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THE AUSTRALIAN NATIONAL UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF THEORETICAL PHYSICS

ANNUAL REPORT 1966

Academic Staff:

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

Dr. L. J. Tassie, B.Sc., M.Sc., Ph.D.(Melb.)

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

Teaching:

Student enrolments and examinations are set out in the following table:-

	Enrolled	Examined	Passed
Theor. Phys. III	5	5	5 (1HD, 2Cr, 2P)
Theor. Phys. IV	1	1	1 (H1)
Ph.D.	2	-	-

Some of the fourth year lectures were also attended by people from the I.A.S.

Research:

It is known that non-singular potentials approximating that of the one-dimensional hydrogen atom have a bound state whose binding energy tends to infinity as $V \to -1/|x|$. It was proved that in the limit this state does not exist. A paper on this work was accepted for publication in the American Journal of Physics. (Andrews)

The amplitudes for the d-p reactions have a singularity for a particular unphysical value of the momentum transfer, and extrapolation of the amplitude to this singularity should allow the simple determination of the reduced width (a quantity analogous to a coupling constant). The feasibility of such an extrapolation was investigated by attempting to extrapolate the results of a distorted wave Born approximation (DWBA) calculation to the singularity. The results were inconclusive because the usual DWBA amplitude does not have a singularity. A computer program for a modified DWBA calculation with the correct analytic behaviour is being prepared. Such a program should be useful for the analysis of experiments at high ener energies where the usual DWBA calculation converges slowly. (Bertram [Ph.D. student])

By way of certain generalizations arising from Bertram's work an investigation is proceeding into the singularities and zeros of analytically continued amplitudes and cross-sections in relation to the spins and parities of the particles involved. (Andrews, Bertram, Tassie)

The investigation of certain general relativistic gaseous spheres consisting of a medium whose physical realizability is not excluded and the equation of state of which can be exhibited in simple closed form was concluded. A paper on this work has been accepted for publication in the Astrophysical Journal. (Buchdahl)

Two manuscripts dealing with the calculus of rotors, i.e., of complex 3-vectors which stand in one-one correspondence with self-dual bivectors, were revised and accepted for publication in the Journal of the Australian Mathematical Society. (Buchdahl)

An investigation was undertaken of a quantum mechanical system whose Hamiltonian is that of the linear harmonic oscillator but in which p and q obey a commutation relation which instead of being canonical involves an additional projection operator. The representatives of the raising and lowering operators are then the usual representatives truncated after a finite number N of rows and columns. The limit $N \to \infty$ is of particular interest. A paper on this work has been accepted for publication in the American Journal of Physics. (Buchdahl)

A semi-symmetric optical system is one which possesses an axis of symmetry and which has a built-in screw sense about this axis. The Hamiltonian theory of the aberrations of such systems in general, and the consequences of imposing the additional condition of reversibility were investigated. A paper on this work has been accepted for publication in the Journal of the Optical Society of America. (Buchdahl)

The investigation of the general relativistic incompressible sphere (whose medium obeys an equation of state of the form $p = \rho - \rho_b$) was revised and extended. A paper on this work has been accepted for publication in the Journal of the Australian Mathematical Society. (Buchdahl and Land [Ph.D. student, 1965])

Work is proceeding on the calculus of complex 5-vectors which stand in one-one correspondence with Weyl tensors. (Buchdahl)

The masses of elementary particles have been investigated in collaboration with D. Lichtenberg of Indiana University, using models with approximate SU(3) symmetry with particular attention to the deviation from exact SU(3) symmetry. A paper has been published on relativistic quark-antiquark models of mesons, in which the quarks are described by the Klein-Gordon equation. Baryons have been considered as bound states of a boson and a fermion, and a paper on this has been submitted for publication. (Tassie)

Models of the elementary particles as bound states of two particles are now being considered in which the constituent particles are described by the Dirac equation. (Tassie)

A paper on conservation laws in Aristotelian mechanics has been submitted for publication. It has been shown that the symmetry properties of space and time imply both classical and quantum mechanical conservation laws for Aristotelian mechanics, but that these conservation laws are only formal and have no physical significance. (Tassie)

Work on the theory of "non-axial" aberration coefficients has proceeded successfully and is nearly concluded. Results obtained on the C.S.I.R.O. and university computers are very satisfactory. (Sands [Ph.D. student])

Other Activities:

In September Professor Buchdahl gave a course of six lectures on classical thermodynamics in the Physics Department of the University of Queensland. Before returning from study leave in February, Dr. Tassie attended the Coral Gables Conference on Symmetry Principles at High Energy at the University of Miami.

Publications:

Buchdahl, H. A. "General Relativistic Fluid Spheres. II. General Inequalities for Regular Spheres." Astrophysical Journal, 146 (1966) 275.

Tassie, L. J. and Lichtenberg, D. B. "Quark-Antiquark Models of Mesons with Relativistic Mechanics." Aust. J. Phys., 19 (1966) 599.