THE AUSTRALIAN INSTITUTE OF PHYSICS

NATIONAL CONGRESS ADELAIDE 1974

MAY 21-24 1974

THE FLINDERS UNIVERSITY OF SA

programme

abstracts

SUPPLEMENT TO THE AUSTRALIAN PHYSICIST, APRIL 1974

NATIONAL CONGRESS A.I.P. 21-25 May 1974 FLINDERS UNIVERSITY

AUSTRALIAN INSTITUTE OF PHYSICS 1974

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Acknowledgements -
Thanks are due to The Flinders University of South Australia and the South Australian Institute of Technology for the provision of facilities and staff assistance.

GENERAL INFORMATION

Venue

School of Physical Sciences, The Flinders University, Bedford Park, S.A. 9 miles south of Adelaide.

Registration

This will take place in the School of Physical Sciences from 9.00 a.m. onwards, Tuesday 21 May.

Conference Office

An office and secretary with access to a telephone will be provided. The Flinders University telephone number is 277 1433.

Parking

Parking areas for people attending will be clearly indicated and delegates are requested to observe these strictly.

Accommodation

Reservations up to the limit of accommodation available are being made at Flinders University, and at St. Mark's and Lincoln Colleges, North Adelaide. Other accommodation will be arranged if application is made to the Ansett organisation.

Transport

Free buses will be provided between the Flinders Campus and the city accommodation centres.

Luncheons etc.

The cost of these is included in the registration fee. Luncheon vouchers will be issued at the time of registration.

Conference Dinner

This will be held in the Hotel Australia on Wednesday evening, 22 May, at 7.30 p.m. for 8.00 p.m.

Outside Tours

Assistance to families and friends of conference members is available from The South Australian Tourist Bureau, King William Street, Adelaide, or from the Ansett Travel Consultant at 140 North Terrace Adelaide.

Programme

The Programme set out in the following pages will not be subject to any great variations. Chairman and speakers have been asked to adhere strictly to the timetable. The titles may have been abbreviated. The abstracts for those papers available at this time appear in the pages following the programme and indicate the full titles and authors. A final-summary programme incorporating post-publication changes and late abstracts will be issued to all registrants at the Congress. Members are reminded, however, to bring this supplement with them in order to have all abstracts available.

Abstracts

These are for the convenience of Congress members and others interested in the same field of work. They are not for publication and should not be quoted in literature nor reproduced in abstracting journals as they do not necessarily relate to papers intended for publication.

PROGRAMME

PROGRAMME: TUESDAY MAY 21

9.00 Registration at the School of Physical Sciences, The Flinders University.
Morning Tea

11.15 Session 1 Invited Papers

11.15 The Upper Atmosphere and Magnetosphere - a Review
Professor K.D. Cole - Latrobe University

12.00 The Optical Spectroscopy of Minerals and Gemstones
Professor W.A. Runciman - Research School of Physical Sciences A.N.U.

Luncheon

2.15 Session 2 Parallel Sessions
Nuclear Physics - Invited Papers: Solid State and Optics - Contributed

2.15 Nuclear Physics in Australia
Professor Sir Ernest Titterton - Research School of Physical Sciences A.N.U.

2.45 Nuclear Theory - A Review
Professor B.H.J. McKellar - University of Melbourne
Progress in the basic problem of the theory of the nucleus, namely the computation of its properties from the properties of the nucleon-nucleon interaction will be reviewed. The present situation is that bulk properties of the nucleus (its radius and the total binding energy) are reasonably well understood, but many fine details are not understood from first principles.

3.15 Few-body Problems in Nuclear Physics
Professor I.H. Sloan - University of New South Wales
Why are few-body problems interesting? What progress has been made? What are the prospects for the future? These are the questions to be discussed in this talk.

2.15 *Solid State and Optics
SO2 NMR Observations of Biological Material - GEORGE
SO3 Crystal Field Quenching of Dy Moment in $(Dy_xHO_{1-x})Ni_z$ - BOWDEN, DAY
SO4 Measurement of Spin-Lattice Relaxation for ^{59}Co Nuclie in Ni - BARCLAY et al
SO22 Adiabatic Rapid Passage in Single Crystal Ni Films - CORNELL, POPE

2.15 SO10 Thermal Transient Effects in Transferred Electron Oscillators - McRAE, GRIFFIN
SO12 Computer Study of a Transferred Electron Oscillator - DOWNING
SO13 Liquid Phase Epitaxy of GaAs - Growth Control - McCRAE, GRIFFIN
SO23 Growth and Luninescence of ZnP_2 - YOUNG
Afternoon Tea

4.15 Session 3 - Annual General Meeting of the Australian Institute of Physics

8.15 Evening - Matthew Flinders Theatre, Flinders University

Official Opening of the Congress by His Excellency, the Governor of S.A. Sir Mark Oliphant

Concert
Coffee, Wine and Cheese in the Union

PROGRAMME: WEDNESDAY MAY 22

9.15 Session 4 Invited Papers

9.15 Changes in Secondary Science - Its Implication for Physics Teaching
Dr. E.R. Sandercock - Sturt College of Education
With the demand for relevance, the difficulties associated with employment prospects for physicists, the disappearance of external public examinations at the end of secondary school and the impetus of open education, should the physics community continue with its present educational philosophy or is some rethinking necessary?

10.00 The Fusion Reactor
Professor M.H. Brennan - The Flinders University of S.A.
The basic requirements for achieving plasma conditions suitable for the controlled release of nuclear fusion energy will be discussed. The status of some of the major approaches towards achieving these requirements wil be discussed; particular attention will be given to the Tokamak and high-beta confinement systems. The presentation will include some discussion of the environmental impact of the fusion reactor.

Morning Tea

11.15 Session 5 Contributed Papers Parallel Sessions

*Upper Atmosphere and Magnetosphere

UM1 Thermospheric Temperature and Wind Measurements - JACKA et al

UM2 Drift Velocities of Irregularities in [OI] λ557.7nm Night Airglow - FREUND

UM3 Short Term Variations of the Airglow OH Rotational Temperature - ARMSTRONG

UM4 630nm Night-airglow at Melbourne - HOPGOOD

UM5 Thermospheric O_2 Abundance by Measurement of Oxygen Airglow - SCHAEFFER

*Solid State and Optics

SO24 Diluted Antiferromagnetic Applications to $Cr_{1-x}V_xN$ - DEMPSTER, STREET

SO25 The Effect of Spin-lattice Interaction in Diluted UO_2 - SMITH

SO8 Ferromagnetism of SmCd - STEWART, COSTA, OLCESE

SO9 Magnetic Properties of Pr-Tb and related Alloy Systems -CURRY et al

SO16 Cluster Effects in Disordered Alloys - BEST, LLOYD

*Cosmic Rays

CR2 Nuclear Interactions at Cosmic Ray Energies - 30min. invited paper
Dr. K. Sivaprasad, Tata Institute of Fundamental Research, India

CR3 The Adelaide University Cosmic Ray Air Showers Array - PRESCOTT...

CR4 The History of Free Electrons produced by Cosmic Rays - CROMPTON

CR5 The Characteristics of Pulsed Radio Noise - CLAY,COTTRELL,PRESCOTT

CR6 The Properties of Transient Sources in Xray Astronomy - FENTON

CR7 The Cosmic Ray Sidereal Variation at Energies ~10^{11}eV - HUMBLE

*Physics Education

PE1 A System Approach for Teaching Electronics to Scientists - BARCLAY,HUTTON

PE2 Audio-Tutorial Laboratory Instruction at the D.D.I.A.E. - DOBNEY

PE3 Medical Radiography Courses at W.A.I.T. - O'CONNOR

PE5 The Teaching of Physics to Non-scientists - CLARK

PE6 Physics in Environmental Studies - GOODSPEED

PROGRAMME: WEDNESDAY MAY 22 continued

11.15 Session 5 continued

*Plasma and Discharge Physics

PD12 The Runaway Electron Discharge in LT-3 - HUTCHINSON et al
PD13 Long Wavelength Kink Instabilities - DEWAR et al
PD14 A Fast Linear Z-pinch - JONES,MURRAY,PHILLIPS, WEBER
PD15 Laser Pulse Tailoring for the Optimum Compression of Matter -
PD22 X-ray Spectral Measurements - HOGG,TENDYS HUGHES

*Atomic and Molecular Physics

AM1 The (e,2e) Reaction in Atoms and Molecules - WEIGOLD et al
AM2 Theory of Atomic and Molecular Reactions - McCARTHY
AM3 Elastic Scattering of Electrons from Atomic Hydrogen - WEIGOLD....
AM4 Scattering of Electrons by Ne,Ar,Kr,Xe - LEWIS et al

Luncheon

2.15 Session 6 Invited Papers

2.15 Geophysical Comparisons between the U.S.A. West Coast and the Eastern Coast of Australia
Professor A.L. Hales - Research School of Earth Sciences A.N.U.

3.00 A Search for Tachyons at Adelaide
Dr. R.W. Clay and P.C. Crouch - Physics Dept. University of Adelaide with a theoretical footnote by Professor C.A. Hurst - Department of Mathematical Physics University of Adelaide

Until the last decade it had been almost universally held that a consequence of the special theory of relativity was the impossibility of particle velocities greater than the velocity of light. It was, however, pointed out that provided super-luminary particles were created and remained superluminary,then a redefinition of their mass was possible which was compatible with relativity. There was thus no a priori reason for dismissing the existence of tachyons. Work has been done at Adelaide to detect effects which appear to precede substantially the highly relativistic particles in cosmic ray showers and could therefore be associated with tachyons. Results seem to suggest that some non-random effects may be observable in the time period up to 100μs before the observation of air showers.

Afternoon Tea

4.15 Session 7 Contributed Papers Parallel Sessions

4.15 *Upper Atmosphere and Magnetosphere

UM6 Observations of Travelling Ionospheric Disturbances - CLARKE
UM7 The Influence of the Ionisation Gradient on Disturbances - MUNRO
UM8 Ionospheric Disturbances and Airglow Emission - ARMSTRONG,WRIGHT
UM9 Simultaneous Group and Height Measurements in the F-region -BUTCHER
UM10 Phase Height Measurements on the Ionosphere - JOYNER
UM11 Diurnal Phase and Amplitude Patterns of VFL Transmitter NWC - LYNN

*Solid State and Optics

SO18 U.V. Interference Filters with High Transmission - WARD
SO28 Optical Properties of Thin Films of II-VI Compounds -KHAWAJA,MURTY,
SO29 A Refined Approach to Gas Laser Theory -BAMBINI,TROUP (TOMLIN
SO21 Stimulation of Chemical Reaction by Laser Radiation - PRYOR

PROGRAMME: WEDNESDAY MAY 22 continued

4.15 Session 7 continued

*Physics Education

PE7 Interdisciplinary Undergraduate Courses - PEACOCK

PE8 Contributions of the Physicist to Chemistry and Biology - PILBROW

PE9 Conceptual Framework of Physics Education for Papua New Guinea - BALASUBRAMANIAM,BRAZIER

PE10 Some Aspects of Tertiary Teaching - MOHYLA

*Geophysics

GP1 Melting and Elastic Shear Instability of Solids at High Pressure - JACKSON,LIEBERMAN

GP2 Elasticity and Phase Transformations in the Earth's Mantle - LIEBERMAN,RINGWOOD

GP3 Magnetic Interactions in Fine-grained Magnetites -WESCOTT-LEWIS

GP4 An Electrostatic Wave Generator for Fluid Wave Studies - PHILLIPS

GP5 A Hydrothermal Eruption at Waimangu New Zealand - KEAM,LLOYD

*Plasma and Discharge Physics

PD1 Thermal Diffusion Coefficients of Electrons in Ne and Ar - RHYMES

PD2 Mobilities of H_3^+ and H_5^+ ions and the Reaction $H_3^+ + H_2 + H_2 \rightleftharpoons H_5^+ + H_2$ - M.ELFORD

PD3 Metastable Particle Effects in Ionisation Growth -WILLIAMS,HAYDON

PD4 Ion-Surface Interaction - McDONALD

Evening Hotel Australia, North Adelaide

7.30 Pre-dinner drinks

8.00 Congress Dinner

PROGRAMME: THURSDAY MAY 23

9.00 Visits and Excursions

Plasma and Discharge Physics Work at Flinders
The Buckland Park Array
Historical Exhibition at Adelaide University
Weapons Research Establishment
South Australian Institute of Technology School of Physics

10.00 Plasma and Discharge Physics Session Contributed Papers

PD5 Application of a Generalised Dielectric Function - HINES,FRANKEL

PD6 Relativistic Coulomb Binary Collision Energy Loss - FRANKEL,HINES

PD7 Charged Particle Motion in a Static Magnetic Field - SEYMOUR

11.45 Visit to Seppeltsfield in the Barossa Valley - Bus departs from Flinders and will pick up on the trip.

1.15 Barbecue Luncheon and Winery Visit

Evening Matthew Flinders Theatre The Flinders University

8.00 Public Meeting

Physics in Industry and Society

The discussion will begin with papers from Professor Brian Spicer, Sir Philip Baxter, Dr. Roger Bird and Professor David Morton

PROGRAMME: FRIDAY MAY 24

9.15 Session 8 Invited Papers

9.15 Experimental Nuclear Physics
Professor B.M. Spicer - University of Melbourne
This lecture is concerned with some techniques used in experimental nuclear physics and the type of information that may be gleaned from their use. It will also discuss some of the uses to which the technology of nuclear physics may be put in other areas of physics.

9.40 The Undiscovered Particles in High Energy Physics
Professor D.C. Peaslee - Australian National University
A summary review of the sources and present status of particle hypotheses in high energy physics, along with possible relations between them, as follows: the magnetic monopole, the quark with and without charm, the parton, the gluon, the W-meson, cosmic ray particles, the tachyon.

10.05 The Need for High Resolution Studies in Ultraviolet Photon Absorption
Professor J.H. Carver - University of Adelaide
The need for high resolution measurements will be illustrated by considering the absorption of ultraviolet radiation by atmospheric gases.

