

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

ANNUAL REPORT
1991



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

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Dublin Institute for Advanced Studies

Report of the Council
to the Minister for Education
for the year ended 31 December 1991

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The Dublin Institute for Advanced Studies, through its constituent schools and through its academic staff, is committed to research and to the advancement of knowledge in all fields of human endeavour. The Institute is also committed to the advancement of the Irish language and to the promotion of the Irish language in all its forms.

In presenting this Report to the Minister for Education, the Council of the Institute wishes to express its appreciation for the support and assistance which it has received from the Minister and his staff during the year.

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 1991

The Council of the Institute is pleased to report that the work of the Institute and its constituent schools during the year ended 31 December 1991 has been most successful. The Council is particularly pleased to report that the Institute has received a grant of £1,000,000 from the Department of Education for the year 1991-1992, which will enable the Institute to continue its work in the field of research and the advancement of knowledge in all fields of human endeavour.

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 1991

School of Celtic Studies

The primary statutory function of the School of Celtic Studies is, through its own internal projects and through its academic editing of work submitted by external scholars, to explicate and publish the texts and records which are preserved in extant Irish-language manuscripts, and also to publish analyses and descriptions of all varieties of the Irish language itself [Act 5(1), (a) - (f)].

In publishing five titles in 1991, the School has performed this function effectively. To the extent that its personnel resources have allowed, it has increased the rigour of its editorial control and improved the quality of its productions. However, because of continuing staffing inadequacies, the School remains under pressure in fulfilling its editorial function, and there are some research areas, e.g. the investigation of spoken Irish, for which the School urgently needs to obtain the additional resources to enable it to establish active projects.

Through its Research Associates, and in its provision for Visiting Scholars, the School of Celtic Studies has continued, despite such deficiencies in its staffing, to function reasonably successfully as a resource centre for the promotion of an international interest in Irish/Celtic Studies [Act 5(1), (i)], and through its annual Tionól and Statutory Lecture to help foster a community of scholarship in Irish/Celtic Studies [Act 5(1), (h)].

School of Theoretical Physics

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

Mathematical symposia were held at Easter and at Christmas; thirty-one seminars were held at DIAS and joint seminars with other third level institutions took place. Members of the School gave nine lectures in Ireland. The statutory public lecture was given at UCD by Professor H.-O. Peitgen (University of Bremen).

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-two conferences abroad.

School of Cosmic Physics

The major event of the year for the School of Cosmic Physics was undoubtedly the hosting of the 22nd International Cosmic Ray Conference. This, the largest and most important conference organised within the Institute for many years, is the subject of a special statement on page 45 of this report. It is interesting to note that although section 4(e) of the Establishment Order for the School of Cosmic Physics (1947) expressly states that one of the duties of the School is the 'organisation of seminars, conferences and lectures on topics related to cosmic physics which lie on the frontiers of knowledge' this has, until recently, been a relatively small part of the School's activities. The success of this conference, in terms of the benefit to science, the reputation of the Institute and the national economy, suggest that this aspect of the School's work could be expanded subject to the availability of resources.

The core activity remains of course the 'theoretical, observational and experimental investigation of the problems of cosmic physics' [section 4(a) of the 1947 Establishment Order] and here steady progress was made as described in detail in the body of this report. Some highlights include the increase in our empirical knowledge of outflow phenomena associated with star formation, the demonstration of the stability of the track detectors used in the ultraheavy cosmic ray experiment, and the first results from the interpretation of the data collected in two major seismic experiments in the Kenyan rift valley and in the north-eastern Atlantic. The level of scientific output, as evidenced by the list of publications and contributions to scientific meetings, remains high. However the scattered accommodation of the Institute, the static and low levels of staffing, and reducing level of non-pay funding are serious problems for the School.

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 1991

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 1991.

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 1991.
- 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 1991.

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 (to 31 July); Thomas N. Mitchell, M.A., Ph.D., Litt.D., L.L.D., M.R.I.A. (from 1 August); Aidan Clarke, M.A., Ph.D., F.T.C.D., President, Royal Irish Academy.

Members Appointed by the Governing Boards of Constituent Schools

M. Ó Murchú, M.A., Ph.D.; T. de Bhaldraithe, M.A., Ph.D., D.Litt.; J. T. Lewis, B.Sc., Ph.D.; A. J. McConnell, M.A., M.Sc., Sc.D., F.T.C.D.; E. F. Fahy, M.Sc., Ph.D.; L. O'C. Drury, B.A., Ph.D.

2. GOVERNING BOARD OF THE SCHOOL OF CELTIC STUDIES

Chairman

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

Senior Professors

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

Appointed Members

G. Mac Eoin, M.A., 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.; 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.

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.; N. Porter, Ph.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

Mary Burke, B.A.

Finance Officer

Mary A. O'Rourke, B.A.

Clerks

Angela Stubbs; Noreen Granahan; Helena Moynihan; Gabriel Flynn (to 9 June);
Eibhlín Nic Dhonncha.

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, sexual orientation, parental status or race, 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 27 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 or which affects or impedes the efficient discharge, in the work environment, of 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 1991
adopted at its meeting of 15 May 1992

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1 Staff, Research Scholars, Research 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 (with special responsibility for manuscript studies, and director of publishing)
Fergus Kelly (with special responsibility for Early Irish law texts, and director of events)
Rolf Baumgarten (with special responsibility for bibliography, and director of promotion)

ASSISTANT PROFESSOR:

Malachy McKenna (spoken language studies)

LIBRARIAN:

Siobhán Ní Laoire (also bibliography, and textual and sociolinguistic studies)

PUBLICATIONS OFFICER:

Michelle O Riordan (also historical studies)

RESEARCH ASSISTANTS:

Aoibheann Nic Dhonnchadha (manuscript studies and Irish medical texts)
Pádraig Ó Macháin (manuscript studies and bardic verse)

JUNIOR RESEARCH ASSISTANT:

Seán Ua Súilleabháin (lexicography)

SCHOLAR:

Máirín Ní Dhonnchadha (editorial supervision, early Irish law-texts)

SECRETARY:

Anne Dunphy (to 12 July 1991)
Órla McMorrow (appointed 19 August 1991)

1.2 Part-time and retired Staff

PART-TIME ASSISTANT:

Nessa Ní Sheághdha

COMPUTER CONSULTANT:

Cathair Ó Dochartaigh

OCCASIONAL LIBRARY ASSISTANTS:

Lorcán Mac Meanman

Catherine Rooney

STAFF ON CAREER BREAK:

Mícheál Ó Siadhail (Assistant Professor)

RETIRED STAFF:

Brian Ó Cuív (Professor Emeritus)

1.3 Research Scholars

Ursula Marmé (to 30 September 1991)

Joseph F. Eska

Karen L. Maund

Seán Ó Cearnaigh

Marc Caball

Seán Duffy

Máire Ní Mhaonaigh

David Thornton

1.4 Visiting Senior Professor

Professor Donnchadh Ó Corráin (University College, Cork)

1.5 Research Associates

Dr Gwenllian Awbery, Cardiff

Dr John Carey, Harvard University

Dr Thomas Charles-Edwards, University of Oxford

Professor Toshio Doi, Nagoya Women's College (appointed 1991)

Dr David N. Dumville, University of Cambridge

Professor D. Ellis Evans, University of Oxford

Professor William Gillies, University of Edinburgh

Professor Geraint Gruffydd, Centre for Advanced Welsh and Celtic Studies, Aberystwyth

Professor Eric P. Hamp, University of Chicago

Professor Michael Lapidge, University of Cambridge

Professor Donald MacAulay, University of Glasgow

Professor Toshitsugu Matsuoka, Hosei University, Tokyo (appointed 1991)

Dr Martin McNamara, MSC, Milltown Institute of Theology and Philosophy

Professor Tomás Ó Concheanainn, University College, Dublin (appointed 1991)

Professor Donnchadh Ó Corráin, University College, Cork (appointed 1991)

Dr Cathair Ó Dochartaigh, University College, Bangor

Dr Pádraig Ó Néill, The University of North Carolina at Chapel Hill

Dr Brinley F. Roberts, National Library of Wales, Aberystwyth

Professor R. Mark Scowcroft, Catholic University of America

Dr Richard Sharpe, University of Oxford

Professor Robert L. Thomson, University of Leeds (appointed 1991)

Professor Calvert Watkins, Harvard University

Professor T. Arwyn Watkins, University College, Dublin

1.6 Visiting Scholars

Professor Toshitsugu Matsuoka (Hosei University Tokyo)

Professor Eric P. Hamp (University of Chicago)

Dr James McCloskey (University of California, Santa Cruz)

Dr Rolf Ködderitzsch (University of Bonn)

Dr Nicolas Jacobs (University of Oxford)

Dr Gwenllian Awbery (Cardiff)

Dr Nancy Stenson (University of Minnesota)

Dr Morfydd E. Owen (Centre for Advanced Welsh and Celtic Studies, Aberystwyth)

Fr Marc Schneiders, O.PRAEM. (University of Utrecht)

Dr James Duran (Marymount College, California)

Dr Richard Sharpe (University of Oxford)

Dr David N. Dumville (University of Cambridge)

Dr Melita Cataldi (University of Turin)

Dr Arndt Wigger (University of Wuppertal)

Samantha A. Meigs (Northwestern University, Colorado)

Christophe Vielle (Louvain)

Dr Ann Dooley (University of Toronto)

Professor Edmund Gussmann (University of Lublin, Poland)

Inge Genee (Amsterdam)

Jacqueline Borsje (University of Amsterdam)

Kaarina Hollo (Harvard University)

Gwenole Bihannic (University College, Galway)

Johan Schimanski (Oslo)

2 Research

The School's provision for research and publication during 1991 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.

Clár lámhscríbhinní Gaeilge Choláiste Chorcaí: cnuasach Uí Mhurchú (B. Ó Conchúir), and *Catalogue of Irish manuscripts in Mount Melleray Abbey, Co. Waterford* (P. Ó Macháin) were published during the year. Revision of fasc. xiii and xiv of the *Catalogue of Irish manuscripts in the National Library of Ireland* (Nessa Ní Sheághdha) continued. Arrangements were made for the preparation on computer of volume I (Classical Gaelic manuscripts in the National Library of Scotland) of R. Black's catalogue of the Gaelic manuscripts of Scotland.

Partial drafts were examined of catalogues of the collections of Irish manuscripts in Boston College (K. E. Nilsen) and Villanova University (W. J. Mahon), and recommendations were made for their revision.

Work continued on the re-cataloguing of the Irish medical manuscripts in Trinity College, Dublin (Aobheann Nic Dhonnchadha).

- Rolf Baumgarten continued work on the *Bibliography of Irish linguistics and literature* for database screen user as well as conventional publication.
Celtic studies in the Netherlands (Marc Schneiders and Kees Veelenturf) was put through its final revision with the authors.
Seán Ó Cearnaigh (Research Scholar, School of Celtic Studies) continued work on his *Bibliography of the printed material in the Irish language 1571-1700*.
- Work on early Irish law continued under the direction of Fergus Kelly and Máirín Ní Dhonnchadha, general editors of the *Early Irish Law Series*.
Briathra Flainn Fhína (ed. Colin Ireland) was thoroughly revised.
Early Irish contract law (ed. Neil McLeod) was put through further revisions, but was subsequently withdrawn by the author.
Máirín Ní Dhonnchadha continued work on *Cáin Adomnáin* for publication, and Fergus Kelly worked on his book on *Early Irish agriculture: the evidence of the law-texts*.

2.2 Other research and editing

Máirtín Ó Murchú continued work on a description of West Perthshire Gaelic; work continued on the preparation for publication of the phonetic record of the Scottish Gaelic Survey. Three book-length submissions on aspects of the spoken language were examined, annotated, and returned to the authors for revision.

Proinsias Mac Cana continued work on literary and linguistic topics and on aspects of historical Welsh syntax.

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

Malachy McKenna completed a draft of his linguistic introduction to the vernacular nineteenth-century text *The spiritual rose*.

Siobhán Ní Laoire studied register and stylistic variation in Modern Irish.

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

Pádraig Ó Macháin continued work on Irish bardic poetry.

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

Brian Ó Cuív (retired) worked on various linguistic, literary and historical aspects of the Irish language,

including the preparation for publication of *Aibidil Goidheilge & Caiticíosma* by Seán Ó Cearnaigh (1571).

2.3 Research Scholars' work

Ursula Marmé continued work on verbal composition in Old Irish.

Joseph F. Eska continued research on Celtic diachronic verbal syntax and on the genetic classification of the Celtic languages.

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

Marc Caball continued research on the intellectual history of early modern Ireland.

Seán Duffy continued work on Ireland's relations with Scotland and Wales in the eleventh and twelfth centuries. He worked on the revision for publication of the late Cardinal Ó Fiaich's thesis *The kingdom of Airgiolla and its sub-kingdoms*.

Máire Ní Mhaonaigh continued work on *Cogad Gáedel re Gallaib*.

David Thornton continued work on Irish genealogies.

3 Publishing

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.

Computerised editing and typesetting was directed by Pádraig de Brún and Michelle O Riordan. Computer consultant was Dr W. G. Sullivan of University College, Dublin. Book design was under the expert guidance of Professor Bill Bolger of the National College of Art and Design.

In all, four items (in eight volumes) were published in 1991 (two being reprints of 1958 and of 1903-35 publications respectively), as well as one volume of the School's journal *Celtica*, and an updated catalogue of the School's publications:

- *Clár lámhscríbhinní Gaeilge Choldáiste Chorcaí: Cnuasach Uí Mhurchú. Le Breandán Ó Conchúir. 1991. xi + 201 pp. (Taighde ar Lámhscríbhinní / Studies in Irish Manuscripts. Eagarthóir ginearálta: Pádraig de Brún.) ISBN 1-85500-140-3. ISSN 0791-1890. Ir£15.*
- *Catalogue of Irish manuscripts in Mount Mellerey Abbey, Co. Waterford. By Pádraig*

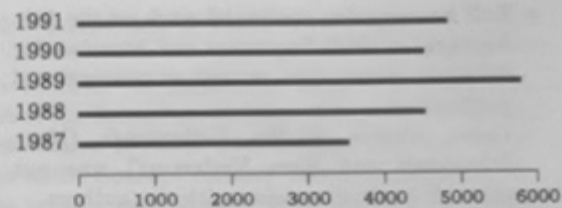
- Ó Macháin. 1991. (Studies in Irish Manuscripts / Taighde ar Lámhscríbhinní. General editor: Pádraig de Brún.) vi + 128 pp. ISBN 1-85500-151-9. Ir£12.
- *Celtica*, vol. 22, 1991. Edited by Pádraig de Brún, Máirín Ní Dhonnchadha, Máirtín Ó Murchú, and Michelle O Riordan. iv + 196 pp. ISBN 1-85500-150-0. ISSN 0669-1399. Ir£12.
 - *Gaelic words and expressions from South Uist and Eriskay*. Collected by Rev. Fr. Allan McDonald of Eriskay (1859-1905); edited by J. L. Campbell. Second edition with supplement: 1991 (reprint of the second edition 1972; first edition 1958). 317 pp. ISBN 1-85500-142-X. Ir£15.
 - *The metrical Dindshenchas*. By Edward Gwynn. 1991. 5 vols. (originally published by Royal Irish Academy, Todd Lecture Series, 8-12, 1903-35). ISBN 1-85500-143-8, Ir£55 the set. (Part i) ISBN 1-85500-144-6, Ir£8; (ii) -145-4, Ir£8; (iii) -146-2, Ir£18; (iv) -147-0, Ir£18; (v) -148-9, Ir£12.
 - *School of Celtic Studies: Publications in Celtic Studies, Catalogue 1991 / Scoil an Léinn Cheiltigh: Foilseacháin sa Léann Ceilteach, Catalóg 1991*. 52 pp.

4 Booksales

The classified and annotated catalogue of the School of Celtic Studies publications from its beginning was updated and distributed.

Promotion of publications was through advertising in *Books Ireland*, *Comhar*, *Archæology Ireland*, *Saol*, etc.

The number of books sold during 1991 was 4844. 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 4533 for 1990, 5804 for 1989, 4542 for 1988, 3534 for 1987. The ca. 900 copies of the *Newsletter* that have since 1987 been annually distributed world-wide have not been taken into consideration. The following chart is a projection of the above figures.



5 Library

The library now holds approximately 10,500 items and a substantial range of periodicals as well as an off-print and pamphlet collection. Some 600 new items were added during the year. Under the direction of Siobhán Ní Laoire, some organisational changes were introduced, such as rearrangement of the holdings, new shelving, and a Current Periodicals Display Unit in the Reference Room. Priority was given to backlog cataloguing and binding of periodicals.

6 Events

6.1 Lectures

- The Statutory Public Lecture for the year 1991 was delivered by Dr Neil Buttimer (University College, Cork), on 22 November 1991, at Trinity College, Dublin, entitled 'Manuscript and book in pre-Famine Gaelic Ireland'.
- Two lectures were delivered by Dr G. M. Awbery (Cardiff) on 7 and 9 May 1991 in the Institute, entitled 'Of graves and epitaphs: dialect, language shift, and Welsh cemeteries' and 'Wild flowers, garden produce, and weeds in Welsh oral tradition'.

6.2 Seminars

- Weekly seminars were conducted by Fergus Kelly, from January to March 1991, entitled 'Old Irish law-texts on cattle, sheep, and roads'.
- A seminar entitled 'Biblical style in early Celtic Latin' was conducted by Dr D. R. Howlett (University of Oxford) on 21 February 1991.
- The following weekly seminars were conducted during October - November 1991:

'Reading and writing in the Celtic realms of the mid-first millennium AD' by Dr Anthony Harvey (Royal Irish Academy).

'The Laigin and the Uí Néill from the fifth to the seventh century: a reassessment' by Ailbhe Mac Shamhráin (Trinity College, Dublin).

'On the crossroads of phonology and syntax: the origin of Vendryes' Restriction' by Dr Joseph F. Eska (School of Celtic Studies).

'Irish matter in *Historia Gruffud vab Kenan*' by Seán Duffy (School of Celtic Studies).

'Modern Irish *tá sé déanta agam*: the periphrastic perfect' by Dr Diarmuid Ó Sé (Institiúid Teangeolaíochta Éireann).

'Riseard Pluincéad's *Vocabularium latinum et hibernum*' by Dr Seán Ua Súilleabháin (School of Celtic Studies).

