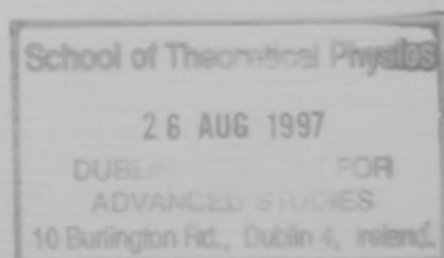


INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)



ANNUAL REPORT 1993



P.N.1390

Institiúid Ard-Léinn Bhaile Átha Cliath
Dublin Institute for Advanced Studies

*Annual Report of the work of the
Institute and its Constituent Schools
presented by the Council to the
Minister for Education in respect of
the year ended 31 December 1993*

P.N. 1390

*Summary of the Annual Report of the Work of the
Constituent Schools for the year ended 31 December 1993*

School of Celtic Studies

In 1993, the School of Celtic Studies continued work on its active projects: investigating and cataloguing Irish manuscripts [Act 5(1)(a)]; Early Irish Law [Act 5(1)(a)(e)]; Irish Lexicography [Act 5(1)(b)]; and bibliography and history [Act 5(1)(e)(f)].

Editing by staff of the School continued on a range of submitted work [Act 5(1)(j)]. Of the latter, Michael Herren's important edition of the poems of Johannes Scottus Eriugena was published. A number of works were reprinted, some with editorial improvements by staff of the School. The School's annual TIONÓL and public lecture again drew large attendances [Act 5(1)(h)].

Sales of the School's publications increased slightly over 1992, and the number of overseas scholars spending study visits at the School, representing a significant demand on staff time, also continued to increase. As against that, some very welcome staff promotions were approved by the Minister.

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; forty-one scientists from abroad visited the School during the year.

Mathematical symposia were held at Easter and at Christmas; thirty-two seminars were held at DIAS and joint seminars with other third level institutions took place. Members of the School gave fourteen lectures in Ireland. The statutory public lecture was given at University College Dublin by Professor L.O'Raifeartaigh (DIAS).

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

School of Cosmic Physics

The ability of Irish research groups to compete with the best in Europe and to be accepted as valuable partners in large-scale cooperative science is very impressive given the low level of support they get. These cooperative projects seem to be the way forward in most disciplines. The School has recently been very successful in attracting partners and winning EU funds in spite of its small size and relatively meagre base. However, inadequate national funding for scientific research will, unless it is corrected, gradually reduce Ireland's ability to compete and starve the country of all the benefits that a strong and active research community generates. In the School, there are five academic vacancies and two more at the technical level. There has been an increase in numbers of Research Scholars but they need infrastructural support too, not usually provided in research contracts and almost never in EU ones. Having said that, the School has good reason to be pleased with its progress in many topics.

The main thrust in the Geophysics Section has continued to be in studies of complex crustal structures in the eastern North Atlantic using seismic methods combined with gravity measurements made at the ocean surface and from sea surface altimeter measurements made by the GEOS missions. These studies have, for example, changed our model for the development of the huge offshore basins off Ireland in a way that could have important implications for the country. Continuing work on the East African Rift in Kenya has been further encouraged by the winning of an EU contract to extend the studies further south, ultimately into Tanzania. Another exciting project, a detailed study of the earth's core, using methods developed by staff in the Institute, has also been funded. The Section will coordinate this world-wide project.

The Cosmic Ray Section also has a wide-ranging programme. The large effort that has been put into the Ultra Heavy Cosmic Ray Experiment (UHCRE) is bearing fruit. The sample of ultra heavy nuclei which has been collected is fifteen times larger than the present world data set and the UHCRE work was selected for a special Highlight Session at the 23rd International Cosmic Ray

Conference. Other experimental work has produced observations on the Giotto missions (to Comets Grigg-Skjellerup and Halley) and the Phobos-Mission to Mars. Theoretical studies have included work on improved propagation calculations, particularly important where observations are to be used to test theories of cosmic ray origin. A number of other projects are studying shock structure and development and associated stellar outflows. There is also active research in stellar formation using ground based observations and, in the future, the Infrared Space Observatory.

The Astronomy Section has done work on solar spectroscopy, studying microturbulence for which no convincing physical mechanism has yet been proposed. An active sun made observations difficult. Collaboration continued throughout the year on the TRIFFID image sharpening system and a number of new features were added.