Morning Tea

11.15 Session 9 Contributed Papers Parallel Sessions

*Upper Atmosphere Rocket Observations
UM18 The Properties of the Atmosphere Above 90 km - LOW
UM19 Annual Variations of Neutral Atmosphere Parameters - PEARSON
UM20 Molecular Oxygen Concentrations and Time Variation - ILYAS,HORTON
UM21 Lyman α Radiation in the Night-time Atmosphere - O'CONNOR
UM22 Optical Daytime Wind Detector - HIND

*Magnetosphere
UM23 Solar Wind Interaction with the Magnetosphere - COLE
UM25 Ionospheric Duct Propagation of Hydromagnetic Waves - FRASER
UM26 An Association among Planets, Sunspots and Solar Plasma Tongues - GOODWIN
UM27 Eclipse Induced Geomagnetic Effects observed in Kenya - BRAZIER

*Solid State and Optics
SO14 A Selective Absorbing Surface for Solar Radiation - SABINE et al
SO17 X-ray Diffraction Studies of Metal Crystals - BEDNARZ,FIELD,MEDLIN
SO27 Narrow 5d Energy Bands in the Heavy Rare Earth Metals - EAGLES

*Nuclear Physics
NP6 The N-N Interaction - ENGLEFIELD
NP7 pp Total Cross section in the "T" Region - PEASLEE et al
NP8 Distribution of Mass in the Symmetric Region of Neutron-induced Fission - de LAETER
NP9 The Possible Transmutation of Radioactive Waste from Nuclear Reactors - HARRIES

*Plasma and Discharge Physics
PD8 Magnetoacoustic Oscillations as a Plasma Diagnostic -FROMMELT,JONES
PD9 Langmuir Probes in the Presence of Negative Ions - PLUMB
PD10 Non Linear Interaction of Hydromagnetic Waves -BRENNAN,CHEETHAM, JONES
PD11 Non Linear Wave Interaction in Bounded Plasmas - CARR

PROGRAMME: FRIDAY MAY 24 continued

11.15 Session 9 continued

*Atomic and Molecular Physics

AM6 The Construction of a 6 metre Ultraviolet Monochromator - McCOY

AM7 Angular Distribution and Partial Cross Sections of Photoionisation in Argon - MITCHELL

AM8 The Measurement of Partial Cross-sections by Photo-electron Spectroscopy - BLAKE,HUTTON,LINDEMANS

AM9 Differential Cross-sections for elastic and inelastic electron Scattering from Atomic Hydrogen - TOROP, BOHM

AM14 Synchrotron Radiation - A National Facility - LYNCH

Luncheon

2.15 Session 10 Contributed Papers Parallel Sessions

*Upper Atmosphere

UM12 Recent Satellite Measurements of F-region Irregularities - DYSON

UM13 Scattering from Irregularities at the F region Peak - CORNELIUS

UM14 A 6 year Synoptic Study of Winds between 80 and 100 km - G.ELFORD

UM15 Upper Atmosphere Winds by Radio Techniques - VINCENT

UM16 Some Properties of D-region Irregularities from Partial Reflection- STUBBS

UM17 Ionospheric Observations using an Ultrasonic Image-forming System - BRIGGS et al

*Solid State and Optics

SO5 Cryogenics as seen from Industry - POWELL

SO7 Thermal Expansion of Superconductors - SMITH,FINLAYSON

SO26 Screened Local Interaction Parameters - COX

*Plasma and Discharge Physics

PD16 MHD Electric Power - MESSERLE

PD17 Radiative Energy Loss from a Shock Tube Plasma - LOGAN,STALKER

PD18 Plasma Generated Current Density and Potential Field - CALDERSMITH

PD19 Arc Driven Shock Waves - PHILLIPS,PUGATSCHEW

PD20 Shock Refraction at Cold to Hot Gas Interface - GEROFI

*Atomic and Molecular Physics

AM10 The Stark Effect of ^{1}H and $^{4}He^{+}$ in the Beam-foil Source -DOOBOV...

AM11 Semiclassical Theory of Resonant Scattering of Light from Atomic Systems - DALTON,WHITE

AM12 Classical Scattering of Symmetric Tops and the Boltzmann Equation for Anisotropic Molecules - EVANS,WATTS

AM13 Determination of Ion-Atom Interaction Potentials - MILLOY et al

AM15 Long Range Dipole Moment of Ternary Atomic Collisions - LO

4.00 Closure Session followed by Drinks and Coffee

Dr. F.J. Jacka - President of the Australian Institute of Physics

ABSTRACTS

SECTION: UM:- UPPER ATMOSPHERE AND MAGNETOSPHERE

Organiser B.H. Briggs University of Adelaide

SESSION: AIRGLOW

Thermospheric Temperature and Wind Measurements. Using a 15 cm scanning Fabry-Perot interferometer at Mt. Torrens (near Adelaide) measurements have been made on the Doppler width and displacement of the [OI] λ630 nm airglow line from which the kinetic temperature and neutral wind are inferred. The instrument will be described briefly and results from the first year of operation will be discussed. Typical temperatures and winds are 800 - 900 °K and 50 - 100 m/s respectively.

UM1
F. Jacka
A.R.D. Bower
D.F. Creighton
P.A. Wilksch
Mawson Institute for Antartic Research, University of Adelaide, S.A.

Drift Velocities of Irregularities in OI λ557.7 nm Night Airglow. Night airglow observations have been carried out at Mt. Torrens (near Adelaide) at 557.7 nm using a photometer capable of measuring the intensity in four spatially adjacent regions. At certain times short term fluctuations with a period around eight minutes are observed and these have been used to determine drift velocities.

UM2
J.T. Freund
Mawson Institute for Antartic Research, University of Adelaide, S.A.

Short-Term Variations of the Airglow OH Rotational Temperature. Observations at Camden and Culgoora, N.S.W., of the OH(6,1) and (8,3) bands in the airglow with a photon-counting scanning spectrometer provided rotational temperature values at intervals of about 20 min. Relatively short-term temperature variations could thus be observed. Some results are presented and discussed. Occasionally the distribution of intensity among the first three lines of the P-branch of the (6,1) band appeared distorted, suggesting a non-Boltzmann distribution among the rotational populations. Possible causes of this are discussed.
A regular variation of temperature with a period of 65 min. was clearly evident on one night. This is believed to be due to the passage of a gravity wave.

UM3
E.B. Armstrong
CSIRO Division of Physics, Solar Observatory, Narrabri, N.S.W.

630 nm Night-Airglow at Melbourne. Measurements of 6300Å night-airglow are being made at Beveridge near Melbourne.
Two tilting-filter photometers are in use, one of which is directed vertically up, the other pointing northwards at elevations generally less than 45°.
Large scale enhancements in the airglow intensity have been observed moving through the ionosphere. By combining the airglow measurements with total electron content and ionosonde data, the direction of propagation and speed of the enhancements can be determined.
These data will be discussed and correlated with other ionospheric parameters.

UM4
P.A. Hopgood
Dept. of Physics, Latrobe University, Melbourne, Vic.

The Study of Thermospheric O_2 Abundance by Measurement of the Oxygen Airglow Enhancements in Twilight. Twilight measurements of the oxygen airglow emission lines at λ 5577 and 6300Å from the Fritz Peak Observatory, Colorado, have revealed enhancements with decreasing solar zenith angle that bear directly on the abundance of molecular oxygen in the lower thermosphere. The green line enhancement can be accounted for by the dissociative recombination of O_2+ ions with F-region electrons and has a pronounced seasonal variation due primarily to seasonal variation of twilight F2-layer behaviour. For the morning red line enhancements, a strong dependence on the activity of the Earth's magnetic field is evident. As the measured enhancements arise largely from the photo-dissociative excitation of the red line by solar radiation in the Schumann-Runge continuum (1350 - 1750Å), a magnetic dependence for thermospheric O_2 concentration is inferred.

UM5
R.C. Schaeffer
Dept. of Physics, University of Adelaide, S.A.

TRAVELLING DISTURBANCING AND PHASE MEASUREMENTS

Spaced-Station Observations of Travelling Ionospheric Disturbances - Computer Simulations and Experimental Studies

UM6
R.H. Clarke
Defence Scientific Services,
Dept. of Supply,
W.R.E.,
Salisbury, S.A.

A three-dimensional ray-tracing analysis is employed to calculate ray paths through a model ionosphere which itself is perturbed by the passage of a horizontally moving wavelike disturbance. A knowledge of various parameters (e.g. phase and group paths, angle of arrival, doppler frequency shift) for ray paths connecting a central transmitter with spaced receivers permits an evaluation of several spaced-station techniques for measuring horizontal phase velocities of travelling ionospheric disturbances (TIDs). It is shown that in experiments with transmitter-receiver spacings of less than 150 km, reliable velocity estimates may be expected, even though the assumption of a horizontally stratified ionosphere which is common to all methods is strictly invalid.

The Influence of the Ionisation Gradient on the Observability of Disturbances.

UM7
G.H. Munro
Dept. of Electrical Engineering,
University of Sydney, N.S.W.

Some of the published statistics of occurrence of travelling ionospheric disturbances were based solely on those detected clearly by a particular observing system. It has become increasingly clear that the observability of such disturbances is influenced very much by the existing ionisation gradient. This is examined by studying ionosonde records at the time of observation. The principles involved will apply also to observations of Spread-F and Scintillation.

The Influence of Travelling Ionospheric Disturbances on the Night Airglow Emissions.

UM8
E.B. Armstrong
CSIRO Division of Physics.
C.S. Wright
Ionospheric Prediction Service.

Quasi-periodic variations in the intensity of the OK6300A night airglow emission observed at Camden and Culgoora, N.S.W. are described. For periods of 40m to 120m, they are shown to be closely related to variations in h'F recorded on a local ionosonde. Cases in which the pattern of the h'F variations observed during a night was evident at a number of stations in the Australian Ionospheric Prediction Service network indicated disturbances travelling equatorward at speeds in the range 300 m/s to 700 m/s. These disturbances were considered to be due to the now well-known gravity waves propagating equatorward from the auroral oval during magnetic storms.
Occassionally similar periodic intensity variation patters appeared in both the 6300A and 5577A emissions during the passage of a gravity wave (as indicated by h'F) and such eases are also considered.
Coinciding airglow intensity and h'F periodic variations were also observed under quiet magnetic conditions. The sources of the gravity waves causing these were not located.
Processes causing the airglow intensity variations during the passage of gravity waves are discussed.

Simultaneous Group and Phase Height Measurements on the F-Region

UM9
E.C. Butcher
Dept. of Physics,
Latrobe University,
Melbourne, Vic.

A combined phase sounder - phase ionosonde system with on-line computer for data reduction will be described. Some preliminary results, to indicate the usefulness of such a system, will be presented.

Phase Height Measurements on the Ionosphere.

UM10
K.H. Joyner
Dept. of Physics,
Latrobe University,
Melbourne, Vic.

Phase height measurements have been taken on 2.5 MHz E-region reflection over two paths during the day. The two paths have equivalent vertical frequencies of 2.4 MHz and 1.8 MHz. Vertical pulse measurements on 2.4 MHz have also been recorded. Results and discussion on comparisons between these measurements will be presented.
Phase and amplitude measurements using 4.5 MHz O and E rays have also been taken at night, F region reflection. In particular, spectral analysis of these results will be discussed.

Diurnal Phase and Amplitude Patterns of the VLF Transmitter NWC as Received in Australia.

UM11
K.J.W. Lynn
Upper Atmosphere Research,
W.R.E.,
Salisbury, S.A.

Diurnal phase and amplitude records of the VLF transmitter NWC at North West Cape, W.A., as received in Woomera, Adelaide, Melbourne, Canberra, Sydney and Brisbane, show a pattern of rapid change both with frequency and distance from the transmitter.
At the distances (2.5 - 4.0 megameters) and frequencies (22.3, 19.8, 18.0, 15.5 kHz) concerned, the waveguide theory of VLF propagation predicts that several modes will be present at the receiver and that mode conversion effects at sunrise and sunset will be most significant. The ability of waveguide theory to reproduce the experimental observations in detail is investigated.

IONOSPHERIC IRREGULARITIES AND MOVEMENTS

UM12
P.L. Dyson
Dept. of Physics,
Latrobe University,
Melbourne, Vic.

Recent Satellite Measurements of F-region Irregularities.
The retarding potential analyzer aboard Ogo 6 has provided high resolution observations of the ion concentration along the satellite path. Changes in ion concentration as small as .03% and at times .01% could be measured. Spatial resolution varied from 35 to 380 meters. Samples of data have been spectrally analyzed to determine the variation of irregularity amplitude with scale size. The most common spectrum observed is of the form $A \propto S^n$ where A is the irregularity amplitude and S is the scale size. The spectrum was measured over the scale size range 70 m to 7 km and the values of n obtained were close to one, the average value being 0.95. The spectral index, n, is found to be insensitive to irregularity amplitude. This type of spectrum suggests that the irregularities in this scale size range result from the turbulent dissipation of larger irregularities. At the equator the larger irregularities are probably produced by convective electric fields. At high latitudes electric fields may also be involved but other factors such as precipitating particles may contribute to, or be primarily responsible for, the production of large irregularities. Examples of other types of spectra associated with wave-like irregularities and with "ground glass" (high frequency noise) irregularities are also shown.

UM13
D.W. Cornelius
Dept. of Physics,
Latrobe University,
Melbourne, Vic.

Scattering from Irregularities at the F-region Peak.
A signal is often still received from the ionosphere using medium power C.W. transmitters and narrow band receivers at HF frequencies when the critical frequency of the F-region is below the transmitted frequency. The conditions under which this occurs and the observations of irregularities in the scattered signal is discussed.

UM14
W.G. Elford
Dept. of Physics,
University of
Adelaide, S.A.

A Six Year Synoptic Study of Winds between 80 and 100 km, from Meteor Trail Drifts. Prevailing and tidal winds are determined from regular meteor drift observations carried out at Adelaide, South Australia, during the period 1966-1972. Monthly averages of zonal and meridional winds over the height range 75 - 105 km are presented in the form of isotachs for six successive years. The zonal winds are predominantly eastward with the intrusion of a westward flow above 95 km during winter and spring. The meridional flow is directed away from the pole during summer and toward the pole during winter. The 24 hour and 12 hour tidal winds show marked variation with height and season but the annual behaviour is very similar from year to year.
Calculations of the mean seasonal transient eddy momentum flux have been carried out using daily measurements of the prevailing components of the wind. Results averaged over the six years are presented.

UM15
R.A. Vincent
Dept. of Physics,
University of
Adelaide, S.A.

Upper Atmosphere Winds by Radio Techniques. Reflections of radio waves from weak irregularities of ionization in the D region of the ionosphere can be observed over the height range 60 - 100 km. Observations of the fading of these waves made at spaced aerials can be used to obtain the horizontal motion of the atmosphere in this height interval.
In the present paper observations made at Adelaide and at Woomera (South Australia) by this technique are reported. The results show clear evidence of prevailing winds, strong tidal components (with the diurnal tide predominant), and also evidence for shorter period velocity fluctuations. Comparisons with drifts of meteor trails made at Adelaide show good agreement. Comparisons with winds observed at Woomera by various rocket techniques, including drifts of luminous vapour trails, have also been made. Although this aspect of the work is at an early stage of development, encouraging evidence of agreement has already been found. It is concluded that the radio wave sounding technique provides a valuable and relatively inexpensive method for obtaining continuous observations of horizontal atmospheric winds, tides, and wave phenomena in the height range 60 - 100 km. Its use on a world-wide basis should be encouraged.

Some properties of D-region Irregularities derived from Partial Reflection Studies. The paper begins with a brief description of how information about the ground diffraction pattern is obtained from the three-receiver fading records. Consideration is then given to the relationship between this pattern and the actual ionospheric irregularities. Certain characteristics of the patterns are then discussed, notably diurnal, seasonal and height variations of the pattern size. Some evidence is presented indicating that at certain heights the earth's magnetic field may control the alignment of irregularities.

UM16
T.J. Stubbs
Dept. of Physics,
University of
Adelaide, S.A.