'Údarás na dtéacsanna clóite sa Ghaeilge, 1571-1700' by Dr Seán Ó Cearnaigh (Scoil an Léinn Cheiltigh).

6.3 Annual Symposium / Tionól 1991

The Annual Symposium / Tionól was held on 23-24 November, incorporating as a key feature the Statutory Public Lecture. In addition, the following papers were read:

- Joseph F. Eska, 'Today's morphology is yesterday's syntax': two examples from Early Irish'.
- Máirtín Ó Briain, 'Seilg Mhór Bhoireann Uí Lochlainn'.
- Roibeárd Ó hÚrdail, 'The lapse of fortis vibrant phonemes, and its aftermath, in Modern Irish: the received view and the evidence'.
- Liam P. Ó Murchú, 'Dhá chaoineadh aiceanta ar Dhonnchadh Ó Briain, ceathrú hIarla Tuamhan († 1624), sa LS M 107, Má Nuad'.
- Donnchadh Ó Corráin, 'Some legal aspects of the pillow-talk in *Táin bó Cúailnge* (LL)'.
- Uáitéar Mac Gearailt, 'On the language of some late Middle Irish texts in the Book of Leinster'.
- Diarmuid Ó Sé, 'The forms of the personal pronouns in Irish'.

6.4 Minister's visit

The Minister for Education, Mary O'Rourke, T.D. visited the School on 23 May 1991. She received a presentation of recent publications from the Chairman of the Board, Professor Tomás de Bhaldraithe. Also present were Senator Tony McKenna, and the Ambassador of the Federal Republic of Germany, Dr Martin Elsässer. An illustrated exhibition of the School's publications was arranged for the occasion by Rolf Baumgarten.

7 Outside activities and contributions to scholarship

7.1 Activities

The Ninth International Congress of Celtic Studies in Paris (8-12 July 1991) was attended by Brian Ó Cuív (President of the International Organisation for the Congress of Celtic Studies), Proinsias Mac Cana who delivered a plenary lecture entitled 'On the early development of written narrative prose in Irish and Welsh', Fergus Kelly who gave the inaugural lecture entitled 'Early Irish law: the present state of research', and Malachy McKenna who read a paper entitled 'Printed texts and dialect reconstruction in Irish'.

Proinsias Mac Cana delivered the Edward Lhuyd Memorial Lecture on 'The insular origins of the legend of Arthur' at the northern branch of the National Museum of Wales at Llanberis (April 1991). He also lectured on 'Y canu mawl yn Iwerddon' at a conference in Cardiff in June 1991 organized by the Centre for Advanced Welsh and Celtic Studies. As Visiting Professor at Harvard University (Fall semester 1991) he conducted a seminar on *Imacallam in dá thuarad*. He received an honorary doctorate of literature from the University of Ulster, July 1991.

Máirtín Ó Murchú (Director of the School) lectured to the Japan-Ireland Society in November.

Fergus Kelly lectured on 'Who did the work in early Irish society?' at the University of Oxford (10 February), 'Early Irish farming' to the Thomond Archaeological Society, Limerick (12 April), 'Early Irish law: the present state of research', O'Donnell Lecture, University of Edinburgh (2 May). He attended a conference on 'Celtic society' at Rewley House, University of Oxford (8-10 February).

Malachy McKenna gave an M.Phil. course on generative and non-linear phonology and on morphological theory at the Language and Communication Centre, Trinity College, Dublin (April–May); he conducted a beginners' course on Breton in the Department of Welsh, University College, Dublin (October–December). He proof-read the reprint of *Brezhoneg buan hag aes* for Cork University Press. Siobhán Ní Laoire was Visiting Lecturer at the Institute of Irish Studies, University of Liverpool. Aoibheann Nic Dhonnchadha lectured on 'Irish medical manuscripts' to the 14th Congress of the British Society for the History of Medicine, Royal College of Surgeons in Ireland (7 September). She contributed three items on 'Na lámh-scribhinní leighis Gaeilge' to Raidió na Gaeltachta's programme 'Peann agus pár' (transmitted on 23 March, 30 March, and 6 April).

Máirín Ní Dhonnchadha lectured at the Summer School in Irish Studies, Trinity College, Dublin (13, 14 and 18 June 1991). Brian Ó Cuív (retired) continued his activities as Chairman of the 'Corpus apocryphorum Hiberniae' publication project (RIA), as a member of the Irish Manuscripts Commission, and as a member of the Council of the Irish Texts Society. He acted as special extern examiner to the National University of Ireland in connection with the Mansion House Fund Scholarship examination.

7.2 Contributions to scholarly publications

Proinsias Mac Cana published 'Further notes on constituent order in Welsh', in J. Fife and E. Poppe (eds), *Studies in Brythonic word order* (Amsterdam/Philadelphia, 1991) 45–80; Celtic religion and mythology and 'Celtic heroic tradition' (*The Celts* (Milan, 1991) 596–604, 649–56). He edited the section on Old and Middle Irish literature in *The Field Day anthology of Irish writing*, I, ed. S. Deane (Derry, 1991) I, 1–60. He co-edited *Ériu* 42 (1991), and contributed a paper entitled 'Irish *maccóem*, Welsh *makwyf*'. His *Celtic mythology* appeared in Japanese translation (Tokyo, 1991).

Máirtín Ó Murchú published 'De Ierse taal' (*De Europese Gemeente* (Maastricht) 26, nr 7, 5–9).

Pádraig de Brún published 'Kerry diocese in 1890: Bishop Coffey's survey' (*Kerry Arch. and Hist. Soc. Jn.* 22 (1989 [1991]) 99–180).

Fergus Kelly contributed 'Celtic law' to *The Celts* (Milan, 1991) 657–8).

Rolf Baumgarten co-edited *Ériu* 42 (1991).

Malachy McKenna published 'A note on *pecthad* "sinner" in the Würzburg Glosses' (*Zeitschrift für celtische Philologie* 44 (1991) 79); and 'A textual history of *The spiritual rose*' (*Clogher record* 1991, 52–73).

Siobhán Ní Laoire contributed to the *Encyclopedia of language and linguistics* (Pergamon Press).

Michelle O Riordan published *The Gaelic mind and the collapse of the Gaelic world* (Cork, 1990 [1991]). She contributed reviews to *Comhar* ('Ar mo sheilf'). Aoibheann Nic Dhonnchadha published 'Irish medical manuscripts' (*Irish pharmacy journal* May 1991); 'Irish pharmaceutical texts' (*ibid.*, no. 7, July 1991).

A review of Pádraig de Brún (tr.) *An Odaisé* (ed. Ciarán Ó Coigligh) was published by Seán Ua Súilleabháin (*Comhar Eanáir* 1991, 29–31).

Máirín Ní Dhonnchadha published a review of David Dickson and Mary Daly (eds), *Popular literacy in Ireland 1750–1900* (*Comhar* March 1991); she co-edited *Revising the Rising* (Derry, 1991).

Máirtín Ó Murchú and Brian Ó Cuív contributed articles to *The Oxford companion to Irish literature*. The latter published 'Dinnshenchas – the literary exploitation of Irish place-names' (*Ainm* 4, 90–196); 'Béaltraidisiún Chorcaí–a chúla' (*Béaloides* 58, 181–202).

Research Scholars' publications during the year were Karen L. Maund *Ireland, Wales, and England in the eleventh century*, Woodbridge, 1991 (*Studies in Celtic history*, 12). Joseph F. Eska 'Syntactic notes on the great inscription from Peñalba de Villastar' (*Bulletin of the Board of Celtic Studies* 37 (1990) 104–7); 'Two notes on Continental Celtic: 1. On a question of concord in the inscription of Botorrita, 2. Gaulish *To-so.KoTe* (Vercelli)' (*Études celtiques* 27 (1990) 191–5); 'The demonstrative stem *isto- in Continental Celtic' (*Zeitschrift für celtische Philologie* 44 (1991) 70–3). Seán Duffy 'The Bruce brothers and the Irish Sea world, 1306–29' (*Cambridge medieval Celtic studies* 21 (Summer 1991) 55–86). David Thornton 'Glastonbury and the Glastening', in L. Abrams & J. P. Carley (eds), *The archaeology of Glastonbury Abbey* (Woodbridge, 1991) 191–203. Seán Ó Cearnaigh published reviews of Ré Ó Laighléis, *Ciorcal meiteamorfach* (*Anois*, 20–21 Iúil 1991), and of Seán de Fréine (ed.) *Croí cine* (*Comhar*, Samhain 1991). Alan Harrison's *The Irish trickster* was reviewed by Marc Caball (*Folklore* 102 (1991) 114).

Annual Report of the Governing Board of the School of Theoretical Physics for the year ending 31 December 1991 adopted at its meeting on 21 December 1992.

1 Staff, Scholars and Associates

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

LIBRARIAN: Position Vacant

SECRETARY: M. Matthews

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

SCHOLARS: F. Benatti (Italy) to 31 March, G. da Costa (Brazil) from 19 November, N.G. Duffield (UK) to 30 September, D. McManus (Ireland) from 15 November, D. McMullan (England) from 1 October, A. Patrick (Russia) from 1 April, P. Ruelle (Belgium), I. Tsutsui (Japan).

RESEARCH ASSOCIATES: Re-appointed to 31 December 1991:

TCD: 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. Tchrakian

UCG: J. Burns, M.J. Conneely, M.P. Tuite, T.N. Sherry

DIT KEVIN ST: 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, A.C. Ottewill

U.C. IRVINE: P. McGill

METEOROLOGICAL SERVICE: P. Lynch

DEPT. OF FINANCE: A.J. Curran

UNAFFILIATED: G.M. O'Brien

VISITING SCIENTISTS: A.P. Balachandran (Syracuse) 13-25 May, P. Barry (Waterford) 28 Mar., F. Benatti (Trieste) 1-28 Oct., D. Botvich (Moscow) 7 Mar.- 2 Apr., 23 Oct.- 10 Nov., 27 Nov.- 2 Dec., J. Byatt-Smith (Edinburgh) 18-21 Dec., U. Cegrell (Sweden) 27 Mar., A. Chakrabarti (France) 26 June - 3 July, T.C. Dorlas (Swansea) 17-20 Sept., L. Fehér (Hungary) 1-9 Oct., G.W. Ford (Michigan) 25 June - 28 July, V.I. Gaiduk (Moscow) 26 Feb.- 5 Mar., 11 Oct.- 2 Nov., C. Graham (Simon Fraser) 6 Apr. - 3 May, 19 Aug. - 6 Sept., P. Horvathy (Tours) 8-19 Feb., D. Hurley (Cork) 19-20 Dec., N.S. Izmailyan (Yerevan) 17 May - 1 June, Y. Kalmykov (Moscow) 21-28 Jan., Yu. A. Kubyshin (Moscow) 31 May - 15 June, B. McCann (Waterford) 19-20 Dec., P. McGill (Irvine) 15-20 Dec., W. McGlenn (Notre-Dame) 13-26 May, D. McMullan (Warwick) 26 Aug. - 2 Sept., Ph. A. Martin (Lausanne) 11-22 Mar., T. Matsui (Tokyo) 20-27 July, R.L. Mkrtchyan (Yerevan) 17 May - 1 June, H. Neunzert (Kaiserslautern) 25-26 Aug., M. Newell (Galway) 27-28 Mar., R.F. O'Connell (Louisiana) 21 June - 28 July, H.-O. Peitgen (Bremen) 6-7 Mar., Yu. A. Petcherski (Moscow) 9-16 June, D. Ya. Petrina (Kiev) 6-20 Apr., C. Pfister (Lausanne) 7-16 Oct., W.I. Skrypnik (Kiev) 6-20 Apr., R. Sorkin (Syracuse) 13-25 May, B. Spence (Southampton) 2-15 Sept., M. Stynes (Cork) 19-20 Dec., T. Sudbery (York) 2-3 Dec., Yu. Suhov (Moscow) 19 Jan.- 18 Feb., E. Thiran (Louvain) 30 July - 12 Aug., J. Toland (Bath) 18-21 Dec., B. Toth (Edinburgh) 12-19 Aug., J. Twamley (Alberta) 21-28 Aug., M. Vandyck (Cork) 19-20 Dec., W. von Waldenfels (Heidelberg) 16-26 July, R. Werner (Osnabrück) 31 Aug. - 21 Sept., A. Wipf (Zurich) 3-15 June, P. Zweifel (Virginia) 18-20 Nov.

2 General

International cooperation was again a feature of the activities of the School during the year; thirty-eight visitors from abroad (including nine from the former Soviet Union) collaborated with members of the School.

3 Research and Study

3.1 Theoretical Particle Physics

The main work of the particle physics group, led by Professor L. O'Raifeartaigh, over the past year was on the conformal reduction of Wess-Zumino-Witten (WZN) theories. In previous years the group had shown that the reductions associated with the principal embeddings of $sl(2)$ in the WZW group produced the well-known conformally-invariant, integrable Toda field theories. Furthermore, they provided a full set of solutions and showed that the symmetry algebras of the Toda theories were Zamolodchikov algebras (extensions of the Virasoro algebras by primary fields). The activity of the past year concerned the generalization of this earlier result to arbitrary $sl(2)$ embeddings. It has been shown that such reductions exist and produce a new class of conformally-invariant integrable systems, equipped with a full set of solutions and a Zamolodchikov symmetry-algebra. This work was carried out in collaboration with L. Fehér (Montreal University) and A. Wipf (ETH Zurich) and a joint paper on the subject will be published in Physics Reports C.

A second field of investigation, concerns the derivation of the spin-statistics theorem from more general assumptions than are made in the context of Quantum Field Theory. In particular, it is concerned with the derivation, and generalization, from assumptions concerning the topology of any space of particles and anti-particles (or strings and anti-strings) admitting pair creation and annihilation. It has been shown that a determining factor for all of such spaces are the homology groups and that, for systems with up to three particles or anti-particles, the non-triviality of the first and second homology groups are the main factors underlying the spin-statistics theorem and the existence of closed two-forms (such as those associated with the Berry phase and topological field theory) respectively. Present work is concerned with the generalization of these results to any numbers of particles and anti-particles and their realization in the context of field-theory. The work is being carried out in collaboration with A.P. Balachandran and R. Sorkin (Syracuse University) and W. McGlinn (Notre Dame) under a US NSF grant.

Dr. Dolan worked on constrained dynamical systems and quantum field theory in curved space-time. He also studied dynamical symmetry breaking in the standard model of elementary particle physics - bound state Higg's bosons.

Dr. Tsutsui worked on W-algebras and Toda theories in the reduction of the WZNW theory.

Dr. Ruelle conducted a study of reductions of Wess-Zumino-Novikov models by first class constraints. He investigated their relationship to 2-dimensional integrable models possessing the conformal symmetry.

Dr. M.J. Tuite continued his studies of techniques developed for finite temperature field theory and of their application to gauge theories and condensed matter physics. He began a study of the coherent and squeezed states of the electromagnetic field and of their uses in quantum optics.

Dr. McMullan studied constrained systems and quantisation.

Dr. Tchakian, with G.M. O'Brien, worked on Sphaleron solutions in the $SO(4) \times U(1)$ non-abelian Higgs model. He also studied, with Burzlaff and Chakerbarti, axially symmetric solutions of generalised selfdual equations.

3.2 Classical Statistical Mechanics

Professor Lewis continued his investigation with C. Pfister on large deviation principles in statistical mechanics. In collaboration with W.G. Sullivan, he continued work on the manuscript of a book on statistical mechanics and the thermodynamic formalism.

Professor McConnell examined the investigations of Yu. P. Kalmykov (Moscow) on dielectric relaxation of a dilute solution of polar molecules dissolved in a nonpolar solvent. They then collaborated in generalizing the two parameter theory of Burshtein and McConnell by adopting a J-diffusion model based on three parameters, namely, the Debye relaxation time, the angular momentum correlation time and a collision time. He also collaborated in investigations of Gaiduk, Tseitlin and Novscova (Moscow), in which molecular collisions are taken to be equivalent to reorientation in a $\cos\theta$ - or a $\cos^2\theta$ -potential well. Professor McConnell also studied the papers of C. Lanczos on Dirac's equation

and wrote reports on them in preparation for the celebration in 1993 of the birth of Lanczos.

Dr. Buffet used classical probability theory to study the gelation transition in systems of polymers. The effect of disorder in the asymptotic behaviour of random walks for a specific model, was studied in great detail.

Dr. Patrick carried out research on polymers in a random media and on ferromagnets in inhomogeneous external fields.

3.3 Quantum Statistical Mechanics

Professor Lewis, together with T.C. Dorlas and J.V. Pulé, continued the investigation of models of an interacting boson gas using the large deviation principle. Having previously established a variational principle for the pressure, they completed their programme on the full diagonal model by investigating the properties of minimizers.

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

Professors Ford and McConnell continued their collaboration with Professor Lewis under the US NSF International Programme on quantum tunneling in a black-body radiation field.

3.4 Quantum Theory and Quantum Electronics

Dr. Heffernan carried out research in nonlinear physics and quantum optics.

3.5 General Relativity and Gravitation

In the field of supergravity, Dr. Vandyck continued the study of space-time symmetries and generalised the Birkhoff theorem (in the weak-field limit). He investigated R^4 and $S^1 \times R^3$ gravitational instantons, in relation with Witten's proof of the positivity of energy in relativity.

3.6 Applied Mathematics

Professor Lewis and Drs. Buffet and Duffield continued their collaboration with the Electronic Engineering Department at DCU as part of the Programme in Advanced Technology

in Telecommunications. They began an investigation of queueing problems associated with the design of multiplexers.

Dr. Burzlaff studied solitons and soliton-like solutions of nonlinear partial differential equations. In particular, he investigated the scattering of vortices in superconductors and the generation and propagation of optical solitons. Energy loss in bent fibre was also investigated.

3.7 Pure Mathematics

Professor O'Farrell made a systematic study of the T_ϕ operator, or Vitushkin localisation operator, and identified the essential characteristics of the function spaces on which T_ϕ acts. This operator is a crucial technical tool in the study of removable singularities. In joint work with J. Feinstein, S. Dineen (UCD) and R. Timoney (TCD), he obtained a new kind of fixed-point theorem for holomorphic self-maps of the unit disc. With J. Feinstein and H. Lande, he worked on $D(M)$ spaces of infinitely differentiable functions. He continued research with D. Lord into the genetics of Multiple Sclerosis.

