INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

ANNUAL REPORT
1987

10 Burlington Road, Dublin 4

P1.6217

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

Annual Report of the work of the Institute and its Constituent Schools presented by the Council to the Minister for Education in respect of the year ended 31 December 1987

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INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
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Summary of Annual Report
of the work of the Constituent Schools
for the year ended 31 December 1987

School of Celtic Studies

Ten papers were read at the School's annual Tionól, which took place on the 27-8 March. The triennial Summer School was held on the 22 June - 10 July and was attended by 66 students from Austria, Canada, Czechoslovakia, France, Germany, Ireland, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, and the United States. The series of short seminars was concluded with contributions from A. Harvey, F. Kelly, U. Mac Gearailt, D. Ó Sé, J. Uhlich, and H. Wagner. P. Mac Cana and T.A. Watkins continued their seminar on Culhwch ac Olwen. Professor John Kelleher of Harvard University gave a public lecture at the School on 'The Battle of Móin Mór 1151', and the Statutory Public Lecture was delivered by R. Baumgarten at Trinity College on 'The Galatians: Celts in Asia Minor'.

Projects on editing early Irish Law texts, on the cataloguing and description of Irish manuscripts, and on the bibliography of Irish linguistics and literature continued to make good progress. A substantial amount of other work on language and texts was in hand. Further progress was made in the use of personal computers in research and publication.

Four titles were published by the Institute for the School during 1987 and three titles were reprinted. Two external journals were edited by members of the School and more than forty contributions were made to journals and learned conferences.

Of the ten people who were present as scholars for the whole or part of 1987, four were from overseas.
In September, A. Nic Dhonnchadha relinquished her Junior Research Assistantship to return to her position in Carysfort College of Education.
In October, M. Ó Siadhail left on a career break.
M. Ó Murchú took over as Director on the 16 September from P. Mac Cana.

School of Theoretical Physics

Staff, Scholars, Research Associates, and Visitors made much use of the School's facilities in their primary research activities, especially of the opportunities for informal discussions, and of the library resources. Thirty-five research workers from the universities or other institutes of research or higher education (mainly in Ireland) were admitted as research associates of the School; thirty-seven scientists from abroad visited the School during the year.

The Easter and Christmas Symposia were held as in previous years; seminars at DIAS and joint seminars (with UCD, TCD, Maynooth, NIHED) in special subject areas were continued. Twenty-two seminars and six courses/series were given at DIAS, eight contributions were made to the Journal's Club, and eight lectures were given at Irish universities (including QUB) during the year. The Statutory Public Lecture was given at UCD by Sir Rudolf Peierls FRS; his title was "Recollections of the Early Days of Quantum Mechanics: More about Physicists that Physics". A meeting of the Irish Mechanics Group was held, and at a Seminar held to mark the 90th Birthday of Prof. Emer. J.L. Synge talks were given by two eminent ex-students of his; guests at the Seminar included Professor Synge's daughter, Cathleen Synge Morawetz (an eminent mathematician at NYU), and the Reception afterwards was attended by the President, Dr. P.J. Hillery.

The School continued its research. The primary areas of research were theoretical and particle physics, classical statistical mechanics, and quantum statistical mechanics; secondary areas were general relativity and gravitation, applied mathematics, and pure mathematics. One book was published, and forty-six contributions to scientific journals or conference proceedings were published.

Members of the School attended thirty-six conferences abroad, and gave twenty seminars at these. They gave thirty-six lectures and two courses of lectures at universities abroad.

The Director was authorised by the School's Board to sign an exchange agreement with JINR (Dubna, USSR).

School of Cosmic Physics

The research work of the School during the year included contributions to astronomy, to the physics of particle detection, and to the geophysics of the environment of Ireland.

Cosmic ray detectors in earth orbit since 1984 have continued to accumulate data due to the hiatus in the NASA Shuttle launch programme. The significance of the results is expected to be increased by this prolonged exposure. Electronic circuits for particle detectors due to be launched on the USSR Mars mission Phobos in 1988 were designed, constructed and provided with operating routines; they were tested in conjunction with other authorities in Ireland, West Germany, the Netherlands, Hungary, and the USSR.

Results from the 1986 Giotto mission to Halley's Comet were analysed in terms of the structure of the interplanetary matter affected by the passage of the comet and other work on the heliosphere and on possible future projects with the European Space Agency was carried out.

The responsibility for Irish participation in the Spanish observatories in the Canary Islands resulted in work on X-ray sources (Galway), on blue compact galaxies (Maynooth), on double star photometry (with Cambridge) for the Hipparcos astrometry satellite and on jets from young stellar objects, and a start was made ou instrumental developments intended to enhance the quality of optical images. Several new features were revealed in studies of Herbig-Haro objects. Theoretical work in astrophysics included shock acceleration theory and interpretation of apparent superluminal velocities.

Geophysical work centred on many extensive surveys of the lithospheric structure under the seas around Ireland, based on magnetic and gravity surveys, carried out in conjunction with the Irish Geological Survey and the Geophysics Institute of Hamburg. Several dozen seismic profiles were secured and methods for computation of the structure were extensively developed and used. Other projects, in Kenya, around the Iberian peninsula, and through the European continent, were worked on in conjunction with geophysical workers from other countries, particularly the United Kingdom, West Germany, Switzerland and Spain. Palaeomagnetic data from Denmark and from Ireland have also been studied.

A wide range of external activities, lectures, colloquia, etc., throughout Ireland and in other countries took place during the year.

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

Annual Report of the work of the Institute and its Constituent Schools presented by the Council for the year ended 31 December 1987

In accordance with the provisions of Section 29 of the Institute for Advanced Studies Act, 1940 (No.13 of 1940), the Council of the Institute has the honour to present to the Minister for Education for submission to the Government a report of the work and activities of the Institute and its Constituent Schools for the year ended 31 December 1987.

The report is presented under the following principal heads:-

I - Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31 December 1987.

II - Report of the Governing Board of the School of Celtic Studies.

III - Report of the Governing Board of the School of Theoretical Physics.

IV - Report of the Governing Board of the School of Cosmic Physics.

I Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31 December 1987.

1 THE COUNCIL OF THE INSTITUTE

Chairman

T. K. Whitaker, D.Econ.Sc.

Ex-Officio Members

Patrick Masterson, M.A., Ph.D., President, University College, Dublin; W. A. Watts, M.A., Sc.D., Provost, Trinity College, Dublin; J. C. I. Dooge, M.E., M.Sc., C.Eng., F.I.E.I., F.A.S.C.E., D.Agr.Sc., President, Royal Irish Academy.

Members appointed by the Governing Boards of Constituent Schools

M. Ó Murchú, M.A., Ph.D.; T. de Bhaldraithe, M.A., Ph.D., D.Litt.; J. T. Lewis, B.Sc., Ph.D.; A. J. McConnell, M.A., M.Sc., Sc.D., F.T.C.D.; P. A. Wayman, Ph.D.; E. F. Fahy, M.Sc., Ph.D.

2 GOVERNING BOARD OF THE SCHOOL OF CELTIC STUDIES

Chairman

T. de Bhaldraithe, M.A., Ph.D., D.Litt.

Senior Professors

M. Ó. Murchú, M.A., Ph.D.; P. Mac Cana, M.A., Ph.D.; B. Ó Cuív, M.A., D.Litt.

Appointed Members

G. Mac Eoin, M.A., Ph.D.; S. Mac Mathúna, B.A., Ph.D. (Q.U.B.); M. P. Ní Chatháin, M.A., Ph.D. (Edin.); S. Ó Coileáin, M.A., Ph.D. (Harv.); P. Ó Fiannachta, M.A., Ph.D.; T. Ó Floinn, M.A.; S. Ó Tuama, M.A., Ph.D.; G. Stockman, M.A., Ph.D., Dip.Ed.; G. Victory, B.A., Mus.D.; T. K. Whitaker, D.Econ.Sc.

3 GOVERNING BOARD OF THE SCHOOL OF THEORETICAL PHYSICS

Chairman

A. J. McConnell, M.A., M.Sc., Sc.D., F.T.C.D.

Senior Professors

J. T. Lewis, B.Sc., Ph.D.; J. R. McConnell, M.A., D.Sc.; L. Ó Raifeartaigh, M.Sc., Ph.D.

Appointed Members

J. C. I. Dooge, M.E., M.Sc., C.Eng., F.I.E.I., F.A.S.C.E., D.Agr.Sc.; J. N. Flavin, M.Sc., Ph.D.; M. A. Hayes, M.Sc., Ph.D.; P. Quinlan, B.E., D.Sc., Ph.D.; T. D. Spearman, M.A., Ph.D. (Cantab.), F.T.C.D.; S. S. Tóibín, M.Sc., Ph.D.

4 GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS

Chairman

E. F. Fahy, M.Sc., Ph.D.

Senior Professors

T. Murphy, D.Sc.; P. A. Wayman, Ph.D.; L. O'C. Drury, B.A., Ph.D.

Appointed Members

A. Brock, M.A., Ph.D., F.R.A.S., F.Inst.P.; D. J. Bradley, Ph.D., F.R.S., F.T.C.D.; P. K. Carroll, M.Sc., Ph.D.; M. de Groot, Ph.D.; G. F. Imbusch, Ph.D., D.Sc.; D. L. Linehan, B.Sc., B.E.; V. J. McBrierty, B.Sc., M.A., Ph.D. (Lond.), Sc.D., C.Phys., F.Inst.P., F.T.C.D.; N. A. Porter, Ph.D.; D. L. Weaire, B.A. (Cantab.), Ph.D. (Cantab.).

5 ADMINISTRATIVE STAFF

Registrar

Lt. Col. J. P. Duggan, B.A., H.Dip.Ed., M.Litt., MIL.

Senior Clerk

Maura Devoy, B.A.

Accounts Clerk

Mary A. O'Rourke, B.A.

Clerks

Angela Stubbs; Noreen Granahan; Caitríona Tubridy; Desmond Pender; Eibhlín Nic Dhonncha.

II - Annual Report of the Governing Board of the School of Celtic Studies for the year ended 31 December 1987 adopted at its meeting on 10th June 1988.

I. STAFF AND SCHOLARS

Senior Professors:

Proinsias Mac Cana (Director to 15 September), Brian Ó Cuív, Máirtín Ó Murchú (appointed 1 January, Director from 16 September).

Professor:

Heinrich Wagner

Assistant Professors:

Pádraig de Brún, Fergus Kelly, Kolf Baumgarten, Mícheál Ó Siadhail (career break from 1 October)

Research Assistant:

Malachy McKenna

Assistant (part-time)

Nessa Doran

Junior Research Assistants:

Aoibheann Nic Dhonnchadha (to 31 August), Pádraig Ó Macháin

Librarian Executive:

Máire Breatnach

Secretary/Publications Officer:

Máire Uí Chinnseala

Clerical Staff:

Karen Elson

Professors Emeriti:

D. A. Binchy, James Carney

Scholars:

Colmán Etchingham (to 31 March); Andrew Breeze, Máire Ní Mhaonaigh, Kevin Walsh (to 30 September); James Galvin, Colin Ireland, Jürgen Uhlich; Aidan Breen, Kaarina Hollo, Seán Ua Súilleabháin (from 1 October).

Visiting Research Associates:

Dr. Marilyn Garriets, St. Francis Xavier University, Antigonish (to 31 July), Professor R. Geraint Gruffydd of the Centre for Advanced Welsh and Celtic Studies, University College of Wales, Aberystwyth (2-6 March), Dr. Mark Scowcroft, Department of English, University of Virginia (from September), Dr. Neil McLeod, Department of Law, University College, Dublin and Australian National University (October - December).

Visitor:

Mr. Bill Malone, Ph.D. student at Catholic University of Washington was granted study facilities in the School from 12 January to 30 April while attending the Institute of Public Administration in Dublin.

2. RESEARCH AND EDITING

Professor James Carney continued his work on Archaic Irish verse. An article on this subject was accepted for publication in the proceedings of the Conference on 'Mündlichkeit und Schriftlichkeit in der älteren irischen Literatur' which is to be published by the University of Freiburg. See also §§ 7, 8.

Professor Proinsias Mac Cana collaborated with Professor T. Arwyn Watkins in the preparation of an edition of the Middle Welsh tale Culhwch ac Olwen and continued work on an edition of Fled Bricrenn. He also worked on a number of topics of Irish and Welsh syntax. He refereed the manuscripts of two books and several articles for foreign publishers and journals and read doctoral theses for the University of Geneva and the University of Ulster. The following articles were accepted for publication:
(i) 'The Poet as Spouse of his Patron' (Ériu 39);
(ii) 'The Conjunctive Pronouns in Middle Welsh' (Festschrift for Professor T. Arwyn Watkins. See also §§ 5, 7, 8, 10 (c) and (e).

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH

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NOTES TO THE ACCOUNTS (Contd.)

5. Fixed Assets (Furniture & Equipment):

	£
Cost at 1 January, 1987	611,723
Additions	55,386
Cost at 31 December, 1987	667,109
Accumulated Depreciation at 1 January, 1987	314,143
Depreciation in year	59,497
Accumulated Depreciation at 31 December, 1987	373,640
Net book value at 31 December, 1987	293,469
Net book value at 31 December, 1986	297,580

6. Capital Reserve:

Balance at 1 January, 1987	297,580
Income capitalised in year	55,386
	352,966
Depreciation	59,497
Balance at 31 December, 1987	293,469

7. Leasing:

(a) Operating Leases:

The premises occupied by the Institute are leased from the Office of Public Works. The commitment on foot of such leases in respect of 1988 is £39,800. All except £260 of this commitment is on foot of leases of property from year-to-year.

(b) Finance Leases:

There were no appreciable finance leases in existence at 31 December, 1987.

8. Superannuation:

The total superannuation payments in the year amounted to £110,812. The salaries and superannuation charge in the accounts is net of contributions totalling £10,228.

9. Miscellaneous:

Included in Miscellaneous is Bank Interest earned of £45,648 (1986 - £47,084) for the year.

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH
(Dublin Institute for Advanced Studies)

Report of the Comptroller and Auditor General

I have examined in accordance with approved auditing standards the Accounts set out on Pages 1 to 8 which are in the form approved under the provisions of Acht um Institiuid Ard-Leinn, 1940. I have obtained all the information and explanations which I considered necessary for the purpose of my audit.

In my opinion proper books of account have been kept by an Institiuid and the Accounts, which are in agreement with them, give a true and fair view of the state of its affairs at 31 December 1987, and of its transactions and source and application of funds for the year then ended.

P. L. McDONNELL
Comptroller and Auditor General
16 December 1988

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

ANNUAL REPORT
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INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
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Summary of Annual Report
of the work of the Constituent Schools
for the year ended 31 December 1988

School of Celtic Studies

The School of Celtic Studies made continuing progress on one of its most important statutory responsibilities, that of investigating Irish MSS: Fasciculus X of the Catalogue of Irish MSS in the NL was completed and published, and a further three fasciculi were completed in first draft; Dr de Brún's valuable survey Lámhscríbhinní Gaeilge: Treoirliosta was completed and published. In regard to the School's duty to edit and publish the contents of the Irish MSS tradition: L. Breatnach Uraicecht na Ríar was published as Vol. 2 of the Early Irish Law Series, and work continued on an edition of the Old Irish Bríathra and other texts for the series; editing K. Jackson Aislinge Meic Con Glinne continued; research for an edition of the work of the Bardic poet Fearghal Óg Mac an Bhaird was completed; with a view to its eventual publication, work began on making a computer copy of R. Plunket's 17th century Latin-Irish dictionary; Dr Breen continued work on editions of Hiberno-Latin materials, and Dr. Lapidge and Dr Sharpe agreed to become General Editors of the Scriptores Latini Hiberniae Series.

In regard to language study: work was completed on aspects of West Muskerry Irish and of Perthshire Gaelic; work continued on the editing of P. Russell Celtic Word- Formation; arrangements were made for the editing and publication of the University of Edinburgh's Gaelic Survey of Scotland archive.

In the wider field of Celtic Studies: G.C.G. Thomas A Welsh Bestiary of Love was published as Vol. 9 of the Medieval and Modern Welsh Series; Vol. XIX of Celtica and No. 2 of the Newsletter were published.

The School's annual Tionól was held on the 25-26 March and attracted a wide range of contributors; weekly seminars were conducted by P. Mac Cana, A. Watkins (UCD), and C. Ireland; F. Kelly delivered the Statutory Lecture at UCD on 'Early Irish Farming: the evidence of the 7th - 8th century law-texts'.

Through retirement, death, and resignation, 1988 brought a sharp reduction in the full-time permanent staff of the School, the total by the end of the year being 7; of the 9 scholars who were present for a whole or part of 1988, four were from overseas; the School continued to attract visiting academics to avail of its study and research facilities; and the practice of appointing Research Associates was resumed with the appointment of Drs Lapidge, Ó Dochartaigh, and Sharpe.

School of Theoretical Physics

Staff, Scholars, Research Associates, and Visitors made much use of the School's facilities in their primary and secondary research activities, especially of the opportunities for informal discussions, and of the library resources. Thirty-six research workers from the universities or other institutes of research or higher education (mainly in Ireland) were admitted as research associates of the School; thirty scientists from abroad visited the School during the year.

The Easter and Christmas Symposia were held as in previous years; seminars at DIAS and joint seminars (with UCD, TCD, Maynooth, NIHE-D) in special subject areas were continued. Fourteen seminars, one informal discussion, and two series/courses were given at DIAS, eight contributions were made to the Journal's Club, and seven lectures were given at Irish University and other Meetings during the year. The Statutory Public Lecture was given at TCD by Professor Lewis, his title was "Understanding Phase Transitions", and the lecture was illustrated by computer simulations based on a programme by Dr. Sullivan: a One-Day Workshop was held on Statistical Mechanics.

The School continued its research. The primary areas of research were theoretical particle physics, classical statistical mechanics, quantum statistical physics, and quantum electronics; secondary areas were general relativity and gravitation, applied mathematics, and pure mathematics. One book was published, and another was in press; forty-three contributions to scientific journals or conference proceedings were published.

Members of the School attended thirty conferences abroad, and gave lectures at seventeen of these. They gave twenty-one lectures and two courses/series of lectures at Universities or research labs abroad.

Dr. E. de Valera presented his father's and grandfather's collection of scientific books to the School Library, on permanent loan. Professor McConnell retired in February and was made Professor Emeritus; Ms Matthews went on a career break in August.

School of Cosmic Physics

General

The School occupies premises at 5 Merrion Square, Dublin 2, and at Dunsink Observatory, Castleknock, Dublin 15 . At the end of the year the Academic Staff numbered twelve, including two Senior Professors. Professor Thomas Murphy, Head of the Geophysics Section from 1964 and Director of the School for the period 1984-1987, retired during 1988 and responsibility for that Section has been undertaken for one year by Professor A.W.B. Jacob.

From its inception in 1947, the work of the School has been carried out under three Sections, within the areas now designated as Astronomy, Cosmic Rays, and Geophysics. There are areas of common interest, especially in the common ground of astrophysics and cosmic rays and in the provision of library, computing and workshop facilities. In the main Report, the research work in astronomy and cosmic rays is grouped together, but for the purposes of this summary, which is not all-embracing, each Section is reported on separately.

Scholars in each Section are able to register for higher degrees in the Irish Universities and the co-operation of the several academic departments involved is greatly appreciated. During 1988 six Scholars were availing of this provision. At the same time, some lecture courses in the Dublin universities, principally Trinity College, are reported for 1988.

Astronomy Section

Occupying a building long associated (since 1783) with the science of astronomy, the Section continues to fulfil a dual role. As well as providing research facilities in astronomical science based mainly on mathematics and physics for its own scientists and for Research Associates (and others) in the Irish universities interested in using those facilities, the Section acts non-statutorily as an authority on astronomical phenomena generally.

Legal enquiries on, e.g. lighting-up times fixed by the local time of sunrise and sunset, require careful attention. Also, by tradition, the 12-inch South Telescope is made available for public viewing twice per month from September to March and tickets are provided for up to 100 persons on each occasion. The renovation of the telescope in 1988, principally by Jeremiah Daly of the Cosmic Ray Section, has been an asset that was chosen as an Institute contribution to 'Dublin Millennium Year'.

The principal access to observational work in astronomy must, in the present day, depend either on work with scientific instruments on board space vehicles launched for specific purposes or on elaborate telescopic equipment erected on sites selected for climatic excellence. Modest equipment on mediocre sites is still in use, mainly for experimental and test purposes, but even this seems less than economic in Irish financial and climatic conditions. Access to first class facilities at high-altitude sites, however, as well as participation in space projects, is possible through international schemes of co-operation. In 1979 a formal agreement to participate with the UK Science and Engineering Research Council was signed by the Institute that has enabled Irish scientists to apply for telescope observing time on any of the SERC facilities principally on the island of La Palma in the Canary Islands, at the Spanish International Astrophysical Observatory (IAC), but also at Siding Spring, Australia, and on Mauna Kea, Hawaii. One example of a programme benefitting from the conditions on La Palma has been the securing during 1986-88 by a Cambridge-Brussels-Dublin observing team, in a relatively short period, of a very large number of double star measurements (relative brightness and position) badly needed by the forthcoming European Space Agency Hipparcos astrometric satellite project due for launch in 1989 and completion around 1995.

During 1988 the principal observational interest was in the setting up of joint work with University College, Galway, Physics Department (Dr R.M. Redfern), at the large (4.2-m diameter mirror) William Herschel Telescope on La Palma, which is still undergoing commissioning and which will not be completely commissioned until late in 1989. This telescope, for some five or six years, taking into account the quality of the site 2400 m. above sea level, must be regarded as one of the world's most powerful ground-based telescopes. With a superb site there is great interest, and indeed a scientific obligation, in investigating methods of overcoming some of the remaining deleterious effects of the earth's atmosphere, particularly in improving the angular

resolution, or image definition, attainable. The present experiments are intended to utilise real-time operation of standard PC computers, equipped with INMOS 'Transputer' circuitry, to distinguish moments of superior atmospheric quality and to record selectively the images received at those moments. The tests carried out in 1988 were promising but there is some way to go before profitable astronomical results are yielded.

The other (1-m. and 2.5-m) telescopes on La Palma were used for a variety of programmes, including work on 'Jets from Young Stellar Objects' by T.P. Ray of the Cosmic Ray Section in co-operation with individuals at the Heidelberg Max Planck Institut für Astronomie. Although star formation from the interstellar medium is certainly taking place, the mechanisms involved seem to incorporate little-understood processes and in their supposedly early stages of formation some stars emit jets of ionised material ('plasma') in two diametrically opposite directions. The behaviour of these fairly rare jets can be investigated from high-definition images taken through selected optical and infrared filters. Some good results have been obtained in 1987 and 1988; in due course this topic may benefit greatly from the high-resolution studies being started at the William Herschel Telescope.

In theoretical work, T. Kiang has been interested for some years in the problem of why asteroid (minor planet) orbits in the solar system show a non-random distribution in their semi-major axes (or in their energies). This is a little-understood phenomenon of resonance with the orbital period of Jupiter, causing some resonances to be over-populated and others to be vacated, the 'Kirkwood Gaps'. Although his work in this field has had some elaborate modelling, in 1988 Kiang made lengthy computations using many significant figures in order to determine whether a relatively simple dynamical model, previously thought to represent a stable solution in resonance, would, if sufficiently prolonged by numerical integration, exhibit the instability of the 2:1 resonance with Jupiter. After large amounts of computing time had been used, an inconclusive result was obtained, although the indication was that the model does not in fact exhibit the instability that exists at that resonance.

Professor Brian Ó Cuív continued research on linguistic, metrical and literary topics in Irish and he prepared several articles for publication. He continued to advise on Professor K. Jackson's edition of Aislinge Meic Con Glinne. He brought to its final stages the edition of Celtica 19 to which he contributed an edition of a Middle Irish historical poem as well as two shorter items and reviews of books. The following articles were accepted for publication: (i) 'Personal names as an indicator of relations between native Irish settlers in the Viking period', in Settlement and Society in Ireland: Viking and Medieval Times, ed. by John Bradley; (ii) 'An item relating to the legend of Labraid Loingsech', in Ériu 39. See also §§ 5, 7, 8, 10, (a), (b) and (e).

Professor Máirtín Ó Murchú completed the preparation of Perthshire Gaelic I for publication and the work was sent to press in September - October. Preparation of Perthshire Gaelic II continues. See also §§ 8, 10 (a) and (e).

Professor Heinrich Wagner saw his edition of ZCP 42 through the press. Work on a forthcoming publication on Comparative Celtic Grammar continued. He also worked on linguistic links between Celtic, Basque and Afro-Asiatic. The following articles were accepted for publication in ZCP (43) (i) 'Phonetische Texte aus Dunquin Part II' (with N. Mc Gonagle); (ii) 'The system of absolute and conjunct verbal endings in Celtic'. He contributed an article on 'Oral Literature from Cárna (Conamara)' (based on material collected from Páraic Mac an Iomaire in 1946) to a forthcoming monograph by N. McGonagle. See also §§ 5, 6, 7, 10, (c) and (e).

Dr. Pádraig de Brún continued work on the catalogue of Irish manuscripts in TCD (with Aoibheann Nic Dhonnchadha) and on a guide to locations of manuscripts in Irish. Work on the annotation of a list of the Irish Society's Bible Teachers 1818-27 progressed. An article entitled 'Dhá bhlogh de theagasg críostaí - ó ré Éilíse I (?)' was accepted for publication in Celtica. See also §§ 9, 10 (e)

Dr. Fergus Kelly finalized the typescript of An Introduction to Early Irish Law which was ready for press by the end of the year. He began work on another volume for the Early Irish Law Series entitled Early Irish Agriculture. He acted as director of the Celtic Studies Summer School which was held in June-July. See also §§ 5, 7, and 8.

The electronics workshop of the Section, as well as completing, in 1988, the design and testing of the digital electronics used on the SLED space vehicle described below (Cosmic Ray Section), joined with Armagh Observatory and Queen's University, Belfast, in upgrading to common-user standard an echelle spectrograph designed for use on the 1-m telescope on La Palma. Other electronic work begun during the year concerns the design and construction of the photon-imaging-detector circuits intended for the image-enhancement programme with Galway. In this way, the Section is contributing to technical advances directed towards astronomy, but having parallels with other applications. This duality is a feature of astronomical methods (e.g., clocks, position-finding, optics) through the ages.

Cosmic Ray Section

The Cosmic Ray Section studies the universe around us through the detection and interpretation of charged particles. This involves, on the one hand, experimental programmes to measure the charged particle populations in situ by detectors on satellites and space probes, and on the other, theoretical studies to understand the observations in terms of models for particle acceleration and propagation.

The use of sheets of polymers to detect highly ionizing particles (solid state nuclear track detectors) is a technique which has been exploited in the Section for many years to study heavy and ultra-heavy particles in the cosmic rays. The advantage of the method is that it is insensitive to the protons and alpha-particles which constitute the bulk of the cosmic rays; thus only the heavy nuclei are detected. The disadvantage is that the polymer sheets have to be recovered, etched to reveal the tracks left by the cosmic ray particles, and then measured. The largest-ever experiment of this type was built by DIAS in collaboration with the European Space Agency's science and technology centre, ESTEC, and exposed in space on the NASA Long Duration Exposure Facility launched in 1984. Because of the tragic disruption of the Space Shuttle programme, this exposure has been much longer than intended, but this will greatly increase the value of the cosmic ray experiment, which is expected

to yield the first statistically significant sample of ultra-heavy cosmic ray nuclei. In preparation for the recovery (anticipated for the end of 1989) and subsequent analysis, a programme of fundamental studies on the long-term stability of the detectors is being carried out.

A more conventional technique is the use, at the much lower energies typical of solar system particles, of silicon barrier detectors. These were successfully employed in the EPA experiment on Giotto, the European mission to Halley's comet. The Institute was a partner in this experiment and analysis of the data obtained is continuing. The design of the EPA formed the basis for two SLED (Solar Low Energy Detector) instruments on the Soviet Phobos mission to Mars and its moons. These were the first space instruments to be almost completely built in Ireland and were constructed during 1986 and 1987 as part of a collaboration of the Astronomy and Cosmic Ray Sections with St. Patrick's College, Maynooth, ESTEC, the Max-Planck-Institut für Aeronomie, Lindau, the Central Research Institute for Physics, Budapest (KFKI), and the Space Research Institute, Moscow (IKI). The two spacecraft, Phobos-1 and Phobos-2, were launched early in July 1988, each carrying a SLED instrument towards Mars. Both operated satisfactorily after launch and data was obtained on solar energetic particles in the region between Earth and Mars, but contact with the first spacecraft was lost in early September. The second spacecraft, with its SLED instrument, continued to work throughout the year and reached Mars early in 1989.

Observations alone are of little use; to understand and interpret the data from experiments and to plan new observations, theoretical models and other calculations are needed. As part of his Ph. D. Peter Duffy has developed an analytical model for particle acceleration around comets which improves in several ways on existing models. This will be compared with the observations of energetic ions near Comet Halley made by the EPA and other instruments on Giotto. As part of a collaboration with former colleagues in Heidelberg, Luke Drury has developed theoretical models which strengthen the widely-held view that the bulk of galactic cosmic rays are produced in supernova remnants, the residue of exploded evolved giant stars.

The most widely-reported result of the year was unrelated to the main work of the Section, a study by Tom Ray of the astronomical significance of the megalithic tomb at Newgrange in the Boyne valley. His conclusion, that with high probability Ireland possesses the oldest known structure with a significant astronomical alignment, received international media coverage and a photograph of the solsticial sun shining down the passage of the tomb was used as the cover illustration for the issue of the journal Nature in which his article appeared.

Geophysics Section

The year 1988 was a busy one for the Section. Studies of the earth's lithosphere in and around Ireland continued. The lithosphere is the cool, relatively rigid, outer shell of our planet. In old continental areas, like Ireland, it may vary between 100 and 200 km thick, while under the younger, hotter conditions to be found under oceans, it is normally much thinner. It is particularly thin near mid-ocean ridges where there is an upwelling from the mantle and new oceanic lithosphere is being produced. The material cools as it moves away from the ridge and, as it cools, the lithosphere thickens. The generation of oceanic plates (as they are known) and the movement on the earth's surface is described by what is called plate tectonics.

Ireland is in a particularly interesting position, with the very large Eurasian continental landmass to the East and the expanding North Atlantic Ocean to the West. It is currently a 'passive' zone, but it has, buried within its present-day structures, the traces of major geological events in the past. These include the intercontinental collision (the Caledonian collision) at the closing of the previous 'Atlantic' around 400 million years ago, and the stretching and rifting which preceded the opening of the present Atlantic. These latter effects began around 200 million years ago. One result of this stretching is that there are many sedimentary basins around Britain and Ireland. These, and the mechanism of their formation, are very interesting problems in themselves. They also, of course, contain many structures that give us gas and oil today.

The Geophysics Section is carrying out research projects which examine a number of these topics. Most of this work is in cooperation with other groups, as each project is often beyond the resources of any one group.

Two seismic profiles completed in 1988 were part of the COOLE project. In particular, one studied the Caledonian collision zone in central Ireland. The very pronounced 'buckling' of deeply buried features over a belt some 60 km wide betrayed the horizontal forces involved in this collision. None of this shows at the surface, although there was a strong indication in the gravity data gathered by the Section over a period of about 30 years. The meaning of this was not clear until the seismic profile was carried out. Another striking result from this profile was the definition of a buried granite, a southwestern extension of the Leinster granites which appear at the surface in Co. Wicklow for example. This had been predicted in outline on the basis of earlier gravity work, but detailed confirmation was not possible without the seismic data.

The second seismic profile published in 1988 ran southwestwards from Co. Kerry into the Porcupine Seabight and the ocean beyond. This showed the rifting that produced the Seabight, the thinned continental crust under it, and the sharp transition to oceanic structure under water 4 km deep at the mouth of the Seabight. This was important new information.

A study of the North Celtic Sea Basin, which contains the Kinsale gas field, is also under way and making promising progress. Again there is evidence of crustal stretching, though not as severe as in the Porcupine Seabight.

Some of the most striking results have come from a much deeper study. This has used data recorded in Ireland from a pattern of seismic shots in the North Sea. The sources were not particularly big, but they have produced a magnificent set of seismic sections containing signals which have passed through the lower lithosphere down to depths approaching 100 km. This data, when combined with an earlier profile in Britain and another subsequent one in Ireland, has shown that the lithosphere in this area has layers where the seismic velocities vary with direction. This is known as anisotropy and we believe that it contains a record of localized heating and strain. This is a rapidly developing area in seismology and our data is the best of its kind recorded anywhere in the world. Our experience has allowed us to help in the design of a new programme to study these effects under Iberia.

Ireland is not in an active earthquake zone but events do happen from time to time. Only one occurred on-shore in 1988, between Wexford and Enniscorthy, but the Irish Sea was more active than usual, with about 20 events recorded and located by our stations. All these events were small. The aftershock sequence of the much larger event in July 1984 still continues, though now at a very low level.

Work has continued in both off-shore and on-shore gravity studies and new results should begin to come in 1989. Gravity studies tie in well with seismic work as rock density and seismic velocity generally correlate in a significant way. It can be very useful to interpret both data sets together. The delineation of the buried granite, mentioned above, is a good example.

Some geodetic work was carried out and meteorological observations continued at a reduced level. Further studies in the palaeomagnetism of lake sediments were also carried out. Recordings were made in New England as part of the preparation for a project in the East African Rift (Kenya) and the seismic field gear has been further developed to work in a remote, very hot, area. Perhaps the most exciting occurrence was the RAPIDS project in the North Atlantic in September/October. The weather was vile and conditions frighteningly bad at times, but a lot of good data was gathered and we hope to have much to report in 1989 from this examination of the Continental Shelf out over the Rockall Trough.

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

Annual Report of the work of the Institute and its Constituent Schools presented by the Council for the year ended 31 December 1988

In accordance with the provisions of Section 29 of the Institute for Advanced Studies Act, 1940 (No. 13 of 1940), the Council of the Institute has the honour to present to the Minister for Education for submission to the Government a report of the work and activities of the Institute and its Constituent Schools for the year ended 31 December 1988.

The report is presented under the following principal heads:-

I - Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31 December 1988.

II Report of the Governing Board of the School of Celtic Studies.

III Report of the Governing Board of the School of Theoretical Physics.

IV Report of the Governing Board of the School of Cosmic Physics.

I Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31 December 1988.

1 THE COUNCIL OF THE INSTITUTE

Chairman

T.K. Whitaker, D.Econ.Sc.

Ex-Officio Members

Patrick Masterson, M.A., Ph.D., President, University College, Dublin; W.A. Watts, M.A., Sc.D., Provost, Trinity College, Dublin; J.C.I. Dooge, M.E., M.Sc., C.Eng., F.I.E.I., F.A.S.C.E., D.Agr.Sc., President, Royal Irish Academy.

Members appointed by the Governing Boards of Constituent Schools

M. Ó Murchú, M.A., Ph.D.; T. de Bhaldraithe, M.A., Ph.D., D.Litt.; J.T. Lewis, B.Sc., Ph.D.; A.J. McConnell, M.A., M.Sc., Sc.D., F.T.C.S.; P.A. Wayman, Ph.D.; E.F. Fahy, M.Sc., Ph.D.

2 GOVERNING BOARD OF THE SCHOOL OF CELTIC STUDIES

Chairman

T. de Bhaldraithe, M.A., Ph.D., D.Litt.

Senior Professors

M. Ó Murchú, M.A., Ph.D.; P.Mac Cana, M.A., Ph.D.

Appointed Members

G. Mac Eoin, M.A., Ph.D.; S. Mac Mathúna, B.A., Ph.D. (Q.U.B.); M.P. Ní Chatháin, M.A., Ph.D. (Edin.); S. Ó Coileáin, M.A., Ph.D. (Harv.); P. Ó Fiannachta, M.A., Ph.D.; T. Ó Floinn, M.A.; S. Ó Tuama, M.A., Ph.D.; G. Stockman, M.A., Ph.D., Dip.Ed.; G. Victory, B.A., Mus.D.; T.K. Whitaker, D.Econ.Sc.

3 GOVERNING BOARD OF THE SCHOOL OF THEORETICAL PHYSICS

Chairman

A. J. McConnell, M.A., M.Sc., Sc.D., F.T.C.D.

Senior Professors

J.T. Lewis, B.Sc., Ph.D; L. Ó Raifeartaigh, M.Sc., Ph.D.

Appointed Members

J.C.I. Dooge, M.E., M.Sc., C.Eng., F.I.E.I., F.A.S.C.E., D.Agr.Sc.; J.N. Flavin, M.Sc., Ph.D.; M.A. Hayes, M.Sc., Ph.D.; P.Quinlan, B.E., D.Sc., Ph.D.; T.D. Spearman, M.A., Ph.D. (Cantab.), F.T.C.D.; S.S. Tóibín, M.Sc., Ph.D.

4 GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS

Chairman

E. F. Fahy, M.Sc., Ph.D.

Senior Professors

P.A. Wayman, Ph.D.; L. O'C. Drury, B.A., Ph.D.