Ionospheric Observations using an Ultrasonic Image-Forming System. An imaging system will be described which operates by converting radio signals into ultra-sonic waves in water, which are then focussed to produce an acoustic image. This image is sampled by an array of transducers and converted into a visible picture. The system has been used to study ionospheric irregularities using an 89 element antenna array, and a cine-film illustrating some of the results will be shown.

UM17
B.H. Briggs
D.N. Hart
N. Holmes
Dept. of Physics,
University of
Adelaide, S.A.

ROCKET OBSERVATIONS

A Review of Experiments on the Properties of the Atmosphere above 90 km carried out at Woomera. Neutral atmospheric properties like wind, temperature and diffusion coefficients have been measured using chemical seeding techniques for over 15 years at Woomera. In the last five years interest in the interaction of the neutral and ionised atmosphere has developed.

UM18
C.H. Low
Upper Atmosphere
Research,
W.R.E.,
Salisbury, S.A.

Annual Variations of Neutral Atmosphere Parameters between 30 and 97 km at Woomera shortly after Dusk, 1962 - 1972. Over a number of years falling sphere experiments have been conducted at Woomera on a regular basis. Most of these firings, which have released two metre diameter inflatable spheres, have been made shortly after local sunset. Sinusoidal curves have been fitted to over 50 of these firings and models produced between 97 km and 40 km.

UM19
P.H.O. Pearson
Upper Atmosphere
Research,
W.R.E.,
Salisbury, S.A.

Molecular Oxygen Concentration and the Time Variations between Some recent molecular oxygen measurements made using ultraviolet ion chambers in rocket flights from Woomera are described. Some previous measurements have been reanalysed as described before (1) and used to infer information about seasonal and diurnal variations in oxygen concentrations in the altitude range of 70 - 100 km. (1)

UM20
M. Ilyas
B. Horton
Dept. of Physics,
University of
Adelaide, S.A.

Rocket Measurements of Lyman α-Radiation in the Night-time Atmosphere. Rocket-borne vacuum ultraviolet telescopes have been used to make measurements of the intensity and distribution of Hydrogen Lyman radiation in the altitude range between 75 and 120 km. The dominant source in this region is solar radiation resonantly scattered from geocoronal hydrogen.
The observations have been described in terms of a simple spectral model and the results have been used to derive density profiles of molecular oxygen and atomic hydrogen.
In the range between 80 and 100 km, where there is a lack of previous measurements, the data suggest a much lower density of atomic hydrogen than current photo-chemical models predict.

UM21
G.G. O'Connor
Upper Atmosphere
Research,
W.R.E.,
Salisbury, S.A.

Optical Daytime Wind Detector. An optical wind detector has been built to track lithium released from upper atmosphere sounding rockets during the day. The trail, from 80 to 150 km to observed from two sites for a period of about 15 minutes.
The instrument uses a very narrow band optical filter mounted in front of a photomultiplier. A chopper system coupled with a sensitive detector enable the lithium to be detected against the sky foreground. A scanning mirror is used to build up a frame data which is stored on tape for processing.
Daytime winds measured so far, show similar values and patterns to those from twilight or night observations.

UM22
A.D. Hind
Upper Atmosphere
Research,
W.R.E.,
Salisbury, S.A.

THE MAGNETOSPHERE

Outline of a Theory of Solar Wind Interaction with the Magnetosphere. Some new ideas on the interaction of the solar wind with the magnetosphere are brought forward. The mechanism of reflection of charged particles at the magnetopause is examined. It is shown that in general the reflection is not specular but that a component of momentum of the particle parallel to the magnetopause changes. A critical angle is derived such that particles whose trajectories make an angle less than it with the magnetopause enter the magnetosphere freely, so transferring their forward momentum to it.

UM23
K.D. Cole
Div. of Theoretical
and Space Physics,
Latrobe University,
Melbourne, Vic.

Spatially or temporally non-uniform entry of charged particles into the magnetosphere causes electric fields parallel to the magnetopause which either allow the free passage of solar wind across it or vacuum reconnection to the interplanetary magnetic field depending on the direction of the latter. These electric fields can be discharged in the ionosphere and so account qualitatively for the dayside agitation of the geomagnetic field observed on the polar caps. The solar wind plasma which enters the magnetosphere creates (1) a dawn-dusk electric field across the tail, (2) enough force to account for the geomagnetic tail, and (3) enough current during disturbed times to account for the auroral electrojets. The entry of solar wind plasma across the magnetosphere and connection of the geomagnetic to interplanetary field can be assisted by wind generated electric field in the ionosphere transferred by the good conductivity along the geomagnetic field to the magnetopause. This may account for some of the observed correlations between phenomena in the lower atmosphere and a component of magnetic disturbance.

UM24

B.J. Fraser
Dept. of Physics,
University of
Newcastle, N.S.W.

East-West Ionospheric Duct Propagation of Hydromagnetic Waves.
Energy from hydromagnetic emission type Pcl pulsations, generated in the magnetosphere is propagated parallel to the surface of the earth in an ionospheric duct. Using time delay location and polarization techniques in conjunction with data from NOAA-USGS stations at Great Whale River, Boulder, and College, East-West propagation has been studied for selected events. Characteristics of the duct propagation and the effects of ionospheric density discontinuities will be considered.

UM25

G.L. Goodwin
School of Physics,
S.A.I.T.,
Adelaide, S.A.

An Association among Planets, Sunspots and Solar Plasma "Tongues".
Evidence is presented that when one or more planets are in a solar plasma "tongue", sunspot numbers are enhanced in the region of the "base" of the "tongue". As a qualitative explanation, it is suggested that on entering a "tongue", a planet might cause a magnetodynamic wave disturbance to propagate along the "tongue", distorting the magnetic field near the "base" and possibly "triggering" sunspots.

UM26

I.M. Brazier
P.N.G. University
of Technology,
Lae, N.G.

Eclipse Induced Geomagnetic Effect as observed in Kenya during the Total Eclipse of June 30th, 1973. An array of three-component magnetometers was operated in Kenya for a period before, during and after the total eclipse which crossed Africa on June 30th, 1973.
Unfortunately, this was a period of intense magnetic activity which tended to mask any expected effects due to changes in the conductivity of the ionosphere during the passage of the eclipse.
By comparison of eclipse day records with records from a quieter day and also by comparison of records from different sites it is believed that an eclipse effect has been extracted.

SECTION: PD: PLASMA AND DISCHARGE PHYSICS.

General Chairman M.H. Brennan The Flinders University of S.A.

PD1

T.O. Rhymes
Ion Diffusion Unit,
Research School of
Physical Sciences,
Australian National
University,
Canberra, A.C.T.

Thermal Diffusion Coefficients of Electrons in Neon and Argon.
The diffusion coefficient of electrons at thermal energies has been measured in neon and argon by the electron density sampling method of Cavalleri. From the neon experiments it was evident that experimental conditions could not be found for pure argon whereby the thermalization time of the electrons was significantly less than the maximum allowable repetition time for the experiment. This problem was overcome by the addition of small quantities of hydrogen. An analysis based on the integral expression for the diffusion coefficient shows that measurement of the thermal diffusion coefficient can yield information on the behaviour of the electron-argon cross section in the vicinity of the Ramsauer Townsend minimum.

PD2

M.T. Elford
H.B. Milloy
Ion Diffusion Unit.
Research School of
Physical Sciences,
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Canberra, A.C.T.

The Mobilities of H_3^+ and H_5^+ ions in Hydrogen at 293 K and 196 K and the equilibrium rate constant for the reaction $H_3^+ + H_2 + H_2 \rightleftarrows H_5^+ + H_2$.
The mobilities of positive hydrogen ions have been measured in hydrogen at 293 and 196 K using the Bradbury-Nielsen time-of-flight method at pressures ranging from 1 to 200 torr and at values of E/N from 0.3 to 23 Td. The measured mobilities at 293 K were a function of gas pressure, the data being accurately fitted by a relation based on the equilibrium reaction scheme $H_3^+ + H_2 + H_2 \rightleftarrows H_5^+ + H_2$. The zero field mobilities at 293 K obtained from the fitting procedure are 11.1 ± 0.1 $cm^2\ sec^{-1}\ volt^{-1}$ for H_3^+ and 10.65 ± 0.05 $cm^2\ sec^{-1}\ volt^{-1}$ for H_5^+. The identity of the ions, the nature of the reaction and the effect of gas impurities were investigated with a drift tube coupled to a quadrupole mass spectrometer.

Metastable Particle Effects in Ionization Growth Experiments.

PD3
O.M. Williams
S.C. Haydon
Physics Dept.,
University of New
England,
Armidale, N.S.W.

For many years, persistent inconsistencies have existed among ionization growth measurements in nitrogen, with significant differences in the values of both primary and secondary ionization coefficients reported by different experimenters. In a detailed study of the spatial and temporal aspects of ionization growth in nitrogen during the past two years at Armidale, we have established that much of the earlier inconsistency has arisen because of neglect of the effect of secondary electron emission by metastable particle impact on the cathode. The presence of a significant metastable particle secondary effect is detected either by the characteristic spatial dependence of the secondary ionization current to changes in the primary electron current leaving the cathode. Both of these effects occur as a result of the diffusive motion of the metastable particles produced in the gas by electron impact excitation, and detailed analysis has resolved much of the earlier uncertainty in the interpretation of ionization growth measurements in nitrogen, enabling more reliable measurements to be made of the primary and secondary ionization coefficients.

Ion-Surface Interaction.

PD4
R.J. MacDonald
Dept. of Physics,
The Australian
National University,
Canberra, A.C.T.

Application of a Generalised Dielectric Function. An extension of the Lindhard dielectric constant is presented and applications discussed in the areas of plasma physics, solid state physics, astrophysics and the physics of liquid metals.

PD5
K.C. Hines
N.E. Frankel
School of Physics,
University of
Melbourne,
Parkville, Vic.

In this work Fermi-Dirac statistics are assumed for the electrons and Lindhard's restriction to zero temperature is avoided. As a consequence, particular attention must be given to the chemical potential for the system which not only occurs in the distribution function for the electrons, but must also satisfy a subsidiary condition yielding the number of particles in the system.

Results are presented showing the behaviour of the real and imaginary parts of the dielectric function for a variety of temperatures and densities.

For some applications the use of plane wave states is inadmissable and attention is therefore given to the form of the spectrum appropriate to various physical applications.

It turns out that the regions of parameter space for which the approximations made are valid, correspond well to conditions in the interior of the sun. Applications of this work to radiation transport in the solar interior will therefore be discussed.

Relativistic Coulomb Binary Collision Energy Loss. Energy transfer equations for a test particle in a fully ionized relativistic plasma are presented. The charged particles interact via Lienard-Wiechert potentials and the dominant contribution to the scatterings are from small angle binary collisions. Asymptotic expansions of the energy rate equations are presented for all cases where either the test or the field particles or both are relativistic. These asymptotic equations are used to derive equations determining rates of equipartition of energy from which appropriate equipartition times are deduced. This work represents a relativistic generalization of non-relativistic binary collision coulomb scattering.

PD6
N.E. Frankel
K.C. Hines
School of Physics,
University of
Melbourne,
Parkville, Vic.

Charged Particle Motion in a Static Magnetic Field having a Power Law Dependence. As a generalisation of Seymour's exact solution for the drift velocity of a charged particle in a static magnetic field of constant gradient (A.J.P., Vol.12, pp.309-14, 1959), M. Headland and P.W. Seymour have obtained an exact solution for charged particle drift in a static magnetic field represented by $B_z = \lambda x^{\alpha}$, where λ and α are constants. The nature of the bound orbits obtained in this magnetic field are critically controlled by α. Four main cases arise, involving charged particle motions which do and do not cross the neutral plane of the magnetic field existing at $x = 0$. In the former case magnetic fields of non-reversing and reversing direction are analysed. Exact solutions for displacement per cycle, periodic time and drift velocity are expressed in terms of gamma, hypergeometric and confluent hypergeometric functions, and for $\alpha = 1$ the solution in terms of complete elliptic integrals obtained by Seymour in 1959 are recovered. Both types of hypergeometric function can be calculated by programs developed by this author for use with the Monroe 1956 desk top calculator/computer in cases where choice of α does not lead to expression of the hypergeometric functions in terms of better known well-tabulated special functions of mathematical physics.

PD7
P.W. Seymour
Mawson Institute
for Antartic
Research,
University of
Adelaide, S.A.

PD8

J.J.B. Frommelt
Ieuan R. Jones
School of Physical Sciences, Flinders University of S.A., Bedford Park, S.A.

The Use of Magnetoacoustic Oscillations as a Plasma Diagnostic Technique. Radial magnetoacoustic oscillations of a magnetized, cylindrical argon afterglow plasma were continuously excited by passing an r.f. current through a solenoid wound around the exterior of a discharge tube. The radial profile of the axial magnetic component, $b_z(r)$, of the wave field was measured during the lifetime of the decaying plasma.
A theoretical analysis was developed which yielded numerically computed $b_z(r)$ profiles. In this analysis the collision frequencies between the various species of particles present in the plasma were treated as free parameters. The values of these free parameters at any given instant during the decay of the plasma were well determined by fitting the computed and experimentally measured $b_z(r)$ profiles. By making certain reasonable assumptions, it was possible to deduce values of the electron temperature (T_e) and the ion-neutral cross section for momentum transfer (Q_D) from these collision frequencies.
The reliability of this plasma diagnostic technique was demonstrated by its ability to produce values for T_e and Q_D which agreed closely with results obtained by other workers.

PD9

T.C. Plumb
G.A. Woolsey
Physics Dept., University of New England, Armidale, N.S.W.

Langmuir Probe Characteristics in the Presence of Negative Ions.
In a plasma containing negative ions, the value of the floating potential of a Langmuir probe is lowered below the corresponding value for an electron-positive ion plasma, the reduction depending on the degree of attachment in the plasma. Hence, a measurement of probe floating potential in an electro-negative plasma can be used to provide a value for the ratio of negative ion to electron number density (degree of attachment) in the plasma. Measurements have been made in the Faraday dark space region of an iodine glow discharge. The principal sources of error are the location of plasma potential, and the extrapolation of the positive ion current region of the probe. Nevertheless, good agreement is obtained between values using the lowering of floating potential technique and more conventional probe methods, thereby providing a useful mutual check in the probe study of plasmas containing large numbers of negative ions.

PD10

M.H. Brennan
A.D. Cheetham
I.R. Jones
School of Physical Sciences, Flinders University of S.A., Bedford Park, S.A.

Non Linear Interaction of Hydromagnetic Waves. When the equations of magnetohydrodynamics are used to investigate the small amplitude hydromagnetic oscillations of the magnetosphere, it is found that two modes of oscillation may be excited - poloidal and toroidal oscillations.
In a cylindrical system having the main magnetic field lying in the direction of the axis of the cylinder, it is again found that small amplitude hydromagnetic oscillations can be classified into two modes, torsional and compressional oscillations. We have predicted that, for this case, a weakly nonlinear interaction of the torsional oscillations can lead to the generation of a compressional oscillation. Details of the theory and of the experiment which has confirmed this prediction will be presented.
In view of the efficiency of this interaction, it is postulated that a possible mechanism for the generation of poloidal oscillations in the magnetosphere is the nonlinear interaction of the toroidal oscillations.

