

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

ANNUAL REPORT
1990



P.L. 8774

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 1990

P.L. 8774

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

GOLDEN JUBILEE 1940-1990

**A Statement from
Dr T. K. Whitaker
Chairman of the Council**

The Dublin Institute for Advanced Studies was founded fifty years ago at a time when more immediate concerns and preoccupations might have been expected to predominate. The Institute is the creation and inspiration of one man, Éamon de Valera, whose personal interest, perseverance and political influence brought it into being.

Two Schools of the Institute have attained their Golden Jubilee - the School of Celtic Studies and the School of Theoretical Physics - and the third, the School of Cosmic Physics, is so close behind in years and so much an integral part of the Institute that it has participated fully and equally in the commemoration.

The three Schools which were established reflect Mr de Valera's predominant intellectual interests and his aspiration to perpetuate the international status and reputation of Irish scholarship. Mathematics was his first love and remained an abiding interest throughout his long life. He held Sir William Rowan Hamilton, the discoverer of quaternions, in the highest esteem, 'this is the country of Hamilton' he claimed in Dáil Éireann, 'a country of great mathematicians'. Mr de Valera had not been long head of an Irish Government when, by the mid-1930's, plans began to be discussed, at first separately, for the support of research and scholarly publishing in Irish Studies and for the creation of a centre for advanced research in mathematics. These plans, under Mr de Valera's supervision, eventually coalesced in the establishment in 1940 of a School of Celtic Studies and a School of Theoretical Physics as constituents of the Dublin Institute for Advanced Studies. The functions of the new Institute's School of Celtic Studies were based on proposals set out in a report which had been prepared in 1938 for the Department of Education by the Royal Irish Academy's Committee for Irish Studies. The final draft of that report had been prepared by D. A. Binchy, and he was to become the first Chairman of the Governing Board of the School of Celtic Studies and later, in 1949, a Senior Professor. For guidance regarding a School of Theoretical Physics, de Valera had access to outstanding scientists, principally A. W. Conway, E. T. Whittaker and Erwin Schrödinger (a Nobel Prize winner unsafe in Nazi-controlled Europe). He attracted Schrödinger to temporary posts in Ireland in advance of his appointment as the first Senior Professor and Director of the School, with Conway (by then President of U.C.D.) and Whittaker (Professor at Edinburgh and formerly at Dunsink) being appointed to the Governing Board, Conway as Chairman.

There was much argument as to whether there should be one overall Governing Body or one for each School, the eventual outcome being largely autonomous Governing Boards for

Schools and an Institute Council with some cross-representation from Boards and ex-officio links with the Universities and the Royal Irish Academy.

The principal statutory duty of the School of Celtic Studies is to provide for the investigation and publication of the manuscript heritage extant in Irish and for the publication of studies of all periods of the Irish language. It is also required to act as academic publisher for the whole field of Celtic Studies. The School achieved an early momentum in this work under the directorship of T. F. O'Rahilly and by 1990 had published over 200 volumes. The School has also contributed substantially to the maintenance of an international interest in Irish and Celtic Studies.

The main work of the School of Theoretical Physics is the investigation of fundamental problems in two areas: statistical mechanics, which seeks to explain the bulk properties of matter in terms of the properties of its constituent atoms and elementary particles, which are the basic components of atoms. The School's academic complement is three Senior Professors, an Assistant Professor and six scholars but, in addition to these, many research workers from universities and other institutes of research participate in the work of the School as Research Associates. It is visited by outstanding scholars, including Nobel Prize winners. Its library provides a specialised service nationally to research workers in physics. Through its research activities, lectures, seminars and symposia, the School keeps mathematicians and Irish physicists abreast of the advance of knowledge in the world at large.

As the war came to a close, Mr de Valera was able to realise his long-held ambition to do something about Dunsink and experimental physics, particularly astrophysics and geophysics. He had been in consultation with Whittaker, Lindsay of Armagh Observatory and Shapley and Birkoff of Harvard University as well as Schrödinger, J. J. Nolan and Pollak (then Senior Meteorological Officer) and, in 1943, had obtained Government approval in principle for the establishment of a new constituent school of the Institute to be entitled the School of Cosmic Physics and for the conduct of negotiations with Trinity College for the transfer of Dunsink to the Institute. Eminent scientists were head-hunted and, by the time the resolutions approving the establishment of the School were passed by Dáil and Seanad in 1947, Dunsink had been acquired by the State and was available for leasing to the School and Janossy, Pollak and Brück had been recruited for appointment as Senior Professors in the Cosmic Ray, Geophysics and Astronomy sections, respectively. Again, this School keeps Irish scholarship at the highest international level. Through it, Ireland is involved in research in space, in exploring the extent and structure of our continental shelf and in observing the heavens from La Palma, where President Hillery participated in the inauguration of new observatories a few years ago.

The work of all three Schools upholds Ireland's reputation for scholarship and excellence in research. Ireland is kept in touch with and plays its part in the rapid advance of scientific knowledge. The benefits can be direct as well as indirect; enlargement of Ireland's acknowledged continental shelf, for example, will increase our potential oil and mineral resources. The total cost is moderate in relation to the importance and value of what is achieved.

It is with pride that one surveys the past fifty years of the Institute and, with encouragement, looks towards its centenary and beyond in the continuing service of Irish scholarship and research.

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

Summary of Annual Report
of the work of the Constituent Schools
for the year ended 31 December 1990

School of Celtic Studies

At the end of 1990, the School of Celtic Studies was permitted to promote six members of staff to positions more consistent with their responsibilities and achievements, and to fill the vacancies of Librarian, Publications Officer, and Secretary. These much appreciated adjustments restored a coherent staff structure to the School and thereafter enabled it to provide more efficiently, and to an essential degree of professional competence, for the fulfilment of its publishing function [Act 5(10)(f)(j)].

However, the School is still well below the level of 15/16 staff which it has been permitted in the past, and its present complement is less than one third of the level of academic staffing which it was expected to have reached at the end of its first five years of development. Consequently, the School is able to make only a very limited impact on the range of its core duties as set out in [5(1)(a)-(e)] of the Act. To sustain an adequate investigation of spoken Irish [(Act 5(1)(c)), for example, it would be necessary in addition to present staffing to engage a small project team of at least three people.

Projects which by the end of 1990 were being conducted to a satisfactory degree in relation to resources were: manuscript cataloguing [(Act 5(1)(a)), Irish Studies bibliography [(Act 5(1)(f)), and Early Irish Law studies [(Act 5(1)(a)(e)]. There were two important catalogue publications in 1990.

Staff of the School made substantial editorial contributions [(Act 5(1)(j))] to four further titles which appeared in 1990: Aislinge Meic Con Glinne, Celtic word formation, Celtica 21, and Cath Maighe Léna.

The School marked its fiftieth anniversary with the publication of a comprehensive report. It also brought out a revised bibliographically exact, catalogue of its publications, and it was decided that for the future this should be updated annually.

School of Theoretical Physics

Thirty-eight 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-nine scientists from abroad visited the School during the year.

Mathematical symposia were held at Easter and at Christmas; thirty-six seminars were held at DIAS and joint seminars with other third level institutions took place. Members of the School gave eight lectures in Ireland. The statutory public lecture was given at TCD by Professor L. S. O'Raifeartaigh.

The primary areas of research were theoretical particle physics and statistical mechanics, members of the School published papers in scientific journals and conference proceedings; they participated in thirty conferences abroad.

School of Cosmic Physics

This was a relatively exciting year for the School, marked as it was by important steps in several major projects. In January, news of the last-minute retrieval by NASA of the Long Duration Exposure Facility carrying with it the DIAS/ESTEC Ultra-Heavy Cosmic Ray Experiment arrived during the 21st International Cosmic Ray Conference in Australia where the Institute, with the assistance of Bord Fáilte and commercial sponsors, was promoting Dublin as the venue for the 22nd conference in 1991. Disassembly of the UHCRE experiment, and study of the effects of the over five year exposure to the near-Earth space environment, took most of the rest of the year.

In Astronomy further progress was made in demonstrating the feasibility of the image-sharpening techniques being pursued in collaboration with UCG and ICL. A systematic study of outflow and jet phenomena in young stellar objects revealed that the energy content of these effects is better correlated with the properties of the inferred circumstellar discs than those of the central condensations (protostars and pre-main-sequence stars). The Infra-red Space Observatory is expected to yield important information in this area and the Institute played a major part in coordinating proposals to study star formation with ISO when it is launched.

For the Geophysics section January was marked by the start, after various delays, of the Kenyan Rift Valley seismic study (KRISP). Despite hostile conditions (including an attack by a hippopotamus!) the DIAS staff and equipment performed very well and excellent data were obtained in this major international collaboration. Closer to home, following the successful 1988 RAPIDS study of the crust under the northeastern Atlantic, another major seismic project was carried out there. Long profiles were investigated along the axis of the Rockall Trough and westwards from the end of the 1988 profile into the ocean beyond the Hatton bank. This profile now stretches more than halfway from Ireland to Greenland.

Theoretical modelling and interpretation of data gathered in these and other experiments continued in all sections throughout the year. The statutory public lecture, entitled *High Energy Phenomena associated with Young Stellar Objects*, was given by Dr Thierry Montmerle (CEN Saclay) to coincide with the celebrations marking the 50th anniversary of the foundation of the Institute. Six other seminars were arranged in the School and 25 contributions made to external scientific meetings. In September, for two weeks, the School hosted the third European Astrophysical Doctoral Network summer school which was attended by 60 graduate students from all over Europe.

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 1990

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 for the year ended 31 December 1990.

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 1990.
- 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.

- 1 Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31 December 1990.

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., L.L.D., D.Sc., 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., (to 15/3/90); Aidan Clarke, M.A., Ph.D., F.T.C.D., President, Royal Irish Academy, (from 16/3/90).

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.; E. F. Fahy, M.Sc., Ph.D.; P. A. Wayman, Ph.D., (to 16/10/90); L. O'C. Drury, B.A., Ph.D., (from 17/10/90).

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., D.Phil.; 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.; T. Ó Floinn, M.A. (to 31/3/90); 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., D.Sc. L.L.D., F.T.C.D.

Senior Professors

J. T. Lewis, B.Sc., Ph.D.; L. O'Raiheartaigh, 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

L. O'C. Drury, B.A., Ph.D.; P. A. Wayman, Ph.D.; A. W. B. Jacob, M.A., M.Sc., Ph.D. (from 17/1/90)

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., D.Sc., Ph.D., F.Inst.P.; M. de Groot, Ph.D.; G. F. Imbusch, Ph.D., D.Sc.; D. J. Murphy, B.Sc., M.Sc.; V. J. McBrierty, B.Sc., M.A., Ph.D., C. Phys., F.Inst.P., F.T.C.D.; D. L. Weaire, B.A. (Cantab.), Ph.D. (Cantab.), C.Phys., F.Inst.P., F.T.C.D.

5. ADMINISTRATIVE STAFF

Registrar

John Duggan, B.Sc.

Senior Clerk

Maura Devoy, B.A. (to 25 May); Mary Burke, B.A. (from 24 April)

Finance Officer

Mary A. O'Rourke, B.A.

Clerks

Angela Stubbs; Noreen Granahan; Helena Moynihan (from 1 September); Gabriel Flynn (from 1 July); Eibhlín Nic Dhoncha.

EQUALITY OF OPPORTUNITY

Council of the Dublin Institute for Advanced Studies at its meeting of 31 May 1988 formally adopted the Government's Policy statement on Equality of Opportunity between men and women on the staff of the Institute.

The Council of the Institute, recognising the importance of promoting equal opportunity, appointed its Chief Executive Officer as Employment Equality Officer (EEO) with responsibility for staff development. The EEO participates in the newly formed networks of EEOs in Semi-State bodies.

The Council supports equality of opportunity in recruitment and any vacancy advertised is open to everyone qualified irrespective of sex, race or marital status, except where otherwise stated and where so otherwise stated shall be strictly in accordance with the Employment Equality Act 1977. No candidate will be discriminated against on account of physical handicap or disablement, provided that she/he can perform the job satisfactorily. Subject to Public Service practice, no discriminatory age limits will apply but the interview board will take into account ability of candidates to give effective service on appointment.

The following measures designed to promote equal opportunities have been adopted by Council of the Institute:

1. Introduction of flexible working arrangements.
2. Operation of a career break facility. Three members of staff have availed of career breaks.
3. Setting up of a joint management negotiating committee; any difficulties arising from operation of the Equal Opportunity programme may be referred to this committee.

The Institute's staff complement is 33 male and 25 female. One disabled person is employed.

POLICY STATEMENT ON SEXUAL HARASSMENT

It is the policy of the Dublin Institute for Advanced Studies to treat freedom from sexual harassment as a condition of work which an employee of either sex is entitled to enjoy and it regards sexual harassment as a breach of this policy.

The Council defines sexual harassment as any unwanted, unwelcomed and unreciprocated act, gesture or statement of a sexual nature made by one member of staff to another which is offensive or objectionable and causes discomfort, embarrassment or humiliation to the recipient's duties as may be laid down by Council or the Governing Boards of the Schools. Sexual harassment, which is behaviour of an unsolicited and unwanted nature, is distinguished from normal interpersonal behaviour or exchanges which are mutually desired and welcomed.

Sexual harassment is regarded as conduct which is unbecoming and which may be subject to disciplinary action. Council appoints the Registrar who is the Employment Equality Officer as investigating officer should a complaint be made. Any alleged incident of sexual harassment should be reported immediately to the Registrar who will cause the matter alleged by the complainant to be investigated in an objective, sensitive and confidential manner. If the complainant feels for any reason that this reporting procedure is inappropriate, the established grievance procedures may be availed of. The Council, depending on the seriousness and veracity of the complaint, will cause appropriate disciplinary action to be taken should a prima facie case be established. Such disciplinary action may take the form of a verbal warning or for very serious incidents of sexual harassment or repeated harassment after warnings the question of suspension or dismissal may arise.

The Employment Equality Agency provides comprehensive advice to any person who, notwithstanding the foregoing, may wish to seek legal redress in the Labour Court in accordance with the provisions of the Employment Equality Act, 1977. The remedy provided by the Court on a successful outcome of a case will include a recommendation to the persons concerned on a specified course of action and compensation of such amount as the court thinks reasonable but not exceeding 104 weeks pay.

The Council emphasises that all complaints of sexual harassment which are brought to its attention will be dealt with objectively, promptly and in complete confidence.

Annual report of the Governing Board of
the
School of Celtic Studies
for the year ending 31 December 1990

Contents

1 Staff, Scholars, Associates	7
1.1 Staff	7
1.2 Part-time and retired staff	7
1.3 Scholars	8
1.4 Research Associates	8
1.5 Visiting scholars	8
2 Research	8
2.1 Primary project areas	8
2.2 Other research	9
2.3 Scholars' work	9
3 Publishing and Publications	9
3.1 Publications	9
3.2 Publication technology	10
4 Booksales	10
5 Events	11
5.1 Public lectures	11
5.2 Seminars	11
5.3 Annual Symposium / Tionól 1990	11
5.4 Fiftieth anniversary	11
6 Outside activities and contributions to scholarship	12
6.1 Activities	12
6.2 Contributions to scholarly publications	12

1 Staff, Scholars, Associates

1.1 Staff

SENIOR PROFESSORS:

Máirtín Ó Murchú (Director of the School; with special responsibility for spoken language studies)
Proinsias Mac Cana (with special responsibility for Early Irish, Welsh, and Breton)

PROFESSORS:

Pádraig de Brún (appointed 1 September 1990; with special responsibility for manuscript studies, and director of publishing)

Fergus Kelly (appointed 1 September 1990; with special responsibility for Early Irish law texts, and director of events)

Rolf Baumgarten (appointed 1 September 1990; with special responsibility for bibliography, and director of promotion)

ASSISTANT PROFESSOR:

Malachy McKenna (appointed 1 September 1990; spoken language studies)

LIBRARIAN:

Siobhán Ní Laoire (appointed 1 December 1990; also bibliography and textual studies)

PUBLICATIONS OFFICER:

Máire Uí Chinnseala (to 2 October 1990)

RESEARCH ASSISTANTS:

Aoibheann Nic Dhonnchadha (appointed 1 January 1990; manuscript studies and Irish medical texts)

Pádraig Ó Macháin (appointed 1 September 1990; manuscript studies and bardic verse)

JUNIOR RESEARCH ASSISTANT:

Seán Ua Súilleabháin (appointed 1 September 1990; lexicography)

SCHOLAR:

Máirín Ní Dhonnchadha (appointed 23 November 1990; law-texts and editorial assistance)

SECRETARY:

Anne Dunphy (appointed 10 December 1990)

1.2 Part-time and retired staff

PART-TIME ASSISTANT:

Nessa Ní Shéaghda

COMPUTER CONSULTANT:

Cathair Ó Dochartaigh

TEMPORARY LIBRARY PERSONNEL (by arrangement with FÁS):

Lorcán Mac Meanman (to 30 September 1990)

STAFF ON CAREER BREAK:

Mícheál Ó Siadhail (Assistant Professor)

RETIRED STAFF:

Brian Ó Cuív (Professor Emeritus)

1.3 Scholars

Aidan Breen (to 30 September 1990)
 Kaarina Hollo (to 30 September 1990)
 Ursula Marmé
 Joseph F. Eska
 Karen L. Maund
 Seán Ó Cearnaigh (from 1 August 1990)
 Marc Caball (from 1 October 1990)
 Seán Duffy (from 1 October 1990)
 Máire Ní Mhaonaigh (from 1 October 1990)
 David Thornton (from 1 October 1990)

1.4 Research Associates

Dr Gwenllian Awbery (Cardiff; appointed 11 May 1990)
 Dr John Carey (Harvard University; appointed 11 May 1990)
 Dr Thomas Charles-Edwards (Corpus Christi College, Oxford; appointed 11 May 1990)
 Dr David N. Dumville (University of Cambridge)
 Professor D. Ellis Evans (Corpus Christi College, Oxford; appointed 11 May 1990)
 Professor William Gillies (University of Edinburgh)
 Professor Geraint Gruffydd (Centre for Advanced Welsh and Celtic Studies, Aberystwyth)
 Professor Eric P. Hamp (University of Chicago)
 Dr Michael Lapidge (University of Cambridge)
 Donald MacAulay (University of Aberdeen)
 Dr Martin McNamara, MSc (Milltown Institute of Theology and Philosophy)
 Dr Cathair Ó Dochartaigh (University College, Bangor)
 Dr Pádraig Ó Néill (University of North Carolina, Chapel Hill; appointed 11 May 1990)
 Dr Brinley F. Roberts (National Library of Wales, Aberystwyth; appointed 11 May 1990)
 Professor R. Mark Scowcroft (Catholic University of America; appointed 11 May 1990)
 Dr Richard Sharpe (University of Oxford)
 Professor T. Arwyn Watkins (Swansea)
 Professor Calvert Watkins (Harvard University; appointed 11 May 1990)

1.5 Visiting scholars

Professor Edgar M. Slotkin (University of Cincinnati)
 Dr Gwenllian Awbery (Cardiff)
 Professor Toshitsugu Matsuoka (Hosei University, Tokyo)
 Dr Nancy Stenson (University of Minnesota)
 Professor R. Mark Scowcroft (Catholic University of America)

Dr Morfydd E. Owen (Centre for Advanced Welsh and Celtic Studies Aberystwyth)
 Dr Richard Mark Crowe (Geiriadur Prifysgol Cymru)
 Professor Joan Newlon Radner (The American University, Washington)
 Dr Séamas Ó Direáin (Marymount College, California)
 Fr Marc Schneiders, O.Praem. (University of Utrecht)
 Kees Veelenturf (University of Amsterdam)
 Dr Erich Poppe (University of Marburg)
 Dr Ruairí Ó hUiginn (Queen's University, Belfast)
 Dr Rolf Ködderitzsch (University of Bonn)
 Dr Ailbhe Ó Corráin (University of Uppsala)
 Dr A. J. Hughes (Queen's University, Belfast)
 Éamonn Ó Ciosáin (St Patrick's College, Maynooth)
 Giovanni Giusti (Università di Pisa)
 Nicole Müller (University of Oxford)
 Barbara Hillers (University College, Dublin)
 Dr Breandán Ó Ciobháin (An Foras Duibhneach)

2 Research

The School's provision for research and publication during 1990 was, as in recent years, at its most adequate level in the fields of manuscript studies, bibliography, and early Irish law; projects also continued on medical texts and lexicography.