Appointed Members

A. Brock, M.A., Ph.D., F.R.A.S., F.Inst. P.; D.J. Bradley, Ph.D., F.R.S., F.T.C.S.; P.K. Carroll, M.Sc., Ph.D.; M. de Groot, Ph.D.; G.F. Imbusch, Ph.D., D.Sc.; D.L. Linehan, B.Sc., B.E.; V.J. McBrierty, B.Sc., M.A., Ph.D.; (Lond.), Sc.D., C.Phys., F.Inst.P., F.T.C.D.; N.A. Porter, Ph.D.; D.L. Weaire, B.A. (Cantab.), Ph.D. (Cantab.).

5 ADMINISTRATIVE STAFF

Registrar

Lt. Col. J.P. Duggan, B.A., H.Dip.Ed., M. Litt., MIL.

Senior Clerk

Maura Devoy, B.A.

Accounts Clerk

Mary A. O'Rourke, B.A.

Clerks

Angela Stubbs; Noreen Granahan; Caitríona Tubridy (on career break); Desmond Pender; Eibhlín Nic Dhonncha.

II - Annual Report of the Governing Board of the School of Celtic Studies for the year ending 31 December 1988, adopted at its meeting on 12 May 1989

1. STAFF AND SCHOLARS.

Professors Emeriti:

D.A. Binchy, James Carney.

Senior Professors:

Máirtín Ó Murchú (Director), Proinsias Mac Cana, Brian Ó Cuív (retired 20 November).

Professor:

Heinrich Wagner (died 11 September).

Assistant Professors:

Pádraig de Brún, Fergus Kelly, Rolf Baumgarten, Mícheál Ó Siadhail (career break from 1 October 1987).

Research Assistant:

Malachy McKenna

Assistant (part-time):

Nessa Doran

Junior Research Assistant:

Pádraig Ó Machaín (to 30 September).

Librarian Executive:

Máire Breatnach (retired 29 February).

Secretary/Publications Officer:

Máire Uí Chinnseala

Clerical Staff:

Karen Elson (resigned 1 July)

Mr. Rolf Baumgarten worked on the Bibliography of Irish Linguistics and Literature 1972-86. He edited and produced Scéala Scoil an Léinn Cheiltigh / Newsletter of the School of Celtic Studies, No. 1 (Nov. 1987), to which he contributed, inter alia, accounts of the 'History of the School', 'Publications', 'Kuno Meyer's Irish manuscript'. He also arranged and shelved the library left to the School by the late Professor E.G. Quin. See also §§3,10(b) and (e).

Mícheal Ó Siadhail rewrote some sections of his new publication on Modern Irish Dialects and did some further research on the relationship of Hiberno-English to Modern Irish. See also §§7, 10 (e).

Dr. Malachy McKenna continued work on an edition of The Spiritual Rose and prepared a contribution for volume 1 of Newsletter of the School of Celtic Studies entitled 'Breton Dialectology: A Sample Survey'. See also §§ 7, 8, 10 (e).

Mrs. Nessa Doran (Nessa Ní Shéaghdha) saw Fasc X (MSS G 434 - G 500) of Catalogue of Irish Manuscripts in the National Library of Ireland through the press, completed the description of MSS G 600 - G 699 for Fasc XII and described MSS G 800 - G 825 for Fasc XIV. An article entitled 'The Irish Hand of John O Mahony' was accepted for publication in Festschrift in honour of James Carney. See also § 9.

Aoibheann Nic Dhonnchadha continued cataloguing the medical manuscripts in TCD under the supervision of Pádraig de Brún. A review of John Bannerman: The Beatons: a medical kindred in the classical Gaelic tradition was accepted for publication in Cambridge Medieval Celtic Studies. See also §§ 6, 7, 8, 9.

Pádraig Ó Macháin continued work, which included proof-reading, preparation of typescripts and revision of the Glossary, on Professor K. H. Jackson's edition of Aislinge Meic Con Glinne. He commenced the description of manuscripts for Fasc XIII of the Catalogue of Irish MSS in the National Library of Ireland (G 700 - 799), and also for a catalogue of Irish manuscripts in the Library of Mount Melleray Abbey, Co. Waterford. See also §§ 7, 8, 9, 10 (e).

Colmán Etchingham continued research and writing up his Ph. D. thesis on 'Ecclesiastical Lordship in Early Ireland'.

Temporary Library and Bibliographical Personnel:

Teresa Costelloe, Thomas Kearns, Brendan Teeling (appointed 17 November by arrangement with FÁS).

Scholars:

James Galvin (to 30 September); Aidan Breen, Kaarina Hollo, Colin Ireland, Seán Ua Súilleabháin, Jürgen Uhlich; Ursula Marmé, Pádraig Ó Macháin (from 1 October).

Research Associates:

Dr Michael Lapidge, Cambridge University, Dr Cathal Ó Dochartaigh, Bangor, Wales, Dr Richard Sharpe, Oxford University (appointed 18 November).

Visiting Research Associate:

Dr Mark Scowcroft, University of Virginia (to August).

Visitors to the School:

Aoife Nic Ghiollamhaith, M.A. (February to June), Dr Erich Poppe, University of Marburg, (August - September), Dr Nancy Stenson, University of Minnesota, (June to August), Dr Melita Cataldi, University of Turin (October).

2. RESEARCH AND EDITING

Professor Máirtín Ó Murchú worked on proofs of his forthcoming volume East Perthshire Gaelic and continued preparatory work on West Perthshire Gaelic. An article entitled 'Diglossia and Interlanguage Contact in Ireland' was accepted for publication in Language and Curriculum. See also §§6, 8(a).

Professor Proinsias Mac Cana worked on: (i) aspects of Old and Middle Welsh syntax; (ii) on an edition of Fled Bricrenn and (iii) the Early Irish Immacallam in dá Thuarad. The following articles were accepted for publication: (i) 'Word-order in Old Irish and Middle Welsh: an analogy' for a festschrift to Eric P. Hamp; (ii) 'On the uses of the conjunctive pronouns in Middle Welsh' for a festschrift to T. Arwyn Watkins. See also §§6, 8(d) 8(e).

Professor Brian Ó Cuív continued research on various aspects of Irish Language and literature. Works brought to an advanced stage of preparation include (i) an edition of two Irish versions of the Old Testament Book of Proverbs, those of William Bedell and Peadar Ua Laoghaire, and (ii) a chapter on 'Irish language and literature, 1845-1921' for A New History of Ireland Vol. VI. The following items were completed for publication: 'An ornamental device in Irish verse' (for Éigse 23), 'Two religious poems in Irish', '"Bróga ar nós Polónia"', and several book reviews (for Celtica 20), and 'Vowel hiatus in Early Modern Irish' (for a festschrift in honour of Eric P. Hamp). Editorial Work on Celtica xx, was brought to its final stages. See also §§6, 8 (e).

Professor Heinrich Wagner who died on 11 September had been working on the preparation of articles for publication in Zeitschrift für Celtische Philologie.

Dr Pádraig de Brún continued work on the Irish MSS in TCD, supervised and edited the preparation of catalogues of MSS in the National Library of Ireland, University College Cork and at Madison-Wisconsin. He prepared for press and completed his guide to locations of Irish MSS - Lámhscríbhinní Gaeilge: Treoirliosta. The following articles were accepted for publication: Bíobláir á chosaint féin' and 'The Irish Society's Bible teachers, 1818-27 V' (Éigse); 'Lament for Garret Pierse of Aghamore, slain at Liscarroll, 1642' [with John A. Pierse] (Kerry Archaeological and Historical Society Journal). See also §§7, 8(e).

Dr Fergus Kelly saw A Guide to Early Irish Law through the final stages of production. He commenced work on The Early Irish Farm: the evidence of the law-texts for the Early Irish Law Series and supervised Colin Ireland's edition of Senbríathra Fíthail for the above series. See also §§3, 8(e).

Mr. Rolf Baumgarten worked on the Bibliography of Irish Linguistics and Literature 1972-86. He edited and produced Scéla Scoil an Léinn Cheiltigh / Newsletter of the School of Celtic Studies no. 2; revised previously written and published (1968-) articles for Kindlers Neues Literatur Lexikon (1988-); acted as co-editor of Ériu. He instructed and supervised FÁS personnel (Teresa Costelloe, Thomas Kearns, Brendan M. Teeling) and began computerized indexes (with Brendan Teeling) to Celtica vols 1-20. See also §§ 6, 8(b), 8(e).

Dr Malachy McKenna continued work on The Spiritual Rose and prepared an article entitled 'Conjugation of the verb in East Ulster Irish' for publication. He began work on a register of School of Celtic Studies academic personnel for the period 1940-1990. See also §§6, 8(c), 8(e).

Mrs. Nessa Doran (Nessa Ní Shéaghdha) corrected a computer print-out of Catalogue of Irish MSS in the National Library of Ireland Fasc. XII (mss G 600-G 699) and described mss G 703-G 731, G 774-G 854 for Fasc. XIII An article entitled 'Irish Scholars and Scribes in Eighteenth-century Dublin' was accepted for publication in Eighteenth-century Ireland. See also §§6,7.

Pádraig Ó Macháin, whose period as Junior Research Assistant expired on 30 September, was appointed a scholar from 1 October. He completed work on his Ph.D. thesis on the Poems of Fearghal Óg Mac an Bhaird and continued work on a Catalogue of Irish MSS in Mount Melleray Abbey, Co. Waterford. Work on the revision of the glossary for Professor K.H. Jackson's edition of Aislinge Meic Con Glinne progressed. See also §6.

Mr. James Galvin submitted his thesis on 'The Syntax of the Article in Old Irish' to the National University of Ireland and was awarded the M.A. Degree.

Dr Aidan Breen submitted his thesis De XII abusivis to Trinity College Dublin and was awarded the degree of Ph.D. in June. He worked on a critical edition, with Introduction, Commentary and Indexes, of Aileran Interpretatio mystica ac moralis See also §8(e).

Miss Kaarina Hollo continued work on an edition of Loinges Mac nDuil Dermait from YBL.

Dr Colin Ireland continued work on his edition of Bríathra Flainn Fína for the Early Irish Law Series. The following articles were accepted for publication: 'Some Analogues of the O.E. Seafarer from Hiberno-Latin Sources' (Neuphilologische Mitteilungen) and 'Aldfrith of Northumbria and the Irish Genealogies' (Celtica) See also §§6, 8(e).

Dr Seán Ua Súilleabháin worked on: (i) the verbal system of the West; (ii) Plunket's seventeenth century Latin-Irish Dictionary; (iii) the Bardic poem 'Abair riom, a Éire ógh'. The following articles and reviews were accepted for publication: (i) Sgáthán an Chrábhaidh, foinsí an aistriúcháin' (Éigse xxiv); (ii) 'Deilbhíocht Bhriathra an Tarna Réimniú i nGaeilge Iarthar Mhúscraí'; Reviews: Seádna (ed. Ciarán Ó Coigligh); Bás Cearbhaill agus Fearbhlaidhe (ed. Siobhán Ní Laoire) Celtica xx. See also §8(e).

Mr. Jürgen Uhlich continued work on 'The morphology of compound personal names in Old Irish' for a Ph.D. thesis. See also 6.

Miss Ursula Marmé worked on the semantic value of the preverb in the Old Irish glosses.

Dr R. Mark Scowcroft of the Department of English, University of Virginia, completed his study of Leabhar Gabhála and began to write a book entitled The Hand and the Child: A Study in Narrative. An article entitled 'Leabhar Gahbála, Part II: The Growth of the Tradition' was accepted for publication in Ériu xxxix.

3. STATUTORY PUBLIC LECTURE

A Statutory Lecture entitled 'Early Irish Farming: The evidence of 7th-8th century law-texts' was delivered by Dr Fergus Kelly at University College, Dublin on 18 November.

4. SEMINARS

Professor Proinsias Mac Cana held a weekly seminar commencing 16 February on Fled Bricrenn.

Professor Proinsias Mac Cana and T. Arwyn Watkins held a weekly seminar commencing 18 February on Culhwch ac Olwen.

Dr Colin Ireland held a weekly seminar commencing 18 October on 'The Old Irish Bríathra: Wisdom ascribed to Fíthal and Flann Fína'.

5. TIONÓL

The annual Tionól was held on 25-26 March for University and College staff and research workers. The following papers were read:

Damien Ó Muirí	Gender of Monosyllabic Nouns in Old Irish
Donall Ó Baoill	Athruithe Fuaime agus Dátú i nGaeilge
Aidan Breen	The date, provenance and authorship of the pseudo-patrician canonical texts (Syn. I and II Patricii)
Colin Ireland	The Old Irish Bríathra
Iosóld Ní Dheirg	Foclóir Saincheirde ó Chontae Mhaigh Eo

Liam Mac Mathúna	:	Multi-referential patterns within the topographical lexicon of Irish
T. de Bhaldraithe	:	Foclóir an Phluincéadaigh mar fhoinse d'fhoclóirithe
Anthony Harvey	:	Compiling a Database and Dictionary of Celtic Latin
Máirtín Ó Briain	:	Diarmait mac Cerbaill agus na gcúigí in Acallam na Senórach
Alan Harrison	:	The Battle of the Books: The publication of Dermot O'Connor's translation of Keatings History
B. Ó Madagáin	:	The lullaby in Irish and Scottish Gaelic: a charm to protect the baby
Niall Buttimer	:	Oidheadh Chloinne Uisneach: New Lamps for Old?

6. EXTERNAL ACTIVITIES

Professor Máirtín Ó Murchú reviewed C. Nic Pháidín Cnuasach Focal ó Uíbh Ráthach on Radio na Gaeltachta in March; he read a paper on ' Contrasts of quantity in complex syllable nuclei: data from Perthshire Gaelic' at the Conference of the British Association of Academic Phoneticians held in Dublin in March. He attended the Maynooth Colloquium on Bilingualism and Language Minorities in May and read a paper on 'Diglossia and Interlanguage Contact in Ireland'.

Professor Proinsias Mac Cana was re-elected a member of the Keltische Kommission of the Austrian Academy of Sciences for the period 1 April 1988 to 31 December 1992; co-opted again to the Board of the Institute of Irish Studies, Queen's University Belfast for a three-year period commencing 1988-89; elected a member of the Rhŷs Trust, Oxford University; spent the Fall semester as Visiting Professor at Harvard University. In March he attended the Celtic Studies Conference at Nagoya, Japan where he delivered a lecture on 'The concept of the centre in Celtic ideology' and in Tokyo he lectured on 'Irish literary tradition' to Japan-Ireland Literary Society in the Irish Embassy. He delivered the O'Donnell Lecture on 'Centres in search of a circumference: further notes on Celtic ideology' at Oxford University in May; lectured on 'Ireland and Wales: medieval literary connections' at the Merriman colloquium in Cardiff in June and lectured on 'Literary connections between Ireland and Scotland in the middle ages' at the Irish Studies Summer School in Magee College Derry in July.

Professor Brian Ó Cuív attended the annual colloquium of the Henry Sweet Society in Oxford, 27-29 September, and a colloquium on 'Linguistics in the Middle Ages: a cross-cultural view', also in Oxford, 29-30 September; at the latter he read a paper on 'Linguistic Study and Teaching in Medieval Gaelic Ireland'. He joined the Editorial Board for the Corpus Apocryphorum Hiberniae publication project of the Irish Biblical Association and was chosen as Chairman. In March and May he broadcast on Radio na Gaeltachta two talks in a series on modern Irish history: 'Athbheochan chultúrtha agus an náisiúnachas nua in Éirinn: 1880-1916' and 'An Ghaeilge 1922-1966'. As a special examiner to the University of Edinburgh he read a dissertation on 'Poems by Fearghal Óg Mac an Bhaird' presented for the degree of Ph.D. by Pádraig O Macháin.

Mr Rolf Baumgarten represented (with Eibhlín Nic Dhonncha) the School of Celtic Studies (under the Dublin Institute for Advanced Studies label) at the Frankfurt Book Fair in October and attended seminars on 'Publishing' (CLÉ) and 'dBase IV'.

Dr Malachy mcKenna read a paper entitled 'Analytic Conjugation in Celtic and Basque: from inflection to periphrasis' at the Workshop on typology of languages of Europe held in Rome in January.

Mrs Nessa Doran (Nessa Ní Sheaghdha) lectured at: (i) the International Summer School in University College, Dublin and (ii) at the Institute of Irish Studies Summer School held in Trinity College, Dublin in July. She delivered a lecture entitled 'Irish scholars and scribes in eighteenth-century Dublin' to the Royal Society of Antiquaries of Ireland on 22 September.

Dr Colin Ireland attended the Modern Language Association Conference in New Orleans in December and read a paper entitled 'The Literary Legacy of Aldfrith of Northumbria'.

Mr Jürgen Uhlich attended seminars at Trinity College Dublin on 'Bretha Nemed' and 'Continental Celtic' during Hilary and Michaelmas terms.

7. CATALOGUING OF IRISH MANUSCRIPTS

Cataloguing of Irish manuscripts progressed under the general editorship of Pádraig de Brún:

National Library of Ireland: Nessa Ní Shéaghdha worked on fasciculi XIII and XIV of the catalogue and on the revision of fasciculus XII for publication.

Trinity College, Dublin: Pádraig de Brún and Aoibheann Nic Dhonnchadha continued the recataloguing of the collection.

Other collections: C.G. Buttimer, Catalogue of Irish manuscripts in the University of Wisconsin-Madison, and B. Ó Conchúir, Clár lámhscríbhinní Gaeilge Cholaiste Ollscoile Chorcaí: cnuasach Uí Mhurchú, were accepted for publication pending revision.

8. PUBLICATIONS

(a) Works in course of printing

Uraicecht na Ríar edited by Liam Breatnach

Catalogue of Irish MSS in National Library of Ireland Fasc. X compiled by Nessa Ní Shéaghdha.

A Welsh Bestiary of Love edited by Graham C.G. Thomas

Aislinge Meic Con Glinne edited by K.H. Jackson

East Perthshire Gaelic by Máirtin Ó Murchú

A Guide to Early Irish Law by Fergus Kelly

Celtica XX edited by Brian Ó Cuív

Lámhscríbhinní Gaeilge: Treoirliosta le Pádraig de Brún

(b) Books published by the Institute

Uraicecht na Ríar (E.I.L.S. vol. II)
ed. Liam Breatnach. pp. xii + 189. IR£16. ISBN 0 901282 89 8

Catalogue of Irish MSS in the National Library of Ireland
Fasc. X. MSS G434-G500.
Nessa Ní Shéaghdha. pp. 140. IR£15. ISBN 0 901282 85 5

Lámhscríbhinní Gaeilge: Treoirliosta
Pádraig de Brún. pp. 101. IR£6. ISBN 0 901282 97 9

A Welsh Bestiary of Love (M.M.W.S. Vol. IX)
ed. Graham C.G. Thomas. pp. xliii + 83. IR£8.
ISBN 0 901282 90 1

Scéala Scoil an Léinn Cheiltigh / Newsletter of the School of Celtic Studies, no., 2
ed. Rolf Baumgarten. pp. 36. No charge. ISSN 0790-9853.

(c) Books published outside the Institute

Proinsias Mac Cana (co-editor)

Ériu xxxix. pp. 204.
Royal Irish Academy.
Les Traditions celtes (Editions Robert Laffont, Paris), translation of Celtic Mythology.

Rolf Baumgarten (co-editor)
Ériu xxxix. pp. 204
Royal Irish Academy.

Malachy McKenna
A Handbook of modern spoken Breton. pp. vii + 310.
Niemeyer, Tübingen

(d) Reprint

The Irish of West Muskerry, Co. Cork by Brian Ó Cuív

(e) Contributions to periodicals and other publications

Máirtín Ó Murchú
Historical Overview of the Position of Irish
The Less Widely Taught Languages of Europe ed. L. Mac Mathúna N. French, E. Murphy (Dublin: IRAAL 1988) 77-88.

also in
Aspects of Bilingual Education, ed. M.W. Ó Murchú and H. Ó Murchú (Dublin: Bord na Gaeilge, 1988) 1-6.

Proinsias Mac Cana
Placenames and mythology in Irish tradition: places, pilgrimages and things
Proceedings of the First North American Congress of Celtic Studies, Ottowa 1986, ed Gordon W. Maclennan (Ottowa 1988) 319-41.

Myth into literature in early Ireland
Myth et folklore celtiques et leurs expressions littéaires en Irlande, Colloque 12-13 déc. 1986, Société Francaise d'Etudes Irlandaises, Université de Lille III, ed. R. Alluin et B. Escarbelt (Univ. de Lille III, [1988]) 31-43.

Review of J.F. Nagy The Wisdom of the outlaw
The Canadian Journal of Irish Studies 14, no. 1 (July 1988) 86-8.

Review of M. Lapidge, D. Dumville (eds) Gildas: new approaches in History of Religions (University of Chicago) 28, 2 (Nov. 1988).

Brian Ó Cuív
An item relating to the legent of Labraid Loingsech
Ériu xxxix 75-8

Pádraig de Brún
Dhá bhlogh de theagasc críostaí - ó ré Eilíse I (?)
Celtica xix 55-8.

Tralee voters in 1835
Kerry Archaeological & Historical Society Journal
19 (1986 [1988]) 73-9

Fergus Kelly
An Old Irish text in court procedure
Peritia 5 (1986 [1988]) 74-106.

Rolf Baumgarten
D. A. Binchy: a bibliography
Peritia 5 (1986 [1988]) 468-77.

The founding of the School of Celtic Studies
Newsletter 2 (1988) 7-8.

Irish Studies theses, 1987/88
ibid. 24-9.

Malachy McKenna
Heinrich Wagner (1923-88): an appreciation
Newsletter of the School of Celtic Studies no. 2 (1988) 10-11.

Aidan Breen
A new Irish Fragment of the Continuatio to Rufinus - Eusebius historia ecclesiastica
Scriptorium (1987 [1988]) 41-2

Colin A. Ireland
Boisil: An Irishman Hidden in the Works of Bede
Peritia 5 (1986) 400-03.

Seán Ua Súilleabháin
Review of Séadna by Peadar Ua Laoghaire
(ed. Liam Mac Mathúna) 1987.
Comhar (Feabhra 1988) 31-2.

Mr. Andrew Breeze prepared some articles for publication: (i) 'The Virgin's Rosary and St. Michael's Scales', (ii) 'The Virgin's Tears of Blood', (iii) 'Chaucer, St. Loy and the Celts'. The following articles were accepted for publication: (i) 'The Three Sorrowful Tidings' (for ZCP 43), (ii) 'Roger Bacon's Head of Brass' (for Trivium xviii) and (iii) Review of D. Simon Evans Writers of Wales: Medieval and Religious Literature (for Cambridge Medieval Celtic Studies xiv). See also §§ 8, 10 (e).

Mr. Kevin Walsh continued work on a linguistic analysis of the Annals of Inisfallen and on an edition of the modern version of Scéla Mucce Meic Dathó. See also §8.

Dr. Colin Ireland prepared an edition, from three separate recensions (fragments contained in 28 different MSS), of the collection of three-word maxims usually referred to formerly as the Bríathra Flainn Fína maic Ossa (ed. K. Meyer, Anecdota III) or the Senbríathra Fíthail (ed. R. Thurneysen, Zu. Ir. Hss.). See also §8.

Mr. James Galvin completed his M.A. thesis on 'The Syntax of the Article in Old Irish and Middle Welsh'.

Mr. Jürgen Uhlich continued work on 'The morphology of compound personal names in Old Irish' for a Ph.D. thesis. See also §§ 5, 8.

Mr. Aidan Breen completed an edition of De XII abusivis, with full critical apparatus, based upon 34 MSS, and English translation. This edition constitutes part of a Ph.D. thesis to be submitted to Trinity College, Dublin. An article entitled 'A new Irish Fragment of the continuatio to Refinus-Eusebius Historia Ecclesiastica' was accepted for publication in Scriptorium. See also §10 (e).

Miss Kaarina Hollo worked on an edition of Loinges mac nDuil Dermait from YBL columns 759-65

Dr. Seán Ua Súilleabháin did field work in Baile Bhuirne, Cúil Aodha and Béal Átha an Chaorthaidh in connection with his study of the inflection of the verb in the Irish of West Muskerry.

III - Annual Report of the Governing Board of the School of Theoretical Physics for the year 1988 adopted at its meeting on 28 September 1989

1. STAFF, EMERITUS PROFESSOR, SCHOLARS, RESEARCH ASSOCIATES, VISITING SCIENTISTS

Staff:

Senior Professors:

John T. Lewis, Director from 1 January 1975; James R. McConnell, retired 25 February; Lochlainn S. O'Raifeartaigh.

Assistant Professor:

G. Raggio, to 31 December.

Librarian-Executive:

E. R. Wills.

Secretary:

M. Matthews; on career break from 6 August.

Professors Emeriti:

John L. Synge; James R. McConnell from 26 February.

Scholars:

M. Vandyck (Belgium) left 30 September; W. Cegła (Poland); N. Gorman (Ireland); T. C. Dorlas (Netherlands); J. Balog (Hungary); M. P. Tuite (Ireland) on leave of absence from 1 October; L. G. Fehér (Hungary) from 1 October; R. Werner (Fed. Rep. Germany) from 1 October.

Research Associates:

Re-appointed to 31 December 1990:

TCD: D. J. Bradley, R.K. Dodd, P.S. Florides, B.K.P. Scaife, D. Weaire

UCD: P.A. Hogan, D.J. Judge, J.O. McCrea, J.V. Pulè, W. Sullivan

St. Patrick's Coll. Maynooth: B. Dolan, C. Nash, A. O'Farrell, J.A. Slevin, J. Spelman, O.H. Tchrakian

UCG: M.J. Conneely, T.N. Sherry

DIT Kevin St: T. Garavaglia, B. Goldsmith, M.J. Tuite

DIT Bolton St: P. Houston

NIHE-D: E. Buffet, J. Burzlaff, D. Heffernan

NIHE-L: R.H. Critchley, J. Kinsella, B. Lenoach

Carlow RTC: D. Ó Sé

Dept of the Environment: J.M. Golden

Open University: A.I. Solomon

Oxford University: R.C. Flood

UC, Irvine: P. McGill

New appointments, to 31 December 1990:

DIT Kevin St: J. Burns

NIHE-D: M. Barman

Cork RTC: M. Vandyck

Visiting Scientists:

A. Amann (Zurich) 28 July - 29 Aug.; H. Araki (Kyoto) 11-15 July; Sir M. Atiyah (Oxford) 13 June; M. van den Berg (Heriot-Watt) 4-6 Jan., 29 Aug. - 25 Sept.; A.I. Burshtein (Novosibirsk) 6-24 June; J.G.B. Byatt-Smith (Edinburgh) 21-22 Dec.; H.-M. Chan (Rutherford) 18 Ap.; J.S. Cohen (Eindhoven) 20 May; H.G. Dales (Leeds) 29-30 Mar.; P.P. Divakaran (Bombay) 11-19 July; J.S. Dowker (Manchester) 11 May; N. Duffield (Heidelberg) 28 Nov. - 3 Dec.; G. Ellis (UCG) 29-30 Mar.; A.C. van Enter (Haifa & Austin TX) 20 June - 8 July; D.E. Evans (Swansea) 18-22 Ap., 13-27 June; G.W. Ford (Ann Arbor) 26 June - 30 July; P. Forgács (Budapest) 3 June - 1 July; G.A.C. Graham (Simon Fraser) 14 Sept. - 31 Aug. 1989; M.B. Green (Queen Mary, London): 10 May; P. Horváthy (Metz & Avignon) 3-18 May, 22-29 Sept, 2-16 Dec.; C. King (Cornell) 8-22 Sept., 21-31 Dec.; S.D. Mathur (Bombay) 19-26 June; R.F. O'Connell (Baton Rouge) 13-20 July; D. O Mathuna (Boston); D. Pottinger (IBM, Winchester (UK)) 28-31 Mar.; J. Rayski (Krakow) 13-20 Sept.; B. Sredniawa (Krakow; 16 Nov. - 7 Dec.; J.F. Toland (Bath) 21-22 Dec.; A. Wipf (MPI Munich) 12 June - 16 July; J.B. Zuber (Saclay) 28-30 Nov.

2. GENERAL

Dr E. de Valera presented his father's and grandfather's collection of scientific books to the School Library, on permanent loan, subject to certain conditions. The books (approx. 1200) include some rare works, and some interesting annotations.

Prof. McConnell retired on 25 February, and the title Professor Emeritus was conferred on him; Ms Matthews went on a career break on 6 August.

3. RESEARCH AND STUDY

Primary areas -

(a) Theoretical Particle Physics

Prof. O'Raifeartaigh continued work on 2-dimensional conformal invariance and on the structure of Kac-Moody algebras with N. Gorman and W. McGlinn (Notre Dame), giving a unified derivation of the centre-terms for Virasoro (conformal) and KM-algebras, and a systematic description of the Weyl group of automorphisms. He commenced work on string theory with J. Balog, L. Féher, and with P. Forgács (Budapest) and A. Wipf (MPI, Munich), giving an algebraic (stability algebra) description of string theory, and pointing out the difficulties with unitarity for non-compact group manifolds. He completed work on quantum mechanical supersymmetry in self-dual gauge-field backgrounds, with L. Féher and P. Horváthy (Avignon). In addition to the collaboration with Prof. O'Raifeartaigh and Dr. McGlinn mentioned above, Dr. Gorman commenced a study of the work of J. B. Zuber on conformal field theory.

Drs. Balog and M.P. Tuite collaborated in a study of Moore's Atkin-Lehner symmetric string models which ensure a non-trivial zero cosmological constant. They showed that for a very general class of lattice-compactified models such a symmetry violates basic physical principles, except for a special case in 2 space-time dimension.

Dr. Tchrakian worked in four main areas, viz.,
1) with G.M. O'Brien and R. Kerner (Paris, P. et M. Curie), on compactification (spontaneous), using generalised Yang-Mills-Higgs systems.
2) with G.M. O'Brien, on the construction of an SO(4) instanton of a non-Abelian Higgs model.
3) with Z.-Q. Ma (Beijing), on generalised gauge field systems on CP^n (and S^{2n}).
4) with R. Werner and G. Savvidy (Erevan), on (non) integrability of generalised Yang-Mills systems.
5) with H.J.W. Mueller-Kirsten (Kaiserslautern) on semiclassical quantisation around a generalised soliton.

Dr. Dolan studied extended objects as fundamental quantities in particular relativistic membranes as extensions to relativistic strings.

Dr. M.J. Tuite continued his studies of thermal field theories, and their application to gauge theories - in particular he studied the real-time formulation of such theories in the case of equilibrium. He began a study of the new techniques for the investigation of the non-equilibrium behaviour of quantum fields.

(b) Classical Statistical Mechanics

(i) Brownian Motion and Relaxation Phenomena

Prof. McConnell extended his nuclear magnetic relaxation studies to asymmetric molecules. In collaboration with A.I. Burshtein (Novosibirsk) he studied for gas mixtures and liquid solutions the effects of non-instantaneous molecular collisions on infrared and far-infrared spectra.

Prof. Scaife completed the ms. of his book on dielectrics and passed it to the publishers.

(ii) Phase Transitions in Lattice Systems

Dr. Solomon worked on applications of superalgebras to condensed matter, especially the theory of high-T_c superconductors. He also worked on the conventional Lie theory approach to many fermion systems.

(iii) Ferrofluids

Prof. Lewis and Dr. Dorlas collaborated with O. Penrose (Heriot-Watt) in the study of the statistical mechanics of ferrofluids.

(c) Quantum Statistical Mechanics

(i) Large Deviations

There were several new developments in the application of large deviation methods to quantum statistical mechanics.

Dr. Pulè and N. Duffield (UCD) combined the method of Cegła, Lewis, and Raggio with Bogoliubov's approximating hamiltonian method to obtain variational principles for the free-energy of inhomogeneous mean-field models. They used their method to solve the full BCS model and the Overhausen model. Dr. Raggio used their method to solve the inhomogeneous spin-boson model. This was an important advance.

Dr. Raggio (with D. Petz (Budapest) and A, Verbeure (Leuven)) investigated Varadhan's asymptotics in a non-commutative setting. On his return to Dublin he began a collaboration with Dr. Werner which resulted in a complete variational theory for non-commutative inhomogeneous mean-field systems. This is an elegant method of great power.

Prof. Lewis continued his collaboration with Dr. Dorlas and Dr. Pulè; together they succeeded in overcoming the technical problems they had encountered in proving second-level large deviation principles. They completed their proof of the Yang-Yang formula for the free-energy of bosons in 1-dimension with a delta-function interaction and Dr. Dorlas began applying the method to other Bethe-ansatz problems. Together with M. van den Berg (Heriot-Watt) they completed their proof of a variational formula for the pressure in the perturbed mean-field model of interacting boson systems.

(ii) Quantum Langevin Equation

Prof. Lewis continued his collaboration under the NSF International Programme with G.W. Ford (Ann Arbor) and R.F. O'Connell (Baton Rouge) on applications of the quantum Langevin equation.

(d) Quantum Electronics

Dr. Garavaglia used the methods of quantum field theory to study quantum noise in electrical systems. He studied nonlinear Lagrangian methods, using the origin of squeezed quantum states, and attempted to relate this work to nonlinear gluon interaction and the origin of squeezed boson particle distributions in high energy scattering. Towards this end, he defined the characteristic function for the energy operator associated with a finite temperature squeezed quantum state, and thus found the related boson probability distribution.

Secondary areas -

(e) General Relativity and Gravitation

Dr. Vandyck continued his study of space-time symmetries in supergravity. He devised a formalism to translate the space-time results he had derived the previous year into superspace framework. This underlined the geometrical interpretation of his calculations, and showed that a space-time symmetry in supergravity may be considered as an ordinary gauge-field symmetry in superspace.

Dr. Dolan studied Ashtekar's canonical transformation in general relativity.

(f) Applied Mathematics

Prof. Graham worked in continuum mechanics, and on boundary value problems in elasticity and viscoelasticity.

Dr. Burzlaff continued his study of solitons and soliton-like objects. He investigated the relevance of optical solitons, and analysed a particular linear eigenvalue problem, with a view to answering questions about the injection of optical solitons into fibres. He also studied soliton-like objects, such as vortices in superconductors, and cosmic strings.

(g) Pure Mathematics

Dr. Goldsmith continued his studies of the application of lifting techniques to realization problems for some classes of Abelian groups.

Research Reports

Research work during the year was written up in the first instance in research reports. Two lists of titles of these reports (preprints) were prepared and circulated to a mailing list of approximately 300 research institutes and university departments throughout the world. As far as available, copies of the preprints were sent out in response to requests. Many of the reports appeared later as publications, or were in press at the end of the year (See Section 10).

DIAS-STP-88-01: J.T. LEWIS, V. A. ZAGREBNOV, & J.V. PULÈ: The large deviation principle for the Kac distribution.

-02: T. C. DORLAS & A.C. van ENTER: Example of a renormalization group fixed point peculiarity.

-03: G.A. RAGGIO: The free energy of the spin-boson model.

-04: N. GORMAN & T.D. SPEARMAN: Equivalence of stabilizing conditions for inverse problems.

-05: S. SEN & M.P. TUITE: A string motivated approach to the relativistic point particle.

-06: D.M. HEFFERNAN, J. O'GORMAN, J. McINERNEY, & P. PHELAN: Nonlinear dynamics of self-pulsing external cavity semiconductor injection lasers.

-07: J. McCONNELL: The theory of nuclear magnetic relaxation in liquids.

-08: T. GARAVAGLIA: Finite temperature field theory and quantum noise in inductively coupled LRC circuits.

-09: M. van den BERG, T.C. DORLAS, J.T. LEWIS, & J.V. PULÈ: A perturbed mean field model of a boson gas and the large deviation principle.

-10: M. van den BERG, J.T. LEWIS, & J.V. PULÈ: The large deviation principle and some models of an interacting boson gas.

-11: J. BURZLAFF: The optical soliton contents of some spectral input pulses.

-12: V. P. BELAVKIN: Multiquantum systems and point processes, I.

-13: N.G. DUFFIELD & J.V. PULÈ: A new method for the thermodynamics of the B.C.S. model.

-14: A. MONTORSI, M. RASETTI, & A.I. SOLOMON: Self-consistency and supersymmetry in a many fermion system.

-15: N.G. DUFFIELD & J.V. PULÈ: Thermodynamics and phase transitions in the Overhausen model.

DIAS-STP-88-16: Zh.-Qi MA & D.H. TCHRAKIAN: Dimensional reduction of higher-order topological invariants: the case CP^M.

-17: Zh.-Qi MA *et al.*: Gauge field systems on CP^M.

-18: J. McCONNELL: Further theoretical investigations on nuclear magnetic spin-rotational relaxation.

-19: M. van den BERG & J.T. LEWIS: Convex optimization and condensation in the free boson gas.

-20: G. O'BRIEN & D.H. TCHRAKIAN: A spherically symmetric SO(4) instanton of a non-abelian Higgs model in 4-dimensions.