PD11

A.R. Carr
School of Physics, University of Melbourne, Parkville, Vic.

Non Linear Wave Interactions in Bounded Plasmas. The phenomenon of nonlinear coupling between waves in a weakly turbulent plasma is important under a wide range of conditions, both inside and outside the laboratory.
Many early studies in the field used simplified models (e.g., cold, infinite, homogeneous plasma) which shortened algebraic manipulations and clarified the general nature of such processes.
Calculations on three- and four-wave interactions are progressively being applied to more realistic plasma models.
The 'averaged Lagrangian' method, introduced for calculation of non-linear effects in fluid mechanics, is one of a number of perturbation techniques applicable to lower order plasma wave coupling.
In a laboratory plasma, it is possible and convenient to study a specific three-wave process by launching the required oscillations with amplitudes much greater than the natural plasmon noise level.
Calculations are presented of interaction efficiencies for the coupling of hydromagnetic waves in a cylindrical plasma. Interpretation of observations requires that consideration be given to linear damping or growth of the interacting waves, and the "kinematics" of nonlinear energy exchange between them.
Similar calculations enable the possibility of nonlinear hydromagnetic wave processes in the Earth's magnetosphere to be investigated. Unfortunately the analytical complexity of realistic magnetosphere equations must be sacrificed in order to pursue analogies with simpler situations.

PD12

I.H. Hutchinson
M.G. Bell
A.H. Morton
J.D. Strachan
C.F. Vance
Dept. of Engineering Physics, A.N.U., Canberra, A.C.T.

The Runaway Electron Discharges in LT-3. In Tokamak discharges at least four distinct regimes may be discerned:

(1) Dissipative, characterised by low temperatures and overall hydromagnetic stability.
(2) Unstable, whose major feature is the 'disruptive instability'.
(3) Stable, featuring a high temperature with good stability.
(4) Runaway, where an appreciable proportion of the current is carried by runaway electrons.

The Canberra device LT-3 operates typically in the Dissipative or Unstable regimes. However, at low filling pressures, it exhibits a runaway type regime which frequently reverts during the discharge to the unstable behaviour. A number of stable discharges have also been observed.
LT-3 appears to run close to the boundaries between various regimes and experiments reveal many of the features observed on other machines. In particular the initiation conditions seem to be important to the later part of the discharge.
Radial scans of the runaway population have been obtained by the introduction of a 1 mm diameter Tungsten wire into the plasma which yields thick target bremsstrahlung characteristic of the runaways. Magnetic probes have also been used to obtain information on current density and the transverse displacement of the plasma. Perpendicular magnetic fields also appear to be important and especially affect the runaway electrons.

PD13

R.L. Dewar*
R.C. Grimm
J.L. Johnson**
E.A. Friemann
J.M. Greene
P.H. Rutherford
Princeton University, Plasma Physics Lab.
* A.N.U. Canberra
**Westinghouse Research Labs.

Long-wavelength Kink Instabilities in Low Pressure, Uniform Axial Current, Cylindrical Plasmas with Elliptic Cross Sections.
The desire for axisymmetric tokamak configurations with higher β and stronger ohmic heating currents at a fixed rotational transform, together with the observation that non-circular plasma cross sections may alleviate trapped particle instabilities, has motivated interest in configurations with non-circular cross sections. Detailed study of the magneto-hydrodynamic stability of systems with realistic current and density profiles is not analytically tractable. For this reason we are developing a computational program to study the nature of the most unstable modes in such devices. It is essential that the development of the program be coordinated with analytic work on tractable special cases, where the analytic work can provide an indication of the accuracy of the numerical program. Analytic studies of such special cases are also useful because they produce insight into the physical mechanisms at work in the system. In the spirit of the above remarks we have investigated the magneto-hydrodynamic stability of a straight plasma column with elliptic cross section, carrying a uniform axial current, by extremizing the Lagrangian of the system using a natural coordinate system based on the magnetic field lines. Stability criteria and eigenfrequencies are derived analytically for systems with uniform mass density inside the plasma. It is shown that coupling between kink modes and Alfven waves, produced by non-circularity, is a destabilizing effect. A technique for solving the problem numerically is also discussed and used to demonstrate the effect of a spatially varying plasma density on the growth rate.

PD14

I.R. Jones
E.L. Murray
M.G.R. Phillips
P.G. Weber
The Flinders University of S.A., Bedford Park, S.A.

A Fast Linear Z-Pinch. The current state of our fast linear Z-pinch plasma source programme will be discussed and initial results presented.
This high β plasma source was first commissioned at the beginning of 1974 and work is now proceeding to define its operating regime. The pinch is established in a vacuum vessel 100 mm in diameter and with a pinch length of 500 mm. A dual circuit high current step generator is used to provide the required fast rising current pulse of the pinching phase and the continuing current of the subsequent confinement period. This circuit was initially proposed by Weibel and Jones and in its present form produces an initial current pulse having a 1.2μ second rise time and an amplitude of 40 K amps. An improved fast capacitor-switch assembly is being obtained to provide an alternative higher performance unit for the hybrid capacitive-inductive energy store circuit. Pre-ionization of the filling gas (deuterium) is achieved by means of a conventional capacitor discharge along the axis of the pinch chamber.
Computer simulation of the pinch behaviour by means of a one-dimensional hydromagnetic programme has been used to aid in the choice of circuit parameters and as a basis for the interpretation and planning of plasma experiments.
Initially studies are being made of the collapse phase and the gross stability of the pinched column. Diagnostic techniques available

include the usual voltage and current measurements and magnetic probes, streak camera, framing camera and, after the physical behaviour of the pinch has been defined, a ruby laser for scattering measurements, and a pulse T.E.A. CO_2 laser for interferometric studies.

Laser Pulse Tailoring for the Optimum Compression of Matter. Laser compression of matter to very high densities would lead to significant advances in the fields of laser-fusion and dense matter physics. The optimum compression of matter to very high densities requires careful tailoring of powerful laser pulses. Results obtained with a versatile pulse tailoring system will be presented.

PD15
J.L. Hughes
Dept. of Eng. Physics,
Research School of Physical Sciences,
A.N.U., Canberra.

MHD Electric Power. Developments in the field of generation of electrical energy using magneto-hydro-dynamic i.e. MHD processes passed a major stepping stone in 1972 with the running up of the first experimental 25 M Watt MHD power station U-25 near Moscow. Most promising at present is the so called open-cycle process using fossil fuels and preheated air to produce the plasma carrier in the generator. There is to be expected a possible increase of the overall efficiency up to 50% in first generation plant and up to 60% later on with an associated considerable drop in thermal and atmospheric pollution. Other approaches considered involve nuclear reactors and fossil fuels to produce the thermal power in conjunction with heat exchangers, transferring the heat to a noble gas as plasma carriers in the MHD generator. Maximum temperature requirements can then be dropped from 3300°K as required in open-cycle systems down to 2000°K. A further reduction down to 1000°K is feasible with liquid metal MHD processes. MHD is also considered in conjunction with nuclear fusion power plant as a natural direct conversion link.

PD16
H.K. Messerle
University of Sydney, N.S.W.

Radiative Energy Loss from a Shock Tube Plasma. A study was made of the radiative energy loss from an argon plasma produced in a shock tube. Experimental measurements were performed at electron densities up to 1.5×10^{18} cm^{-3}, and temperatues of 14,500 °K. Under these conditions, the rate of energy loss by radiation is of the order of 10^6 Watts cm^{-3}, and this produces a strong gradient in the thermodynamic properties of the plasma following the shock wave.
Photographic techniques were used for most of the measurements, and were supported by limited use of photoelectric methods. Electron temperature and density (T_e and N_e) were measured at the shock front, whilst the decay in electron temperature was obtained from measurements at a number of points in the plasma following the shock. Electron temperature was determined by the ratio of line intensities and also the ratio of line intensity to continuum intensity. The electron density was determined from measurement of the Stark width and shift, making allowance for the effect of optical depth of the line.
The decay in electron density in the plasma following the shock was not measured directly. Instead, the time dependence of the continuum radiation was measured. As the continuum intensity is dependent upon $N_e^2/T_e^{\frac{1}{2}}$, and the electron density was the fastest varying thermodynamic property, this provided a good indication of the electron density.
The results were found to be consistent with a theoretical analysis, in which the state of the plasma was calculated by including the energies of the excited states of the atom and the ion, as well as the lowering of the ionization potential, and the radiation from the plasma was determined by accounting for the optical depth of both the continuum and line radiation, and their interrelationship.

PD17
P.F. Logan
R.J. Stalker
Physics Dept.,
A.N.U., Canberra.

Plasma Generated Current Density and Potential Field. Gradients in charged particle density and temperature across and along plasma boundaries constitute e.m.f.'s which drive circulating currents through the body of the plasma. Axial gradients in ion and electron temperature and density produced by the expansion of a gas in a conical hypersonic nozzle are continuous with radial gradients in the nozzle boundary layer, and such a situation provides a case in which the ensuing current field can be solved for, and used to predict the potential field throughout the nozzle. Particular attention must be paid to the satisfaction of all electrical boundary conditions along the debye layer on the nozzle wall.
The predicted current density field is discussed, and the predicted potential field is compared with measured potential.

PD18
G. Caldersmith
Dept. of Physics,
School of General Studies,
A.N.U., Canberra.

Arc Driven Shock Waves. Some properties of plasmas produced behind strong shock waves generated in an electrothermal diaphragm shock tube are discussed. The measurements have been performed mainly in reflected shock plasmas with electron densities around 10^{18} cm^{-3} and temperatures of about 15,000 °K. The diagnostic techniques used include emission line intensity ratios, optical absorption and interferometry.

PD19
M.G.R. Phillips
A.A. Pugatschew
School of Physical Sciences, Flinders University of S.A.,
Bedford Park, S.A.

Shock Refraction at Cold to Hot Gas Interface. Shock refraction has been studied as a shock wave passes from R.F. prepared plasma to cold gas and vice versa.
The interface behaves very much like a step discontinuity in density, and thus one dimensional refraction theory describes the situation adequately.
When the shock wave passes from cold to hot gas, theory predicts a pocket of high mach number gas formed.
Experimentally, streak photographs have given excellent agreement with the predicted speeds of shock fronts and some contact surfaces.
However, it is desired to measure gas velocity another way. A special shock tube has been built allowing Schlieren measurements of gas velocity.
Theoretical and experimental results will be discussed.

PD20
J. Gerofi
Dept. of Elec. Eng.,
Sydney University,
N.S.W.

Collision Induced Dissociation of HeH^+ at 1000eV. When a light diatomic molecular ion such as HeH^+ interacts with a gas target such as helium at laboratory energies in the range of 0.2 to 3 KeV, the interaction time of the proximate colliding bodies is short enough for the internuclear motion of the molecular ion to be treated by the Born-Oppenheimer approximation, while the electrons are considered as adjusting adiabatically during the collision.
Thus at moderate energies the cross-section for electronic excitation of the molecular ion upon collision has sufficiently decreased so that the dissociation channel involving rotational-vibrational transitions to the continuum via polarization forces becomes important. Such mechanisms for both collision induced dissociation and auto-dissociation of molecular ions are being studied experimentally in this energy range using various isotopic species of HeH^+ incident on noble gas and diatomic targets.
"Collision Induced Dissociation" means either:

(a) $HeH^+ + X \rightarrow H^+ + He + X$

or (b) $HeH^+ + X \rightarrow H_e^+ + H + X$

Results show that the 1 KeV HeH^+ which dissociates along the former pathway is probably highly rotationally-vibrationally excited upon leaving the ion source and is promoted on collision to one of a limited number of "quasi-stationary" states. The energies of some of these states are in agreement with those seen by other workers at 10 KeV and their lifetimes are in approximate agreement with theoretical calculations.

PD21
Roger I. Price
University of
W.A.

X-Ray Spectral Measurements of the Dense Plasma Focus. The time resolved spectrum of the X-ray emission from the dense plasma focus has been measured over the energy range 1 to 5 keV using a four channel foil absorption spectrometer. The energy distribution of the electrons in the plasma can be calculated from these measurements and the electron temperature derived.

PD22
G.R. Hogg
J. Tendys
Physics Division,
A.A.E.C. Research
Establishment,
Sutherland, NSW

SECTION: PE: PHYSICS EDUCATION.

General Chairman E.R. Sandercock Sturt College of Education

A System Approach for Teaching Electronics to Scientists.
It is now well accepted that electronics is an important unit of physics courses but the best way to present it is a perennial problem. Several different methods have been tried including a mathematical approach, a qualitative physical approach, and laboratory self-pacing units. Each of these has its advantages, disadvantages, and particular constraints. In trying to overcome some of the problems we have developed a system approach.
This method is designed to bring 2nd or 3rd year students to a level of understanding required to walk into a laboratory and with the aid of manuals, sort out the electronic systems. The basis of the approach is a method of analysis of electronic systems rather than detailed exposition of many different types of circuits. It involves the use of function-oriented block diagrams of systems, apparatuses, circuits, and circuit elements. The details of this approach and examples will be presented.

PE1
J.A. Barclay
D.R. Hutton
Monash University

Audio-Tutorial Laboratory Instruction at the D.D.I.A.E. A self-instruction laboratory course, utilizing Keller-Plan methods, has been used for two years to provide an integration of theory and experimental work in the first-level course in electricity-magnetism. A description of the laboratory and students' test results and attitudes will be presented.

PE2
P.T. Dobney
Darling Downs Institute of Advanced Education,
Toowoomba, Qld.

PE3
B.H. O'Connor
Dept. of Physics,
W.A.I.T.

Medical Radiography Courses at the Western Australian Institute of Technology. Diploma courses in medical radiography (diagnostic and therapeutic) have been established in the Department of Physics at the W.A.I.T. as part of a move to develop medical physics courses in the department.
The courses are offered on a day release basis with students attending W.A.I.T. for two days per week in first and second years, and for one day per week in third year. Students spend the remainder of their time working under supervision in a hospital X-ray department or private radiological practice. Formal credit is given by W.A.I.T. for this clinical practice part of the course.
Teaching is conducted on-campus by W.A.I.T. staff, mainly from the Physics Department, and by visiting clinical lecturers (radiologists, radiographers and a nursing sister).
During the early stages of course development a substantial proportion of the department's equipment vote has been used in building up modern radiographic facilities within the department. This has given a great deal of stability to the teaching programme.

PE4
E.R. Sandercock
Sturt College of Advanced Education,
Bedford Park, S.A.

Changes in Secondary Science - Its Implication for the Teaching of Physics. With the demand by students for relevance, the difficulties associated with employment prospects for physicists, the disappearance of external public examinations at the end of secondary school and the impetus of open education, should the physics community continue with its present educational philosophy or is some rethinking necessary?
In this review some important changes in secondary school education will be outlined and the consequences for tertiary physics education will be discussed. Areas for discussion will include methods of instruction, teacher education, tertiary physics courses for the non-physics major, education of tertiary teachers, physics in interdisciplinary and environmental studies, physicists and social responsibility.

PE5
Jean Clark
Swinburne College of Technology.
Paul Clark
Monash University.