2.1 Primary project areas

- Manuscript studies continued under the direction of Pádraig de Brún. *Fasc. xi* (by Nessa Ní Shéaghda) and *xii* (by Pádraig Ó Macháin) of the *Catalogue of Irish manuscripts in the National Library of Ireland* were published during the year. Revision of *Fasc. xiii* and *xiv* was begun. *Clár lámhscríbhinní Gaeilge Chólaiste Ollscoile Chorcaí: cnuasach Uí Mhurchú* (B. Ó Conchúir) was revised. A draft of the *Catalogue of Irish manuscripts in Houghton Library, Harvard University* (C. G. Buttmer) was examined and recommendations made for its revision. Aoiheann Nic Dhonnchadha continued the re-cataloguing of the medical manuscripts in Trinity College, Dublin. Guidelines were agreed for the revision of vol. I (Classical Gaelic manuscripts in the National Library of Scotland) of Ronald

Black's three-volume catalogue of the Gaelic manuscripts of Scotland.

Arrangements were made for the cataloguing of collections of Irish manuscripts in America, viz. Boston College (K. E. Nilsen) and Villanova University (W. J. Mahon), and samples of each catalogue were inspected and guidelines issued for their completion.

- Rolf Baumgarten continued work on the computerisation of the *Bibliography of Irish linguistics and literature*.

A work entitled *Celtic studies in the Netherlands* was received from Kees Veelenturf and Marc Schneiders of the Netherlands, and criteria for its revision were discussed with the authors.

Scope and lay-out of a study entitled *Bibliography of printed material in the Irish language 1571-1700* were discussed with its author, Seán Ó Cearnaigh (Scholar, School of Celtic Studies), and drafts of his work examined.

- Work on early Irish law continued under the direction of Fergus Kelly. *Bríathra Flainn Fína* (ed. Colin Ireland) and *Early Irish contract law* (ed. Neil McLeod) were both put through a number of revisions.

Fergus Kelly also worked on his own examination of law-texts on *Early Irish agriculture*.

2.2 Other research

Máirtín Ó Murchú continued work on a description of West Perthshire Gaelic; work continued on the preparation for publication of the phonetic records of the Scottish Gaelic Survey; three monographs on aspects of the spoken language were submitted and assessment of them was begun.

Proinsias Mac Cana worked on aspects of the historical syntax of Welsh, and on the editing of textual notes for an edition of *Fled Bricrenn*.

Rolf Baumgarten continued work on an edition of *In lebor gabála*, and on aspects of Early Irish syntax.

Malachy McKenna worked on an edition of the nineteenth-century text, *The spiritual rose*.

Aoibheann Nic Dhonnchadha continued her research on Early Modern Irish medical writings.

Pádraig Ó Macháin continued his work on Irish bardic poetry

Seán Ua Súilleabháin continued work on an edition of Richard Plunket's Latin-Irish dictionary (1662).

2.3 Scholars' work

Aidan Breen continued work on his edition of *De zii abusivis saeculi*.

Kaarina Hollo continued to prepare her edition of *Loinges mac nDuil Dermait*.

Ursula Marmé worked on verbal composition in Old Irish.

Joseph F. Eska continued research on Celtic diachronic syntax and the formation of the early Insular Celtic verbal complex, and on diachronic specification of the Celtic languages.

Karen L. Maund worked on the Annals in Cotton MS Titus A XXV (The Annals of Boyle).

Seán Ó Cearnaigh planned an edition of a printed text from 1631, as a project ancillary to his Catalogue of printed works.

3 Publishing and Publications

3.1 Publications

As one of its statutory functions, in addition to research and publication by its own staff, the School provides for the editing and publishing of books and papers by outside scholars.

In all, six books were published (one being a reprint, with corrigenda, of a 1938 publication) in 1990, as well as one volume of the School's journal *Celtica*, one number of the School's *Newsletter*, and a catalogue of the School's publications:

1. *Catalogue of Irish manuscripts in the National Library of Ireland, fasc. XI: MSS G 501 - G 599*, by Pádraig Ó Macháin. 133 pp. (Studies in Irish Manuscripts / Taighde ar Lámhscríbhinní. General editor: Pádraig de Brún.) ISBN 1-85500-135-7. ISSN 0791-1890. Ir£10.
Description of manuscripts 503 and 512 is by Aoibheann Nic Dhonnchadha.
2. *Catalogue of Irish manuscripts in the National Library of Ireland, fasc. XII: MSS G 600 - G 699*, by Nessa Ní Shéaghdha. 101 pp. (Studies in Irish Manuscripts / Taighde ar Lámhscríbhinní. General editor: Pádraig de Brún.) ISBN 1-85500-136-5. ISSN 0791-1890. Ir£10.
3. *Aislinge Meic Con Glinne*, edited by Kenneth Hurlstone Jackson. xli + 209 pp. ISBN 0-90128-294-4. Ir£16.
Copy-edited and seen through the press by Pádraig Ó Macháin.

4. *Celtic word-formation: the velar suffizes*, by Paul Russell. x + 242 pp. ISBN 1-85500-137-3. Ir£15.

Assessed by M. Ó Murchú and R. Baumgarten; copy-edited and seen through the press by P. de Brún.

5. *Celtica 21: Essays in honour of Brian Ó Cuív*, edited by Pádraig de Brún and Máirtín Ó Murchú, assisted by Colin Ireland. x + 678 pp. ISBN 1-85500-139-X. ISSN 0669-1399. Ir£20.

Includes contributions by members of the School, viz. 'Iduma (Ἰδουμα)' by Aidan Breen, 'The deictic pronominal **key* in Celtic' by Joseph F. Eska, 'A note on Old Irish *cfr-maire*' by Fergus Kelly, 'The prepositional relative in Irish' by Proinsias Mac Cana (with Dónall Ó Baoill), 'Historically-long stressed vowels in a south-east Ulster text' by Malachy McKenna, and 'Gairmeacha beatha roinnt scríobhaithe ón 18ú agus ón 19ú céad' by Nessa Ní Shéaghdha.

6. *Scoil an Léinn Cheiltigh: Tuarascáil leathchéad bliain / School of Celtic Studies: Fiftieth anniversary report 1940-1990*. Edited by Máirtín Ó Murchú. vii + 176 pp. ISBN 1-85500-141-1.

7. *Newsletter of the School of Celtic Studies / Scéala Scoil an Léinn Cheiltigh 4*, edited by Rolf Baumgarten. 47 pp. ISSN 0790-9853. Free.

Contributions by members of the School are by the Editor, by Máirtín Ó Murchú ('A word from the Director'), and by Aoiobheann Nic Dhonnchadha ('Early Modern Irish medical writings').

8. *Cath Maighe Léna*, edited by Kenneth Jackson. (Reprint, orig. published 1938.) xxxv + 189 pp. (Mediaeval and Modern Irish Series IX.) ISBN 1-85500-138-4. ISSN 0332-4265. Ir£12.

9. *Scoil an Léinn Cheiltigh: Publications in Celtic Studies, catalogue 1990 / Foilseacháin sa Léinn Ceilteach, catalóg 1990*. 51 pp.

3.2 Publication technology

The basis of a computerised editing and typesetting operation was established during the year by Pádraig de Brún, and camera-ready copy was produced by him for:

Catalogue of Irish manuscripts in the National Library of Ireland xi (Ó Macháin) and xii (Ní Shéaghdha),

Celtica 21,

School of Celtic Studies: fiftieth anniversary report 1940-1990,

Celtic word-formation: the velar suffizes (Russell), *Publications in Celtic Studies, catalogue 1990*.

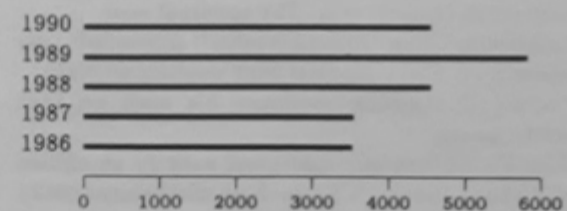
Computer consultant to the project was Dr W. G. Sullivan of University College, Dublin, and book design was under the expert guidance of Professor W. Bolger of the National College of Art and Design.

4 Booksales

A new catalogue of the School of Celtic Studies' publications from its beginnings was published and distributed. An illustrated exhibition of all its publications was arranged by the School in Dublin Castle in November 1990 on the occasion of the fiftieth-anniversary celebrations of the Institute.

Promotion of the most recent publications was through advertising in *Books Ireland*, *Comhar*, etc., through 'New publications' handbills, and through analytic notice in *Scéala Scoil an Léinn Cheiltigh / Newsletter of the School of Celtic Studies 4* (Dec. 1990).

The number of books sold during 1990 was 4533. This figure was calculated from end-of-year stock-taking figures after appropriate deduction of additions etc. during the year. The comparable figures for the preceding years were: 5804 for 1989, 4542 for 1988, 3534 for 1987, 3525 for 1986. Mícheál Ó Siadhail's *Learning Irish* (book and cassettes), which was discontinued in 1987, has not been taken into consideration. Nor have the 900 copies (approximately) of the *Newsletter* that have since 1987 been distributed annually. The following chart is a projection of the above figures.



5 Events

5.1 Public lectures

- The Statutory Public Lecture for the year 1990 was delivered by Professor R. Mark Scowcroft (Catholic University of America), on 23 November 1990, at University College, Dublin, on 'Abstract narrative in Irish'.

5.2 Seminars

- Dr G. M. Awbery (Cardiff): 'Slanders, defamations and eighteenth-century Welsh dialects' and 'Dialect syntax: a neglected resource for Welsh', 20 and 22 March 1990.
- Dr Joseph F. Eska: 'The evolution of Celtic word order and related matters', 5 April 1990.
- Professor Edgar M. Slotkin (University of Cincinnati): 'The folktale nature of *Chwedyl Gereint vab Erbyn*', 12 June 1990.
- Professor Fergus Kelly: 'Law-texts on livestock', weekly from 16 October 1990.

5.3 Annual Symposium / Tionól 1990

The Annual Symposium / Tionól was held on 23-4 November, incorporating as a key feature the Statutory Public Lecture. In addition the following papers were read:

- James Galvin (University College, Dublin): 'Aspects of the article system in Old Irish'.
- Diarmuid Ó Sé (Institiúid Teangeolaíochta Éireann): 'Distinguishing roots and suffixes in Irish verbal forms'.
- Toshi Matsuoka: 'Like the Japanese, the Irish were. . .'
- Rolf Baumgarten: 'Etymological aetiology in Irish tradition'.
- Joseph F. Eska: 'Common Insular Celtic and Gallo-Brittonic'.
- Tadhg Ó Dúshláine (St Patrick's College, Maynooth): 'Odo de Ceritona agus scríbhneoirí Gaeilge an 17ú haois'.
- Ciarán Ó Coigligh (St Patrick's College, Dublin): 'Ainmneacha agus logainmneacha Inis Meáin, Oileáin Árann, Co. na Gaillimhe'.

- Seosamh Watson (University College, Dublin): 'Gnéithe de chuid fhóineolaíochta Ghaeilge na hÉireann agus na hAlban'.
- Donnchadh Ó Corráin (University College, Cork): 'The *Metrical Dindshenchas* poem "Carmun": some remarks'.
- Art Hughes (Queen's University, Belfast): 'On Old Irish *attá* > Modern Pan Gaelic *tá* and *thá*'.

5.4 Fiftieth anniversary

The School of Celtic Studies participated in the Institute's Jubilee celebrations at Dublin Castle in the presence of the President of Ireland, Dr Patrick Hillery, on 5 November 1990. An exhibition of the School's publications was arranged for the occasion by Rolf Baumgarten.

The School published its own comprehensive illustrated *Tuarascáil leathchéad blian / Fiftieth anniversary report 1940-1990*, which contains the following contributions:

- 'Cruaidh an cosnamh: the School of Celtic Studies and the endeavour to provide for systematic research and scholarly publications in Irish and Celtic studies, 1935-1990', by Máirtín Ó Murchú.
- 'Onóir na héigse: portraits of Kuno Meyer and past members of the School of Celtic Studies', selected, with biographical abstracts, by Rolf Baumgarten and Siobhán Ní Laoire.
- 'List of publications by year', arranged by Pádraig de Brún.
- 'Statutory Public Lectures', and 'Governing Boards and personnel', compiled by Malachy McKenna.
- 'Focal scoir', by Nessa Ní Shéaghda.

Also, under the heading of 'The state of the art: personal essays on aspects of Celtic Studies', the following ten essays are included:

- 'Why study Celtic languages?', by Eric P. Hamp.
- 'Welsh and Breton', by R. Geraint Gruffydd and Morfydd Owen.
- 'Early Irish literature', by R. Mark Scowcroft.
- 'Early Irish law', by Thomas Charles-Edwards.

- 'Medieval Irish historical literature', by David N. Dumville.
- 'Bardic poetry', by William Gillies.
- 'Postclassical Modern Irish', by Cornelius G. Buttner.
- 'Scottish Gaelic verse', by Colm Ó Baoill.
- 'Publishing Ireland's Latin literature', by Richard Sharpe.
- 'Scholarly publishing in Irish Studies', by Donnchadh Ó Corráin.

6 Outside activities and contributions to scholarship

As individual academics, members of the School regularly contribute to journals and books published by other institutions, and participate in the activities of outside groups and organisations. The following is a summary account of such activities in 1990.

6.1 Activities

Rolf Baumgarten delivered a paper entitled 'Etymological aetiology in Irish tradition' at the XVIIth International Congress of Onomastic Sciences, Helsinki (August 1990).

Fergus Kelly lectured (January and February 1990) on 'Early Irish law' (University College, Cork; Queen's University, Belfast), 'Brehon law' (Queen's University, Belfast), 'Legal manuscript tradition' (University College, Cork), 'Early Irish farming' (Cork Historical Society; Ulster Historical Society). Proinsias Mac Cana lectured on '*La petite patrie* in Modern Irish and Modern Welsh literature' at Harvard University and at the MLA Annual Conference in Chicago (December 1990). He conducted a series of four seminars on 'The heroic ideal' at the Jung-Institut, Zürich (April 1990). He conducted a series of seminars at Harvard University on *Immacallam in dá thuarad*.

Malachy McKenna contributed lectures on generative phonology to an M.Phil. course at the Language and Communication Centre, Trinity College, Dublin (April-May 1990). He delivered a lecture entitled 'Roparz Hemon and the Breton literary tradition' at a conference commemorating Roparz Hemon (Bord na Gaeilge, Dublin; June 1990).

Nessa Ní Shéaghda (part-time) lectured on 'An

fhealsúnacht ins na LSS leighis Gaeilge' at the Milltown Institute of Theology and Philosophy (October 1990). She also gave lectures at the summer schools of the Institute of Irish Studies (Dublin), and at the International Summer School, University College, Dublin.

Brian Ó Cuív (retired) was elected a member of the advisory International Committee of the Fifth International Conference on the History of the Language Sciences (Galway, September 1990), and delivered the opening address. He continued his activities as Chairman of the *Corpus apocryphorum Hiberniae* publication project, and as a member of the Irish Manuscript Commission. At the symposium on 'Béaloidias Chorcaí' (Baile Bhúirne, April 1990) he read a paper on 'Béaltraidisiún Chorcaí - a chúla'. He lectured on 'An Leabhar Breac' at the Milltown Institute of Theology and Philosophy (November 1990). He gave a talk on 'An Litriú Simplí - cúlra agus úsáid' at a Bord na Gaeilge seminar on 'Córas litrithe na Gaeilge - buanna agus laigi' (Dublin, May 1990).

Seán Ua Súilleabháin conducted a seminar (with Dr Diarmuid Ó Muirthe, University College, Dublin) at the Daniel O'Connell Society Workshop, Caherdaniel, Co. Kerry (October 1990), on 'Daniel O'Connell in folklore and song'. He lectured on 'The history of the Irish language' at St Patrick's College, Carlow (27 March 1990). He gave a number of lectures on folklore in the Modern Irish Department, St Patrick's College, Maynooth (January-May).

6.2 Contributions to scholarly publications

The National University of Ireland journal *Éigse* published, in no. 24 (1990), 'The Irish marginalia in Codex Palatino-Vaticanus no. 830' by Brian Ó Cuív, '*Sgáthán an chrábhaidh*: foinsí an aistriúcháin', by Seán Ua Súilleabháin, a further instalment of 'The Irish Society's Bible teachers, 1818-27', by Pádraig de Brún, and an obituary of James Carney by Nessa Ní Shéaghda.

Ériu (Royal Irish Academy) 40 (1989 [1990]), edited by Proinsias Mac Cana and Rolf Baumgarten (with L. Breatnach), carried papers by Máirtín Ó Murchú, 'Some phonological rules and their chronological order', and R. Baumgarten, 'The syntax of Irish *ar marb*, *ar mbeo* : *ar mairb*, *ar mbí*'.

Máirtín Ó Murchú further published 'Some thoughts about *Sages, saints and storytellers*', *Studia Celtica Japonica* 2 (1989) 45-50.

Brian Ó Cuív published 'Vowel hiatus in Early Modern Irish', *Celtic language, Celtic culture: a*

festschrift for Eric P. Hamp, ed. A. T. E. Matonis and Daniel F. Melia (Van Nuys, CA, 1990) 96–107. The latter work also contains contributions by Proinsias Mac Cana, 'Word-order in Old Irish and Middle Welsh: an analogy', and by Joseph Eska, 'Some proleptic pronouns in Gaulish'. P. Mac Cana also published 'On the uses of the conjunctive pronouns in Middle Welsh', *Celtic linguistics / Ieithydiaeth Geltaidd - readings in the Brythonic languages: festschrift for T. Arwyn Watkins* (Amsterdam) 411–33. Malachy McKenna published 'Conjugation of the verb in modern Celtic and Basque: from inflection to periphrasis', *Toward a typology of European languages*, ed. J. Bechert et al. (Mouton, 1990) 185–92. Also a review of *La Bretagne linguistique: cahiers du groupe de recherche sur l'économie linguistique*

de la Bretagne 4 (1987–8), in *Teangeolas* 28 (Winter 1990) 25–6.

Pádraig Ó Macháin published a review of *Gaelic and Scotland*, ed. W. Gillies (Edinburgh 1989), in *Cambridge Medieval Celtic Studies* 20 (Winter 1990) 119–20.

Joseph Eska further published 'Interpreting the Gaulish inscription of Voltino', *Bulletin of the Board of Celtic Studies* 36 (1989); 'Another look at Gaul. *celicno-* and Goth. *kelikn*', *North-western European Language Evolution* 16 (1990); 'The so-called weak or dental preterite in Continental Celtic, Watkins' law, and related matters', *Historische Sprachforschung* 103 (1990); 'Italic *e/iste*, Hispano-Celtic *isTe*', *Emérita* 57 (1989) 317–23.

Annual Report of the Governing Board of the School of Theoretical Physics for the year ending 31 December 1990.

U.C. IRVINE: P. McGill

METEOROLOGICAL SERVICE: P. Lynch

1 Staff, Scholars and Associates

DEPT. OF FINANCE: A.J. Curran

SENIOR PROFESSORS: John T. Lewis (Director from 1 January 1975), Lochlainn S. O'Raiheartaigh

LIBRARIAN-EXECUTIVE: E.R. Wills to 13 February

SECRETARY: M. Matthews (returned from career break on 1 August)

EMERITI PROFESSORS: John L. Synge, James R. McConnell

SCHOLARS: J. Balog (Hungary) to 30 June, F. Benatti (Italy) from 1 April, L. Dabrowski (Poland) to 31 August, N.G. Duffield (UK), L.G. Fehér (Hungary) to 24 August, N. Gorman (Ireland) to 30 September, D. J. O'Connor (Ireland) to 30 September, P. Ruelle (Belgium) from 1 October, I. Tsutsui (Japan) from 1 October, M.P. Tuite (Ireland) to 31 September, R. Werner (Germany) to 31 July, D. Birmingham (Ireland) to 30 September.