-21: T. N. SHERRY & D.H. TCHRAKIAN: On the classical properties of gaugefield-Higgs models descended from generalized Yang-Mills systems.

-22: J.T. LEWIS: Probabilistic aspects of statistical mechanics.

-23: E. BUFFET & J.V. PULÈ: Gelation: The diagonal case revisited.

-24: M. VANDYCK: On the problem of space-time symmetries in the theory of supergravity. Part III.

-25: N. GORMAN, L. O'RAIFEARTAIGH, D. WILLIAMS, & W. McGLINN: A unified approach to the computation of central terms in Kac-Moody and Virasoro algebras.

-26: B. GOLDSMITH: On endomorphism rings of non-separable Abelian p-groups.

-27: G.W. FORD, J.T. LEWIS, & R.F. O'CONNELL: The quantum Langevin equation.

-28: J. McCONNELL: Theory of nuclear magnetic spin-rotational relaxation for asymmetric molecules.

-29: G.W. FORD, J.T. LEWIS, & R.F. O'CONNELL: Dissipative quantum tunneling: Quantum Langevin equation approach.

-30: M. FANNES, J.T. LEWIS, & A. VERBEURE: Symmetric states of composite systems.

-31: G.W. FORD, J.T. LEWIS, & R.F. O'CONNELL: Memory effects in transport theory: an exact model.

-32: G.W. FORD, J.T. LEWIS, & R.F. O'CONNELL: Comment on the exact calculation of the partition function for a quantum oscillator interacting with the radiation field.

-33: G.W. FORD, J.T. LEWIS, & R.F. O'CONNELL: Quantum oscillator in a blackbody radiation field, II. Direct calculation of the energy using fluctuation-dissipation theorem.

DIAS-STP-88-34: G. D'ARIANO, M. RASETTI, J. KATRIEL, & A.I. SOLOMON: Multiphoton and fractional-photon squeezed states.

-35: B. DOLAN: A Hamiltonian formalism for bosonic membranes.

-36: T. DORLAS: Large deviations and the Bethe-Ansatz soluble model.

-37: D. PETZ, G.A. RAGGIO, & A. VERBEURE: Asymptotics of Varadhan-type and the Gibbs variational principle.

-38: J. McCONNELL: Erwin Schroedinger Austro-Irish Nobel Laureate.

-39: T. DORLAS, J.T. LEWIS, & J.V. PULÈ: The Yang-Yang thermodynamic formalism and large deviations.

-40: J. BALOG & M.P. TUITE: The failure of Atkin-Lehner symmetry for lattice compactified strings.

-41: J. BALOG & L. O'RAIFEARTAIGH: Covariant light-cone algebra.

-42: T.C. DORLAS: The statistical mechanics of a Bethe Ansatz-soluble model.

-43: N. GORMAN, W. McGLINN, & L. O'RAIFEARTAIGH: Cartan-preserving automorphisms and the Weyl group of Kac-Moody algebras.

-44: N. GORMAN & T.D. SPEARMAN: Resonance pole determination in a quantum-mechanical model.

-45: J. BALOG, P. FORGÁCS, A. WIPF, & L. O'RAIFEARTAIGH: Consistency of string propagation on curved manifolds: an SU(1,1)-based counter-example.

-46: A. MONTORSI, M. RASETTI, & A.I. SOLOMON: Superalgebraic solution to the mean-field Hubbard model.

-47: A.I. BURSHTEIN & J. McCONNELL: Spectral estimation of finite collision times in liquid solutions.

-48: R.F. WERNER: An application of Bell's inequalities to a quantum state extension problem.

-49: G.A. RAGGIO & R.F. WERNER: Quantum statistical mechanics of general mean field systems.

-50: J. McCONNELL: Rotational diffusion theory of nuclear magnetic spin-rotational relaxation.

-51: J. McCONNELL: Dublin Institute for Advanced Studies: School of Theoretical Physics.

-52: R.F. WERNER: Inequalities expressing the Pauli principle for generalized observables.

-53: W. CEGŁA & M. KLIMEK: Criterion for the large deviation principle.

4. SEMINARS, REVIEW LECTURES, SERIES, COURSES

Seminar and review lectures, series, and courses, in specialised areas of physics and mathematics were given at DIAS-STP throughout the year, by members or visitors; as in previous years these were attended by members of staff and students from the universities and other third level and research institutes in the Dublin Area, and by members of the scientific schools of DIAS.

Seminars or lectures were given also at the Journals' Club and other Irish venues, by the School's members and visitors.

(a) Seminar and review lectures given at DIAS-STP:

Dr A. AMANN (Zurich): Group theoretical methods in algebraic quantum mechanics.

Prof. H. ARAKI (Kyoto): Wigner's theorem.

Sir Michael ATIYAH (Oxford): Yang-Mills fields.

Prof. H.-M. CHAN (Rutherford): Equations of motion for non-Abelian monopoles.

Dr J. S. COHEN (Eindhoven): Noise in semiconductor lasers.

Prof. D. D. DIVAKARAN (Bombay): Quantum symmetries - superselection rules and anomalies.

Prof. J. S. DOWKER (Manchester): Casimir effect around a cosmic string.

Prof. D. E. EVANS (Swansea): Critical phenomena and index of subfactors.

Dr P. FORGÁCS (Budapest): New heterotic strings in 10 dimensions.

Prof. C. KING (Cornell): Yang-Mills via stochastic differential equations.

Dr S. D. MATHUR (Bombay): Fusion coefficient characterization of two-dimensional conformally invariant field theory.

Prof. G. RAGGIO: Varadhan's asymptotic formula without large deviations: an example.

Prof. B. SREDNIAWA (Krakow): Beginnings of the theory of Brownian motion and fluctuations (Role of Smoluchowski and Svedberg).

Dr A. WIPF (Munich): Sphalerons, tunneling, and proton-decay.

Informal discussion, led by Prof. M. B. GREEN (Queen Mary Coll., London), on Strings.

(b) Series and courses given at DIAS-STP:

The series of seminars on Probability and related topics was continued from the previous year; lectures were given as follows:

Prof. G. RAGGIO: The Gartner-Ellis-de Acosta theorem.

Dr T. DORLAS: Cluster expansions (3 lectures).

Dr. R. WERNER: An application of Bell's inequalities.

Prof. J. T. LEWIS began a (year's) course of lectures on Statistical Mechanics, for final year undergraduate and first-year graduate students.

(c) Contributions to the Journals' Club (Joint TCD-UCD-Maynooth-DIAS Meeting):

J. BALOG: Lattice classification of heterotic string theories.

The failure of Atkin-Lehner symmetry.

J. BALOG, N. GORMAN, M.P. TUITE, *et al.*: Reports on Munich Conference and St. Andrews' Summer School.

B. DOLAN: Relativistic supermembranes.

T. GARAVAGLIA: Squeezed quantum states and particle distributions.

L. O'RAIFEARTAIGH: Chester Meeting on Differential Geometry.

M.P. TUITE: A string motivated approach to point particles.

The absence of Atkin-Lehner symmetry in lattice compactified strings.

Dr. Marilyn Garriets of St. Francis Xavier University Antigonish, continued work on the role of the King as judge in Early Christian Ireland and on the relationship of the King to those sub censu regali. See also §6.

Dr. Geraint Gruffyd conducted two seminars during his visit to the School in March. See also §5.

Dr. Mark Scowcroft of the Department of English, University of Virginia, worked on Leabhar Gabhála and wrote an article entitled 'Leabhar Gabhála, Part II: The Growth of the Tradition' which was accepted for publication in Ériu. See also §10 (e).

Dr. Neil McLeod, Department of Law, University College Dublin and Australian National University, completed the preparation of a book on 'Early Irish Contract Law' with a view to publication in the School's Early Irish Law Series.

3. STATUTORY PUBLIC LECTURE

A Statutory Lecture entitled 'The Galatians: Celts in Asia Minor' was delivered by Mr. Rolf Baumgarten at Trinity College, Dublin, on 13 November.

4. LECTURE

A lecture entitled 'The Battle of Móin Mór 1115' was delivered by Professor John Kelleher of Harvard University, in the Institute on 5 May.

5. SEMINARS

The following weekly seminars were held from 20 January to 7 April:

Uaitéar Mac Gearailt:		The evidence of some LL texts for the language of the twelfth century.
Fergus Kelly	:	Suffixes of agency and Instrument in Irish, I.
Fergus Kelly	:	Suffixes of agency and Instrument in Irish II
Fergus Kelly	:	Suffixes of agency and Instrument in Irish III.

(d) Other lectures or seminars given in Ireland by members of the DIAS-STP:

J. McCONNELL: Erwin Schroedinger: Austro-Irish Nobel Laureate. Dublin, Irish-Austrian Society, 14 April.

L. O'RAIFEARTAIGH: The importance of the path integral formulation of quantum mechanics. UCD Math. Soc. Inaugural Meeting, 20 Jan.

A world made of quarks. UCD Math. Phys Dept, 30 Nov.

Observable phases in quantum mechanics. NIHE-D, 1 Dec.

T. DORLAS: Renormalisation and critical phenomena. UCD, 14 April.

B. GOLDSMITH: Maximal order Abelian subgroups of symmetric groups. Galway, May.

G.A.C. GRAHAM: Asymmetric steady-state solutions for a crack in a visco-elastic field of pure bending. Irish Mechanics Soc. Meeting, Cork, 8 October.

5. ACTIVITIES OUTSIDE IRELAND

Prof. McCONNELL attended the Sixth Annual European Molecular Liquids Group (EMLG) Conference on "Reactive and Flexible Molecules in Liquids", at Nauplion (Greece), 23 Sept. - 2 Oct; he chaired meetings of committees during the conference.

Prof. LEWIS was an invited speaker at the Karpacz Winter School (Poland), 16-23 Jan. He visited Heriot-Watt University for discussions 29 Feb.-4 March. He attended a conference on Operator Algebras in Swansea, 3-6 May, as an invited speaker, and was an invited speaker at the conference "Mathematical Methods in Statistical Mechanics" at the Katholieke Univ., Leuven, 22-24 June. He represented the School at the IBM Schroedinger Lecture at Imperial Coll., London, 31 May; he visited Heriot-Watt for discussions 1-2 June, and the IBM Res. Labs, Winchester, for discussions, 3 June. He gave an invited lecture at the 17th Conference on Stochastic Processes in Rome, 27-30 June. He gave the IUPAP Public Lecture at the Congress of the Internat. Assoc. of Math. Physicists, 17-27 July. He took part in a workshop on Large Deviations at the Math. Inst. Oberwolfach, 31 July - 7 Aug. He attended a conference on Operator Algebras and their Applications in Swansea, 7-9 Oct., as invited speaker. He visited Kiev and Lwow as a guest of the Ukrainian Acad. Sciences, 10-26 Oct., and gave a seminar at the Inst. for Problems in the Transmission of Information of the Soviet Acad. Sciences, Moscow.

Prof. O'Raifeartaigh visited Cosener House (Rutherford Lab.) from 29-31 Jan., to attend the Meeting on "Berry Phase and Related Topics", and to Chair one of its sessions, and for discussions; he attended the XI Warsaw Symposium on "New Theories in Physics", 22-27 May, and the Zakopane Summer School (Poland), 1-10 June. He attended the IIIrd Symposium on Symmetries in Physics, Bregenz (Austria), 24-30 July, the XXIVth International Meeting on Particle Physics, Munich, 6-10 August, and the XVIIth Annual Conference on Differential Geometrical Methods in Physics, Chester, 14-18 August. He attended the XXIIth International Symposium on Particle Physics, Ahrenshoop (E. Germany), 17-21 Oct., and the Banach Workshop on "Gauge Theories of Fundamental Interactions", Warsaw, 22-30 October. Details of the lectures given at these Meetings by Prof. O'Raifeartaigh are set out the next sub-section.

Prof. Raggio was Visiting Professor at the Inst. Theor. Phys. of the Univ. Leuven for the 4-month period April to June. He attended the 9th Congress of the Internat. Association of Mathematical Physicists, Swansea, 17-27 July, and the 4th Workshop on Quantum Probability and Applications, Heidelberg, 26-30 Sept.

Dr. Vandyck visited Univ. Aberdeen 10-16 April for discussions and collaboration on mathematical aspects of supergravity with G. Hall, and to give a seminar. He visited Univ. Cath. de Louvain 16-22 June to give a lecture, and for collaboration with D. Speiser.

Dr. Dorlas was in the United States 19 March - 3 April, visiting Bell Labs 21 March for discussions with V. Elser and Rutgers Univ. 23 March for discussions with J.L. Lebowitz and with C. Maes, visiting and lecturing at Princeton Univ. 25 March, Univ. California at Irvine 31 March, and at Los Angeles 1 April (and for discussions with J. Chayes and L. Chayes), and at a Conference on Statistical Mechanics at Univ. California at Davis, 27-30 March. He attended and lectured at a Conference on Functional Integration and Applications, at Antwerp 28-29 June, and at the IAMP Congress, Swansea 17-27 July.

Dr. Gorman visited and lectured at Univ. Notre Dame 7-13 August, and attended the UK Inst. for High Energy Physics, at St. Andrews, 3-10 Sept.

Dr. M.P. Tuite attended the Cosener House Weekend String Theory Meeting at Rutherford Lab. 14-15 May, the UK Universities' Summer School at St. Andrews 24 Aug. - 7 Sept, and the Stefan Banach Workshop 15-30 Sept.

Dr. Tchrakian visited CERN 1-30 July, and Kaiserslautern 1-30 Aug.

Dr. M.J. Tuite attended the Workshop on Thermal Field Theories, at Case-Western Reserve Univ. 3-5 Oct.

Dr. Burzlaff attended and spoke at the International Conf. on "Solitons and Chaotic Behaviour in Optical Systems" in San José (USA) 6-7 Jan., and visited York Univ. (Canada) 11-12 Jan. and Yale Univ. 13-14 Jan. for talks. He visited Univ. Kaiserslautern 4-15 July, and again 12-23 December, giving a series of lectures on each occasion.

Dr. Balog was on leave from Oct.-Dec. at the Max Planck Institute, Munich, for collaborative work with P. Forgács and A. Wipf.

Dr. Dolan visited Glasgow Univ. for one week in August for discussions. He attended and lectured at the 9th UK Inst. for High Energy Particles, St. Andrews, 24 Aug. - 7 Sept., and the Stefan Banach Workshop, 15-30 Sept.

Dr. Garavaglia attended the Winter Meeting on Theoretical Physics at Rutherford Lab. 14-16 Dec.

Dr. Goldsmith visited the Univ. of Dar es Salaam for January and February, to give a series of staff seminars.

Seminars, Lectures, and Courses given abroad.

Prof. McCONNELL:

Lecture: Further theoretical investigations on spin-rotational relaxation. EMLG Conf.

Prof. J.T. LEWIS:

Lectures: Large deviations and statistical mechanics. Leuven Conf.

Large deviations in quantum statistical mechanics. 2 lectures. Karpacz Sch.

A tutorial on large deviations. Heriot-Watt.

The Yang-Yang trace formula. Swansea Conf., Moscow, Kiev.

Large deviations and the Yang-Yang trace formula. Rome Conf.

The paradox of relevance. Swansea Public Lect.

Large deviations in statistical mechanics. Oberwolfach Workshop.

The perturbed mean-field model of interacting bosons. Swansea Conf.

Large deviations and spin systems. Kiev.

Boson condensation. Lwow.

Prof. O'RAIFEARTAIGH:

Lectures: Weyl group for Kac-Moody algebras. Warsaw Sympos.

Manifest covariance in the light-cone-gauge of the bosonic string. Zakopane Summer School, Chester Conf.

Consistent string propagation on non-compact group manifolds: An SU(1,1)-counter example. Ahrenshoop Sympos.

Supersymmetric quantum mechanics in a self-dual gauge-field background. Bregenz Sympos.

Demystification of the Aharonov-Bohm effect. Banach Workshop.

Prof. RAGGIO:

Course: Statistical mechanics - exact results. Leuven.

Seminar: A large deviation technique in the statistical mechanics of quantum spin systems. Heidelberg.

Dr. VANDYCK:

Seminar: Space-time symmetries in N=1 and N=2 supergravity. Aberdeen.

Lecture: Superspace formalism and space-time symmetries in supergravity. Louvain.

Dr. DORLAS:

Lectures: The large deviation principle and a model of an interacting boson gas. Princeton, Irvine.

Renormalization of a simple hierarchical fermion model. Davis Conf., Los Angeles.

Large deviations and the Bethe Ansatz. Antwerp Conf.

The statistical mechanics of a Bethe Ansatz-soluble model. Swansea Conf.

Dr. GORMAN:

Lecture: Aspects of Kac-Moody and Virasoro algebras. Notre Dame.

Dr. TCHRAKIAN:

Lecture: Conformal invariant sigma-models in all even dimensions. Kaiserslautern.

Dr. BURZLAFF:

Lectures: The optical soliton content of some special input pulses. San José Conf.

The optical soliton eigenvalue problem. York, Yale.

Series of lectures: Group structure of gauge theories. Kaiserslautern, July.

Statics and dynamics of classical Yang-Mills-Higgs fields. Kaiserslautern, Dec.

Dr. DOLAN:

Lecture: A Hamiltonian approach to bosonic membranes. St. Andrews, Warsaw.

Dr. GOLDSMITH:

Lectures at Dar es Salaam: Endomorphism rings of Abelian groups.

Subgroups of the Baer-Specker group.

Transitive Abelian groups.

6. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture under the auspices of the School was delivered by Professor J. T. LEWIS on 1 November in Trinity College, Dublin. The title was 'Understanding Phase-Transitions', and the lecture was illustrated by computer simulations, using a programme devised by Dr W. SULLIVAN.

7. SYMPOSIA

Two Mathematical Symposia were held during the year, 29-30 March, and 21-22 December. The attendance (41 in March, 45 in December) included professors, lecturers, and graduate students from the Irish universities and other third-level and research institutes, and from institutes abroad, and members of the scientific schools of DIAS.

Lectures were given as follows:

MARCH:

Review Lectures:

Prof. H. G. Dales (Leeds Univ.): Convolution algebras, semigroups and Laplace transforms.

Dr D. Pottinger (IBM): 3-D visualisation of scientific data.

Lectures:

Prof. A. G. O'Farrell (Maynooth): C^{∞} maps may increase C^{∞} dimension.

Dr M. Clancy (NIHED): Polar sets as critical submanifolds in compact symmetric spaces.

Prof. L. Beasley (Utah SU & UCD): Linear transformations on Boolean matrices.

Dr G. Ellis (UCG): Classification of maps.

Short Talks:

Prof. J. B. Twomey (UCC): Tangential boundary behaviour of the Cauchy integral.

Dr P. Dolan (Imperial Coll.): An interpretation of the Lanczos potentials in general relativity.

Mr P. Barry (Waterford RTC): Graphics standards and the teaching of mathematics.

Prof. J. T. Lewis: Counting without counting.

Dr A. I. Solomon (Open Univ. & DIAS): Supersymmetry in superconductivity.

Prof. J.N. Sheahan (Alberta & UCG): Applications of linear algebra to principal components analysis.

DECEMBER:

Review Lectures:

Prof. J.F. Toland (Bath): Topological degree theory for dynamical systems.

Prof. C. King (Cornell & Zurich): Knots.

Lectures:

Dr N.S. O Murchadha (UCC): When must stars collapse?

Dr R. Werner: An application of Bell's inequalities.

Dr J. G. Byatt-Smith (Edinburgh): Reflection of a solitary wave by a vertical wall.

Dr M. Klimek (UCD): Fractals.

Short talks:

Prof. F. Hodnett & Mr. T. Moloney (LU): Reformulation of the N-soliton solution of the Kdv equation.

Prof. J. Flavin (UCG): The method of cross-section for partial differential equations.

Prof. A. O'Farrell (Maynooth): Removable singularities.

Dr C. Nash (Maynooth): Topological quantum field theory.

8. WORKSHOP on STATISTICAL MECHANICS

A One-Day Workshop on Statistical Mechanics was held at DIAS on 4 January. The attendance was 8, and speakers and titles of lectures were:

Prof. G. Raggio: The approximating Hamiltonian method for the spin-boson model.

Dr N. Duffield (UCD): Thermodynamics of the full BCS model through large deviations.

Dr W. Cegła: Large deviation principle for product measures.

Dr J. V. Pulè (UCD & DIAS): Variational problems associated with the full BCS model.

Dr W. Sullivan (UCD & DIAS): Random walks on ordered graphs.

Dr M. van den Berg (Heriot-Watt): Entropy estimates and models of an interacting boson gas.

On a problem of Spitzer.

Prof. J.T. Lewis: A second-level large deviation principle and interacting boson models.

Dr T. Dorlas: A second-level large deviation principle and Kac potentials.

9. VISITORS

As in previous years, visitors from abroad came to the School for short or long periods, for discussions with School's members, to give seminars, and to avail of the School's library resources for their research work. For lectures given by Visitors, see §§ 4, 7, 8.

Short visits (up to one week) were made by

H. ARAKI (Kyoto), 11-15 July

Sir Michael ATIYAH (Oxford), 13 June

J. G. B. BYATT-SMITH (Edinburgh), 21-22 Dec.

H.-M. CHAN (Rutherford Lab.), 18 Ap.

J.S. COHEN (Philips Res. Lab., Eindhoven), 20 May

H.G. DALES (Leeds), 29-30 Mar.

J.S. DOWKER (Manchester), 11 May

G. ELLIS (UCG), 29-30 Mar.

M.B. GREEN (Queen Mary Coll., Lond.), 10 May

D. POTTINGER (IBM, Winchester), 28-31 Mar.

J. F. TOLAND (Bath), 21-22 Dec.

J. B. ZUBER (Saclay, Paris), 28-30 Nov.

Longer visits were made by

A. AMANN (ETH, Zurich), 28 July - 29 Aug.

M. van den BERG (Heriot-Watt), 4-6 Jan., 29 Aug. - 25 Sept.

A.I. BURSHTEIN (Novosibirsk), 6-24 June

P.P. DIVAKARAN (Bombay), 11-19 July

N. DUFFIELD (Heidelberg), 28 Nov. - 3 Dec.

A.C.D. van ENTER (Haifa & Austin, TX), 20 June - 8 July

D. E. EVANS (Swansea), 18-22 Ap. & 13-27 June

G.W. FORD (Ann Arbor), 26 June - 30 July

P. FORGÁCS (Budapest), 3 June - 1 July

G.A.C. GRAHAM (Simon Fraser, B.C.) 14 Sept. - 31 Aug. 1989

P. HORVÁTHY (Metz & Avignon), 3-18 May, 22-29 Sept., 2-16 Dec.

C. KING (Cornell), 8-22 Sept. & 21-31 Dec.

S. D. MATHUR (Bombay), 19-26 June

R. F. O'CONNELL (Baton Rouge), 13-30 July

D. O MATHUNA (Boston)

J. RAYSKI (Krakow), 13-20 Sept.

B. SREDNIAWA (Krakow), 16 Nov. - 7 Dec.

A. WIPF (MPI, Munich), 12 June -16 July

10. PUBLICATIONS

Note: Items marked with an asterisk have been recorded as in press in previous reports.

(1) Books:

Published:

J.M. Golden & G.A.C. Graham. Boundary value problem in linear viscoelasticity. Springer, 1 September 1988.

In the press:

B. K. P. Scaife. Principles of Dielectrics. Oxford, Clarendon Press: Monographs on the Physics and Chemistry of Materials.

(2) Communications of the Dublin Institute for Advanced Studies, Series A (Theoretical Physics):

None published.

(3) Contributions to periodical and other publications:

J. McConnell:

* Nuclear magnetic spectral densities for molecular models. Phys. Scripta 37 (1988), 401-406.

Theory of nuclear magnetic spin-rotational relaxation for asymmetric molecules. Physica 152A (1988), 309-327.

Erwin Schroedinger (1887-1961), Austro-Irish Nobel Laureate. Lect. to the Irish-Austrian Society, 14.4.88. RDS 1988, Occas. Papers Ir. Sci. Tech. no. 5, 13 pp.

G. W. Ford, J. T. Lewis, & R. F. O'Connell:

Dissipative quantum tunneling: Quantum Langevin equation approach. Phys. Lett. 128A (1988), 29-34.

Quantum oscillator in a blackbody radiation field II. Direct calculation of the energy using the fluctuation-dissipation theorem. Ann. Phys. 185 (1988), 270-283.

Independent oscillator model of a heat bath: exact diagonalization of the Hamiltonian. J. statist. Phys. 53 (1988), 439-455.

J. T. Lewis:

* The large deviation principle in statistical mechanics and its application to the boson gas. 4 lects., M. Kac Sem. Amsterdam 1987. CWI 1988, 62 pp.

J. T. Lewis & G. A. Raggio:

* The equilibrium thermodynamics of a spin-boson model. J. statist. Phys. 50 (1988), 1201-1220.

W. Cegła, J.T. Lewis, & G. Raggio:

* The free energy of quantum spin systems and large deviations. Commun. math. Phys. 118 (1988), 337-354.

M. van den Berg, J. T. Lewis, & J. V. Pulè:

The large deviation principle and some models of an interacting boson gas. Commun. math. Phys. 118 (1988), 61-85.

J. T. Lewis, V. A. Zagrebnov, & J. V. Pulè:

The large deviation principle for the Kac distribution. Helv. phys. Acta 61 (1988), 1063-1078.

Jürgen Uhlich	:	Morphological archaisms in Old Irish personal names.
Diarmuid Ó Sé	:	Stress shifting in Connacht Irish
Anthony Harvey	:	Making the most of orthographical variations in Adamnán, I.
Heinrich Wagner	:	'Cad tá agat á dhéanamh': its grammatical status.
Anthony Harvey	:	Making the most of orthographical variations in Adamnán, II.

Professors T. Arwyn Watkins and Proinsias Mac Cana held a weekly seminar commencing 5 February on the Middle Welsh text Culhwch ac Olwen.

Professor R. Geraint Grufydd of the Centre for Advanced Welsh and Celtic Studies, University College of Wales, Aberystwyth, during his visit to the School, conducted the following seminars:

(i) 'Poets of the Princes: the question of origins' (3 March)

(ii) 'Poets of the Princes: an end and a beginning' (5 March)

Professor Brian Ó Cuív conducted a weekly seminar on 'Problems in the editing and presentation of Irish verse' on Wednesdays during the Michaelmas term.

6. TIONÓL

The Annual Tionól was held on 27-28 March. The following papers were read:

Diarmuid Ó Doibhlin	:	Tóraidheachd na bhFíréan - an eighteenth-century Ulster Irish translation.
Heinrich Wagner	:	The system of the absolute and conjunct endings of the Celtic Verb- a new approach

M. Fannes, J. T. Lewis, & M. Verbeure:

Symmetric states of composite systems. LMP 15 (1988), 255-260.

G. A. Raggio:

* A remark on Bell's inequality and decomposable normal states. LMP 15 (1988), 27-29.

The free energy of a spin-boson model. J. statist. Phys. 53 (1988), 565-581.

N. G. Duffield & J. V. Pulè:

A new method for the thermodynamics of the BCS model. Commun. math. Phys. 118 (1988), 475-494.

E. E. Mueller:

* Bose-Einstein condensation in dependence of the mean energy density. Ann. Phys. 184 (1988), 219-230.

T. C. Dorlas:

*Renormalization of a hierarchical ϕ^4_3 model. J. Phys. A: Math. Gen. 21 (1988), 1753-1758.

A. C. van Enter:

* One-dimensional spin-glasses, uniqueness and cluster properties. J. Phys. A: Math. Gen. 21 (1988), 1781-1786.

L. O'Raifeartaigh:

Gravitation and the unification of the fundamental forces. Ir. Astron. J. 18 (1988), 196-198.

L. O'Raifeartaigh & A. Wipf:

* WKB properties of the time-dependent Schroedinger system. Found. Phys. 18 (1988), 307-329.

P. A. Horváthy, L. O'Raifeartaigh, & J. H. Rawnsley:

* Monopole-charge instability. Inter. J. mod. Phys. A 3 (1988), 665-702.

Y. Fujimoto, A. Wipf, & H. Yoneyama:

Symmetry restoration of scalar models at finite temperature. Phys. Rev. 38D (1988), 2625-2634.

N. Gorman & T. D. Spearman:

- Equivalence of stabilizing conditions for inverse problems. Europhys. Lett. 5 (1988), 191-194.

- Resonance pole determination in a quantum-mechanical model. Nuovo Cim. 99A (1988), 741-752.

G. M. O'Brien & D. H. Tchrakian:

- Spin-connection generalized Yang-Mills fields on double-dual generalized Einstein-Cartan backgrounds. J. math. Phys. 29 (1988), 1212-1219.

Z.-Q. Ma & D. H. Tchrakian:

Dimensional reduction of higher-order topological invariants. The case CP^n. Phys. Rev. 38D (1988), 3827-3830.

A. Wiedemann, H.J.W. Mueller-Kirsten, & D.H. Tchrakian:

Investigation of a theory with soliton-like configurations. Inter. J. mod. Phys. A 3 (1988), 2349-2369.

R. Kerner & D.H. Tchrakian:

Spontaneous compactification on S^{2n} as solution to the generalized Einstein-Yang-Mills-Higgs system. Phys. Lett. 215B (1988), 87-92.

B. P. Dolan & D. H. Tchrakian:

- New Lagrangians for bosonic m-branes with vanishing cosmological constant. Phys. Lett. 202B (1988), 211-216.

B. P. Dolan:

A group-theoretical approach to black-hole radiation. Nuovo Cim. 102B (1988), 649-659.

J. Burzlaff:

- The soliton number of optical soliton bound states for two special families of input pulses. J. Phys. A: Math. Gen. 21 (1988), 561-566.

T. Garavaglia:

Finite temperature field theory and quantum noise in an inductively coupled oscillator. Phys. Lett. 131A (1988), 151-155.

Finite temperature field theory and quantum noise in an electrical network. Phys. Rev. 38A (1988), 4365-4368.

M. Vandyck:

* On the problem of space-time symmetries in the theory of supergravity. GRG 20 (1988), 261-277.

On the problem of space-time symmetries in the theory of supergravity II. N=2 supergravity and spinorial Lie derivatives. GRG 20 (1988), 905-925.

J. D. McCrea, E. W. Mielke, & F. W. Hehl:

* A remark on the axisymmetric Chen et al. solution of the Poincaré gauge theory. Phys. Lett. 127A (1988), 65-69.

J. O'Gorman, P. Phelan, J. McInerney, & D. Heffernan:

* Nonlinear dynamics of self-pulsing external cavity semiconductor injection lasers. J. opt. Soc. Am. B 5 (1988), 1105-1112.

A. I. Solomon & J. L. Birman:

The mechanism for generation of triplet superconductivity. J. Phys. C: Solid State Phys. 21 (1988), L751-L755.

J. M. Golden & G. A. C. Graham:

* The generalized partial correspondence principle in linear viscoelasticity. Q. appl. Math. 46 (1988), 527-538.

G.A.C. Graham & J.M. Golden:

The three-dimensional steady-state viscoelastic indentation problem. Inter. J. Engg. Sci. 26 (1988), 121-126.

J. L. Synge:

* An unperiodic concentrated sonic impulse. Q. appl. Math. 46 (1988), 65-75.

For the 100th birthday of the American Mathematical Society. A Century of Mathematics in North America. AMS 1988, pt.1, 19-20.

J. G. Kingston & J. L. Synge:

The sequence of pedal triangles. Amer. math. Mon. 95 (1988), 609-620.

In the press:

J.T. Lewis:

Large deviations and statistical mechanics. Leuven Notes in Math. & Theor. Phys. A.

T. Dorlas, J.T. Lewis, & J.V. Pulè:

The Yang-Yang thermodynamic formalism and large deviations. Commun. math. Phys.

D. Petz, G.A. Raggio, & A. Verbeure:

Asymptotics of Varadhan-type and the Gibbs variational principle. Commun. math. Phys.

G.A. Raggio & R.F. Werner:

Quantum statistical mechanics of general mean field systems. Helv. phys. Acta.

R.F. Werner:

Inequalities expressing the Pauli principle for generalized observables. Leuven Notes in Math. & Theor. Phys. A.

An application of Bell's inequalities to a quantum state extension problem. LMP.

T. Dorlas & A.C.D. van Enter:

Non-Gibbsian limit for large-block majority-spin transformations. J. statist. Phys.

T. Dorlas:

The statistical mechanics of a Bethe-Ansatz-soluble model. Proc. 9th IAMP Congr. on Math. Phys, Swansea 17-28 July 1988.

W. Cegła & M. Klimek:

Criterion for the large deviation principle. Proc. RIA, A.

E. Buffet & J.V. Pulè:

Gelation: the diagonal case revisited. Nonlin.

N.G. Duffield & J.V. Pulè:

Thermodynamics and phase transitions in the Overhauser model. J. statist. Phys.

P. McGill:

Some eigenvalue identities for Brownian motion. Math. Proc. Camb. Phil. Soc.

N. Gorman, L. O'Raifeartaigh, D. Williams, & W. McGlinn:

A unified approach to the computation of central terms in Kac-Moody and Virasoro algebras. Inter. J. mod. Phys. A.

J. Balog & L. O'Raifeartaigh:

Covariant light-cone algebra. Nuclear Phys. B

J. Balog, P. Forgács, L. O'Raifeartaigh, & A. Wipf:

String propagation on non-compact group manifolds: An SU(1,1) based counterexample. Nuclear Phys. B

J. Balog & M.P. Tuite:

The failure of Atkin-Lehner symmetry for lattice compactified strings. Nuclear Phys. B

G. M. O'Brien & D.H. Tchrakian:

Spherically symmetric SO(4) instanton of a non-Abelian Higgs model in 4 dimensions. Mod. Phys Lett. A.

M. A. Vandyck:

On the problem of space-time symmetries in the theory of supergravity III: Superspace formalism. GRG.

J. Devitt & P.S. Florides:

A modified Tolman mass-energy formula. GRG.

D.M. Heffernan, J. O'Gorman, B. Hawdon, & J. Hegarty:

Frequency locking and quasiperiodicity in an modulated external cavity injection laser. J. appl. Phys.

Feedback induced instabilities in external cavity injection lasers. Electron. Lett.

J. M. Golden & G.A.C. Graham:

A fixed length crack in a sinusoidally loaded general viscoelastic medium. Continuum Mechanics & Its Applications, eds. G.A.C. Graham & S.K. Malik, Hemisphere (Wash. DC).

B. Goldsmith:

Mixed modules in L. Rocky Mount. J. Math.

11. LIBRARY

Approximately 100 new titles were added to the library stock during the year; approximately 200 current periodicals were taken, of which almost half were received by gift or under exchange arrangements. The RIA 'permanent loan' collection was maintained - and a few new titles added to it; other forms of cooperation with research libraries at home and abroad were continued.

As in previous years, offprints and preprints were received from many scientific institutes and university departments at home and abroad, either directly or in response to requests.

In addition to the regular exchanges and gifts, gifts of books, journals, and other material were received from the estate of the late Mr Ronald Anderson, Professor J. McConnell, Professor Synge, Dr Cegla, Dr Dorlas, Dr Golden and Professor Graham, Professor Sredniawa, Amsterdam Centrum Wisk. Inform., ICTP (Trieste), KEK (Japan), Kyoto Univ., Tokyo Univ., and Univ. of Warsaw.

Dr E. de Valera presented his father's and grandfather's collection of scientific books on permanent loan to the School Library, subject to certain conditions. The books (approx. 1200) include some rare works and some very interesting annotations.

IV - Annual Report of the Governing Board of the School of Cosmic Physics for the Year ending 31 December 1988, adopted at its meeting on 1 June 1989.

1 STAFF, SCHOLARS, ETC.,

Academic Staff

Senior Porfessors:

Astronomy Section:	P.A. Wayman, Director of School
Cosmic Ray Section:	L. O'C. Drury
Geophysics Section:	T. Murphy (to 17 October)

Professors:

A.W.B. Jacob (Officer-in-charge, Geophysics Section, from 18 October), T. Kiang, A. Thompson

Assistant Professors:

D. O'Sullivan, T.P. Ray

Research Assistants:

I. Elliott, P.W. Readman, (1 vacancy)

Experimental Officers:

T.A. Blake, J. Daly, B.D. Jordan

Visiting Scientist:

F.H. Cheng (from 15 December)

Technical and Clerical Staff

Astronomy Section:	A.M. Callanan, W.M. Dumpleton, M. Smyth
Cosmic Ray Section:	G. Broderick, E. Clifton, E. Flood
	A. Grace-Casey, S. Ledwidge, H. Sullivan
Geophysics Section:	K. Bolster, A. Byrne, C. Horan, G. Wallace, V. Ward (to 29 January).

Scholars:

C.J. Bean, R. Biernicowicz, S. Bleszynski (to 31 July), M.N. Devaney (from 1 August), P. Duffy, C.P. Lowe (to 29 February), B. O'Reilly.