Dr. Goldsmith looked at the interplay between logic and algebra and some computer-aided investigations of Abelian groups with finite first Ulm subgroup.

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 9.3).

DIAS-STP-91-

- 01: L. O'RAIFEARTAIGH, P. RUELLE, & I. TSUTSUI: Quantum equivalence of constrained WZNW and Toda theories.
- 02: E. BUFFET, & P. HANNIGAN: Directed random walks in random environments.
- 03: L. O'RAIFEARTAIGH, P. RUELLE, I. TSUTSUI, & A. WIPF: W-Algebras for generalized Toda theories.

- 04: M. McGETTRICK, W. McGLINN, N. GORMAN, & L. O'RAIFEARTAIGH: Virasoro operators for arbitrarily twisted Kac-Moody algebras.
- 05: BRIAN P. DOLAN: Thermal spectra in the early universe.
- 06: F. BENATTI: The classical limit of a class of quantum dynamical semigroups.
- 07: J. BURZLAFF, & P. MC CARTHY: A study of a 90° Vortex-Vortex scattering process.
- 08: L. O'RAIFEARTAIGH, N. STRAUMANN, & A. WIPF: On the origin of the Aharonov-Bohm effect.
- 09: JAMES McCONNELL: Theory of dielectric relaxation.
- 10: A.E. PATRICK, & V.A. ZAGREBNOV: A probabilistic approach to parallel dynamics for the Little-Hopfield model.
- 11: W.I. SKRYPNIK: Gibbs system of interacting scalar fields and particles as an origin of the Sine-Gordon transformation.
- 12: W.I. SKRYPNIK: Infinite particle Hamiltonian dynamics of Chern-Simons type.
- 13: T.C. DORLAS, J.T. LEWIS, & J.V. PULÉ: Condensation in some perturbed mean field models of boson gas.
- 14: JAMES McCONNELL: Maynooth revisited.
- 15: N.G. DUFFIELD, & R.F. WERNER: Classical Hamiltonian dynamics for quantum Hamiltonian mean field limit.
- 16: J.M. AMARO DE MATOS, A.E. PATRICK, & V.A. ZAGREBNOV: Random infinite-volume Gibbs states for the Curie-Weiss random field Ising model.
- 17: L. FEHÉR, L. O'RAIFEARTAIGH, P. RUELLE, I. TSUTSUI, & A. WIPF: Generalized Toda theories and W-algebras associated with integral gradings.
- 18: BRIAN P. DOLAN: Energy spectra in inflationary models.
- 19: M.A. VANDYCK, & BREANNDÁN Ó NUALLÁIN: On Robinson's expansion of the axially symmetric Robinson-Trautman metrics.
- 20: M. VANDYCK, & H. SHANAHAN: On a multipole expansion for instantons.
- 21: M. VANDYCK, & H. SHANAHAN: On a multipole expansion for instantons Part II: $S^1 \times R^3$ instantons.
- 22: L. FEHÉR: W-algebras of generalized Toda theories.
- 23: L. FEHÉR, & P. HORVÁTHY: Isopin-dependent $0(4,2)$ symmetry of self-dual Wu-Yang monopoles.
- 24: B.P. DOLAN, & C. NASH: Zeta function continuation and the Casimir energy on odd and even dimensional spheres.
- 25: MICHAEL P. TUITE: A generalised Conway-Norton relationship between the monster and Conway groups.
- 26: B. PIETTE, T. TCHRAKIAN, & W.J. ZAKRZEWSKI: A class of two dimensional models with extended structure solutions.
- 27: D.H. TCHRAKIAN, & H.J.W. MÜLLER-KIRSTEN: A $(2+1)$ -dimensional model with instanton and sphaleron solutions.
- 28: N.G. DUFFIELD: Local mean-field Markov processes: an application to message switching networks.
- 29: L. FEHÉR, L. O'RAIFEARTAIGH, P. RUELLE, I. TSUTSUI, & A. WIPF: On the general structure of Hamiltonian reductions of the WZNW theory.
- 30: M. LAVELLE, & D. McMULLAN: Gauge fixing, unitarity and phase space path integrals.
- 31: F. BENATTI: On some Hamiltonian models of Brownian motion.
- 32: F. BENATTI: Deterministic quantum noise and Kolmogorov systems.
- 33: M.A. VANDYCK: A remark on the Twin "Paradox".
- 34: E. BUFFET, A. PATRICK, & J.V. PULÉ: Directed polymers on trees: a Martingale approach.
- 35: N.G. DUFFIELD, & R.F. WERNER: Local dynamics of mean-field quantum systems.
- 36: Y. KUBYSHIN, D. O'CONNOR, & C.R. STEPHENS: Dimensional crossover from non-renormalizability to renormalizability.
- 37: Y. KUBYSHIN, D. O'CONNOR, & C.R. STEPHENS: Dimensional crossover, the renormalization group and finite size scaling.
- 38: J. McCONNELL: The electron in physics and chemistry 1897-1935.
- 39: J. GOUGH, & J.V. PULÉ: The spherical model of Bose-Einstein condensation.
- 40: N. MACRIS, & J.V. PULÉ: The density of states of random Schrödinger operators.
- 41: D. McMULLAN: Classical states and the BRST charge.
- 42: L. FEHÉR, L. O'RAIFEARTAIGH, P. RUELLE, & I. TSUTSUI: Polynomial and primary field character of W_n^1 -algebras.
- 43: L. O'RAIFEARTAIGH: W-algebras.
- 44: T.C. DORLAS, J.T. LEWIS, & J.V. PULÉ: The full diagonal model of a Bose gas.

- 45: G.W. FORD, J.T. LEWIS, & R.F. O'CONNELL: Quantum tunneling in a blackbody radiation field.
- 46: M. LAVELLE, & D. MCMULLAN: Problems with the path integral description of the temporal, light-cone and Fock-Schwinger gauges.

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 under the auspices of the Dublin Particle Theory Group by the School's members and visitors.

5.1 Statutory Public Lecture

The Statutory Public Lecture entitled *Fractals: The new challenge for the geometry of nature* was delivered by Professor H.-O. Peitgen (University of Bremen) on 7 March in University College Dublin.

5.2 Seminar and review lectures given at DIAS-STP

- Dr. F. Benatti (Trieste) *A comparison of two Hamiltonian models of Brownian motion*
- Dr. F. Benatti (DIAS and Trieste) *The classical limit of quantum dynamical semigroups*
- Dr. D. Botvich (Moscow) *Lyapunov functions for some classes of communications networks*
- Dr. T. Dorlas (Swansea) *Recent work on the Bethe Ansatz*
- Prof. Ph.A. Martin (Lausanne) *Absence of exponential screening in quantum coulombic matter*
- Dr. T. Matsui (Tokyo) *The ground states of the Heisenberg model of a ferromagnet*
- Prof. P. McGill (Irvine) *On the structure of a transition kernel*
- R.L. Mkrtchyan (Yerevan) *Random matrices with discrete spectrum and finite Toda chains*
- Prof. Dr. H. Neunzert (Kaiserslautern) *Recent results on Boltzmann's equation*
- Dr. A. Patrick *Limiting Gibbs states and absence of selfaveraging for random Ising spin - some illustrations using the Curie-Weiss model*
- Prof. E. Pechersky (Moscow) *A large deviation result for tandem queues*
- Prof. H.-O. Peitgen (Bremen) *The Pascal triangle, divisibility and dynamical systems*
- Prof. D.Ya. Petrina (Kiev) *Bogoliubov's model Hamiltonian in the theory of superfluidity*
- Prof. D.Ya. Petrina (Kiev) *A Green's function approach to the pressure in the HYL model*
- Prof. C.E. Pfister (Lausanne) *Large deviations and phase-separation in the two-dimensional Ising model*
- Prof. A.K. Pogrebkov (Moscow) *Inverse scattering transformations and singular solutions of Liouville theory*
- Prof. W. Skrypnik (Kiev) *Infinite particle Hamiltonian dynamics of Chern-Simon type*
- Prof. W. Skrypnik (Kiev) *The generalized Sine-Gordon transformation*
- Dr. W. Spence (Southampton and Canberra) *KdV-hierarchies and W-algebras*
- Dr. B. Toth (Edinburgh and Budapest) *Failure of saturated ferromagnetism in the Hubbard model with two holes*
- Dr. J. Twamley (Alberta) *Wormholes*
- Dr. R. Werner (Osnabrück) *Recent work on finitely correlated states*

5.3 Seminars given by the Dublin Particle Theory Group in DIAS and elsewhere in Ireland

- Prof. Y. Kubyshin (Moscow) *Dimensional reduction and spontaneous compactification of gauge field theories*
- Dr. D. McMullan *A unified approach to constrained dynamics*

- Dr. D. McMullan *Unitarity and path integrals*
- Dr. C. Nash (Maynooth) *Correlation functions in 4-dimensions*
- Dr. D. O'Connor (Maynooth) *The renormalisation group and dimensional crossover*
- Dr. D. O'Connor (Maynooth) *BRST Quantisation II*
- Prof. L. O'Raifeartaigh *Developments in W-algebra theory*
- Prof. T. Sudbery (York) *Quantum groups*
- Dr. A. Wipf (Zurich) *Finite temperature Schwinger model*

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

- Prof. J.T. Lewis *Statistical mechanics a year's course for final year undergraduate and first-year graduate students*
- Prof. L. O'Raifeartaigh *On the convergence of astrophysics and particle physics* (22nd. Inter. Cosmic Ray Conference)
- Prof. J.R. McConnell *The electron in physics and chemistry 1897-1935* (Royal Dublin Society Conference to celebrate the centenary of the naming of the electron by Stoney.)
- Dr. E. Buffet *Classical queueing theory* (DCU)
- Dr. M. Vandyck *Schwarzschild black holes* (UCC)
- Dr. J. Burzlaff *A barrier penetration formula for optical tunnelling models* (Limerick)
- Dr. P. Lynch *Initialization for numerical weather prediction* (ILIAM VIII, DCU)
- Dr. C. Nash *Knots and physics* (Dublin University Mathematical Society Inaugural Lecture, TCD)
- Prof. A. O'Farrell *What did prehistoric man do in the dark?* (DU Computer Science Society)

5.5 Seminars, Lectures and Courses given abroad

- Prof. J.T. Lewis *Mechanisms for Bose-Einstein condensation* (EPFL - Lausanne)

Thermodynamic aspects of large deviation theory (North-British Probability Seminar-Edinburgh) Series of lectures : *What is Entropy?* (Kaiserslautern) *Large deviations and risk theory* (Leuven)

- Prof. L. O'Raifeartaigh *Constrained WZNW theories and integrable systems* (Georgia, University of Texas at Austin, Syracuse) *Some hidden aspects of hidden symmetry* (Symposium in honour of Prof. H. Doebner, Clausthal University) *Conformal reduction of WZW theories* (Goslar) *On the origin of the Aharonov-Bohm effect* (Notre-Dame) *The U(1) anomaly* (Argonne)
- Prof. J.R. McConnell *Modern science and epistemology* (Coimbra) *Some implications of theoretical physics for epistemology* (Pontifical Academy, Rome)
- Dr. B. Dolan *Thermal spectra in the early universe* (Canada) *Casimir energy on spheres and modifications of thermal spectra in inflationary universes* (Yerevan Physics Institute)
- Dr. N. Duffield *Local correlations in mean-field dynamics* (Osnabrück)
- Dr. L. Fehér *W-algebras of generalized Toda theories* (Moscow)
- Dr. I. Tsutsui *Generalized Toda theories and W-algebras* (Yukawa)
- Dr. P. Ruelle *W-algebras from conformal reductions of WZW models* (Louvain)
- Dr. E. Buffet *Polymeres et graphes oleotoires* (Orsay)
- Dr. J. Burzlaff *Vortex-vortex scattering* (Karpacz)
- Dr. D. Heffernan *The evolution of multifractality in chaotic attractors* (San Jose)
- Dr. P. Lynch *Filtered equations and filtering integration schemes* (Reading) *Initialization* (Series of 16 lectures, Stockholm)
- Dr. C. Nash *Topological field theories* (Finland) *Topological quantum field theories* (New York)
- Prof. A. O'Farrell *Polynomial Hulls* (London Mathematical Society, Couiza) *Tangent Stars* (Bellaterra)
- Dr. B. Goldsmith *Corner's Theorem B - a tale of two theorems* (Curacao)

- Dr. Tchraikian *How overdetermined are ungeneralised selfduality equations* (Durham)
- Dr. A.I. Solomon *Exotic states in quantum optics* (York) *Quantum group applications in quantum optics* (Goslar) *Quantum group squeezed states* (Baku) *Quantum group optical states* (Guernsey)
- Dr. Garavaglia *Quantum variances for transverse SSC injection dynamics* (San Francisco) *Time shift calculations for transverse betatron dynamics* (Corpus Christi) *Four jet signal for associated Higgs production* (Utah)

6 Activities of Staff and Associates

6.1 Activities within Ireland

- PROF. L. O'RAIFEARTAIGH: 22nd. International Cosmic Ray Conference, Dublin, 11-23 August.
- PROF. J.R. MCCONNELL: Royal Dublin Society Conference to celebrate the centenary of the naming of the "electron" by Stoney, 20 November; 22nd. International Cosmic Ray Conference, Dublin, 11-23 August;
- DR. P. LYNCH: ILIAM VIII Information Linkage between Industry and Applied Mathematics, DCU, Dublin 17 May; IMACS International Association for Mathematics and Computers in Simulation. 13th World Congress, TCD, Dublin, 22-26 July.
- DR. C. NASH: Irish Mathematical Society, September Meeting, UCG.

6.2 Activities outside Ireland

- PROF. J.T. LEWIS: Workshop on Stochastic Analysis, Warwick, 10-12 April; EPFL, Lausanne, 29 April- 2 May; Symposium on Quantum Physics, CERN, Geneva, 2-5 May; University of Edinburgh, 21-23 May; North-British Probability Seminar, Edinburgh University, 5-8 June; Conference on Mathematics of Non-linear Systems, University of Bath, 1-6 July; University of Kaiserslautern and Katholieke Universiteit Leuven, 1-14 December;

- PROF. L. O'RAIFEARTAIGH: Workshop on Selected Topics of Theoretical and Modern Mathematical Physics, Tbilisi, Georgia, 22-27 April; Symposium on Quantum Physics, CERN, Geneva, 2-3 May; ETH, Zurich, 7-11 July; 60th. Birthday Fest. of Prof. Doebner, University of Clausthal, 12-14 July; Wigner, Symposium, Goslar, 14-21 July; University of Texas at Austin, Notre Dame University, Argonne National Laboratory, Syracuse University, 14 September - 3 October; Kaiserslautern, 11-14 November.
- DR. B. DOLAN: 4th. Canadian Conference on General Relativity and Astrophysics, Winnipeg, 12-25 September. Miniworkshop on Constrained Dynamical Systems, Winnipeg, 26 September - 2 October. Nor Amkerd Workshop on Particle Theory, Yerevan, 12-25 September.
- DR. P. RUELLE: University of Louvain, 24-30 March.
- DR. N. DUFFIELD: University of Osnabrück, 11-20 March.
- DR. L. FEHÉR: First International Sakharov Conference on Physics, Moscow, 24-31 May; ETH, Zurich, 29 August - 11 September.
- PROF. J.R. MCCONNELL: Meeting of the Dielectrics Society, University of Kent, 3-5 April; NATO Advanced Study Institute on New Perspectives in Physics and Chemistry Conference, 22 September to 3 October; Pontifical Academy of Sciences Conference on Science in the Context of Human Culture, Rome, 30 September - 4 October.
- DR. A. PATRICK: Congress on Mathematical Physics, University of Leipzig, 29 July - 9 August; University of Heidelberg, 10-23 August.
- DR. I. TSUTSUI: Tokyo Institute of Technology, KEK, Osaka University and Yukawa Institute for Theoretical Physics, 15 July - 13 August; IVth. Yukawa International Seminar on Low Dimensional Field Theories and Condensed Matter Physics, 28 July - 3 August.
- DR. E. BUFFET: Statistical Mechanics Conference, Paris, March; Orsay, March.
- DR. J. BURZLAFF: Karpacz '91, XXVII Winter School of Theoretical Physics, 18 February - 1 March.

- DR. D. HEFFERNAN: Physics Computing '91, San Jose, California, 9-17 June.
- DR. P. LYNCH: HIRLAM all-staff Meeting, Norrköping, Sweden, 15-16 March; HIRLAM Technical and Scientific Committee Meeting, Norrköping, 17 March; International Meteorological Institute, Stockholm, March-April; IUGG XX General Assembly, Vienna, August; ECMWF Reading Seminar on Numerical Methods in Atmospheric Models, 9-13 September.
- DR. C. NASH: 2nd. Symposium on Topological and Geometrical Methods in Field Theory, Finland, June; 20th. Symposium in Differential Geometric Methods in Physics, New York, June.
- PROF. A. O'FARRELL: CRM at Bellaterra (Barcelona), April. Lancaster, Leeds and Cambridge.
- DR. B. GOLDSMITH: Caribbean conference on Abelian groups, Curacao, August.
- DR. T. TCHRAKIAN: Durham, February. Kaiserslautern, April.
- DR. A.I. SOLOMON: NATO collaboration, University of Paris, 17-25 June. Second Wigner Symposium, Goslar, 15-21 July. International workshop on squeezing, groups and quantum mechanics, Baku, Azerbaijan, 16-22 September. Annual Conference on quantum mechanics, Guernsey, 30 September - 3 October.
- DR. P. MCGILL: University of Edmonton, Alberta 13-17 March. Seminar on Stochastic Processes, UCLA, Los Angeles, 28-30 March. Strasbourg, Paris 11-13 December.

7 Symposia

Two Mathematical Symposia were held during the year, 27-28 March and 19-20 December. The attendance (27 in March, 44 in December) included professors, lecturers, and graduate students from the Irish universities and other third-level and research institutes, and from institutes abroad, and members of the scientific schools of DIAS.