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.D. McCrea, J.V. Pulé, W. Sullivan

ST. PATRICK'S COLLEGE MAYNOOTH: B. Dolan, C. Nash, A. O'Farrell J.A. Slevin, J. Spelman, D.H. Tchraikian

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

DIT KEVIN ST: J. Burns, T. Garavaglia, B. Goldsmith, M.J. Tuite

DIT BOLTON ST: P. Houston

DCU: M. Barman, E. Buffet, J. Burzlaff, D. Heffernan

LIMERICK UNIV.: R.H. Critchley, J. Kinsella, B. Lenoach

CARLOW RTC: D. O Sé

CORK RTC: M. Vandyck

AN FORAS FORBARTHA: J.M. Golden

OPEN UNIVERSITY: A.I. Solomon

OXFORD UNIVERSITY: R.G. Flood

VISITING SCIENTISTS: N.S. Ananikyan (Yerevan) 16-30 June, A. Bais (Amsterdam) 4-8 April, A. Balachandra (Syracuse) 26 Apr. - 15 May, U. Behn (Leipzig) 18 Nov. - 3 Dec., V. Belavkin (Moscow) 24-25 April, S. Bellucci (Frascati) 8-16 July, M. van den Berg (Heriot-Watt) 16-23 Dec., M. Berry (Bristol) 5 Sept. C. Boldrighini (Camerino) 27 July - 10 Aug., A. Burshtein (Novosibirsk) 16-30 June, A. Chakrabarti (Palaiseau) 22-29 Oct., A. Chillingarian (Yerevan) 16-23 June, T.C. Dorlas (Swansea) 7-21 July, D. Dunbar (Liverpool) 24-27 April, G. Efimov (Dubna) 7-21 July, E. Egorian (Yerevan) 16-30 June, P. Exner (Prague) 22 Sept. - 13 Oct., M. Fannes (Leuven) 14-23 Jan., W. Ford (Ann Arbor) 12 June - 17 July, P. Forgacs (Budapest) 17 Mar. - 7 Apr., S. Gabuda (Novosibirsk) 13-29 Dec., R. Kerner (Paris) 4-9 Nov., F. Lizhi (Cambridge) 21 Nov., S.L. Lukyanov (Moscow) 2-23 June, R.F. O'Connell (Baton Rouge) 19 June - 17 July, Z.-Qi. Ma (Beijing) 7 Nov. - 5 Dec., V. Malyshev (Moscow) 1-7 Oct., P. McGill (Irwin) 12-18 Dec., W. McGlenn (Notre Dame) 26 Apr. - 15 May, 9-20 Dec., G. McKeon (Canada) 14-17 May, P. Mansfield (Oxford) 1-7 April, M. Monastyrsky (Moscow) 8-28 May, A. Morozov (USSR) 24 Mar. - 7 Apr., M. Olshanetsky (USSR) 24 Mar. - 7 Apr., L. Palla (Durham) 18 Mar. - 1 April, C. Pfister (Lausanne) 17-29 Sept., S. Priezzhev (Dubna) 7-21 July, M. Rakowski (Oklahoma) 22-29 May, A.L. Rebenko (Kiev) 6-20 Oct., A.M. Samoilenko (Kiev) 6-20 Oct., T. Sherry (Galway) 15-17 May, R. Sorkin (Syracuse) 22 Apr. - 6 May, C. Stephens (London) 17-22 July, Yu. Suhov (Moscow) 15 July - 9 Sept., B. Toth (Heriot-Watt) 4-9 June, A. Verbeure (Leuven) 13-17 Nov., A. Wipf (Zurich) 25 Mar. - 7 Apr., V.A. Zagrebnov (Dubna) 7-21 July, B. Zegarliniski (Bohn) 23-29 April

2 General

A reception and exhibition in Dublin Castle on 5 November marked the 50th Anniversary (Golden Jubilee) of the Institute. The School contributed material illustrating some aspects of its research activities for the exhibition. Prof. McConnell was formally received into the Pontifical Academy of Sciences by His Holiness Pope John Paul II in October.

3 Research and Study

3.1 Theoretical Particle Physics

Prof. O'Raifeartaigh's research on gauge theories at University of Zurich (in collaboration with N. Straumann and A. Wipf) was completed and a paper on the Aharonov-Bohm effect published. He initiated work on the construction of Virasoro operators for arbitrarily twisted Kac-Moody algebras (in collaboration with M. McGettrick, W. McGlenn and N. Gorman). Research on the topological foundations of the spin-statistics theorem begun in 1989 (in collaboration with W. McGlenn, Balachandran, R. Sorkin and S. Sen, under US NSF contract) continued and substantial progress was made. The main thrust of research for 1990, however, was on the further development of the theory of Wess-Zumino-Witten-model reductions, and the associated W -algebras. This work was carried out in collaboration with J. Balog, L. Fehér, P. Forgacz, A. Wipf, P. Ruelle and I. Tsutsui. The reduction to classical Toda theories was generalised, the W -algebras treated in detail, and initial steps toward quantization taken.

Dr. Fehér studied the theory of Kac-Moody algebras and quantum groups. He carried out research on Hamiltonian reductions of the Wess-Zumino-Novikov-Witten theory to Toda theories, and on the quantum group structure of these theories.

Dr. Ruelle worked on the construction of new two-dimensional integrable models; by reducing the phase space of Wess-Zumino-Novikov-Witten models, he obtained new Toda-like models possessing a two-dimensional extended conformal symmetry (W -algebras).

Dr. Tchrakian worked on the new symmetry-breaking Skyrme-like models in arbitrary dimension. He studied, with H. Müller-Kirsten, the stability analysis of the Skyrme-like model in 2-dimensions. In collaboration with A. Chakrabarti, he investigated new solutions of the Bogomolnyi equations of the Skyrme-like model in 2-dimensions, and the overdetermination of generalised selfduality in 4p-dimensions. He studied further the axially symmetric solutions of YM self-duality equation in 4p-dimensions with J. Burzlaff and A. Chakrabarti.

Dr. Tsutsui worked on constrained WZNW theories and Toda theories and on W -algebras in constrained WZNW theories.

Dr. M. Tuite investigated the moonshine conjectures of Conway and Norton in terms of an orbifold string model and described a number of alternative constructions of the moonshine module of Frenkel, Kac, Lepowsky and Meurman. The objective is to link the moonshine conjectures to the conjectured uniqueness of the moonshine module by means of orbifold constructions in conformal field theory.

Dr. Birmingham worked on the construction, quantization and renormalization of topological quantum field theories.

Dr. Houston examined differential geometry aspects of quantum models.

Dr. Gorman studied Kac-Moody and Virasoro algebras in conformal field theory and the maximum entropy method for inverse problems.

3.2 Classical Statistical Mechanics

Professor Lewis, in collaboration with C. Pfister and J.V. Pulé, investigated the relationship between the large deviation principle and the equivalence of ensembles. In collaboration with W.G. Sullivan, he began work on the manuscript of a book on statistical mechanics and the thermodynamic formalism.

Professor McConnell extended his investigations on nuclear magnetic relaxation by anisotropic chemical shift by dispensing with the condition that the symmetry parameter vanishes. He reviewed work that he had done previously on internal motions of molecules, and he studied hydrogen bonding. He provided articles for the Royal Irish Academy on the School of Theoretical Physics, A.W. Conway, E. Schrödinger and W.

Heitler. He also had discussions in Dublin on dielectric theory with Profs. Zamkov (Leningrad), and Gayduk and Kalmyk (Moscow).

Dr. Buffet worked on polymer dynamics and gelation, random walks in random media, travelling waves in non-linear random systems and queueing processes.

3.3 Quantum Statistical Mechanics

Professor Lewis, in collaboration with T.C. Dorlas and J.V. Pulé, continued the investigation of models of an interacting boson gas using the large deviation principle. The main achievements were the proof of the variational principle for the full diagonal model and the investigation of the existence of condensation in some perturbed mean-field models.

Dr. Pulé, in collaboration with V.A. Zagrebnov, continued his work on a BCS-type model of an interacting boson system.

Professors Ford and O'Connell continued their collaboration with Prof. Lewis under the US NSF International Programme on the application of the quantum Langevin equation to tunneling problems.

Dr. Benatti studied the ergodic properties of classical and quantum stochastic processes.

Dr. Solomon investigated applications of quantum groups to quantum optics.

Dr. Duffield, with R. Werner, continued the study of quantum dynamical semigroups in the mean-field limit and investigated their local dynamics.

3.4 Quantum Theory and Quantum Electronics

Dr. Garavaglia worked on the non-linear dynamics of accelerator beams and quantum properties of proton dynamics.

Prof. Scaife worked on the theory of dielectrics, magnetic liquids and the computation of electric field distributions. He continued editing Vol IV of the Collected Works of W.R. Hamilton.

Dr. Heffernan worked on the nonlinear dynamics of classical and quantum systems, in particular the characterization of chaos in such systems.

3.5 General Relativity and Gravitation

Dr. Dolan worked on Ashtekar's formalism of canonical gravity and self-dual connections and on thermal spectra in Robertson-Walker universes. He also studied thermal spectra in curved space-times and the quantum mechanics of constrained systems.

Dr. Vandyck continued his investigation of the Robinson-Trautman solutions of Einstein's equations. He studied also the problem of gravitational instantons in relation with the positivity of energy in general relativity and the stability of Minkowski space.

Dr. McCrea, in collaboration with F.W. Hehl and E.W. Mielke, investigated the relations between Noether's identities and Bianchi identities in metric-affine theories of gravity. He also completed the manuscript of his lectures on "REDUCE in general relativity" to be published by Oxford University Press.

3.6 Applied Mathematics

Professor Lewis and Drs. Buffet and Duffield set up a programme of collaboration with Drs. Curran and McCabe of the Electronic Engineering Department in D.C.U. on Queueing Network Theory and its applications to Telecommunications Networks. Five joint seminars were held to determine an area of common interest. They were assisted in this by visits to the school of two leading experts in the field: Yu. Suhov and V.A. Malyshev.

Dr. Lynch worked on the development of computer models for numerical weather prediction and novel methods of initialization for numerical weather prediction.

Dr. Burzlaff continued his study of solitons and soliton-like objects. He investigated the scattering process of vortices in superconductors and soliton propagation in optical fibres. He also studied energy loss from bent optical fibres.

Dr. Barman completed a compiler for the computer language "LASS" (Language for stochastic systems).

3.7 Pure Mathematics

Dr. Goldsmith continued investigations in the use of techniques from set and model theory applied to abelian group and module theory. He also began investigation of computer based

algebraic techniques in the study of transitive and fully transitive abelian groups.

4 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 350 research institutes and university departments throughout the world. As far as possible, 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-90-

- 01: E. BUFFET, & R.F. WERNER: A counterexample in coagulation theory.
- 02: J. BALOG, L. FEHÉR, P. FORGÁCS, L. O'RAIFEARTAIGH, & A. WIPF: Kac-Moody realization of W-algebras.
- 03: H.J.W. MÜLLER-KIRSTEN, & D.H. TCHRAKIAN: A Skyrme-like lump in 2 Euclidean dimensions.
- 04: J. BALOG, L. DABROWSKI, & L. FEHÉR: Classical r-matrix and exchange algebra in WZNW and Toda theories.
- 05: A.G. SHUHOV, & YU.M. SUHOV: Towards time-dynamics for bosonic systems in quantum statistical mechanics.
- 06: T.C. DORLAS: Renormalization group analysis of a simple hierarchical fermion model.
- 07: M. FANNES, B. NACHTERGAELE, & R.F. WERNER: Valence bond states on quantum spin chains as ground states with spectral gap.
- 08: D.H. TCHRAKIAN: Solitons in R_3 with winding number n .
- 09: D.H. TCHRAKIAN: Symmetry breaking Skyrme models in R_4 .
- 10: J. BURZLAFF, & A.D. WOOD: Optical tunnelling from one-dimensional square well potentials.
- 11: M. FANNES, B. NACHTERGAELE, & R.F. WERNER: Finitely correlated states on quantum spin chains.
- 12: J.R. MCCONNELL: Theory of nuclear magnetic relaxation by anisotropic chemical shift II.
- 13: N.G. DUFFIELD, & R.F. WERNER: Mean-field dynamical semigroups on C^* -algebras.
- 14: M.P. TUIITE: Monstrous moonshine from orbifolds.
- 15: D. BIRMINGHAM, & S. SEN: Generalized skein relations from Chern-Simons field theory.
- 16: D. BIRMINGHAM, R. KANTOWSKI, & M. RAKOWSKI: The Eta function in Chern-Simons field theory.
- 17: B.P. DOLAN: BRST symmetry and quantum mechanics on homogeneous spaces.
- 18: N.G. DUFFIELD, H. ROOS, & R.F. WERNER: Macroscopic limiting dynamics of a class of inhomogeneous mean field quantum systems.
- 19: L. O'RAIFEARTAIGH, & A. WIPF: Reduced WZNW theories and two-dimensional gravity.
- 20: ED.SH. EGORIAN, & R.P. MANVELIAN: Canonical formulation of 2D induced gravity.
- 21: M.A. VANDYCK: On the problem of space-time symmetries in the theory of supergravity Part IV: Comparison between space-time and superspace formalisms.
- 22: G.V. EFIMOV, & G. GANBOLD: Functional integrals in the strong coupling regime and the Polaron self-energy.
- 23: J. BALOG, L. DABROWSKI, & L. FEHÉR: A new quantum deformation of $SL(3)$.
- 24: D. O'CONNOR, & C.R. STEPHENS: Critical phenomena during a dimensional crossover.
- 25: D. O'CONNOR, & C.R. STEPHENS: Superconductivity in an external magnetic field as a finite size system.
- 26: D. O'CONNOR, & C.R. STEPHENS: Finite size scaling and the renormalization group.
- 27: L. O'RAIFEARTAIGH: Axial anomalies.
- 28: D. BIRMINGHAM, H.T. CHO, R. KANTOWSKI, & M. RAKOWSKI: Gauge dependence of the Eta-Function in Chern-Simons field theory and the Vilkovisky-DeWitt correction.
- 29: J. BALOG, L. DABROWSKI, & L. FEHÉR: Non-standard quantum group in Toda and WZNW theories.
- 30: M.P. TUIITE: 37 New orbifold constructions of the moonshine module?
- 31: D. BIRMINGHAM, & M. RAKOWSKI: The β -function in topological sigma models.
- 32: D. BIRMINGHAM, H.T. CHO, R. KANTOWSKI, & M. RAKOWSKI: Operator phases in BF-type topological field theories.

- 33: C. BOLDRIGHINI, R.L. DOBRUSHIN, & YU. M. SUHOV: One-dimensional hard-rod caricature of hydrodynamics: Navier-Stokes Correction.
- 34: D.H. TCHRAKIAN, & A. CHAKRABARTI: How overdetermined are the generalised selfduality relations?
- 35: J. MCCONNELL: Molecular coordinate systems for relaxation processes.
- 36: J. MCCONNELL: Arthur William Conway.
- 37: J. MCCONNELL: The School of Theoretical Physics.
- 38: J. MCCONNELL: Erwin Schrödinger.
- 39: J. MCCONNELL: Walter Heitler.
- 40: B.K.P. SCAIFE: On the Rayleigh dissipation function for dielectric media.
- 41: J. MCCONNELL: The interplay of science and culture.
- 42: L. O'RAIFEARTAIGH: Short recall of two-dimensional conformal field theory.
- 43: L. O'RAIFEARTAIGH: Conformal reduction of WZNW theories and W-algebras.
- 44: L. O'RAIFEARTAIGH: Conformal reduction of WZNW theories.
- 45: L. O'RAIFEARTAIGH: W-algebras and the embedding of Toda theories in WZNW theories.
- 46: L. O'RAIFEARTAIGH: Some hidden aspects of hidden symmetry.
- 47: E. BUFFET, & J.V. PULÉ: Polymers and random graphs.
- 48: J. MCCONNELL: Self-presentation.
- 49: N.G. DUFFIELD: Local correlation functions for mean-field dynamical semigroups on C^* -algebras.
- 50: D. O'CONNOR, & C.R. STEPHENS: Phase transitions and dimensional reduction.
- 51: T.C. DORLAS, J.T. LEWIS, & J.V. PULÉ: Condensation in a variational problem on the space of measures.
- 52: J. O'GORMAN, B.J. HAWDON, J. HEGARTY, P. JENKINS, & D.M. HEFFERNAN: Frequency locking, quasiperiodicity and chaos in modulated external cavity injection lasers.
- 53: P. JENKINS, & D.M. HEFFERNAN: Non-fractal chaos in two dimensional discrete systems.
- 54: P. JENKINS, M. DALY, B.J. HAWDON, J. O'GORMAN, & D.M. HEFFERNAN: An introduction to chaos and its characterization.

5 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 and lectures were given also at the Journal's Club and other Irish venues, by the School's members and visitors.

5.1 Statutory Public Lecture

The Statutory Public Lecture entitled *Fifty years of particle physics* was delivered by Prof. L.S. O'Raifeartaigh on 6 November in Trinity College Dublin.

5.2 Seminar and review lectures given at DIAS-STP

- Prof. N. S. Ananikian (Yerevan) *Tricritical effects in the BEG-Model on the Bethe lattice*
- Dr. U. Behn (Leipzig) *The random-field Ising model*
- Dr. F. Benatti *Non-commutative Kolmogorov systems: an example*
- Dr. F. Benatti *Dynamical entropy in quantum theory*
- Dr. F. Benatti *Ergodic properties of an infinite quantum harmonic crystal*
- Prof. M. Berry (Bristol) *Hyperasymptotics*
- Prof. C. Boldrighini (Camerino) *Hydrodynamic limit for a one-dimensional hard rod model*
- Prof. A. Chakrabarti (Palaiseau) *Quantum groups*
- Dr. L. Dabrowski *A new quantum deformation of $SL(3)$*
- Prof. G. Efimov (Dubna) *Evaluation of functional integrals in the strong coupling regime with an application to the Polaron problem*
- Prof. E. Egorian (Yerevan) *BRST Quantization of Hamiltonian systems*

- Prof. P. Exner (Prague) *Some problems concerning quantum waveguides*
- Prof. R. Kerner (Paris) *Non-commutative geometry*
- Prof. F. Lizhi (Cambridge) *Periodicity of large-scale structures*
- Prof. Z.-Q. Ma (Beijing) *XXZ model with the Beraha q values*
- Prof. V. Malyshev (Moscow) *Networks*
- Prof. V. Malyshev (Moscow) *Linked cluster theorem*
- Prof. C. Pfister (Lausanne) *Exponential decay and geometric aspect of transition probabilities in the adiabatic limit*
- Prof. S. Priezzhev (Dubna) *Kirchoff's theorem and dimer statistics*
- Prof. A.L. Rebenko (Kiev) *Introduction to cluster expansion methods in statistical mechanics and quantum field theory (Course of six lectures)*
- Dr. P. Ruelle *Modular invariants for Kac-Moody algebras*
- Prof. A. M. Samoilenko (Kiev) *A survey of work on the theory of dynamical systems in the Mathematical Institute, Kiev*
- Prof. Yu. Suhov (Moscow) *Queueing network theory (Course of six lectures)*
- Dr. T. Tchrakian *Scale-breaking Skyrme like solitons*
- Prof. A. Verbeure (Leuven) *Phonons (Goldstone Bosons) and the generation of the mass gap*
- Prof. V.A. Zagrebnov (Dubna) *Random field Curie-Weiss model and Varadhan's theorem*

5.3 Contributions to the Journal's Club (Joint TCD-UCD-Maynooth-DIAS Meeting)

- Prof. O'Raiifeartaigh *WZW-reductions and W -algebras*
- Dr. D. O'Connor *Finite size scaling and the renormalization group*
- Dr. D. Birmingham *Construction and quantization of topological field theories*

5.4 Other lectures or seminars given in Ireland by members of the DIAS-STP

- Professor Lewis *Statistical mechanics a year's course for final year undergraduate and first-year graduate students*
- Dr. Tsutsui *Quantisation of anomalous gauge theories* Dublin Particle Theory Group, T.C.D., October
- Prof. O'Raiifeartaigh *The CERN EPS supercollider Annual Conf. Physics Students of Ireland, D.C.U., January Noether's theorem and conformal invariance in field theory* U.C.D., November
- Dr. Vandyck *Black holes* U.C.C., June
- Dr. McCrea *Algebraic Computation* U.C.D., May *Reduce* U.C.D., May
- Dr. Tuite *Monstrous moonshine from string theory* U.C.C., May
- Dr. Gorman *Special relativity* T.C.D., April *Schrödinger's cat and other quantum mysteries* T.C.D.
- Dr. Heffernan *The characterization of chaos* U.C.D., March *An introduction to chaos* D.C.U., Feb. *The characterization of strange sets* T.C.D., April *Chaos and its characterization* T.C.D., April *Low dimensional structures* U.C.D., Feb. - Mar.
- Dr. Goldsmith *Realizing endomorphism rings via radicals* U.C.G., May