Professors Emeriti:

H.A. Brück, C. O'Ceallaigh

Research Associates:

P.B. Byrne, M. Hoey, N.P. Murphy, W.E.A. Phillips, R.M. Redfern, P.M. Shannon

Vacation Students:

K. Graham, D. Maxwell, L. O'Súilleabháin.

C. Domingo (Scholar, Cosmic Ray Section, 1985-87) was awarded the Ph.D. degree at Universidad Autonoma de Barcelona in September with thesis entitled "Study of the Response of Solid State Nuclear Track Detectors to Ultra Heavy Ions in order to determine the Composition of Cosmic Ray Primaries".

A.W.B. Jacob was appointed to the IASPEI Commission on Controlled Source Seismology.

Minor Planet No. 3751 was named 3751 KIANG by the International Astronomical Union in Minor Planet Circular 12976 or 2 April, on the nomination of E. Bowell of Lowell Observatory, Arizona, in honour of T. Kiang for his contribution to the study of minor planets and their orbital characteristics.

C.P. Lowe (Scholar, Geophysics Section) was awarded the Ph.D. degree by Dublin University in February for her thesis entitled "A Crustal Study along a North-South Seismic Refraction Profile in Ireland".

P.A. Wayman was appointed Chairman of the National Committee for the History and Philosophy of Science of the Royal Irish Academy.

A visit by the Lord Mayor of Dublin, Alderman Carmencita Hederman, to Dunsink Observatory on 17 June marked the completion of the renovation the 12-inch James South Telescope as a contribution to 'Dublin Millennium Year 1988' (see 8.4 below).

2. RESEARCH WORK (Astronomy and Cosmic Rays)

2.1. Instrument Science

2.1.1. Solar Low-Energy Detector

B.D. Jordan, A. Thompson, D. O'Sullivan, and S. Bleszynski, with S. McKenna-Lawlor, SPCM.

Assembly and testing of a third flight model as 'flight spare' was completed. All three SLED models were finally delivered for integration into ESTER modules at KFKI, Budapest, in March and were forwarded to the USSR for integration with the Phobos spacecraft. The launch of the two spacecraft Phobos-1 and Phobos-2 from Baikonur took place on 7 and 12 July respectively; the payload of each included a SLED instrument. These instruments were switched on respectively on 19 and 25 July and were found to be operating satisfactorily. Both space craft operated successfully until 2 September when contact with Phobos-1 was lost. At the end of the year SLED on Phobos-2 was expected to function normally up to the time of close approach to Mars, due to take place in February and March 1989.

The SLED Engineering Model and the check-out equipment that had been used at IKI, Moscow, for test purposes were returned to Dublin in January. The microprocessor board has been donated to Dublin Corporation for inclusion in the 'Dublin Millennium Time Capsule'. The flight spare and associated check-out equipment remain at IKI.

2.1.2. 'Transputer' equipment for Image-Enhancement.

R.M. Redfern, UCG M.N. Devaney, I. Elliott, B.D. Jordan)

A Transputer graphics board was installed in a Tandon PC-AT along with the existing Transputer Development System. The linking together of the two boards provides a marked improvement in the

speed of the graphics manipulation and the system incorporates a 'frame grabber' for recording TV formats from the plate-viewing machine. In principle this feature can be used to receive the TV images of the telescope field of view for record purposes during observing. The original CAMAC-Nova equipment of the measuring machine has now been replaced by the Tandon/Transputer equipment.

A new version of the Imaging Photon Detector Transputer interface is under construction for use at the GHRIL on the William Herschel Telescope on La Palma. It incorporates a T414 Transputer, a high-speed FIFO memory chip, and transceivers to connect the Transputer links at the GHRIL to the main control Transputer in The Tandon PC installed in the telescope control room, an interconnecting distance of about 100m.

Software being written for the Transputer system includes image-analysis and image-sharpening routines and programs to perform on-line analysis of 'seeing' and focussing.

2.1.3 Image-sharpening data reduction

R.M. Redfern, UCG, M.N. Devaney, with IAC, Tenerife, Spain.

A method of using a modified Wiener filter on time-tagged single photon data has been developed, which can pre-process the data for use by a wide range of image-sharpening algorithms, making optimum use of the available information. Application of the method, with the simplest possible centroiding algorithm, using a bright unresolved reference object within the image field, to data from the 50 cm Swedish solar telescope on La Palma (used at night) has been shown to result in near-diffraction-limited images of the bright triple-star system ADS 6650, with high dynamic range, at extremely low counting rates. The method has been shown to be applicable, with the Kapteyn telescope, to fields containing reference stars as faint as 16.75 mag. The use of the Wiener filter with single photon events was shown to be of advantage compared with methods that use data binned into TV frames, even under excellent seeing conditions.

Colin Ireland	:	Irish influence in Northumbria: the evidence of the Royal Family.
Art Hughes	:	Fuar leam longphort mo charad, Diarmaid Mac an Bhaird cc.: Commentary.
Marilyn Gerriets	:	Kingship, Exchange and the Collectio Canonum Hibernensis.
Neil Buttimer	:	Longes Mac n-Uislenn reconsidered.
Dónall Ó Baoill	:	Córas na nguthaí i nGaeilge Uladh.
Terence McCaughey	:	Tense and Aspect in the Scots Gaelic Verb.
Aoibheann Nic Dhonnchadha	:	Some illustrations from Irish medical MSS.
Gearóid Mac Eoin	:	Stair, seanchas agus scéalaíocht.

7. SUMMER SCHOOL

An International Summer School in Celtic Studies was held from 22 June to 10 July under the direction of Fergus Kelly. The School was attended by 66 students representing Austria, Canada, Czechoslovakia, England, France, Germany, Holland, Ireland, Italy, Japan, Scotland, Switzerland, United States of America and Wales.

The following courses were offered: Elementary Old Irish (Fergus Kelly), Old Irish texts (Proinsias Mac Cana) Elementary Modern Irish (Míchéal Ó Siadhail), Comparative Celtic (Heinrich Wagner), Medieval and Early Modern Irish (Brian Ó Cuív) Modern Breton (Malachy McKenna), Historical Development of Modern Irish and Scottish Gaelic (Máirtín Ó Murchú), Medieval Welsh (T. Arwyn Watkins), and Literature and Society (the Staff of the School and Donnchadha Ó Corráin).

Various extra-curricular activities were arranged in which most of the students took part. These included archaeological tours to the Boyne Valley, Eamhain Mhacha and Glendalough; a conducted tour of Old Dublin with Howard Clarke of the Department of History, UCD, as guide and a visit to Marsh's Library.

Study grants were awarded to 24 overseas students and ranged in value from £130 to £350.

2.1.4. Nuclear Track Detector Response Studies

D. O'Sullivan, A. Thompson, J. Daly, with C. Domingo,
University of Barcelona.

Studies of the response of solid state nuclear track detectors (SSNTDs) to high energy ultra heavy nuclei continued, in particular work directed towards latent track variation with time under conditions of long-term exposure (order of years) in earth orbit. The main activity involved (1) processing and analysis of experimental material obtained by exposure of detector stacks to near-relativistic beams of Uranium at the Berkeley Bevalac in 1987, and (2) preparing results from the previous two years' work for publication, with the results reported for the year 1987 and given in detail at the 14th International Conference on SSNTDs in Lahore in April.

2.1.5 Stellar Coronograph

P.A. Wayman

An outline design for a stellar coronograph with provision for image-enhancement has been drawn up, incorporating a CCD detector for recording a circumstellar image in which the definition is enhanced by reception of the stellar image on an imaging photon detector (IPD). The design is intended to utilise real-time image analysis and actuating of a tilting plate image shifting device under computer control. The design was submitted to the La Palma Users' Committee for instrumental development as suitable for the Kapteyn telescope and has been passed to the High-Resolution Studies committee for further consideration.

2.1.6 Image Compression

I. Elliott

Consideration has been given to the application of fractal geometry for data compression of images using the Iterated Function System (IFS) method developed by M. Barnsley and others. A number of fractal and IFS images were generated using the transputer-based image-processing system and programs were written to demonstrate the relationship between Julia sets and the Mandelbrot set. It is intended to investigate the use of IFS methods for compressing certain complex astronomical images such as the solar photosphere granulation.

2.2 Solar System and Heliosphere

2.2.1 Giotto Mission to Comet Halley

Energetic Particle Analyser Experiment

A. Thompson, D. O'Sullivan, with S. McKenna-Lawlor, SPCM, and MPAe and ESTEC

Analysis of the data obtained by the EPA instrument on Giotto has continued. A study of the relativistic electron fluxes recorded after the outbound crossing of the bowshock indicated that they had been strongly beamed by the magnetic field. Among the possible acceleration mechanisms considered were magnetic field line reconnection and a quasi-perpendicular shock formed downstream at the bowshock. The energy spectra and anisotropies of cometary ions observed by the EPA instrument were employed in a study of acceleration processes in the vicinity of Comet Halley. Evidence was found for both first and second order Fermi acceleration.

Attempts to observe an ion foreshock region at Comet Halley, analogous to the electron foreshock reported by Fuselier et al., were abandoned due to poor statistics.

2.2.2 Neutral Particles in the Heliosphere

S. Bleszynski

Discusion of possible experimental techniques for detecting neutral particles in the heliosphere was incorporated in the Ph.D. thesis of S. Bleszynski. Estimates of the sensitivity attainable show that a new technique using impact ionisation on a gas jet should be very suitable for studying hot heliopause hydrogen.

2.2.3 Asteroid Dynamics

T. Kiang

Research on the Kirkwood Gaps in the distribution of asteroid orbits was continued. The problem investigated concerns the accuracy attainable after a long numerical integration of the differential equations of the simplest gravitational model.

It was found that, for 400-year periodicity in orbital variation, 250,000 integration steps were optimal, giving minimum loss of 4 significant figures. Study of the stability equations showed further that the time-constant derived was meaningful only if it was less than 10^{6} years. For the 2:1 resonance gap only one, with one marginal case, out of six periodic orbits tested, was significantly unstable; hence the 2:1 gap is not vindicated on this simplest gravitational model. In this work a new method of integrating the variational equations using just two suitably chosen displacements within the hypersurface of the given Jacobi constant and perpendicular to the orbital motion halved the required computing time.

2.2.4 X-Ray Imager

L. O'C. Drury, A. Thompson

The proposal for a solar X-ray Imager Experiment (XI) in which the Institute had participated was one of two selected by the European Space Agency as candidate for a full disk imaging experiment for the SOHO-Cluster mission. The other candidate was the Extreme-UV Imaging Telescope (EIT) proposal. The two experiments were judged to be approximately equal in scientific merit and in technical quality, but, with better financial support, EIT was eventually chosen for the mission.

2.3. Stellar Astronomy and Clusters

2.3.1 Jets from Young Stars

T.P. Ray with MPIA

Work in conjunction with R. Mundt and T. Bührke of the Max Planck Institut für Astronomie, Heidelberg, on jets associated with young stellar objects (YSO's) and Herbig-Haro (HH) objects has continued. Ray and Bührke have shown that 5 out of 6 known young stars in the HL Tau association have jets or outflows. This remarkable degree of activity can only be explained if the outflow timescale for this group is longer than that expected for an 'isolated' star. Mutual gravitational disturbances may be the cause; the common direction for the HL Tau jets does not appear to be that of the local magnetic field.

Deconvolved images of jets obtained at Calar Alto have been resolved in the direction perpendicular to the flow. It has been possible to follow variation in opening angle with distance from the source for the first time. It was found that these jets are not free for a significant portion of their length. There may be pressure from the hot interstellar medium or from a toroidal field. While it has been clear for some time that stellar jets have very narrow opening angles, this work shows that collimation is achieved over relatively large scale lengths up to 600 AU.

2.3.2 Photometry of Binary Stars

P.A. Wayman, with IOA, Cambridge.

In the programme of binary star measurement for the astrometric satellite project HIPPARCOS, results for a total of 1706 binary stars have been completed down to 9th magnitude and with separations down to 0.5 arcseconds. Where the magnitude differences are less than 1 m. the relative positions are derived to an accuracy of the order of 5 milliarcseconds and the magnitude differences to 0,01 m.

2.3.3 Line Profiles in Beta Lyrae

R. Biernicowicz

The interpretation of H and He profiles in the 350 - 500 nm spectral region of Beta Lyrae have been studied on the basis of its being a massive Algol-type system with a B 8 II giant component enveloped by an optically thick disk. The profiles were presented in the form of 3-dimensional diagrams of intensity against wavelength (radial velocity) and time for, e.g., He 4472A and Mg II 4481A. The optical lines are disturbed by strong absorption components shifting periodically with amplitude corresponding to about 180 k/s, due to the atmosphere of the giant star. Absorption lines from the main sequence companion have not been discovered. The process of subtracting the absorption effects at $H\alpha$ and $H\beta$, using two different model atmospheres (Kurucz and Vidal et al.) has been applied.

R. Biernicowicz also contributed to the joint observing programme of the 'La Palma 5% International Time Programme' for 1988 on Cataclysmic Variables organised by P.A. Charles (R. Greenwich Observatory). He used the Isaac Newton Telescope for eight nights to record 2 A resolution spectra of SU UMa, YZ Cnc, TY Psc and U Gem at different phases.

2.4 Insterstellar Material

2.4.1 Supernova Remnants

L. O'C. Drury, with MPIK).

The collaboration with H.J. Volk and W. Markiewicz in Heidelberg was continued. This aims to achieve a better understanding of cosmic ray production in supernova remnants by constructing simplified models at a leval of complexity intermediate between analytic solutions and full numerical solutions. A consistent set of approximations leading to system of eleven coupled differential equations has been found; this can be integrated in less than a minute on most computers so that it is easy to study the dependence of the solutions on various parameters. Perhaps the most important conclusion is that, with reasonable parameters, solutions can be found which generate enough cosmic rays to supply the Galaxy without reaction effects leading to a contradiction with other observations. This strongly supports the viability of diffusive shock acceleration as the main production mechanism for the galactic cosmic rays at energies below 10^{15} eV. In particular, earlier fears that strong modification of shock structure might lead to insufficient generation of hot gas for consistency with X-ray observations of young remnants seem unfounded.

2.4.2 Fermi Acceleration Theory

P. Duffy.

The second order Fermi acceleration of cometary ions by Alfvén waves was studied. The model used describes molecules originating from the comet nucleus being ionised by solar radiation. Subsequently these ions undergo a pick-up process whereby they are accelerated in the local interplanetary fields to a certain momentum in the frame of the solar wind. Moving on helical trajectories along the ambient magnetic field, the pick-up ions then interact with Alfvén waves of the appropriate resonant wavenumber and are thereby accelerated. Exact solutions for the momentum distribution function's evolution with time were found using this model. Work was also done in Arizona on particle acceleration in a system of periodic shocks.

2.4.3 ISOPHOT experiment on ISO

L.O'C. Drury, T.P. Ray, with MPIA

A Micro Vax II computer system was installed to facilitate work on the photometer for the Infrared Space Observatory. The system has been performing well and the Munich Image Data Analysis System (MIDAS) has been tested. The role of the Institute in the Isophot collaboration has been clarified in discussion with other partners; it will concentrate on defining the scientific requirements for analysis of the polarimetric and spectropolarimetric data from Isophot.

2.5 Galaxies and Cosmology

2.5.1 Cerenkov Line-emission Mechanism

T. Kiang; F.H. Cheng, Hefei

Additional data on Balmer line intensities in quasars and Seyfert galaxies have been analysed. Predicted line-intensities of the Balmer lines contain just two combinations of physical parameters, probably varying from object to object and also in time for one object. Each object has 3, 4 or sometimes 5 observed lines and therefore it was possible to investigate the relationship between the proposed Cerenkov line-emission process and the observed Balmer decrement. A chi-squared test in comparing theoretical intensity ratios with the observations show that quasars' Balmer decrements, but not those of Seyfert galaxies, can be interpreted by the theory of Cerenkov line-emission. This suggests that there is an abundance of relativistic electrons in dense gas clouds representing the broad emission line regions of quasars (BLR's).

Cerenkov line-emission theory has been applied to the two-peak structure of the Lyman alpha emission line of Mk106. The temperature of the HI zone of the optically thick clouds in the BLR was estimated to be around 10^4 K, corresponding to peak position of black-body radiation near to 300 mm.

2.5.2 Blue Elliptical Galaxies

P.L. Grimley, SPC Maynooth

Observations with the CCD camera of the Kapteyn Telescope on La Palma in June produced some good data on galaxies classified as elliptical but having blue continuum colours or uv excess. The images obtained confirmed the elliptical classifications and are providing evidence for interaction and to identify discrete regions of star formation. One object was clearly a spiral galaxy and Mkn 491 showed strong evidence for merging.

2.5.3 LDEF Mission

The Ultra-Heavy Cosmic Ray Experiment.

D. O'Sullivan, A. Thompson, and J. Daly, with C. Domingo, Barcelona, and ESTEC

The UHCRE project deployed from the Space Shuttle 'Challenger' in April 1984 is now scheduled to be retrieved from Earth orbit on 15 November 1989. The experiment is expected to provide the largest sample (>1200) of cosmic ray nuclei with $Z > 65$ ever collected in a single study, including the first significant sample of cosmic ray actinide nuclei. The most recent calculations by NASA of the decay of the LDEF orbit indicate instability below 170 nmi. being reached in February 1990 and re-entry in March 1990, placing more stringent limits on the planned recovery date than existed heretofore.

3 RESEARCH WORK (Geophysics)

3.1 Gravity and Geodesy

3.1.1 Geodesy

T. Murphy

In collaboration with J. Dixon, DIT Bolton Street, coordinates for Dunsink Observatory, No. 5 Merrion Square, and Skreen Church Tower were obtained using the Global Positioning System (GPS)

3.1.2 Onshore Gravity

T. Murphy, K. Bolster

Fieldwork was continued in Counties Kerry and Limerick in order to complete the area covered by Sheets 17 & 18 of the 1:126,720 scale maps. The gravity contouring of Sheet 23 was carried out and the results printed. The gravity contouring of Sheets 12 & 15 has been carried out and made ready for drafting and printing.

3.1.3 Marine Gravity

P.W. Readman with University of Hamburg.

Analysis of data collected during the Hibernian Offshore Gravity Survey (HOGS) has continued in collaboration with the Hamburg Geophysics Institute. The large volume of data has been carefully filtered and corrected, in order to allow, interalia, for the Eotvos correction due to the ship's motion for which the navigational data of the cruise had to be carefully analysed. The data have been merged with that obtained from the COOLE project and with the DIAS land data set to produce a preliminary gravity map.

3.2 Meteorology

K. Bolster

Meteorological work is no longer a research interest of the Geophysics Section. The end of the previous year saw the completion of 40 years of daily observations (1948-1987). Publication of data has now ceased and more limited measurements are carried out at Leinster Lawn and on the roof of 5 Merrion Square (a.m. only) on weekdays, with readings for other days being taken from the hydrograph, thermograph and rain-recorder. Readings are given once a week to the Meteorological Service by telephone and monthly returns of temperatures and rainfall are made on standard forms. Archival and current records remain available to interested enquirers, students, etc.

3.3 Seismic Work

3.3.1 The Seismic Network

A.W.B. Jacob, K. Bolster

An increase in seismic activity took place in 1988. Between January and August 20 events were recorded in the Irish Sea. These were mainly on a NE-SW trend which we have noted before and some were very close to the Irish coast. All were quite small,

the largest being ML 1.7. On 31 December an event was recorded onshore about halfway between Wexford and Enniscorthy.

The most damaging earthquake overseas occurred in Soviet Armenia on 7 December. This was only of magnitude 7, but it happened in a vulnerable area with a large population. It came close to overloading our network, which operates at high amplification in order to monitor smaller events near to Ireland. With valuable technical assistance from the Seismology Unit of the British Geological Survey in Edinburgh and additional support from the Electricity Supply Board, the network, which has been in use for ten years, was thoroughly overhauled early in the year.

3.3.2 Celtic Onshore-Offshore Lithospheric Experiment - COOLE Experiment - COOLE

B. O'Reilly, A.W.B. Jacob, P.M. Shannon

With work on the onshore line (in Press) and the Porcupine Seabight (published 1988) substantially complete, the main effort has been devoted to the profiles in and across the North Celtic Sea Basin. A model for crustal and lithospheric deformation has been developed and this, rather unexpectedly, ties in with earthquake patterns to the south. There is coherence with work on the lower lithosphere (3.3.3 below).

It is likely that mid-crustal detachments played an important part in the structural development of the North Celtic Sea Basin during the Mesozoic. Modelling was carried out using an approach based on the lithospheric stretching model of McKenzie. The situation in the Basin is not simple and there is a marked change across the median basement flexure detected in the seismic structure. The lower lithosphere appears to have been thinned equally on both sides of this flexure but above the mid-crustal detachment surface the pattern is different. This modelling has implications for the development of many basins around Ireland and further to the south and east.

3.3.3 Lower Lithospheric Studies

C. Bean, A.W.B. Jacob

This work developed rapidly during the year and very significant progress has been made. We now have a more detailed picture of crystalline alignment in the lower lithosphere than any available elsewhere on the Earth. The degree of alignment and its direction has been measured and a shear heating mechanism postulated.

In contrast to less well defined results based on S waves which have passed through the Earth's core (the SKS phase) our results indicate that the upper mantle may not be a strain marker for the last major orogenic episode in a region since it can undergo deformation which decouples from the brittle upper crust. Signs of this deformation may thus not be transmitted to the Earth's surface. Evidence of this decoupling was also found in the work in the North Celtic Sea Basin (3.3.2 above).

3.3.4 Seismic Project in Kenya - KRISP

A.W.B. Jacob, G. Wallace

The Kenyan authorities unexpectedly withdrew the Research Permit for this project in August, even though preliminary work was already well advanced. As there were signs that the decision was not necessarily final, the group, including the DIAS Geophysics Section, decided to continue with planned preparations. This included DIAS participation in a US Geological Survey experiment in New England in September. Four DIAS instruments were operated in conjunction with USGS equipment in Vermont. It was decided to delay commitment to similar work in Kenya until the situation there became clearer. Fieldwork was provisionally planned for January 1990 and EC contracts were signed in late autumn of 1988.

3.3.5 GEOTWIN

A.W.B. Jacob, C.J. Bean, T.A. Blake, with University of Karlsruhe.

This EC contract has provided a valuable framework for many of the other projects carried out by the Section in co-operation with other groups. The incentive and opportunity to develop and improve the handling and interpretation of large bodies of seismic data has been most important. In recent years the Section has recorded a great deal of seismic data and has access to much more. This programme continues to April 1990.

3.3.6 EGT - Eupopean Geotraverse

A.W.B. Jacob, T.A. Blake, K. Bolster, with European groups.

More work was needed to supply the University in Zurich with a partially processed data set from the southern part of the Geotraverse. This required extensive measurements of start-times and sampling rates on re-sampled records. During the year some

8. EXTERNAL ACTIVITIES

Professor James Carney attended the Conference on 'Mündlichkeit und Schriftlichkeit in der älteren irischen Literatur' at the University of Freiburg in June and delivered a paper on Archaic Irish Verse.

Professor Proinsias Mac Cana held a series of five lecture-seminars on Celtic religion and mythology from 28-30 April at the C. G. Jung-Institut, Zürich. On 4 June he lectured on 'Prose and Verse in early Irish narrative' at a conference on 'Mündlichkeit und Schriftlichkeit in der älteren irischen Literatur' at the University of Freiburg. He attended the Eighth International Congress of Celtic Studies in Swansea from 19-24 July. On 7 November he delivered a lecture on 'The Content and Context of Táin Bó Cuailnge' to a conference organized by the American Committee of Irish Studies at Hofstra University, New York. He spent the period October 1987 - January 1988 (inclusive) as Visiting Professor in the Department of Celtic Languages and Literatures of Harvard University.

Professor Brian Ó Cuív was Visiting Professor of Celtic Languages and Literatures in Harvard University in the second semester of the academic year 1986-7, and gave two courses on (i) Late Middle and Early Modern Irish (3 hours weekly), (ii) The Irish Manuscript Tradition (2 hours weekly). He also held a class in Modern spoken Irish. At the end of the semester students from all three courses presented for examination. In addition to giving seminars and classes Professor Ó Cuív advised post-graduate students in connection with work on their doctoral dissertations. During his time in Harvard he read, as special extern examiner to the University of Edinburgh, a dissertation on 'Irish versification' presented for the Ph.D. degree by Virginia Blankenhorn, and in September he visited Edinburgh to take part in the Viva and meeting of examiners. During his visit to Edinburgh he met Professor Jackson and discussed with him some matters relating to the edition of Aislinge Meic Con Glinne. He attended the Eighth International Congress of Celtic Studies in Swansea, 19 - 24 July, and was chosen to succeed Professor Kenneth Jackson as President of the International Organization for the Congress of Celtic Studies. He also took part in two meetings of the Council of the Irish Texts Society, one in Swansea and one in Dublin.

segments of the data were merged and record sections produced. The profile crosses crust which varies widely in thickness from less than 30 km beneath the Po plain and the Swabian Jura to more than 50 km below the Alps. The nature of the crust also changes. A preliminary paper is in Press.

3.3.7 ILIHA - Project in Iberia, 1989

A.W.B. Jacob

Planning of this complex and very extensive experiment continued during 1988. Following meetings at San Fernando (Cadiz) in October and Estoril (Portugal) a timetable and plan for seismic work in September/October 1989 was drawn up. As a direct result of DIAS research in the lower lithosphere, the ILIHA plans were substantially altered. The project derives from and is part of the EGT programme (3.3.6 above).

3.3.8 RAPIDS - Seismic Profile West from Ireland

A.W.B. Jacob, C.J. Bean, T.A. Blake, K. Bolster, B. O'Reilly, P.W. Readman, with University of Hamburg.

This project was inaugurated in Cork on 6 September by Dr. S. McCarthy, Minister of State for Science and Technology, and the German Ambassador. The survey vessel, F.S. Valdivia, returned on 10 October after carrying out over 700 km of seismic refraction profiling in the ocean to the west of Ireland. There were some problems with equipment early in the cruise and the weather in the second half was unusually bad. Even though work was suspended at one stage, a large data set was gathered using small explosive sources near the surface and seismic stations on the sea bottom. Maximum water depth was about 3 km.

By the end of 1988 digitizing of the data was in progress and first indications were that the quality was very good. The sea-bottom stations give good records even though surface conditions are bad.

3.4 Palaeomagnetism

P.W. Readman with N. Abrahamsen, Aarhus.

Some further work has been done on post-glacial lake sediments from Denmark, in particular from Soro So, a lake about 120 km from Skanderborg So, from which a record was already obtained of the secular variations in geomagnetic declination and inclination since 8500 BP. The new results from Soro so have been found to largely confirm those from the previous study. However, some fine structure observed in part of the Skanderborg record, similar to that found in historical and archaeomagnetic records, was not found in the equivalent part of the record from Soro So. This may have resulted from differences in sediment

deposition rates or from differences in their physical properties of the sediment relevant to the process by which the sediment acquires its remanence. The collaboration with Aarhus is continuing.

5 COMPUTER INSTALLATIONS

5.1. At 5 Merrion Square

T.A. Blake

After the SI 470 MByte disk was moved to the new MicroVAXII the Data General S130 system was phased out and the maintenance contract discontinued. The MicroVAXII was installed in February and the disk storage is fully used. Later in the year a Vaxstation 2000 was added and the DEC machines configured as a local area Vaxcluster. Ethernet was installed in part of the building. To allow data transfer between the MicroVaxII and the MV2000 equipment, media and documentation for the MV2000 Kermit Protocol were acquired. Other equipment acquired during the year included a portable Amstrad PPC computer, one Atari 1040ST and one Atari MegaST with 2 MB of memory.

5.2 Dunsink Observatory

I. Elliott

Two Tandon PC-AT systems with EGA graphics, 20 MB hard disk drives and Epson LQ-500 printers were purchased for general computing and word processing requirements. Software purchased and implemented included ChiWriter, MathCAD, PC-Imega and Kermit.

The data link to the VAX 11/780 at UCD Computer Centre worked reliably during the year. Re-allocation of storage space on the 470 MB (Astronomy) disk for Starlink programs became necessary and the Starlink software collection was up-dated.

6. HISTORICAL AND EDUCATIONAL ASTRONOMY

6.1 Megalithic Astronomy, Newgrange

T.P. Ray, with L. O'Suilleabháin

A study of the astronomical orientation of the Newgrange Megalithic Tomb was concluded. The results show that the statistical case for Newgrange having an astronomical function is very strong, certainly as good as, if not better than, that for

Stonehenge built some 1000 years later. It was shown that 5100 years ago sunlight would have penetrated into the main chamber immediately at sunrise on the shortest day of the year although at present it is 4.5 minutes later. The direction of sunrise at the winter solstice 5100 years ago corresponds to the minimum azimuth seen from the chamber through the roof-box. Hence 'first light' would have been an extremely narrow beam. This line was found to be along the major axis of the chamber and sunlight would have disappeared from the chamber just along the line of maximum azimuth though the roof-box. That is, the geometry - roof-box, passage, chamber - is symmetrical with respect to the Winter Solstice of 3100 BC.

6.2 Grubbs of Dublin

P.A. Wayman

The contribution of T. Grubb (1800-78) and H. Grubb (1844-1932) to the development of telescope design over nine decades is only partially described in historical accounts. Material relevant to successive stages in this development is being collected in conjunction with I. Glass (Cape Town) and C.J. Butler (Armagh) and others.

6.3 Astronomy Education

I. Elliott, P.A. Wayman

A proposal was submitted jointly with UCD Audio Visual Centre and Armagh Planetarium to the DELTA project of the EC in respect of evaluating Interactive Video Techniques for the teaching of scientific concepts. A study was made during a visit to the United States of the STAR (Science Teaching through its Astronomical Roots) programme and an account presented at an educational meeting in Dublin.

7 LA PALMA OBSERVATORY

7.1 General

The Governing Board continued its responsibility for Irish participation in the Spanish International Astrophysical Observatory of the Canary Islands at the Observatorio del Roque de los Muchachos on the island of La Palma. It received the advice of an Advisory Committee, as in previous years. The membership of the Advisory Committee was B. O'Donnell (EOLAS), M. de Groot (R.I.A. nominee), P.A. Wayman, P.K. Carroll and T.P. Ray.

The Committee met twice and was represented at meetings of the UK the UK Panel for Allocation of Telescope Time held in January and July. Information Sheets Nos. 17 & 18 were distributed in March and September respectively.

The La Palma Users' Committee meeting 1-2 November was attended by R.M. Redfern and the Herstmonceux Conference on 'Results from the Roque' was attended by N. Devaney, P.A. Wayman and T.P. Ray.

7.2 La Palma visits, 1988

Visits for observing and instrumental work on La Palma were made as follows:

N. Smith (UCD), JKT, 23 - 25 January

P.O'Kane (UCG), GHRIL on WHT, 29 March - 5 April

P.L. Grimley (SPCM), JKT, 7 - 12 June

B.D. Jordan, QUBES on JKT, 22 - 29 July

R.M. Redfern, WHT, 3 - 10 August

T.P. Ray, WHT, 8 - 11 September; INT 10 - 12 December

R. Biernicowicz, INT, 21 - 29 December

7.3 Image Sharpening

R. M. Redfern, N. Devaney

R. M. Redfern finished the academic year 1987-'88 as Visiting Professor in the Instrumentation Section of the Instituto de Astrofisica de Canaries (Tenerife), working particularly on image-sharpening methods at the GHRIL (Ground-based High-Resolution Imaging Laboratory) on the 4.2-m William Herschel Telescope. Successful tests were made at the Swedish 50-cm Solar Telescope (used at night) and at the GHRIL, the recorded IPD counts being analysed subsequently. Real-time analysis has not yet been done. Attempts by R.M. Redfern, in conjunction with T. Shanks (Durham) and others, to detect blue giant stars in a Virgo Cluster galaxy by image-sharpening were not successful but preliminary results were encouraging.

8 SEMINARS, COLLOQUIA, LECTURES

8.1 Statutory Public Lecture

The Statutory Public Lecture of the School was given on November 10 in Trinity College, Dublin by Professor T. Murphy on 'Why measure gravity?'

8.2 Seminars in the School

The following seminars were presented on Institute premises during the year:

6 January	J.W. Menzies (Cape Town): "The LMC Supernova 1987A"
25 February	Y.Y. Zhou (Hefei): "Clustering of Radio Sources and Quasars"
6 June	I. Elliott: "Transtech Devices for Computer Graphics"

8.3 External Lectures

P.A. Wayman and L. Drury contributed to Maths Course 444 for Senior and Junior Sophister students at Trinity College, Dublin, during the Michelmas Term on 'Topics in Stellar Physics' and 'The Interstellar Medium' respectively.

D. O'Sullivan gave a series of eight lectures on 'Cosmic Rays' to Sophister students in physics at Trinity College, Dublin.

I. Elliott gave a course of sixteen lectures on 'Introductory Astrophysics' to Junior Sophister students in honours physics in Trinity College, Dublin, in the Michelmas Term.

Contributions to meetings of the Astronomical Science Group of Ireland were as follows:

31 March, University College, Cork:

T.P. Ray, 'Cluster of Jets in the HL Tau region'

P.A. Wayman, 'Gas Shells of RS Puppis'

T. Kiang, 'Periodic Orbits for Asteroids in the 2:1 Kirkwood Gap'

5 October, Royal Irish Academy, Dublin:

L.O'C. Drury, 'Infrared Space Observatory'

I. Elliott, 'The Universe as a Teaching Aid'

P.A. Wayman, 'The STAR Programme of the US National Science Foundation'

P.A. Wayman addressed the Royal Aeronautical Society (Irish Branch) on 'Navigation Principles' on 25 January.

L. O'C. Drury spoke on 'Fermi Acceleration' at the Ringberg Workshop in Germany on Hotspots in Radio Galaxies, 8 - 12 February.

A.W.B. Jacob and C.P. Lowe gave a seminar on 'Seismic Refraction Methods' in the Department of Geology, Trinity College, on 8 February.

C.J. Bean gave a paper 'A Refraction Seismic Study of the Upper Mantle between Ireland and Northern Britain' at the Annual Irish Research Meeting of the Irish Geological Association in Trinity College, Dublin, on 27 February.

P.W. Readman gave a talk entitled 'Palaeolmagnetism of Holocene Lake Sediments from Soro So, Denmark' at a meeting of the European Geophysical Society at Bologna, Italy, 21 - 25 March.

D. O'Sullivan gave an invited talk and two contributed papers on Solid State Nuclear Track Detectors at Lahore, Pakistan, in April. In the same month he gave a seminar at the Space Physics Department and spoke at a Colloquium at the Department of Astronomy and Astrophysics of the Tata Institute, Bombay.

C.J. Bean presented a joint paper with A.W.B. Jacob entitled 'P-wave Anisotropy below the Moho' at the Third International Workshop on Seismic Anisotropy, Berkeley, California, on 1 June.

P.A. Wayman spoke on'The Pursuit of Good Seeing on La Palma' at the Physics Department, University of California at Santa Cruz, on 22 July and at Lowell Observatory, Flagstaff, Arizona, on 27 July.

T. Kiang described his work on numerical investigation of stability in the Kirkwood Gap orbits of asteroids at Gaithersberg, Florida, 25-29 July, at a meeting of the American Astronomical Society on Dynamical Astronomy and at Colloquium No. 109 of the International Astronomical Union on 'Applications of of Computer Technology to Dynamical Astronomy'.

T. Kiang contributed a paper 'A Chronological Chart of Chinese Astronomical Records' at Commission 41 (History of Astronomy) at the XXth General Assembly of the International Astronomical Union in Baltimore, Maryland, on 3 August.

L. O'C. Drury spoke on 'Particle Acceleration and Shock Wave Structure' and on 'Cosmic Rays - a Short Survey of Open Problems' at the Varenna International Summer School and Workshop on Plasma Astrophysics, 24 August - 3 September.

A.W.B. Jacob spoke on 'Anisotropy in the Lower Lithosphere' at the ILIHA Workshop Meeting in Estoril, Portugal, 10 - 12 November.

At the 30th Herstmonceux Conference on 'Results from the Roque' at the Royal Greenwich Observatory, Sussex, on 14 November, T.P. Ray spoke on 'Jets and Herbig-Haro Objects from High-Luminosity Young Stellar Objects' and N. Devaney spoke on 'Real-Time Image Sharpening'.

L. O'C. Drury gave an invited discourse, 'Die Kosmische Strahlung: Neue Aspekte eines alten Problems' at the Max Planck Institut für Astronomie Jubilaumskolloquium, 24 November.