The Teaching of Physics to Non-Scientists. Courses in Physics for students with a non-scientific background have been offered at the tertiary level for many years. These courses have not met with great success and some possible reasons for this are discussed. Recently, however, the growth in student demand for studies of an interdisciplinary or multidisciplinary nature has indicated the need for tertiary institutions to review the status of non-specialist courses in their educational programmes.
Courses in Physics for students of the humanities are being introduced this year (1974) at both Monash University and Swinburne College of Technology. The major objective of these courses and examples of the learning structures adopted will be presented. Results, conclusions, and impressions, if any, will be given at the conference.

PE6
M.J. Goodspeed
CSIRO, Division of Land Research,
Canberra.

Physics in Environmental Studies. The paper reviews applications of physics in the increasingly important area of environmental studies. Emphasis is directed towards applications of physical principles, methods and instruments rather than to studies of the physics of the environment, although the distinction is often ill-defined.
Examples discussed range from methods for remote sensing of environmental parameters, and interpretation of the data obtained, to the design of instrumentation for the recording of environmental data in unfavourable areas.
It is suggested that several problem areas exist where application of physical knowledge and techniques may be able to provide solutions.

PE7
T.E. Peacock
Dept. of Chemistry,
University of Queensland,
St. Lucia, Qld.

Interdisciplinary Undergraduate Courses. Over the past four or five years several interdisciplinary courses with a high physics content have been developed in the University of Queensland. This development is discussed and one such course is described in detail. This is a course entitled 'Molecular Energetics' and is given as a third year course and presupposes some knowledge of quantum mechanics, classical thermodynamics and statistical mechanics. It is designed for students with substantial backgrounds in physics, or mathematics or chemistry or any combination of these subjects.
The basic aim of the course is to explore the meaning of the concept of entropy. During the course students are led into a consideration of the energetic questions which arise in chemistry, biochemistry, biophysics, cybernetics and cosmology. Tutorials and problems classes enable many of the concepts discussed in lectures to be developed at greater length with maximum student involvement. The students are finally led to ultimate questions such as 'What sort of thermodynamic system is the universe?' and 'What do we mean by The Arrow of Time?' .

Textbooks:-

Contributions of the Physicist to Chemistry and Biology.

PE8

J.R. Pilbrow
Dept. of Physics,
Monash University.

The principles of physics provide the basis for a theoretical understanding not only of those areas of knowledge traditionally the preserve of the physicist, but also for much of the present insight into chemistry. Some of the greatest successes of physics have come about through the application of quantum mechanics to chemistry! For example, in the electron spin resonance of metal ion compounds or complexes of chemical and biological interest, it now turns out that development of the physics of low symmetry systems is needed in order to make any progress at the present time. This indicates that there are often fruitful opportunities for the physicist to be involved in some of the problems of his chemist or biologist colleagues, but there has to be a willingness to understand what these other people are doing before it is possible to see whether major opportunities for new interpretive or experimental skills exist. Physicists, by virtue of a training which is more comcerned with ideas, general principles, and a broad experimental experience, are ideally suited to be involved in more fundamental physical and model building aspects of problems which lie completely outside the traditional areas of physics. Such research and development requires genuine collaborative and interdisciplinary activity, and usually cannot be done by a physicist working in isolation.

A Conceptual Framework of Physics Education for Papua New Guinean Students.

PE9

E. Balasubramaniam
I. Brazier
Papua New Guinea
University of
Technology,
Lae

The teaching of Physics in Papua New Guinea is challenging because the teacher should not only know his subject matter well but he should be able to cope with the educational problems presented by the rapidly developing culture. Students from a very wide variety of backgrounds will be found in the one class. These may vary from relatively sophisticated urban experiences such as in Port Moresby to village life in remote areas where western influence is still very minimal. The majority of students will come from a basically non-technological society. There will also be a lack of a common basic language although by high school they will have learnt English as a second language.

Often the slowing down of the learning processes is not due to any intellectual disabilities but is a result of some degree of personal maladjustment.

Further in a rapidly changing society such as Papua New Guinea, the knowledge, skills and insights which are acceptable by graduates at the time of graduation tend to decay unless they are continually utilized and replaced. Here the teacher should play a more important role by motivating the students to continue their own education after they leave the Institution. It is clear then that the task of preparing any teaching material for the Papuan New Guinean student of today should consider content that has value for his environment today and tomorrow. A person's scientific literacy results from his basic knowledge, investigating experience and curiosity. This paper outlines a conceptual framework in which these factors are integrated, balanced and developed through the students involvement with major physics concepts, key process-oriented concepts and challenging problems for investigation. Examples are cited to help students develop their thinking processes from the concrete to the abstract and how, as they accumulate experiences and ideas, their curiosity becomes more disciplined and creates an awareness of its usefulness to their own society.

Some Aspects of Tertiary Teaching.

PE10

Jury Mohyla
Sturt College of
Advanced Education,
Bedford Park, S.A.

Pedagogy is the work of a teacher. Pedagogics is the art and science of teaching. These are two complementary functions. The art of teaching is revealed in the process of instructing students, the science of teaching is applied to course and curriculum development.

Any improvement in science education at the tertiary level will not be solely due to the outcry for curriculum reforms. Science Education in Australia, as elsewhere, will flourish only in the hands of exemplary teachers, men and women of magnanimous character and intellectual integrity.

The rush to teach topical courses such as Environment and Conservation, Energy Crisis, Health Science may not enhance the attractiveness of science courses to undergraduate students. These types of courses, most suited to post-graduate programmes, when offered to undergraduate students with no or minimal background in physics, chemistry, biology and mathematics may even fail to produce a scientifically literate laity.

In this paper a number of teaching/learning modes will be discussed with an orientation towards the natural, physical and applied sciences. The role of the teacher at a University and C.A.E. will be examined through a number of activities, such as teaching, research and community service. Evidence drawn from research in many aspects of

education and from established philosophy of education indicates that there is no single blue-print for a mass production of competent tertiary teachers, and no single curriculum that can be successfully applied en masse.

SECTION: CR: COSMIC RAYS

General Chairman J.R. Prescott University of Adelaide

A Search for Tachyons at Adelaide. Until the last decade it had been almost universally held that a consequence of the special theory of relativity was that particle velocities greater than the velocity of light were not possible. It was however pointed out that provided super-luminary particles were created and remained superluminary, then a redefinition of their mass was possible which was compatible with relativity. There was thus no a priori reason for dismissing the existence of tachyons.
Work has been done at Adelaide to detect effects which appear to precede substantially the highly relativistic particles in cosmic ray showers and could therefore be associated with tachyons. Results seem to suggest that some non-random effects may be observable in the time period up to 100μs before the observation of air showers.

CR1
R.W. Clay
P.C. Crouch
Dept. of Physics,
University of
Adelaide, S.A.

Nuclear Interactions at Cosmic Ray Energies. In spite of the ever-increasing energy of accelerators, cosmic rays continue to provide a supply of particles at energies substantially larger than accelerators can provide. The paper will discuss some of the ways in which the properties of nuclear interactions at such energies can be inferred from cosmic ray studies.

CR2
K. Sivaprasad
Tata Institute
of Fundamental
Research,
Bombay, India.

The Adelaide University Cosmic Ray Air Shower Array at Buckland Park. An installation consisting of eight scintillators, spaced over an area of about $10^4 m^2$ is in operation. It records the direction of arrival, size and point of impact of cosmic ray air showers in the energy region about 10^{16}eV. Radio-like signals associated with the arrival of showers have been observed over a range of frequencies from 100 kHz to 50 MHz. At the high frequency end of this range the signals are known to be generated by the interaction with the earth's magnetic field of the electric charges in the shower. At low frequencies the observations at Buckland Park suggest that an interaction with the earth's electric field is responsible. At frequencies of a few MHz the measurements seem inconsistent with those at either lower or higher frequencies.

CR3
J.R. Prescott
J.R. Patterson
D.M. McDonald
A.G. Gregory
P.C. Crouch
R.W. Clay
Dept. of Physics,
University of
Adelaide, S.A.

The History of Free Electrons Produced by Cosmic Rays at Sea Level. Knowledge of the mean lifetime and motion of free electrons produced in the lower atmosphere by cosmic rays is required to test alternative theories of the origin of low frequency radio signals that are associated with cosmic ray showers. The transport data that are available for air and oxygen have been analyzed in an attempt to make reasonable estimates of the behaviour of the electrons between formation and capture. The analysis highlights the inadequacy of all the existing data for low energy electron swarms in air.

CR4
R.W. Crompton
Ion Diffusion
Unit, Research
School of
Physical Sciences,
Australian National
University.

The Characteristics of Pulsed Radio Noise. Models of background radio noise are often based on impulsive processes such as lightning discharges and motor ignition. To obtain a better understanding of these processes, it is desirable to study the radio impulses with large receiver bandwidths in order to determine what time structure, if any, they exhibit.
Observations of noise pulse structure have been made at 50 MHz with 10 MHz bandwidth at both a rural and an urban site. Considerably more time structure is observed at the urban site, with the structure typically extending up to several hundred nano-seconds after the start of the noise event. Such structure has been observed in the vicinity of vehicles under test.

CR5
R.W. Clay
P.C. Cottrell
J.R. Prescott
Dept. of Physics,
University of
Adelaide, S.A.

A Review of the Properties of the Transient Sources observed in X-Ray Astronomy. Among the cosmic X-ray sources is a class of object known as X-ray novae. The first example, Centaurus X-2, was discovered in 1967 in a Skylark rocket flight from Woomera as the result of an experiment by the joint Universities of Adelaide and Tasmania group. Since then several other sources with similar characteristics have been discovered by other observers, the main characteristics being that a source of X-rays appears in the sky where none had been seen

CR6
K.B. Fenton
Dept. of Physics,
University of
Tasmania.

before and the intensity then declines with a time constant of weeks or months. The available data are discussed with the objective of examining to what extent the X-ray emission of such objects can be understood in terms of models appropriate for other galactic X-ray sources such as those involving processes in the vicinity of compact objects (neutron stars or black holes).

The Cosmic Ray Sidereal Variation at Energies ~ 10^{11} eV. A small diurnal variation in sidereal time has been observed for many years in the flux of cosmic rays in the energy range 10^{10} to 10^{12} eV. It now seems that more than one mechanism contributes to this effect. There is strong evidence for the existence of a genuine sidereal variation independent of any solar system parameters. Another mechanism is controlled by the interplanetary magnetic field. The interpretation of observational data is discussed in the light of these effects.

CR7
J.E. Humble
Dept. of Physics,
University of
Tasmania.

SECTION: NP: NUCLEAR PHYSICS

General Chairman I.E. McCarthy Flinders University of S.A.

Nuclear Theory. Progress in the basic problem of the theory of the nucleus, namely the computation of the properties of a nucleus from the properties of the nucleon-nucleon interaction, will be reviewed. In summary the present situation is that bulk properties of the nucleus (its radius, and the total binding energy) are reasonably well understood, but that many fine details are not understood from first principles.

NP1
Bruce H.J. McKellar
School of Physics,
University of
Melbourne,
Parkville, Vic.

The Undiscovered Particles in High Energy Physics. A summary review of the sources and present status of particle hypotheses in high energy physics, along with possible relations between them, as follows: the magnetic monopole, the quark with and without charm, the parton, the gluon, the W-meson, cosmic ray particles, the tachyon.

NP2
D.C. Peaslee
Australian Nation-
al University.

Nuclear Physics in Australia.
A review paper.

NP3
Sir Ernest Titterton
Research School of
Physical Sciences

Experimental Nuclear Physics. This lecture is concerned with some techniques used in experimental nuclear physics and the type of information that may be gleaned from their use, and also some of the uses to which the technology of nuclear physics may be put in other areas of physics.
Some aspects of the contribution of silicon detector telescopes in identifying the particles emitted in nuclear reactions will be discussed. Such particle identification enables the study of weak reactions in the presence of prolific ones, and in identifying exotic nuclear species emitted in reactions. They are mandatory for the study of reactions induced by heavy ions. These reactions may be used to study nuclear collective motion and/or nucleon clustering in nuclei.
The advent of the Ge(Li) detector has opened a new era in γ-ray spectroscopy. The resolution obtainable is at least a factor of 20-40 better than that obtainable with sodium iodide. The resolution of the Ge(Li) detectors is high enough to allow the measurement of the Doppler shift in the energy of a γ-ray emitted by a moving source. If this moving source is a recoiling nucleus, techniques developed enable the measurement of nuclear state lifetimes in the range 10^{-10} to 10^{-13} sec. Some discussion of these will be presented.
The use of α-particle backscattering experiments in determining the properties of surface films will be discussed, for two possible systems. The first is concerned with films of solids deposited on solid, and is able to give a good deal of information on the nature of the film-solid interface. The other situation envisaged is that of a gas-liquid interface, although the detection of characteristic X-rays following α-particle bombardment may be a better way to analyse that interface.
If time permits, some attention will also be given to simple forms of position-sensitive detectors which are proving to be absolutely necessary in nuclear physics at energies of some hundreds of MeV. Superconductivity is also making its presence felt in nuclear physics and at least two electron linear accelerators with superconducting wave guides are being built now.

NP4
B.M. Spicer
School of Physics,
University of
Melbourne,
Parkville, Vic.

Few-Body Problems in Nuclear Physics. Why are few-body problems interesting? What progress has been made, and what are the prospects for the future? These are the questions to be discussed in this talk. The fundamental answer to the first question is that few-body systems are relatively simple, perhaps even simple enough to be worked out exactly, once the nuclear forces are given. In that way one might hope to discriminate between different nuclear forces, by comparing the different few-body predictions with experiment.
Great progress has been made with few-body studies over the past ten or so years, both theoretically and experimentally, but the goal of elucidating the underlying nuclear forces remains elusive. In the case of the three-nucleon bound states, the available experimental information is limited, and discrepancies between theory and experiment are not easy to interpret. For three-nucleon scattering states, on the other hand, there is now a wealth of experimental information, but it seems that most reaction observables are rather insensitive to the details of the nuclear forces. In one sense, however, the insensitivity is an advantage, since it means that the three-nucleon (and four-nucleon, etc.) amplitudes provide valuable input information. It is likely, therefore, that few-body studies will help to open an upward path to a quantitative understanding of more complex nuclear processes, as well as a downward path to the underlying nuclear forces.

NP5
I.H. Sloan
Dept. of Applied Mathematics, University of N.S.W.

The N-N Interaction.

NP6
M.J. Engerfield
Monash University

High Momentum Resolution $\bar{p}p$ Total Cross Section in the 'T' Region.
We report here on a high mass resolution measurement of the pp total cross section in the 'T-meson' region at P_{lab} = 1.3 GeV/c.
The experiment utilized a partially separated beam at the Brookhaven AGS. It was performed in an optical spark chamber array originally designed to measure angular distributions of pure neutral mesonic final states of $\bar{p}p$ annihilations. At the end of this experiment we performed an experiment to search for resonances of definite G-parity in the T region by a measurement of the true pion multiplicity (charged and neutral) of $\bar{p}p$ annihilations. The trigger for this experiment was a small counter downstream of the target which vetoed the unscattered beam. The electronic rates monitored during data taking - closely related to the total cross section - showed strong suggestions of substructure in the T-meson region. We repeated the electronics portion of the experiment with higher statistics, extracted the total cross section, and present the results here.