Lectures were given as follows:

March

Review Lectures:

- Prof. U. Cegrell (UMEA Univ., Sweden) *Ideals of analytic functions*
- Prof. M. Newell (UCG) *Review of properties of Engel elements*

Lectures:

- Prof. L. O'Connor Drury (DIAS) *The acceleration of test particles at a shock*
- Dr. J.V. Pulé (UCD) *A variational problem on a space of measures*
- Dr. F. Benatti (DIAS) *An introduction to quantum dynamical entropy*
- Mr. P. Barry (Waterford RTC) *A tour around the Bézier curve*

Short Talks:

- Dr. P. Dolan (Imperial College London) *Technique of separation of variables for tensor differential equations*
- Dr. N. Duffield (DIAS) *Local meanfield dynamics*
- Dr. C. Nash (Maynooth) *Topological quantum field theory*
- Dr. T. Murphy (TCD) *Maths in C and C++*
- Prof. J.T. Lewis (DIAS) *Stirling's formula, yet again!*

December

Review Lectures:

- Prof. J.F. Toland (Bath) *The Benjamin-Ono equation - a non-linear problem in harmonic analysis*
- Dr. J. Byatt-Smith (Edinburgh) *Exponentially small quantities and asymptotics to all orders*

Lectures:

- Dr. M. Stynes (UCC) *Finite element methods for first-order hyperbolic equations*
- Dr. D. Hurley (UCC) *Ergodicity of geodesic flows*
- Dr. M. Vandyck (RTC, Cork and UCC) *Birkhoff's theorem in supergravity*
- Dr. B. McCann (RTC, Waterford) *Products of finite p-groups*

Short Talks:

- Prof. J.N. Flavin (UCG) *A new identity and a modified maximum principle*
- Prof. A.G. O'Farrell (Maynooth) *The tangent star of an arbitrary closed set in \mathbb{R}^d*

- Prof. A. Wood (DCU) *Exponential improvement of Stirling's approximation for the gamma function*
- Dr. J.G. Murphy (UCC) *Azimuthal shearing of special compressible materials*
- Dr. E. Buffet (DCU) *Directed polymers and martingales*
- Prof. P. McGill (Irvine) *Borel-Cantelli in continuous time*

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 5.2

Short visits (up to one week):

- P. Barry (Waterford) 28 Mar.,
 D. Botvich (Moscow) 27 Nov.-2 Dec.,
 J. Byatt-Smith (Edinburgh) 18-21 Dec.,
 U. Cegrell (Sweden) 27 Mar.,
 A. Chakrabarti (France) 26 June - 3 July,
 T.C. Dorlas (Swansea) 17-20 Sept.,
 D. Hurley (Cork) 19-20 Dec.,
 Y. Kalmykov (Moscow) 21-28 Jan.,
 B. McCann (Waterford) 19-20 Dec.,
 P. McGill (Irvine) 15-20 Dec.,
 D. McMullan (Warwick) 26 Aug. - 2 Sept.,
 T. Matsui (Tokyo) 20-27 July,
 H. Neunzert (Kaiserslautern) 25-26 Aug.,
 M. Newell (Galway) 27-28 Mar.,
 H.-O. Peitgen (Bremen) 6-7 Mar.,
 Yu. A. Petcherski (Moscow) 9-16 June,
 M. Stynes (Cork) 19-20 Dec.,
 T. Sudbery (York) 2-3 Dec.,
 J. Toland (Bath) 18-21 Dec.,
 B. Toth (Edinburgh) 12-19 Aug.,
 J. Twamley (Alberta) 21-28 Aug.,
 M. Vandyck (Cork) 19-20 Dec.,
 P. Zweifel (Virginia) 18-20 Nov.

Longer visits:

- A.P. Balachandran (Syracuse) 13-25 May,
 F. Benatti (Trieste) 1-28 Oct.,
 D. Botvich (Moscow) 7 Mar.- 2 Apr.,

- 23 Oct.-10 Nov.,
 L. Fehér (Hungary) 1-9 Oct.,
 G.W. Ford (Michigan) 25 June - 28 July,
 V.I. Gaiduk (Moscow) 26 Feb.- 5 Mar.,
 11 Oct.-2 Nov.,
 C. Graham (Simon Fraser) 6 Apr. - 3 May,
 19 Aug. - 6 Sept.,
 P. Horvathy (Tours) 8-19 Feb.,
 N.S. Izmailyan (Yerevan) 17 May - 1 June,
 Yu. A. Kubyshin (Moscow) 31 May -
 15 June,
 W. McGlenn (Notre-Dame) 13-26 May,
 Ph. A. Martin (Lausanne) 11-22 Mar.,
 R.L. Mkrtychyan (Yerevan) 17 May - 1 June,
 R.F. O'Connell (Louisiana) 21 June -
 28 July,
 D. Ya. Petrina (Kiev) 6-20 Apr.,
 W.I. Skrypnik (Kiev) 6-20 Apr.,
 R. Sorkin (Syracuse) 13-25 May,
 B. Spence (Southampton) 2-15 Sept.,
 Yu. Suhov (Moscow) 19 Jan.- 18 Feb.,
 E. Thiran (Louvain) 30 July - 12 Aug.,
 W. von Waldenfels (Heidelberg) 16-26 July,
 R. Werner (Osnabrück) 31 Aug. - 21 Sept.,
 A. Wipf (Zurich) 3-15 June,

9 Publications

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

9.1 Books

- *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

- G.W. Ford, J.T. Lewis, & R.F. O'Connell: *Quantum tunneling in a blackbody radiation field*. *Phys. Lett. A* 158(1991)367-9.

- T.C. Dorlas, J.T. Lewis, & J.V. Pulé: Condensation in some perturbed mean field models of boson gas. *Helv. Phys. Acta* 64(1991)1200-1224.
- L. O'Raiheartaigh: On the convergence of astrophysics and particle physics. *Proc. 22nd. Inter. Conf. on Cosmic Ray Physics, Reprint Ltd., Dublin, 1991. (Distributors, DIAS).*
- L. O'Raiheartaigh: Conformal reduction of WZNW theories and W-algebras. *Proc. XVIIIth Conf. on Group Theoretical Methods in Physics, Moscow, 1990, ed. V. Dodonov and V. Manko, Springer(1991).*
- L. O'Raiheartaigh: W-algebras and constrained WZ theories. *Proc. 14th John Hopkins Workshop on Current Problems in Particle Theory, Debrecen, 1990, ed. G. Domokos et al., World Scientific, Singapore(1991).*
- L. O'Raiheartaigh, P. Ruelle, & I. Tsutsui: Quantum equivalence of constrained WZNW and Toda theories. *Phys. Lett. B* 258(1991)359-363.
- L. O'Raiheartaigh, N. Straumann, & A. Wipf: On the origin of the Aharonov-Bohm effect. *Comments Nucl. Part. Phys.* 20(1991)15-22.
- A. Patrick: A probabilistic approach to parallel dynamics for the Little-Hopfield model. *J. Phys. A* 24(1991)3413-3426.
- *J. Burzlaff: On the generation of optical solitons. *Proc. ECMI Conference 89, St. Wolfgang, Austria, eds. HJ. Wacker and W. Zulehner, Teubner 1991, p.219.*
- J. Burzlaff: Vortex-vortex scattering. *Proc. XXVII Winter School of Theoretical Physics, Karpacz 1991, Poland, eds. P. Garbaczewski and Z. Popowicz, World Scientific, 1991, p. 244.*
- J. Burzlaff, & P. Mc Carthy: A study of a 90° Vortex-Vortex scattering process. *J. Math. Phys.* 32(1991)3376-3380.
- J. Burzlaff, & A. Wood: Optical tunnelling from one-dimensional square-well potentials. *IMA J. Appl. Math.* 47(1991)207.
- J. McConnell: Theory of dielectric relaxation. *Proceedings of the Meeting of the Dielectrics Society on Relaxation, Charge Injection and Charge Transport, Canterbury, 1991*
- *J. McConnell: Inertial theories of dielectric relaxation in liquids. *J. Mol. Liquids* 48(1991)99-109.
- M. Vandyck, & H. Shanahan: On a multipole expansion for instantons. *Class. and Quantum Gravity* 8(1991)2035-2048.
- M. Vandyck, & H. Shanahan: On a multipole expansion for instantons Part II: $S^1 \times R^3$ instantons. *Class. and Quantum Gravity* 8(1991)2049-2055.
- M.A. Vandyck: A remark on the Twin "Paradox". *Found. Phys. Lett.* 4(1991)593-600.
- *M.A. Vandyck: An alternative formulation of the WKB approximation in quantum mechanics. *European J. Phys.* 12(1991)112-115.
- L. Fehér: W-algebras of generalized Toda theories. *Proc. First Inter. A.D. Sakharov Conf. on Physics, Moscow, 1991*
- Y. Kubyshin, D. O'Connor, & C.R. Stephens: Dimensional crossover, the renormalization group and finite size scaling. *Proc. RG '91, J.I.N.R. Dubna 1991 Editor D.V. Shirkov et al.*
- *E. Buffet, & P. Hannigan: Directed random walks in random environments. *J. Stat. Phys.* 65(1991)645-672.
- *E. Buffet, & R.F. Werner: A counter-example in coagulation theory. *J. Math. Phys.* 32(1991)2276-2278.
- *E. Buffet, & J.V. Pulé: Polymers and random graphs. *J. Stat. Phys.* 64(1991)87-110.
- *A. Chakrabarti, & D.H. Tchrakian: How overdetermined are the generalised self-duality relations? *J. Math. Phys.* 32(1991)2532-2539.
- H.J.W. Müller-Kirsten, & D.H. Tchrakian: Skyrme-like solitons with absolute scale in (2+1) dimensions. *Phys. Rev. D.* 44(1991)1204.
- G.M. O'Brien, & D.H. Tchrakian: A non-abelian Higgs model with instantons and sphaleron. *Phys. Lett. B.* 282(1991)111.
- D. O'Connor, & C.R. Stephens: Phase transitions and dimensional reduction. *Nucl. Phys. B* 360(1991)297-336.
- G.A. Raggio, & R.F. Werner: The Gibbs variational principle for inhomogeneous mean-field systems. *Helv. Phys. Acta* 64(1991)633-667.

- *R.F. Werner: Dilations of symmetric operators shifted by a unitary group. *J. Funct. Analysis* **92**(1990)166-176.
- *N.G. Duffield: Local correlation functions for mean-field dynamical semigroups on C^* -algebras. *Helv. Phys. Acta* **64**(1991)610-632.
- *D. Birmingham, R. Kantowski, & M. Rakowski: The Eta function in Chern-Simons field theory. *Phys. Lett. B* **251**(1990)121-7.
- Brian P. Dolan: Thermal spectra in the early universe. *Class. and Quantum Gravity* **8**(1991)1955-60.
- Brian P. Dolan: Energy spectra in inflationary models. *Proc. 4th. Canadian Conference on General Relativity and Relativistic Astrophysics, 1991.*
- *P. Lynch: Filtering integration schemes based on the Laplace and Z transforms. *Monthly Weather Review* **119**(1991)653-666.
- P. Lynch: Filtered equations and filtering integration schemes. *Proc. Seminar on Numerical Methods in Atmospheric Models, ECMWF, 1991*
- P. Lynch: Initialization for numerical weather prediction. *Proc. ILIAM VIII, Dublin, 1991*
- P. Lynch: Filtered equations and filtering integration schemes. *Technical Note No. 52, Meteorological Service, Dublin.*
- C. Nash: Topological field theories. *Proc. 2nd. Symposium on Topological and Geometrical Methods in Field Theory, Finland, 1991, World Scientific.*
- C. Nash: Topological quantum field theories. *Proc. 20th. Symposium on Differential Geometric Methods in Physics, New York, 1991, World Scientific.*
- D. Lord, & A.G. O'Farrell: Removable singularities for analytic functions of Zygmund class. *Proc. R.I.A.* **91A**(1991)195-204.
- A.G. O'Farrell: Capacities in function theory. *Proc. of the Nagoya Conference on Potential Theory, Springer, 1991.*
- P. Jenkins, M. Daly, B.J. Hawdon, J. O'Gorman, & D.M. Heffernan: An introduction to chaos and its characterization. *Solitons and Chaos in Optical Systems, ed. by H. Morris and D. Heffernan, Plenum, New York, 1991.*
- D.M. Heffernan, & P. Jenkins: The evolution of self-similarity in chaotic attractors. *Proc. Physics Computing '91, AIP Press, 1991.*
- *J. O'Gorman, B.J. Hawdon, J. Hegarty, P. Jenkins, & D.M. Heffernan: Three frequency chaos in external cavity injection lasers. *J. Modern Optics* **38**(1991)1243.
- *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* **46A**(1991)686.
- J. Katriel, & A.I. Solomon: A q-analogue of the Campbell-Baker-Hausdorff expansion. *J. Phys. A* **24**(1991)L1139-L1142.
- J. Katriel, & A.I. Solomon: Quantum group applications in quantum optics. *Proc. of the Second Wigner Symposium, Goslar, 1991*
- P. McGill: Remark on the intrinsic local time. *Seminar on Stochastic Processes, Birkhäuser, Progress in Probability* **29**(1991)123-128.

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- L. O'Raifeartaigh: Conformal reduction and W-algebras. *Proc. of Workshop on Selected Topics in Modern Math. Phys., Borjomi, Georgia, 1991, World Scientific.*
- L. O'Raifeartaigh: Conformal reduction of WZNW theories by first-class constraints. *Proc. IInd Wigner Symposium, Goslar, Germany, 1991, Springer.*
- L. O'Raifeartaigh: Some hidden aspects of hidden symmetry. *Differential Geometry, Group Representations and Quantization (Festschrift in Honour of Prof. H. Doebner), ed. J. Hennig et al., Springer Lecture Notes in Physics (1991).*
- L. O'Raifeartaigh: Constrained WZNW theories and integrable systems. *Proc. Sudarshan Workshop, Austin, Texas, 1991, World Scientific.*
- L. Fehér, L. O'Raifeartaigh, P. Ruelle, & I. Tsutsui: Polynomial and primary field character of W_n^1 -algebras. *Phys. Lett. B*
- L. Fehér, L. O'Raifeartaigh, P. Ruelle, I. Tsutsui, & A. Wipf: On the general structure of Hamiltonian reductions of the WZNW theory. *Phys. Rep.*

- L. O'Raifeartaigh, P. Ruelle, I. Tsutsui, & A. Wipf: W-Algebras for generalized Toda theories. *Commun. Math. Phys.*
- L. Fehér, L. O'Raifeartaigh, P. Ruelle, I. Tsutsui, & A. Wipf: Generalised Toda theories and W-algebras associated with integral gradings. *Ann. Phys.*
- A. Balachandran, W. McGlenn, L. O'Raifeartaigh, S. Sen, & R. Sorkin: The spin-statistics connection from homology groups of configuration space and an Anyon Wess-Zumino term. *Inter. J. Mod. Phys. A.*
- A. Balachandran, W. McGlenn, L. O'Raifeartaigh, S. Sen, & R. Sorkin: Topological spin-statistics theorem for strings. *Mod. Phys. Lett. A.*
- A. Patrick: Random infinite-volume Gibbs states for the Curie-Weiss random field Ising model. *J. Stat. Phys.*
- A. Patrick: Parallel dynamics for an extremely diluted neural network (comment). *J. Phys. A*
- M. McGettrick, W. McGlenn, N. Gorman, & L. O'Raifeartaigh: Virasoro operators for arbitrarily twisted Kac-Moody algebras. *Int. J. Mod. Phys.*
- H.J.W. Müller-Kirsten, & D.H. Tchrakian: A class of (2+1)-dimensional models with instanton and sphaleron-like solutions. *J. Phys.A.*
- H.J.W. Müller-Kirsten, J.-Q. Liang, & D.H. Tchrakian: Solitons, bounces and sphalerons on a circle. *Phys. Lett. B.*
- J.R. McConnell: Dielettrici in campi elettrici variabili. *Dizionario delle Scienze Fisiche*
- M. Lavelle, & D. McMullan: Gauge fixing, unitarity and phase space path integrals. *Int. J. Mod. Phys.*
- D. McMullan: Classical states and the BRST charge. *Commun. Math. Phys.*
- M. Lavelle, & D. McMullan: Problems with the path integral description of the temporal, light-cone and Fock-Schwinger gauges. *Mod. Phys. Lett. A*
- B.P. Dolan, & C. Nash: Zeta function continuation and the Casimir energy on odd and even dimensional spheres. *Comm. Math. Phys.*
- P. Lynch, & H. Xiang-Yu: Initialization of the HIRLAM model using a digital filter. *Mon. Weather Rev.*
- P. Lynch: Richardson's barotropic forecast - a reappraisal. *Bull. Amer. Met. Soc.*
- A.G. O'Farrell, & R.O. Watson: The tangent stars of a set, and extensions of smooth functions. *J. für die Reine und Angew. Math.*
- A.G. O'Farrell, & F. Perez-Gonzalez: Pointwise bounded approximation by polynomials. *Math. Proc. Camb. Phil. Soc.*
- A.G. O'Farrell: "T-invariance". *Proc. R.I.A.*
- A.G. O'Farrell, & P. de Paepe: Approximation on a disk II. *Math. Zeit.*
- B. Goldsmith, & P. Zanardo: On the analogue of Corner's finite rank theorem for modules over valuation domains. *Archiv der Mathematik*
- P. McGill: Generalised transforms, quasi diffusions, and Désiré André's equation. *Seminaire de Prob. edited by Azema, Meyer, & Yor, Springer.*
- P. McGill: Borel-Cantelli lemmas in continuous time.
- P. McGill: On the structure of a transition kernel.
- B. Piette, D.H. Tchrakian, & W.J. Zakrzowski: A class of (2+1)-dimensional models with extended structure solutions. *Zeit. Physik C.*

10 Library

Approximately 220 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. Due to overcrowding in the library, a large scale reorganisation of the journals was undertaken. This involved moving a lot of the journals to our store in the lower basement, where a huge job of sorting and reshelving is in progress.

Annual report of the Governing Board of the School of Cosmic Physics for the year ending 31 December 1991 adopted at its meeting on 8 October 1992.