5.5 Seminars, Lectures and Courses given abroad

- Prof. Lewis *Large deviations and the asymptotics of operator traces* (Heriot-Watt Univ., University College, Swansea, London Mathematical Society meeting, Bath, Royal Society of Edinburgh Conference, University of Nottingham, Mathematical Institute, Kiev.) *Large deviations and phase transitions* (London Mathematical Society Symposium, Durham) *Mechanisms for condensation in some models of an interacting boson gas* (Dubna conference, Moscow State University, Universities of Yerevan, Groningen, Göttingen, Osnabrück, Leuven)

- Prof. O'RaiFeartaigh *Graduate course on gauge theory* (Univ. of Zurich) *WZW-reductions and W-algebras* (Univ. of Mannheim, Karlsruhe, Cambridge, Imperial College, Teheran, ITEF Moscow and Lebedev Inst. Moscow) *Chiral anomalies* (Univ. of Zurich, Paul Scherrer Inst.) *Synopsis of 2-D conformal field theories* (Teheran)
- Prof. McConnell *Interplay of science and culture* (Pontifical Academy)
- Dr. Tuite *Monstrous moonshine from orbifolds* (Univ. of St. Andrews)
- Dr. Dolan *Ashtekar's variables and canonical gravity* (Durham, Moscow State University and Stekhov Mathematical Institute)
- Dr. Benatti *Non commutative Arnold's cat map* (University of Rome)
- Dr. Goldsmith *Realizing endomorphism rings in $V=L$* (University of Padova) *Maximal order abelian subgroups of symmetric groups* (University of Padova) *Realizing endomorphism rings at small cardinalities* (University of Padova) *Transitive and fully transitive p -groups* (Bresanone)
- Dr. Garavaglia *Non-linear dynamics during SSC injection* (Washington) *Numerical studies of the SSC injection process long term tracking* (Maimi)
- Dr. Solomon *N cluster Hubbard model: superalgebraic approach* (Moscow)
- Dr. McGill *Multiplicative martingales for branching Brownian motion* (Auburn, Swansea) *Fluctuating time changes for Brownian motion; a theory in dimension one* (Berne, Durham, Swansea, Strasbourg)
- Dr. Burzlaff *Exponentially-improved approximations in optical tunnelling models* (Durham)
- Dr. Duffield *Classical Hamiltonian dynamics for quantum Hamiltonian mean-field limits* (Swansea)
- Dr. Buffet *Polymères et graphes aléatoires* (Lausanne) *Polymers and random graphs* (Edinburgh)
- Dr. O'Connor *Superconductivity as a finite size system* (Imperial College)
- Dr. Gorman *An introduction to conformal field theory* (Notre Dame) *Les algèbres de Kac-Moody et Virasoro* (Montpellier)

- Dr. Heffernan *Three frequency instabilities in external cavity semiconductor lasers* (University of New Mexico) *Non-fractal chaos in two dimensional discrete systems* (Dusseldorf) *The Ruelle-Takens-Newhouse route to chaos in external cavity semiconductor lasers* (University of New Mexico)
- Dr. Fehér *WZNW description of Toda theories and W-algebras* (Trieste)

6 Activities of Staff and Associates

6.1 Activities within Ireland

- PROF. O'RAIFEARTAIGH: Annual conf. of physics students of Ireland, D.C.U., 26-28 January; Annual conf. of Irish branch of Inst. of Physics, Kilkenny, April.
- DR. LYNCH: IGBP meeting, Trinity College, 19 January; EOLAS, Climate study group meeting, 9 April.
- DR. GOLDEN: Irish Mechanics Society Conference University College, Dublin, 1 December.
- DR. BURZLAFF: Irish Mathematical Society Conference, Dublin, 6-7 September.
- DR. MCCREA: Conference on the teaching of numerical mathematics and algebraic computation, University College Dublin, 15-17 May.
- PROF. MCCONNELL: Annual meeting of the Irish Branch of the Institute of Physics, Kilkenny, 6-8 April.
- DR. GOLDSMITH: Groups in Galway, May.

6.2 Activities outside Ireland

- PROF. LEWIS: Heriot-Watt University, Edinburgh, 22-26 January; University College, Swansea, 15 February; London Mathematical Society, Bath, 16 February; Royal Society of Edinburgh Conference: Probability and Potential Theory, 27 February - 3 March; University of Nottingham, 26-27 April; Joint Institute for Nuclear Research, Dubna, Mathematical Institute,

- Kiev and Physics Research Institute, Yerevan, May; London Mathematical Society Symposium: Stochastic Analysis, Durham, 16-21 July; Workshop on Statistical Mechanics, Edinburgh, 31 July; Institutes for Theoretical Physics: Groningen, Göttingen, Osnabrück, Leuven, 9-15 December.
- PROF. O'RAIFEARTAIGH: University of Zurich, January to February; University of Mannheim, February; University of Karlsruhe, February; University of Karlsruhe Spring School, Bayrischzell, Bavaria, March; Paul Scherrer Institute Spring School, Graubünden, Switzerland, April; University of Cambridge, May; Imperial College, London, May; IVth Regional Conference on Theoretical Physics and Applied Mathematics, Teheran, May; ITEF Moscow, June; Lebedev Institute, Moscow, June; XVIIIth Conference on Group Theoretical Methods in Physics, Moscow, June; XIVth. John Hopkins Workshop on Current Problems in Particle Theory, Debrecen, Hungary, August.
- PROF. MCCONNELL: Hydrogen Bond Physics Conference and the VIII EMLG meeting, Lucca, Italy, 11-14 September; Meeting of the International Executive Committee of the European Molecular Liquids Group; Plenary Session of the Pontifical Academy of Sciences on Science in the Context of Human Culture, 29-31 October.
- DR. M.P. TUITE: UK Institute for Higher Energy Physics, Univ. of St. Andrews, Scotland, August.
- DR. P. RUELLE: Annual Rutherford Appleton Laboratory meeting, 17-19 December.
- DR. I. TSUTSUI: Annual Rutherford Appleton Laboratory meeting, 17-19 December.
- DR. SOLOMON: 18th. International Colloquium in Group Theoretical methods, Moscow 4-9 June; Haifa, Israel, 20-30 August; Manchester, Round table (USARNY), 24-25 September.
- DR. DOLAN: Durham, 7-11 January; BUSS-THP Summer School, Glasgow, 23 August - 6 September; Moscow State University, 15-29 September; ESO symposium, Brighton, 20-23 December.
- DR. GOLDSMITH: University of Padova, 3-30 September; Conference on rings and modules, Bresanone, 1-6 October.
- DR. GARAVAGLIA: International symposium on the Super Collider Maimi, March; APS Spring meeting, Washington April; SSCL Spring meeting on electro-weak physics, May.
- DR. LYNCH: HIRLAM meeting, Helsinki, 6-8 Feb.; NASA/GSFC, Washington, 4 June; NCAR colloquium, Boulder, Colorado, 6 June - 3 July; RPN, Montreal, 3 July; Institute of Geophysics, Cologne 8 Oct.; EWGLAM meeting, Offenbach, Germany, 9-12 Oct.
- DR. GOLDEN: Visiting professor in Dept. of Mathematics and Statistics, Simon Frazer University, Burnaby B.C. Canada, 18 Aug. - 15 Oct.; Memorial University, Newfoundland 11-18 Aug.
- DR. MCGILL: University of Auburn, Alabama, 4-8 Apr.; University College Swansea, 26 June - 9 July; University of Berne, Switzerland, 7 Dec.; Visiting professor, Université Louis Pasteur, Strasbourg, 1 Oct.- 31 Jan.; Seminar on stochastic processes, Vancouver, 10-13 May; Durham Symposium, 12-21 July; Seminaire de Probabilités, Marseille, 21-27 October.
- DR. BURZLAFF: 11th. Dundee Conference on Differential Equations, 3-6 July.
- DR. DUFFIELD: Stochastics and Quantum Mechanics meeting, Swansea, August.
- DR. BUFFET: EPF- Lausanne, 7-14 June: Statistical Mechanics Conference, Edinburgh, 31 July.
- DR. TCHRAKIAN: Durham, Ecole Polytechnique, Paris, Kaiserslautern and Yerevan.
- DR. NASH: Cambridge, U.K., August.
- DR. BIRMINGHAM: University of Mainz, April; Conference on Topological Methods in Quantum Field Theory, Trieste, June.
- DR. GORMAN: University of Notre Dame, U.S.A., Jan.; Laboratoire de Physique Mathematique, Montpellier, Mar. and May.
- DR. O'CONNOR: Imperial College, London, Feb.
- DR. HEFFERNAN: Centre for High Technology Materials, University of New Mexico, Albuquerque, 5-11 Feb., 10-19 Aug.; AT&T

Bell, Telephone Laboratories, New Jersey, 19-24 Aug.

DR. FEHÉR: Conf. on string theory and conformal field theory, Trieste, April; XIVth John Hopkins Workshop on non-perturbative methods in field theory, Debrecen, Hungary, September.

7 Symposia

Two Mathematical Symposia were held during the year, 11-12 April and 20-21 December. The attendance (45 in April, 36 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:

- Dr. P. Fitzpatrick (UCC) *Block codes for error correction*
- Dr. R. Werner (DIAS) *Bell's inequalities*

Lectures:

- Dr. M. Tuite (DIAS) *The monster group and string theory*
- Prof. N. O Murchadha (UCC) *Binding energy in spherical stars*
- Dr. P. Lynch (Met. Service) *Filtering schemes for numerical integration and the Laplace- and Z-transformations*
- Dr. M. Vandyck (RTC Cork) and Prof. N. O Murchada (UCC) *Physical degrees of freedom of the gravitational field in the Ashteker variables*

Short Talks:

- Dr. J. Burzlaff (DCU) *Exponentially - improved approximations in optical tunnelling models*
- Dr. E. Buffet (DCU) *Polymers and random graphs*
- Mr. D. Carrol and Dr. B. Goldsmith (DIT) *Transitive and fully transitive groups*
- Dr. M. Mathieu (UCC and Tubingen) *Some properties of the product of two derivations of a C^* -algebras*

- Dr. P. Dolan (Imperial College, London) *Tensor potentials for gravitational radiation*

December

Review Lectures:

- Dr. A. Wasserman (Cambridge) *von Neumann algebras and conformal field theory*
- Prof. S. Dineen (UCD) *Complex geodesics*

Lectures:

- Mr. S. Hughes (Harvard) *Exotic statistics of particles and solitons*
- Dr. M. van den Berg (Heriot-Watt) *The spectrum of the Dirichlet Laplacian on wild domains*
- Dr. J. Burns (UCG) and Dr. B. Goldsmith (DIT) *Quasi-permutation representations of finite groups*
- Dr. E. Buffet (DCU) *Random walks in random media*

Short Talks:

- Dr. B. McCann (RTC, Waterford) *Normal products of infinite groups*
- Dr. N. Gorman (Maynooth) *Automorphisms of compact lie algebras*
- P. Barry (RTC, Waterford) *Fourier analysis of Bézier curves*
- Prof. M. Newell (UCG) *Engel-elements of length three*
- Dr. C. Thompson (Southampton Univ.) *Rotation numbers for families of functions on the circle*

8 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 section 4.1

Short visits (up to one week):

- A. Bais (Amsterdam) 4-8 April,
- V. Belavkin (Moscow) 24-25 April,
- S. Bellucci (Frascati) 8-16 July,
- M. van den Berg (Heriot-Watt) 16-23 Dec.,
- M. Berry (Bristol) 5 Sept.
- A. Chakrabarti (Palaiseau) 22-29 Oct.,
- A. Chillingarian (Armenia) 16-23 June,

D. Dunbar (Liverpool) 24-27 April,
 S. Gabuda (Novosibirsk) 13-29 Dec.,
 R. Kerner (Paris) 4-9. Nov.,
 F. Lizhi (Cambridge) 21 Nov.,
 V. Malyshev (Moscow) 1-7 Oct.,
 P. McGill (Irwin) 12-18 Dec.,
 G. McKeon (Canada) 14-17 May,
 P. Mansfield (Oxford) 1-7 April,
 M. Rakowski (Oklahoma) 22-29 May,
 T. Sherry (Galway) 15-17 May,
 C. Stephens (London) 17-22 July,
 B. Toth (Heriot-Watt) 4-9 June,
 A. Verbeure (Leuven) 13-17 Nov.,
 B. Zegarliniski (Bohn) 23-29 April
 Longer visits:
 N.S. Ananikyan (Yerevan) 16-30 June,
 A. Balachandra (Syracuse) 26 Apr.-15 May,
 U. Behn (Leipzig) 18 Nov. - 3 Dec.,
 C. Boldrighini (Camerino) 27 July - 10 Aug.,
 A. Burshtein (Novosibirsk) 16-30 June,
 T.C. Dorlas (Swansea) 7-21 July,
 G. Efimov (Dubna) 7-21 July,
 E. Egorian (Yerevan) 16-30 June,
 P. Exner (Prague) 22 Sept. - 13 Oct.,
 M. Fannes (Leuven) 14-23 Jan.,
 G.W. Ford (Ann Arbor) 12 June - 17 July,
 P. Forgacs (Budapest) 17 Mar. - 7 Apr.,
 S. Gabuda (Novosibirsk) 13-29 Dec.,
 S.L. Lukyanov (Moscow) 2-23 June,
 R.F. O'Connell (Baton Rouge) 19 June -
 17 July,
 Z.-Qi. Ma (Beijing) 7 Nov.- 5 Dec.,
 W. McGlenn (Notre Dame) 26 Apr. -
 15 May,
 9-20 Dec.,
 M. Monastyrsky (Moscow) 8-28 May,
 A. Morozov (USSR) 24 Mar. - 7 Apr.,
 M. Olshanetsky (USSR) 24 Mar. - 7 Apr.,
 L. Palla (Durham) 18 Mar. - 1 April,
 C. Pfister (Lausanne) 17-29 Sept.,
 S. Priezhev (Dubna) 7-21 July,
 A.L. Rebenko (Kiev) 6-20 Oct.,
 A.M. Samoilenko (Kiev) 6-20 Oct.,
 R. Sorkin (Syracuse) 22 Apr. - 6 May,
 Yu. Suhov (Moscow) 15 July - 9 Sept.,
 A. Wipf (Zurich) 25 Mar. - 7 Apr.,

V.A. Zagrebnoy (Dubna) 7-21 July,

9 Publications

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

9.1 Books

in press

C. Nash: Differential topology and quantum field theory. Academic Press.

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

None published.

9.3 Contributions to periodical and other publications

M. van den Berg, T.C. Dorlas, J.T. Lewis, & J.V. Pulé: A perturbed mean field model of an interacting boson gas and the large deviation principle. *Commun. Math. Phys.* **127**(1990)41-69.

J. Balog, L. Fehér, L. O'Raiheartaigh, P. Forgacs, & A. Wipf: *Toda theory and W-algebra from a gauged WZNW point of view. *Annals of Phys.* **203**(1990)76-136.

J. Balog, L. Fehér, L. O'Raiheartaigh, P. Forgacs, & A. Wipf: Kac-Moody realization of W-algebras. *Phys. Lett. B* **244**(1990)435-441.

J. Balog, L. Dabrowski, & L. Fehér: Classical r-matrix and exchange algebra in WZNW and Toda theories. *Phys. Lett. B* **244**(1990)227-234.

J. Balog, L. Dabrowski, & L. Fehér: A new quantum deformation of SL(3). *Phys. Lett. B* **257**(1991)74-78.

J. Balog, L. Dabrowski, & L. Fehér: Non-standard quantum group in Toda and WZNW theories. *Proc. XIVth John Hopkins Workshop, Debrecen, Hungary, Pub. World Scientific.*

N.G. Duffield: A large deviation principle for the reduction of product representations. *Proc. American Math. Soc.* **109**(1990)503-515.

- N.G. Duffield: Classical and thermodynamic limits for generalised quantum spin systems. *Commun. Math. Phys.* **127**(1990)27-39.
- H.J.W. Müller-Kirsten, & D.H. Tchrakian: A Skyrme-like lump in 2 Euclidean dimensions. *J. Phys. A.* **23**(1990)L363-L367.
- D.H. Tchrakian: Solitons in R_3 with winding number n . *Phys. Lett. B.* **244**(1990)458-460.
- D.H. Tchrakian: Symmetry breaking Skyrme models in R_d . *J. Phys. A.* **24**(1991)1959-1967.
- D.H. Tchrakian, H.J.W. Müller-Kirsten, & J.-Z. Zhang: *Stability of metastability and eigenvalues of the equation of small oscillations. *Int. J. Mod. Phys.* **5**(1990)1319-1339.
- E. Buffet, & J.V. Pulé: On Lushnikov's model of gelation. *Jn. Statistical Phys.* **58**(1990)1041-1058.
- Ed.Sh. Egorian, & R.P. Manvelian: Canonical formulation of 2D induced gravity. *Mod. Phys. Lett. A* **5**(1990)2371-2375.
- B. Goldsmith, & R. Dimitric: Sir William Rowan Hamilton. *Math. Intelligencer* **11**(1989)29-30.
- M.A. Vandyck: On the problem of space-time symmetries in the theory of supergravity Part IV: Comparison between space-time and superspace formalisms. *GRG* **22**(1990)1259-1270.
- M.A. Vandyck, & Breannán Ó Nualláin: On Robinson's expansion of the axially symmetric Robinson-Trautman metrics. *Class. Quantum Grav.* **8**(1991)769-777.
- D. O'Connor, & C.R. Stephens: Superconductivity in an external magnetic field as a finite size system. *Phys. Rev. B* **43**(1991)3652-3655.
- J. McConnell: Arthur William Conway. *More people and places in Irish Science and Technology ed. by C. Mollan, W. Davis, & B. Finucane, Royal Irish Acad. 1990*
- J. McConnell: The School of Theoretical Physics. *More people and places in Irish Science and Technology ed. by C. Mollan, W. Davis, & B. Finucane, Royal Irish Acad. 1990*
- J. McConnell: Erwin Schrödinger. *More people and places in Irish Science and Technology ed. by C. Mollan, W. Davis, & B. Finucane, Royal Irish Acad. 1990*
- J. McConnell: Walter Heitler. *More people and places in Irish Science and Technology ed. by C. Mollan, W. Davis, & B. Finucane, Royal Irish Acad. 1990*
- J. McConnell: Theory of nuclear magnetic relaxation by anisotropic chemical shift II. *Physica A* **169**(1990)126-138.
- B.P. Dolan: BRST symmetry and quantum mechanics on homogeneous spaces. *J. Phys. A* **23**(1990)4439-4453.
- T. Berger, & I. Tsutsui: Chiral quantum gravity in two dimensions. *Nucl. Phys. B* **335**(1990)245-259.
- T. Berger, & I. Tsutsui: Chiral fermions in 2D quantum gravity. *Z. Phys. C* **49**(1991)337-341.
- T. Berger, & I. Tsutsui: Anomalous aspects of the chiral quantum gravity in two dimensions. *Phys. Rev. D* **43**(1991)1876-1882.
- P. Houston: Geometrical aspects of operator ordering terms in gauge invariant quantum models. *J. Phys. A* **23**(1990)349-365.
- T. Garavaglia et al.: Numerical studies of the SSC injection process. *Supercollider 2 ed. M. McAshan, Plenum 1990*
- T. Garavaglia et al.: Collider ring particle loss with SSCTRK. *Supercollider 2 ed. M. McAshan, Plenum 1990*
- T. Garavaglia et al.: Application of SSCTRK numerical simulation program. *Supercollider 2 ed. M. McAshan, Plenum 1990*
- T. Garavaglia et al.: The effect of magnetic peaking on the dynamic aperture. *SSCL-269 Report, SSCL Tech. Pubs. Dallas, 1990*
- P. Lynch, & A. McDonald: A multi-level limited area slow equation model: Application to initialization. *Quart. J. Royal Met. Soc.* **116**(1990)595-609.
- P. Lynch, & R. McGrath: Hurricane Charlie: Modelling a severe storm with the HIRLAM system. *HIRLAM Tech. Rep. No. 8, pp 83-98 1990.*
- P. Lynch, & R. McGrath: Spectral synthesis on rotated and regular grids. *HIRLAM Tech. Rep. No. 6*