8.4 Popular Astronomy

Talks were given to the Irish Astronomical Society by N. Devaney, I. Elliott, D. O'Sullivan, T.P. Ray and P.A. Wayman, to the Society of Electronic and Radio Technicians by I. Elliott, and to the Limerick Astronomy Club and the Cork Astronomy Club by P.A. Wayman. In March and again in October, W. Dumpleton and P.A. Wayman contributed the programme material for week-end courses on introductory astronomy at the West of Ireland Agricultural College, Ballinafad, Co. Mayo. Open Nights at Dunsink Observatory were held on fourteen nights, as usual, and a week-long

series of open evenings, 17-25 June, was arranged as marking Dublin Millennium Year, 1988. The Youth Conference of the Royal Dublin Society on Science and Arts was received at Dunsink Observatory on 7 July and other group visits were made by the Irish Society for Archives, the Guinness Choir, the Irish Astronomical Society, the Finglas Environment Heritage Project, and the Royal Aeronautical Society.

9 EXTERNAL WORK

The following working visits to other institutions and conferences were undertaken during the year (see also 7.2 and 8.3 above):

C.J. Bean:

A visit to the Geophysics Institute, Karlsruhe, and the Cambridge reflection seismics group (BIRPS) to discuss the lower lithospheric results.

6 - 8 April. 12th UK Geophysical Assembly, Leeds.

T.A. Blake:

1 March. Seminar on Open Networking, EOLAS, Dublin.

21-25 March. Vax/Vms Systems Management course, Dublin.

1-2 September. DECUS (Ireland) annual meeting, Dublin.

L. O'C. Drury:

25 Jan. - 7 Feb. M.P. Inst. Heidelberg

8 - 10 March. Isophot Review, Heidelberg

28 - 31 March. SLED Meeting, KFKI Budapest

15 April. EIT/XI meeting, ESA Paris.

10 - 11 May. Isophot meeting, DSRI Copenhagen

12 Sept. Steering Committee, 22 Cosmic Ray Conference, London

7 - 9 Nov. ESIS/SPAN meeting, Frascati

10 - 11 Nov. Isophot status review, Heidelberg

24 - 27 Nov. MPAe Lindau, 50th Anniversary Meeting

I. Elliott:

27 - 29 March. Occam Users' Group Meeting, Sheffield

30 - 31 March. R. Astronomical Society, Spring Meeting, Preston.

C. Horan:

9 Nov. - 9 Dec. University of Hamburg on RAPIDS digitization.

A.W.B. Jacob:

Visits on a number of occasions to University of Hamburg in connection with RAPIDS project (etc.)

Visits to University of Karlsruhe were made in connection with GEOTWIN co-operative project.

10 February. EC meeting on earthquake monitoring

6 - 8 April. 12th UK Geophysical Assembly, Leeds

27 April (with C.J. Bean). William Smith Meeting on the Continental Lithosphere, Geological Society, London

31 May - 4 June (with C.J. Bean). Third International Workshop on Seismic Anisotropy, Berkeley, California.

July. Marine Geophysics group, University of Cambridge.

B.D. Jordan:

Several visits to Armagh Observatory and Queen's University, Belfast in connection with the Echelle Spectrograph project.

T. Murphy:

6 - 8 April. 12th UK Geophysical Assembly, Leeds

D. O'Sullivan:

24 - 27 May. Giotto Plasma Workshop, MSSL London

5 - 14 July. Phobos Mission activities, IKI Moscow (launch of Phobos-1 and Phobos-2)

23 - 29 July. 27th Plenary meeting, COSPAR Helsinki

12 September. Steering Committee for the 22nd International Cosmic Ray Conference, London.

P.W. Readman:

Two visits to the Geophysics Institute, Hamburg, to work on the HOGS project.

A visit to Geophysical Laboratory, University of Aarhus, Denmark in connection with lake sediment palaeomagnetic work.

A. Thompson:

18 - 23 March. Heavy Nucleus Collector Science Steering Committee and LDEF Status Review; NRL collaboration. Washington D.C.

14 - 17 April. SOHO/EIT-XIO Meeting, ESA, Paris

21 - 27 July. 27th Plenary Meeting COSPAR, Helsinki

12 - 16 September. ESTER Collaboration meeting, Budapest.

28 Sept. - 1 Oct. Ph.D. examination, Barcelona.

P.A. Wayman:

13 May. R. Astronomical Society meeting, London

1 - 11 August. XXth General Assembly, International Astronomical Union, Baltimore, Maryland. (Irish National Representative.)

11 November. R. Astronomical Society meeting, London

14 - 15 November. 30th Herstmonceux Conference, R. Greenwich Observatory.

10 PUBLICATIONS

10.1 Journals

L. O'C. Drury, with A.F. Heavens:

"Relativistic Shocks and Particle Acceleration", Mon.Not. R. Astr. Soc., 235 997, 1988.

Professor Máirtín Ó Murchú held a seminar for postgraduates at University College, Cork on 'Sociolinguistics of Bardic Verse' in April, and at St. Patrick's College, Drumcondra he read a paper on 'The Irish Language' to the IRAAL Symposium. In August he attended the Sixth International Conference on Dialectology at Bangor, Wales. He acted as extern examiner in NUI during September and in November he gave a talk on 'Irish in Education' to the Tralee Gaelscoileanna Committee.

Dr. Fergus Kelly lectured on 'Early Irish Crops' at the Eighth International Congress of Celtic Studies held in Swansea in July. He acted as Visiting Lecturer in Old Irish in University College, Dublin from October to December

Dr. Malachy McKenna, during a visit to the University of Uppsala, Sweden, in February, lectured on 'Chrétien de Troyes and the Arthurian Tradition'.

Aoibheann Nic Dhonnchadha lectured at the UCD Postgraduate seminar in January on 'Leagan Gaeilge (1400A.D.) le Tadhg Ó Cuinn ar thrachtaireacht Gheralldus de Solo ar an naoú leabhar d'Almuiór Raisis'.

Pádraig Ó Macháin delivered two lectures at the UCD Postgraduate seminar (i) on 16 January on 'Fearghal Óg mac an Bhaird: gnéithe dá shaothar'; (ii) on 13 November on 'Bás Fhinn mhic Cumhaill'.

Mr. Andrew Breeze lectured on 'The Dance of Death' to the Medieval and Renaissance Society at University College, Cork, on 25 February; he attended the First Conference of Irish Medievalists at Maynooth College and lectured on 'Chaucer, St. Loy and Gabha an tSuic' on 24 May; at the International Congress of Celtic Studies, held at Swansea he lectured on 'Siôn Cent, the Oldest Animals, and the Day of Life' on 21 July.

Mr. Kevin Walsh attended the Eighth International Congress of Celtic Studies at Swansea in July.

Dr. Colin Ireland attended the Eighth International Congress of Celtic Studies at Swansea in July and read a paper entitled 'Aldfrith/Flann Fína: the Irish Legacy of an Anglo-Saxon Monarch', and from December 27-30 he attended the Modern Languages Association Conference in San Francisco, California.

Mr. Jürgen Uhlich lectured on 'Archaisms in Old Irish personal names' at University College, Galway on 10 March. He attended Dr. Liam Breatnach's seminars on 'Córus Béscnai' and 'Bretha Nemed' at Trinity College, Dublin. In July he attended the Eighth International Congress of Celtic Studies in Swansea.

A.W.B. Jacob, T. Murphy, with J. Makris, R. Egloff, P. Mohr and P. Ryan:

"Continental Crust under the Southern Porcupine Seabights West of Ireland", Earth and Planetary Science Letters, 89: 387-397, 1988.

T. Kiang, with S.P. Xiang and J.L. Zhang:

"Apparent Velocities of Sources Moving in the Gravitational Field of a Kerr Black Hole", Astrophysical Journ., 330 168 - 177, 1988.

T. Murphy:

"Notes on the Six-inch and One-inch Sheet Maps of Ireland and Methods for Deducing Rectangular and Geographical Coordinates for Points Thereon ", Geophysical Bulletin, Series D, (DIAS), No. 39.

D. O'Sullivan, A. Thompson, with P. Daly E. Kirsch, S. McKenna-Lawlor, and K-P. Wenzel:

"Energetic Particles in Space: The Giotto Mission to Halley's Comet". Irish Astronomical Journal, 18: 176-178, 1988.

T.P. Ray, with T. BÜhrke and R. Mundt:

"A Detailed Study of HH34 and its Associated Jet", Astron. Astrophys., 200 99, 1988.

T.P. Ray, with R. Mundt and T. BÜhrke:

"A Close Association of Five Jet and Outflow Sources in the HL Tauri Region", Astrophys. Journ. Lett., 333 L69, 1988.

P.W. Readman, with N. Abrahamsen:

"Quaternary Magnetostratigraphy in Denmark", Boreas, 16 375-380, 1987.

P.W. Readman, with N. Abrahamsen:

"Palaeomagnetism of Post Glacial Lake Sediments from Skandferborg So, Jutland, Denmark", Physics of the Earth and Planetary Interiors, 52, 177-192, 1988.

A. Thompson, D. O'Sullivan, with S. McKenna-Lawlor, E. Kirsch and K-P. Wenzel:

"The Lightweight Energetic Particle Detector EPONA and its Performance on Giotto", Journ. Phys. E: Sci. Instr., 20: 732-740, 1987.

A Thompson, D. O'Sullivan, with E. Kirsch, S. McKenna-Lawlor and F.M. Neubauer:

"Detection of Energetic Electron (E > 300 keV) and Ion Fluxes (E > 97 keV) from Comet P/Halley by the Giotto Experiment EPA on 1986 March 13/14", Astron. Astrophys., 193: 303-308, 1988.

C.J. Bean and A.W.B. Jacob:

"A Seismic Study of the Subcrustal Lithosphere between Ireland and Northern Britain", (Abstract), Geophys. Journ. R. Astr. Soc., 92: 555, 1988.

C. Domingo, D. O'Sullivan, A. Thompson, with C. Baixeras, F. Fernandez and A. Vidal-Quadras:

"A Study of Charge Discrimination for the UH Cosmic Ray Component with Polycarbonate Detectors", The 11th European Cosmic Ray Symposium, Balatonfured, Hungary, 21-27 August 1988.

C. Domingo, D. O'Sullivan, A. Thompson, with C. Baixeras, F. Fernandez and A. Vidal-Quadras:

"Latent Track Intensification due to Ageing in Solid State Nuclear Track Detectors", Proceedings of the 14th International Conference on Solid State Nuclear Track Detectors, Lahore, 2-6 April 1988.

L. O'C. Drury:

"Particle Acceleration and Shock Wave Structure", Proceedings of the Varenna International Summer School and Workshop on Plasma Astrophysics, ESA SP285, 1, 131.

L. O'C. Drury:

"Cosmic Rays - a Short Survey of Open Problems", Proceedings of the Varenna International Summer School and Workshop on Plasma Astrophysics, ESA SP285, 1, 205.

D. O'Sullivan, A. Thompson, C. Domingo, with V. Domingo and K-P. Wenzel:

"The Outlook for Ultra Heavy Cosmic Ray Studies with Plastic Track Detectors", Proceedings of the 14th International Conference on Solid State Nuclear Track Detectors, Lahore, 2-6 April 1988.

D. O'Sullivan, A. Thompson, with V. Afonin, K. I. Gringauz, E. Keppler, E. Kirsch, A.K. Richter, S.M.P. McKenna-Lawlor, A.J. Somogyi, L. Szabo, K. Szego, and I. Szucs:

"The Low Energy Charged Particle Detector SLED", The 11th European Cosmic Ray Symposium, Balatonfured, Hungary, 21-27 August 1988.

D. O'Sullivan, A. Thompson, with S. McKenna-Lawlor, E. Kirsch, P. Daly and K -P. Wenzel:

"In-situ Energetic Particle Observations at Halley's Comet 12-15 March 1986, recorded by the EPONA Experiment abroad Spacecraft Giotto", Proceedings of the 13th General Assembly of the European Geophysical Society, Bologna, 21-25 March 1988.

D. O'Sullivan, A. Thompson, with E. Kirsch, S. McKenna-Lawlor, P. Daly, K-P. Wenzel and F.M. Neubauer:

"Pitch Angle Distribution of Ions (>60 keV) and Electrons (> 300ke V) measured by the EPA Instrument during the Giotto Halley Encounter", Proceedings of the 13th General Assembly of the European Geophysical Society, Bologna, 21-25 March 1988.

T.P. Ray with R. Mundt:

In "Mass Outflows from Stars and Galactic Nuclei", eds. L. Bianchi and R. Gilmozzi, Kluwer 1988, p. 293.

T.P. Ray with T. Bührke and R. Mundt:

In "Formation and Evolution of Low Mass Stars", eds. A. K. D upree and M.T.V.T. Lago, Kluwer, 1988, p. 281.

P.W. Readman, with N. Abrahamsen:

"Palaeomagnetism of Holocene Lake Sediments from Soro So, Denmark". (Abstract), Ann. Geophysicae, Special Issue, p. 21, 1988.

P.W. Readman, with S. Papamarinopoulos and K.M. Creer:

"Geomagnetic Intensity Studies from Baked Earth Objects and Limnic Sediments from Greece for the last 4000y B.P." (Abstract), Proceedings of the NATO Advanced Study Meeting on Palaeomagnetism, Newcastle-upon-Tyne, 1988.

8.3 Irish Astronomical Journal

The Irish Astronomical Journal produced one issue during 1988, Vol. 18 No. 3. The March 1988 issue included the following contributions,

p. 147 P.A. Wayman: Opening Remarks, Mason conference, R.Astr. Soc.

p. 157 T. Kiang: A Time-Chart of Extraordinary Astronomical Events in Chinese History

p. 176 D. O'Sullivan: Energetic Particles in Space

p. 189 T. Kiang: Introduction to the Wayman Symposium

p. 219 T. P. Ray: Bowshocks from Young Stellar Object Jets

p. 221 T. Kiang: The Two Types of Equation

p. 227 M. Hoey: The Morphology of Planetary Nebulae - The Eskimo Nebula

p. 229 P.A. Wayman: My First Love - Plate Diagram Analysis

p. 235 I. Elliott: Communicating in Science: Writing and Speaking (Review)

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH
(Dublin Institute for Advanced Studies)

FINANCIAL STATEMENTS FOR YEAR ENDED 31 DECEMBER 1988

CONTENTS

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH

(Dublin Institute for Advanced Studies)

1988

GENERAL

The Institute was established under the Institute for Advanced Studies Act, 1940.

Its functions include the provision of facilities for the furtherance of advanced studies and the conduct of research in specialised branches of knowledge.

It comprises three Schools - Celtic Studies, Theoretical Physics and Cosmic Physics.

ACCOUNTING POLICIES

1. Accounting basis:

   The Accounts have been prepared under the historical cost convention.

2. Oireachtas and Lottery Grants

   Income shown in the Accounts under these headings is the actual cash received in the period of the Account and includes £102,000 for increases in remuneration.

3. Fixed Assets:

   Fixed Assets comprise the furniture and equipment of the Institute and are shown at cost less accumulated depreciation.

   The rate of depreciation is 10% per annum.

   Premises occupied by the Institute are leased from the Office of Public Works.

4. Capital Reserve:

   The capital reserve comprises income allocated for the purchase of fixed assets. It is written down in line with the depreciation of the related assets.

5. Library:

   Expenditure on library books and materials is charged to the Income and Expenditure Account. The current value of such books and materials is estimated at £470,000.

6. Publications:

Expenditure on publications is written off in the year in which it is incurred. The estimated value of such publications on hand at 31 December 1988 was £674,500.

7. Superannuation:

Salaries are charged net of pension contributions. Expenditure arising under the Institute's superannuation schemes is met out of Oireachtas Grants in the year of payment. No provision has been made in these accounts for future superannuation commitments.

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH
(Dublin Institute for Advanced Studies)

Income and Expenditure Account
for the year ended 31 December 1988

1987 £		1988 £
	INCOME	
1,892,000	Oireachtas Grants	1,317,000
---	Lottery Grant	605,000
47,180	Sales of Publications	37,847
6,301	Celtic Studies Summer School Fees	---
32,332	School of Cosmic Physics (Note 4)	191,253
49,021	Miscellaneous (Note 9)	41,381
2,026,834		2,192,481
55,386	Less allocated for capital purposes (Note 6)	160,124
1,971,448		2,032,357
	EXPENDITURE	
436,105	School of Celtic Studies	503,272
262,777	School of Theoretical Physics	264,786
683,944	School of Cosmic Physics	836,148
449,256	Administration	459,642
1,832,082		2,063,848
139,366	SURPLUS (DEFICIT) for year	(31,491)
306,200	Balance at 1 January	445,566
445,566	Balance at 31 December	414,075

The Accounting Policies, Notes 1 to 9 and Statement 1 form part of these accounts.

CHAIRMAN - COUNCIL OF THE INSTITUTE

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH

(Dublin Institute for Advanced Studies)

Balance Sheet at 31 December 1988

1987				1988
£	£		£	£
293,469		Fixed Assets (Note 5)		384,968
		Current Assets:		
	439,785	Cash on hands and at Bank	350,884	
506,917	67,132	Debtors and prepayments	168,839	519,723
800,386		Total Assets		904,691
		Current Liabilities:		
	(40,354)	Creditors and Accruals (Note 2)	(83,508)	
(61,351)	(20,997)	Funds (Note 1)	(22,140)	(105,648)
739,035		Net Assets		799,043
		Financed by:		
445,566		Surplus-Income and Expenditure Account		414,075
293,469		Capital Reserve (Note 6)		384,968
739,035				799,043

The Accounting Policies, Notes 1 to 9 and Statement 1 form part of these accounts.

CHAIRMAN - COUNCIL OF THE INSTITUTE

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH
(Dublin Institute for Advanced Studies)

Statement of Source and Application of Funds
for the year ended 31 December 1988

	£
Source of Funds:	
Deficit for the year	(31,491)
Capital Income	160,124
	128,633
Application of Funds:	
Purchase of Fixed Assets	160,124
	(31,491)
Increase/(Decrease) in Working Capital:	
Increase in Debtors	101,707
Increase in Current Liabilities	(44,297)
Decrease in Cash Balances	(88,901)
	(31,491)

9. CATALOGUING OF IRISH MANUSCRIPTS

Work on Irish manuscripts in the National Library of Ireland continued. Fasciculus X (MSS G 434-G 500) compiled by Nessa Ní Shéaghdha was seen through the press. Nessa Ní Shéaghdha also described MSS G 600-G 699 for fasciculus XII and MSS G 800-G 825 for fasciculus XIV. Pádraig Ó Macháin completed descriptions of the manuscripts in fasciculus XI (G 501 - G 599), commenced work on fasciculus XIII (G 700 - G 799), and prepared a catalogue of Irish manuscripts at Mount Melleray Abbey, Co. Waterford.

Pádraig de Brún and Aoibheann Nic Dhonnchadha continued with the recataloguing of the Irish manuscripts in Trinity College, Dublin.

10. PUBLICATIONS

(a) Works in course of printing

Uraicecht na Ríar edited by Liam Breatnach

A Welsh Bestiary of Love edited by Graham Thomas

Aislinge Meic Con Glinne edited by K. H. Jackson

Catalogue of Irish Manuscripts in the National Library of Ireland
Fasc. X compiled by Nessa Ní Shéaghdha.

Celtica 19 edited by Brian Ó Cuív

East Perthshire Gaelic by Máirtín Ó Murchú

(b) Works published by the Institute

Celtica 19
ed. Brian Ó Cuív, pp. 204 £12.

Aspects of Irish Personal Names
by Brian Ó Cuív. pp. 36. £1.50

Lexique Étymologique de l'Irlandais Ancien - Lettre C
J. Vendryes, E. Bachellery, P. - Y. Lambert. pp. 300 £27.

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH

(Dublin Institute for Advanced Studies)

Statement I

Detailed Analysis of Income and Expenditure for the year ended 31 December 1988

	School of Celtic Studies	School of Theoretical Physics	School of Cosmic Physics	Adminis-tration	Total	1987 Total
INCOME	£	£	£	£	£	£
Oireachtas Grants	1,000	258,000	736,400	321,600	1,317,000	1,892,000
Lottery Grant	455,000	-	-	150,000	605,000	-
Sales of Publications	37,185	27	635	-	37,847	47,180
Celtic Studies Summer School Fees	-	-	-	-	-	6,301
School of Cosmic Physics (Note 4)	-	-	191,253	-	191,253	32,332
Miscellaneous (Note 9)	1,313	-	6,092	33,976	41,381	49,021
	494,498	258,027	934,380	505,576	2,192,481	2,026,834
Less allocated for capital purposes (Note 6)	14,351	1,600	123,785	20,388	160,124	55,386
	480,147	256,427	810,595	485,188	2,032,357	1,971,448
EXPENDITURE						
Salaries, Wages and Superannuation (Note 8)	403,913	177,840	591,730	226,010	1,399,493	1,234,118
Scholarships	30,030	36,309	25,468	-	91,807	80,729
Honoraria	602	50	250	591	1,493	1,008
Library	11,775	27,035	21,866	-	60,676	54,971
Microfilms	247	-	-	-	247	3,440
Publications	27,488	1,848	4,109	-	33,445	58,944
General Administration (Note 3)	-	-	-	208,995	208,995	200,968
Travel & Survey Expenses	7,229	8,543	35,766	828	52,366	57,644
Symposia & Seminar Expenses	84	974	-	-	1,058	17,201
Equipment: Consumable & Maintenance	-	-	36,874	-	36,874	38,034
Special Commitments and Projects	-	-	97,407	-	97,407	13,282
General Expenses	21,904	12,187	22,678	23,218	79,987	71,743
	503,272	264,786	836,148	459,642	2,063,848	1,832,082
SURPLUS (DEFICIT) FOR YEAR	(23,125)	(8,359)	(25,553)	25,546	(31,491)	139,366
Balance at 1 January 1988	180,612	37,327	102,465	125,162	445,566	306,200
Balance at 31 December 1988	157,487	28,968	76,912	150,708	414,075	445,566

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH

(Dublin Institute for Advanced Studies)

NOTES TO THE ACCOUNTS

1. Funds:

These comprise:		£
	Vernam Hull Bequest	20,939
	Carmody Fund	1,201

The funds are held on deposit.

2. Creditors and Accruals:

Included in this heading is £11,027 contract research monies unexpended at 31 December, 1988, which is credited to revenue in line with expenditure on projects.

3. General Administration Expenses:

	£
Rent, Rates & Insurance	79,484
Premises Maintenance	56,776
Postage & Telephones	39,622
Fuel, Light & Power	27,950
Sundry Supplies	5,163
	208,995

4. School of Cosmic Physics - Research Programmes & Fees:

Project	Contributor	Opening Balance	Income	Applied	Unexpended
		£	£	£	£
Seismic Survey at Carnsore	**ESB**	-	300	300	-
Geotwin	**EEC**	8,260	10,376	18,636	-
EGT (Geotraverse)	**EEC**	-	473	473	-
HOGS	Dept.Energy/ Oil Industry	3,110	1,000	1,786	2,324
BGS	Br.Geol.Surv.	-	4,186	4,186	-
KRISP	**EEC**	22	10,734	10,756	-
ISOPHOT	**ESA**	-	65,927	65,927	-
ILIHA	**EEC**	-	9,074	1,629	7,445
RAPIDS	Dept.Ind. & Commerce	-	83,797	83,039	758
Cosmic Ray Conf. (1991)	Bord Fáilte	-	500	-	500
Other Fees and Contributors	Various	-	4,521	4,521	-
		11,392	190,888	191,253	11,027

NOTES TO THE ACCOUNTS (Contd.)

5. Fixed Assets (Furniture & Equipment):

	£	£
Cost at 1 January 1988		667,109
Additions	160,124	
Less Disposals	2,909	157,215
Cost at 31 December, 1988		824,324
Accumulated Depreciation at 1 January, 1988		373,640
Depreciation in year	68,323	
Less Depreciation on Disposals	2,607	65,716
Accumulated Depreciation at 31 December, 1988		439,356
Net book value at 31 December, 1988		384,968
Net book value at 31 December, 1987		293,469

6. Capital Reserve:

Balance at 1 January 1988		293,469
Income capitalised in year	160,124	
Less Disposals	2,909	157,215
		450,684
Depreciation	68,323	
Less Depreciation on Disposals	2,607	65,716
Balance at 31 December, 1988		384,968

7. Leasing:

(a) Operating Leases:

The premises occupied by the Institute are leased from the Office of Public Works. The commitment on foot of such leases in respect of 1988 is £39,800. All except £260 of this commitment is on foot of leases of property from year-to-year.

(b) Finance Leases:

There were no appreciable finance leases in existence at 31 December, 1988.

8. Superannuation:

The total superannuation payments in the year amounted to £313,574. The salaries and superannuation charge in the accounts is net of contributions totalling £11,086.

9. Miscellaneous:

Included in Miscellaneous is Bank Interest earned of £33,531 (1987 - £45,648) for the year.

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH
(Dublin Institute for Advanced Studies)

Report of the Comptroller and Auditor General

I have examined in accordance with approved auditing standards the Accounts set out on Pages 1 to 8 which are in the form approved under the provisions of Acht um Institiuid Ard-Leinn, 1940. I have obtained all the information and explanations which I considered necessary for the purpose of my audit.

In my opinion proper books of account have been kept by an Institiuid and the Accounts, which are in agreement with them, give a true and fair view of the state of its affairs at 31 December 1988, and of its transactions and source and application of funds for the year then ended.

P. L. McDONNELL
Comptroller and Auditor General
30 November 1989.

Scéala Scoil an Léinn Cheiltigh - Newsletter of the School of Celtic Studies

edited by Rolf Baumgarten. pp. 28. No charge.

(c) Books published outside the Institute

Proinsias Mac Cana ed.:

Ériu 38. pp. 208.
Royal Irish Academy.

Heinrich Wagner ed.:

Zeitschrift für Celtische Philologie Vol. 42. pp. 419
Max Niemeyer Verlag Tübingen.

(d) Reprints

The Poems of Taliesin (MMWS Vol. III). Ed. Sir Ifor Williams: English version by J. E. Caerwyn Williams.

Thesaurus Palaeohibernicus I. Edited by W. Stokes and J. Strachan.

Thesaurus Palaeohibernicus II. Edited by W. Stokes and J. Strachan (with Supplement by W. Stokes).

(e) Contributions to periodicals and other publications

Proinsias Mac Cana

Articles on 'Celtic Religion', 'Conal Cernach'. 'Ferghus mac Roich', 'The Head Cult', 'Sídhe' and 'Táin Bó Cualinge' (some 20,000 words). Encyclopedia of Religions, 16 cols. ed. Mircea Eliade. Macmillan, New York, London. 1987.

Obituary of Ernest Gordon Quin (1910-1986).
Ériu 38, 1-3

Fianaigecht in the pre-Norman period.
The Heroic Process: Form, Function and Fantasy in Folk Epic
Proceedings of the International Folk Epic Conference
University College Dublin, 2-6 September 1985, ed.
Bo Almqvist, Séamus Ó Catháin and Pádraig O hÉalaí
(Dún Laoghaire, Co. Dublin, 1987) 75-99.

Yr hen Gymdeithas Wyddelig (Early Irish Society)
Y Gwareiddiad Celtaidd, ed. Geraint Bowen (Llandysul, 1987)
112-136.

Y Trefedigaethau Gwyddelig ym Mhrydain (The Irish
Settlements in Wales) ibid. 153-181.

Brian Ó Cuív

The observations of medieval Irish scholars on sandhi
phenomena in Irish,

Papers in the History of Linguistics: Proceedings of the
Third International Conference on the History of the
Language Sciences, ed. Hans Aarsleff, Louis G. Kelly and
Hans-Josef Niederehe.

John Benjamins Publishing Company, Amsterdam and Philadelphia.

A Poem of Prophecy on Ua Conchobhair Kings of Connacht,
Celtica 19, 31-54

The Decline of Poesy,
ibid. 126-127

The Surname of Ó Casaide,
ibid., 176

Reviews of publications,
ibid., 186-189, 201-204.

Máirtín Ó Murchú

Review of G. Broderick: A handbook of Late Spoken Manx,
Vol. 3 Celtica 19, 197-199.

Heinrich Wagner

The Roots of Finno-Ugric Folk Epic,
The Heroic Process: Form, Function and Fantasy in Folk Epic
Proceedings of the International Folk Epic Conference,
University College Dublin, 2-6 September 1985, ed.
Bo. Almqvist et al. (Dún Laoghaire, Co. Dublin, 1987).
347-370.

The Celtic Invasions of Ireland and Britain,
Zeitschrift für Celtische Philologie 42 (1987). 1-40

Phonetische Texte aus Dunquin, Co. Kerry, Part 1 (with
Noel McGonagle), ibid. 219-241.

Pádraig de Brún

Litir ó Thor Londain,
Éigse 22 (1987). 49-53.

The Irish Society's Bible teachers, 1818-27: IV
ibid. 54-106.

A song relative to a fight between the Kerry Militia and some Yeomen at Stewartstown, Co. Tyrone, July 1797,
The Bell (Stewartstown) 2 (1987-8). 49-82.
(Illustrated reprint from Kerry Archaeological & Historical Society Journal 6 (1973) 101-130

Braithre Leasa Gabhail,
Clogher Record 1987, 298-299

The Cataloguing of Irish manuscripts,
Newsletter of the School of Celtic Studies 1 (1987) 27.

Rolf Baumgarten

The kindred metaphors in Bechbretha and Coibnes uisci thairidne, Peritia 4 (1985 (1987)) 307-327.

Placenames, etymology and the structure of Fianaigecht,
The Heroic Process: Form, Function and Fantasy in Folk Epic Proceedings of the International Folk Epic Conference, University College Dublin, 2-6 September 1985, ed. Bo Almqvist et al. (Dún Laoghaire, Co. Dublin, 1987) 1-24. Also in Béaloideas 54-5 (1986-87) 1-24.

An Irish manuscript in Berlin,
Celtic Cultures Newsletter 5 (Dec. 1987) 9-10.

Ernest Gordon Quin: a bibliography,
Ériu 38, 4-8.

Michael A. O'Brien (1896-1962): a bibliography,
Celtica 19, 121-125.

Malachy McKenna

Reviews of Publications.
Celtica 19, 183-186, 191-193.

Míchéál Ó Siadhail

Reviews of Publications.
Celtica 19, 193-197

Pádraig Ó Machaín

Rann ar Thadhg Dall,
Celtica 19, 59-60

Andrew Breeze

The Girdle of Prato and its Rivals,
Bulletin of the Board of Celtic Studies xxxiii, 95-100

Llyfr Durgrys,
ibid. 145

Welsh Poetry and the Crowing of the Cock in Hamlet,
Notes and Queries (June 1987), 212.

The Dance of Death,
Cambridge Medieval Celtic Studies xiii, 87-96.

The Charter of Christ in Medieval English, Welsh and Irish,
Celtica 19, 111.

Aidan Breen

The evidence of antique Irish exegesis in Pseudo-Cyprian,
De duodecim abusivis saeculi,
Proceedings of the Royal Irish Academy 87 C (1987) no. 4.

Mark Scowcroft

Leabhar Gabhála Part 1: The Growth of the Text.
Ériu 38, 81-142.

III - Annual Report of the Governing Board of the School of Theoretical Physics for the year 1987 adopted at its meeting on 30 June 1988.

1. STAFF, EMERITUS PROFESSOR, SCHOLARS, RESEARCH FELLOW, RESEARCH ASSOCIATES, VISITING SCIENTISTS:

Staff:

Senior Professors:

John T. Lewis, Director from 1 January 1975; James R. McConnell; Lochlainn S. O'Raifeartaigh.

Assistant Professor:

G. Raggio, appointed 1 January.

Librarian-Executive:

Evelyn R. Wills.

Secretary:

Margaret Matthews.

Emeritus Professor:

John L. Synge.

Scholars:

E. Mueller (Fed. Rep. Germany) left 30 September; P. Horváthy (Hungary) left 30 September; M. Vandyck (Belgium); W. Cegła (Poland); N. Gorman (Ireland) on one year's leave of absence from 1 October; T. C. Dorlas (Netherlands) from 1 May; M. P. Tuite (Ireland) from 1 October; J. Balog (Hungary) from 1 October.

European Science Exchange Fellow (Royal Society of London):

D. Williams (UK) to 30 September.

Research Associates:

Appointments continued to 31 December 1987:

TCD: D. J. Bradley, R. K. Dodd, P. S. Florides, H. C. Morris, A E. Raftery, B. K. P. Scaife, D. Weaire

UCD: P. A. Hogan, D. J. Judge, J. D. McCrea, J. V. Pulè, W. Sullivan

St. Patrick's Coll. Maynooth: B. Dolan, P. McGill, C. Nash, A. O'Farrell, J. Spelman, D. H. Tchrakian

UCG: M. J. Conneely, T. N. Sherry

DIT Kevin St.: T. Garavaglia, B. Goldsmith, M. J. Tuite

DIT Bolton St.: P. Houston

NIHED: E. Buffet, J. Burzlaff, D. Heffernan

NIHEL: R. H. Critchley, J. Kinsella, B. Lenoach

Carlow RTC: D. Ó Sé

An Foras Forbartha: J. M. Golden

Open University: A. I. Solomon

Oxford University: R. C. Flood.

New Appointment:

St. Patrick's Coll. Maynooth: J. A. Slevin from 30 January.

Visiting Scientists:

A. P. Balachandran (Syracuse) 24 Aug. - 7 Sept.; N. L. Balazs (Stony Brook) 20-26 March; J. Basecq (Zurich) 2-6 July; V. P. Belavkin (Moscow) 6 Sept. - 9 Oct.; M. van den Berg (Heriot-Watt) 10-23 Aug.; M. Berry FRS (Bristol) 20 Nov; R. Bott (Harvard) 22-23 March; A. D. Buckingham (Cambridge) 11-14 March; R. Coquereaux (Luminy-Marseille) 29 June - 4 July; T. Dorlas (Groningen) 9-15 April; Sir Sam Edwards FRS (Cavendish) 31 Aug. - 4 Sept.; A. C. van Enter (Haifa) 1-30 Sept.; D. E. Evans (Warwick) 12-23 Jan.; G. W. Ford (Ann Arbor) 28 June -2 Aug; A. Fowler (Oxford) 15-16 April; D. G. Frood (Lakehead) 8 Aug. - 5 Sept.; B. Gellai (Budapest) 18-22 Dec.; G. A. C. Graham (Simon Fraser) 8 Sept. 1986 - 31 Dec. 1987; H. Hasegawa (Kyoto) 10-19 June; P.

Horváthy (Metz) 30 Nov. - 8 Dec.; W. D. McGlinn (Notre Dame) 2 Jan. - 1 July, 31 July - 14 Aug.; Z.-Q. Ma (Beijing) 8 Aug. - 16 Sept.; W. Mecklenberg (Hamburg) 29 June - 3 July; S. Meljanac (Zagreb) 8 June - 20 July; M. Muldoon (York, Ont.) 15-20 April; R. Musto (Naples) 1-21 Feb.; P. M. Naghdi (Berkeley) 27 March; K. S. Narain (Rutherford Lab) 29-30 April; R. F. O'Connell (Baton Rouge) 30 June - 3 Aug.; D. O Mathuna (Boston); G. Parravicini (Milan) 27 July - 5 Sept.;Sir Rudolf Peierls FRS (Oxford) 9-11 Mar.; A. Raina (Bombay) 19-27 Oct.; W. I. Skrypnik (Kiev) 12 Nov. - 11 Dec.; G. Turchanyi (Budapest) 29 Aug. - 5 Sept.; J. Walsh (Vancouver) 4-5 June; R. Werner (Osnabrueck) 29 June - 5 July.

2. GENERAL

The School celebrated the 90th birthday of Professor Synge with a special seminar on 22 March, followed by a reception at which the President, Dr. P.J.Hillery, was present.

Following his visit to the USSR in May, the Director was authorised by the Board of the School to sign an exchange agreement with the Joint Institute for Nuclear Research, Dubna.

3. RESEARCH AND STUDY

Primary areas -

(a) Theoretical Particle Physics

Prof. O'Raifeartaigh continued and completed (temporarily at least) research on the Index Theorem, and on U(1) anomalies in noncompact, notably Euclidean, spaces. The result is an extension of the Index Theorem to include scattering states along the lines of the Levinson theorem in quantum mechanics. He commenced study and work on Kac-Moody and Virasoro algebras, which have come to play a fundamental role in modern quantum theory, particularly in the string theory of particles and fields.

Dr. M. P. Tuite's study and research was in the area of string theory, and he completed (with S. Sen, TCD) an article for publication on a string-motivated approach to the relativistic point particle.

Dr. Balog worked with Prof. O'Raifeartaigh on Kac-Moody algebras and strings. They started a study of the Beta algebra, which is related to the light-cone algebra of bosonic strings. When string theory is formulated in this way, the consistency condition of the theory is equivalent to demanding flatness of the Beta algebra.

Dr. Gorman studied Goddard & Olive's review of Kac-Moody and Virasoro algebras in relation to quantum physics, and B.R.S.T. quantization in string theory. He worked on a unified approach to the computation of central extensions of Kac-Moody and Virasoro algebras, and the connection between the vanishing of the centre and the vanishing of the square of the B.R.S.T. charge in general constrained systems.

Dr. Hórvathy continued his work on monopole instability, and on dynamical symmetry of monopole scattering.

