THE AUSTRALIAN NATIONAL UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF THEORETICAL PHYSICS

ANNUAL REPORT 1973

GENERAL COMMENTS

The purpose of courses in theoretical physics is, on the one hand, to provide an appropriate background for those students intending to take up a career in the subject and, on the other hand, to lead to an appreciation of the formal notions which underlie the physical sciences in general.

Rather poor enrolments are presumably a reflection not only of the employment position as it exists at present but also of the curious anti-scientific attitudes which have appeared on a world-wide scale in recent years. Fortunately two new courses, one at second and one at third year level, given for the first time in 1973, have somewhat ameliorated the situation.

ENROLMENTS AND EXAMINATION RESULTS

See Appendix. In the table actual numbers are given since these are too small to make percentages meaningful. (The "wastage" of 3 in B01 seems meaningless since it includes students who, though apparently enrolled, never showed up at all.)

GRADUATE STUDIES

W. Sy completed and presented his Ph.D. thesis early in the year and was duly admitted to the degree. The thesis was entitled "Microturbulent magnetoactive plasmas and polarized radiation from the solar corona".

STAFF

Professor:	H.A. Buchdahl, D.Sc. (Lond.), F.A.A.
Reader:	D.B. Melrose, B.Sc. (Tas.), D.Phil. (Oxon.)
Lecturer:	M. Andrews, B.Sc., M.Sc., (Qld.), Ph.D. (Birm.)
Postdoctoral Fellow: (until August)	P.J. Sands, B.Sc., Ph.D. (ANU)

Dr Melrose spent the first six months of 1973 on study leave with the CSIRO Division of Radiophysics in Sydney.

EXTERNAL SUPPORT

Dr Sands was supported until August by a grant from the Australian Research Grants Committee. Thereafter he took up a position as Senior Research Scientist with the CSIRO Division of Computing Research.

OTHER ACTIVITIES

Dr Melrose gave two lectures at the May meeting of the Astronomical Society of Australia. He attended the General Assembly of the International Astronomical Union in Sydney in August, and gave a lecture at the IAU Symposium No. 57 "Coronal Disturbances" at Surfers Paradise in September.

Professor Buchdahl attended the annual meeting of the Australian Mathematical Society in Hobart during May. In October he gave an invited lecture in the Physics Department of La Trobe University.

VISITOR

Professor Peter Rastall, Professor of Physics in the University of British Columbia, has been in the department since September. He is engaged in studies on the theory of spinors.

RESEARCH

M. Andrews

Calculations were made of the static polarizability of Argon II and Argon III ions. These results, together with measurements using a shock tube, are being presented in a paper in preparation jointly with J. Sandeman of the Physics Department and P. Meier who was awarded his Ph.D. in Physics during the year.

A quantum-mechanical system which is a one-dimensional analogue of the hydrogen atom is being investigated with a view to resolving contradictions to be found in the literature.

H.A. Buchdahl

The groups $SO(3,2)$ and $Sp(4R)$ are locally isomorphic. A calculus based on this isomorphism was developed in a paper to appear in TENSOR.

In most elementary (and many not so elementary) text books there appear incorrect arguments in the context of the polynomial method as applied to the harmonic oscillator equation. A paper rectifying these errors will appear in the American Journal of Physics.

The factor $1/N!$ in the canonical partition function is often claimed to be an ad hoc insertion. A paper in which it is argued that its presence is dictated by the requirement of the internal consistency of the Gibbsian ensemble formalism will appear in the American Journal of Physics.

A proof of Carathéodory's Theorem which is formally covariant with respect to arbitrary transformations of variables is contained in a manuscript submitted to Proc. Camb. Phil. Soc.

A general theory of the chromatic aberrations of optical systems without symmetries has been developed. A manuscript has been submitted to OPTIK.

A great deal of time was spent on writing a pedagogically motivated book on phenomenological and statistical thermodynamics. Whether it will see the light of day remains to be seen.

Other as yet not quite complete work in optical aberration theory and in tensor calculus will be reported on next year.

D.B. Melrose

The theory of coupling between the natural wave modes in an inhomogeneous magnetoactive plasma and its application to the solar corona were explored. One paper on the application to the solar corona is to be published in the Proceedings of the Astronomical Society of Australia, and another two papers in which the theory is developed are to be published in the Australian Journal of Physics.

A theory was developed for absorption due to the inverses of the plasma emission processes, which are the accepted emission processes for solar radio bursts of spectral types II and III; the theory was applied to the interpretation of certain absorption features in the spectra of solar radio bursts. Two papers on this topic are to be published in the Australian Journal of Physics. The analysis of these absorption processes provided further insight into the emission processes for solar radio bursts of spectral types II and III; the theory was applied to the interpretation of certain absorption features in the spectra of solar radio bursts. Two papers on this topic are to be published in the Australian Journal of Physics. The analysis of these absorption processes provided further insight into the emission processes. A paper on this subject was given at IAU Symposium No. 57, and the paper has been further revised and submitted to Solar Physics.