- B.K.P. Scaife, P.C. Fannin, & S.W. Charles: The measurement of the frequency dependent susceptibility of magnetic colloids. *J. Magnetism and Magnetic Materials* **72**(1988)95-108.
- B.K.P. Scaife, P.C. Fannin, & S.W. Charles: The field dependence of the complex frequency-dependent susceptibility of magnetic fluids. *J. Physics D* **21**(1988)533-4.
- S. Ciulli, M. Mounisif, N. Gorman, & T.D. Spearman: On the application of maximum entropy to the moments problem. *J. Math. Phys.* **32**(1991)1717-1719.
- J.M. Golden, & G.A.C. Graham: Energy balance criteria for viscoelastic fracture. *Quart. Applied Math.* **48**(1990)401-413.
- J.M. Golden, & G.A.C. Graham: Asymmetric steady-state solution for a crack in a viscoelastic field of pure bonding. *Inter. J. Engineering Science* **29**(1991)223-235.
- J.M. Golden, & G.A.C. Graham: Stress, strain and area-controlled modes for the steady-state normal viscoelastic contact problem. *Proc. 11th. Annual Conf. Canadian Applied Math. Soc., Halifax, 1989.*
- A.I. Solomon: N cluster Hubbard model: super-algebraic approach. *Proc. 18th. Inter. Colloquium on group theoretic methods, Moscow, 1990.*
- A.I. Solomon, & J. Katriel: On q-squeezed states. *J. Phys. A.* **23**(1990)L1209-1212.
- A.I. Solomon, & J. Katriel: Generalized q-bosons and their squeezed states. *J. Phys. A.* **24**(1991)2093-2105.
- R. Bruch, H. Wang, D. Schneider, L. Lipsky, & M.J. Conneely: Doubly excited states of 3-electron systems ($Z=2$ to 10) below the (is2l) SLII threshold. *Proc. Vth. Inter. Conf. on the Physics of highly-charged ions, Giessen, Germany, 1990.*
- P. McGill: Jacobi elliptic functions and change of variable in a convolution. *Aequat. Math.* **39**(1990)114-119.
- J. Burzlaff, & L. O'Raifeartaigh: On the construction of Higgs sectors. *Proc. Capri symposia 1983-97, ed. F. Buccella, Napoli: Bibliopolis 1990.*
- J.D. McCrea, F.W. Hehl, & E.W. Mielke: Mapping Noether identities into Bianchi identities in general relativistic theories of gravity and in the field theory of lattice defects. *Inter. J. Theor. Phys.* **29**(1990)1185-1206.
- C. Nash: Singularly perturbed Chern-Simons theory. *J. Math. Phys.* **31**(1990)2258-2262.
- D.M. Heffernan, J. McInerney, & Li Yuan: Optical bistability and switching by nonlinear waveguiding in semiconductor lasers. *Technical digest of the SPIE symposium on infrared optical systems, Florida, 1990.*
- D.M. Heffernan, J. McInerney, T. Salvi, & Li Yuan: Optical bistability and switching by nonlinear waveguiding in semiconductor lasers and laser amplifiers. *Proc. SPIE - Int. Soc. Opt. Eng.* **1307**(1990)262.
- IN PRESS
- J. McConnell: Inertial theories of dielectric relaxation in liquids. *J. Molecular Liquids*
- N.G. Duffield: Local correlation functions for mean-field dynamical semigroups on C^* -algebras. *Helv. Phys. Acta*
- N.G. Duffield, H. Roos, & R.F. Werner: Macroscopic limiting dynamics of a class of inhomogeneous mean field quantum systems. *Ann. Inst. H. Poincaré: Phys. Th.*
- E. Buffet, & R.F. Werner: A counter-example in coagulation theory. *J. Math. Phys.*
- E. Buffet, & P. Hannigan: Directed random walks in random environments.
- E. Buffet, & J.V. Pulé: Polymers and random graphs. *Jn. Stat. Phys.*
- M.P. Tuite: Monstrous moonshine from orbifolds.
- M.P. Tuite: 37 New orbifold constructions of the moonshine module?
- R. Göbel, & B. Goldsmith: On almost free modules over complete discrete valuation domains. *Rend. Mat. Sem. Univ. Padova*
- D. Birmingham, H.T. Cho, R. Kantowski, & M. Rakowski: Gauge dependence of the Eta-Function in Chern-Simons field theory and the Vilkovisky-DeWitt correction. *Phys. Rev. D*
- D. Birmingham, R. Kantowski, & M. Rakowski: The Eta function in Chern-Simons field theory. *Phys. Lett. B*
- T. Garavaglia et al.: Quantum variances for transverse SCS injection dynamics. *Proceedings of the Particle Accelerator (APS/IEEE) Conference, San Francisco, May 1991*

- P. Lynch: Filtering integration schemes based on the Laplace and Z transforms. *Monthly Weather Review*
- J. Burzlaff: On the generation of optical solitons. *Proc. 4th. European Conf. on Math. in Industry*
- J. Burzlaff, & A. Wood: Optical tunnelling for square-well potentials. *I.M.A. J. Appl. Math.*
- M.A. Vandyck: An alternative formulation of the WKB approximation in quantum mechanics. *European J. Phys.*
- F.W. Hehl, W. Kopyzynski, J.D. McCrea, & E.W. Mielke: Chern-Simons terms in metric-affine spacetime: Bianchi identities as Euler-Lagrange equations. *J. Math. Phys.*
- D.H. Tchrakian, & A. Chakrabarti: How overdetermined are the generalised selfduality relations?
- H.J.W. Müller-Kirsten, & D.H. Tchrakian: Skyrme-like solitons with absolute scale in 2+1 dimensions.
- J. O'Gorman, B.J. Hawdon, J. Hegarty, P. Jenkins, & D.M. Heffernan: Three frequency chaos in external cavity injection lasers. *J. Modern Optics*
- J. O'Gorman, B.J. Hawdon, & D.M. Heffernan: Stability properties of nonlinear delay systems and the breakdown of the adiabatic principle. *Zeitschrift für Naturforschung*

10 Library

Approximately 50 new titles were added to the library stock during the year; 200 current periodicals were taken, of which almost half were received by gift or under exchange arrangements. The RIA 'permanent loan' collection was maintained. 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.

Annual report of the Governing Board of the School of Cosmic Physics for the year ending 31 December 1990.

1 Staff, Scholars and Associates

SENIOR PROFESSORS: L. O'C. Drury (Director from 17 October), A. W. B. Jacob (from 17 January), P. A. Wayman (Director to 16 October)

PROFESSORS: T. Kiang, A. Thompson, A. W. B. Jacob (to 16 January) (1 vacancy from 17 January)

ASSISTANT PROFESSORS: D. O'Sullivan, T. P. Ray

RESEARCH ASSISTANTS: I. Elliott, P. W. Readman, (1 vacancy)

EXPERIMENTAL OFFICERS: T. A. Blake, J. Daly (to 30 December), B. D. Jordan, W.-M. Tai (from 1 December)

VISITING SCIENTISTS: I. van Breda (Cambridge, England), Fang Li-zhi (Hefei, China; Cambridge, England) K. Stammler (Erlangen, Germany), C. Prodehl (Karlsruhe, Germany)

TECHNICAL AND CLERICAL STAFF: K. Bolster, G. Broderick, A. Byrne, A. M. Callanan, E. Clifton, W. Dumbleton, E. Flood, A. Grace-Casey, C. M. Horan, S. W. Ledwidge, M. Smyth, H. Sullivan, G. Wallace (2 vacancies)

SCHOLARS: J. Bosch (from 1 March), D. Corcoran, P. Duffy (to 30 September), Li Guoping (April to August), R. Keegan (from 1 November), B. M. O'Reilly, S. P. Xiang (from 17 December)

PROJECT SUPPORTED POSITIONS: F. Hauser (RAPIDS, from 1 October), S. Russell (ISOPHOT), H. Walls (RAPIDS)

PROFESSORS EMERITI: H. A. Brück, T. Murphy, C. O'Ceallaigh

RESEARCH ASSOCIATES: C. J. Bean, P. B. Byrne, M. Cawley, M. Hoey, R. Keary, E. Kennedy, N. P. Murphy, W. E. A. Phillips, R. M. Redfern, P. M. Shannon

VACATION STUDENTS: W. Maciejewski, N. O'Mahony, S. Ni Riain, A. Rooney, K. Stanek

2 Research Activities in the Astronomy Section

2.1 Image-Sharpener Studies

P. A. Wayman, R. M. Redfern, I. Elliott

Use of the GHRIL facility in February and March in conjunction with UK groups from Durham and 'Greenwich' was only partly successful due principally to poor winter weather. Records of ADS 6650, the triple star formerly observed with the Swedish Solar Telescope, gave confidence in the value of image sharpening from data recorded with an Imaging Photon Detector (IPD). Good sequences of photon records have been incorporated in a demonstration video that was used at the Galway Workshop in May. Recordings from Virgo galaxies and from the central stars of planetary nebulae were obtained but these have not yet been analysed; they are unlikely to produce more than marginal results because of their brevity.

A new informal agreement has been made with University College Galway and Imperial College, London, to assist in the construction of equipment that will use a PAPA detector instead of the more limited IPD heretofore available. Progress is reported in Section 5 below.

2.2 Spectra of Symbiotic Stars

P. A. Wayman, with J. Mikolajewska (Torun)

Echelle spectra taken with the Kapteyn telescope in 1989 were registered in detail to produce H-alpha and other profiles of ten symbiotic stars using the Starlink routines on the VAX 11-780 of UCD. A variety of interesting profiles are shown by the stars AG Dra, Z And, CH Cyg, AG Peg, R Aqr, EG And and 45 Ari, but these are all substantially constant during the period over which they were observed. T CrB, on the other hand, shows definite profile changes during that period and these are interpreted in terms of changes in the gas streams between the components of the stars. Supplementary observations have been proposed in order to provide necessary records at other wavelength regions.

2.3 CCD Photometry of Planetary Nebulae

M. Hoey

A PC-based image-processing system for images from CCD cameras in FITS format has been developed. The outer limits of luminosity of Planetary Nebulae have been investigated and scattering theory has been applied to measurement of relative intensities at different wavelengths. The observing work was by service observing on La Palma with the Kapteyn telescope in 1987 and 1988.

2.4 Relativity and Cosmology

T. Kiang

A representation of the Horizon Problem has been constructed by a modification of the customary published diagrams that use co-moving and conformal coordinates. These have been made more informative in the former instance by replacing the curve giving the radius of the observable (or observed) universe by that of our 'world-picture'; in the latter instance the axes are re-interpreted. The first representation led to the definition of an epoch t_d dependent on the model of expansion such that all the events before t_d suffer from the difficulty of the horizon problem, and all events after t_d are free of it. The microwave background radiation is shown to be long before t_d for the standard Friedmann model and long after the t_d for the inflationary model. The Penrose diagram using conformal coordinates is the same for all models. It is by identifying its time coordinate with the time integral of the reciprocal scale factor and its space coordinate with the co-moving radial coordinate, thus quantifying the axes differently for different models, that the different behaviours of different models can be made manifest.

In discussing the classical problem of the 'Twins Paradox', it has been found helpful to show side-by-side the spacetime diagrams of both twins (A, the stay-at-home, and B, the traveller). A's world-line in B's diagram is inclined and stretched in the same way as B's world-line in A's diagram - hence the paradox. But the former necessarily contains a discontinuity, because B uses two different coordinate systems, one on going out, one on coming back. The evident discontinuity means that A will finish younger by a factor g , despite the fact that throughout the trip each regarded the other's clock as going slow

by the same factor g . Analytically, the key step in resolving the paradox is the recognition that the form of the Lorentz transformation given in the usual texts refers to a special case, and that in more general situations we must replace the coordinates in the transformation by coordinate-differences.

2.5 History of Astronomy

2.5.1 Grubbs of Dublin

P. A. Wayman, with I. Glass (Cape Town)

The history of the 48-in. Melbourne Reflector from its beginning as a proposal of the Royal Society in 1852, with appreciable Irish participation, through the construction period, 1862-65, under the auspices of the Colonial Government of the State of Victoria, to the transfer of the telescope to Mount Stromlo, Canberra, has been traced in the context of this famous Dublin-built telescope being reckoned a failure. It would appear that more serious than any deficiencies in the instrument, were many unappreciated factors in organisation and funding of the project. Parallels with the unsatisfactory performance of the 24-in. Grubb reflector built for the Royal Observatory, Edinburgh, in 1880 are being investigated.

2.5.2 Hamilton History

P. A. Wayman

The emergence during the year of a copy of a personal pamphlet produced by William Edwin Hamilton (1834-1903) called *Peeps at My Life* has provided fresh views of this eldest son of Sir William Rowan Hamilton. His talents as a student and surveying engineer and his latent literary ability as a journalist in provincial Canada in comparison with the attributes of his famous father have been made more clear and some sidelights on the formative years of the son of a genius are revealed anew.

3 Research Activities in the Cosmic Ray Section

3.1 Star formation studies

T. Ray, D. Corcoran with M. Corcoran

In collaboration with Mundt, Poetzel, Eislöffel and Solf of the Max Planck Institute for Astronomy in Heidelberg the relationship between optical and molecular outflows in the case of high luminosity young stellar objects (YSOs) has been examined. Several jets and Herbig-Haro (HH) objects have now been discovered emanating from the latter. The optical outflows, however, do not appear to be highly-collimated in all cases: a typical example being Cepheus A (Ray, Poetzel and Mundt 1990). It has been found that neither the energy nor the momentum fluxes of the optical outflows are sufficient to drive their associated molecular outflows. The molecular outflows, although they have much lower velocities, appear to be much more extensive than the optical component. Ray, Poetzel and Mundt (1990) have found, however, that the energy and momentum fluxes in both the optical and molecular components scale in the same way with the luminosity of the source. This would indicate that the same physical mechanism is responsible for the origin of both. Edwards, Ray and Mundt (1991) argue that the source of the jets and the driving wind for the molecular outflows is ultimately the YSO's circumstellar disk. Such disks, with Solar System-like dimensions, are detected either directly by sub-millimetre interferometric observations or indirectly by examining the spectral energy distribution (SED) of the source. Edwards, Ray and Mundt (1991) have shown that if there is no disk present (or at least no material within about 1 AU of the star) then there is no outflow. Moreover, where an optical outflow is present, they found that its properties depended only on the accretion luminosity of the disk and not on the luminosity of the underlying star. These observations clearly imply that the disk, and not the star, is the source of the mass outflows. The highest velocity component of the winds from these disks are thought to give rise directly to jets while the somewhat lower velocity component drives the molecular outflow via momentum-conserving shocks.

D. Corcoran (PhD student, DCU) is working with Ray on the nature of bow shocks near YSOs. These bow shocks are generated where a highly-collimated outflow from the young star ploughs into the surrounding medium. Myles Corcoran (a TCD final year physics student) worked for

3 months with D. Corcoran and T. Ray on proper motions of Herbig-Haro (HH) objects as his Moderatorship project. M. Corcoran found that two HH objects (HH35 and HH130) were due to the Herbig Ae star V380 Ori. It was also possible to confirm the exciting source for the HH33/40 jet as an IRAS source.

3.2 Abundance Studies

S. Russell

The second of three papers to be derived from the PhD of S. Russell was published in the *Astrophysical Journal Supplement* series. This presents the first consistent abundance analysis of both HII regions and Supernova remnants in the Magellanic Clouds. The results are based on detailed modeling of medium resolution spectra extending from 3000-11000Å. It was found that there was essentially no zero point error between the low mass abundance scale from the HII regions and the high mass scale of the supergiants (Russell and Bessell 1989). The O/Fe ratio is solar, unlike the metal poor stars in the Galaxy which have an excess of O. Finally, there was a suggestion that the elemental abundances relative to iron in the clouds are more closely related to our local interstellar medium (ISM) than to the Sun itself. The third major paper entitled *Abundances of the Heavy Elements in the Magellanic Clouds III. Interpretation of Results*, has been reviewed and is now undergoing final revision before publication in *Astrophysical Journal*. This paper expands on the results from the previous paper and Russell and Bessell (1989). The C/Fe ratios in the Clouds were found to be solar, in contrast to the HII regions, which were found to be severely depleted in C. A detailed investigation of the heavier elements reveals that the s-process has been as effective in the Magellanic Clouds as in the local ISM up to atomic number $Z=40$ in the SMC and $Z=56$ in the LMC. The pattern of abundances beyond these numbers is, however, consistent with a purely r-process origin, and inconsistent with any contribution from the s-process. These conclusions require further confirmation from the analysis of more data from the Magellanic Clouds, and this is one of the main aims of ongoing research. In addition, analyses of B stars and K giants from young clusters in the Clouds have appeared in the literature recently with derived abundances

much lower (up to 4 times) than the F star abundances. Whether this is merely due to systematic errors in the analyses, or due to a real difference between the evolution of clusters and field stars in the Clouds is being investigated. What ever the result, the answer to this question may have far reaching implications.

3.3 Isophot

L. Drury, T. Ray and S. Russell

Work on refining the observing proposals for the ISO central programme continued throughout the year. The main emphasis was on proposals in the area of low-mass star formation (see also section 7.4). The definition of the Astronomical Observing Templates, which roughly represent the User Requirements for the analysis software, took considerable time, but was substantially finished by the end of the year.

3.4 The Ultra Heavy Cosmic Ray Experiment (UHCRC) on the LDEF Mission

D. O'Sullivan, A. Thompson, J. Daly, J. Bosch, R. Keegan with K.-P. Wenzel (ESTEC), A. Smit (ESTEC) and C. Domingo (UAB)

The NASA Long Duration Exposure Facility (LDEF) was successfully retrieved from Earth orbit in January, just six weeks before the estimated date for re-entry into the Earth's atmosphere. Retrieval was accomplished by the space shuttle Columbia during a ten day mission with launch on 9 January, rendezvous and grapple followed by in-orbit photo survey on 12 January and landing at Edwards AFB on 19 January. The LDEF was transported to Kennedy Space Center by ferry flight on 28 January and was accessible for initial inspection in a large clean room facility from 5 February. The cosmic ray exposure time for the UHCRC detectors in Earth orbit was 5.8 years at an inclination of 28.5° with a geometry factor, allowing for Earth shadowing, of $15 \text{ m}^2\text{sr}$ (single sided).

LDEF de-integration and experiment tray processing began on 23 February and the last of sixteen UHCRC trays was removed on 26 March. In addition to collecting cosmic ray events, its original objective, the retrieved UHCRC hardware had acquired a wealth of other space environment effects. In particular, the outer thermal covers of the UHCRC trays had accumulated about 5000 micrometeorite and space debris impacts. These thermal blankets were distributed

for data extraction and analysis to a NASA Special Investigation Group involving several American laboratories (one third of total area) and to a consortium of European laboratories (two thirds of total area).

The UHCRC hardware was shipped to ESTEC in early April. Six of the forty-eight UHCRC pressure vessels (each of which contains four detector stacks) were selected in ESTEC and transported, along with a ground control pressure vessel, to the Lawrence Berkeley Laboratory Bevalac facility in California for post-flight calibration during May. Approximately one hundred separate exposures to seven ion beams, ranging from 400/1610 MeV/N iron to 920 MeV/N uranium, were successfully implemented at the Bevalac.

Disassembly of the UHCRC hardware at ESTEC began in June and continued into September. A few detector plates were etched during August for "first-look" requirements. Optical examination of these plates suggested that the detectors were in excellent condition and that background was very low, as estimated. The complete set of 192 retrieved UHCRC detector stacks were shipped back to Dublin during October and the first batch of ninety UHCRC detector plates for optical scanning was etched during December.

3.5 The Energetic Particle Analyser (EPA) on the Giotto Mission

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

Analysis of the data on energetic ion and electron fluxes obtained by EPA during the Giotto encounter with Comet Halley continued with emphasis, this year, on the magnetic cavity and the magnetic pile-up region. The flux densities of energetic water group ions ($E > 60 \text{ keV}$) measured in six sectors and four energy channels within Halley's magnetosheath decreased, generally, with decrease of distance from the cometary nucleus for $5 \times 10^5 \text{ km}$ on either side of closest approach with intensities clearly related to magnetic field magnitude and direction. Evidence of the so-called M_1 (Mantle) boundary, a quasistationary structure in the inner coma identified by VEGA magnetometer investigators, was found in the EPA (and MAG) data at 3.0 to $3.6 \times 10^5 \text{ km}$ from the nucleus. This structure had not previously been identified in any Giotto data and appears to coincide with

the start of the magnetic pile-up region. The M_1 boundary scatters the energetic particle fluxes, tending to render them isotropic.

