applied after the primary signals have been correlated.

This poster displays the results of several experiments conducted on baseband data collected with the Australia Telescope Compact Array. These experiments demonstrate the essential equivalence of the pre and post correlation approaches.

J.5 The Australia Telescope Millimetre Wave Receiver System

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Abstract-- In early 1997, the Major National Research Facility (MNRF) funded project to extend the frequency coverage of the Australia Telescope Compact Array commenced. The new receivers being built as part of this upgrade will be described and the use of Monolithic Microwave Integrated Circuits (MMIC) in the receiver electronics will be highlighted. Three evaluation receivers, installed on the Compact Array, are currently being used for test and calibration observations at frequencies in the 22 GHz and 86 GHz bands. An early result from this receiver system will be presented.

J.6 Monitoring the 0–2 GHz Spectrum: A High-School Radio-Science Awareness Project

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A project to raise awareness of radio-science and the importance of the radio-frequency (RF) spectrum will be run in several Australian high schools in 2002 and 2003. Students from city and country high schools will measure 0–2 GHz RF signal levels in their area and compare results via the Internet. Their data will give the students an appreciation of the requirements of a "radio-quiet" site for the Square Kilometre Array radio telescope, and may be used in the site selection process. Outcomes for the students will include an increased understanding of the value and use of the radio spectrum for communication and astronomy and give them practical experience in radio-science. It may also inspire some students to consider careers in this area.

J.7 Prototyping SKA Technologies at the Molonglo Radio Telescope

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The Molonglo radio telescope near Canberra, Australia, is an east-west array of two collinear cylindrical parabolic reflectors with a total length of 1.6 km. Its 18,000 m2 collecting area is the largest of any radio telescope in the Southern Hemisphere. We will prototype on the telescope, technologies relevant to the next generation radio telescope, the square kilometre array (SKA). We plan to equip the telescope with new wide-band feeds, low-noise amplifiers, digital filterbanks and FX correlator, and demonstrate 300–1420 MHz continuous frequency coverage and multibeam mode operation. This will allow us to develop and test several new technologies and will provide a new capability for low-frequency radio astronomy in Australia, enabling exploration of the distant universe.

Commission K

K.1 The Numerical Evaluation of a SAR Measurement Phantom at the Telstra Research Laboratories

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At Telstra Research Laboratories (TRL), both experimental and computational environments have been established to determine the levels of electromagnetic energy (EME) induced in the human body from exposure to radiofrequency (RF) transmitters.

The experimental facilities feature a robot controlled measurement system, and a set of fibreglass human phantoms that can hold various human tissue equivalent liquids. A phantom can be exposed to an RF source under investigation, and the interior of the phantom scanned by the robot to determine the localised specific energy absorption rate (SAR). Measurement of the SAR level is presently the standard method of showing compliance with regulatory RF safety limits.

The computational modelling environment complements the experimental approach. Numerical models of the human body can be used for prompt evaluation of SAR levels under a wide range of scenarios that may not be easily achieved experimentally. This paper discusses the development of numerical models of the phantom and their use to evaluate the accuracy of the experimental approach.

K.2 Effects of Mobile-Phone type Signals on Calcium Ion Levels within Human Lymphocytes

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The poster describes results of experiments using a novel exposure chamber which exposes biological cells to RF radiation similar to that emitted by mobile telephones, whilst using laser scanning confocal microscope imaging.

Human lymphocytes were kept within ±0.5°C of 37°C, allowing for the investigation of possible RF athermal effects. These cells were loaded with a fluorescent probe specific for calcium ions, and were monitored over two 10 minute periods.

Five different conditions for cell exposure were investigated. Both continuous wave 900MHz and 217Hz pulse modulated 900MHz wave exposures were carried out on cells that were either unactivated, or alternatively activated by the mitogen *phytohaemaglutinin* (PHA). For these 4 conditions the average Specific Absorption Rate (SAR) was estimated to be 2W/Kg. A group of unactivated cells were also exposed to continuous wave 900MHz energy with an SAR of 10W/Kg.

Results showed substantially no significant changes in calcium ion levels or signalling patterns between RF exposed and sham-exposed cells.