1 Staff, Scholars and Associates

SENIOR PROFESSORS: L. O'C. Drury (Director), A. W. B. Jacob, P. A. Wayman

PROFESSORS: T. Kiang, A. Thompson (1 vacancy)

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

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

EXPERIMENTAL OFFICERS: T. A. Blake, B. D. Jordan, W.-M. Tai

VISITING SCIENTISTS: N. Abrahamsen (Aarhus), C. Domingo (UAB, Barcelona), L. Dorman (Moscow, USSR), R. Mundt (MPIA, Germany), J. Neuberg (Leeds), K. Olah (Konkoly, Czechoslovakia), R. Poetzel (MPIA, Germany), C. Prodehl (Karlsruhe), V. Ptuskin (Moscow, USSR), K. Stammler (Erlangen), R. Veis (Clausthal), U. Vogt (Hamburg), I. van Breda (Cambridge, England),

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

SCHOLARS: J. Bosch, M. Callinan (from 1 November) D. Corcoran, M. Corcoran (from 1 October), E. Houdebine (from 3 June), R. Keegan, I. O'Brien (from 1 October), S. P. Xiang

PROJECT SUPPORTED POSITIONS: F. Hauser (RAPIDS), S. Russell (ISOPHOT), A. Moorhouse (Low mass star formation), H. Walls (RAPIDS, to 30 June)

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: M. Heanue (Maynooth), E. Keary, T. P. Downes (TCD)

2 Research Activities in the Geophysics Section

2.1 Gravity

P. W. Readman and T. Murphy, with staff of University of Hamburg and British Geological Survey, Edinburgh

2.1.1 Onshore Gravity Surveys

Publication of the 1/2 inch series of Bouguer Anomaly maps corresponding to the Ordnance Survey 1/2 inch series has been continued. During the year Sheet numbers 12, 17 and 18 were completed and are awaiting publication. Maps covering approximately one half of the country have now been finalized.

The Geophysics Section's land gravity data set is the only national gravity data set available for Ireland (and indeed the only wholly Irish obtained geophysical data set covering the country) and forms a unified and consistent data set suitable for use in the production of high quality gravity maps. Apart from its own series of maps referred to above, the Geophysics Section has contributed in the preparation of two maps to be produced by the British Geological Survey. These are Bouguer and Free Air Anomaly maps of Britain, Ireland and its surrounding seas at a scale of 1:1 000 000, and a Bouguer Anomaly overlay which forms part of a Tectonic Map of North West Europe at a scale of 1:1 500 000. The Geophysics Section has also collaborated with the Geological Survey of Ireland in the production of a detailed gravity map of a prospective area in the Irish midlands.

2.1.2 Marine Gravity Surveys

Work has continued on the production and interpretation of the gravity map of the continental shelf offshore west of Ireland in collaboration with the University of Hamburg. This was thought to have been essentially completed but a recently discovered uncertainty in part of the original data reduction has necessitated some further data processing.

2.2 Meteorology

K. Bolster

Limited measurements were continued as described in the 1990 Report and enquiries are dealt with regularly. The DIAS station provides the only Dublin city data in the new version of the "Monthly Weather Bulletin" published by the Meteorological Service.

2.3 Seismic Work

2.3.1 The Seismic Network (DNET and ENET)

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

The move of the DNET base station and recording equipment was completed at Lyons Estate and the old analogue recording system was operational again by 15 April. Even though the new recording point is lower than the old one, the radio signals from Croghan and Kingscourt are quite strong and it has not proved necessary to install an aerial higher up the hill. This reduces the amount of cabling required.

The second major change during the year was the acquisition of digital equipment for a triggered event recording system. This is part of an EPOCH project (European Community Programme) for rapid exchange of digital earthquake data. Seismic events which activate the trigger are stored on each national seismic network (DIAS in the case of Ireland) and this data can be accessed by each of the other participating national networks. It will allow us immediate access to seismic data and also allow us to check the state of individual elements of DNET in real time. With the old Geostore analogue system problems may go undetected for over a week. While the new system is operational at DLF, remote access to it will have to await installation of a telephone line and modem in 1992. Access to other networks was already possible in 1991.

2.3.2 Significant Events on the Seismic Network

1991 was a quiet year with no recorded events onshore or close offshore Ireland. The Lleyn area, site of the large seismic events in 1984 which were widely felt in Ireland, is still active though the number of events is now quite small. The largest regional events, both only $M_L=2.8$, were near Newton in Wales on 16 June and in Stirlingshire, Scotland, on 4 August. The

disposal of two World War Two mines near Creadon Head in Co. Waterford on 9 June was recorded on the network.

More distant events included one in Northern India on 9 June which caused 2000 deaths, together with serious landslides and other damage. Other damaging events recorded included ones in Pakistan (January), Costa Rica and Western Caucasus (both in April) and Southern California in June. The events in the Western Caucasus were unusual in that there were many foreshocks, building up to the major event in April. This is the reverse of the normal pattern.

2.3.3 Lower lithospheric work including the Iberian Experiment (ILIHA)

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

The collection of all the ILIHA data and its incorporation into a single data set was completed during the year at Karlsruhe. The final set is to be transferred to the Geophysics Section in SEG-Y format. One paper is in press and a second one has been submitted. The findings of the second one are that a stratified lower lithosphere, similar to that found by Bean and Jacob under Northern Britain and Ireland, lies under the Iberian peninsula. It is likely that the rotation of Iberia at the opening of the Bay of Biscay provided the shear stresses necessary for such anisotropic stratification.

2.3.4 Seismic Programme in Kenya - KRISP 90

A. W. B. Jacob and F. Hauser with European and American groups

The unification of all the data for this experiment was completed during the year. These refraction and wide-angle-reflection data were obtained with US Geological Survey instruments (90%) and DIAS instruments (10%) and the compatibility was very good. The Geophysics Section's main research interests were in the detailed structure of the Rift flank and in the seismic sources, together with their spectra and effectiveness in the Rift and on the flank. The Moho reflections on the northeastern flank have been particularly interesting with strong multiples and an indication that the Moho is a more continuous feature at frequencies over 10 Hz than it is at lower frequencies. This was unexpected. Possible mechanisms are being considered.

Papers were presented at the UK Geophysical Assembly in Leicester, the EGS Assembly in Wiesbaden, the IUGG in Vienna and the

Fall Meeting of AGU in San Francisco. Workshops were held in August near Karlsruhe and in December in Menlo Park, California. KRISP 90 has been an outstandingly successful project and promises to resolve some basic questions about the structure and development of the East African Rift.

2.3.5 Seismic wave scattering

C. J. Bean, J. McCloskey and A. W. B. Jacob

Scattering of seismic waves by lithospheric heterogeneities produces seismic coda which typically look random. A technique has been introduced for evaluating the predictability of time-series data as an indicator of underlying determinism. Both earthquake and explosive source seismic coda have been analyzed using this method and have been found to display strong short term predictability which is not consistent with a random generation mechanism.

2.3.6 RAPIDS - Seismic Profiles in the Northeastern Atlantic.

A. W. B. Jacob, P. M. Shannon, F. Hauser, M. Callinan, H. Walls and K. Stammler with University of Hamburg

Work on this project has continued in both Dublin and Hamburg during the year. A paper on part of the RAPIDS 1 project was published and the three main aspects of the project are now being studied by F. Hauser in Dublin (the Rockall Trough axial structure and the transition to oceanic structure) and by U. Vogt in Hamburg (the margin and transition zone west of the Hatton-Rockall Basin). Later in the year, M. Callinan began work in Dublin on the shallow shelf west of Ireland and on the neighbouring Rockall Trough. With such a large project, involving more than 120 seismic sections each containing up to 200 records, the processing has taken a lot of work and this extended well into 1991. The interpretation program, Seismic Handler, has been further developed during the year and will be very useful in other projects as well.

2.3.7 Proposed study of the earth's core-mantle boundary

A. W. B. Jacob

A. W. B. Jacob proposed to the IASPEI Commission on Controlled Source Seismology (CCSS) in Vienna in August that it was now possible to make a study of the core-mantle boundary (CMB) using the very small teleseismic

sources employed by Jacob and Willmore (1972). The big change that has occurred since then is that the observational equipment necessary to carry out an experiment now exists. Studies of the CMB to date have been hampered by the very uneven distribution of stations and earthquake sources throughout the world. A controlled experiment with a known source wavelet could add greatly to our knowledge of the CMB and the D" layer above it. These may have a controlling influence on mantle plumes (like the Iceland one).

2.4 Palaeomagnetism

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

Work on the project to investigate the behaviour of the geomagnetic field during Late Glacial times has continued. This project uses material collected in the detailed studies being undertaken by Drs. M. O'Connell (Galway) and S. Bohnicke (Amsterdam) in Co. Galway and Co. Clare. Samples have now been taken from cores from most of their sites and preliminary palaeomagnetic measurements made. In general the natural magnetisation is very weak (less than 10 A/m) making measurement with the Digico magnetometer very slow and often unreliable, so it is planned to remeasure the samples using a SQUID magnetometer at the University of Edinburgh. From the results obtained so far it appears that at least one of the sites may be able to show reproducible angular geomagnetic secular variations. Records of geomagnetic field behaviour through the Late Glacial are very few, and those that exist suffer from very poor age control. Therefore considerable effort to derive the field behaviour from these weakly magnetised samples is justified as they ultimately promise to be very well characterized and dated as a result of the other intensive work being undertaken. This work follows on from work on geomagnetic secular variations during Post Glacial times and some early work done on Late Glacial sediments from Denmark by N. Abrahamsem and P. W. Readman. It is hoped to link it with some more recent work from Danish sediments.

3 Research Activities in the Astronomy Section

3.1 Image-Sharpener Studies

P. A. Wayman, R. M. Redfern (UCG)

Although the design and construction work for image-sharpening equipment advanced considerably during the year (see section 5.2), virtually no new observing work was possible. Time allocated on the William Herschel Telescope during July in conjunction with Imperial College London and UCG, could not be used due to problems at Imperial College with the PAPA detector provided by makers in the United States.

Some work was done by M. Redfern at the Kapteyn telescope in December but poor weather limited the amount of data secured.

3.2 Spectra of Symbiotic Stars

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

Re-observation of principal symbiotic stars in H β as well as in H α was carried out with the Kapteyn Telescope in September. Of the four nights allocated, three were excellent. 93 spectra were obtained and about half of them have been processed, using the Starlink facility of Armagh Observatory. Many good profiles, even of faint (10 mag.) stars were obtained. Substantial changes from the 1989 results are apparent in some of the H α profiles.

3.3 Photometry of BL Lac Objects

B. McBreen (UCD) with N. Smith (Cork RTC)

Observations with the Kapteyn Telescope of ten BL Lac objects were made on five nights in October/November. Three nights were unusable. 143 exposures of between 5 and 15 minutes were recorded.

3.4 Relativity and Cosmology

T. Kiang and S.-P. Xiang

The overall density of the universe, including the indication from observations that relate to long 'look-back' times, tends to be inconsistent with 'Standard Cosmology' either with only Cold Dark Matter or with only Hot Dark Matter as the principal component. The hypothesis that approximately equal amounts of Cold and Hot Dark Matter have prevailed has been examined and it has been found possible to retain Standard Cosmology on this basis.

New work was begun on the morphology of galaxy distribution to throw light on the question of whether clumps, sheets or filaments dominate. Is the universe characterized by a distribution of material within a space, or is it better thought of as voids within a plenum, as in a sponge? To answer such questions a method of "neighbourhood complexion analysis" was developed and tested. Rhombic dodecahedra divide space in a manner such that each cell is surrounded by 12 equivalent neighbours and the galaxies listed in the Cambridge for Astronomy Catalogue were assigned to such cells. The cell-size was adjusted so that approximately equal numbers of empty and occupied cells occurred. A statistically significant difference emerged as regards the neighbours of the two categories; less definite were data on the disposition of neighbour-occupation.

3.5 Stellar Activity

E. R. Houdebine, K. Olah (Konkoly), P. B. Byrne (Armagh)

Reports of two new types of stellar flare, namely those with periodic energy-release and "Homothetique" flares, were published and an analysis of other white light flares observed at ESO was carried out.

Studies of stellar flares initiated elsewhere have been developed during the year. In particular, with T. P. Downes, progress was made on a major investigation of radiative pumping effects of chromospheric lines by white light flares.

Chromospheric activity in dK(e) and dM(e) stars was studied spectroscopically with M. Heanue, and with K. Olah 129 flux correlations of the active RSCVn star HK Lac were studied. Further work on a model for correction for interstellar absorption and for deriving spot and plage filling-factors was carried out with a view to deriving parameters of importance in describing stellar activity. An IUE/Ground-based follow-up programme has been organized. Presentations on stellar flare work at JILA (Boulder) in October were followed by a visit to the Bartol Institute (Delaware) where aspects of stellar magnetic activity were worked on with D. J. Mullan. An attempted complete stellar flare "scenario" was prepared for publication.

3.6 History of Astronomy

I. Elliott

In preparation for a presentation at the 1992 Colloquium on Stellar Photometry, and by use of the extant correspondence of George Francis Fitzgerald, the circumstances leading up to the first electrical measurements of starlight in August 1892 have been studied. It has been made clear that G. M. Minchin and W. H. S. Monck were the principal persons involved and that the roles of S. M. Dixon and G. F. Fitzgerald, though important, were secondary.

In conjunction with M. T. Brück (Edinburgh), an examination of the role of Lady Huggins (b Dublin, 1848) in her joint work with Sir William Huggins (1824-1910) has indicated that it has an importance not usually recognised. Her family, Murrays with Scottish origin, has been traced, and her contribution to the Huggins partnership of photographic skill in stellar spectroscopy has been demonstrated.

The early life of Agnes Mary Clerke (b Skibbereen, 1842) has also been examined and connections with Trinity College through her brother have been found.

4 Research Activities in the Cosmic Ray Section

4.1 The Ultra Heavy Cosmic Ray Experiment (UHCRE) on the LDEF Mission

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

Results during the year from post-flight investigation of the retrieved UHCRE detector stacks were very encouraging in regard to both sample size and quality of data. In addition to stereoscopic optical scanning, an improved semi-automatic ammonia scanning technique was developed. This technique has proved to be very efficient and will be used in future as the main method of event location for post-flight data extraction. Extrapolation from detector stacks scanned to date indicates that about 3000 ultra heavy cosmic ray nuclei, in the charge region with $Z > 60$, have been collected. This sample is more than ten times the current world data in the

field (taken to be the data set from the HEAO-3 mission plus that from the Ariel-6 mission) and will be sufficient to provide the world's first statistically significant sample of actinide ($Z > 88$) cosmic rays.

With regard to data quality, track analysis of batches of pre-flight and post-flight uranium calibration events showed excellent agreement in track response at all energies from 500 MeV/N down to 100 MeV/N. In fact, the pre-flight and post-flight events are indistinguishable. This implies that the charge spectrum determination will not suffer any degradation from possible long term latent track evolution effects such as fading. This excellent result reflects the UHCRE hardware design which provided a dry nitrogen/oxygen pressure vessel environment for the detectors with independent damped passive thermal control of thermally decoupled (from the LDEF) detector stacks.

Extensive post-flight thermal analysis of the UHCRE hardware, dedicated to track response requirements, was carried out during the year on behalf of DIAS by Lockheed Engineering and Sciences under sub-contract to the NASA Langley Research Center. The results show a relatively benign detector temperature history remaining well within pre-flight design predictions during the six year mission. The overall mean temperature of the detector stacks was $-23^{\circ}\text{C} \pm 3^{\circ}\text{C}$ and the maximum temperature gradient across any stack was $< 0.1^{\circ}\text{C}$. The mean maximum temperature excursion was $\pm 10^{\circ}\text{C}$. Detailed temperature history information is very important with regard to variation of track response with temperature during registration and is thus critical for overall data quality. Track response work during the year (see Section 4.3) also demonstrated that possible short term (2 to 10 days) latent track evolution in the detectors would not degrade UHCRE charge resolution under conditions arising from the short term (45 days) LDEF temperature cycle. It is now apparent that the integrated effect of all temperature related latent track variations will cause a maximum charge shift of $\pm 0.8e$ for uranium and $\pm 0.6e$ for the platinum-lead group. Thus the primary determinant of charge resolution in the stacks will not be temperature variation but the more fundamental question of the precision with which energy change through the $\sim 50 \text{ kg m}^{-2}$ thick detector stacks can be measured.

4.2 The Energetic Particle Analyzer (EPA) on the Giotto Mission

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

Analysis of the EPA energetic particle data, obtained during the Giotto-Halley encounter, continued with emphasis this year on the study of particle propagation and acceleration processes in the Halley bowshock environment. An integrated approach was employed with correlated data from the JPA (Johnstone Plasma Analyser) and MAG (Neubauer Magnetometer) experiments. Water group ions observed by EPA in energy channels from 60 keV up to ~ 300 keV total energy were used in conjunction with solar wind data and low energy H_2O^+ ion measurements (1-85 keV) from JPA and with magnetic field observations from MAG.

It was found that energetic ions were accelerated in association with a strong magnetosonic wave field in the foreshock, in the inbound bowshock, within the near cometosheath, as well as immediately inside and outside the broad outbound bowshock. A relatively hard spectrum was observed in the inbound foreshock ($\gamma = 3.3$). Inside the bowshock itself, the spectrum was somewhat softer ($\gamma = 4.1$), due to an increase in the fluxes in the lowest energy channels. Further acceleration of the particles took place inside the cometosheath ($\gamma = 3.5$). Similar, but somewhat steeper, spectra were observed on the outbound side.

It was concluded that particle acceleration at the inbound and outbound bowshock observed by EPA was most likely due to a combination of first and second order Fermi processes and the transit time damping effect. It was found that the pickup process and the shock drift acceleration process could be discarded as the reason for the existence of the Halley foreshock. It was also found that more particles escaped from the outbound than from the inbound cometosheath indicating a general flux anisotropy, probably caused by the transit time damping mechanism.

4.3 Nuclear Track Detector Response Studies

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

In order to investigate the temperature dependence of short term (2 to 10 days) latent track evolution in polycarbonate, hitherto un-

known, nine thick ($\sim 10 \text{ kg m}^{-2}$) detector stacks had been exposed to near relativistic uranium and gold beams at $+18^\circ\text{C}$ and at -78°C , and stored at -78°C for periods varying from 0 to 200 hrs, equivalent to a limiting range of 2 to 10 days. During the year, batches of uranium events registered at 18°C and at -78°C with 0, 60 and 160 hours storage times, were measured and analyzed. It was found that events from the three storage times were indistinguishable from each other within the statistical errors and that the fractional change in signal strength per degree centigrade was consistent with earlier DIAS results for the Registration Temperature Effect (RTE) which is, essentially, very short term (< 2 days) differential latent track evolution. This is a very important result for application to the analysis of LDEF/UHCRE events (see Section 4.1) and means that the short term LDEF temperature cycle will not degrade the UHCRE charge resolution by causing apparent charge shifts beyond the known RTE. Earlier track response studies by DIAS have shown that possible long term (> 10 days) temperature dependent latent track evolution will have no measurable impact on UHCRE charge assignment.