NP7
W. Aitkenhead
R.E. Lanou Jr.
M. Marx
D.C. Peaslee
F. Posa
L. Rosenson
R.K. Thornton
ANU-Bari-Brown-M.I.T. collaboration

Distribution of mass in the symmetric region of neutron-induced fission.
One of the most important characteristics of low energy fission is the asymmetric distribution of mass, mass yields in the symmetric trough being some 100 times smaller than in the asymmetric peak regions for thermal neutron-induced fission. Few accurate cumulative yields have been made in the symmetric region of the fission yield curve, even for the technically important fissionable nuclei such as ^{235}U and ^{239}Pu.
The two mode fission hypothesis predicts the existence of a symmetric peak in the cumulative fission yield distribution, the probability of which increases with increasing excitation energy. The presence of fine structure in the symmetric region is also predicted where discontinuities in the neutron emission versus mass curve exist.
A study of the cumulative yields in the symmetric region for thermal and fast neutron induced fission of ^{233}U and ^{235}U and fast neutron induced fission of ^{238}U has been carried out using solid source mass spectrometric techniques. Tin and cadmium, with 10 and 8 isotopes respectively, are ideally suited to this problem since many of their isotopes are the stable end products of fission chains in the symmetric region.
The results indicate that the mass yield curve for thermal induced fission is relatively flat from mass 111 to mas 120 and then steepens sharply at larger masses. On the other hand, the fast fission data reveals evidence of fine structure in the valley of symmetry and this is critically dependent on the mass of the fissioning nuclide. No evidence of a symmetric peak was observed.

NP8
J.R. de Laeter
Dept. of Physics, W.A. Institute of Technology.

The Possible Transmutation of Radioactive Waste from Nuclear Reactors

NP9

J.R. Harries
AAEC Research Establishment, Lucas Heights, NSW.

A nuclear reactor power program produces high level and long lived radioactive wastes. The high level activity is associated with fission products, but beyond 400 years the principal waste hazard is from transuranic elements produced in the reactor.
Several schemes have been proposed for the transmutation of the problem isotopes into more easily handled isotopes. The neutron flux in a thermal reactor is not high enough to significantly reduce the longer lived fission product isotopes ^{90}Sr and ^{132}Gs, but the transuranic elements can be reduced by recycling through power reactors. The limitation on recycling of the transuranic elements is the separation process to remove trace quantities from the waste stream. In fast reactors the transuranic elements are the principal fuel and fast reactor waste contains only half as much ^{90}Sr as thermal reactors. However, the overall waste hazard is similar to thermal reactors.
A sufficiently intense neutron flux for fission product transmutation could perhaps be produced by a spallation reactor driven by a proton linear accelerator or a controlled thermonuclear reactor. However, both concepts are still some years in the future. Transmutation by accelerator sources of protons, electrons or gammas tend to require more energy than neutron transmutation.

SECTION: AM: ATOMIC AND MOLECULAR PHYSICS

General Chairman A.J. Blake University of Adelaide

SESSION: ATOMIC REACTIONS

The (e,2e) Reaction in Atoms and Molecules.

AM1

E. Weigold
S.J. Hood
P.J.O. Teubner
School of Physical Sciences, Flinders University of S.A., Bedford Park, S.A.

A study has been made of electron impact ionization in which the kinematics of all the electrons are fully determined. The two final electrons are detected in coincidence, their energies and angles being separately determined. The apparatus and associated electronics will be fully described. The experiments are carried out with an online computer (PDP-8L) in order to speed up data taking.
Accoridng to the off-shell distorted wave impulse approximation (AR2), the coincidence counting rate as a function of momentum transfer to the ion should be given by the square of the momentum space wave function of the ejected electron. This has been very well confirmed by the results of our investigations on the outer states of He and Ar (i.e. the 1s and 3p states). The high lying hole states of Ar and Kr (3s and 4s respectively) show level splitting which can only arise from electron-electron correlations. This is not observed in neon.
The technique has also been used to investigate momentum space wave functions of electrons in molecular orbitals and the results on H_2 and CH_4 will be presented.

Theory of Atomic and Molecular Reactions.

AM2

I.E. McCarthy
Flinders University Of S.A., Bedford Park, S.A.

The amplitudes for the reactions (e,2e) and (e,e) on atoms and molecules contain quasi-three-body amplitudes for the interaction of two electrons with each other and with a third atomic or molecular body which has internal degrees of freedom.
The off-shell distorted-wave impulse approximation has been developed to describe these amplitudes. The electron-atom interaction in this approximation is described by an optical model potential. This potential has also been derived from first principles and calculated for electron elastic scattering at various energies on argon, neon, krypton, hydrogen and potassium. Excellent fits to angular and energy distributions are obtained.
It has been shown that an eikonal approximation is valid for the optical model wave functions. With this approximation the (e,2e) cross section for argon (3s and 3p) and helium has been evaluated. We are able to confirm that the best single-particle model is given by the best Hartree-Fock wave functions. The fit is very sensitive to the details of such functions. We are able to investigate correlated wave functions and derive absolute spectroscopic factors from (e,2e) data.
The (e,2e) reaction has been calculated for molecules, allowing for rotations and vibrations. Radial details of multi-centre wave functions are obtainable. Slater (effective charge) wave functions are inadequate. Free-atom Hartree-Fock functions are much better.

Elastic Scattering of Electrons from Atomic Hydrogen. Differential cross sections for the elastic scattering of electrons from atomic hydrogen have been measured at 9.4, 12.0, 20, 30, 50, 100, and 200eV over the angular range of 15° - 135°. The data at 9.4eV are shown to agree with a previous measurement and to agree with the prediction of the close coupling approximation even at the smaller scattering angle of the present experiment. The data at 12eV agree very well with the 6-state close coupling calculation. The data at 20eV agree well with a close coupling calculation except at the most forward angles. The results at the higher energies, 30eV - 200eV, normally called the medium energy range, are compared with various theoretical calculations based on both low energy and improved high energy approximations. Neither the high (e.g. Born, Glauber etc.) nor the low energy approximations give an adequate description of the data over the whole angular range in this intermediate energy region. Below 50eV, however, the low energy approximations appear to give more satisfactory results.
The ratios of the total cross sections for elastic scattering of electrons from atomic and molecular hydrogen have also been determined over the above energy range.

AM3
E. Weigold
R. Lloyd
B.R. Lewis
P.J.O. Teubner
Flinders University of S.A., Bedford Park, S.A.

Elastic and Inelastic Scattering of Electrons by Ne, Ar, Kr, and Xe. Measurements are reported of angular distributions for electrons elastically scattered from argon in the energy range from 15eV to 200eV, and over a more limited energy range for krypton, neon and xenon. A modulated crossed beam technique was employed and an angular resolution of about 3° realized in the range 20° - 140°. In general the results agree well with those of previous workers at the higher energies, but it is observed that the dynamic range of the present results is far greater at intermediate and lower energies. We have calculated angular distribution using a semiphenomenological optical model and find good agreement with the experimental data down to 30eV. The recent relativistic calculation of Walker (1971, Advances in Physics 20, 257-323) are in good agreement with the data over the whole energy range. The measured relative dependence with energy of the differential cross sections at 30° are compared with theory. Several angular distributions for the inelastic scattering of electrons from argon and krypton have been measured in the energy range 30-120eV. The data are compared with the theory of Sawada et al (1971, Phys. Rev. A4, 193-203).

AM4
B.R. Lewis*
J. Furness
E. Weigold
P.J.O. Teubner
Flinders University of S.A., Bedford Park, S.A.
*Now at Adelaide University

The Need for High Resolution Studies in Ultraviolet Photon Absorption. The need for high resolution measurements is illustrated by considering the absorption of ultraviolet radiation by atmospheric gases. The case of the Schumann-Runge bands of molecular oxygen provides an important example where broad band absorption cross section measurements cannot be used to give an accurate determination of the penetration of solar ultraviolet radiation through the atmosphere. While some approximate analytical techniques can be devised to make better use of broad band measurements a full understanding of the problem requires complete resolution of the rotational structure of the diatomic molecule.
The Adelaide six metre vacuum monochromator with its designed resolution of 10^{-2} Å provides the means to measure vacuum ultraviolet absorption cross sections with the necessary resolution. The relevance of this work to the problem of the origin of atmospheric oxygen will be discussed.

AM5
J.H. Carver
Dept. of Physics, University of Adelaide, S.A.

Construction of a Six Metre Vacuum Ultraviolet Monochromator. A six metre monochromator designed to operate from the visible to the far vacuum ultraviolet has been constructed in the Physics Department of the University of Adelaide. The instrument will be used primarily for the precise measurement of the ultraviolet photoabsorption of gases of interest in the study of atmospheric composition and evolution. The design principles of this unique instrument will be outlined. In particular some of the problems encountered in the construction of an instrument which can operate as a scanning monochromator while at the same time achieve the maximum resolving power will be discussed. Finally the technique used for alignment and calibration of the instrument will be given.

AM6
D.G. McCoy
Dept. of Physics, University of Adelaide, S.A.

Angular Distributions and Partial Cross-Sections for Photoionization in Argon. In the experiments to be described here synchrotron radiation was used as a continuum radiation source to study the way in which the angular distribution of photoelectrons from the 3p shell of argon varies in the range 0-20 eV above threshold. The partial cross-section for the photoionization of the 2p shell was also measured as a function of energy.

AM7
P. Mitchell
University of N.S.W., Kensington, N.S.W.

Measurement of Partial Cross-Sections by Photon-Electron Spectroscopy.
Photo-electron spectra have been obtained for some atmospheric gases using a spherical grid retarding potential analyser with 0.6% resolution. Electrons were collected at an angle of 54° to the principal axes to eliminate effects of photon beam polarization, and angular distribution of ejected photo-electrons. Relative partial cross-sections for ionization to discreet electronic states were measured over a range of wavelengths using a 1 meter vacuum monochromator. Relative strengths of vibrational levels were measured for some states, both on and off autoionized resonances, and results compared with Franck-Condon factors. Atomic oxygen has been produced by microwave discharge and can be distinguished in a mixture of O_2 by its photo-electron spectrum.

AM8
A.J. Blake
J.M. Hutton
W. Lindemans
Physics Dept., University of Western Australia.

Differential Cross-sections for Elastic and Inelastic Electron Scattering from Atomic Hydrogen at Intermediate Energies.
Measured differential cross sections will be presented for elastic and inelastic scattering of electrons from hydrogen atoms in the energy range 50 to 300 eV and for angles from 20° to about 60°. The results were obtained by first measuring the ratio of a desired hydrogen cross section to that for elastic scattering from helium at the same energy using a modulated crossed-beam apparatus, and then multiplying this ratio by the measured absolute helium cross section published by Chamberlain, Mielczarek and Kuyatt in 1970. Comparison with theoretical predictions will be made. Particular attention will be paid to the question of the validity of the Glauber approximation.

AM9
L. Torop
R. Bohm
Dept. of Physics, University of Adelaide, S.A.

The Stark Effect of ^1H and $^4He^+$ in the Beam-foil Source.
The appearance of Stark patterns obtained with a beam-foil source differed from those characteristically obtained from gas discharge sources. In the former source excitation of the hydrogenic ions occurred in a brief time interval ($< 10^{-14}$s) during the passage of a high of a high velocity unidirectional beam of ions which produces non-statistical population distributions for the Stark perturbed states.
The relative intensities of Stark perturbed components of the H_β hydrogen line and the F_α ionized helium line have been measured in a beam-foil source. In each case an initial population of states of principal quantum number n = 4 due to radiative decay and Stark mixing, and comparing the resultant patterns with the observed patterns. The inferred population distributions indicate that the states of low orbital angular momentum (L) are preferentially populated, and alignment referred to the beam axis is produced such that states with lower z component of L are preferentially populated.

AM10
M.H. Doobov,
H.J. Hay
C.J. Sofield
C.S. Newton
Australian National University, Canberra.

Semi-classical Theory of Resonant Scattering of Light from Atomic Systems. The semiclassical theory of radiation developed by Jaynes and collaborators (Phys.Rev., 179, 1253, 1969), (A1, 106, 1970) , is applied to the problem of the resonant scattering of light from atomic systems in which two nearby excited states are present. The finite lifetimes of the excited states are taken into account. This situation applies to the case of level crossing and anti-crossing experiments.
The angular distribution of the scattered radiation agrees with that predicted by Lassik (Phys.Rev., 135, A1218, 1964) from quantum electrodynamics, thereby further defining the regime of validity of the semiclassical theory.

AM11
B.J. Dalton
I.A. White
Physics Dept. University of Queensland.

Classical Scattering of Symmetric Tops and the Boltzmann Equation for Anisotropic Molecules. The binary collisions of symmetric top molecules with angle dependent interaction potentials are investigated by numerical solution of the classical equations of motion. The results are compared with those obtained employing certain approximations which have been adopted by workers investigating the effects of anisotropic interaction potentials in determining the nonequilibrium properties of gases.

AM12
D.J. Evans
Diffusion Research Unit, Research School of Physical Sciences, The Australian National University.
R.O. Watts
Computer Centre, The Australian National University.

Determination of Ion-Atom Interaction Potentials. Apart from computer simulation techniques which are very expensive for this application all previous attempts to determine ion-atom interaction potentials at low energies (< 10 eV) have been based on a comparison of measured and theoretical transport coefficients. The Boltzmann equation has been used as the basis of the theoretical treatments but all solutions to date have been based on a perturbation technique and the comparison of experiment and theory is limited to an energy range $1.5\ kT \leq \varepsilon < 15\ kT$. It will be shown that this energy range is not sufficiently large to allow accurate determinations of the interaction potentials to be made with even the most accurate experimental data available.
Alternative approaches to the determination of ion-atom interaction potentials will be discussed, including the feasibility of a low energy beam experiment.

AM13
H.B. Milloy
M.T. Elford
R.E. Robson
R.O. Watts
Research School of Physical Sciences, Australian National University, Canberra, A.C.T.

Synchrotron Radiation - A National Facility? The unique features of synchrotron radiation sources have permitted significant advances to be made in the fields of atomic, molecular and solid state spectroscopy. Important properties of the source will be discussed and some of the more interesting experiments under investigation and in the developmental stages will be reviewed. The trend towards the provision of national research centres in this field will be reviewed and its relevance in the Australian context discussed.