Dr. Tchrakian continued the construction of non-abelian Higgs models in 4-dimensions (with Dr. G.M. O'Brien), the construction of gauge fields on CP(n) satisfying generalised duality relations (with Dr. Ma), the demonstration of dimensional reduction over CP(n) of Chern classes, and the general construction of non-abelian (generalised) Higgs models (with Dr. Sherry). With Dr. O'Brien, he constructed meron fields in all even dimensions, as well as self-dual spin-connection gauge fields on double-dual gravitational backgrounds.

Drs Tchrakian and Dolan collaborated in research on conformally invariant field theories in 4 and more dimensions, and their relation to extended objects of more than one dimension.

Dr. M. J. Tuite continued his study of field theory at finite temperature and density, with the aim of understanding the connections between (a) the imaginary-time (Euclidean) approach, and (b) the real-time approach (Minkowski time-path method and thermo-field dynamics); a further objective being comparison/contrast of these approaches in applications such as phase transitions in spontaneously broken gauge theories at finite temperature.

Dr. Burzlaff continued his study of soliton (or soliton-like) solutions of nonlinear partial differential equations; in particular he studied a) time-dependent vortices and monoples, b) topolocally non-trivial solutions in more than 4 dimensions, and c) optical soliton solutions. In cases a) and b) he looked at questions of existence, and in case c) he established criteria for the injection of solitons into optical fibres.

(b) Classical Statistical Mechanics

(i) Brownian Motion and Relaxation Phenomena

Prof. McConnell continued his studies on nuclear magnetic relaxation. He studied the effects on internal motions in molecules. A considerable amount of his time was devoted to activities connected with the celebration of the centenary of the birthday of Schroedinger, giving lectures, and supplying information to Schroedinger's biographer, Walter Moore.

Prof. Scaife worked on the manuscript for a book on 'Principles of Dielectrics'.

(ii) Ferrofluids

Prof. Lewis & Dr. Dorlas collaborated with O. Penrose (Heriot-Watt) in an investigation of the free-energy of a model of a ferrofluid using the principle of large deviations.

(iii) Phase Transitions in Lattice Systems

Dr. Solomon examined the application of dynamical symmetry and supersymmetry to systems of interacting fermions; he developed coherent states and squeezed states involving group theoretical description, especially in the context of the novel 'fractional photon' states.

(c) Quantum Statistical Mechanics

(i) Quantum Spin Systems

Prof. Lewis (with Prof. Raggio and Dr. Cegła) investigated the equilibrium thermodynamics of quantum spin systems using the principle of large deviations. They proved a theorem which provides upper and lower bounds for the specific free-energy of a quantum spin system and applied it to the BCS model and the spin-boson model. The theorem was also used by Profs Lewis and Raggio to investigate the nature of the phase-transition in the spin-boson model.

(ii) Boson Condensation

Prof. Lewis continued his investigation of boson condensation in interacting systems, using the principle of large deviations to study the perturbed mean-field model (with Drs Dorlas, Pulè and van den Berg) and a 1-dim model with a delta-function interaction which is solvable using the Bethe Ansatz (with Drs Dorlas and Pulè).

Dr. Mueller studied the asymptotic dynamics in the coupling of a matter field with the radiation field, and implemented the relevant recursion, using REDUCE. Also he studied Debye potentials, and the Dirac equation, and collaborated with G. Parravicini on a study of the group theoretical background of Debye decomposition.

Dr. Dorlas continued his previous work on renormalisation of a hierarchical fermion model, and began new research on the use of the method of large deviations in statistical mechanics. This work was concerned with 1) the mean-field model for a ferrofluid, 2) a perturbed mean-field model of a boson gas, and 3) a soluble model of a 1-d boson gas, with delta function interaction (involving the Bethe Ansatz).

(iii) Quantum Stochastic Processes

Prof. Lewis continued work on the application of the quantum Langevin equation to atomic systems (with G. W. Ford (Ann Arbor) and R. F. O'Connell (Baton Rouge)).

Secondary areas -

(d) General Relativity and Gravitation

Dr. Vandyck, having completed his study of the Robinson-Trautman metrics in general relativity (see Annual Report for 1986), pursued investigations on supergravity, and developed an appropriate notion of a space-time symmetry; this required a detailed analysis of the problem of defining the Lie derivative of a spinor. He applied the resulting framework to the special case of plane waves in N=1 and N=2 supergravity, and compared these waves with their analogues in general relativity. He is now seeking a re-interpretation of all these results, in the context of superspace.

Dr. Dolan studied black hole radiation.

Dr. McCrea used a method initiated by Baekler and Guerses to find a Kerr-like solution of the Poincaré gauge field equations: in subsequent collaboration with Baekler, Guerses, and Hehl, he generalized this solution to one with Kerr-Newman metric and dynamic torsion. He completed work with Kopczynski and Hehl on the currents associated with the Weyl group, and submitted the results for publication.

(e) Applied Mathematics

Prof. Raggio used large-deviation techniques to study the thermodynamic limit of thermodynamic functions. In the area of the mathematical foundations of quantum theory, his research was concerned with correlations in composite quantum systems and with entropy-increasing/decreasing maps.

Dr. Cegła studied the large deviation method in statistical mechanics, and the quantum version of the large deviation principle. He also studied the quantum logic approach to quantum mechanics and causal structures in Minkowski space-time.

Dr. Houston studied features of the geometrical structure of gauge invariant quantum models.

Prof. Graham and Dr. Golden continued their research work on boundary-value problems in elasticity, contact problems, crack problems, and applications to fracture.

(f) Pure Mathematics

Dr. Goldsmith studied the application of simple combinatorial principles to problems involving Abelian subgroups and factor groups of permutation groups. In addition he studied the application of lifting techniques to realization problems for some classes of Abelian groups.

Research Reports

Research work during the year was written up in the first instance in research reports. Three lists of titles of these reports (preprints) were prepared and circulated to a mailing list of approximately 300 research institutes and university departments throughout the world. As far as available, copies of the preprints were sent out in response to requests. Many of the reports appeared later as publications, or were in press at the end of the year (See Section 11).

DIAS-STP-87-01: G. A. RAGGIO: A note on mixing-increasing and mixing-decreasing maps.

-02: G. A. RAGGIO: Two-level systems interacting with bosons: Thermodynamic limit of thermodynamic functions.

-03: E. MUELLER: Scalar potentials for vector fields in quantum electrodynamics.

-04: P. MacAONGHUSA & J. V. PULÈ: An extension of Levy's stochastic area formula.

-05: A. MONTORSI, M. RASETTI, & A. I. SOLOMON: Dynamical superalgebra and supersymmetry for a many-fermion system.

-06: A. I. SOLOMON & J. L. BIRMAN: Dynamical SU(8) - A laboratory for phase coexistence.

-07: J. KATRIEL, M. RASETTI, & A. I. SOLOMON: Group theoretical approach to squeezed states using generalised Bose operators.

-08: D. WILLIAMS & J. F. CORNWELL: Superfields and the irreducible representations of the super Poincaré algebra.

-09: P. A. HORVÁTHY, L. O'RAIFEARTAIGH & J. H. RAWNSLEY: Monopole-charge instability.

-10: T. GARAVAGLIA: The squeezed quantum state at finite temperature.

-11: W. CEGŁA: Lattice structure in Minkowski space.

-12: P. MacAONGHUSA & J. V. PULÈ: Hard cores destroy Bose-Einstein condensation.

-13: J. T. LEWIS: Do bosons condense?

-14: L. O'RAIFEARTAIGH: U(1) anomaly and index theorem for compact and Euclidean manifolds.

-15: W. CEGŁA, J. T. LEWIS, & G. A. RAGGIO: Equilibrium thermodynamics of matter interacting with the quantized radiation field.

-16: L. O'RAIFEARTAIGH & A. WIPF: WKB properties of the time-dependent Schroedinger system.

-17: J. BURZLAFF: The soliton number of optical soliton bound states for two special families of input pulses.

-18: M. van den BERG & J. T. LEWIS: On the asymptotics of a Wiener integral.

-19: J. McCONNELL: Equality of NMR relaxation times for different molecular models.

-20: G. M. O'BRIEN & D. H. TCHRAKIAN: Meron field configurations in every even dimension.

-21: J. McCONNELL: Nuclear magnetic spectral densities for molecular models.

-22: M. van den BERG & J. T. LEWIS: Limit theorems for stochastic processes associated with a boson gas.

-23: J. McCONNELL: Relaxation of rigid and non-rigid molecules in liquids.

-24: G. A. RAGGIO: On Bell's inequality for W*-algebras.

-25: G. M. O'BRIEN & D. H. TCHRAKIAN: Spin-connection generalised Yang-Mills fields on doubledual generalised Einstein-Cartan backgrounds.

-26: J. T. LEWIS: The large deviation principle in statistical mechanics: an expository account.

-27: P. JENKINS & D. HEFFERNAN: Numerical investigation of chaos in the time-delay Ikeda laser-ring cavity.

-28: M. van den BERG, J. T. LEWIS, & J. V. PULÈ: Large deviations and the boson gas.

-29: J. BURZLAFF & L. O'RAIFEARTAIGH: On the construction of Higgs sectors.

-30: J. M. GOLDEN & G. A. C. GRAHAM: Energy balance criteria for viscoelastic fracture.

-31: J. L. BIRMAN & A. I. SOLOMON: Discrete symmetries and selection rules in unified SU(8) for superconductivity and density waves.

-32: A. MONTORSI, M. RASETTI, & A. I. SOLOMON: Dynamical superalgebra and supersymmetry for a many-fermion system.

-33: G. d'ARIANO, S. MOROSI, M. RASETTI, J. KATRIEL, & A. I. SOLOMON: Squeezing versus photon number fluctuations.

-34: J. KATRIEL, A. I. SOLOMON, G. d'ARIANO, & M. RASETTI: Multi-photon squeezed states.

-35: T. C. DORLAS: Renormalization and the continuum limit.

-36: Zhong-Qi MA & Bo-Wei XU: The embedding SO(4) pseudoparticle solutions to the Yang-Mills equations.

-39: B. DOLAN & D. H. TCHRAKIAN: Conformally invariant sigma-models in 2n dimensions.

-40 D. H. TCHRAKIAN: On the dimensional reduction of gravity with torsion.

-41: N G DUFFIELD & J. V. PULÈ: Thermodynamics of the BCS model through large deviations.

-42: P. J. HOUSTON: Geometrical aspects of operator ordering terms in gauge invariant quantum models.

-44: W. CEGŁA, J. T. LEWIS, & G. A. RAGGIO: The free energy of quantum spin systems and large deviations.

-45: T. GARAVAGLIA: A quantum model for DNA.

-46: M. VANDYCK: On the time evolution of some Robinson-Trautman line elements.

-47: B. P. DOLAN & D. H. TCHRAKIAN: New Lagrangians for bosonic m-branes with vanishing cosmological constant.

-48: A. C. D. van ENTER: One-dimensional spin-glasses, uniqueness and cluster properties.

-49: J. L. BIRMAN & A. I. SOLOMON: Dynamical SU(8) for phase-coexistence: Thermodynamics of the SO(4) x SO(4) submodel.

-50: A. MONTORSI, M. RASETTI, & A. I. SOLOMON: Supersymmetry in a BCS-Umklapp model.

-51: J. T. LEWIS & G. A. RAGGIO : The equilibrium thermodynamics of a spin-boson model.

-52: W. CEGŁA & W. KLIMEK: Large deviation principle for product measures.

-54: L. O'RAIFEARTAIGH: The anomaly flux-index identity and its Euclidean extension.

-55: T. DORLAS: Renormalization of a ϕ^4_3 hierarchical model.

-56: W. I. SKRYPNIK: Integrable solutions of the hierarchy of the BBGKY-type for Brownian particles in the mean-field limit.

-57: J. M. BURNS & B. GOLDSMITH: On Abelian subgroups of symmetric groups.

-58: L. O'RAIFEARTAIGH: Gravitation and the unification of the fundamental forces.

-59: B. DOLAN: A group theoretical approach to black hole radiation.

-60: M. VANDYCK: On the problem of space-time symmetries in the theory of supergravity. Part II.

4. SEMINARS, REVIEW LECTURES, SERIES, COURSES.

Seminar and review lectures, series, and courses, in specialised areas of physics and mathematics were given at DIAS-STP throughout the year, by members or visitors; as in previous years these were attended by members of staff and students from the universities and other third level and research institutes in the Dublin Area, and by members of the scientific schools of DIAS.

Seminars or lectures were given also at the Journals' Club, and other Irish venues, by the School's members and visitors.

(a) Seminar and review lectures given at DIAS-STP:

Prof. V. P. BELAVKIN (Moscow): (1) Large deviations and kinetic equations in the multicomponent quantum systems.

(2) The method of generating functionals in algebraic quantum theory.

(3) Quantum stochastical branching processes.

Prof. C. BENDER (Imperial Coll. Lond., & Washington U., St. Louis): Quantum theory on a lattice.

Prof. M. V. BERRY, FRS (Bristol): The quantum phase: Four years after.

Prof. A. D. BUCKINGHAM, FRS (Cambridge): The effects of collisions on molecular properties.

Prof. R. COQUEREAUX (CNRS, Luminy-Marseille): Geometrical aspects of dimensional reduction.

Dr. T. DORLAS: Discrete spin renormalization and its peculiarities (2 lectures).

Dr. N. DUFFIELD (UCD): The BCS Model by means of large deviations.

Prof. H. HASEGAWA (Kyoto): (1) Entropy production of a quantum dynamical system.

(2) The hydrogen atom in a magnetic field - Present status.

Mr. P. MacAONGHUSA (UCD): The asymptotics of planar Brownian motion.

Dr. S. McMURRY (TCD): Photon number operators and Lorentz invariance.

Prof. P. M. NAGHDI (Univ. California, Berkeley): Features and capabilities of the direct approach in mechanics exemplified by water wave theory.

Dr. K. S. NARAIN (Rutherford Appleton Lab): Asymmetric orbifolds.

Sir Rudolf PEIERLS, FRS (Oxford): Momentum and pseudo-momentum of light and sound.

Dr. A. RAINA (Tata Inst.): The Kac determinant.

Dr. W. I. SKRYPNIK (Kiev): Weak solutions of the Bogoliubov hierarchy for interacting Brownian particles.

Dr. T. TAYLOR (Fermilab): Problems in string theory.

Dr. M. P. TUITE: Review of string theory.

Dr. R. WERNER (Osnabrueck): Bell's inequality in quantum field theory.

(b) Series and courses given at DIAS-STP:

Sir Sam EDWARDS FRS (Cambridge): Series of five lectures:

(1) The size of a random walk.

(2) A new formalism for networks.

(3) Deposition.

(4) The glass transition.

(5) The dynamics of the glass transition.

Dr. A. C. D. van ENTER (Haifa): Series of four seminars on mathematical problems associated with the replica trick.

Prof. J. T. LEWIS: Course of lectures on Statistical Mechanics, continued from previous year.

Prof. Zhong-Qi MA (Acad. Sinica, Beijing): Series of three lectures on Yang's generalized Sturm-Liouville method.

Prof. L O'RAIFEARTAIGH, N. GORMAN, et al.: Series on Kac-Moody and Virasoro algebras. (Twice weekly for the Spring Semester).

The series entitled "Proability Seminar" was continued from the previous year; lectures were given as follows:

Dr. W. CEGŁA: Course on theory of probability (Review of Sinai's course at Moscow).

Dr. T. DORLAS (Groningen): Renormalization of a hierarchical fermion model.

Dr. N. DUFFIELD (UCD): Boson condensation in driven systems.

Dr. P. McGILL (Maynooth & DIAS): The Malliavin Calculus.

Dr. J. V. PULÈ (UCD & DIAS): The Feynman-Kac-Îto formula and diamagnetism.

(c) Contributions to the Journals' Club (Joint TCD-UCD-Maynooth-DIAS Meeting, held in TCD):

A. P. BALACHANDRAN: Skyrmions and glueballs.

B. P.DOLAN: Supermembranes.

T. C. DORLAS: Block spin renormalization of a hierarchical model.

N. GORMAN: Some examples of Kac-Moody and Viaroso algebras.

L. O'RAIFEARTAIGH: (1) Generation of bound states by SUSY.

(2) Galilean structure of Kac-Moody algebras.

(3) Weyl group for Kac-Moody algebras.

D. WILLIAMS: Integration in supermaths.

(d) Other lectures or seminars given in Ireland by members of the DIAS-STP:

J. McCONNELL: Schroedinger and UCD. UCD Chemistry Dept, 28 Oct.

L. O'RAIFEARTAIGH: Supersymmetry. QUB, 24 Feb.

Connection between multiplicities of bound states and phase-shifts in quantum mechanics. UCD, 24 Nov.

Newton's legacy: the search for a unified theory of matter. Padraic de Brun Commemorative Lecture, UCG, 9 Dec.

G. RAGGIO: Equilibrium thermodynamics of matter interacting with the quantized radiation field. Opto-electronics Group Meeting, TCD, 9 Oct.

C. GRAHAM: Viscoelastic boundary value problems. UCC, UCD.

E. MUELLER: Bose-Einstein condensation of free photons. TCD, 26 May.

A. I. SOLOMON: Algebra and superalgebra. DU Math. Soc. Inaugural Lecture, TCD, 30 April.

5. ACTIVITIES OUTSIDE IRELAND

Professor McConnell visited Budapest from 28 February - 7 March, to attend the Jánossy Memorial Session of the Hungarian Academy of Sciences, and to visit the Central Research Institute for Physics, the Central Research Institute for Chemistry, and Semmelweiss Univ.; he attended the Schroedinger Centenary Conference at Imperial College London, 31 March - 3 April, and the General Conference of the Condensed Matter Division of the European Physical Society, Pisa, 7-10 April. He visited the Shemyakin Institute of Biorganic Chemistry, Moscow, and the Institute of Chemical Kinetics and Combustion, Novosibirsk, from 14-21 May; he visited the Physics Institute of the Jagellonian Univ. of Krakow, the A. Mickiewicz Univ. of Poznán, the Univ. of Wrocław, and

the Technical Univ. of Warsaw, from 25 June - 9 July. He attended the Conference on Liquids of Small Molecules, and chaired meetings of committees of the European Molecular Liquids Group, Santa Trada, Calabria (Italy), 20-26 September; from 8-17 December he visited the Physical Chem. Dept, Univ. of Padua, and the Dept. of Electrotechnics, Univ. Pavia, and attended the Convegno Internazionale di Studi "Erwin Schroedinger, Scienziato e Filosofo", at Ca'Dolfin, Venice.

Professor Lewis visited Heriot-Watt Univ. 5-9 Jan., and Univ. Tuebingen 23-24 Jan. He attended a meeting of editors of Europhysics Letters in Paris on 16 January. He participated in the the Quantum Stochastics Symposium, Oberwolfach, 25-29 Jan. He visited the Tech. Univ. Delft on 5 Feb., and participated in the Mark Kac Seminar at the University of Amsterdam on 6 Feb., 6 Mar., 2 April and 8 May. He participated in the 26th Internationale Universitatswochen at Schladming, 17-23 Feb.; he visited the Inst. Theor. Phys., Utrecht, on 5 Mar. He participated in the Nederlands Math.-Phys Conf., Lunteren, 23-25 Mar., the C*-Algebra Conf., Warwick, 25-28 Mar., the Schroedinger Centenary Conf., London, 31 Mar. - 3 April, and visited the Inst. Theor. Physics Leuven 4-7 April, Univ. Nijmegen 7 May. He visited the Joint Inst. for Nuclear Research, Dubna, 12-28 May. He attended a one-day meeting at Univ. Warwick ,4 June, and chaired the meeting of the Organizing Committee of the 9th Congress of the International Association of Mathematical Physics at Imperial Coll. London , 6 June, and visited ETH, Zurich, 8-10 July. He participated in the UK-US Symposium on Operator Algebras at Univ, Warwick, 19-25 July, in the Conference on Mathematical Problems in Statistical Mechanics at Heriot-Watt Univ. 2-8 Aug., and in the Advanced Research Workshop, Acquafredda di Maratea 3-9 Oct.; he visited the Kath. Univ. Leuven 1-4 Dec.

Professor O'Raifeartaigh attended the Schroedinger Centenary Conference at Imperial College, London, 31 March - 3 April. He visited the University of Naples from 10-24 May, and attended the Conference on Symmetry in Fundamental Interactions, Capri, 25-30 May,and the Conference on String Theory, Capri, 31 May - 4 June. He attended the Xth Summer School in Theoretical Physics, 6-12 June, and the XVIth International Conference on Group Theoretical Methods in Physics, 13-22 June, both in Varna (Bulgaria); and he attended the 2nd Regional Conference on Theoretical Physics, Cukorova Univ. (Turkey), 20-27 September.

Professor Raggio attended the Workshop on Operator Algebras in Mathematical Physics, Univ. Warwick, 23-25 March, and visited Univ. Leuven 2-5 June.

Dr. Tchrakian made research visits to Annecy (LAPP) and to Geneva (CERN) in July, to Trieste (SISSA) and Trento in September, and to the Steklov Inst. (Moscow) and Erevan Inst. of Physics in October.

Drs Dolan, Gorman, and M. J. Tuite attended the UK Inst. for Theoretical High Energy Physics, Cambridge, 23 August - 5 September.

Drs M. P. Tuite and Dorlas attended the Rutherford-Appleton Lab. Meeting on Particle Theory, 14-16 Dec.

Dr. Vandyck attended the 2nd Hungarian Relativity Workshop, Relativity Today, Budapest 31 Aug. - 5 Sept.

Dr. Mueller visited the Frauenhofer Institute for Solar Energy Systems, Freiburg i Br., from 20-22 Mar., and the Univ. Tuebingen on 23 May.

Dr. Cegła attended the Conf. on Quantum Stochastics, Oberwolfach, 25-31 January, and the Symposium on Quantum Probability and Applications, Rome Univ., 2-30 June.

Dr. Dorlas attended the Conf. on Mathematical Problems in Statistical Mechanics, Edinburgh, 1-6 Aug, and visited Univ. Groningen 18 Dec.

Dr. Horváthy attended a Spring School on Espaces fibres en physique, Trieste, 27 April - 1 May, the School on Geometrical Methods in Physics, Ferrara (Italy), 1-15 June, and the Relativity Workshop in Budapest from 1-5 September. During the year he visited Ecole Polytechnique (Paris), and the Univ. Metz.

Professor Scaife attended the Schroedinger Centenary Conf., 31 Mar. - 3 April, and chaired one of the Sessions.

Dr. Burzlaff visited the Univ. Kaiserslautern, 15-26 June.

Dr. McCrea visited Univ. Koeln from 12-26 June, to collaborate with F. Hehl, and Queen Mary Coll. (London), 2-3 July.

Professor Graham attended the SIAM Conf., Paris, June, and Univ. Glasgow.

Dr. Goldsmith attended the Conf. on Abelian Groups and Modules, Perth (W.A.), August.

Dr. Solomon attended the International Conf. on Group Theoretical Methods in Physics, Varna, 13-22 June.

Seminars, Lectures, and Courses given abroad:

Professor McCONNELL:

Lectures: Theory of intramolecular nuclear relaxation. Semmelweiss

Schroedinger's nonlinear optics. London Conf.

Equality of NMR relaxation times for different molecular models. Pisa Conf.

Theory of NMR relaxation by intramolecular interactions. Krakow and Poznán

Schroedinger in Irlanda. Padova

Erwin Schroedinger a Dublino. Venice Conf.

Theory of dielectric relaxation. Novosibirsk, Chemical Kinetics Institute.

Theory of nuclear magnetic relaxation. Novosibirsk, Inorganic Chemistry Institute.

Professor LEWIS:

Large deviations and models of an interacting boson gas. Edinburgh, Tuebingen, Utrecht, Moscow, Dubna, and the Confs. at Oberwolfach, Schladming, and Warwick.

Do bosons condense? London Conf.

Large deviations in quantum statistical mechanics. Warwick, Zurich, Leuven, Moscow, Dubna.

Large deviations in statistical mechanics. 2 lectures, Lunteren, Edinburgh, Acquafredda di Maratea Wksp.

Course: Probabilistic aspects of statistical mechanics. 4 lectures, Amsterdam.

Professor O'RAIFEARTAIGH:

Course: 14 lectures on the fundamental integral formalism of quantum mechanics and quantum field theory. Naples.

Lectures: Weyl group for Kac-Moody algebras. Capri (First Conf., 1 Lecture), and Varna Summer School (2 lectures).

The U(1) anomaly, index theorem, and other Euclidean extensions. Varna Conf.

Professor RAGGIO:

Quantum spin systems and large deviation methods. Leuven.

Dr. VANDYCK:

Lecture: On the time evolution of some Robinson-Trautman line elements. Review, Budapest Wksp.

Dr. HORVÁTHY:

Lectures: Monopole instability. Paris.

Geometric quantization. 3 lectures, Metz.

Dr. MUELLER:

Lecture: Bose-Einstein condensation of photons. Freiburg.

Dr. CEGŁA:

Lectures: Large structure in Minkowski space-time. Oberwolfach Conf.

Large deviation principle for product measures. Rome Symposium.

Large deviation for Dicke maser model. Rome Symposium.

Covering property in a causal logic. Rome Symposium.

Dr. DORLAS:

Lectures: Renormalisation theory and hierarchical models. Edinburgh Conf.

Fixed point peculiarities of a discrete spin renormalisation transformation. Groningen.

Dr. McCREA:

Lecture: A Kerr-like solution of the Poincaré gauge field equations. Koeln, and London.

Dr. BURZLAFF:

Lecture Series: Nonlinear partial differential equations in physics. Kaiserslautern.

Dr. TCHRAKIAN:

Lectures: Generalised Yang-Mills and gravity systems. Trieste, Trento, Moscow, and Erevan.

Dr. DOLAN:

Lecture: Conformally invariant m-branes. Cambridge Conf.

Dr. GOLDSMITH:

Lecture: Endomorphism rings of non-separable Abelian p-groups.

Dr. SOLOMON:

Lectures: Self-consistency and supersymmetry in a moving fermion system. Varna Conf.

Dynamical SU(8) for phase coexistence: thermodynamics of an SO(4) x SO(4) submodel. Varna Conf.

Professor GRAHAM:

Lecture: Viscoelastic boundary value problems. Glasgow.

6. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture under the auspices of the School was delivered by Sir Rudolf PEIERLS, FRS, on 10 March in University College Dublin. The title was 'Recollections of the early days of quantum mechanics: more about physicists than physics'.

7. SYMPOSIA

Two Mathematical Symposia were held during the year, 15-16 April, and 21-22 December. The attendance (28 in April, 49 in December) included professors, lecturers, and graduate students from the Irish universities and other third-level and research institutes, and from institutes abroad, and members of the scientific schools of DIAS.

Lectures were given as follows:

APRIL:

Review Lectures:

Prof. M. MULDOON (York Univ., Ont.): The Hellmann-Feynman theorem and zeros of Bessel functions.

Dr. A. FOWLER (Oxford): Recent progress in the application of chaotic dynamics to turbulent flows.

Lectures:

Prof. P. BARRY (UCC): On generating functions.

Prof. D. SIMMS (TCD): The moduli space of Riemann surfaces.

Dr. J. V. PULÈ (UCD & DIAS): An extension of Lévy's stochastic area formula.

Dr. J. KINSELLA (NIHEL): Simulated annealing: new developments in combinatorial optimization.

Short Talks:

Prof. R. HARTE (UCC): Invertibility and singularity.

Dr. S. McMURRY (TCD): A unified model for vector gauge mesons.

Prof. J. T. LEWIS: The Berezin-Lieb inequalities.

Dr. R. RYAN (UCG): The Grothendieck inequality.

DECEMBER:

Review Lectures:

Prof. D. S. F. CROTHERS (QUB): Quantal phase integrals: Berry phases and Wannier thresholds.

Prof. B. GOLDSMITH (DIT Kevin St & DIAS): Invariants of Abelian groups with an application to symmetric groups.

Lectures:

Dr. E. BUFFET (NIHED & DIAS): Polymer growth and gelation.

Dr. M. BARMAN (NIHED): A language for stochastic systems.

Dr. M. VANDYCK : Space-time symmetries in supergravity.

Dr. T. HURLEY (UCG): Computer algebra.

Short Talks:

Dr. G. ELLIS (UCG): Non-Abelian techniques in algebraic topology.

Prof. A. G. O'FARRELL (Maynooth & DIAS): C^∞ maps may increase C^∞ dimension.

Prof. R. HARTE (UCC): Compound matrices revisited.

Prof. F. HOLLAND (UCC): An analogue of the Fejér-Riesz lemma for analaytic Besov spaces.

Prof. J. N. FLAVIN (UCG): Some remarks on the Monge-Ampère equation.

Dr. P. MURPHY (TCD): Modular invariance in finite temperature string theories.

8. IRISH MECHANICS GROUP / DIAS-STP MEETING

A Meeting on 'Advances in Mechanics' organised by the Irish Mechanics Group in collaboration with DIAS-STP was held at DIAS on 15 April: the attendance was 15. Lectures were given as follows:

Prof. M. HAYES (UCD): Universal relations in continuum mechanics.

Prof. A. WOOD (NIHED): Quick and dirty methods in asymptotics of differential equations.

Prof. J. N. FLAVIN (UCG): A class of problems in fluid dynamics, etc.

Dr. J. J. GRANNELL & Dr. M. J. A. O'CALLAGHAN (UCC): The edge function method for eigenvalue problems in elastodynamics.

Dr. E. A. COX (UCD): The evolution of quadratic resonance in a closed gas tube.

Dr. A. FOWLER (Oxford): The mechanics of glacier surges.

9. NINETIETH BIRTHDAY OF EMER. PROF. J. L. SYNGE, Hon. FTCD, MRIA, FRSCan., FRS, Sc.D (Dubl.), LL.D (h.c. St Andrew's), D.Sc (h.c. QUB), D.Sc (h.c. NUI), Tory Medal (RS Can.), Boyle Medal (RDS)

A seminar to mark the Ninetieth Birthday of Emeritus Professor JOHN L. SYNGE, Senior Professor of DIAS-STP from 1948 to 1972, was held at DIAS on 22 March; there were two speakers, as follows:

Prof. R. BOTT (Harvard): Geometry today.

Prof. N. L. BALAZS (SUNY at Stony Brook): New experimental tests of general relativity.

A Reception afterwards was attended by The President, Dr. P. HILLERY, Prof. C. S. MORAWETZ (daughter of Professor Synge, and Director of the Courant Institute, New York Univ.), and other guests. Dr. GOLDSMITH presented a photo-portrait of Professor Synge, on behalf of DIT Kevin St.

10. VISITORS

As in previous years, visitors from abroad came to the School for short or long periods, for discussions with School members, to give seminars, and to avail of the School's library resources for their research work. For lectures given by Visitors, see Sections 4, 6-9.

Short visits (up to one week) were made by

N. L. BALAZS (SUNY at Stony Brook), 20-26 March

J. BASECQ (Zurich U.), 2-6 July

C. M. BENDER (Washington U., St. Louis), 8 April

M. BERRY FRS (Bristol U.), 20 Nov.

R. BOTT(Harvard U.), 22-23 March

A. D. BUCKINGHAM (Cambridge), 11-14 March

J. CONLON (U. Missouri), 7 July

R. COQUEREAUX (CNRS, Luminy-Marseille), 29 June - 4 July

Sir Sam EDWARDS FRS (Cavendish Lab.), 31 Aug. - 4 Sept.

A. FOWLER (Oxford), 15-16 April

B. GELLAI (Budapest), 18-22 Dec.

M. KAZUNO (Tohu), 25 Aug.

W. MECKLENBERG (DESY, Hamburg), 29 June - 3 July

M. MULDOON (York U., Ont), 15-20 April

P. M. NAGHDI (U. California, Berkeley), 27 March

K. S. NARAIN (Rutherford Lab.), 29-30 April

Sir Rudolf PEIERLS FRS (Oxford), 9-11 March

G. TURCHANYI (Semmelweiss U., Budapest), 29 Aug.-5 Sept

R. WERNER (Osnabrueck U.), 29 June - 5 July

Longer visits were made by

A. P. BALACHANDRAN (Syracuse U.), 24 Aug. - 7 Sept.

V. P. BELAVKIN (MIEM, Moscow), 6 Sept. - 9 Oct.

M. van den BERG (Heriot-Watt U.), 10-23 Aug.

T. DORLAS (Groningen), 9-15 April

A. C. van ENTER (Israel Inst. Tech.), 1-30 Sept.

D. E. EVANS (Warwick), 12-23 Jan.

G. W. FORD (U. Michigan, Ann Arbor), 28 June - 2 Aug.

D. G. FROOD (Lakehead U., Ont), 8 Aug. - 5 Sept.

G. A. C. GRAHAM (Simon Fraser U.), 8 Sept. 1986 - 31 Dec. 1987

H. HASEGAWA (Kyoto U.), 10-19 June

P. HORVÁTHY (Metz U.), 30 Nov. - 8 Dec.

W. D. McGLINN (Notre Dame U.), 2 Jan. - 1 July, 31 July - 14 Aug.

Zhong-Qi MA (U. Beijing), 8 Aug. - 16 Sept.

S. MELJANAC (U. Zagreb), 8 June - 20 July

R. MUSTO (U. Naples), 1-21 Feb.

R. F.O'CONNELL (U. Louisiana, Baton Rouge) 30 June - 3 Aug.

D. O MATHUNA (Boston)

G. PARRAVICINI (U. Milan), 27 July - 5 Sept.

A. RAINA (Tata Inst. Fund. Res., Bombay), 19-27 Oct.

W. I. SKRYPNIK (Acad. Sci. Uk.SSR, Kiev), 12 Nov. - 11 Dec.

J. WALSH (U. Brit. Columbia), 4-5 June

11. PUBLICATIONS

Note: Items marked with an asterisk have been recorded as in press in previous reports.

(1) Book:

Published:

*J. McConnell. The theory of nuclear magnetic relaxation in liquids. Cambridge Univ. Press, 31 August 1987.

(2) Communications of the Dublin Institute for Advanced Studies, Series A (Theoretical Physics):

None published.

(3) Contributions to periodical and other publications:

J. McConnell:

* Schroedinger's nonlinear optics. Schroedinger Centenary Celebrations of a Polymath, Ed. C. W. Kilmister, Camb. Univ. Pr. 1987, pp.146-164.

* From nonlinear optics to nuclear magnetics. Boyle Medal Lecture 1986, Occas. Papers in Irish Sci. & Tech., No. 3, Royal Dublin Society 1987.

* Relaxation of rigid and non-rigid molecular liquids. Rotational Dynamics of Small and Macromolecules in Liquids. Proc. Bielefeld, 1986, Eds. Th. Dorfmueller & R. Pecora, Springer LNP 293, 1987, pp. 26-40.

Equality of NMR relaxation times for different molecular models. Proc. 7th Gen. Conf. Condensed Matter Div. of EPS, Pisa 1987, vol. 11A, p. 325.

Schroedinger a Dublino, Convegno Internaz. Venezia 1987, libro di riassunti, pp.3-4.

J. T. Lewis:

* Do bosons condense? Schroedinger Centenary Celebrations of a Polymath, Ed. C. W. Kilmister, Camb. Univ. Press 1987, pp. 136-145.

G. W. Ford, J. T. Lewis, & R. F. O'Connell:

* On the thermodynamics of quantum electrodynamic frequency shifts. J. Phys. B: At. Mol. Phys. 20 (1987), 899-906.

Memory effects in transport theory: an exact model. Phys. Rev. 36A (1987), 1466-1469.

M. van den Berg & J. T. Lewis:

On the asymptotics of a Wiener integral. Proc. Roy. Soc. Edinb. 105A (1987), 195-198.

W. Cegła, J. T. Lewis, & G. A. Raggio:

Equilibrium thermodynamics of matter interacting with the quantized radiation field. Europhys. Lett. 4 (1987), 517-520.

G. A. Raggio:

A note on mixing-increasing and mixing-decreasing maps. Helv. phys. Acta 60 (1987), 903-912.

M. van den Berg:

* On the asymptotics of the heat equation and bounds on traces associated with the Dirichlet Laplacian. J. funct. Anal. 71 (1987), 279-293.

P. MacAonghusa & J. V. Pulè:

Hard cores destroy Bose-Einstein condensation. LMP 14 (1987), 117-121.

N. G. Duffield & J. V. Pulè:

Thermodynamics of the BCS model through large deviations. LMP 14 (1987), 329-331.

E. E. Mueller:

Scalar potentials for vector fields in quantum electrodynamics. J. math. Phys. 28 (1987), 2787-2790.

P. Forgács, L. O'Raifeartaigh, & A. Wipf:

Scattering theory, U(1) anomaly and index theorems for compact and non-compact manifolds. Nucl. Phys. 293B (1987), 559-592.

P. A. Horváthy & J. Rawnsley:

* Monopole invariants. J. Phys. A: Math. Gen. 20 (1987), 747-751.

L. G. Féher & P. Horvathy:

* Dynamical symmetry of monopole scattering. Phys. Lett. 183B (1987), 182-186.