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

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

During the year analysis of the SLED energetic electron and ion data from the Phobos Mission Cruise Phase (Earth to Mars) and from the near Martian environment continued. Over the period from 25 July 1988 until 27 March 1989 the SLED instrument on Phobos-2 had recorded variable interplanetary fluxes in the range ~ 30 keV to ~ 30 MeV. This time interval, which overlapped with data obtained from 19 July until 30 August 1988 by an identical SLED instrument on Phobos-1, coincided with a period when the interplanetary medium was expected to be in the course of evolving from one solar-cycle dominated characteristic state to another. Investigation of the SLED data shows that the interplanetary medium was indeed greatly disturbed during this period. Co-rotating events, which are characteristic of solar minimum conditions, as well as strong solar particle events associated with major flaring were observed. The co-rotating events were characterized by a preceding structured spike, probably caused

by a forward/reverse shock, followed by an enhancement exhibiting an exponential decay phase and a harder energy spectrum. A particle shielding effect for protons up to ~ 30 MeV, caused by planet Mars, was detected by SLED in March 1989 when the interplanetary medium was disturbed by major flares.

SLED particle data from the lowest energy channel (34-51 keV) were compared with magnetic field data simultaneously recorded by the Phobos magnetometer (MAGMA). This was possible for 13 out of 114 circular orbits of Mars. Two types (A and B) of particle enhancement were identified deep in the Martian magnetotail. Type A had pitch angles close to 0° and 180° while Type B had pitch angles close to 90° . Possible explanations include (1) mechanisms similar to those known to accelerate ions in the Earth's auroral regions (Type A); the pickup process in the dayside of Mars (Types A and B); (3) partial confinement of particles in the magnetotail within closed magnetic field loops (Type B).

4.5 The Energetic Particle Analyzer (EPA) on the Giotto Extended Mission (GEM)

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

The Giotto spacecraft remained in hibernation during the year. It had been powered down on 23 July 1990 following confirmation of the trajectory to comet Grigg-Skjellerup, which it will encounter on 10 July 1992 between 15:10 and 15:30 UTC. A key objective of this encounter is the investigation of comet/solar wind interactions using the onboard particle and field instruments. In this context EPA, which incorporates three semiconductor particle telescopes, will measure the energetic electron and ion environment of Grigg-Skjellerup, employing eight energy channels, from 20 keV up into the MeV region, viewing in sixteen sectors with 0.5 seconds time resolution.

Scheduled Mission and Science Working Team (SWT) activities for the year have been implemented. By the end of the year preparations at ESOC for the Encounter period were well under way and the rooms for the experiment teams and their Experiment Ground Support Equipment were ready. The operational status of the ground segment will be confirmed in the formal Ground Segment Readiness Review on 23 March 1992. With regard to EPA Ground Support and

Quick Look equipment, it was decided to refurbish the hardware which had been used for the Halley Encounter. This will provide a facility for real time displays of EPA data during the Grigg-Skjellerup encounter. Such display facilities are required by the European Space Agency for use during the extensive public relations activities planned for the encounter period.

The encounter scenario and spacecraft targeting were discussed at the last SWT meeting of the year, on 5 December. Targeting error should be less than 1000 km and two options for the SWT emerged: (1) to go as close as possible to the nucleus, i.e. to aim at impacting on the nucleus, or (2) to aim for the tail forming region, about 300 km to the tailward side, a cometary area unexplored to date. A final choice will be made during the SWT meeting on 24 March 1992, giving the Flight Operations Team sufficient time to optimize the encounter strategy.

4.6 Star Formation

T. Ray, D. Corcoran, M. Corcoran, A. Moorhouse and S. Russell with MPIA and other groups

During 1991, the observational group working on star formation studies has grown with the arrival of a jointly funded DIAS-EOLAS postdoc, Alan Moorhouse, formerly of the Royal Observatory Edinburgh, and a new postgraduate student, Myles Corcoran, who is registered with TCD.

Much of the group's efforts have gone into understanding the various mass loss phenomena that occur during the early phases of star formation. It now appears that every young star, including our Sun at one time, went through such an outflow phase. In fact, most current theories of star formation require a degree of mass loss, even while the core is still actively accreting, if a star is to form at all. In addition to directly studying the wind properties close to the star by analyzing line profiles, the group have also studied its impact on the young stellar object (YSO) environment using certain outflow tracers. Such tracers include high-velocity CO-line emission and shock-excited H₂ line emission. The most highly-collimated outflow component, however, near YSOs can be observed optically in the form of Herbig-Haro (HH) objects or HH-like jets and these "optical" outflows continue to be a main area of interest for the group. Like HH objects, jets are emission-line

objects excited by shock waves with velocities of 30 to 100 km/s. This excitation mechanism gives rise to a characteristic spectrum, in which lines such as $H\alpha$, [SII] and [OI] are very prominent. These lines can be used to carry out studies of the morphology, by imaging, and the kinematics, through imaging and spectroscopy. Close ties with the Max Planck Institut für Astronomie (MPIA) in Heidelberg continued, both in the area of groundbased studies of young stars and in the preparation of the star formation core programme for the Infrared Space Observatory (ISO). During the Summer of '91, Drs. R. Mundt and R. Poetzel of the MPIA visited Dublin for approximately two weeks while T. Ray and D. Corcoran reciprocated in November. A total of four joint observing campaigns with the Heidelberg group have been carried out. These include runs on the European Southern Observatory's New Technology Telescope (NTT) in Chile (Poetzel and Ray), the Isaac Newton Telescope (INT) on La Palma (Corcoran and Ray), the MPI 2.2m Telescope in Chile (Moorhouse) and the United Kingdom Infrared Telescope (UKIRT) in Hawaii (Ray and Bastien). The latter programme was also in collaboration with the University of Montréal.

With Alex Raga (University of Manchester), Ray and Mundt have found clear evidence that jets from young stars are largely collimated on scales of a few hundred astronomical units (AU) rather than a few stellar radii; these observations have important implications for the theory of outflows from such stars. In order to measure the degree of collimation close to the star, image deconvolution techniques have had to be applied to frames (already obtained under excellent seeing conditions) at Calar Alto (the MPI observatory in Southern Spain).

Combining data on a range of outflows from young stars with different luminosities, Ray has found that the mass loss rates scale roughly with the square root of the luminosity. This is seen to be the case irrespective of whether one is observing these outflows in the molecular (i.e. mm wavelengths) or in the optical or radio continuum bands. Such a result is surprising given that one is supposed to be observing different parts of the outflow at these widely different wavelengths.

With Susan Edwards (Massachusetts), Ray and Mundt have shown that the presence of

disks around young stars (as evidenced by their infrared signature) is a necessary prerequisite for outflows to form. Since outflows come from deep within the gravitational potential well of the parent star, they must therefore arise from the inner regions of the surrounding accretion disk.

Stellar jets usually consists of a series of often quasi-periodically spaced knots. Using the large data bank of images acquired over several epochs, Ray and the MPIA group have made proper motion measurements of these knots and it has been found that knots move out at velocities less than the velocities of the jet material itself. The knot speed is therefore essentially a pattern speed and it is currently being investigated whether knots might be due to some form of hydrodynamic instability.

Several new optical outflows from high luminosity sources have been discovered by the DIAS and MPIA groups. In some cases (for example MWC 1080, Cepheus A) the outflows appear to be poorly-collimated while in others (for example LkH α 198 and AFGL 2591) this is not so. It is not clear yet what connection, if any, there is between luminosity and degree of collimation. The DIAS group's results for Cepheus A are quite spectacular in that they show the first clear ring of Herbig-Haro emission ever seen. Finally Ray and others have detected a brightening (in the optical) of the young star SVS 13 by several magnitudes. This brightening is now being monitored by several groups photometrically and spectroscopically. It appears to be a rare EX Or event rather than a FU Or event.

Ray, in collaboration with Pierre Bastien (University of Montréal) and Mundt, searched for disks around YSOs using UKIRT's infrared camera (IRCAM) and a polarimeter. Six YSOs were imaged in several wavebands. Several YSOs showed a "slab" pattern in their polarization vectors indicative of a disk. All of the objects studied had well-determined optical outflows in the sense that their true spatial orientations are known from proper motion and spectroscopic studies. This information is to be used to model the polarization disks and examine their origin. From the data, it is hoped to test whether multiple scattering or magnetically aligned grains are the cause of "polarization disks". Initial indications are that multiple scattering is the most likely origin.

In August R. Mundt (MPIA) visited DIAS for two weeks to work on a joint paper and to initiate a new programme on FU Orionis stars. Corcoran and Ray used the Isaac Newton Telescope (INT) for one week with the Intermediate Dispersion Spectrograph (IDS) to observe Herbig Ae/Be stars and, in addition, some Herbig-Haro objects from high luminosity YSOs. Only half a night was lost due to bad weather. This data, currently under analysis by M. Corcoran, shows that these stars have either symmetric or purely blue-shifted forbidden line emission. A similar effect is seen in the forbidden lines of T Tauri stars and it is almost certainly due to the obscuring effects of a circumstellar disk. Corcoran's result is probably the strongest evidence yet found for disks around young intermediate mass stars.

S. Russell is involved in a study of the Chamaeleon star formation region. Using results from the new infrared array IRIS on the AAT, he and his colleagues are probing the luminosity function of the region to great depth. So deep, indeed, that sub-stellar objects, or the fabled 'brown dwarfs', may be detectable. This is a project designed to support the future work to be carried out by the infrared space observatory (ISO) on star formation. In further support of this space project, he is coordinating several proposals to observe star formation regions at mm-continuum wavelengths.

4.7 Abundance Studies

S. Russell

The third of three papers derived from the PhD thesis of S. Russell, entitled *Abundances of the Heavy Elements in the Magellanic Clouds: III Interpretation of Results* by Russell and Dopita, was accepted for publication in the *Astrophysical Journal* (it appears in volume 384, p508, January 1992).

Recently there have been several investigations of the elemental abundances of F-G as well as B type stars in both clusters and the fields of the Magellanic Clouds (for instance: Richtler et al. 1989, 1990; Reitermann et al. 1990; Dufton et al. 1990; Barbuy et al. 1991; McWilliam and Williams 1991; Spite et al. 1989a, 1989b). The results of these various investigations are discussed in detail by Russell (1991) and are the subject of continuing research. Russell concluded that the results of different authors, different stars, and different sites broadly agree with each

other. However, cluster stars show a systematic overabundance of very heavy elements compared to field stars. In addition, hot stars show a systematic overabundance of oxygen compared to cool stars.

4.8 Shock structure and stability

L. O'C. Drury and I. O'Brien

There is an interesting analogy between the equations governing the structure of shocks modified by energetic particle reaction effects (often called cosmic ray shocks) and those for shocks in partially ionized media. An investigation was started to see whether techniques developed in the cosmic ray case could be usefully applied to the partially ionized case.

4.9 Cosmic ray production in supernova remnants

L. O'C. Drury

The simplified models for particle acceleration in supernova remnants developed over the last few years in collaboration with the Heidelberg group were implicitly criticised in a paper by Kang and Jones. They reported a calculation, using their more detailed hydrodynamic programme, of one of the simplified models which gave very different results. However a detailed examination of the calculation showed that the differences were almost entirely the result of slightly different assumptions about the closure parameters and starting conditions. With the same starting conditions and closure parameters the differences between the two calculations are only slight.

4.10 Turbulent Reconnection

L. O'C. Drury with M. Goldstein (GSFC)

Arising from discussions at the Cargèse workshop, the possibility that the electric fields associated with turbulent magnetic reconnection in the Galactic disc and halo might be significant in the acceleration of cosmic rays was considered.

5 Facilities

5.1 Geophysics Instruments

G. A. Wallace, T. A. Blake, C. M. Horan

Some work was done on the seismic field instruments in order to make it possible to use the small 4.5 Hz seismometers. The output from these needs some preamplification before being fed into the existing amplifier-modulators. Conversion to 3-component recording was also considered and two test instruments were built. However, this would be a major investment which might be better applied to moving to a smaller number of digital 3-component instruments while keeping the, very successful, analogue single component instruments operational as well.

The rehabilitation of the DNET base station at Lyons Estate took a good deal of staff time. The final outcome has been considerably improved housing for the analogue equipment and the provision of a suitable environment for the new digital equipment.

5.2 Imaging Techniques (UCG-DIAS-ICL-RAL Collaboration)

R. M. Redfern (UCG), B. D. Jordan, I. van Breda, P. A. Wayman

The Transputer-based interface and correcting mirror-drive electronics, together with the UCG data acquisition system, were completed during the year. All these items were ready for laboratory testing with the Imperial College PAPA detector by February and, with the PAPA incomplete, were taken to London and found to work satisfactorily in conjunction with the software of the detector and the SUN workstation display. It was subsequently apparent that the PAPA, as delivered to ICL, was unsatisfactory due to alignment and focussing difficulties. Consequently, a promising scheduled observing period using the GHRIL laboratory of the Herschel Telescope on La Palma had to be cancelled.

During August the possibility of gaining access to the Rutherford Appleton Laboratory photon counting system was discussed at RAL. This followed on from work previously done by I. van Breda while at the Royal Greenwich Observatory. It was envisaged that a hardware preprocessor would be incorporated in the system, which could otherwise be adapted to the interface and data acquisition system which had been developed for the Imperial College PAPA detector. The RAL detector equipped with image-pro-

cessing circuitry as designed by I. van Breda and tested at RAL is potentially superior to any existing photon-counting detector available elsewhere which makes use of a microchannel plate at the front end.

Based on possible use of the RAL detector, a mechanical assembly has been constructed in UCG using two detectors, one for monitoring image movement by a broad-band filter and the other capable of recording narrow-band photons. The assembly is designed for multiple-aperture use at the GHRIL laboratory on the 4.2-m Herschel telescope and a computer-controlled stepper motor driver for the eight motors involved was designed and built for rack mounting at the finished instrument. It is intended that the RAL detector shall be used at the broad-band focus and either the ESO MAMA detector, the existing GHRIL IPD detector (the only one used to date at the GHRIL), or eventually the PAPA detector of ICL, at the recording focus. The equipment would, however, be available for use on other telescopes and preliminary enquiries were made during the year as regards the availability of the Nordic Optical Telescope (NOT) on La Palma and the New Technology Telescope (NTT) at the Chilean ESO site.

In order to improve the data-recording fidelity of the IPD, a new method of processing the signals using digital rather than analog techniques has been devised. A prototype system with a 12-bit A/D converter was built at Dunsink during the year and four printed-circuit-board versions were produced with a view to improving the IPD output from the former 7-bit specification to 10 bits, with the use of a look-up table. In order to pursue this proposal, an IPD detector belonging to the Physics Dept., Maynooth College, has been made available on loan.

5.3 Servo Motor Drive

B. D. Jordan

Due to difficulty in getting the 4MS development system to respond fully to the software supplied, work on the D. C. servo motor drive, in conjunction with the Royal Greenwich Observatory was in abeyance. Lack of documentation to solve the difficulties prevents further progress and alternative methods have been proposed to RGO using a transputer-based system, or VME 68020/68030 processors.

5.4 QUBES Electronics

M. Smyth worked from 5 April on secondment to the Royal Greenwich Observatory, Observatorio del Roque de los Muchachos, La Palma, Canary Islands, Spain. His work has included the application and maintenance of the QUBES system in support of observing schedules from, *inter alia*, the Astronomy Section and Armagh Observatory.

6 Computers

6.1 Merrion Square

T. A. Blake, W. M. Tai

A major change took place when the computer room equipment was moved to the basement in the second half of the year, however this was accomplished at little inconvenience to the users. In large part this was due to the fact that the whole building is now threaded by an ethernet cable to which most of the PCs and all the workstations are connected. The connection of this network to the other Institute sites was planned and leased lines connecting 5 Merrion Square to Dunsink Observatory, 10 Burlington Road and the TCD computer science department were installed by October.

The Microvax Workstation, a Sun IPC (installed in June) and PCs were used for seismic analysis. The most recent version of RAY84PC was installed on the PCs and the Seismic Handler now operates on both VMS and UNIX systems.

Software acquisitions during the year included Microsoft Fortran and C programming languages, PC-NFS for Sun-PC communication, PC-XVIEW to display Sun windows on a PC, and PROCOMM to trap VME data transfer from the seismic network. PMDF was bought for communication with computers on the major external networks.

K. Stammer and W. M. Tai worked on the "Seismic Handler" programme on the Sun IPC in June and T. A. Blake went to Edinburgh in early July to work on the new VME seismic system. He also attended the DECUS Conference at Dublin City University in September.

Extensive work was done in support of the MIDAS and IRAF image analysis systems which were heavily used throughout the year. The Sparc I was upgraded to a Sparc II, a 1.6GB disc was added to the system and a SLC workstation purchased for program development and maintenance.

The SPAN network connection was reasonably reliable and was heavily used both for e-mail communication and to down-load files from various archive sites. A guest account made available to participants attending the International Cosmic Ray Conference was heavily used. A proposal to install a Megapac X25 switch in Merrion Square as an extension of the ESIS project to Irish research institutes was discussed during the SPAN users meeting in Frascati in October.

6.2 Dunsink Observatory

I. Elliott

Among equipment added during the year was a Sun SPARC station with 8 MB internal memory, a 207 MB hard disk, a 1000 MB hard disk, a 3.5-in. disk drive, and a 16-in. colour monitor. The workstation will act as a fileserver for a Local area network and will be connected by a leased line to 5 Merrion Square.

The PC TCP package was installed on one of the Tandon computers to provide remote login capability to the Sunstation, etc. and various additions to the hardware and software of the PC system were made. The datalink to UCD Belfield operated reliably during the year, with one 4-day interruption. The electronic mail facility was in constant use.

7 La Palma Observatory

The Advisory Committee for La Palma and the HST met twice. It was noted that the one Irish proposal accepted for the HST, first round, has been postponed on the basis of its being a priority proposal for the second round of observations 1992/93. Allocations for travel funds for observing work were made in respect of Semesters T and U, covering March 1991 to January 1992, and proposals for Semester V, to July 1992, were reviewed. In Semesters T and U six Irish proposals were granted observing time by the UK panel (PATT), one long-term proposal was continued

and one UK proposal with Irish participation was approved. Professor B. McBreen (UCD), a member of PATT, attended panel meetings as Irish representative in July and December. R. M. Redfern attended two meetings of the GHRIL committee but the La Palma Users Committee was not convened.