EPA data also show that the first and/or second order Fermi process responsible for ion acceleration in the cometosheath cease to operate at about 4.5×10^4 km from the nucleus, inbound, although the energy spectra become harder with decreasing distance from the nucleus. It appears that energetic ions escaping from the magnetic cavity contribute to the observed spectra in the region. In the magnetic cavity, which has a diameter of about 8000 km at Giotto's trajectory, an unexpected high intensity spike of high energy particles ($60 \text{ keV} < E \leq 10 \text{ MeV}$) was observed by EPA, as previously reported, but the nature of the particles and the acceleration process had not yet been understood. It is now hypothesised that micro-dust particles, with mass in the region 10^{-17} to 10^{-20} grams, are responsible for this spike.

3.6 Nuclear Track Detector Response Studies

A. Thompson, D. O'Sullivan, J. Bosch with C. Domingo (UAB)

Ultra heavy nuclear track response studies during the year centered on the temperature dependence of very short term (less than 10 days) latent track evolution in polycarbonate detectors. In this regard, nine detector stacks, which had been exposed to 1040 MeV/N gold nuclei and 960 MeV/N uranium nuclei, were processed. A total of more than 2000 detector plates from these stacks were etched under standard conditions for periods varying from 8 hours to 72 hours in preparation for optical measurement of tracks, which began in December. With regard to long term (order of years) ageing, detector stacks which had been exposed to successive ultra heavy ion beams were maintained in temperature controlled environments during the year in continuation of a long term LDEF exposure simulation.

3.7 The Energetic Particle Analyser (EPA) on the Giotto Extended Mission (GEM)

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

The Giotto spacecraft reactivation activities started on 19 February using the 70m antenna of the NASA Deep Space Network. Contact with the spacecraft, which was 1.2×10^8 km

from Earth, was successful on the very first attempt. The payload checkout period had to be delayed until 26 April due to the high spacecraft temperatures while passing through perihelion (0.8 AU from the Sun) with thermal control systems which had been damaged in the Halley encounter.

During this checkout period, which ended on 18 May, the EPA instrument was operated in real time mode and found to be working nominally. There was no indication of degradation resulting from the Halley encounter or from the extended period in deep space. Particle count rates were consistent with a quiet interplanetary environment and all housekeeping data showed nominal values.

On 13 June, the ESA Science Policy Committee accepted the recommendation to proceed with the Giotto Extended Mission as an Optional Programme.

The Earth swing-by manoeuvre (the first by any spacecraft) took place on 2 July with the closest approach being 22,732 km above the Earth's surface. EPA was again switched on and was operated, this time, in storage mode. Again, instrument performance was nominal. On 23 July, after confirmation of the trajectory to comet Grigg-Skjellerup, the spacecraft was again powered down into hibernation. The encounter with Grigg-Skjellerup, on the present trajectory, will take place on 10 July 1992.

3.8 The Solar Low Energy Detector (SLED) on the Phobos Mission

A. Thompson, D. O'Sullivan, B. Jordan with S. McKenna-Lawlor (SPCM) and MPAC, KFKI, IKI

Investigation of the ion and electron data obtained by the SLED instrument, while the Phobos-2 spacecraft was in orbit around Mars, continued during the year. Particles of both solar and planetary origin were observed. For both elliptical and circular orbits, especially during periods with spin stabilisation, superimposed particle fluxes appeared which are interpreted as O^+ , O_2^+ and CO_2^+ ions, with $E \geq 55$ keV, which originated as neutral molecules escaping from the Mars atmosphere, became ionised and were then accelerated by the pick-up process in the solar wind.

Spikes observed during circular orbits for two azimuth angles outside the Mars bowshock

may be caused by scattered light and interpreted as evidence for a faint dust ring around Mars along the orbit of the moon Phobos.

3.9 Dynamics of Ionization Cones

L. Drury with D. Breitschwerdt (Heidelberg)

Some strong astronomical sources of ionizing photons are thought to be surrounded by relatively dense toroidal regions of absorption, so that the resultant H-II regions have a conical rather than spherical structure. These ionization cones have been observed in active galactic nuclei and similar structures are seen in some protostellar objects. The dynamical evolution of such conical H-II regions will differ from that of spherical H-II regions because matter can flow out through the sides of the cone, thus lowering the recombination rate in the H-II region and modifying the dynamics of the ionization front. A simple model was developed to estimate this effect and applied to recent VLA observations of the compact H-II region NGC6334(A)

3.10 Time dependent diffusive acceleration of test particles at shocks

L. Drury

The time dependence of diffusive shock acceleration is important because in many cases it is the finite age of the system which limits the energies to which the process can accelerate particles. In particular the maximum energy to which protons can be accelerated in ordinary supernova remnants is largely determined by age considerations. Analytic expressions were found for the mean and the variance of the acceleration time distribution in the case where the diffusion coefficient has an arbitrary dependence on position and momentum and used as the basis for an approximation scheme. Comparison with numerical solutions showed that the approximation gives an excellent representation of the spectral shape at the cut-off in most cases.

3.11 Numerical calculation of shock acceleration

P. Duffy

The acceleration of particles including the reaction of the particles on the shock structure was studied using a Godunov scheme on a hierarchical grid. Unlike earlier studies the momentum dependence of the diffusion coefficient was taken

to be what is physically expected, namely proportional to momentum in the relativistic range and to momentum squared in the non-relativistic range. A preliminary comparison with the closure approximations made in the simplified two-fluid models indicates reasonable agreement.

4 Research Activities in the Geophysics Section

4.1 Gravity

T. Murphy, P. W. Readman with staff of University of Hamburg

4.1.1 Marine Gravity Surveys

A colour map incorporating the marine gravity data collected by the DIAS in collaboration with the Geophysics Institute of the University of Hamburg with all the land gravity data collected by the DIAS was completed during the year. This has produced a map covering a larger area than the previous one and so has allowed the observation and analysis of larger scale features in the gravity field.

4.1.2 Onshore Gravity Surveys

Eight of the half-inch series of gravity maps have now been printed and four more are in an advanced state of preparation. The process involves very extensive and careful checking of the data on file and on preliminary plots.

4.2 Meteorology

K. Bolster

Limited measurements continue to be carried out at Leinster Lawn and on the roof of 5 Merrion Square 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 temperature and rainfall are made on standard forms. Archival and current records remain available to interested enquirers, students, etc.

4.3 Seismic Work

4.3.1 The Seismic Network

K. Bolster, C. M. Horan, A. W. B. Jacob, G. Wallace

The network was unchanged at six stations, three each in DNET and ENET. Maintaining elderly equipment continued to be a problem during the year. Electrical surges due to thunderstorms caused damage to circuits on more than one occasion. Steps are now being taken to install some surge protection as these incidents seem to be occurring more often than before. We had assistance from the Seismology Unit of the British Geological Survey with a maintenance visit from R. Young in August. We are most grateful for this support. The site (DLE) at Lyons Estate has had to be moved and renamed DLF. The installation was not complete by the end of the year and four months recording time has been lost. As a partial substitute, a new station (DMS) has been put in the basement in Merrion Square. The surroundings are noisy but the larger events are being recorded satisfactorily on a Lennartz chart recorder.

4.3.2 DNET Events for 1990

There were no onshore events during 1990, the nearest being in the Irish Sea. Three quite close to the Irish coast occurred in February, May and June. One event, on 13 December, gave rise to many macroseismic reports from Co. Wicklow and Co. Dublin but no seismic wave was recorded. Its origin is uncertain. The largest regional event took place in Shropshire, England on 2 April. It had a magnitude $ML=5.1$ and was felt on the East coast of Ireland. It was one of the largest British earthquakes this century.

The network recorded some major and disastrous earthquakes overseas. On 30 May a very deep magnitude 6.7 (Mb) event in Romania caused some deaths and widespread damage. The most serious event occurred on 20 June in Iran where a magnitude 7.7 MS earthquake killed around 50,000 people. The real total will probably never be known. Events in the Philippines (July) and Sicily (December) also caused deaths, injuries and severe damage.

4.3.3 Celtic Onshore-Offshore Lithosphere Experiment - COOLE

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

B. M. O'Reilly completed his thesis, based

mainly on seismic results obtained in COOLE, and a paper has been published (O'Reilly, Shannon, Vogt). While the work was based initially on data gathered in the North Celtic Sea Basin, the model makes predictions that will be tested by the final Rockall Trough model that emerges from the RAPIDS project (see below).

4.3.4 Lower Lithospheric Studies and the Iberian Experiment (ILIHA)

A. W. B. Jacob, C. Horan, G. Wallace

The data collected in Iberia in late 1989 had to wait for the end of the fieldwork in Kenya before it could be processed (see KRISP, below). DIAS demodulation equipment was taken to Karlsruhe and installed in their digitizing system. Data from other institutes was digitized in one of three other centres (Madrid, Paris and Zurich). Preliminary seismic sections were available early enough to present some results at the European Seismological Commission meeting in Barcelona in September. As more data was processed, a short workshop was held in Paris in November. The main Geophysics Section interest is in the lower lithosphere and the data for this is excellent though the azimuthal control is not complete. Very well separated lower lithospheric phases show sub-horizontal layering which may be generated by crystalline alignment of olivine in the mantle.

4.3.5 Seismic Project in Kenya - KRISP

A. W. B. Jacob, T. A. Blake, C. M. Horan, B. M. O'Reilly, P. W. Readman, G. Wallace with European and American groups

This experiment finally got under way in January, one year later than originally planned. It has turned out to be a most successful seismic refraction study of the East African Rift, with very good data along almost the whole length of the Rift in Kenya, along a transverse line from Lake Victoria in the west to the eastern flank of the Rift near Chanlers Falls, and on a flank line extending SE from the southern end of Lake Turkana. The DIAS seismic stations, which were developed in the Geophysics Section, were one of only two types of station selected for the experiment (the other stations were provided by the US Geological Survey). Both types are compact, light, and extremely robust. It is a tribute to the operators (Blake, Horan, Readman) and our Senior Technician (Wallace) that the DIAS equipment produced such good results in

very hostile conditions. Temperatures on one profile reached 47 degrees Celsius.

The other major DIAS contribution came in the planning and execution of the seismic shooting. Previous expeditions had experienced very great difficulty in generating sufficiently energetic seismic waves. Good signal-to-noise ratio is vital for successful interpretation and that has been achieved in KRISP. Jacob (DIAS), Vees (Clausthal, FRG) and Braile (Purdue, USA) planned the shots and Jacob, O'Reilly and Wallace, together with A. Mussett (Univ. Liverpool) were the shot party responsible for the Lake Baringo shot point. This lay at the crossing of the axial and transverse lines and more shots were fired there than at any other point.

The DIAS records were digitized in Karlsruhe in the same way as for ILIHA and the first interpretation workshop was held near Karlsruhe in August. This produced a preliminary model which was presented at the IASPEI meeting in Nairobi later that month. C. Prodehl (Univ. Karlsruhe) spent some time in DIAS in October and the interpretation of the flank line was further developed. Two posters were presented at the American Geophysical Union Meeting in San Francisco in December and the opportunity was taken to get the scientists involved together in a workshop before and after the meeting.

4.3.6 GEOTWIN

A. W. B. Jacob, C. J. Bean with Prodehl (Karlsruhe) and Stammler (Erlangen)

This EC-funded programme was completed during the year and the final report was written and accepted. It has been a most valuable collaboration. One very useful outcome has been the development of a program for manipulating and interpreting seismic refraction data on a workstation. Modelling directly onto the seismic sections speeds and improves the interpretation.

4.3.7 RAPIDS - Seismic Profiles in the Northeastern Atlantic

A. W. B. Jacob, P. M. Shannon, C. J. Bean, K. Bolster, C. M. Horan, Li Guoping, F. Hauser, P. W. Readman, G. Wallace, H. Walls with University of Hamburg

This was the second major seismic project carried out during the year. It was a follow-up to the 700 km of profiles recorded in September/October 1988. The weather had been very bad during that cruise but the 1990 work took place in May and June in much better weather.

The original profile was extended westwards by a further 300 km and a 600 km axial line was run in the Rockall Trough. This was planned to reach true oceanic structures south of the mouth of the Trough. More stations were deployed on this occasion and about twice as much data has been recorded. Processing of the records began almost immediately after the cruise and continued to the end of the year. During that time, two DIAS staff usually spent half of each month in Hamburg. To get relatively unimpeded access to the processing facilities, most of the work has to be done at night. The bulk of the good records had by then been digitized. Interpretation was due to begin in the new year. Preliminary indications are that the transmission of seismic energy has again been good. Two of the lines, both in the Rockall Trough, have quite good reflection seismic data on or close to them. This is a useful contribution to shallow control.

4.4 Palaeomagnetism

P. W. Readman with N. Abrahamsen (Aarhus)

4.4.1 Cave sediments

Analysis of the palaeomagnetic record derived from the sediment deposited in a cave near Schoharie, New York, U. S.A. was finalised and published.

4.4.2 Irish deposits

A programme of work to investigate the geomagnetic secular variations during Late Glacial times was started in collaboration with the Botany Department, University College Galway (Dr. M. O'Connell and A. Paus) and the Earth Science Department of the Free University of Amsterdam (S. Bohnicke). Several sites in Connemara and Co. Clare were sampled in May using a Livingstone corer after sediment thicknesses had been mapped using narrow-bore sampling tubes. Palaeomagnetic samples are being taken as the cores are reopened for the pollen and other analyses. The indications are that a continuous record of the Late Glacial spanning about 1.5 m of sediment will be available. It is hoped eventually to obtain a good record of the geomagnetic field variations during the Late Glacial which will not only be useful from a geophysical point of view for analysis of the geomagnetic field, but will also serve as a dating tool for workers in other disciplines.

5 Facilities

5.1 Image-Sharpening Equipment

B. D. Jordan, I. Elliott

In order to provide compatibility with the proposed Imperial College PAPA detector, an improved IPD interface was built using a wire-wrap extended Eurocard, with front panel and two ground planes to improve noise stability. The new interface incorporates larger FIFO memory and event counter, as well as other features needed for compatibility. Equipment to control the tip-tilt mirror in the Imperial College speckle camera used a Transputer motherboard and two TRAM modules. One of these controls the high-voltage power supplies for driving a pair of piezoelectric crystals that tilt the mirrors, and the other, with a T800 Transputer, contains the required software. A 19-inch rack, incorporating a standard Transputer back plane was constructed to house the detector interface and the remainder of the equipment to control the speckle camera.

5.2 Servo Motor Drive

B. D. Jordan

The lead screw and specimen table of the Joyce Loebel densitometer were adapted to be operated by a 45 watt d.c. servomotor, with a 12-bit incremental encoder and tacho generator on a single shaft. With alternative drive by a stepping motor, the table is convenient for testing the hardware and software for the single-axis control system under development. Through a digital to analogue converter, the RGO 6303 microcomputer controls a d.c. servoamplifier so that it acts as a torque amplifier to the servomotor. The incremental encoder is interfaced to the control computer. The software specification and command structure was written, incorporating speed control based on a comparison of desired and actual shaft angular position. A programmed digital filter will ensure smooth motor operation.

5.3 Solid state nuclear track detector laboratory

J. Daly

The two etching baths were completely overhauled and a third bath constructed. The

temperature control system was improved by substituting thyristor control circuits for the mechanical relays formerly used. The stack holders were adjusted to take the UHCRE plates.

5.4 Mechanical Workshop

J. Daly

It was decided to close the mechanical workshop in the basement of 5 Merrion square and make this space available for alternative use.

5.5 Geophysics Instruments

G. A. Wallace, C. Horan

The seismic field stations, which worked extremely well in Kenya early in the year, are kept charged with their clocks running and ready for use. The clocks are now very stable and field operation has been simplified by merely checking clock corrections before and after recording and omitting the radio receiver in each station.

The spare Willmore MkIII A seismometers (used in the fixed network) were repaired and serviced during the year, as were some that were temporarily out of use due to the closure of DLE. The opportunity was also taken to carry out extensive maintenance on electronic equipment associated with the network. A considerable amount of time was spent on work associated with the reestablishment of DNET and the recording site move at Lyons Estate.

5.6 Computers

5.6.1 Merrion Square

T. Blake

Some changes and improvements to the MicroVax system have been made, particularly with regard to communication with the outside world. The installation of a DPV11 synchronous interface in the MicroVaxII, and PSI software, took place in March. The Seismic Bulletin Board software from BGS Edinburgh was also installed on the MicroVaxII and two modems were bought. A Lima 5000 is being used for general remote logon and a Lima 4000 is for the Seismic Bulletin Board captive account.

The MV2000 computer was taken out of commission and sold in April. At various times throughout the year, detailed discussions took place with possible suppliers of hardware including disk storage, plotters, Unix boxes.

An intermediate seismic ray-tracing package (RAY84/87, J. Luetgert, USGS) was obtained from Copenhagen (H. Thybo) and Zurich (J. Ansorge) and implemented on the 286/386 PCs and the MicroVax system respectively.

The Decnet was configured to allow X.25 connection to the European Space Agency's Data Distribution Network, a tail circuit of which is shared by EOLAS and the Institute.

The Sun SparcStation I proved very reliable and was used extensively for image analysis with the MIDAS system. An external 661MB Fujitsu disc was purchased and provided adequate storage capacity for most of the year; however by the end of the year space on the file system was again becoming congested. The EUNet connection was moved to the Sun early in the year with a considerable improvement in performance.

5.6.2 Dunsink Observatory

I. Elliott

The one substantial addition to the computer equipment has been the purchase of a Hewlett-Packard LaserJetIII printer. Existing software packages were configured to make use of the Postscript facility.

The leased line connection to the UCD computing centre has been maintained satisfactorily and was used extensively with Starlink software and magnetic tape data held in UCD.

5.7 La Palma Observatory

The Advisory Committee for La Palma met twice. In response to a request from EOLAS and with support of that body, responsibility for giving advice on proposals for use of the Hubble Space Telescope has been assumed. The defect in the optical elements is seriously delaying the observing programme and the one proposal from Ireland that was scheduled in the General Observer programme of the first year is now expected to be undertaken during the second half of 1991.

Recommendations on the allocation of travel funds for observing work were made in respect of the period September 1990 to August 1991 (Semesters S and T). The Committee was represented at the meetings of the UK Panel for Allocation of Telescope Time by B. McBreen (UCD) on 9-10 January and 11-12 July and by P. A. Wayman on 13-14 December.

R. M. Redfern attended meetings of the La Palma Users' Committee, the GHRIL Users Committee and the GHRIL Instrument Committee, some of which were held in Ireland, during the year. T. P. Ray, invited to join the Space Telescope - European Coordinating Facility Users' Committee, in respect of the Hubble Space Telescope, attended one meeting.

Two Information Sheets (Nos. 22 and 23) were issued during the year.

The Governing Board supported the holding of a Workshop on High-Resolution Imaging, attended by some fifty-five scientists from six countries, in the Physics Department, UCG, 23-24 May.

At the invitation of the Governing Board, a meeting of the UK Science and Engineering Research Council La Palma Users' Committee was held at 10 Burlington Road on 18 October. On 19 October members of the Committee visited 5 Merrion Square, where illustrations of work in progress were provided by the Astronomy and Cosmic Ray Sections.

5.7.1 La Palma Visits, 1990

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

- T. P. Ray and D. Corcoran, WHT, 5-10 January
- R. M. Redfern and P. O'Kane (UCG), WHT, 2-6 February (postponed from November 1989)
- R. M. Redfern and P. O'Kane (UCG), WHT, 27 February - 6 March
- R. Ekins (UCD), JKT, 14-20 September

Service observing work by over-rides for B. McBreen et al., in connection with gamma-ray sources observed in the Sigma satellite programme, was scheduled but not implemented.

6 Seminars, Colloquia, Lectures

6.1 Statutory Public Lecture

The statutory public lecture entitled *High Energy Phenomena associated with Young Stellar Objects* was delivered by Dr. Thierry Mont-

merle (CEN Saclay, France) on 6 September in Trinity College, Dublin.