M. Vandyck:

* On the motion of test-particles in a plane wave of supergravity. Class. Q. Grav. 4 (1987), 683-693.

* On the time evolution of some Robinson-Trautman solutions. II. Class. Q. Grav. 4 (1987), 759-768

D. H. Tchrakian:

On the dimensional reduction of gravity with torsion. Class. Q. Grav. 4 (1987), L217-L224.

D. Ó Sé & D. H. Tchrakian:

* Conformal properties of the BPST instantons of generalised Yang-Mills system. LMP 13 (1987), 211-218.

G. M. O'Brien & D. H. Tchrakian:

* A dimensional reduction of the GYM-Dirac system in 4p-dimensions (p=2). Il Nuovo Cim. 97A (1987), 673-689.

* Localised instantons in four dimensions. Phys. Rev. 35D (1987), 1468-1477.

Meron field configuration in every even dimension. Phys. Lett. 194B (1987), 411-414.

B. Dolan & D. H. Tchrakian:

Conformally invariant models in 2n dimensions. Phys. Lett. 198B (1987), 447-450.

J. Burzlaff, D. Ó Sé, and D. H. Tchrakian:

* A finite-action solution to generalized Yang-Mills-Higgs theory. LMP 13 (1987), 121-125.

J. Burzlaff:

Time-dependent vortices and monopoles. Proc. 15th Internat. Conf. on Differential Geom. Methods in Theor. Phys., Clausthal 1986, ed. H. D. Doebner & J. D. Hennig, World Sci., 1987, p. 118.

T. Garavaglia:

*The Runge-Lenz vector and Einstein perihelion precession. Am. J. Phys. 55 (1987), 164-165.

P. A. Hogan:

An equation satisfied by the tangent to a shear-free geodesic, null congruence. LMP 13 (1987), 283-285.

E. Schruefer, F. W. Hehl, & J. D. McCrea:

* Exterior calculus on the computer:: the REDUCE package EXCALC applied to general relativity and to the Poincare gauge theory. GRG 19 (1987), 197-218.

B. Lenoach:

*Surface wave propagation in a random layered medium. J. Phys. A: Math. Gen. 20 (1987), 2367-2377.

Zhong-Qi Ma & Bo-Wei Xu:

The embedding SO(4) pseudoparticle solutions to the Yang-Mills equations. J. Phys. A: Math. Gen. 20 (1987), L1223-L1227.

A. I. Solomon:

Dynamical Lie algebras. Bull. Irish Math. Soc. 18 (1987), 58.

J. Katriel, M. Rasetti, & A. I. Solomon:

* Generalised Holstein-Primakoff squeezed states for SU(n). Phys. Rev. 35D (1987), 2601-2602.

Squeezed and coherent states of fractional photons. Phys. Rev. 35D (1987), 1248-1254.

J. Katriel, A. I. Solomon, G. d'Ariano, & M. Rasetti:

Multiphoton squeezed states. J. Opt. Soc. Am. B4 (1987), 1728-1736.

Multiboson Holstein-Primakoff squeezed states for SU(2) and SU(1,1). Phys. Rev. 34D (1986), 2332-2338.

A. Montorsi, M. Rasetti, & A. I. Solomon:

Dynamical superalgebra and supersymmetry for a many-fermion system. Phys. Rev. Lett. 59 (1987), 2243-2246.

G. d'Ariano, S. Morosi, M. Rasetti, J. Katriel, & A. I. Solomon:

Squeezing versus photon-number fluctuations. Phys. Rev. 36 D (1987), 2399-2407.

A. I. Solomon & J. L. Birman:

An SU(8) model for the unification of superconductivity, charge, and spin density waves. J. math. Phys. 28 (1987), 1526-1534.

Spectrum generating algebras in condensed matter physics. Spectrum Generating Algebras in Physics, Ed. A. Boehm & Y. Ne'eman, World Sci., 1987.

J. D. McCrea:

*Poincaré gauge theory of gravitation: foundations, exact solutions, and computer algebra. Differential Geometric Methods in Math. Physics, Proc. Salamanca 1985, Eds. P. L. García & A. Pérez-Rendon, Springer LNM 1251, 1987, pp. 222-237.

J. D. McCrea, P. Baekler, & M. Guerses:

A Kerr-like solution of the Poincaré gauge field equations. Nuovo Cim. 99B (1987), 171-177.

J. M. Golden & G. A. C. Graham:

*The transient quasi-static plane viscoelastic moving load problem. Internat. J. Engg. Sci. 25 (1987), 65-84.

*The steady-state plane normal viscoelastic contact problem. Internat. J. Engg. Sci. 25 (1987), 277-291.

In the press:

J. McConnell:

Nuclear magnetic spectral densities for molecular models. Phys. Scripta.

J. T. Lewis:

Probabilistic aspects of statistical mechanics. Math. Cent. Amsterdam.

J. T Lewis & G. A. Raggio:

The equilibrium thermodynamics of a spin-boson model. J. statist. Phys.

W. Cegła, J. T. Lewis & G. Raggio:

The free energy of quantum spin systems and large deviations. Commun. math. Phys.

G. A. Raggio:

A remark on Bell's inequality and decomposable normal states. LMP.

W. Cegła:

The covering property in a causal logic. Proc. Conf. on Quantum Probability & Applications, Rome 1987.

E. E. Mueller:

Bose-Einstein condensation in dependence of the mean energy density. Ann. Phys.

T. C. Dorlas:

Renormalization of a hierarchical ϕ^4_3 model. J. Phys. A: Math. Gen.

Renormalization and the continuum limit. Proc. Mark Kac Seminar, Amsterdam.

A. C. van Enter:

One-dimensional spin-glasses, uniqueness and cluster properties. J. Phys. A: Math. Gen.

L. O'Raifeartaigh & A. Wipf:

WKB properties of the time-dependent Schroedinger system. Found. Phys.

P. A. Horváthy, L. O'Raifeartaigh & J. H. Rawnsley:

Monopole charge instability. Inter. J. mod. Phys. A.

N. Gorman & T. D. Spearman:

Equivalence of stabilizing conditions for inverse problems. Europhys. Lett.

Resonance pole determination in a quantum-mechanical model. Nuovo Cim. A.

B. P. Dolan & D. H. Tchrakian:

New Lagrangians for bosonic m-branes with vanishing cosmological constant. Phys. Lett. B.

G. M. O'Brien & D. H. Tchrakian:

Spin-connection generalized Yang-Mills fields on double-dual generalized Einstein-Cartan backgrounds. J. math. Phys.

J. Burzlaff:

The soliton number of optical soliton bound states for two special families of input pulses. J. Phys. A: Math. Gen.

M. Vandyck:

On the problem of space-time symmetries in the theory of supergravity. GRG.

On the time-evolution of some Robinson-Trautman solutions. Proc. 2nd Hungar. Relativity Workshop, Budapest 1987. Ed. Z. Perjes, World Sci.

J. D. McCrea, E. W. Mielke, & F. W. Hehl:

A remark on the axisymmetric Chen et al. solution of the Poincaré gauge theory. Phys. Lett. A.

J. O'Gorman, P. Phelan, J. McInerney & D. Heffernan:

Nonlinear dynamics of self-pulsing external cavity semiconductor injection lasers. J. Opt. Soc. Am.B.

J. M. Golden & G. A. C. Graham:

The generalized partial correspondence principle in linear viscoelasticity. Q. appl. Math.

J. M. Burns & B. Goldsmith:

On Abelian subgroups of symmetric groups. Bull. Lond. Math. Soc.

B. Goldsmith:

Endomorphism rings of non-separable Abelian p-groups. J. Alg.

12. LIBRARY

Approximately 70 new titles were added to the library stock during the year: approximately 200 current periodicals were taken, of which almost half were received by gift or under exchange arrangements. The RIA 'permanent loan' collection was maintained: other forms of cooperation with research libraries at home and abroad were continued.

Offprints and preprints were received from many scientific institutes and university departments at home and abroad, either directly or in response to requests.

In addition to the regular exchanges and gifts, gifts of books, journals, and other material were received from Professor J. McConnell, Profesor Synge, Dr. Cegła, Dr. J. D. McCrea, Professor Wayman, Irish Meteorological Service, Acad. Rep. Soc. of Roumania, Amsterdam Centrum Wiss. Inform., Hungarian Acad. Sci., ICTP (Trieste), Inst. Nat. Phys. Nucl. (Paris), KEK (Japan), Univ. of Warsaw, and the Zentralbibliothek of the Univ. of Vienna.

A portrait, an oil painting, and archival material consisting of manuscript material, letters, photographs, and other miscellaneous items, were lent to the Science Museum, London, from March to July, for display in an Exhibition there in connection with the Schroedinger Centenary Conference at Imperial College. Archival and other material was shown also to a visiting team from Austrian TV, in connection with a Schroedinger Centenary broadcast from Vienna on 12 August.

IV - Annual Report of the Governing Board of the School of Cosmic Physics for the year ending 31 December 1987 adopted at its Meeting on 16 June 1988.

1. STAFF, SCHOLARS, ETC.

ACADEMIC STAFF:

Senior Professors:

Astronomy Section:

P.A. Wayman (Director of School from 1 October)

Cosmic Ray Section:

L. O'C. Drury

Geophysics Section:

T. Murphy (Director of School to 30 September)

Professors:

A.W.B. Jacob, T. Kiang, A. Thompson.

Assistant Professors:

D. O'Sullivan, T.P. Ray.

Research Assistants:

I. Elliott, P.W. Readman (1 Vacancy)

Experimental Officers:

T. A. Blake, J. Daly, B.D. Jordan

Visiting Scientist:

P. Grimley (1 January - 30 June)

Technical and Clerical Staff:

Astronomy Section:

A.M. Callanan, W. M. Dumpleton, M. Smyth.

Cosmic Ray Section:

G. Broderick, E. Clifton, E. Flood, A. Grace-Casey, S. Ledwidge, H. Sullivan.

Geophysics Section:

K. Bolster, A. Byrne, C. Horan, G. Wallace, V. Ward.

Scholars:

C. Bean, S. Bleszynski, C. Domingo (to 31 July), P. Duffy, C.P. Lowe, B. O'Reilly.

Professors Emeriti:

H.A. Brück, C. O'Ceallaigh.

Research Associates:

P.B. Byrne, M. Hoey, N.P. Murphy, W.E.A. Phillips, R.M. Redfern, P. Shannon.

Vacation Students:

D. Muckian, K. O'Flaherty.

P.J. Callanan (Scholar, Astronomy Section, 1984-86) was awarded the Ph.D. degree at University College, Galway, in October, with a thesis entitled "X-ray and Optical Observations of Galactic X-ray Sources".

L.O'C. Drury, Head of the Cosmic Ray Section, received the Shakti P. Duggal Award at the 20th International Cosmic Ray Conference in Moscow on 3rd August. This award is given for "outstanding work by a young scientist in the field of Cosmic Ray Physics".

T.P. Ray was awarded, for the period April to October, a Fellowship of the Alexander von Humboldt Foundation of W. Germany for work in conjunction with R. Mundt, Heidelberg, on jet phenomena in astrophysics.

The 40th Anniversary of the founding of the School in March 1947 was marked by an informal lunch on 11 June. The guest of honour was Professor E.T.S. Walton, who served on the Governing Board from its inception, holding the office of Chairman from 1952 to 1960.

On December 18 a reception was held at 5 Merrion Square with principal guests Algirdas J. Rimas, First Secretary, US Embassy, and Alexander Elezov, Counsellor, Soviet Embassy. A display indicating instrumental work of the Cosmic Ray Section using US, European, and USSR scientific satellites was presented.

2. RESEARCH WORK (Astronomy and Cosmic Rays)

2.1. Instrument Science

2.1.1. Solar Low-Energy Detector (B. D. Jordan, A. Thompson, D. O'Sullivan, and S. Bleszynski, with S. McKenna-Lawlor, SPCM)

The second flight model, part of the ESTER instrument package being prepared for launch in 1988 on the USSR PHOBOS Mission to Mars, in conjunction with the Max Planck Institut für Aeronomie, Lindau, FRG, was completed in February and both flight models (FM-1 and FM-2) underwent thermal-vacuum testing at Lindau and, in due course, vibration tests at ESTEC when integrated with ESTER. There were some problems with voltage failure at -35° C and others due to high levels of noise when the particle sensors were connected for the first time. These problems were gradually overcome during the remainder of the year. It was necessary to design and build new check-out equipment, providing a continuous record of SLED power consumption. Also, further check-out equipment was constructed to provide for continuous operation during vacuum testing and to act as 'common user' equipment in Lindau, Budapest and Moscow. The equipment was based on the INTEL 8052 BASIC microprocessor. Suitable interactive software was written and the equipment was finished within twelve weeks, greatly facilitating subsequent operation of the flight models.

The test programmes included ESTER tests in Budapest in April, spacecraft integration tests in Moscow in June, and further tests in Budapest in July. Full thermal-vacuum and vibration tests were completed by the end of the year and both flight models were stored at Lindau pending final thermal design of the mountings. During the year the Soviet Space Agency made a formal commitment to include the second SLED instrument, FM-2, in the payload of the spacecraft Phobos-2. It has become necessary for a third flight model, FM-3, to act as flight spare, and many component items have been obtained for assembly early in 1988.

2.1.2. 'Transputer' equipment for Image-Enhancement. (R.M. Redfern, UCG, I. Elliott, B.D. Jordan)

The University College, Galway, prototype system for image enhancement, has been used by R. M. Redfern for test purposes on a 0.50-m telescope at Izana, Tenerife, in a joint project with the Spanish International Astrophysical Observatory of the Canary Islands. A similar development system has been installed at Dunsink and connected, by a specially-designed interface, to the CAMAC-based measuring equipment built in 1980. This was overhauled and the high-speed video digitizer adapted to generate video data from a photographic plate for input to the Transputer as simulated real-time data.

A number of test programmes were written in Occam with a view to establishing parallel processing when the final design, using about 10 Transputers, is constructed. In evaluating the performance of the T414 Transputer, benchmark tests show that the Fortran 77 compiler is efficient, giving execution speeds up to 90% of those provided by the transputer programming language, Occam. Floating point calculations on a single T414 were found to be comparable to those of a PDP11/55 with RSX. The T8 series floating-point transputer available soon can be expected to give an improvement by a factor of eight, giving considerable computing power for real-time image-assessment at the telescope at modest cost.

Tests of the graphics display have shown that GW Basic graphics is too slow at high resolution and transputer-based graphics are under consideration.

2.1.3. Nuclear Track Detector Response Studies (A. Thompson, D. O'Sullivan, J. Daly, C. Domingo, with University of Barcelona).

Investigation of the track response of polymers to energetic heavy nuclei continued, particularly in respect of the effect of time and temperature history of stored latent tracks after registration. This work is in preparation for interpreting the data from the Ultra Heavy Cosmic Ray Experiment of the LDEF mission, 1984 - 1989. Detector etching, track measurement and data analysis from the ultra heavy ion exposures made in 1986 were largely completed.

During February a set of solid state nuclear track detector (SSNTD) stacks (polycarbonates and polyester) was constructed and in March these stacks were exposed to 930 MeV/N beams of uranium nuclei at the Bevalac accelerator in Berkeley, California. The primary objective was to study short-term ($\lesssim$ 30 days) latent track intensification and to carry out the second phase of a re-exposure programme. Experimental work resulting from the March exposures was on schedule at the end of the year and is planned to continue throughout 1988.

It has been found, with regard to latent track intensification, that the results of these tests are inconsistent with a strong dependence of signal strength on long-term ($>$ 100 days) storage of latent tracks, at temperatures between -70° C and +40° C, over the storage times available. This is in disagreement with the dependence reported elsewhere (Univ. of California).

In collaboration with the Barcelona group, joint exposure of SSNTD stacks to near-relativistic uranium beams at the Berkeley Bevalac were carried out and investigation of the exposed material has begun. This work is directed towards latent track behaviour under the condition of long-term exposure (of the order of years) in earth orbit.

2.2. Solar System and Heliosphere

2.2.1 Energetic Particle Analyser Experiment (D. O Sullivan A. Thompson, with S. McKenna-Lawlor, SPCM, and MPAe and ESTEC).

With the participation of the Max-Planck Institut für Aeronomie, Lindau, (E. Kirsch and P. Daly) and the Space Science Department of ESTEC, (K.-P. Wenzel), analysis of data from the Irish-German experiment EPA on board the Giotto spacecraft mission to Comet Halley in 1985/86 was continued. Field-line merging on the sunward side of the compressed magnetic field could be responsible for the high-energy particles detected near closest encounter with the comet; Fermi acceleration is also probable. The energetic particles at the Halley bow-shock were studied on both the inbound and outbound sections of the spacecraft trajectory.

An investigation of the energy spectra of pick-up ions observed upstream from the bow-shock, at the bow-shock, and downstream from it, was undertaken in collaboration with the Mullard Space Science Laboratory group responsible for the Implanted Ion Sensor (IMS) on Giotto. Combined EPA and IMS data, covering the energy range 2 - 280 KeV, were compared with theoretical spectra by Ip and Axford. It was found that second-order Fermi acceleration and adiabatic compression provided a reasonable model for the observations at the bowshock and downstream from it: study of the upstream region is continuing.

In March the Giotto Science Working Team agreed that there would be an extension to the Giotto Mission based on Comet P/ Grigg-Skjellerup, with re-activation of the spacecraft in November 1989, earth swing-by on 2 July 1990 and encounter with the comet on 10 July 1992.

2.2.2. Neutral Particles in the Heliosphere (S. Bleszynski)

In carrying out further thesis work on the topic 'Calculations of Neutral Particles in the Heliosphere', a theoretical model has been constructed of distant planetary exospheres. Formulae have been obtained that give the density expected at large distances from planets in the presence of a radiation drag force acting upon exospheric atoms with the ionization and charge-exchange losses included in the analysis. The method is based on a power-series expansion of expressions occurring in the Hamiltonian equations of motion, written in parabolic co-ordinates. Analytic integrals for terms to the first order give the equations of trajectories and these are

used with an equation of mass conservation to derive the densities. The REDUCE algebraic programming package has been used for this work.

2.2.3. Asteroid Dynamics (T. Kiang)

The long-standing question of the origin of the Kirkwood Gaps in the frequency distribution of asteroid semi-major axes has been approached by applying computer representation of dynamics in two dimensions to the motion within resonance orbits (e.g. 2:1 resonance with Jupiter), following the integration over one libration period. For 'medium-period' periodic orbits one libration period in the critical argument for the 2:1 resonance is about 400 years. Means have been explored to evaluate correctly the characteristic behaviour of such orbits and in order to do this computational accuracy to many significant figures has to be maintained. The existence of a Kirkwood Gap will be demonstrated by the finding of real exponents that correspond to a growth-time appropriate to the asteroid system, of the order of 100 million years.

2.2.4 Proposed Space Project (L. O'C. Drury, A. Thompson)

After discussion with other interested parties, participation of the Cosmic Ray Section in a proposal for an X-ray Imager (XI) on the forthcoming ESA cornerstone mission SOHO, the Solar Heliospheric Observatory, has been agreed. SOHO, together with the four-spacecraft magnetospheric mission CLUSTER, is the first priority in 'Horizon 2000', the ESA plan for the future of European Space Physics. If XI is selected, the Section will be responsible for providing part of the software and hardware needed for testing the experiment.

2.3 Stellar Astronomy and Clusters

2.3.1. X-ray Binary Source in M15 (R. M. Redfern, UCC)

Using the La Palma Jacobus Kapteyn and Isaac Newton Telescopes observations with simultaneous 3-colour CCD photometry and spectroscopy of the identified optical object corresponding to the X-ray binary source in the globular cluster M15 were made on four nights in August. Good weather was present each night but some mechanical difficulties with the JKT (1-m telescope) prevented the best results being obtained. Also, the activity of the source, as shown spectroscopically, was unexpectedly low during the period of observation.

2.3.2. Jets from Young Stars (T.P. Ray, with MPIA)

Work in conjunction with R. Mundt and T. Buhrke of the Max Planck Institut für Astronomie, Heidelberg, on jets associated with young stellar objects (YSO's) and Herbig-Haro (HH) objects has continued. During the year a large data base of images and spectra was obtained using the 2.2-m telescope of the European Southern Observatory, Chile, for 3 weeks, the 2.5-m Isaac Newton telescope, La Palma, for 4 days, and the 3.5-m German telescope at Calar Alto, Spain, for two weeks. Most of the CCD data (Calar Alto) and the ESO spectroscopic data have been reduced.

It has been found that the jet associated with HH 34 contains at least 13 knots quasi-periodically spaced. The jet itself has been resolved transversely with 0.7-arcsecond resolution and an interpretation on the basis of the Kelvin-Helmoltz (wind over water) instability occurring between the jet and the surrounding medium is being examined. The theory attempts to show how oblique shocks form within the jet and why it emits light.

At the front of the jet a bow-shock type HH object can form in the surrounding medium. Using images from different spectral lines, it was found that high excitation is confined to the apex of the bow-shocks while at lower excitation there are extended wings to the HH objects. Clumpiness in the emission has been examined and in HH34, probably due to post-shock cooling, the clumps are displaced with different emission-line filtering. A counter-bow-shock has been discovered near HH 34, proving the bipolar nature of this system.

2.3.3. Stellar Photometry of Ap Stars (I. Elliott)

Service observations were obtained with the CCD camera of the Jacobus Kapteyn telescope in June to test the feasibility of searching for short-period Ap stars. Sequences of repeated exposures and trailed exposures are being compared. The material has not yet been fully reduced.

2.3.4 Photometry of Binary Stars (P. A. Wayman, with IOA, Cambridge)

In a joint programme for the Hipparcos Astrometric Satellite project with A. N. Argue, Institute of Astronomy, Cambridge, and others, accurately measured separations, position angles and V, R. magnitudes for binary stars in the range of separations 0.5 to 5.0 arcseconds have been obtained with the CCD camera of the Jacobus Kapteyn telescope on La Palma,

plus some of wider separation, in order to permit these stars to be used accurately in the astrometric work of the satellite. Much of the programme required was completed during a week of exceptional weather in January when the telescope and the CCD camera performed well and over 800 measurements were secured.

Reduction work at Cambridge, following routines prepared by M. Irwin,IOA, have shown that good data down to separations equal to one half the seeing-spread, normally 1 to 1.5 arcseconds, can be secured. Thus, under good conditions separations down to 0.5 arcseconds can be dealt with. 2056 binaries out of a total proposed of 3800 have been observed and 1366 have been reduced to date. Accuracies of 0.02 magnitude are obtained for magnitude-difference over most of the range, and separation accuracy of about 0.01 arcseconds, unless the magnitude-difference is greater that 2 magnitudes. These are data of good quality and unsurpassed observing efficiency, made possible by use of the CCD camera on the 1-m telescope on La Palma, which is a site of exceptionally good 'seeing'.

2.4. Interstellar Material

2.4.1 Supernova Remnants (L. O'C. Drury, with MPIK)

In continuing collaboration with H. J. Volk and W. Markiewicz (Max Planck Institut für Kernphysik, Heidelberg) simplified models for the dynamical evolution of supernova remants incorporating reaction effects from particle acceleration were studied. The results were not entirely satisfactory as the models exhibit a wide variety of effects and it is not always easy to distinguish between inherent problems of the physics and artificial problems introduced by the approximations that are necessarily used. However, the intrinsic richness of the problem is fascinating and the collaboration will be continued.

2.4.4. Shock Acceleration Theory (L. O'C. Drury, P. Duffy)

A new development in diffusive shock acceleration theory during the year was the publication by Kirk and Schneider of an analysis at the pitch angle level. With A. Heavens (Edinburgh), the analysis has been repeated using a different technique and more realistic pitch angle diffusion coefficients.

While of interest in itself, this approach is of importance for relativistic shocks such as are thought to occur in radio sources. Here the particle distributions can be very anisotropic and a treatment at the pitch angle level is necessary.

In a study of acceleration mechanisms for energetic particles in typical astrophysical surroundings, attention was paid to the way in which turbulent electromagnetic fields, mostly in the form of Alfvén waves, affect the evolution of the energetic particle spectrum. Previous results invoked momentum-space diffusion alone, while working to the first order in the small parameters. By employing the Fokker-Planck formalism it can be shown that in certain model systems the momentum-space diffusion description is incomplete. The general case of plasma turbulence was re-examined to find the form of the momentum changes to second order. It was found that no systematic terms occurred and the higher order corrections to the momentum-space diffusion coefficient were obtained. The study shed light on the relationship between the two main methods used in the analysis of stochastic acceleration - the Fokker-Planck formalism and the quasi-linear theory. This was achieved by examining the necessary and sufficient conditions in both approaches for particular forms of the transport equation.

2.4.3. ISOPHOT experiment on ISO (L. O'C. Drury, with ESA)

The ISOPHOT instrument is a photopolarimeter selected by the European Space Agency for incorporation in an astronomical satellite observatory called the Infrared Space Observatory (ISO), mounting a cryogenically-cooled infrared telescope with 600 mm aperture. Launch by Ariane-4 is planned for 1993. Planning for software for the ground segment continued during the year and the software group met in Dublin in March. Under discussion is the proposal that the School undertake, with the Danish Space Research Institute, the analysis of data from the far-infrared detectors (200 microns) during the so-called serendipity mode.

2.5. Galaxies and Cosmology

2.5.1. Observation of blue compact galaxies (P. Grimley)

One night of Service time with the imaging interferometer 'Taurus' on the Isaac Newton telescope on La Palma was scheduled for observation of two of the blue compact galaxies for which CCD images were previously obtained. Good data were obtained for Markarian 297. With narrow bandwidth imaging over a limited wavelength range, an emission-line object gives information about the whole velocity structure, revealing such phenomena as the interaction or merging of two galaxies. At the end of the year, the data were not fully reduced but it is evident that a chaotic velocity field has been revealed in this instance, leading to possible interpretation of the CCD images.

2.5.2. Superluminal Velocities (T. Kiang, with Hefei, China)

The investigation of 'superluminal' motion around a rotating black hole was continued. All the limiting formulae have been derived, including the physically most interesting case of matter ejected along the axis of rotation. It was found that there, and for a given latitude and radial distance from the centre of the black hole, only photons with a particular range in longitude can reach the observer at infinity; the face of the black hole is not round but lop-sided to varying degrees, depending on the latitude of the observer. This account clarifies somewhat the relativistic picture of the origin of superluminal velocities in the vicinity of a rotating black hole. A paper, jointly with S.P. Xiang and J.L. Zhang of Hefei, China, has been accepted for publication.

2.5.3. The Ultra-Heavy Cosmic Ray Experiment - LDEF Mission (A. Thompson, D. O'Sullivan, J. Daly, C. Domingo, with ESTEC)

In conjunction with V. Domingo and K.-P Wentzel of ESTEC (ESA) the UHCRE experiment launched in 1984 aboard the Long Duration Exposure Facility vehicle is currently expected to be retrieved in the period July-November 1989. On this basis, it is expected that about 1000 cosmic ray nuclei with $Z > 65$ will be recorded, including about 600 in the region $74 < Z < 87$ and $13 \sqrt{7}$ actinides. Due to the unplanned extension of the mission, following the NASA Shuttle disaster of January 1986, the number of recorded events will be increased greatly. An account of the extended experiment was presented at the Moscow International Cosmic Ray Conference during August, including discussion of the current programme for optimising the charge resolution of the expected UHCRE data, with special reference to signal strength variation with

latent track storage time in orbit. Results to date suggest that the advantage of increased sample size can be almost completely realized in spite of the increased range of storage times.

Higher than normal levels of the rising solar activity have significantly changed the projected LDEF orbit-decay characteristics. The deadline for successful retrieval is now June 1990, with nominal re-entry in November 1990. A new Shuttle manifest is planned for March 1988.

3 RESEARCH WORK (Geophysics)

3.1. Gravity Surveys

3.1.1. Fieldwork in Irish Counties (T. Murphy)

Fieldwork was continued in Counties Carlow, Kilkenny and Wicklow in order to complete the area of Sheet 19 of the 1 : 126720 scale map. After processing the data, the Bouguer anomaly contours were drawn and prepared for publication. The gravity data of Sheet 16 of the series were assessed and the analysis, together with the contoured map, was published. The gravity contouring of Sheet 13 was carried out and the results printed. Since the analysis was not complete, publication was postponed.

3.1.2. Marine Gravity and Magnetic Survey (P.W. Readman, G. A. Wallace, K. Bolster with Hamburg University)

The Hibernian Offshore Gravity Survey (HOGS) was carried out between 17 October and 11 November, as a joint project with the Geological Survey of Ireland (R. Keary) and the Geophysics Institute of the University of Hamburg, operating the German vessel, R. S. 'Valdivia'.

The results of COOLE in 1985/86 indicated the possible existence of a sedimentary basin between the Irish mainland and the Porcupine/Slyne Trough. In order to provide information for seismic surveys, this project was designed to explore the offshore geological structure up to latitude 55° .

During the survey 66 profiles covering 6000 km were completed. Good weather favoured the completion of several long east-west lines, following particular anomalies and a profile along a proposed future seismic line was completed. Considerable effort was devoted to the recording of the navigational data (Loran-C, GPS satellite, gyrocompass recording, Decca navigator, Transit satellite). Microcomputer diskettes and 1/2-inch magnetic tape were used for these records. Analysis of the data has begun and a preliminary gravity anomaly map produced.

3.2. Meteorology (K. Bolster)

The anemometer mast and part of the superstructure above 5 Merrion Square, were deemed to be becoming unsafe and were dismantled in June. Wind records with the Dines Anemometer have been discontinued but Cup Anemometer records continue. Routine meteorological observations were continued throughout the year, autographic records tabulated and the results published.

The 35-year normals for temperature, rainfall and sunshine were published in the Bulletin Series.

To reduce the amount of work associated with meteorological records, experiments were conducted to record certain of the elements for storage in digital form on diskettes. Results were encouraging.

3.3. Seismic Work

3.3.1. The Seismic Network (A.W.B. Jacob)

Limited progress was made with the Seismic Network during the year. Processing of data has continued and, with a FAX machine now available, communication with other networks has been improved. Small earthquakes can cause major damage in areas where major seismic activity is rare and the European research programmes are intended to counter this problem. The event of July 1984, felt widely in Ireland, indicates that significant stresses still exist and there is recent geological evidence for large earthquakes (> magnitude 6) in Scotland within the last ten millennia. No events were detected in Ireland in 1987, except for the continuing aftershock sequence from the July 1984 Irish Sea event.

3.3.2 Celtic Onshore-Offshore Lithospheric Experiment - COOLE, Line 1 (C. P. Lowe)

Work on a profile between Ardmore, Co. Waterford, and Donegal Bay was completed. The aim of this work was to establish a crustal cross-section which would be pertinent to future tectonic studies in Ireland. One-dimensional and later two-dimensional inversion techniques were used to model travel times of observed P-waves. Also, relative amplitudes of seismic phases were modelled. The final model presented for COOLE I identifies a buried granite towards the southern end of the line and a broad deformation zone, in the middle and lower crust, associated with the Iapetus Suture. The crustal thickness was found to be approximately 30 km, in good agreement with that found in the previous ICSSP profile and also with measurements in Britain. The base is defined by the Moho transition zone, about 2 km thick, shallowing slightly towards the coasts and over a part of the Midlands.

3.3.3 Celtic Onshore-Offshore Lithospheric Experiment - Porcupine Seabight (A.W.B. Jacob, with Hamburg)

Seismic investigation along a line running SW from Dursey Is. (West Cork) through the Porcupine Seabight was substantially completed in a joint project with R. Egloff of the University of Hamburg.

The Porcupine Seabight contains the largest of the Irish sedimentary basins. It is surrounded by continental crustal structures comprising the Porcupine Ridge, the Irish Mainland Shelf, and the Goban Spur. In the present work, the nature of the crust is demonstrated unequivocally to be 'continental' below the southern Seabight out to water depths of 4000 m. with a rifted margin of the basin on the eastern side. Crustal thickness (including 6 km sediment) decreases from 23 km in the east to about 10 km at a sharp continent/ ocean transition in the west.

These results have been compared with recent work on the continental margin east of Newfoundland.

3.3.4 COOLE - North Celtic Sea Lines (B. O'Reilly, with Hamburg)

A third area of work in 1987 was of three profiles in the North Celtic Sea; the investigation being done jointly with U. Vogt (University of Hamburg) was to investigate the role played by crustal and lithospheric deformation during

the Mesozoic and Genozoic periods in determining the structure of this basin. Among the results to date is that isostatic compensation operates with the depth to the base of the crust varying antipathetically with the sedimentary thickness. Work continues on this project and the aim is to incorporate gravity and seismic reflection data into the final model.

3.3.5 Lower Lithospheric Studies (A. W. B. Jacob, C. Bean)

The results of seismic work on a lithospheric line running from Youghal to Dundalk, using North Sea explosions in September, allowed interpretation of velocity variations with depth as being due to anisotropy in the lower lithosphere. These velocity variations were measured on two orthogonal profiles and contain information about crystalline alignment between 30 and 100 km depth. This, in turn, is linked to directions of stress in the lower lithosphere.

3.3.6 Seismic Project in Kenya - KRISP 89 (A.W.B. Jacob)

An invitation to take part in British, German and US geophysical work in Kenya has been received, based on the experience in the School in development of underwater seismic explosions and from the development in Ireland of compact and light seismic recorders suitable for use in remote areas. The important work of the Kenya Rift International Seismic Project 1989 is concerned with improving the understanding of continental rifts, with the East African Rift System as the best example. No satisfactory seismic experiment has yet been carried out there because it is a difficult terrain, and so the Irish seismic methods may prove to be an essential element to success. In January/ February 1989 some work will be started and a preliminary visit in September, by a group that included B. Jacob, had the three aims (a) to find suitable shot points, (b) to investigate the available roads and tracks along the profiles, and (c) to draw up a provisional plan for 1989. In 15 days the group travelled 4000 km in 4-wheel drive vehicles, including altitudes up to 3000 m., temperatures up to 110 F, and on many near-impossible roads. Good sites were found at Lake Turkana, Lake Baringo, a small lake near Lake Naivasha,

a lake south of Eldoret, and Lake Victoria.

It is proposed to provide 140 compact automatic stations of which 20 will be supplied from Ireland and the remainder from the US Geological Survey. A trial experiment for KRISP, with full participation from the different countries, was arranged to take place in the Shannon Estuary in November: five shots in two days were made and a preliminary assessment indicates that the trial was successful.

3.3.7 Iberian Project, ILIHA, 1989 (A.W.B. Jacob)

An application was made to the EEC Stimulation Programme, jointly with Spanish and Portuguese organisations, to carry out an experiment 'Iberian Lithosphere Heterogeneity and Anisotropy' on a large scale, the preliminary contract with DIAS being signed in December 1986. The project was not fully funded in 1987, but a revised plan was drawn up in Madrid in June. B. Jacob presented preliminary results of work done in the neighbourhood of Britain and Ireland, in the expectation that the ILIHA programme, taking place in 1989, will use similar methods under a different tectonic environment.

3.3.8 European Geotraverse, EGT (A.W.B. Jacob, C. Horan, T.A. Blake)

Demultiplexing and re-sampling of the data of the European Traverse, obtained in 1985/86, continued through the year. 250 MB working disc space was required, using the Eclipse S130 computer. The resulting digital tapes were joined at Karlsruhe with data from other sources. Further stages of processing were subsequently carried out in order to clear the large amount of data for use in Zurich.
A preliminary report on the experiment was made at the Strasbourg meeting of the European Union of Geosciences in April.

3.4. Theoretical and Modelling Techniques

3.4.1 Geotwin (A.W.B. Jacob, C. Bean, B. O'Reilly with Karlsruhe)

Continuing an EEC Stimulation Programme Contract with the University of Karlsruhe (GEOK), to develop seismic inversion techniques, several reciprocal visits were made during the year. Data transfer, plotting, computer programming

and modelling, and the use of ATARI computers were subjects of discussion. Interest is now focussed on the development of more sophisticated polarization filters to be included in a final program package.

In the area of signal enhancement, techniques developed in 1986 have been used on real data and some have been further developed. The stacking program by B. Jacob has been used on COOLE I data, with a particular target being the ill-defined PMP phases. Definition of the gradient zone varies with region: its upper depth limit is well defined by the stacking but the lower levels present difficulties. At GEOK, R. Stangl has used the ray-tracing programs to produce static corrections with respect to a reference crust. This promises to be a more useful and practical approach than using the 2-dimensional trial structures to control the stacking.

3.4.2 Modelling, COOLE I (A.W.B. Jacob and C.P. Lowe)

Various enhancement techniques were used on the data of COOLE I (3.3.2) and sections with a variety of different frequency filters were produced. 3-component records enabled seismograms from which most of the S-wave energy had been removed to be constructed. When the phases were identified, the 1-dimensional interpretation program on the computer was modified to be more interactive and able to plot the velocity depth function, leading to the ray-tracing stage.