Two Information Sheets, Nos 24 and 25, were issued during the year. In response to a request from the Governing Board, discussions on funding of the La Palma observing work and similar proposed facilities at ESO, Hawaii(US), Calar Alto, etc. were held with the Minister for Science and Technology and at EOLAS.

7.1 Observing Visits, La Palma, etc.

Observing work was carried out during the year as follows:

- T. P. Ray, with R. Poetzel (Heidelberg), NTT, Chile, 6-10 February.
- A. Moorhouse, UK Infrared Telescope, Hawaii, 2-10 July;
- T. P. Ray and D. Corcoran, INT, 28 August - 3 September.
- P. A. Wayman, JKT, 1-4 September.
- B. McBreen, M. Rabette (UCD) and N. Smith (Cork RTC), JKT, 24 October - 4 November.
- R. M. Redfern, with J. C. Dainty (ICL), JKT, 16-22 December
- T. P. Ray, with P. Bastien (Montreal), UKIRT, Hawaii, 29 December - 1 January.
- A. Moorhouse, ESO/MPI 2.2m Telescope, Chile, 10-31 December (continued into January 1992).

8 Seminars, Colloquia, Lectures

8.1 Statutory Public Lecture

Dr. P. W. Readman (Geophysics Section) delivered the Annual Statutory Public Lecture at University College, Dublin on 26 November 1991. The lecture was entitled *The Earth's Magnetic Field - How it Varies in Time*.

8.2 Seminars in the School

- 17 May: Y. Kozai (Mitaka, Tokyo), Japanese Telescope Projects, Optical and Radio.
- 20 June: K. Olah (Konkoly, Budapest), Stellar Activity on Varying Time-scales.
- 24 July: J. B. Hearnshaw (Christchurch, New Zealand), High-precision Stellar Radial Velocities and the Search for Dark Companions.
- 10 October: R. Vees (Technical University, Clausthal) Underwater Seismic Sources
- 15 November: S.-P. Xiang, Hot and Cold Dark Matter in the Universe.

8.3 Lecture Courses

- D. O'Sullivan gave a course of eight lectures on cosmic ray astrophysics to 3rd year students at TCD during Hilary term.
- I. Elliott gave a course of 17 lectures on Introductory Astrophysics at Junior Sophister level in Trinity College.
- I. Elliott gave two courses of 10 lectures each to the U. C. D. Adult Education Department Astronomy Now (Spring Term), An Introduction to the Solar System (Autumn Term).
- T. Ray gave a course of 10 lectures on plasma astrophysics to 4th year students at TCD during Michaelmas term.

8.4 Contributions to Scientific Meetings

A. W. B. Jacob with C. Prodehl et al., Crustal Structure of the East African Rift in Kenya - Preliminary results from KRISP-90, Meeting of the European Union of Geosciences, Strasbourg, March.

A. W. B. Jacob with C. Prodehl et al., Refraktionsseismische Untersuchungen des Ostafrikanischen Rifts in Kenia - Experiment und erste Ergebnisse, Meeting of the German Geophysical Society, Bochum, March.

A. W. B. Jacob with J. Mechie et al., Structure and Evolution of the Kenya Rift as derived from the KRISP '90 Experiment, General Assembly of the European Geophysical Society, Wiesbaden, April.

A. W. B. Jacob with N. A. Khan et al., A detailed seismic investigation of the Kenya Rift,

at the XX General Assembly IUGG, Vienna, 11-24 August.

A. W. B. Jacob with J. Diaz et al., An investigation of the lithospheric heterogeneity and anisotropy in Iberia: the ILIHA-DSS experiment, at the XX General Assembly IUGG, Vienna, 11-24 August.

P. M. Shannon, A. W. B. Jacob and J. Makris, Proposed Study of the correlation between seismicity and geochemical emissions at a mid-ocean ridge, EC MAST II Workshop, Brussels, 16-17 October.

A. W. B. Jacob with J. Mechie et al., Crustal and Upper Mantle Structure Beneath the Kenya Rift: Principal Results from KRISP 90, AGU Fall Meeting, San Francisco, 9-13 December.

C. Prodehl, A. W. B. Jacob, E. Dindi, H. Thybo, R. Stangl, Crustal Structure on the Northeastern Flank of the Kenya Rift, KRISP 90 Workshop, US Geological Survey, Menlo Park, California, 7 December.

A. W. B. Jacob, Source Spectra and their variation with distance, KRISP 90 Workshop, US Geological Survey, Menlo Park, California, 7 December.

P. A. Wayman gave an invited public lecture *Co-operation between Dunsink and Armagh Observatories over 200 years* on the occasion of the visit to Armagh of the Royal Irish Academy on 27 March, during the Bicentenary Year, 1990-91, of Armagh Observatory.

T. Kiang spoke on Probing the Large Scale Structure with Rhombic Dodecahedron Cells at the International Workshop on Galaxy Environments and Large Scale Structure of the Universe, Trieste Italy, 22-25 October. A poster paper Clustering in a Universe dominated by Multiple Dark Matter by S.-P. Xiang and T. Kiang was presented at the same meeting.

E. Houdebine spoke on *Periodic Flare Activity* at the Cool Star Consortium Meeting, JILA, Boulder, in October.

T. Kiang spoke on *A Tool for Researching into the Shape of Things: The Rhombic Dodecahedron* at the Maynooth meeting of the ASGI, 12 September.

A. Thompson presented a poster paper entitled "The Ultra Heavy Cosmic Ray Experiment on the LDEF Spacecraft - A Postflight Report" at the 22nd International Cosmic Ray Conference, Dublin, 11-23 August.

S. Russell spoke on *The Magellanic Clouds: How Well do we Know What Our Closest Neighbours are Made of?* at the RAS/ASGI meeting in Armagh, 3 April.

T. P. Ray spoke on *The origin of mass loss from young stars* at the RAS/ASGI meeting in Armagh, 5 April.

8.5 External Seminars

B. D. Jordan addressed the Institution of Control and Measurement Engineers on Electronic designs for the SLED mission in March.

I. van Breda spoke on Inertial Guidance for Telescopes and on Transputers in Parallel Control Systems at the South African Astronomical Observatory in September.

P. A. Wayman spoke at Armagh Observatory on *The Total Solar Eclipse of 11 July 1991 and its antecedents* on 27 November.

P. A. Wayman spoke on Grubb Telescope Design at the Physics Department, Carlow R. T. C., on 22 January.

D. O'Sullivan gave a colloquium on ultra heavy nuclei to the Space Science Unit of the University of Canterbury on December 11.

T. P. Ray gave a colloquium to the Department of Astronomy of the University of Manchester on "Optical Outflows" on October 24.

S. Russell gave an Invited talk at Canterbury University in Christchurch, New Zealand, on the 18th April 1991, entitled *The Heavy Element Abundances in the Magellanic Clouds*.

8.6 Popular Lectures

D. O'Sullivan spoke on *Particles in Space* to the Irish Physics Students' Association in Cork (January).

P. A. Wayman addressed the Irish Astronomical Society on *Large Telescope Design* on 4 March and on *The Total Solar Eclipse of 11 July 1991* on 4 November.

P. A. Wayman addressed groups visiting Dunsink Observatory from the Sundai School, Newbridge, (23 January), the Royal Aeronautical Society (22 February), the Schools of Celtic Studies and Theoretical Physics (27 February), visitors in connection with the Hamilton Walk (16 October), the Finglas Arts Festival (11 November), Castleknock Youth Group (19 November),

and the Society for Parents of Gifted Children (29 November).

P. A. Wayman and W. Dumbleton talked at a weekend conference of the Westport Historical and Literary Society at Westport 22-23 November. Topics were The Solar System (W. D.), The 1991 Total Solar Eclipse (P. A. W.) and Time Measurement (P. A. W.).

I. Elliott spoke on Astronomy in the Teaching of Physics under the Institute of Physics sponsored lecture scheme to branches of the Irish Science Teachers Association in Dundalk (2 Sept), Longford (10 Dec.) and Dublin (27 Nov.). He also gave a lecture to H. Dip. Ed. students in the U. C. D. Education Department on the Junior Cycle environment course (5 Feb.).

I. Elliott spoke to the visiting students of the Royal Dublin Society Youth Science and Arts Week on 8 July.

The programme of Public Open Nights at Dunsink Observatory continued as in previous years on fourteen nights with assistance from members of the Irish Astronomical Society. Use of a slide sequence on the Total Solar Eclipse of 11 July observed from La Paz, Baja California, Mexico, has proved to be very popular. T. Kiang addressed a large group from the Chinese Embassy on 27 March.

9 Organisation of Meetings

9.1 XXII International Cosmic Ray Conference, 1991

Local Organising Committee: N. Porter (Chairman), D. O'Sullivan (Secretary), M. Cawley, L. Drury, D. Fegan, D. Spearman; E. Flood, W. M. Tai

Preparations continued until August when the conference opened at Trinity College Dublin. The Local Organising Committee met six times between January and August.

The second circular was mailed to prospective participants on Feb 19th. A total of 940 were mailed; Durham University paid the postage for those going to the USSR and Europe and Bord Failte contributed to the cost of the remainder.

The original plan of having the proceedings printed by the Leeds University Press had to be

abandoned following the 'commercialisation' of the press and subsequent unacceptable increases in the price quoted. A very favourable contract was eventually negotiated with Reprint (Dublin). The contract for printing the books of abstracts was also awarded to Reprint.

Serious problems could have arisen as a result of international travel restrictions brought about by the Gulf war, but happily these were relaxed some months before the conference opened.

More than one hundred requests for financial assistance were received from scientists interested in attending the conference and thirty six were eventually offered some support.

Efforts to raise sponsorship for the 22nd ICRC were successful. The International Union of Pure and Applied Physics awarded a generous grant and seventeen other institutions and companies provided financial assistance or facilities free of charge.

The deadline for receipt of abstracts was fixed for May 15. A total of 969 abstracts were received and these were published in two volumes given to each participant at registration. A small number of late abstracts were also included in the scientific programme at a later date.

A provisional scientific programme was prepared in May. The Third Circular and notification of acceptance of abstracts were mailed early in June. Confirmation of accommodation was also included.

A social committee which was set up in autumn 1990 met on several occasions during the year. This committee made arrangements for the provision of a hospitality room for delegates and accompanying persons at TCD and provided information and assistance with local tours and visits to historic sites and places of cultural interest.

Registration opened at TCD on August 11. The conference was attended by 520 delegates and 100 accompanying persons. The Opening Ceremony took place in the National Concert Hall on August 12. The IUPAP Cosmic Ray Commission and delegates were welcomed by the chairman of council, Dr Whitaker. The Shakti P. Duggal Award for 1991 was presented to Todd Joseph Haines and following the performance of a specially commissioned piece of music, the first invited talk of the conference was delivered by Professor O'Raifeartaigh of the School of

Theoretical Physics. Following this, a reception for the delegates was hosted by the Lord Mayor of Dublin. Scientific sessions at Trinity College started on August 13 and continued there until the final day of the conference, August 23. A total of 781 contributed papers were read and there were 8 invited and 9 rapporteur talks. The Inaugural Hess Lecture was delivered by Professor Bonnet, the director of the scientific programme of the European Space Agency, at the Royal Dublin Society on the evening of August 21. Eleven workshops were held at evening time and were very well attended.

The organisers of the 23rd ICRC were provided with facilities to promote the next conference, to be held at the University of Calgary in 1993.

The Minister for Tourism and Transport hosted a State Reception for the delegates at Dublin Castle on August 12 which was attended by over 700 guests. Prior to the Hess Lecture at the RDS delegates attended a reception sponsored by DCC. Included in the social programme were two evenings of Irish music and a Conference Dinner and entertainment at Trinity College. Many delegates took part in two specially arranged tours to Birr Castle (including Mount St Joseph's Monastery) and Newgrange/Knowth/Monasterboice. A wide ranging social programme was also provided for the accompanying persons by the social committee.

The Closing Ceremony was held at Trinity College on the afternoon of August 23.

The Proceedings of the 22nd ICRC, comprising five volumes, were collated during September and October and prepared for publication. Seven hundred complete sets were printed (3500 volumes in all) and mailing to delegates was completed by mid December.

9.2 Solar-Terrestrial Science Symposium

A. Thompson with ESTEC, RIA and Eolas

During the year the European Space Agency (ESA) agreed to upgrade the International Symposium on the Study of the Solar-Terrestrial System by reclassifying it as the 26th ESLAB Symposium. The Symposium is being organised by the Space Science Department of ESA in collaboration with the Dublin Institute for Advanced Studies and Eolas. Sponsorship is by the Inter-Agency Consultative Group for Space Science

(IACG) and the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP). The primary objective of the Symposium is to address outstanding scientific problems in solar, heliospheric and space plasma physics using a unified and co-ordinated approach.

The Scientific Programme Committee, at its first meeting on 24 October, decided to adopt a cross-fertilisation approach to the structure of the programme, which would emphasise the common aspects of solar, interplanetary and magnetospheric physics, leading to the study of the same, similar or analogous physical processes in different regions. The Local Organising Committee met three times during the year on 25-26 June, 27-29 August and 9 December. It was decided that the Symposium, which is scheduled for 16-19 June 1992, would be preceded by one-day parallel ESA/NASA Cluster and SOHO Science Working Team meetings (on 15 June 1992). The Cluster and SOHO missions are central to the ESA Solar-Terrestrial Science Programme (STSP) which is the first "Cornerstone" of the "Space Science: Horizon 2000" plan.

9.3 Image Detector Workshop

A small Workshop on the progress achieved in respect of image-detectors suitable for the UCG-DIAS-ICL programme of image-enhancement methods was held at Dunsink Observatory, 12-13 November. Arrangements to use equipment assembled at the Rutherford Appleton Laboratory, Oxfordshire, were confirmed (see Section 5.3 above).

9.4 IAU Colloquium No. 136

I. Elliott and P. A. Wayman

The title of this colloquium is Stellar Photometry - Current Techniques and Future Developments and is to be held as part of the Trinity College Quatercentenary Programme of scientific activity, 4-7 August 1992. Preparation for the Colloquium continued with distribution of the First Announcement to over 900 individuals and institutions. By the end of the year over 180 replies had been received. Meetings of the Local Organising Committee have reviewed the programme for the colloquium and for associated events. A separate Workshop on Robotic Observatories is planned for 29-31 July to be held in Kilkenny under the joint chairmanship of R.

Genet (Arizona) and I. Elliott.

9.5 Astronomical Science Group of Ireland

S. Russell

The Autumn meeting was held in Maynooth on 12 September; the main speaker was Prof. F. Kahn (Manchester).

10 External Work

10.1 Geophysics Section

- T. A. BLAKE: to BGS, Edinburgh, 1-6, July re new digital seismic equipment; to DECUS Conference, DCU, 4-6 September.
- K. BOLSTER: seismic data processing, BGS Edinburgh, 10-17 April.
- F. HAUSER: RAPIDS visits to Karlsruhe, 4-6 January, Hamburg 16-30 January, 4-22 February, 29 May - 9 June, 3-17 July, 11-21 December.
- C. M. HORAN: RAPIDS visits to Hamburg 16-30 January, 3-17 July, seismic tests in Kerry, 2-4 October.
- A. W. B. JACOB: EC Meeting, London, 25 January, RAPIDS visit to Hamburg, 6-7 March, 22-23 August, and 18-20 December, attended XVth UK Geophysical Assembly, 3-5 April, seismic data processing, BGS Edinburgh, 10-17 April, ESF, Strasbourg, 28-30 May, Karlsruhe, 2-9 June, KRISP Workshop nr. Karlsruhe, 4-11 and 15-22 August, IUGG Vienna, 12-15 August, seismic tests in Kerry 2-4 October, EC MAST II Workshop in Brussels, 16-17 October, KRISP 90 Workshop, Menlo Park, California, 7-8 December, AGU Fall Meeting, San Francisco, 9-13 December.
- T. MURPHY: attended R. Astr. Soc. Geophysical Meeting, London, 11 January, seismic tests in Kerry, 2-4 October.
- P. W. READMAN: attended XVth UK Geophysical Assembly, Leicester, 3-5 April; visited Botany Dept., UCG in June re palaeomagnetic cores; attended XXth General Assembly of IUGG held in Vienna 11-24 August; visited University of Hamburg re marine gravity data, 6-20 October; Free University of Amsterdam re palaeomagnetic samples.
- P. M. SHANNON: RAPIDS visit to Hamburg, 6-7 March, 22-23 August, and 18-20 December, EC MAST II Workshop in Brussels, 16-17 October.
- G. WALLACE: Seismic tests in Kerry, 2-4 October.

10.2 Cosmic Ray Section

- L. O'C. DRURY: Cargèse workshop *Collective Acceleration in Collisionless Plasmas*, 9-15 June; external PhD examiner, University of Leeds, 20 September; collaboration with Dr. M. Goldstein, Goddard Space Flight Center, 3 December; Bartol Research Institute workshop on *Particle Acceleration in Cosmic Plasmas*, 4-6 December.
- A. THOMPSON: Giotto Extended Mission Science Working Team meeting, ESOC, Darmstadt, 8-9 November.
- D. O'SULLIVAN: Institute of Physics (Irish Branch) spring meeting, Galway, 22-24 March; First LDEF Post Retrieval Symposium, Orlando, USA, 1-9 June; Space Science Unit, University of Canterbury, 10-12 December.
- T. P. RAY: Gordon Research Conference *The Origins of Solar Systems*, July; ISOPHOT consortium meeting, 10 September; Meeting on *Stellar Jets and Bipolar Outflows*, Capri, 18-21 September; Space Telescope European Coordinating Facility, Munich 21-22 November; MPIA Heidelberg, 23 November - 7 December.
- D. CORCORAN: MPIA Heidelberg, 23 November - 7 December; Meeting on *Stellar Jets and Bipolar Outflows*, Capri, 18-21 September.
- A. MOORHOUSE: Meeting on *Stellar Jets and Bipolar Outflows*, Capri, 18-21 September;
- S. RUSSELL: ISOPHOT meetings: AOT-working group meeting, Heidelberg, 23-26 January; GBPP-working group meeting, Leiden, 5th February; AOT-working group meeting held at Rutherford Appleton Laboratories, 11-15 February; consortium meeting, Heidelberg, 29-30 April; AOT-working group meeting, ESTEC, 12 July; consortium meeting, Heidelberg, 10 September. Edinburgh Conference Next

Generation Infrared Space Observatory, 23rd - 24th May (chaired the first session).