6.2 Seminars in the School

- 2 March: H. Reeves (CEN Saclay) *Cosmochronology*
- 20 March: D. Breitschwerdt (Universität Heidelberg) *Is there a Galactic Wind?*
- 3 May: M. Doherty (MPI für Kernphysik, Heidelberg), *Energetics of the Solar Wind*.
- 29 May: T. Weekes (Whipple Observatory, Tucson) *VHE Gamma Ray Observations of the Crab*.
- 29 June - 2 Aug: P. A. Wayman, with assistance from T. Kiang and T. P. Ray, gave a series of lectures for vacation students, covering a variety of topics.
- 18 September: Dr I. van Breda (RGO, Cambridge), *Photon Detection and new trends in Charge-Coupled Devices*.
- 21 November: Prof. Fang Li-zhi (Hefei and Cambridge), *Periodicity of Large-Scale Structures in the Universe*.

6.3 Lecture Courses

P. A. Wayman contributed 12 lectures on *Topics in Stellar Physics* to Maths Course 444 for Senior and Junior Sophister students at Trinity College Dublin, during the Michémas Term.

I. Elliott gave a course of 17 lectures on *Introductory Astrophysics* to Junior Sophister students in Trinity College during the Hilary and Michémas Terms.

L. Drury contributed two lectures on *Cosmic Ray Astrophysics* to the SERC predoctoral school in Belfast on 5 September.

D. O'Sullivan delivered a course of 8 lectures to junior sophister students at TCD on *Cosmic Ray Astrophysics*.

T.P. Ray delivered his usual lecture course in TCD on *plasma astrophysics*.

6.4 Contributions to Scientific Meetings

- L. Drury gave an invited talk on *Cosmic Ray Acceleration* at the 21 International Cosmic Ray Conference in Adelaide on 10 January.

- L. Drury gave two talks, *Shock Acceleration of Cosmic Rays* and *Acceleration Theory* at the Erice Advanced Study Institute 26 July to 5 August.
- T. Kiang spoke on *Resolution of the Twins Paradox with Diagrams* at the meeting of the Irish Astronomical Science Group in the Regional Technical College, Cork, on 17 September.
- D. O'Sullivan delivered an invited talk on initial results from the Ultra Heavy Cosmic Ray Experiments on LDEF at the International Conference on Particle Tracks in Solids held at Marburg, on 3-7 September.
- T. P. Ray gave a talk on the relationship of optical to molecular outflows at the Manchester meeting on 30 March.
- T. P. Ray, R. Mundt and S. Edwards gave an invited review on *Stellar Jets* at the Protostars and Planets III meeting held in Tucson from 4-13 March.
- S. Russell presented a paper entitled *Elemental Abundances in the Magellanic Clouds* at the Irish Astronomical Science Group meeting in QUB on 6 April.
- S. Russell presented a poster paper *Chemical Abundance Constraints on the Star Formation History of the Magellanic Clouds* at the NATO Advanced Studies Institute on *Physics of Star Formation and Early Stellar Evolution*, Crete, 27 May-8 June.
- S. Russell presented a poster paper *The Chemical Evolution of the Magellanic Clouds* at the IAU Symposium No. 148 in Sydney, 9-13 July.
- S. Russell presented a poster paper *Heavy Element Abundances in the Magellanic Clouds* at the IAU 5th Asian-Pacific regional Astronomy Meeting, Sydney, 16-20 July.
- A. Thompson presented two poster papers entitled "Retrieval from Earth orbit of the Ultra Heavy Cosmic Ray Experiment on the LDEF Spacecraft" and "The Influence of Latent Track Variations on Ultra Heavy Nuclei Identification with Solid State Nuclear Track Detectors" at the 21st International Cosmic Ray Conference, Adelaide, Australia, 6-19 January.

- P. A. Wayman spoke on the early history of Dunsink and Armagh Observatories at the Stated Meeting of the Royal Irish Academy on 16 March.
- P. A. Wayman addressed the Scientific Instrument Society on *The Melbourne Reflector and the Vienna Refractor of Thomas and Howard Grubb* at their meeting in the Royal Dublin Society on 15 May.
- P. A. Wayman contributed to the Workshop on High-Resolution Imaging at University College, Galway, with a talk on *Design Considerations of Eight-Metre Mirrors* on 23 May.
- L. Drury gave an invited talk *Review of Diffusive Shock Acceleration* at the international symposium on *Origin of the highest energy Cosmic Rays* held in Kofu (Japan) from 26 to 29 November.
- A. W. B. Jacob gave a lecture, *Seismic Structure of the Kenyan Rift*, to the Irish Geological Association in TCD, 4 April.
- A. W. B. Jacob and C. J. Bean, *P-wave sections in a realistic anisotropic lithosphere*, Fourth International Workshop on seismic anisotropy, Edinburgh, 2-6 July
- C. Prodehl with A. W. B. Jacob et al., *The KRISP seismic refraction investigation of the East African Rift in Kenya*, Regional IASPEI Meeting, Nairobi, August 1990
- J. Diaz with A. W. B. Jacob et al., *The ILIHA deep seismic sounding experiment: lithospheric sampling of the Iberian peninsula*, XXII General Assembly of the European Seismological Commission, Barcelona, 17-22 September
- D. Cordoba with A. W. B. Jacob et al., *Seismic reflectivity and velocity in the sub-crustal lithosphere of Iberia*, XXII General Assembly of the European Seismological Commission, Barcelona, 17-22 September
- L. W. Braile with A. W. B. Jacob et al., *New models for the Kenyan Rift* at the 1990 Fall Meeting of the American Geophysical Union, San Francisco, 3-7 December.
- G. R. Keller with A. W. B. Jacob et al., *The Kenya Rift International Seismic Project (KRISP)* at the 1990 Fall Meeting of the American Geophysical Union, San Francisco, 3-7 December.
- M. Ford with P. W. Readman and C. Brown, *The analysis and tectonic interpretation of gravity data over the Variscides of SW Ireland*, UKGA, Plymouth, 18-20 April.

6.5 External Seminars

- L. Drury gave a seminar *Cosmic Rays and Supernova Remnants* at CEN Saclay on 26 April.
- S. Russell gave a seminar at Mount Stromlo Observatory in Canberra Australia on 26th July 1990 entitled *The Infrared Space Observatory (ISO)*.

6.6 Popular Lectures

I. Elliott gave a course of 10 lectures on *An Introduction to the Solar System* to extra-mural students in UCD during the autumn term.

At the Irish Astronomical Society P. A. Wayman spoke on *Hipparcos - How and Why* on 5 March and on *Large Mirror Design Considerations* on 28 April.

P. A. Wayman spoke on *The Big Bang - Fact or Fiction* at the Callan Science Society, Maynooth College, on 26 November and at the Cork Astronomy Club on 3 December.

I. Elliott gave the opening lecture on *Solar Activity* at the week-end meeting of the West Cork Astronomical Society on 31 March and the opening lecture on *The Beginning of Time* at the Whirlpool Star Party organised by the Limerick Astronomy Club at Birr, Co. Offaly, on 15 September.

L. Drury gave a talk *Cosmic Rays - Cosmic Mystery?* to the Physics Society in DCU on 8 March.

D. O'Sullivan delivered a talk entitled 'Particles Near and Far' to the Scientific Society of UCD on April 16.

I. Elliott addressed the Physical Society of Trinity College Dublin on 15 November on *Chaos in the Cosmos*.

P. A. Wayman addressed the American Women's Club in Dublin on 15 March and, at the request of the Minister for Science and Technology, spoke to a group of European Community scientists visiting in respect of the CREST programme at the site of the Rosse Telescope, Birr Castle, on 18 May.

The programme of Public Open Nights continued on fourteen nights during the year. New slide and video material was assembled, with some assistance from vacation students A. Rooney and S. Ni Riain. Visiting groups at Dunsink Observatory during the year included the Antiquarian Horological Society, the School of Celtic Studies, the Royal Dublin Society Youth Science and Arts Week, the Irish Mathematical Society (Hamilton Walk on 16 October), and the Finglas Arts Festival organisation. Other visitors included Sir Francis and Lady Graham-Smith (Jodrell Bank) and Dr Thierry Montmerle (Saclay).

7 Organisation of Meetings

7.1 International Cosmic Ray Conference 1991

D. O'Sullivan, N. Porter

The local organising committee continued with preparations for the 22nd International Cosmic Ray Conference, to be hosted by the Institute in the Trinity Conference Centre in August 1991. A very successful *Irish Evening* (sponsored by Bord Fáilte) was held at the Adelaide conference in January to promote the Dublin meeting. In September the first circular was printed and distributed to some 1000 scientists worldwide. A conference secretariat was established in 5 Merion Square.

7.2 EADN Summer School

T. Ray

In September, for two weeks, DIAS hosted the 3rd European Astrophysical Doctoral Network (EADN) Summer School. This was held in Trinity College with the cooperation of the TCD Physics Department. Close to sixty students from various parts of Europe attended the School with the themes *Central Activity in Galaxies* and *From Observational Data to Astrophysical Diagnostics*. The proceedings of the school will be edited by Ray and Sandqvist (Stockholm Observatory) and published by Springer-Verlag.

7.3 IAU Colloquium No. 136

P. A. Wayman, I. Elliott

The International Astronomical Union has approved the holding at Trinity College Dublin of a Colloquium *Stellar Photometry - Current Techniques and Future Developments*, from 4 to 7 August, 1992. This will be the first IAU scientific meeting held in Ireland since 1982; it marks the 100th anniversary of the first photoelectric observations of starlight made in Dublin by Monck and Dixon in 1892. A Local Organising Committee has been formed with P. A. Wayman as chairman and I. Elliott as secretary.

7.4 Solar-Terrestrial Science Symposium

A. Thompson

The International Symposium on the Study of the Solar-Terrestrial System will be held in Killarney during the week 15-19 June 1992. The Symposium is being organised by the European Space Agency in association with Irish institutions and sponsored by the Inter-Agency Consultative Group for Space Science (IACG) and the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP). The Local Organising Committee met several times during the year and preparations are on schedule.

7.5 ISO working group on star formation

S. Russell

The first meeting of the ISO Star Formation Working Group was held in Dublin, 15-16 March, and attended by representatives of all four instrument consortia. The second meeting was held in Frascati, Italy, 15-16 October. Both meetings were chaired and organised by Dr. Russell.

8 External Work

8.1 Astronomy Section

P. A. WAYMAN: Royal Astronomical Society, London, 9 March, 14 December; Royal Astronomical Society, Glasgow 4-6 April; Hubble Space Telescope launch, Cape

Canaveral, 10-12 April; High-Resolution Imaging Workshop, UCG, 23-24 May; International Science Council for the Canary Islands, Utrecht, 28-29 May; Official opening ceremonies at the Royal Greenwich Observatory, Cambridge, 14 June; Opening ceremonies for the Bicentenary Year (1990-91) of the Armagh Observatory, 26 July; European Southern Observatory, Garching, 11-12 December.

- B. D. JORDAN: High-Resolution Imaging Workshop, UCG, 23-24 May.
- I. ELLIOTT: High-Resolution Imaging Workshop, UCG, 23-24 May; International Colloquium on *Surface Inhomogeneities in Late-Type Stars*, Armagh Observatory, 24-28 July.

8.2 Cosmic Ray Section

- L. DRURY: The 21st International Cosmic Ray Conference, Adelaide, Australia, 5-22 January; Paris (ESA), 23 January; Heidelberg, 27-30 March; Paris (Saclay), 25-26 April; Erice (Italy), 26 July-5 August; Schloß Ringberg (Germany), 12-16 November; Kofu (Japan), 26-29 November.
- A. THOMPSON: The 21st International Cosmic Ray Conference, Adelaide, Australia, 5-24 January; LDEF de-integration, LDEF/UHCRE meetings and UHCRE hardware processing at Kennedy Space Center, Florida, 7 February - 11 March; GEM Science Working Team meeting, ESOC, Darmstadt and ICPTS, Marburg, 3-6 September.
- D. O'SULLIVAN: The 21st International Cosmic Ray Conference, Adelaide, Australia, 6-19 January; UHCRE inspection and dismantling, Kennedy Space Center, Florida, 10-19 February and 15-28 March; ICPTS, Marburg, 3-7 September; Giotto Extended Mission meeting, ESOC, 15 September. Represented Irish Branch of Institute of Physics at meeting in London, 2 May and 17 October.
- J. DALY: UHCRE hardware post-flight testing and disassembly with extraction of detector stacks, ESTEC, the Netherlands, 3-13 April, 6-23 June and 7 August - 2 September.

T. P. RAY: Meeting on Molecular Clouds, Manchester, 30 March; Protostars and Planets III, Tucson, 4-13 March.

- S. RUSSELL: ISOPHOT consortium meeting, Heidelberg, 28-29 March; ISOPHOT consortium meeting, London, 11-12 June; IAU Symposium No. 148, Sydney, Australia, 9-13 July; IAU 5th Asian-Pacific regional Astronomy Meeting, Sydney, Australia, 16-20 July; The Astronomical Science Group of Ireland Autumn Meeting, Cork, 17 September; The second central programme meeting for ISO, Elmau, F. R. Germany, 12th - 16th November.

8.3 Geophysics Section

- C. J. BEAN: RAPIDS-2 experiment, NE Atlantic, 21 May - 6 June; RAPIDS-2 processing, Hamburg, 9-20 July.
- T. A. BLAKE: KRISP field work in Kenya, 15 Jan - 20 Feb; QUASH visit to Karlsruhe, 9-14 April; DECUS conference, Dublin City University, 29-31 Aug; RAPIDS-2 processing visit to Hamburg, 8-22 Nov.
- K. BOLSTER: RAPIDS-2 experiment, NE Atlantic, 6-24 June; Seismic data processing, BGS, Edinburgh, 18-24 April.
- F. HAUSER: RAPIDS-2 processing, Hamburg, 8-22 Nov, 5-19 Dec.
- C. M. HORAN: KRISP fieldwork in Kenya, 15 Jan - 20 Feb; KRISP equipment collection, Karlsruhe, 25 Mar - 1 April; RAPIDS-2 experiment, NE Atlantic, 21 May - 6 June; RAPIDS-2 processing, Hamburg, 9-20 July, 14-28 Aug, 19 Sept - 3 Oct, 8-12 Nov.
- A. W. B. JACOB: KRISP experiment in Kenya, 12 Jan - 20 Feb; EPOCH grant assessment, Brussels, 12-14, 19-22 March; Seismic data processing, BGS, Edinburgh, 18-24 April; RAPIDS-2 visit to Hamburg, 2-4 May; GEOTWIN final report, visit to Karlsruhe, 28 May - 1 June; 4th International Conference on Seismic Anisotropy, Edinburgh, 1-6 July; KRISP Workshop, nr. Karlsruhe, 6-12 Aug; European Seismological Commission, Barcelona, 16-22 Sept; ILIHA Meeting, Paris, 22-25 Nov; KRISP Workshop and AGU Meeting, San Francisco, 29 Nov - 11 Dec.

- LI GUOPING: RAPIDS experiment, NE Atlantic, 21 May - 24 June.
- B. M. O'REILLY: KRISP fieldwork in Kenya, 16 Jan - 19 Feb.
- P. W. READMAN: KRISP fieldwork in Kenya, 15 Jan - 20 Feb; XV General Assembly EGS, Copenhagen, 23-27 April; University of Aarhus, Denmark, 28 April - 2 May; Palaeomagnetic work, West of Ireland, 9-12 and 15-17 May; RAPIDS-2 experiment, NE Atlantic, 6-24 June; Gravity work in University of Hamburg, 20 Nov - 20 Dec.
- G. WALLACE: KRISP fieldwork in Kenya, 5 Jan - 20 Feb; KRISP equipment collection, Karlsruhe, 25 Mar - 1 April; Set-up of digitizing equipment, Karlsruhe, 13-15 May; RAPIDS-2 experiment, NE Atlantic, 21 May - 24 June.
- H. WALLS: RAPIDS-2 processing, Hamburg, 14-28 Aug, 19 Sept - 3 Oct and 5-19 Dec.

9 Miscellanea

A Reception and Exhibition in Dublin Castle on 5 November marked the 50th Anniversary (Golden Jubilee) of the Dublin Institute for Advanced Studies. The three Sections contributed a range of exhibition material for the exhibition.

P. A. Wayman was renominated to the Management Committee of the Armagh Observatory and Planetarium.

P. A. Wayman continued as Chairman of the National Committee for the History and Philosophy of Science in the Royal Irish Academy. He gave the opening address at the RIA Workshop *Methodology of Economics* on 23 November.

A. Thompson continued as Secretary of the National Committee for Physics in the Royal Irish Academy.

The (European) Scientific Instruments Society held a meeting in Dublin at the invitation of the Royal Dublin Society on 15-17 May and included in its programme a visit to Dunsink Observatory for viewing the instrument collection. *An Inventory of Historic Scientific Instruments in Institutional Collections included in the Visit* by Charles Mollan, was produced by the RDS and EOLAS and this includes an index of 1342 items available at Dunsink, Maynooth, the National Museum, the RDS, TCD and UCD.

T. Kiang continued as Translation Editor of the Pergamon Press journal *Chinese Astronomy and Astrophysics*. Volume 14 (pp.480) was produced during the year.

UTV (N. Ireland) recorded material at Dunsink Observatory during September in connection with a programme marking the Bicentenary Year of Armagh Observatory; RTE obtained material at Dunsink for a 'Jo-Maxi' programme on 14 December.

A group from Dun Laoghaire College of Art made a film *The Awakening* in Observatory House in March, using antique astronomical instruments.

On 13 September a helicopter was used to produce aerial photographs and video material of Dunsink Observatory buildings, grounds and environs.

T. P. Ray has been made a member of the Space Telescope European Co-ordinating facility User Committee. This body monitors the ST-ECF to ensure it fulfills its duty to the astronomical community and the committee reports directly to ESA.

An agreement on direct scientific cooperation between the School of Cosmic Physics and the Department of Cosmic Rays, Institute of Terrestrial Magnetism Ionosphere and Radio Wave Propagation (IZMIRAN), USSR Academy of Sciences was entered into, the agreement to take effect in January 1991 and run for five years.

10 Publications

10.1 Books

- P. A. Wayman, *Thomas Grubb, Engineer and Optician*, pp.18-19, and *School of Cosmic Physics at Dunsink Observatory*; J. Brinkley; E. T. Whittaker, pp.100-103, in *More People and Places in Irish Science and Technology*, ed. Charles Mollan, William Davis and Brendan Finucane, Royal Irish Academy, 1990.
- P. M. Shannon and D. Naylor, *Petroleum Basin Studies*, Graham and Trotman, London, 1989, 206 pp.