3.4.3. Crustal S-wave Studies

Several studies of S-phases are in progress. A. Ruthardt (Karlsruhe) is working on data sets from the ICSSP project (Ireland) and the Demara project (SW Africa). A comparison is being made of different filtering methods, particularly the time domain filter in use in Dublin and the Rectilinear Motion Detector of GEOK. Synthetic and real data sets are being used for the comparison and the Dublin method appears to be very effective.

3.4.4. ICSSP Lower Lithosphere (C. Bean, B. Jacob, T. Blake)

The data of ICSSP are being interpreted now taking into account the amplitude information. There is close agreement with the structure observed by LISPB (Lithospheric Structure of the Porcupine Bank). Differences between the German and the Scottish/Irish anisotropies immediately below the Moho are being identified.

Speculative work, potentially of great value, in looking for coda patterns generated by lower lithospheric reflectors,has begun. R. Kind (Karlsruhe) is using German data similarly for comparison. In a visit to Ireland in August he found some evidence in earthquake data for reflections from deep horizons in the crust of North Wales. More data are being prepared relevant to the problem.

3.5. Palaeomagnetism

3.5.1. Danish Studies (P.W. Readman, with N. Abrahamsen, Aarhus)

Secular variation patterns of palaeomagnetic data from Skanderborg Soe, Denmark, have been compared with UK patterns. Dating uncertainties have been investigated. The direction of motion of the virtual geomagnetic pole position during the last 9000 y has been mainly 'clockwise' except for a period of about 1400 y, implying a predominantly westward drift of the earth's magnetic field over this period.

3.5.2. Lough Doo (P.W. Readman, with M.O'Connell, UCG)

Results from Lough Doo, Co. Mayo, indicate age discrepancies from UK data, similar to those of the Danish sediments. Lough Doo has sediments with low carbonate content making them suitable for radiocarbon dating. The work indicates the need for more determinations of palaeomagnetic variation from well-dated sediments.

4. WORKSHOPS (J. Daly, B.D. Jordan, G.A. Wallace, W.M. Dumpleton)

4.1. Mechanical Workshops

4.1.1. The South Telescope

A start was made in June on the dismantling and thorough overhaul of the 12-inch South Telescope at Dunsink Observatory. All parts were removed from the base casting, including the two main axes, and the subsidiary parts prepared for renovation. The paintwork accumulated over 120 years was stripped from the tube, the axes and the base casting, and a start made on the re-finishing and lacquering of the brasswork of the telescope. As far as is known, this is the first time the telescope has been dismantled since it was erected in 1868.

4.1.2 Subsidiary Instruments

During the process of tidying the storage areas at Dunsink Observatory several old instruments have been taken into observatory workshop for renovation as potential exhibition items. The following were completed during the year:

Fraunhofer and Utzschneider 3-inch refractor on tripod (c.1810)
One of two Grubb Transit Circle Chronographs (1885)
Chronograph Clock Drive by Grubb (1885)
Pistor and Martins Collimating Telescope (1874)
Troughton and Simms 16-cm plate measuring machine (c.1895)
Troughton and Simms 9-cm dual plate measuring machine (c.1895)
Grubb 8-inch Coelostat (c. 1905)
Telescope Clock Drive for Roberts Telescope by Grubb (1895)

Note:- The coelostat, or one like it, originally the property of the Royal Irish Academy, was used in the Greenwich Observatory Eclipse Expedition of 1919 to Sobral, Brazil, where, in conjunction with a 20-foot lens also owned by the Academy (on loan at the time to Stonyhurst College Observatory), it was used to provide most of the 'weight' in determining the deflection of light at the solar limb for testing the General Theory of Relativity.

4.2. Electronics Workshops.

4.2.1 SLED Instruments

The digital circuits for the Solar Low Energy Detectors (2.1.1) were finished during the year and tests carried out in accordance with the procedures required for the USSR project Phobos. Test Equipment for the SLED circuitry was built at Dunsink during the year and the observatory workshop was used during the year to provide purpose-made mountings and cases for that equipment. A description of the design of the SLED circuits was published.

4.2.2. Computer Terminals

Along with other new provisions, a Tandon PC-AT system with 20 MB hard disk drive and 60 MB tape cartridge drive was purchased for use with a 32-bit T414 Transputer (using 2 MB of dynamic RAM) mounted on a board that is located inside the Tandon PC.

4.2.3. Geophysics Instruments

Maintenance work on the fixed seismic networks increased as the equipment is ageing. The 20 mobile stations were used in a major experiment in September and a smaller one in November.

Further development of the mobile stations was begun, including the incorporation of a crystal clock to allow equipment to be used in areas where reception of radio time signals is poor. Prototype 3-component recorders are under consideration, requiring suitable 4-track cassette recorders.

A method was developed to transfer the navigational data collected on R.S. Valdivia to the in-house computer. This was done through the medium of Hewlett-Packard formatting, involving hardware and software development that can now be used in future projects.

4.3. Buildings and Grounds

Re-wiring of the School premises at 5 Merrion Square, alterations to the ironwork giving access to meteorological instruments at roof level, and other minor modifications to accommodation were made during the year.

At Dunsink Observatory, several tons of overburden were removed from the cobblestone surface of the yard, and the main building and lodge were repainted externally.

The use of the area adjacent to the Dunsink Observatory grounds by the Dublin Corporation as a refuse tip area gives increasing cause for concern as making a serious deterioration in the amenities of the immediate surroundings. The final ground level of the tip area will now, evidently, be higher than the observatory ground.

5. COMPUTER INSTALLATIONS (T.A. Blake. I. Elliott)

5.1. Dunsink Observatory

The VAX 11/780 at UCD Computer Centre continued to provide access to Starlink programs and to networks such as HEANET and JANET. During the year it became possible to access BITNET directly and useful contacts were made with the Very Large Array (VLA) headquarters in Socorro, New Mexico, and with the Space Telescope Science Institute in Baltimore, Maryland. The data link to UCD was more reliable than in former years.

5.2. 5 Merrion Square

Following the setting up of a Computer Coordinating Committee for the Institute, a review was made of the installation at 5 Merrion Square of the Eclipse S130 and the Data General MV2000.DC with 6 MB memory installed in 1986. The Systems Industries 470MB disk storage unit was 70% filled by the end of the year, containing a large body of software for the Geophysics and Cosmic Ray Sections. Some alterations to the system, including phasing out of the S130, are being planned for the immediate future.

Several Atari ST microcomputers were purchased during the year. Among other programs, the algebraic language REDUCE and the scientific typesetting language TeX have been used. An emulator was written so that the Ataris can be used as Data General terminals.

An Atari microcomputer has been purchased to replace the Digico computer which controls the spinner magnetometer for rock magnetism studies. An 'XT-clone' was purchased to allow MS-DOS diskettes and programs to be used.

6 HISTORICAL ASTRONOMY

6.1 W.H.S. Monck (I Elliott)

An index of the complete papers of W.H.S. Monck was compiled in order to assess his total contribution to astronomy at the end of the 19th Century. Arrangements were made for the erection of a commemorative plaque to Monck at 16 Earlsfort Terrace, where the first electrical measurements of starlight were carried out in 1892. In conjunction with a meeting of the Astronomical Science Group of Ireland, an unveiling ceremony was performed by Mr. Gerard Brady, T.D., on 6th April.

6.2. Dunsink Observatory, 1785 - 1985 (P.A. Wayman)

Publication of the Bicentennial History of Dunsink Observatory was marked by a launching of the book on the publication date of 22nd October at the premises of the Royal Dublin Society. The book is published jointly by the Institute and the Society in the RDS series on the History of Science and Technology in Ireland. It provides chapters on each decade in the history of the observatory and describes the activities of the principal scientists and others concerned in its history. It deals in a semi-popular way with the scientific activities and attempts to analyse some poorly-understood items for the first time. It gives an outline of the private circumstances of each of the successive directors without duplicating other published accounts (e.g. W.R. Hamilton R.S. Ball). The same material has been the subject of talks, history seminars, etc. during the year.

6.3. The Astrographic Telescopes by H. Grubb (P.A. Wayman)

Material relevant to the lenses and telescopes made by Howard Grubb in Rathmines following the definition of the requirements for systematic stellar photography by the Paris Astrographic Congress of 1887 has been collected and examined. An account was presented at the Centennial Paris Colloquium in June.

6.4. Megalithic Astronomy, Newgrange (T.P. Ray)

With the co-operation of the Office of Public Works (OPW) work has been done to test the statistical importance of the well-known alignment of the roof-box at the entrance to the Newgrange megalithic tomb with the direction of the rising sun at the Winter Solstice (December 20-23). The site is older than the Pyramids of Egypt and is now known to pre-date Stonehenge. The question was addressed as to whether measurement of the penetration achieved by the Sun's rays at the relevant times would, taking into account variation in the orbit of the Earth over 4500 years, indicate how accurately the alignment was made. As well as carrying out a survey of the entrance site, a photographic record of the illuminated patches within the tomb was attempted over several days and a particularly successful record was obtained on December 21 in the presence of Mr. C.J. Haughey, the Taoiseach.

7 LA PALMA OBSERVATORY

7.1 General

The Governing Board continued its responsibility for Irish participation in the Spanish International Astrophysical Observatory of the Canary Islands at the Observatorio del Roque de los Muchachos on the island of La Palma. It received the advice of the Advisory Committee, as in previous years. The Advisory Committee met twice and was represented at meetings of the UK Panel for Allocation of Telescope Time held in January and July. Information Sheets No. 15 & 16 were distributed in March and September respectively.

The outstanding achievement on La Palma during the year was the completion by the contractors and the RGO telescope commissioning team of the 4.2-m William Herschel Telescope and its initial tests by instrument commissioning teams and others. The first results of instrumental and site quality are very promising and use of the telescope for work initiated from Ireland is likely during 1988 (see 2.1.2 above).

7.2 La Palma visits, 1987

Visits for observing work on La Palma were made as follows, with reference given to relevant sections:

P.A. Wayman, 7 - 14 January, (2.3.4); 8-9 December (see below)
I. Elliott 16 - 19 March (see below)
T.P. Ray 5 - 8 August (2.3.2)
R.M. Redfern and P.J. Callanan 15 - 18 August (2.3.1)

In addition, several nights were allocated on the Isaac Newton Telescope and on the Jacobus Kapteyn Telescope for Service Observing on specific programmes (2.3.3, 2.5.1). For use of the echelle spectrograph, visits by I. Elliott in March and by P.A. Wayman in December were both made unsuccessful by unfavourable weather. At the end of the year, the spectrograph, from Queen's University, Belfast, was returned to Belfast for modification by Armagh Observatory, with participating interest from the Astronomy Section.

7.3 Image Sharpening (R.M. Redfern, N. Devaney, UCG)

R.M. Redfern is spending the academic year 1987-88 as Visiting Professor in the Instrumentation Section of the Instituto de Astrofisica de Canarias (Tenerife), working in close collaboration with the La Palma Observatory, with particular reference to the GHRIL (Ground-based High-Resolution Imaging Laboratory) on the 4.2-m William Herschel Telescope. The project is to produce sharper images with the assistance of real-time image processing. An instrument using an Imaging Photon Counting Detector (IPD) and up to 10 Transputers will be used to assess image quality and to integrate from selected centred frames. By the end of the year, laboratory tests were done and some limited tests on a small telescope (0.5-m) on Izana were sufficiently promising to enable plans to be made for demonstrations of the system on the William Herschel Telescope (with the GHRIL) in April 1988.

P.O'Kane (UCG) visited Tenerife in December to assist with development.

7.4 Support Astronomer on La Palma

The first Support Astronomer visit from Ireland was arranged for a period of two weeks in December when R.M. Redfern spent two weeks on La Palma in this capacity on the Jacobus Kapteyn Telescope during, unfortunately, an extended period of unfavourable weather.

8 SEMINARS, COLLOQUIA, LECTURES

8.1. Statutory Public Lecture

The Statutory Public Lecture of the School was given on May 13 in University College, Dublin, by Professor L.O'C. Drury with the title "Cosmic Rays: Old Problems, New Ideas" It was also presented as a farewell symposium in Heidelberg on July 2.

8.2. Seminars in the School

The following seminars were presented on Institute premises during the year:

February 9	Xiang Shou-ping (Hefei and Bonn), "Cosmic Strings and Galaxy Formation"
March 3	T.P. Ray, "Jets from Young Stars"
June 9	P.L. Grimley, "Galaxy Interactions"
November 3	G. Ranalli (Ottawa), "Episodic Creep in Mantle Deformation"
November 10	R. Stangl (Karlsruhe), "A Long-range Seismic Profile in Fennoscandia"

8.3. 'Wayman' Colloquium

At a one-day colloquium held at Dunsink Observatory on October 12, the following talks were given, marking the 60th birthday of Professor P.A. Wayman, in recognition of his contributions to astronomy over forty years (1948-87):

C.A. Murray (RGO, UK)	"Proper Motions in the Study of the Galaxy"
R.M. West (ESO, FRG)	"Supernova 1987a"
N.A. Porter (UCD)	"Nuclearites and the Missing Mass Problem"
L. O'Raifeartaigh (STP)	" Unification of Fundamental Interactions"
M.J. Stift (Wien)	"Supergiant Photometry in the LMC"
C.J. Butler (Armagh)	"Coordinated Observations of Stellar Flares"
P.B. Byrne (Armagh)	"Stellar Chromospheres"
C.M. Sharp (MPIA, FRG)	"Opacities in Cool Atmospheres"
P.L. Grimley (SPCM)	"Current Understanding of Elliptical Galaxies"
T.P. Ray	"Are some Herbig-Haro Objects Bow-shocks?"
T. Kiang	"Two types of Equations"
T.D. Spearman (TCD)	"Some ideas on Image Reconstruction"
A.N. Argue (Cambridge)	"Double star CCD Photometry and Astrometry"
P.A. Wayman	"My First Love - Plate-Diagram Analysis"

Twenty-four persons took part, including the first Scholar of the Astronomy Section, A.N. Argue, and Professor Wayman's successor as General Secretary of the International Astronomical Union, R.M. West.

8.4. External Lectures

L.O'C. Drury gave a short course of lectures on the "Physics of the Interstellar Medium" as a final year optional subject in TCD Physics Department.

P.A. Wayman gave eight lectures on "Topics in Astronomy and Astrophysics" to Sophister students in TCD Mathematics Dept. in the Hilary Term.

I. Elliott gave a course of 16 lectures "Introductory Astrophysics" to Sophister students in honours physics in TCD in the Michelmas Term.

L. O'C. Drury spoke on shock acceleration processes in TCD (April 13) and at St. Patrick's College Maynooth (April 23).

P.A. Wayman spoke on "The LMC Supernova, 1987a" at Maynooth (December 17) and contributed a poster paper "The Astrographic Telescopes of H. Grubb" at the IAU Symposium No. 133, "Mapping the Sky", held in Paris June 1-5.

T.P. Ray gave a seminar on "Kelvin-Helmholtz Instabilities in Astrophysics" at the Max Planck Institut fÜr Astronomie in Heidelberg, FRG, in September.

L. O'C. Drury gave an invited talk "Particle Acceleration in Magnetized Shocks" at a Workshop on magnetic fields in extragalactic objects at Cargese, Italy, June 1-6, and similarly on the topic "Particle Acceleration Mechanisms in Astrophysics" at a meeting of the French Physical Society in Strasbourg, July 9-11.

At the 'SW6' meeting at Estes Park, Colorado, August 23-29, L. O'C. Drury gave an invited talk on "Shock Structure Modifications resulting from Particle Acceleration".

A.W. B. Jacob presented results and preliminary conclusions from "Lithospheric Profiles in Britain and Ireland" in Madrid on June 27.

P.W. Readman spoke on "Aspects of Palaeomagnetism" in the Dept. of Geology, UCD, in March and he described the HOGS project (3.1.2) on board R.S. Valdivia on October 21. He also contributed to a joint paper with N. Abrahamsen (Denmark) at a Quaternary Symposium in Aarhus, Denmark, in September.

A.W.B. Jacob, on board R.S. Valdivia, on October 21, spoke on seismic and gravity results from COOLE.

A.W.B. Jacob and C.P. Lowe jointly gave a seminar "Seismic Refraction Methods" in the Dept. of Geology, TCD, on March 6.

C.P. Lowe spoke on "Seismic Profiling in Ireland" to the Joly Society, TCD, on December 3.

A contribution by P.A. Wayman on the spectrograph designs of H. Grubb was made to the exhibition "Unweaving the Rainbow" held by the Physics Department of TCD in July.

S. Bleszynski contributed a paper "Filtering of the Local Interstellar Medium" at the meeting of the Astronomical Science Group of Ireland held in Trinity College, Dublin on April 6.

R.M. Redfern presented a paper entitled "Real-time Analysis of Astronomical Images" at an Institution of Electrical Engineers Conference on 'Motion Compensated Image Processing' in London in November.

T. Kiang spoke on "Ancient Chinese Astronomical Observations" at the Mason Conference of the British Association for the Advancement of Science Meeting at Queen's University Belfast, 27-28 August, which was entitled "Astronomy in Ireland". D. O'Sullivan spoke on the results from the Giotto EPA experiment and the opening address of the Conference was given by P.A. Wayman.

D.O'Sullivan delivered talks on topics in Space Physics at the Mathematics Department, Trinity College, in January, at University College, Galway, Physics Department in March, and to the Dublin Centre, Irish Astronomical Society, in March.

P.A. Wayman spoke to the Dublin Centre of the Irish Astronomical Society on "The Jovian Planets" on February 2, and on "The LMC Supernova 1987a" on November 2nd. He addressed the Cloyne Literary and Historical Society on "John Brinkley, Astronomer and Cleric" on 23rd September.

J. Daly spoke to the Royal Aeronautical Society (Irish Branch) on constructing experimental equipment for space vehicles on October 19.

I. Elliott spoke on "Recent Advances in Solar Physics" at the Astronomical Society of UCG on November 26 and gave three short talks, "The Star of Bethlehem: SN 1987a: Solar Physics", at the West Cork Astronomical Society on December 11.

I. Elliott arranged several meetings in conjunction with the Dublin Centre, Irish Astronomical Society, on the topic of the use of microcomputers in amateur astronomy.

Contributions to an exhibition commemorating the 50th Anniversary of the Irish Astronomical Society (founded in Dublin in 1937) were made by the Astronomy Section and the Cosmic Ray Section.

Fourteen Public Open Nights were held at Dunsink Observatory on Saturdays during the year. With the South Telescope under repair and renovation, the loan of an 8-inch Dynamax telescope by a member of the Dublin Centre was much appreciated.

9 EXTERNAL WORK

9.1 SLED and EPA Projects

As described in (2.1.1) above, B.D. Jordan made visits to ESTEC (January 25-30), to MPAe Lindau (February 24-March 4 and April 22-25), and to KFKI Budapest (April 26-27 and July 2-5) in connection with the testing of flight hardware destined for the SLED instrument on 'Phobos".

A. Thompson attended the meeting of the Giotto Science Working Team at Darmstadt on March 12-13, and he visited Lindau, FRG, May 24-28.

9.2. Geophysical Work

B. O'Reilly spent six months at the University of Hamburg.

A.W.B. Jacob made several visits to Germany and Spain, as described in Section 3 above. He visited Kenya in September in order to carry out survey work for the KRISP 89 project (3.3.6).

G.A. Wallace visited the Universities of Hamburg and Karlsruhe in December.

C. Bean visited the University of Karlsruhe in April.

9.3. Miscellaneous

L. O'C. Drury visited Kiel, January 12-16, in connection with the SOHO project, MPAe Lindau, January 18-20, with A. Thompson, for discussion of the XI proposal on SOHO, MPI Kernphysik, Heidelberg, 28 June - 5 July for collaborative work, Graz, Austria, July 6 - 8 for a meeting on the Cassini project, Edinburgh, July 13-26, for collaborative work with A. Heavens, and MPI Astronomy, Heidelberg, November 9-11, for a meeting on ISOPHOT software.

C. Domingo worked at the Berkeley Bevalac installation, February 26 to March 8, for exposure of Nuclear Track Detector material (2.1.3.)

During his tenure, April to October, of an Alexander von Humboldt Fellowship, T.P. Ray worked at the Max Planck Institut für Astronomie, Heidelberg. He attended the Second Turin Workshop on Mass Outflow from Stars and Galaxies, May 4-8, and undertook observations with the German 3.5-m telescope at Calar Alto, Spain, for six nights in September.

P.A. Wayman visited the Royal Observatory, Edinburgh, on October 7, the Royal Greenwich Observatory on June 19, and the Institute of Astronomy, Cambridge on June 22, for collaborative work.

9.4. Conferences, etc.

T. Murphy took part in a seminar on 'Early Years of Palaeomagnetism' at the Joint Association for Geophysics at the Geological Society, London, on February 13.

C.P. Lowe and T. Murphy attended the 11th United Kingdom Geophysical Assembly in Durham, April 6-8.

T. Murphy attended a meeting at the Royal Society Working Group on Explosion Seismology in Durham, April 8.

P.W. Readman attended the European Geophysical Society XII General Assembly at Strasbourg, April 9-14.

A.W.B. Jacob, P.W. Readman and C. Bean attended the Fourth Meeting of the European Union of Geosciences in Strasbourg, April 13-16; A.W.B. Jacob co-convened the Symposium on 'Geophysical and Geochemical Constraints on Mantle Discontinuities'.

A.W.B. Jacob attended an ORFEUS meeting at the Hague in October.

I. Elliott attended an Occam Users Meeting in Guildford, Surrey, April 13-15, Meetings of the La Palma Users Group in London on June 12 and at RGO on November 12, and the William Herschel Telescope Critical Review Meeting at RGO on November 10-11.

D. O'Sullivan attended the Symposium on 'The Diversity and Similarity of Comets' in Brussels, April 6-9.

The 20th International Cosmic Ray Conference, Moscow, August 2-15, was attended by L.O'C. Drury, A. Thompson and D. O'Sullivan.

P. Duffy attended an SERC Summer School on Solar System Plasmas at the Royal Holloway and Bedford Colleges, London in July.

T. Kiang attended the Arp Symposium on Observational Cosmology held in Venice in April.

P.A. Wayman attended meetings of the Royal Astronomical Society in London, in February and October and took part in the William Herschel Telescope Critical Review meeting at the Royal Greenwich Observatory, Sussex, November 10-11.

Other absences are as described in Section 2, 3 & 8 above.

10 PUBLICATIONS

10.1 Books

P.A. Wayman:

'Dunsink Observatory, 1785-1985. A Bicentennial History' published October 22, in the series 'Historical Studies in Irish Science and Technology', No.7, by the Royal Dublin Society and the Dublin Institute for Advanced Studies, pp. xiv+353, ISBN 0 86027 0203.

10.2 Journals

S. Bleszynski:

"Filtering of the Local Interstellar Medium at the Heliopause", Astron. Astrophys., 180: 201-206. 1987.

K. Bolster:

The Climate of Dublin City, 1951 to 1985, Comm. DIAS Series D. Geophys. Bull. No. 37.

H.P. Deasy:

"Observational Evidence for Mass Loss from Classical Cepheids", Mon. Not. R. Astr. Soc., 231: 673-694, 1988

I. Elliott:

"Interactive Video. A Tool for Teaching Astronomy" Journal of Higher Education Studies, 2: 15-17, 1987.

A.W.B. Jacob, with R. Altherr:

"Geophysical and Geochemical Constraints on Mantle Discontinuities". Terra Cognita, 7: 667-669, 1987.

B.D. Jordan, with P. Kermode and M. Martin.

"SLED - A Low-Energy Particle Detector", Technology Ireland, 19: 39-44, 1988

T. Kiang:

"Normalized Units" Quart Journ. R. Astr. Soc., 28: 456-471, 1987.

C.P. Lowe and A.W.B. Jacob:

"North-South Seismic Profile in Ireland" Geophysical Journal. R. Astr. Soc., 89: 484, 1987.

N.P. Murphy:

"Upper Crustal Structure in Eastern Ireland", Irish Journal of Earth Science, 8: 211-224, 1987.

T. Murphy:

Gravity Anomaly Map 1:126720 scale, Sheet 16, Wicklow - Kildare, Comm. DIAS, Series D, Geophys. Bull. No. 36.

P.W. Readman, with S. Papamarinopoulos, Y. Maniatis and A. Simopoulos:

"Palaeomagnetic and Mineral Magnetic Studies of Sediments from Petralona Cave, Greece", Archaeometry, 29: 50-59, 1987.

P.W. Readman, with M.O'Connell, F.J.G. Mitchell, T.J. Doherty and D. A. Murray:

"Palaeological Investigations towards the Reconstruction of the Post-glacial Environment at Lough Doo, County Mayo, Ireland", Journal of Quaternary Science. 2: 149-164, 1987.

P.W. Readman and N. Abrahamsen:

"Palaeomagnetism of Post-glacial Lake Sediments from Denmark" (Abstract), Terra Cognita, 7: 475, 1987.

P.A. Wayman:

Harold William Newton (Obituary Notice), Quart. Journ. R. Astr. Soc., 28: 542, 1987.

10.3 Conference Proceedings, etc.

C. Domingo, A. Thompson, and D. O Sullivan, with C. Baixeras, F. Fernandez, and A. Vidal-Quadras:

"The Influence of Latent Track Intensification in the Response of SSNTD's and its Implications for UH Nuclei Detection", Proceedings of the 20th International Cosmic Ray Conference, Moscow, 2: 406-409, 1987.

L. O'C. Drury:

"On the Possibility of Diffusive Shock Accelerations at Perpendicular Shocks", Proceedings of the 20th International Cosmic Ray Conference, Moscow, 2: 161-163, 1987.

L.O'C. Drury:

"Particle Acceleration in Magnetized Shocks", in 'Magnetic Fields and Extragalactic Objects'(ed. E. Asseo and D. Gresillon), Cargese Workshop, Editions de Physique, 1987.

I. Elliott:

"Requirements of a Network Telescope", in Advances in Helio-and Astero-seismology'. IAU Symposium No. 123, pp. 541-544 (D. Reidel, 1987).

A.W.B. Jacob:

"Seismology in Ireland", Irish National Report to IUGG, pp. 63-79, 1987.

A.W.B. Jacob, with F.A. Cook and D.H. Matthews:

"Crustal and Upper Mantle Structure of the Appalachian-Caledonian Orogen from Seismic Results" in 'The Caledonian-Appalachian Orogen' (ed. A.L. Harris and D.J. Fettes), Special Publications of the Geological Society, London, 38: 21-34, 1987.

D. O'Sullivan and A. Thompson, with E. Kirsch, S. McKenna-Lawlor and P.W. Daly:

"Observation of Energetic Particles (E>30keV) by the Giotto experiment EPA in the Magnetic Cavity of Comet Halley", Symposium on the Diversity and Similarity of Comets, Brussels, April 1987, ESA SP-278, pp. 145-148. 1987.

D. O'Sullivan, A. Thompson and C. Domingo:

"Latent Track Intensification due to Ageing in Solid State Nuclear Track Detectors" Proceedings of the 20th International Cosmic Ray Conference, Moscow, 2: 410-413, 1987.

D. O'Sullivan, A. Thompson with S. McKenna Lawlor, E. Keppler, E. Kirsch, A. Richter, V. Afonin, K. Gringauz, K. Kecskemety, A. Somogyi, L. Szago and A. Varga:

"An Energetic Particle Detector (SLED) for the Phobos Mission to Mars". Proceedings of the 20th International Cosmic Ray Conference, Moscow, 4: 410-413 1987.

A. Thompson, D. O'Sullivan, with E. Kirsch, S. McKenna Lawlor, K-P. Wentzel, P. Daly, F.M. Neubauer:

"Particle Acceleration near Comet Halley observed by the Giotto Experiment EPA 1986". Proceedings of the 20th International Cosmic Ray Conference, Moscow 3: 237-240. 1987.

A. Thompson and D. O'Sullivan, with S. McKenna-Lawlor, B. Wilken, P. Daly W.-H. Ip. E. Kirsch, A. Coates, A. Johnstone and K.-P Wentzel,

"Energy of Pick-up Ions recorded during the Encounter of Giotto with Comet Halley", Symposium on the Diversity and Similarity of Comets, Brussels, April 1987, ESA SP-278, pp. 133-137, 1987.

A. Thompson, D. O'Sullivan, C. Domingo, with K.-P. Wentzel and V. Domingo,

"Extended Exposure for the Ultra Heavy Cosmic Ray Experiment on the LDEF Spacecraft" Proceedings of the 20th International Cosmic Ray Conference, Moscow, 2: 402-405, 1987.

P.A. Wayman:

"The Grubb Astrographic Telescopes, 1887-1896", in 'Mapping the Sky', (ed, S. Debarbat), IAU Symposium No. 133 (D. Reidel, in press).

10.4 Irish Astronomical Journal

Under the joint auspices of the Astronomy Section and Armagh Observatory, the Irish Astronomical Journal produced three issues during 1987, Vol. 17, No. 4 and Vol. 18 Nos. 1 & 2. In March and September 1987, the following contributions, including those of Research Associates, appeared:

Vol. 17. p. 387, L. Metcalfe, B. McBreen, T. Ray, P.A. Wayman and B.D. Jordan: A CCD Camera System and Observations of Haro Galaxies (omitted from 1986 Report).

10.5 Miscellaneous

T. Kiang continued as Chief Translation Editor of 'Chinese Astronomy and Astrophysics', Pergamon Press, Oxford. Four issues, Volume 11, Nos. 1-4, were produced during the year.

D. O'Sullivan continued as a member of the editorial board of 'Nuclear Track and Radiation Measurements'.

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH
(Dublin Institute for Advanced Studies)

FINANCIAL STATEMENTS FOR YEAR ENDED 31 DECEMBER 1987

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INSTITIUID ARD-LEINN BHAILE ATHA CLIATH

(Dublin Institute for Advanced Studies)

1987

GENERAL

The Institute was established under the Institute for Advanced Studies Act, 1940.

Its functions include the provision of facilities for the furtherance of advanced studies and the conduct of research in specialised branches of knowledge.

It comprises three Schools - Celtic Studies, Theoretical Physics and Cosmic Physics.

ACCOUNTING POLICIES

1. Accounting basis:

The Accounts have been prepared under the historical cost convention.

2. Oireachtas Grants:

Income shown in the Accounts as Oireachtas Grants is the actual cash received in the period of the Account and includes £17,000 for increases in remuneration.

3. Fixed Assets:

Fixed Assets comprise the furniture and equipment of the Institute and are shown at cost less accumulated depreciation.

The rate of depreciation is 10% per annum.

Premises occupied by the Institute are leased from the Office of Public Works.

4. Capital Reserve:

The capital reserve comprises income allocated for the purchase of fixed assets. It is written down in line with the depreciation of the related assets.

5. Library:

Expenditure on library books and materials is charged to the Income and Expenditure Account. The current value of such books and materials is estimated at £470,000.

6. Publications:

Expenditure on publications is written off in the year in which it is incurred. The estimated value of such publications on hand at 31 December, 1987 was £679,000.

7. Superannuation:

Salaries are charged net of pension contributions. Expenditure arising under the Institute's superannuation schemes is met out of Oireachtas Grants in the year of payment. No provision has been made in these accounts for future superannuation commitments.

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH
(Dublin Institute for Advanced Studies)

Income and Expenditure Account
for the year ended 31 December 1987

1986 £		1987 £
	INCOME	
1,773,000	Oireachtas Grants	1,892,000
46,292	Sales of Publications	47,180
---	Celtic Studies Summer School Fees	6,301
30,555	School of Cosmic Physics (Note 4)	32,332
51,128	Miscellaneous (Note 9)	49,021
1,900,975		2,026,834
94,128	Less allocated for capital purposes (Note 6)	55,386
1,806,847		1,971,448
	EXPENDITURE	
402,366	School of Celtic Studies	436,105
261,599	School of Theoretical Physics	262,777
702,669	School of Cosmic Physics	683,944
484,784	Administration	449,256
1,851,418		1,832,082
(44,571)	SURPLUS (DEFICIT) for year	139,366

The Accounting Policies, Notes 1 to 9 and Statement 1 form part of these accounts.

CHAIRMAN - COUNCIL OF THE INSTITUTE

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH
(Dublin Institute for Advanced Studies)

Balance Sheet at 31 December 1987

1986				1987
£	£		£	£
297,580		Fixed Assets (Note 5)		293,469
		Current Assets:		
	287,816	Cash on hands and at Bank	439,785	
398,949	111,133	Debtors and prepayments	67,132	506,917
696,529		Total Assets		800,386
		Current Liabilities:		
	(73,567)	Creditors and Accruals (Note 2)	(40,354)	
(92,749)	(19,182)	Funds (Note 1)	(20,997)	(61,351)
603,780		Net Assets		739,035
		Financed by:-		
306,200		Surplus-Income and Expenditure Account		445,566
297,580		Capital Reserve (Note 6)		293,469
603,780				739,035

The Accounting Policies, Notes 1 to 9 and Statement 1 form part of these accounts.

CHAIRMAN - COUNCIL OF THE INSTITUTE

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH
(Dublin Institute for Advanced Studies)

Statement of Source and Application of Funds
for the year ended 31 December 1987

	£
Source of Funds:	
Surplus for the year	139,366
Capital Income	55,386
	194,752
Application of Funds:	
Purchase of Fixed Assets	55,386
	139,366
Increase/(Decrease) in Working Capital:	
Decrease in Debtors	(44,001)
Decrease in Current Liabilities	31,398
Increase in Cash Balances	151,969
	139,366

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH

(Dublin Institute for Advanced Studies)

Statement I

Detailed Analysis of Income and Expenditure for the year ended 31 December 1987

	School of Celtic Studies	School of Theoretical Physics	School of Cosmic Physics	Adminis-tration	Total	1986 Total
INCOME	£	£	£	£	£	£
Grants	441,700	274,700	752,000	423,600	1,892,000	1,773,000
Sales of Publications	46,578	-	602	-	47,180	46,292
Celtic Studies Summer School Fees	6,301	-	-	-	6,301	-
Fees & Contributions (Note 4)	-	-	32,332	-	32,332	30,555
Miscellaneous (Note 9)	75	586	2,200	46,160	49,021	51,128
	494,654	275,286	787,134	469,760	2,026,834	1,900,975
Less allocated for capital purposes (Note 6)	12,084	557	34,730	8,015	55,386	94,128
	482,570	274,729	752,404	461,745	1,971,448	1,806,847
EXPENDITURE						
Salaries, Wages and Superannuation (Note 8)	317,011	173,917	521,126	222,064	1,234,118	1,169,314
Scholarships	24,687	32,175	23,867	-	80,729	67,257
Honoraria	100	350	100	458	1,008	100
Library	12,725	24,915	17,331	-	54,971	69,353
Microfilms	3,440	-	-	-	3,440	12,937
Publications	48,091	994	8,549	1,310	58,944	58,331
General Administration (Note 3)	-	-	-	200,968	200,968	234,407
Travel & Survey Expenses	4,003	10,190	41,194	2,257	57,644	54,354
Summer School, Symposia and Seminar Expenses	14,157	2,829	215	-	17,201	4,834
Equipment: Consumable & Maintenance	-	-	38,034	-	38,034	41,341
Special Commitments and Projects	-	-	13,282	-	13,282	70,423
General Expenses	11,891	17,407	20,246	22,199	71,743	68,767
	436,105	262,777	683,944	449,256	1,832,082	1,851,418
SURPLUS (DEFICIT) FOR YEAR	46,465	11,952	68,460	12,489	139,366	(44,571)
Balance at 1 January, 1987	134,147	25,375	34,005	112,673	306,200	350,771
Balance at 31 December, 1987	180,612	37,327	102,465	125,162	445,566	306,200

INSTITIUID ARD-LEINN BHAILE ATHA CLIATH

(Dublin Institute for Advanced Studies)

NOTES TO THE ACCOUNTS

1. Funds:

		£	£
These comprise:	Vernam Hull Bequest	19,864	
	Carmody Fund	1,133	

The funds are held on deposit.

2. Creditors and Accruals:

Included in this heading is £11,392, contract research monies unexpended at 31 December, 1987, which is credited to revenue in line with expenditure on projects.

3. General Administration Expenses:

Rent, Rates & Insurance	74,835
Premises Maintenance	50,436
Postage & Telephones	38,339
Fuel, Light & Power	31,543
Sundry Supplies	5,815
	200,968

4. School of Cosmic Physics:

Fees and Contributions receivable by the School of Cosmic Physics were as follows:

Seismic and Space Research Programmes:

	Contributor	Amount	
Seismic Survey at Carnsore	ESB	300	
Geotwin Project	EEC/NBST	31,444	
EGT (Geotraverse)	EEC	16,314	
HOGS Project	Dept. Energy/ Oil Industry	5,450	
BGS Project	Brit. Geol. Survey	2,856	
KRISP Project	Karlsruhe Univ.	844	
ISOPHOT Project	ESA	552	
		57,760	
Other Fees & Contributions		1,887	59,647

The above fees and contributions have been accounted for as follows:-

Income	32,332
Offset against expenditure	15,923
Unexpended	11,392
	59,647