W. M. TAI: ESRIN (Frascati, Italy), European Space Physics Analysis Network Users meeting, October.

10.3 Astronomy Section

P. A. WAYMAN: Cambridge Meeting on Active Optics, 7 March; R. Astronomical Society, London, 8 March; Armagh, 3-6 April; La Palma C. C. I. Meeting, Cambridge, 28 May; visit to La Paz, Mexico, 8 - 17 July, for the Total Solar Eclipse; Optics in Astronomy Meeting, Cambridge, 8-10 September; R. A. L., Chilton, 22-23 October; Armagh Observatory, 25-27 November.

T. KIANG: Beijing and Hefei, China, 1-20 October; International Workshop, Trieste, 22-25 October.

I. ELLIOTT: Royal Astronomical Society, Armagh, 3-5 April; London, 11 October; ESF Network Meeting for Robotic Telescopes, London, 11 October.

B. D. JORDAN: R. A. L., Chilton, 22 October.

I. VAN BREDa: S. A. A. O., Cape Town, September.

11 Miscellanea

P. W. Readman was the Official Irish Delegate to IAG at the XX General Assembly of IUGG in Vienna, 11-24 August.

A. W. B. Jacob continued as member of the National Council for Geodesy and Geophysics, as Irish correspondent to IASPEI, and was Official Irish Delegate to IASPEI at IUGG in Vienna in August.

A. W. B. Jacob was a member of the European Geotraverse Project Review Panel for the European Science Foundation in Strasbourg, 28-30 May.

L. O'C. Drury was appointed a member of the European Space Agency's Astronomy Working Group.

T. P. Ray was appointed chairman of the Space Telescope European Users Committee.

President Robinson, with members of her family, paid an informal visit to Dunsink Observatory on 20 February. Other visitors included the Astronomer Royal, Professor A. W. Wolfendale, Dr A. Chitty (N. E. I. Newcastle) and Dr T. C. Weekes. During the ICRC, No. 5 Merrion Square and Dunsink Observatory were visited by many participants.

A display illustrating the work of the School was provided for the Aer Lingus Young Scientists' Exhibition in January.

The buildings and grounds of Dunsink Observatory were inspected by architects of the Office of Public Works during the year and a Report was issued by the Director, O. P. W., stating the great historic and architectural merit of the premises and their potential value in terms of a resource for science education in the future. This inspection was part of a general review undertaken during the year in the knowledge that road works during the period 1993-1996 will materially affect access to and usage of the neighbourhood of the observatory.

For the Trinity College Dublin exhibition *Let there be Light* in the O'Reilly building, TCD, in December, several display panels dealing with the first electrical measurements of starlight in Dublin in 1892 were prepared by I. Elliott. Also provided was a demonstration video of the recording of single photons on La Palma by the Physics Dept., U. C. G.

Following the completion of fourteen years as Chief Translation Editor of *Chinese Astronomy and Astrophysics* from its inception, T. Kiang relinquished this position during the year, with transfer of responsibility to Professor S.-G. Wang, Beijing University, China.

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

12 Publications

12.1 Journals

A. W. B. Jacob with P. Maguire et al., The Kenya Rift international seismic project: models of crustal structure from the seismic refraction profiles, *Geophys. J. Int.*, 104:697 (1991) (A).

A. W. B. Jacob with J. Makris et al., A new look at the Rockall region, offshore Ireland, *Marine and Petroleum Geology*, 8:410-416 (1991).

A. W. B. Jacob with KRISP Working Party, Large-scale variation in lithospheric structure along and across the Kenya Rift, *Nature*, 354:223-227 (1991).

A. W. B. Jacob, C. J. Bean, B. Nolte and C. Prodehl, P-wave sections in a realistic anisotropic lithosphere, *Geophys. J. Int.*, 107:709-714 (1991).

J. McLoskey, C. J. Bean, and A. W. B. Jacob, Evidence for chaotic behaviour in seismic wave scattering, *Geophysical Research Letters*, 18:1901-1904 (1991).

A. W. B. Jacob with J. Mechie et al., Crustal and Upper Mantle Structure Beneath the Kenya Rift: Principal Results from KRISP 90, *EOS*, 72:44S:298 (1991) (A).

T. Murphy with D. R. Barraclough et al., 150 years of magnetic observatories: recent researches on world data, *Surveys in Geophysics*, 13:47-88 (1992).

P. W. Readman with S. Papamarinopoulos, Y. Maniatis and A. Simopoulos, Palaeomagnetic and mineral magnetic studies of sediment from Ball's Cavern, Schoharie, U. S. A, *Earth and Planetary Science Letters*, 102:198-212 (1991).

E. R. Houdebine, with P. M. Panagi and P. B. Byrne, High-resolution observations of chromospheric lines in late-type dwarfs., *Astron. Astrophys. Suppl. Ser.*, 90, 437-450 (1991).

E. R. Houdebine, U and I band Observations of Stellar Flares, *IAU Information Bulletin on Variable Stars*, No. 3631 (1991).

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S. P. Xiang, Correlations of Large Scale Peculiar Velocity Field and Potential Flow Analysis

(Review in Chinese), *Progress in Astronomy*, 9, 114-122 (1991).

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12.2 Conference Proceedings

A. W. B. Jacob with C. Prodehl et al., A compilation of data from the 1990 Kenya rift international seismic project, KRISP 90, seismic refraction - wide angle reflection experiment, Geophysical Institute Karlsruhe, Open-File Report 91-1.

A. W. B. Jacob, W. Mooney, and G. Panza, European Geotraverse Project (EGT), Review Panel Report, European Science Foundation, Strasbourg, 1991.

E. R. Houdebine, with C. J. Butler, K. Olah, et al., Periodic and Homothetic Stellar Flares, Seventh Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, Tucson (1991).

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D. Corcoran and T. P. Ray with Mundt, R. 1992, "Herbig-Haro Emission Associated with Molecular Outflow Sources" in *Stellar Jets and Bipolar Outflows: Proceedings of the 6th International Workshop of the OAC*, in press

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T. P. Ray with Poetzel, R., Mundt, R. and Solf, J. 1991, "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 of Disks, Editions Frontières, p503.

T. P. Ray with Poetzel, R. and Mundt, R. 1991, "The Relationship of Optical to Molecular Outflows", in *Molecular Clouds*, eds. R. A. James, T. J. Millar (Cambridge University Press), p145.

12.3 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; T. P. Ray continued to edit the proceedings of the ASGI meetings.

The following contributions were included in Vol. 20, Nos. 1 and 2, published during the year.

p.42 S. C. Russell, The Abundance of heavy Elements in the Large Magellanic Cloud.

p.46 P. A. Wayman, The European Astronomical Society

p.51, I. Elliott, The Origins of our Universe, by Malcolm S. Longair (review).

12.4 Reports

A. W. B. Jacob, Seismology Report to the Irish National Committee for Geodesy and Geophysics, February 1991.

A. W. B. Jacob, RAPIDS Report to EOLAS, Year 1991.

A. W. B. Jacob, DIAS experience of the German Irish Programme, Proceedings of the German Irish programme: Review, October 1990.

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

XXIInd INTERNATIONAL COSMIC RAY CONFERENCE
DUBLIN, AUGUST 1991

This conference was hosted by the Institute, following an invitation from the Cosmic Ray Commission of the International Union for Pure and Applied Physics. It was organised over a two year period by the Local Organising Committee, which consisted of:

M. Cawley (Maynooth)
L. O'C. Drury (DIAS)
D. J. Fegan (UCD)
D. O'Sullivan (DIAS, Secretary)
N. A. Porter (UCD, Chairman)
T. D. Spearman (TCD)

All the committee members contributed generously in time and effort, but perhaps special mention should be made of the crucial organising role of Professor O'Sullivan and of his assistant Ms Eileen Flood.

It was generally agreed that the conference was a success; 520 delegates attended from many countries, with 100 accompanying persons. The number of delegates from abroad was the largest ever recorded in this series of conferences, which goes back to Cracow in 1947. Social functions included a State reception, and many excursions. Wives of the committee members and friends organised a hospitality room, where coffee, newspapers, travel information, and information about theatres and excursions were provided.

N. A. Porter

N. A. Porter
Chairman of the Organising Committee

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

FINANCIAL STATEMENTS FOR YEAR ENDED 31 DECEMBER 1991

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INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

1991

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.

The rates of depreciation, calculated on a straight line basis, are as follows:-

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

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

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

1991

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 1991 was £716,711.

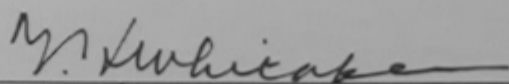
7. Superannuation:

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 1991

<u>1990</u>		<u>1991</u>
£		£
<u>Income</u>		
1,474,000	Oireachtas Grant	1,725,500
590,000	Lottery Grant	524,500
34,429	Sales of Publications	37,627
-	Theoretical Physics Workshop Fees	-
249,849	School of Cosmic Physics (Note 4)	169,186
54,945	Miscellaneous (Note 9)	39,506
2,403,223		2,496,319
167,843	Transfer from Capital Account (Note 6)	(24,980)
2,571,066		2,471,339
<u>Expenditure</u>		
478,138	School of Celtic Studies	599,314
327,742	School of Theoretical Physics	315,047
1,049,652	School of Cosmic Physics	1,013,276
611,510	Administration	537,817
263,348	Depreciation (Note 5)	128,965
25,835	Loss on Disposals	
2,756,225		2,594,419
(185,159)	<u>Surplus (Deficit) for year</u>	(123,080)
414,247	Balance at 1 January	229,088
229,088	Balance at 31 December	106,008

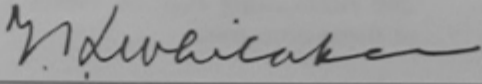
The Accounting Policies, Notes 1 to 10 and Statement 1 form part of these accounts.


CHAIRMAN - COUNCIL OF THE INSTITUTE

Balance Sheet at 31 December 1991

<u>1990</u>				<u>1991</u>
£	£		£	£
221,270		Fixed Assets (Note 5)		246,250
		Current Assets:		
	341,848	Cash on Hands and at Bank	216,849	
460,889	119,041	Debtors and Prepayments	110,906	327,755
<u>682,159</u>	<u> </u>	TOTAL ASSETS	<u> </u>	<u>574,005</u>
		Current Liabilities:		
	206,319	Creditors and Accruals (Note 2)	194,437	
231,801	25,482	Funds (Note 1)	27,310	221,747
<u>450,358</u>	<u> </u>	Net Assets	<u> </u>	<u>352,258</u>
		Financed by:		
229,088		Surplus Income and Expenditure Account		106,008
221,270		Capital Reserve (Note 6)		246,250
<u>450,358</u>				<u>352,258</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 1991**

	£
Source of Funds:	
Deficit for the year	(123,080)
 Adjustment for items not involving the movement of funds:	
Transfer from Capital Account	(24,980)
Depreciation	(128,965)
	(277,025)
 Application of Funds:	
Purchase of Fixed Assets	153,945
	(123,080)
 Increase/(Decrease) in Working Capital:	
Decrease in Debtors and Prepayments	(8,135)
Decrease in Creditors and Accruals	11,881
Increase in Funds	(1,828)
Decrease in Cash on hands & at Bank	(124,998)
	(123,080)

Statement 1

Detailed Analysis of Income and Expenditure
for the year ended 31 December 1991

<u>INCOME</u>	School of Celtic Studies	School of Theoretical Physics	School of Cosmic Physics	Adminis- tration	Total	1990 Total
	£	£	£	£	£	£
Oireachtas Grants		328,300	888,400	508,800	1,725,500	1,474,000
Lottery Grant	524,500	-	-	-	524,500	590,000
Sales of Publications	37,426	13	188	-	37,627	34,429
Theoretical Physics Workshop Fees	-	-	-	-	0	-
School of Cosmic Physics (Note 4)	-	-	169,186	-	169,186	249,849
Miscellaneous (Note 9)	58	232	195	39,021	39,506	54,945
	<u>561,984</u>	<u>328,545</u>	<u>1,057,969</u>	<u>547,821</u>	<u>2,496,319</u>	<u>2,403,223</u>
<u>Transfer from Capital Account (Note 6):</u>						
Allocated for Capital purposes	(52,303)	(12,636)	(68,846)	(20,160)	(153,945)	(121,340)
Amount released on disposals	-	-	-	-	0	25,835
Amortisation in line with asset depreciation					<u>128,965</u>	<u>263,348</u>
	509,681	315,909	989,123	527,661	2,471,339	2,571,066
<u>EXPENDITURE</u>						
Salaries, Wages and Superannuation (Note 8)	377,477	207,674	688,082	256,572	1,529,806	1,465,884
Scholarships	50,380	39,091	23,741	-	113,211	115,470
Honoraria	1,516	150	304	-	1,970	1,752
Library (incl. Microfilms)	23,054	34,048	25,550	-	82,652	72,602
Publications	76,485	1,285	2,228	1,443	81,441	47,566
General Administration (Note 3)	-	-	-	238,074	238,074	228,017
Travel and Survey Expenses	15,355	13,484	40,241	2,772	71,852	84,911
Symposia & Seminar Expenses	1,912	883	-	-	2,795	3,966
Equipment: Consumable & Maintenance	-	-	34,440	-	34,440	32,001
Special Commitments and Projects	-	-	175,416	-	175,416	254,291
General Expenses	53,135	18,432	23,274	38,955	133,797	142,029
Adaptation of Premises	-	-	-	-	0	18,553
	<u>599,314</u>	<u>315,047</u>	<u>1,013,276</u>	<u>537,817</u>	<u>2,465,454</u>	<u>2,467,042</u>
Depreciation (Note 5)					128,965	263,348
Loss on disposals (Note 5)					<u>0</u>	<u>25,835</u>
					<u>2,594,419</u>	<u>2,756,225</u>
<u>SURPLUS (DEFICIT) FOR YEAR</u> (89,633)		862	(24,153)	(10,156)	(123,080)	(185,159)
Balance at 1 January 1991	94,365	(6,518)	57,698	83,543	229,088	414,247
Balance at 31 December 1991	4,732	(5,656)	33,545	73,387	106,008	229,088

NOTES TO THE ACCOUNTS

1.		<u>Funds:</u>	
	These comprise:	Vernam Hull Bequest	25,827
		Carmody Fund	1,483
			27,310

The funds are held on deposit.

2.		<u>Creditors and Accruals:</u>	
		Included in this heading is £23,613 contract research monies unexpended at 31 December, 1991, which is credited to revenue in line with expenditure on projects (Note 4).	

3.		<u>General Administration Expenses:</u>	
		Rent, Rates & Insurance	87,869
		Premises Maintenance	46,560
		Postage & Telephones	58,221
		Fuel, Light & Power	36,707
		Sundry Supplies	8,718
			238,074

NOTES TO THE ACCOUNTS (Cont.)

School of Cosmic Physics - Research Programmes and Fees:

4.

<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	-
EGT	EC	-	1,482	1,482	-
HOGS	Various	-	10,015	10,015	-
BGS	Br.Geol.Surv.	-	24,236	24,236	-
KRISP	EC	-	1,799	1,799	-
ISOPHOT	ESA	-	35,455	35,455	-
RAPIDS	Dept. of Industry & Commerce	47,685	15,023	45,087	17,621
Cosmic Ray Conf.'91	Bórd Fáilte & Others	-	29,888	29,888	-
La Palma Obser.	Eolas	-	3,000	3,000	-
Low Mass Star Formation	Eolas	3,684	11,939	9,631	5,992
UCG/ICL project	Imperial Cge. London	-	7,530	7,530	-
Other Fees	Various	-	763	763	-
		<u>51,369</u>	<u>141,430</u>	<u>169,186</u>	<u>23,613</u>

NOTES TO THE ACCOUNTS (Cont.)

5. Fixed Assets

	Furniture & Equipment	Motor vehicles	Computers	Total
Cost @ 1/1/91	£	£	£	£
Opening Balance	503,376	7,075	452,174	962,625
Additions	33,327	10,500	110,118	153,945
	<u>536,703</u>	<u>17,575</u>	<u>562,292</u>	<u>1,116,570</u>
Depreciation				
Opening Balance 1/1/91	387,003	7,075	347,277	741,355
Charge 1991	28,477	2,625	97,863	128,965
	<u>415,480</u>	<u>9,700</u>	<u>445,140</u>	<u>870,320</u>
Net book value 31/12/91	121,223	7,875	117,152	246,250
Net book value 31/12/90	116,373	0	104,897	221,270

6. Capital Reserve:

Balance at 1 January, 1991	221,270
<u>Transfer to Income and Expenditure Account</u>	
Income allocated for capital purposes	153,945
Amortisation in line with asset depreciation	(128,965)
Balance at 31 December, 1991	246,250

NOTES TO THE ACCOUNTS (Cont.)

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 1992 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, 1991.

8. Superannuation:

The total superannuation payments in the year amounted to £219,222. The salaries and superannuation charge in the accounts is net of contributions totalling £24,837.

9. Miscellaneous:

Included in Miscellaneous is Bank Interest earned of £38,759 (1990 - £49,160) for the year.

10. International Cosmic Ray Conference:

The Institute was responsible for hosting this conference in 1991.

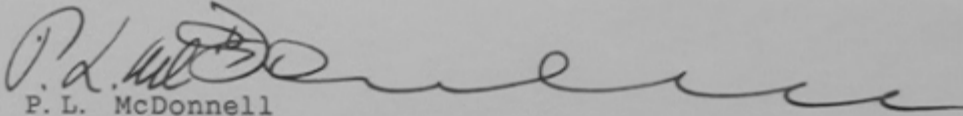
Total expenditure on the conference amounted to £265,000 which was met by delegates' fees of £254,000 and grants and miscellaneous income of £16,000.

All balances arising from the conference have been incorporated into the balance sheet of the Institute at 31 December 1991.

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 the Institute's affairs at 31 December 1991 and of its transactions and source and application of funds for the year then ended.


P. L. McDonnell

Comptroller and Auditor General

14 January 1993