68/1969

THE AUSTRALIAN NATIONAL UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF THEORETICAL PHYSICS

ANNUAL REPORT 1968

Academic Staff:

Professor: *H.A. Buchdahl, B.Sc.(Lond.), A.R.C.S., D.Sc.(Lond.), F.A.A.

Reader: **L.J. Tassie, B.Sc., M.Sc., Ph.D. (Melb.)

Lecturer: M. Andrews, B.Sc., M.Sc.(Q'land), Ph.D. (Birm.)

Temporary Lecturer: †S.C. Gupta, Ph.D.(A.N.U.)

* On study leave January-September

** Resigned 1st December

† 26th February - 10th August

Introduction:

Training at both undergraduate and postgraduate level is provided for students intending to become theoretical physicists. The undergraduate course also provides a background in theoretical physics for other students.

Research has been carried out on tensor and spinor calculus, geometrical optics, elementary particle physics, nuclear physics and scattering theory.

Teaching:

Student enrolments and examinations are set out in the attached table.

Research:

Existence has been proved and explicit bounds derived for a representation of partial waves for superpositions of Yukawa potentials together with a repulsive Coulomb potential. (Andrews)

Work on analytic properties of (d,p) stripping amplitudes, outlined in the previous report, has been completed. (Andrews, Bertram [Ph.D. student] and Tassie)

The quantization of magnetic flux in superconductors has been investigated using a condensed boson gas model. Previous work on this problem has used the simplifying assumption of cylindrical symmetry. The effects of breaking cylindrical symmetry have been investigated. (Bowring [Honours student] and Tassie) A more general

approach to quantization of magnetic flux in superconductors is being carried out in collaboration with M. Peshkin of Argonne National Laboratory.

A largely original, comprehensive presentation of Hamiltonian optics was prepared with emphasis on pedagogic simplicity on the one hand and the implications of symmetries on the other. This work will appear in January 1970 as one of the Cambridge Monographs in Physics under the title "An Introduction to Hamiltonian Optics" (about 350 pp.). (Buchdahl)

The existence of functionally constant invariants of the Riemann tensor in n-dimensional Riemann spaces was investigated, and a manuscript prepared. (Buchdahl)

There are two versions of the 2-spinor calculus of Infeld and van der Waerden, known as the ϵ-formalism and γ-formalism respectively. There exists a somewhat analogous situation in the calculus of 4-spinors; and a manuscript on this problem was prepared. (Buchdahl)

Various problems connected with non-linear Lagrangians in general relativity were considered, such as cosmological implications, linearised equations, and the representation of sources. (Buchdahl and Raval [Ph.D. student])

The effect of finite rest mass of the electron in the nuclear scattering of relativistic electrons has been investigated. (Clayton [Honours student] and Tassie)

Work on transport coefficients of binary gas mixtures was prepared for publication. (Gupta)

A new representation of partial wave scattering amplitudes has been derived in the context of non-relativistic potential scattering. This representation makes explicit the behaviour of the discontinuity across the physical cut and investigations into the scattering process from this point of view are continuing. (Ilic [Ph.D. student] and Andrews]

The quark model of elementary particles is being investigated. By using an independent-particle-model approach, it is possible to obtain estimates of the quark mass from the observed spectrum of elementary particles and the high energy scattering. (Smith [Ph.D. student] and Tassie)

Other Activities:

Professor Buchdahl spent the second part of the northern academic year at the Institute of Optics, University of Rochester, Rochester, New York, as New York State Professor of Optics. Thereafter, until September, he was attached to the Department of Applied Mathematics and Theoretical Physics, University of Cambridge, England. In September he attended the Fifth International Conference on Gravitation and General Relativity at Tbilisi, Georgia.

Dr. Tassie spent January at the Argonne National Laboratory, and attended the annual meeting of the American Physical Society in Chicago and the Symposium on Elementary Particles at Northwestern University.

Ph.D. Thesis Approved:

W.K. Bertram - "Dispersion Theory and (d,p) Reactions"

This thesis was presented early in the year and the examiners reported on it in very favourable terms. Dr. Bertram is the second graduate student of this Department to obtain his Ph.D. degree; and he is now with the Australian Atomic Energy Commission at Lucas Heights, N.S.W.

Publications:

Andrews, M., Bertram, W.K. and Tassie, L.J. - Australian Journal of Physics, 21 (1968), 423-9
"The Behaviour of DWBA Stripping Amplitudes near the Butler Pole"

Bertram, W.K. and Tassie, L.J. - Physical Review, 166 (1968), 1029-1035
"Pology and (d,p) Reactions"

Buchdahl, H.A. - Proceedings of the Royal Society A, 303 (1968), 355-379
"On the Calculus of Four-Spinors"

Lichtenberg, D.B.,† Tassie, L.J. and Keleman, P.J.† - Physical Review, 167 (1968), 1535-1542
"Quark-Diquark Model of Baryons and SU(6)"

Tassie, L.J., Bertram, W.K. and Andrews, M. - Bulletin of the American Physical Society, 13 (1968), 100
"Effect of Coulomb Interactions on Pology of Stripping Reactions"

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† Not a member of this University

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DEPARTMENT OF THEORETICAL PHYSICS EXAMINATION RESULTS

1. Subject or unit	2. Enrolled	3. Sitting	4. High Distinction	5. Distinction	6. Credit	7. Pass with merit	8. Pass	9. Fail	10. Wastage (i.e., 2 - 3)	11. Failure plus wastage (i.e., 9 + 10)
Theor. Phys. III	9	9	1	5	1	---	2	---	---	---

	Enrolled	Sitting	Results	(headings above do not apply)
Final Honours	2	2	2	(H2A, H2B)
Masters Qualifying	---	---	---	
Masters Degree	---	---	---	
Ph.D.	3½	1	1	