Annual Report of the work of the Institute and its Constituent Schools presented by the Council for the year ended 31 December 1993.

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 1993.

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 1993.*
- II. *Administrative Staff of the Institute.*
- III. *Report of the Governing Board of the School of Celtic Studies.*
- IV. *Report of the Governing Board of the School of Theoretical Physics.*
- V. *Report of the Governing Board of the School of Cosmic Physics.*

- I. Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31 December 1993.

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; Thomas N. Mitchell, M.A., Ph.D., Litt.D., LL.D., D.Hum.L., F.R.C.P.I. (Hon.), Hon. F.R.C.S.I., M.R.I.A., Provost, Trinity College, Dublin; Seán Scanlan, President, Royal Irish Academy, M.E., Ph.D. (Leeds), D.Sc. F.I.E.E., F.I.M.A., F.I.E.E.E., F.I.E.I., M.R.I.A.

Members Appointed by the Governing Boards of Constituent Schools

M. Ó Murchú, M.A.(Dubl.NUI), Ph.D., M.R.I.A.; T. de Bhaldraithe, M.A., Ph.D., D.Litt., M.R.I.A.; J. T. Lewis, B.Sc., Ph.D.; E. F. Fahy, M.Sc., Ph.D.; L. O'C. Drury, B.A., Ph.D. (to 16 October 1993); A.W.B. Jacob, M.A., M.Sc., Ph.D. (from 17 October 1993).

Governing Board of the School of Celtic Studies

Chairman

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

Senior Professors

M. Ó Murchú, M.A.(Dubl.NUI), Ph.D., M.R.I.A.; P. Mac Cana, M.A., Ph.D., M.R.I.A.

Appointed Members

G. S. Mac Eoin, M.A., D.Phil., M.R.I.A.; 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., M.R.I.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., M.R.I.A.

Governing Board of the School of Theoretical Physics

Chairman

Vacant.

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., M.R.I.A.; P. Quinlan, B.E., D.Sc., M.S., Ph.D.; T. D. Spearman, M.A., Ph.D. (Cantab.) M.R.I.A., Member Academia Europaea, F.T.C.D.; S. S. Tóibín, M.Sc., Ph.D.

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.; 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., M.R.I.A.; D. J. Murphy, B.Sc., M.Sc.; V. J. McBrierty, B.Sc., M.A., Ph.D., Sc.D, C. Phys., F.Inst.P., M.R.I.A., F.T.C.D.; N. Porter, Ph.D.; D. L. Weaire, M.A. (Cantab.), Ph.D. (Cantab.), C.Phys., F.Inst.P., M.R.I.A.

II. Administrative Staff of the Institute

Registrar

John Duggan, B.Sc.

Executive Officer

Mary Burke, B.A.

Finance Officer

Eamonn Harrigan, B.Comm., H.Dip.Ed., A.C.M.A.

Assistant Finance Officer

Angela Stubbs.

Clerks

Noreen Granahan; Helena Moynihan; Tony Broderick; Eibhlin Nic Dhonncha.

III. Annual report of the Governing Board
of the
School of Celtic Studies
for the year ending 31 December 1993
adopted at its meeting of 20 May 1994

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1 Staff, Research Scholars, Research Associates

1.1 Staff

- Rolf Baumgarten (Professor; special responsibility for bibliography, and director of promotion)
Pádraig de Brún (Professor; special responsibility for manuscript studies, and director of publishing)
Fergus Kelly (Professor; special responsibility for Early Irish law texts, and director of events)
Proinsias Mac Cana (Senior Professor; special responsibility for Early Irish, Welsh, and Breton)

- Malachy McKenna (Assistant Professor; spoken language studies)
Órla McMorrow (Secretary of the School)
Aoibheann Nic Dhonnchadha (Assistant Professor, promoted 1 July 1993; manuscript studies and Irish medical texts)
Máirín Ní Dhonnchadha (Chief Editor, appointed 1 July 1993; also Irish textual and literary studies)
Siobhán Ní Laoire (Librarian; also textual and sociolinguistic studies)
Pádraig Ó Macháin (Assistant Professor, promoted 1 July 1993; manuscript studies and bardic verse)
Máirtín Ó Murchú (Senior Professor; Director of the School; special responsibility for spoken language studies)
Michelle O Riordan (Publications Officer; also historical studies)
Seán Ua Súilleabháin (Research Assistant, promoted 1 Sept 1993; lexicography)
Emma Ryan (Publications Secretary, appointed 1 July 1993)