10.2 Journals

- I. Elliott, with T. J. Kreidl et al., *Variability of the Ap Star 21 Com: results from multiple-site campaign*, *Monthly Notices Royal Astr. Soc.*, **245**, 642-651 (1990).
- I. Elliott, *The Sunspot Maximum*, *Technology Ireland*, 21 9 26-30 (1990).
- T. Kiang, with J. Doyle, et al., *A Periodicity in the Flaring Rate on the Eclipsing Binary YY Geminorum*, *Astron. Astrophys.*, **232** 83-88 (1990).
- S. Russell and M. Dopita: *Abundancies of the heavy elements in the Magellanic clouds II; HII regions and supernova remnants*, *Astrophys. J. Supp.* **74** 93 (1990).
- W. J. Markiewicz, L. O'C. Drury and H. J. Völk: *Diffusive particle acceleration in spherically symmetric shock waves: supernova remnant origin of cosmic rays*, *Astron. Astrophys.*, **236**, 487-502 (1990).
- A. Thompson and D. O'Sullivan with E. Kirsch, S. McKenna-Lawlor, P. Daly, W.-H. Ip, F. M. Neubauer, and K.-P. Wenzel: *Particle observations by EPA/EPONA during the outbound pass of Giotto from Comet Halley and their relationship to large scale Magnetic Field Irregularities*, *Annales Geophysicae*, **8**, 455-462 (1990).
- D. O'Sullivan and A. Thompson with S. McKenna-Lawlor, V. V. Afonin, K. I. Gringauz, E. Keppler, E. Kirsch, A. Richter, M. Witte, A. J. Somogyi, L. Szabo and A. Varga: *The Low Energy Particle Detector SLED (30 keV-3.2 MeV) and its Performance on the Phobos Mission to Mars and its Moons*, *Nuclear Instruments and Methods*, **A290**, 217-222 (1990).
- A. Thompson and D. O'Sullivan with C. Domingo, C. Baixeras, F. Fernandez and A. Vidal-Quadras: *Long Term Ageing Effect for Energetic Ultra Heavy Ion Tracks in Polycarbonate Solid State Nuclear Track Detectors*, *Nuclear Instruments and Methods*, **B51**, 253-262 (1990).
- C. J. Bean and A. W. B. Jacob, *P-wave anisotropy in the lower lithosphere*, *Earth and Planetary Science Letters*, **99**, 58-65 (1990).
- A. W. B. Jacob with B. Aichroth et al., *The European Geotraverse seismic refraction experiment of 1986 from Genova, Italy, to Kiel, Germany*, *Tectonophysics*, **176**, 43-57 (1990).
- A. W. B. Jacob with L. W. Braile et al., *Preliminary New Models of the Crustal Structure Beneath the Kenya Rift from the KRISP 90 Seismic Refraction Profiles*, *EOS*, **71**, 1450 (1990). (A)
- A. W. B. Jacob with G. R. Keller et al., *The Kenya Rift International Seismic Project (KRISP 90): Background and Seismic Refraction Experiment*, *EOS* **71**, 1450(1990). (A)
- B. M. O'Reilly, P. M. Shannon and U. Vogt, *Seismic studies in the North Celtic Sea Basin: implications for basin development*, *J. Geol. Soc. London*, **148**, 191-195 (1991).
- P. M. Shannon with A. Brock and P. D. Ryan, *The deep geology and geophysics of Ireland and its continental margin*, *J. Geol. Soc. London*, **148**, 129-130 (1991).
- P. W. Readman with M. Ford and C. Brown, *The analysis and tectonic interpretation of gravity data over the Variscides of SW Ireland*, *Geophys. J. Int.*, **101**, 276 (1990). (A)
- P. W. Readman with N. Abrahamsen, *Geomagnetic secular variations from Holocene lake sediments of Soro So, Denmark*, *Phys. Earth Planet. Inter.*, **62**, 4-18 (1990).
- P. W. Readman with N. Abrahamsen, K. M. Storetvedt and M. Westphal, *Introduction to the Special Issue on Palaeomagnetism and the Evolution of the Tethys*, *Phys. Earth Planet. Inter.*, **62** 1-2 (1990).
- P. W. Readman *Magnetic after-effects*, in *Selected Works of Louis Neel*, ed. N. Kurti, (Translation), Gordon and Breach, New York, 341-384 (1990).
- P. W. Readman with M. Ford and C. Brown, *Analysis and tectonic interpretation of gravity data over the Variscides of south-west Ireland*, *J. Geol. Soc.*, London, **148** 137-148 (1991).
- Edwards, S., Ray, T. P. and Mundt, R.:1990, *Energetic Mass Outflows from Young Stars in Protostars and Planets III*, eds. E. Levy, J. Lunine, (University of Arizona Press), in press
- Mundt, R., Ray, T. P., Bührke, T., Raga, A. C., Solf, J.: 1990, *Optical Jets and Outflows*

- in the HL Tau Region, *Astron. Astrophys.* **232**, 37
- Poetzel, R., Mundt, R., Ray, T. P.: 1990, *Discovery of a High-Velocity Herbig-Haro Outflow in AFGL 2591*, *Astron. Ges. Abstr. Ser.*, **5**, 58
- Poetzel R., Mundt, R., Ray, T. P.: 1990, *Jets and Herbig-Haro Objects from Luminous Young Stars*, *Astron. Ges. Abstr. Ser.*, **5**, 59
- Poetzel, R., Mundt R., Solf, J., Ray, T. P.: 1990, *Optical Jets from Young High-Luminosity Stars: LkHa 234 and AFGL 4029*, *Astron. Ges. Abstr. Ser.* **4**, 27
- Poetzel, R., Mundt, R., Solf, J., Ray, T. P.: 1990, *Shock-Excited Emission Associated with Z CMa and Related High-Luminous Young Stellar Objects* in Proceedings of the 6th IAP Meeting - IAU Colloquium No. 129 Structure and Emission Properties, in press
- Ray, T. P.: 1990, *Stone Age Astronomy: Fact or Fiction?*, *Technology Ireland*, **22**, 6, 50
- Ray, T. P., Poetzel, R., Mundt, R.: 1990, *The Relationship of Optical to Molecular Outflows, in Molecular Clouds*, eds. R. A. James, T. J. Millar (Cambridge University Press), in press
- Ray, T. P., Poetzel, R., Solf, J., Mundt, R.: 1990, *Optical Jets from Young High-Luminosity Stars: LkHa 234 and AFGL 4029*, *Astrophys. J. (Letters)* **357**, L45
- ### 10.3 Conference proceedings
- P. A. Wayman, *Phase and Power for 19th Century Electrical Timekeepers*, XVIIIth International Congress of History of Science, ICHS Hamburg-Munich, 1989, ed. F. Krafft and C. J. Scriber, p.R93 (abstract).
- P. A. Wayman, *Thomas Grubb, Telescope Maker and Banknote Printer*, Symposium on the History of Technology, Science and Society, 1750-1914, University of Ulster, 1989.
- L. Drury, *Acceleration of Cosmic Rays*, Proc. 21 ICRC (Adelaide), **12**, 85-100.
- A. Thompson, D. O'Sullivan, K.-P. Wenzel, V. Domingo, C. Domingo, J. Daly and A. Smit: *Retrieval from Earth Orbit of the Ultra Heavy Cosmic Ray Experiment on the LDEF Spacecraft*, Proceedings of the 21st International Cosmic Ray Conference (Adelaide), **4**, 441-444 (1990).
- D. O'Sullivan, A. Thompson, S. M.P. McKenna-Lawlor, V. V. Afonin, K. I. Gringauz, E. Keppler, E. Kirsch, A. K. Richter, M. Witte, K. Kecskemety, A. J. Somogyi, L. Szabo, K. Szego and A. Varga: *Measurement of Electron and Ion Fluxes near Mars by the SLED instrument on Phobos-2*, Proceedings of the 21st International Cosmic Ray Conference (Adelaide), **7**, 50-53 (1990).
- A. Thompson and D. O'Sullivan with C. Domingo, C. Baixeras, F. Fernandez and A. Vidal-Quadras: *The Influence of Latent Track Variations on Ultra Heavy Nuclei Identification with Solid State Nuclear Track Detectors*, 21st International Cosmic Ray Conference (Adelaide), **4**, 437-440 (1990).
- D. O'Sullivan and A. Thompson with S. M.P. McKenna-Lawlor, V. V. Afonin, K. I. Gringauz, E. Keppler, E. Kirsch, A. K. Richter, M. Witte, K. Kecskemety, A. J. Somogyi, L. Szabo and A. Varga: *Energetic Particle Phenomena recorded by the SLED Instrument during the Phobos Mission to Mars*, 21st International Cosmic Ray Conference (Adelaide), **7**, 54-57 (1990).
- A. Thompson and D. O'Sullivan with E. Kirsch, S. McKenna-Lawlor, P. W. Daly, F. M. Neubauer and K.-P. Wenzel: *Observations of Energetic Water Group Ions ($E > 60$ keV) near the Magnetic Pile-up Region of Comet Halley obtained onboard the Giotto spacecraft on 13/14 March 1986* Proceedings of the 21st International Cosmic Ray Conference (Adelaide), **5** 352-355 (1990).
- D. O'Sullivan and A. Thompson with E. Kirsch, E. Keppler, M. Witte, S. McKenna-Lawlor and V. V. Afonin: *Possible Evidence for a Dust Ring along the Orbit of the Mars Moon Phobos*, Proceedings of the Fourth Workshop on Dusty Plasmas (Iowa), 17-18 (1990).
- A. Thompson and D. O'Sullivan with E. Kirsch and S. McKenna-Lawlor: *Particle Observations in the Magnetic Cavity of Comet Halley*, Proceedings of the Fourth Work-

shop on Dusty Plasmas (Iowa), 20-21 (1990).

10.4 Irish Astronomical Journal

The Journal continued publication under the joint auspices of Armagh and Dunsink Observatories. P. A. Wayman and I. Elliott served on the Publications Committee.

The following contributions were included in Vol. 19, Nos. 3 & 4, published during the year.

- p.119 P. A. Wayman, *Franz Friedrich Brunnow - A link between Dunsink and Ann Arbor*
p.156 P. A. Wayman, *La Palma, Retrospect and Prospect*
p.160 P. Duffy, *The Second-Order Fermi Acceleration of Pick-up Ions*
p.161 T. Kiang, *Are those Flares Periodic?*
p.168 P. A. Wayman, *Astronomy at the School of Cosmic Physics in 1988 and 1989*
p.179 P. A. Wayman, *What is a Parsec?*
p.182 I. Elliott, *Universe*, by William J. Kaufmann III (review).
p.186 S. Russell, *Evolutionary Phenomena in Galaxies*, ed. J. E. Beckman and B. E.J. Pagel (review).
p.189 T. P. Ray, *Records in Stone*, ed. c.l.n. Ruggles (review).

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

FINANCIAL STATEMENTS FOR YEAR ENDED 31 DECEMBER 1990

CONTENTS

	Pages
Accounting Policies	1-2
Income and Expenditure Account	3
Balance Sheet	4
Statement of Source & Application of Funds	5
Detailed Income & Expenditure Account	6
Notes to the Accounts	7-10

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

1990

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.

3. Fixed Assets:

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

Prior to 1990 the rate of depreciation was 10% per annum calculated on a straight line basis.

From 1990 onwards the rates of depreciation are as follows:-

Furniture and Equipment	10%
Computers	25%
Motor vehicles	25%

An adjustment has been made in 1990 to give effect to this change in accounting policy amounting to £184,257.

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 1990 was £669,710.

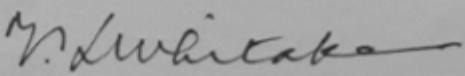
7. Superannuation:

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.

Income and Expenditure Account
for the year ended 31 December 1990

<u>1989</u>		<u>1990</u>
£		£
<u>Income</u>		
1,325,000	Oireachtas Grant	1,474,000
517,000	Lottery Grant	590,000
46,505	Sales of Publications	34,429
3,900	Theoretical Physics Workshop Fees	—
205,816	School of Cosmic Physics (Note 4)	249,849
46,561	Miscellaneous (Note 9)	54,945
2,144,782		2,403,223
(4,145)	Transfer from Capital Account (Note 6)	167,843
2,140,637		2,571,066
<u>Expenditure</u>		
404,464	School of Celtic Studies	478,138
285,924	School of Theoretical Physics	327,742
885,561	School of Cosmic Physics	1,049,652
494,816	Administration	611,510
69,700	Depreciation (Note 5)	263,348
	Loss on disposals (Note 5)	25,835
2,140,465		2,756,225
172	<u>Surplus (Deficit) for year</u>	(185,159)
414,075	Balance at 1 January	414,247
414,247	Balance at 31 December	229,088
414,247		229,088

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

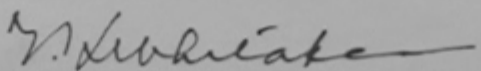


CHAIRMAN - COUNCIL OF THE INSTITUTE

Balance Sheet at 31 December 1990

<u>1989</u>			<u>1990</u>
£	£		£
389,113		Fixed Assets (Note 5)	221,270
		Current Assets:	
	385,524	Cash on Hands and at Bank	341,848
594,494	208,970	Debtors and prepayments	119,041
<u>983,607</u>	<u> </u>	TOTAL ASSETS	<u>682,159</u>
		Current Liabilities:	
	156,722	Creditors and Accruals (Note 2)	206,319
180,247	23,525	Funds (Note 1)	25,482
<u>803,360</u>	<u> </u>	Net Assets	<u>450,358</u>
<u> </u>			<u> </u>
		Financed by:	
414,247		Surplus Income and Expenditure Account	229,088
389,113		Capital Reserve (Note 6)	221,270
<u>803,360</u>			<u>450,358</u>
<u> </u>			<u> </u>

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


 CHAIRMAN - COUNCIL OF THE INSTITUTE

**Statement of Source and Application of Funds
for the year ended 31 December 1990**

Source of Funds:

Deficit for the year

£
(185,159)

**Adjustment for items not involving the
movement of funds:**

Transfer from Capital Account

167,843

Depreciation

(263,348)

Less Depreciation on disposals

31,049

(232,299)

(249,615)

Application of Funds:

Purchase of Fixed Assets

121,340

Less disposals

56,884

64,456

(185,159)

Increase/(Decrease) in Working Capital:

Decrease in Debtors and Prepayments

(89,929)

Increase in Creditors and Accruals

(49,597)

Increase in Funds

(1,957)

Decrease in Cash on hands & at Bank

(43,676)

(185,159)

Statement 1

Detailed Analysis of Income and Expenditure
for the year ended 31 December 1990

<u>INCOME</u>	School of Celtic Studies	School of Theoretical Physics	School of Cosmic Physics	Adminis- tration	Total	1989 Total
	£	£	£	£	£	£
Oireachtas Grants	1,000	316,000	763,200	393,800	1,474,000	1,325,000
Lottery Grant	440,000	-	-	150,000	590,000	517,000
Sales of Publications	34,084	38	307	-	34,429	46,505
Theoretical Physics Workshop Fees	-	-	-	-	-	3,900
School of Cosmic Physics (Note 4)	-	-	249,849	-	249,849	205,816
Miscellaneous (Note 9)	2,752	88	3,004	49,101	54,945	46,561
	<u>477,836</u>	<u>316,126</u>	<u>1,016,360</u>	<u>592,901</u>	<u>2,403,223</u>	<u>2,144,782</u>
<u>Transfer from Capital Account (Note 6):</u>						
Allocated for Capital purposes	(64,761)	(8,370)	(15,016)	(33,193)	(121,340)	(73,845)
Amount released on disposals	-	-	-	-	25,835	-
Amortisation in line with asset depreciation	-	-	-	-	<u>263,348</u>	<u>69,700</u>
					2,571,066	2,140,637
<u>EXPENDITURE</u>						
Salaries, Wages and Superannuation (Note 8)	330,401	215,477	628,097	291,909	1,465,884	1,236,136
Scholarships	41,438	56,888	17,144	-	115,470	111,314
Honoraria	1,352	60	340	-	1,752	500
Library (incl. Microfilms)	18,542	26,565	27,495	-	72,602	66,164
Publications	36,187	849	819	9,711	47,566	61,802
General Administration (Note 3)	-	-	-	228,017	228,017	206,024
Travel and Survey Expenses	7,905	9,257	65,270	2,479	84,911	49,714
Workshop '89 Symposia & Seminar Expenses	2,538	1,428	-	-	3,966	14,286
Equipment: Consumable & Maintenance	-	-	32,001	-	32,001	33,102
Special Commitments and Projects	-	-	254,291	-	254,291	194,676
General Expenses	39,775	17,218	24,195	60,841	142,029	97,047
Adaptation of Premises	-	-	-	18,553	18,553	-
	<u>478,138</u>	<u>327,742</u>	<u>1,049,652</u>	<u>611,510</u>	<u>2,467,042</u>	<u>2,070,765</u>
Depreciation (Note 5)					263,348	69,700
Loss on disposals (Note 5)					<u>25,835</u>	-
					<u>2,756,225</u>	<u>2,140,465</u>
<u>SURPLUS (DEFICIT) FOR YEAR</u>	<u>(65,063)</u>	<u>(19,986)</u>	<u>(48,308)</u>	<u>(51,802)</u>	<u>(185,159)</u>	<u>172</u>
Balance at 1 January 1990	159,428	13,468	106,006	135,345	414,247	414,075
Balance at 31 December 1990	94,365	(6,518)	57,698	83,543	229,088	414,247

NOTES TO THE ACCOUNTS

1.	<u>Funds:</u>		
	These comprise:	Vernam Hull Bequest	24,099
		Carmody Fund	1,383
			25,482

The funds are held on deposit.

2.	<u>Creditors and Accruals:</u>		
		Included in this heading is £51,369 contract research monies unexpended at 31 December, 1990, which is credited to revenue in line with expenditure on projects (Note 4).	

3.	<u>General Administration Expenses:</u>		
		Rent, Rates & Insurance	85,156
		Premises Maintenance	49,158
		Postage & Telephones	50,273
		Fuel, Light & Power	31,443
		Sundry Supplies	11,987
			228,017

NOTES TO THE ACCOUNTS (Cont.)

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

<u>Project</u>	<u>Contributor</u>	<u>Opening Balance</u>	<u>Income</u>	<u>Applied</u>	<u>Unexpended</u>
		£	£	£	£
Seismic Survey at Carnsore	ESB	-	300	300	-
Geotwin	EEC	694	4,068	4,762	-
EGT	EEC & ESF	-	1,195	1,195	-
HOGS	Dept. Energy/ Oil Industry	1,454	2,000	3,454	-
BGS	Br.Geol.Surv.	-	973	973	-
KRISP	EEC	-	32,869	32,869	-
ISOPHOT	ESA	-	31,848	31,848	-
ILIHA	EEC	-	59	59	-
RAPIDS	Depts. Energy & Industry & Commerce Hamburg Univ.	28,534	150,300	131,149	47,685
Cosmic Ray Conf.'91	Bórd Fáilte & Others	187	2,797	2,984	-
La Palma Obser.	Dept. Ind & Comm	-	5,000	5,000	-
EADN Conference	Various	-	17,483	17,483	-
R.G.O.	Royal Greenwich Obser.	-	3,179	3,179	-
Low Mass Star Formation	Dept. Industry & Comm.	-	5,559	1,875	3,684
UCG/ICL project	Imperial Cge. London	-	11,665	11,665	-
Other Fees	Various	-	1,054	1,054	-
		<u>30,869</u>	<u>270,349</u>	<u>249,849</u>	<u>51,369</u>

NOTES TO THE ACCOUNTS (Cont.)

5. <u>Fixed Assets</u>	Furniture & Equipment £	Motor vehicles £	Computers £	Total £
Cost @ 1/1/90				
Opening Balance	471,081	7,075	420,013	898,169
Additions	32,465	0	88,875	121,340
	<u>503,546</u>	<u>7,075</u>	<u>508,888</u>	<u>1,019,509</u>
Disposals	(170)	0	(56,714)	(56,884)
	<u>503,376</u>	<u>7,075</u>	<u>452,174</u>	<u>962,625</u>
Depreciation				
Opening Balance 1/1/90	359,555	3,535	145,966	509,056
Charge 1990	27,499	707	50,885	79,091
Adjustment 1990		2,833	181,424	184,257
	<u>387,054</u>	<u>7,075</u>	<u>378,275</u>	<u>772,404</u>
Depreciation on disposals	(51)	0	(30,998)	(31,049)
	<u>387,003</u>	<u>7,075</u>	<u>347,277</u>	<u>741,355</u>
Net book value 31/12/90	116,373	0	104,897	221,270
Net book value 31/12/89	111,206	3,540	274,367	389,113

6. Capital Reserve:

Balance at 1 January, 1990		389,113
<u>Transfer to Income and Expenditure Account</u>		
Income allocated for capital purposes	121,340	
Amount released on disposals	(25,835)	
Amortisation in line with asset depreciation	(263,348)	(167,843)
Balance at 31 December, 1990		<u>221,270</u>

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 1991 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, 1990.

8. Superannuation:

The total superannuation payments in the year amounted to £296,904. The salaries and superannuation charge in the accounts is net of contributions totalling £27,581.

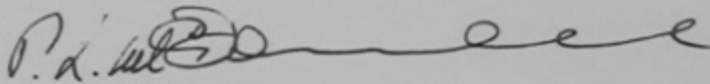
9. Miscellaneous:

Included in Miscellaneous is Bank Interest earned of £49,160 (1989 - £39,329) for the year.

Dublin Institute for Advanced Studies
Report of the Comptroller and Auditor General

I have examined in accordance with auditing standards the Accounts set out on pages 1 to 10 which are in the form approved under the provisions of the Institute for Advanced Studies Act, 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 the Institute and the Accounts, which are in agreement with them, give a true and fair view of the state of its affairs at 31 December 1990 and of its transactions and source and application of funds for the year then ended.



P. L. McDonnell

Comptroller and Auditor General

23 December 1991