The propagation of the streams of electrons which cause solar radio bursts of type III is still poorly understood; simple theory predicts that the streams would suffer excessive energy losses in propagating a distance negligible in comparison with the distances streams are known to propagate. A new idea was developed on how this difficulty might be overcome, and a manuscript is being prepared for submission to Solar Physics. Another paper criticizing a suggestion by D.F. Smith on this subject has been submitted to the same journal.

Theories which predict a preferential backward emission at the second harmonic in solar radio bursts of type III are outdated; the simplest theory predicts only forward emission. A paper demonstrating this simple result is to be published in Astrophysical Letters.

A short paper criticizing a standard treatment of gyromagnetic absorption at the fundamental is to be published in the Australian Journal of Physics. A paper in which an alternative to the maser hypothesis for sources of anomalous OH emission is to be published in the Proceedings of the Astronomical Society of Australia.

A paper in which the non-relativistic quantum mechanical treatment of emission and absorption processes in a magnetoactive plasma is to be published in Astrophysics and Space Science. A manuscript in which the corresponding relativistic quantum theory is developed has been submitted to Plasma Physics.

A theory for the acceleration process thought to be responsible for second phase acceleration in the solar corona was developed; a manuscript has been prepared for submission to Solar Physics.

P.J. Sands

A paper was published which discusses the computation of the derivatives of the paraxial coefficients with respect to the parameters specifying symmetric optical systems containing inhomogeneous media.

Further work was carried out on the theory of the aberrations of double-plane symmetric systems. A paper was published discussing the aberrations of thin field lenses. An interactive computer programme was written for carrying out an analysis of the first and third order image forming properties of double-plane symmetric systems. A manual which was prepared is obtainable by request from the ANU Press.

The geometrical optics of the ommattidium of the soldier beetle (Chauliognathus Pulchellus) was analysed in detail, in cooperation with the Department of Neurobiology, I.A.S. A paper is in preparation.

PUBLICATIONS

BUCHDAHL, H.A.
'On certain tensors and spinors associated with Dirac algebra.'
Tensor, 25, 137-147, 1972.
'Note on the reality of the scalar curvature of unitary spaces.'
Tensor, 23, 307-308, 1972.
'Adjoint solutions of the Brans-Dicke equations.'. Int. Jour. Theor.
Phys., 7, 287-289, 1973.
'Concerning the absolute temperature function.' Amer. J. Phys.,
41, 98-103, 1973.
'Rays in gradient index media: Separable systems.' J. Opt. Soc.
America, 63, 46-49, 1973.
'Static sources in the Brans-Dicke theory.' General Relativity
and Gravitation, 4, 319-326, 1973.
'Symplectic formalism in the aberration theory of systems without
symmetries.' Optik, 37, 571-587, 1973.
'Quadratic Langrangians and static gravitational fields.' Proc.
Camb. Phil. Soc., 73, 145-148, 1973.
'Functional derivatives of invariants of the curvature tensors of
unitary spaces.' Tensor, 27, 1973.

MELROSE, D.B.
'Coherent gyromagnetic emission as a radiation mechanism.' Australian
Journal of Physics, 26, 229-249, 1973.
'A covariant formulation of wave dispersion.' Plasma Physics, 15,
99-106, 1973.
'The relevance of bipola type I storm structures to the theory of
mode coupling in the solar corona.' Proc. Astronomical Soc. Aust.,
2, 1973.
'A plasma hypothesis for anomalous OH emission.' Proc. Astronomical
Soc. Aust., 2, 1973.

SANDS, P.J.
'Aberration coefficients of double-plane symmetric systems.' J. Opt.
Soc. Am., 63, 425-430, 1973.
'Aberrations of thin double-plane symmetric lenses.' J. Opt. Soc. Am.,
63, 431-434, 1973.
'Aberration coefficients and surfaces of best-focus.' J. Opt. Soc. Am.,
63, 582-588, 1973.
'Prediction of vignetting.' J. Opt. Soc. Am. 63, 803-805, 1973.
'Inhomogeneous lenses VI: Derivatives of paraxial coefficients.'
J. Opt. Soc. Am., 63, 1210-1216, 1973.

THE AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF THEORETICAL PHYSICS ANALYSIS OF STUDENT PERFORMANCE

		Number Enrolled			Number Sitting						
1	2	3	4	5	6	7	8	9	10	11	12
Subject or unit	Enrolled as at 30.4.73	Sitting	Wastage (i.e. 2 - 3)	Failure	Sitting	High Distinction	Distinction	Credit	Pass with Merit	Pass	Fail
FO1	11	8	0	3	8	2	2	1	-	3	0
CO1	9	9	0	2	9	1	1	3	-	1	2
CO2	3	3	0	0	3	0	2	1	-	0	0
CC3	3	3	0	0	3	0	1	2	-	0	0
CO5	6	6	0	1	6	2	0	2	-	1	1

	Enrolled (as at 30 April 1973)	Sitting	Results	(headings above do not apply)
Final Honours	1	1	H1	
Ph.D.	-		admitted: 1	