AM14
M.F. Lynch
Western Australian Institute of Technology

Long Range Dipole Moment of Ternary Atomic Collisions. The experimental study of the three-body intermolecular potential (e.g. the third dielectric virial coefficient) has been proved to be difficult, because it usually represents a small correction to the pair potential effects. A three-body property which might prove somewhat more accessible to experimental determination is the electric dipole moment, $\mu(R_{12},R_{23},R_{31})$, for three identical spherical atoms such as argon or xenon, since in this case the one-body and two-body dipole moments vanish by symmetry. Experimentally the three-body dipole moment of pure noble gas should be observable in collision-induced far infrared translational absorption at sufficiently high densities when ternary collisions are of importance. By the use of the Laplace expansion for 1/R and the Schrodinger-Rayleigh perturbation scheme, the long range three-body dipole is expanded in inverse powers of the interatomic distances and the leading term is found to vary as R^{-10}. The coefficients of expansion involve higher-order atomic properties which are difficult to interpret physically. As in the case of the van der Waals coefficient in the energy expansion, the dipole coefficients reduce to products of generalized atomic polarizabilities and hyperpolarizabilities in the London-Unsold approximation. An attempt is made to understand physically the dispersion mechanism of this three-body dipole. From known polarizability values of argon, an estimate is made of the order of magnitude of this three-atom dipole moment and of the density needed to observe experimentally collision-induced infrared translational absorptions in pure argon gas.

AM15
B.W.N. Lo
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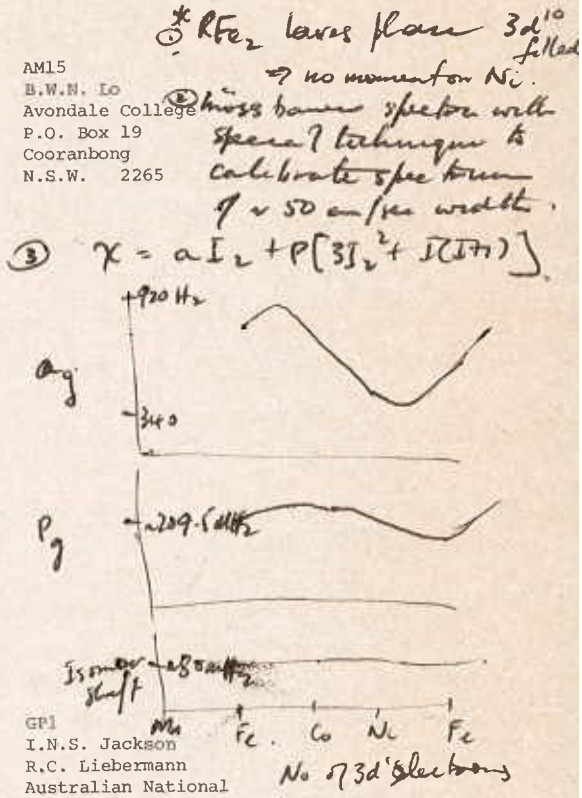


SECTION: GP: GEOPHYSICS

General Chairman F.H. Chamalaun Discipline of Earth Sciences, The Flinders University

Melting and Elastic Shear Instability of Solids at High Pressure. Ultrasonic data for the elaxtic moduli c_{ij} as functions of pressure and temperature may be used to calculate critical temperatures T_{cr} (P=O) and their initial pressure derivatives $(\partial T_{cr}/\partial P)_{P=O}$ for the elastic stability of crystalline lattices. The criterion for instability is the vanishing of one of the elastic shear moduli. For the alkali halide with the rock-salt and CsCl structures, the critical curves exhibit remarkable correlations with the fusion curves, offering strong support to the existence of a connexion between shear instability and melting. Emphasis in this work is also placed on the role of polymorphism of the solid and on the elucidation of the properties of the liquid in an attempt to establish a reliable theory of melting at elevated pressures for materials of geophysical interest. Such a theory is essential to extrapolations of laboratory data to the pressures of the deep interior of the Earth. The aim is to provide bounds on the Earth's internal temperature distribution which, in turn, constrains the past geochemical evolution of the planet and its present internal dynamic processes.

GP1
I.N.S. Jackson
R.C. Liebermann
Australian National University
Canberra

Elasticity and Phase Transformation in the Earth's Mantle. Ultrasonic data for the velocities of the low- and high-pressure polymorphs of a wide variety of crystallographic phase transformations relevant to discussions of the Earth's interior are presented. Velocity (v)-density (ρ) relationships across such transitions depend on crystal structures, and are not always equivalent to v-ρ changes caused by compression or thermal expansion of a homogeneous material, or by varying composition at constant mean atomic weight M. For the Earth, these data imply that offsets in v-ρ diagrams for

GP2
R.C. Liebermann
A.E. Ringwood
Research School of Earth Sciences
Australian National University

the transition zone of the mantle need not be ascribed to changes of M due to variations in iron content. Other evidence is discussed supporting this conclusion that a homogeneous mantle of constant FeO/(FeO+MgO) ratio is consistent with available laboratory data and current geophysical models.

Magnetic Interactions in Fine-grained Magnetites.

GP3
M.F. Wescott-Lewis
Riverina C.A.E. N.S.W.

An Electrostatic Wave Generator for Fluid Wave Studies. Stable and precise electrostatic techniques for generating fluid waves is described. The amplitude of standing surface waves on shallow water has been studied as a function of driving stress and frequency. The non-linear interaction of the waves plays a significant role in the interpretation of the observations.

GP4
M.G.R. Phillips
The Flinders
University of
South Australia

A Hydrothermal Eruption at Waimangu, New Zealand. The Waimangu hydrothermal area in the Rotorua district of New Zealand is interesting because of its recent formation and because of its quasi-cyclic behaviour. Simple monitoring devices were installed a few years ago and have given significant information on the nature of the system. A small unexpected hydrothermal eruption occurred in February 1973. The disturbance this caused, and some deductions it enables one to make about the system are described.

GP5
R.F. Keam
Physics Department
Auckland University
E.F. Lloyd
Geological Survey
D.S.I.R. (N.Z.)

SECTION: SO: SOLID STATE AND OPTICS

Organiser S.G. Tomlin University of Adelaide

NMR Observations of Biological Material. The nuclear magnetic resonance (NMR) relaxation times of protons in toad muscle water have been measured at three frequencies: 2.3, 8.9 and 30 MHz. The results are analyzed in terms of a distribution of correlation times, and it is found that only a few percent of the observed protons have mobilities more than two orders of magnitude smaller than normal. Sodium and chloride ion chemical potentials in some hydrated materials with similar proton NMR characteristics to toad muscle have been found to be heightened, but not sufficiently to account for the distribution of sodium ions in muscle.

SO2
E.P. George
Department of Physics
University of N.S.W.

Crystal Field Quenching of Dy Moment in $(Dy_xHo_{1-x})Ni_2$ - Mossbauer Effect.

SO3
G.J. Bowden
R.K. Day
National Standard
Laboratory

The Measurement of Spin-lattice Relaxation for Co Nuclei in Fe Using Adiabatic Rapid Passage in Single Crystal Nickel Films. Several recent measurements of the nuclear spin-lattice relaxation times of Co in Nickel substantially disagree with one another. Since investigation of the mechanisms involved in the relaxation depends on accurate relaxation time values, we proceeded to apply adiabatic rapid passage of Co in Ni to determine this number. In this technique the anisotropy from oriented ^{60}Co nuclei was used to detect the signal. The decay of the signal immediately after the passage leads to accurate relaxation measurements. The variation of the relaxation time with temperature and the amplitude of the adiabatic rapid passage signal under different conditions will be discussed.

SO4
J.A. Barclay
J.M. Pope
G.A. Stewart
Physics Department
Monash University
Clayton Vic. 3168

Cryogenics as seen from Industry.

SO5
K.R. Powell
C.I.G. Ltd.

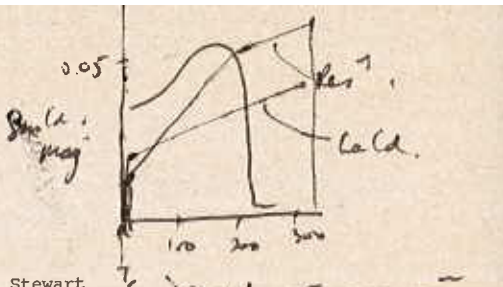
Thermal Expansion of Superconductors. Low temperature thermal expansion measurements have been made on two classes of superconductor which exhibit enhanced transition temperatures under applied pressure: (a) Nb-Zr solid solution alloys (b) A15 structure compounds. Quite different explanations for the positive values of $\partial T_c/\partial P$ have been advanced for the two cases. For (a) a correspondence between the change of T_c with pressure and the variation of the density of states at the Fermi level with the number of conduction electrons has lead to the suggestion that a rigid band shift, resulting in an increase in the density of states, is responsible, whereas for (b) the effect has been attributed to an inherent instability of the crystal lattice which is enhanced with pressure. The Grüneisen parameter, γ_G, is related to the thermal expansion through the relationship, $\gamma_G=\beta V B_s/C_p$, where β is the volume expansion, C_p/V the heat capacity at constant pressure per unit volume and B_s is the adiabatic bulk modulus. For measurements taken at sufficiently low temperatures ($\lesssim\Theta_D/50$) β and C_p can be resolved into the separate contributions from the electrons and the lattice to give the individual Grüneisen parameters $\gamma_e(=\partial\ln N(0)/\partial\ln V)$ and γ_l $(=-\partial\ln\omega/\partial\ln V)$. Such an analysis applied to the Nb-Zr alloys indicate that $\gamma_e>0$ and thus the density of states does not increase with pressure as suggested. The expansion coefficient for V_3Ge, a member of class (b), is found to be negative below ~35K and passes through a relatively sharp minimum at ~23K. Expressed in terms of the Grüneisen parameter this behaviour results in large negative values for γ_G, or even larger values for γ_l if the entire effect is attributed to

SO7
T.F. Smith
Division of Physics
N.S.L. Sydney 2008
T.R. Finlayson
Physics Department
Monash University
Clayton Vic. 3168

the lattice, which are considerably in excess of the zero temperature limit for γ_1 estimated from the pressure dependence of the elastic constants. Alternatively, the expansion behaviour may be accounted for by assuming that there is a slight distortion from the cubic structure, such as is found in the isostructural compounds V_3Si and Nb_3Sn.

Ferromagnetism of SmCd. Measurements have been made of the magnetic properties and the resistivities of polycrystalline specimens of SmCd and LaCd. SmCd is found to be a ferromagnet with a Curie point of 194K and a large magnetocrystalline anisotropy which is responsible for the highly anomalous form of the magnetisation-temperature curve below the Curie temperature. No sign is found of the transition to diamagnetism at 110K which had been reported by other workers, and it is concluded that the samarium is in a reipositive ionic state up to a temperature of at least 700K. The susceptibility obeys a Curie-Weiss law above the Curie point, in agreement with a theory which has recently been proposed, and some evidence is found for a non-colinear ferromagnetic spin structure. LaCd is a Pauli paramagnet, and has a broad superconducting transition in the region of 3^{o}K.

S08
A.M. Stewart
School of Physics
University of N.S.W.
G. Olcese
University of Genoa
Italy



Magnetic Properties of Pr-Tb and Related Alloy Systems. The magnetic properties of various compositions in the praseodymium-terbium alloy series have been studied. These alloys exist in three crystal structure types: double h.c.p. (Pr rich), h.c.p. (Tb rich) and an intermediate phase with the samarium structure. In both the h.c.p. and Sm phases, the specimens exhibit magnetic ordering for which the spin structures have been determined using neutron diffraction techniques. There is no sign of ordering in the d.h.c.p. phase alloys although the well known polycrystalline magnetic transitions in pure Pr have been observed. The absence of ordering in these alloys is thought to result from the competition of the Pr-Pr and Pr-Tb exchange interactions in a local sense. Inelastic neutron scattering shows that the crystal field states of the Pr ions change with Tb concentration, a result which is supported by electrical conductivity measurements. The origin of this change is not yet understood.

S09
R.G. Curry
K.N.R. Taylor
University of N.S.W.
Kensington N.S.W.

Thermal Transient Effects in Transferred Electron Oscillators.

S010
C.J. McRae
D.W. Griffin

Computer Study of Frequency Dependence of a Transferred Electron Oscillator on Supply Voltage Bias and Temperature. A computer model has been developed to study the transient and steady state behaviour of a microwave transferred electron device and its associated coaxial mounting structure operating in any of the modes characterised by the formation and propagation of a high-field dipole domain within the active region of the device. The model is based upon the velocity-field characteristic of the n-type Gallium Arsenide material used and the equations governing the process of growth and decay of the dipole domains. These processes, and the mode and frequency of operation of the oscillator are dependent upon a number of device parameters such as its physical dimensions, the concentration of free carriers and the shape of the velocity-field characteristic as well as external parameters such as bias voltage, ambient temperature, duty cycle of operation and details of the mounting structure. Transferred electron devices have many practical applications in radar and microwave communications systems and changes in the bias supply voltage or the temperature of the active region of the device could cause significant variation of the operating frequency which would degrade the performance of the system in which they were incorporated. The computer model is able to simulate the oscillator under a wide range of operating conditions and predict the magnitudes of these frequency shifts. It enables one to study the mechanisms responsible for these shifts and to choose operating conditions for which the frequency dependence on bias supply or temperature is small.

S012
A.R. Downing
Electrical Eng. Dept.
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South Australia

Liquid Phase Epitaxy of Gallium Arsenide - Growth Control. Liquid phase epitaxy has been established as a preferred alternative to vapour phase epitaxy for the growth of relatively thick, uniform layers of III-V compounds in the preparation of material for use in the eventual production of solid state devices such as transferred electron oscillators and nuclear detectors. In applying liquid phase epitaxy two methods are possible; (i) temperature transient technique and (ii) steady state temperature differential technique. The latter method is preferred and a study of the steady state theory is presented based on the empirical Ga-GaAs phase diagram. In growing epitaxial layers two basic requirements must be met, namely, the desired thickness and doping level. The doping level depends upon the purity of the solute and solvent, and the cleanliness of the melt environment. Lower background impurity level materials are continually being sought by manufacturers to allow adequate controlled doping by the careful addition of measured quantities of selected dopant. The thickness of the grown layer, however, is well within the control parameters of the epitaxial system and the theory determines these parameters for a specified thickness. The predicted results are compared with measurements on grown layers. The liquid phase assembly including ancillary equipment is described and particular attention given to temperature stability, cleaning facilities and some novel substrate handling techniques.

S013
C.J. McRae
D.W. Griffin
Electrical Eng. Dept.
Adelaide University
South Australia

A Selective Absorbing Surface for Solar Radiation.
The optical absorption coefficient in the visible region of the spectrum, and the emissivity in the infra-red region of a chromium based oxide surface formed by electrodeposition on copper and steel substrates has been examined.
It is shown that optical results equivalent to those from multi-layer inference stacks can be obtained from this material and that, because of cheapness and resistance to damage under operating conditions, it is an attractive material for solar energy applications.

S014
T.M. Sabine
R.B. Gammon
C.L. Riddiford
School of Physics and Materials, N.S.W. Institute of Technology, Broadway, N.S.W.
G.H. Derrick
School of Physics, University of Sydney, N.S.W.

Cluster Effects in Disordered Alloys. The coherent potential approximation (C.P.A.) has proved a very useful scheme to describe the behaviour of elementary excitations in disordered materials, especially in alloys. However, being a single site approximation, it does not reproduce adequately the fine structure in the density of states that is known to be due to certain configurations of the constituent atoms. Recent generalisations of the C.P.A. approach often produce equations that are not readily soluble and indeed may contain non-analyticities for certain ranges of parameters. We propose a simple method, based upon previous cluster analysis, of incorporating the effects of clusters without unduly increasing the complexity of the resulting equations. The connection with the C.P.A. is established and possible extensions of the method discussed. We report our numerical results for the case of a one-dimensional binary alloy where the 'exact' results are known.

