65/1968

THE AUSTRALIAN NATIONAL UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF THEORETICAL PHYSICS

ANNUAL REPORT 1967

Academic Staff:

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

Reader: L.J. Tassie, B.Sc., M.Sc., Ph.D.(Melb.)
(Acting Head of Department)

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

* On study leave from September

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 following table:-

	Enrolled	Examined	Passed
Theor. Phys. III	6	6	6 (1HD,2D,1Cr,2P)
Theor. Phys. IV	1	1	1 (H1)
Ph.D.	4 (Present)	1	1

Research:

Attempts have been made to derive rigorous analytic properties in the momentum transfer variable of scattering amplitudes for a central potential together with a spin-orbit potential. (Andrews and Ilic [Ph.D. student])

A representation for partial waves (essentially a Laplace transform) used successfully by A. Martin for superpositions of Yukawa potentials has been generalized to apply when a repulsive Coulomb potential is also present. The properties of this representation are being investigated. (Andrews)

The analytic behaviour of amplitudes for nuclear stripping reactions has been investigated using the representations for partial waves of Andrews. A paper on this work has been submitted for publication. (Andrews, Bertram [Ph.D. student], and Tassie)

Calculations have been made of (d,p) stripping reactions which have the correct analytic behaviour in a neighbourhood of the most important singularity. The extrapolation of cross sections to this singularity has been investigated, and it has been shown that Coulomb effects prevent the determination of reduced widths by such an extrapolation in many important cases. A paper on this work has been accepted for publication in The Physical Review. (Bertram and Tassie)

Other aspects of (d,p) stripping calculations and the determination of reduced widths have been investigated. (Bertram)

An investigation was undertaken of the general theory of four-spinors, in both flat and curved spaces, with particular emphasis on the connexion between four-spinors and six-dimensional Lorentz transformations. A manuscript concerning this work has been accepted for publication in the Proceedings of the Royal Society. (Buchdahl)

A computer program has been written for the elastic scattering of relativistic electrons by nuclei including both the effect of the finite size of the nucleus and of the mass of the electron, enabling calculations to be made over a wide range of energies. The program provides electron wave functions suitable for use in other calculations. (Haasz [Honours student] and Tassie)

In the quark model of elementary particles, it is necessary to consider particles whose binding energies are comparable with their rest masses. The binding in a deep potential well of a particle described by the Dirac equation is being investigated. (Smith [Ph.D. student] and Tassie)

Previous work on a two-body model of baryons has been extended, in collaboration with D. Lichtenberg and P.J. Kelemen of Indiana University, to a model with approximation SU(6) symmetry. A paper on this work has been submitted for publication. (Tassie)

Other Activities:

Academic staff, one Ph.D. student and the Honours student attended the Australian Mathematical Society Summer Research Institute held in Canberra in January and February.

Professor Buchdahl left on study leave during the year, and is at present at the Institute of Optics, University of Rochester, New York. His activities there include the preparation of the manuscript of a comprehensive monograph on Hamiltonian Optics.

Dr. Tassie visited Argonne National Laboratory in December.

Ph.D. Thesis Approved:

P.J. Sands - "Off-Axis Aberration Coefficients"

This thesis was presented early during the year and the examiners reported on it in very favourable terms. Peter Sands is the first graduate student of this department to obtain a Ph.D. degree. He is now Assistant Professor in the Institute of Optics, University of Rochester, New York.

Publications:

Andrews, M.
"Ground State of the One-Dimensional Hydrogen Atom." <u>American Journal of Physics</u>, <u>34</u>, (1966) 1194.

Buchdahl, H.A.
"On Rotor Calculus. I and II." <u>Journal of the Australian Mathematical Society</u>, <u>6</u> (1966), 402-448.

Buchdahl, H.A.
"General Relativistic Fluid Spheres. III. A Static Gaseous Model." <u>Astrophysical Journal</u>, <u>147</u> (1967), 310-316.

Buchdahl, H.A.
"Concerning a Kind of Truncated Quantized Linear Harmonic Oscillator." <u>American Journal of Physics</u>, <u>35</u> (1967), 210-218.

Buchdahl, H.A.
"Optical Aberration Coefficients. XIII. Theory of Reversible Semi-Symmetric Systems." <u>Journal of the Optical Society of America</u>, <u>57</u> (1967), 517-522.

Lichtenberg, D.B.[‡] and Tassie, L.J.
"Baryon Mass Splitting in a Boson-Fermion Model." <u>The Physical Review</u>, <u>155</u> (1967), 1601.

Lichtenberg, D.B.,[‡] and Tassie, L.J.
"Boson-Fermion Model of Baryons and SU(6)." <u>Bulletin of the American Physical Society</u>, <u>12</u> (1967), 698.

Publications:

[‡] Not a member of this University.