S016
P. Best
P. Lloyd
Dept. of Physics
Monash University
Clayton Vic. 3168

X-Ray Diffraction Studies of Metal Crystals. Accurate X-ray diffraction studies of b.c.c. alkali metals sodium and potassium have been carried out at room temperature. Anisotropy in the relative intensities has been observed, and has been attributed to anharmonic vibration properties of the metals. The data has been analysed in terms of a fourth order anisotropic expansion of the atomic potential for individual atoms about their equilibrium positions. The analysis and interpretation of the experimental data will be discussed, and the vibration parameters and room temperature structure factors presented.

S017
B. Bednarz
D.W. Field
E.H. Medlin
Dept. of Physics
Adelaide University

Thin Film Coatings for Solar Energy.

S018
J. Ward
Weapons Research Est.
Salisbury S.A.

Stimulation of Chemical Reaction by Laser Radiation.

S021
A.W. Pryor
A.A.E.C. Research Est.
Lucas Heights N.S.W.

A Pulsed NMR Study of Nuclear Spin-Lattice Relaxation in the Off-resonance Rotating Frame. An r.f. pulse sequence is described that measures the nuclear spin lattice relaxation time in the presence of a large rotating r.f. field, distant from the N.M.R. condition by 10^5 to 10^7 rad/sec. Assuming the weak collision approximation $\tau_C \ll T_2$ this relaxation time is interpreted to provide a direct measure of correlation times in the range 10^{-5} to 10^{-7} sec, which are difficult to obtain by conventional techniques that measure T_1 or $T_{1\rho}$. The results of an illustrative study on solid SF_6 were in good agreement with the theory.

S022
B.A. Cornell
J. Pope
Dept. of Physics
Monash University
Clayton Vic. 3168

Growth and Luminescence of ZnP_2. The problems of growing inclusion free single crystals of ZnP_2 are discussed and the results of vapour deposition and solution growth are presented. Cathodoluminescence and photoluminescence Spectra of tetragonal ZnP_2 for various temperatures are presented for crystals grown by different techniques. The yellow band luminescence for Sn doped samples is noted, and the photoluminescence spectrum for such samples at 1.8K shows a complex phonon structure.

S023
R.L. Young
The Capricornia Inst. of Advanced Education
Dept. of Applied Phys.
Queensland

Diluted Antiferromagnets - Application to $Cr_{1-x}V_xN$. Present theoretical work indicates that for most diluted magnetic lattice systems, the critical concentration of magnetic ions above which magnetic structures may exist is about P_c=0.2-0.4. Preliminary investigations on the solid solutions $Cr_{1-x}V_xN$ show that for this system, $P_c \simeq 0.7$, very much higher than anything previously observed, theoretically or experimentally. We briefly look at the electrical resistivity and X-ray diffraction on $Cr_{1-x}V_xN$. For $x<0.3$, the system orders antiferromagnetically below a certain temperature T_t, undergoing an orthorhombic distortion and for $x>0.3$, no transition, magnetic or otherwise, is observed.

S024
A.J. Dempster
R. Street
Dept. of Physics
Monash University
Clayton Vic.

The Effect of Spin-Lattice Interaction on Neel Point and Critical Concentration in diluted UO_2.

S025
G.B. Smith
N.S.W. Institute of Technology, Broadway, N.S.W.

Screened Local Interaction Parameters. Over the last decade several models which include many-electron interactions have been put forward to explain metal/insulator, magnetic and other transitions in narrow band metals. The two-particle electron interaction term in these models' Hamiltonians is often allowed a non-zero value only when the two electrons occupy states on the same metallic site. Moreover, the interaction is screened by correlation effects so that it is far smaller than the direct Coulomb integral between the two occupied states. Hitherto little has been known about the actual value of such a screened interaction, and it has usually been replaced by a variable parameter in the Hamiltonian. In this paper a method is outlined to calculate the screened interaction from first principles. Self-consistent solutions to the Hartree-Fock equations in a spherical cell with Wigner-Seitz boundary conditions are calculated, and the screened interactions are then deduced from the change in an eigenvalue when the occupation configuration of the cell is changed.

S026
B.N. Cox
Monash University, Clayton, Vic.

Narrow 5d Energy Bands in the Heavy Rare Earth Metals. A revised version of a recently published model {Solid State Commun. 12, 291 (1973), Phys. Kondens.Materie 16, 181 (1973)} for 5d electrons in the ferromagnetic state of the heavy rare earth metals is described. In the new approach, a starting point is to use wave functions and energy levels calculated for $4f^n5d6s^2$ atomic configurations, subject to the restriction that the 4f shell is taken as rigidly fixed with its moment fully aligned in the magnetisation direction. The 5d states are assumed to spread uniformly over energy bands of width W in the metals. With local wave functions as discussed above, the 5d contributions to the saturation magnetic moments are determined unambiguously in the model for a given W. Hence, after allowing for a small 6s moment contribution, the change of the combined 4f, 5d moments due to admixtures of incompletely aligned f states required to explain the observed saturation moments in the metals can be found. For atoms with large f shell excitation energies, a method of calculating the expected reduction in the saturation moment for a given W due to non-aligned f state admixture has also been developed. Thus W can be determined by the requirement that the two methods of estimating the moment reduction give the same results, and it is found that W = 1.0eV in Gd and W = 0.5eV in Tm. These small widths are attributed to initial bare bandwidths of the order of 4eV reduced by correlation effects which are treated by methods analogous to those of small polaron theory. Electronic specific heats, magnetic moments, magnetic hyperfine fields, electric field gradients and magnetic anisotropy in the heavy rare earths are discussed within the framework of the model.

S027
D.M. Eagles
C.S.I.R.O., Div. of Applied Physics, National Standards Lab., Chippendale, NSW.

Optical Properties of Thin Films of II-VI Compounds. From a systematic study of the optical properties of thin films of the II-VI compounds the results of measurements on CdS, ZnS, CdSe and ZnSe will be presented. The experimental method used allows an accurate study of the absorption near the band edge and from this the nature of the electron transitions responsible for the absorption can be deduced. In CdS films, for example, the absorption is due to direct transitions for photon energies above a threshold of 2.42eV, and to combined direct and indirect transitions above 2.82eV. But CdSe shows two distinct direct transitions with thresholds at 1.67eV and 2.05eV. These and other results will be discussed in relation to theoretical studies of electron energy levels.

S028
E. Khawaja
T.G.K. Murty
S.G. Tomlin
Dept. of Physics, University of Adelaide, S.A.

A Refined Approach to Gas Laser Theory. A density-matrix approach to gas laser theory is described, in which it is possible to take the effect of collisions into account - i.e., whether they are strong or weak, whether they partially or totally destroy the correlation of the atomic states, etc. The approach shows quite clearly why, in the Doppler limit, the Rabi shift and the Rabi frequency are not observed: the reason is destructive interference between the radiation from different atoms. If the atoms are assumed to be 'recreated' in a state for which the density matrix is of diagonal form, the complex susceptibility for a single running mode for a Lorentzian-gaussian convolution lineshape agrees with that obtained using a Bloembergen-Purcell-Pound approach to saturation. This has certain implications for other theories which are claimed to be exact. For certain cases, the new approach is also capable of treating heavily saturated systems: these will be outlined.

S029
A. Bambini
Laboratorio di Electronica, Quantistica Firenze, Italy.
G.J. Troup
Dept. of Physics, Monash University, Clayton, Vic.

Comments:-
(1) Chairmen who know Speakers & must keep to time
(2) 10-15 minute talks only and 20 minutes actually planned
(3) Christian names to be used
(4) Research student competition for best paper.
(5) A bit more efficiency on Slides Required.

ABSTRACTS AND CORRECTIONS

Paper S03.

Crystal field quenching in $(Dy_xHo_{1-x})Ni_2$

by G.J. Bowden and R.K. Day, CSIRO Division of Applied Physics, National Standards Laboratory, Chippendale, N.S.W. 2008.

Mossbauer experiments using the 25.6 keV ^{161}Dy γ-ray have been carried out on the compounds $(Dy_xHo_{1-x})Ni_2$ where x = 0.2, 0.4, 0.6, 0.8 and 1.0. Rare earth - transition metal compounds of the type RT_2 generally exhibit enhanced hyperfine fields over those found in pure rare earth metals. However, in the case of $DyNi_2$ the 3d bands become filled and crystal fields quench some of the orbital moment of the $Dy^{3+}4f$ electrons. This results in magnetic hyperfine and electric field gradients at the ^{161}Dy site of $DyNi_2$ of the same order as those found in pure dysprosium.

The hyperfine fields in $(Dy_xHo_{1-x})Ni_2$ reach a maximum at about x = 0.7(847 $\pm$ 3 MHz), whereas the electric field gradient at the nucleus increases as the dysprosium is diluted by holmium. The maximum value of the hyperfine field is about 1.9% above that found in pure dysprosium. The question of whether these results can be explained in terms of crystal field quenching will be examined.

Paper S010.

Thermal transient effects in transferred electron microwave oscillators.

by C.J. McRae, Department of Electrical Engineering, University of Adelaide, Adelaide, S.A. 5000.

Abstract:

Over the past decade much research and development has been aimed at increasing the output power capabilities of the various solid state microwave oscillators and in particular the transferred electron devices. It has been found necessary in many applications to apply pulsed biassing to avoid excessive heating since the bias-to-radio frequency conversion efficiency is only a few percent. For example, the limited-space charge-accumulation (L.S.A.) mode devices provide high output peak powers, but owing to the large rate of heat dissipation, low duty cycle biassing must be used, resulting in low average power levels. In all pulse biassed devices efforts have been made to increase the safe operating duty cycle, by improved heat sinking and increased efficiency, to raise the average power level. Unfortunately it has long been observed that transferred electron devices have a frequency-temperature differential that is dependent on the properties of the device, associated circuitry and operating parameters. Although, with improved technology, increases in maximum duty cycle have been realised, there exists a periodic temperature component that causes frequency "chirping". The resulting spectra may be quite unacceptable in many applications and environments.

Research has been undertaken to model transferred electron devices operating under thermal transient conditions. Thermal models have been developed to predict the temperature characteristics of devices, and, in combination with existing electron dynamic models or empirical results, the frequency shifts determined. In addition the spectra of the temperature influenced, frequency modulated, pulsed R.F. wave trains have been simulated, using Fourier transform methods, and compared with experimental observations. Circuit-device interaction effects have been investigated and used to explain the observed frequency jumping and hysteresis phenomena that can occur under certain conditions.

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The title of paper S022 is:

"A PULSED N.M.R. STUDY OF NUCLEAR SPIN-LATTICE RELAXATION IN THE OFF-RESONANCE ROTATING FRAME".

The title of paper S04 is:

"THE MEASUREMENT OF SPIN-LATTICE RELAXATION FOR Co NUCLEI IN Ni USING ADIABATIC RAPID PASSAGE IN SINGLE CRYSTAL NICKEL FILMS".

Paper S05.

Cryogenics as seen from Industry in Australia.

by K.R. Powell, Marketing Manager, Compressed Gases, C.I.G., Bell Street, Preston. Victoria.

Industry in Australia at times gets the reputation for relying too heavily on overseas technology, research and development expenditure being somewhat reluctant. In contrast, the very nature of our geography forces us to be independent and we often take for granted some of the innovations that occur in this country.

A brief account of some cryogenic processes and applications which are commercially and technically successful will be given. Freezing and storage of various materials, shrink fitting of metal components, scrap recovery and the recent introduction of liquid helium importation are some applications which will be cited.

Paper S030.

Cryogenic Instrumentation.

by J.C.R. Kubale, Managing Director, Oxford Instruments Australia Pty.Ltd., 138 Bourke Road, Alexandria. N.S.W.

The research demands of the Scientific community have led to the development of a wide range of cryogenic instrumentation operating with liquid nitrogen and liquid helium.

Among suppliers of this equipment is the Oxford Instrument Co. of Oxford U.K. This company is a world leader in the area of Superconducting Magnets, Cryostats, and electronic control and measurement instrumentation. This paper will describe the present state of development of instruments offered for commercial sale.

Paper UM9. To replace the paper by E.C. Butcher.

Models of the Ionospheric F Region over Eastern Australia and a comparison with Experimental Data.

by Dr. K. Jones, Department of Physics, University of Queensland.

Models intended to simulate processes in the mid latitude F Region are presented with particular emphasis on nighttime phenomena.

The night F layer must be maintained by neutral air winds or influx of plasma from outside the region or a combination of both.

Ideas are presented for determining the relative importance of these processes.

Invited Paper.

Optical Spectroscopy of Minerals and Gemstones.

by Professor W.A. Runciman, Department of Solid State Physics, Research School of Physics Sciences, Australian National University, Canberra, A.C.T. 2600.

Colour is one of the distinctive features of gemstones and its understanding is of interest. By examining the absorption spectrum the colour can be attributed to specific ions, commonly iron and chromium. A more extensive study of the absorption spectra of minerals and gemstones at low temperatures, including the ultraviolet and infrared spectral regions, provides much information about electronic and vibronic levels of the excited states of the ions concerned. When the spectrum contains fairly narrow lines, less than 20 cm^{-1} wide, detailed studies using perturbations, especially uniaxial stress and magnetic fields, allow information to be derived about the symmetry of the colour centres and the degeneracy of the levels. Zeeman experiments on zircon with fields of 220 kilogauss have been carried out in the Magnet Laboratory operated by the Department of Engineering Physics. When the absorption bands are broad, additional techniques may include those of magnetic circular dichroism and electric field modulation spectroscopy. On the theoretical side, use is made of group theory and crystal field theory. Recently, advances have been made in understanding the absorption spectra of ferrous iron in the minerals, enstatite, olivine and garnets. Other studies include the triclinic crystal, rhodonite, which may contain iron as well as manganese. Some of the results obtained by absorption spectroscopy may prove to be of astrophysical or geophysical interest.

Paper 5018.

Laser mirrors with 100% reflection - can they ever be made?

by J.Ward, Weapons Research Establishment.

There are many application where mirrors with 100% reflection are needed. Efficient laser systems would not be possible without multi-layer mirrors which presently can achieve reflection values of about 99.9%.

The problem areas associated with the making and measuring of super, high quality laser mirrors will be described. Are there limitations in manufacture, measurement, substrate roughness, layer inhomogeneity, dispersion, absorption scattering? An attempt will be made to resolve some of these queries.

NAME	INITIAL	TITLE	AFFILIATION
ADHIKARI	S.K.	MR.	SCH. MATHS U OF NSW
ANDREWS	G.	MR.	APPLIED PHYSICS RMIT
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CAMPBELL	R.D.	DR.	PHYSICS SAIT
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COLLOCOTT	S.J.	MR.	PHYSICS UNI NSW
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COX	B.N.	MR.	PHYSICS MONASH
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FIELD	D.W.	DR.	PHYSICS U OF A
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HIBBERD		MRS.	
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WRIGHT		MRS.	
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