1.2 Part-time and retired Staff

- Cathair Ó Dochartaigh (Computer Consultant)
Tarlach Baumgarten (Occasional Assistant; Computer applications)
Brian Ó Cuív (Professor Emeritus)

1.3 Research Scholars

- Seán Ó Cearnaigh
Seán Duffy (to 30 September 1993)
Máire Ní Mhaonaigh (to 30 September 1993)
David Thornton (to 30 September 1993)
Brian Ó Curnáin (from 1 July 1993)
Caoimhín Breatnach (from 1 October 1993)
Brian Ó Catháin (from 1 October 1993)
Dorothee Tratnik (from 1 October 1993)
John Higgins (from 1 October 1993; without income)

1.4 Visiting Senior Professor

- Professor Donnchadh Ó Corráin (University College, Cork)

1.5 Research Associates

(year of first appointment)

- Dr Gwenllian Awbery, University of Wales, Cardiff (1990)
 Dr John Carey, Harvard University (1990)
 Dr Thomas Charles-Edwards, University of Oxford (1990)
 Professor Toshio Doi, Nagoya Women's University (1991)
 Dr David N. Dumville, University of Cambridge (1989)
 Professor D. Ellis Evans, University of Oxford (1990)
 Professor D. Simon Evans, St David's University College, Lampeter (1992)
 Professor William Gillies, University of Edinburgh (1989)
 Professor Geraint Gruffydd, Centre for Advanced Welsh and Celtic Studies, Aberystwyth (1989)
 Professor Eric P. Hamp, University of Chicago (1989)
 Professor Michael Lapidge, University of Cambridge (1988)
 Professor Donald MacAulay, University of Glasgow (1989)
 Professor Toshitsugu Matsuoka, Hosei University, Tokyo (1991)
 Dr Martin McNamara, MSc, Milltown Institute of Theology and Philosophy (1989)
 Professor Tomás Ó Concheanainn, University College, Dublin (1991)
 Professor Donnchadh Ó Corráin, University College, Cork (1991)
 Dr Cathair Ó Dochartaigh, University College, Bangor (1988)
 Dr Pádraig Ó Néill, The University of North Carolina at Chapel Hill (1990)
 Dr Brinley F. Roberts, National Library of Wales, Aberystwyth (1990)
 Professor R. Mark Scowcroft, Catholic University of America (1990)
 Dr Richard Sharpe, University of Oxford (1988)
 Professor Robert L. Thomson, University of Leeds (1991)
 Professor Calvert Watkins, Harvard University (1989)
 Professor T. Arwyn Watkins, University College, Dublin (1990)

1.6 Visiting Scholars

- Edel Bhreatnach (Discovery Programme, Dublin)
 Jacqueline Borsje (Free University of Amsterdam)

- Dr Melita Cataldi (University of Turin)
 Prof Dr Johan Corthals (Universität Hamburg)
 Dr Ann Dooley (University of Toronto)
 Dr David N. Dumville (University of Cambridge)
 Inge Genee (University of Amsterdam)
 Professor Eric P. Hamp (University of Chicago)
 Gisbert Hemprich (University of Freiburg)
 Dr Patricia Kelly (Royal Irish Academy)
 Dr Rolf Ködderitzsch (Universität Bonn)
 Dr Breandán Ó Cíobháin (ORBA)
 Dr Séamas Ó Direáin (Marymount College, California)
 Dr Morfydd E. Owen (Centre for Advanced Welsh and Celtic Studies, Aberystwyth)
 Prof Diego Poli (University of Macerata)
 Marc Schneiders (University of Utrecht)
 Dr Nancy Stenson (University of Minneapolis)
 Olivier Szerwiniack (Institut de Recherche et d'Histoire des Textes, Paris)

2 Research

The School's provision for research and publication during 1993 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. Continuing staffing inadequacies, however, hamper the School in fulfilling its functions of publishing Irish manuscript texts and, in particular, of investigating spoken Irish.

2.1 Primary project areas

- Manuscript studies continued, under the direction of Pádraig de Brún, on the *Catalogue of Irish manuscripts in the National Library of Ireland* (Pádraig Ó Macháin); *Catalogue of the Gaelic manuscripts of Scotland* (R. Black); *Catalogue of Irish manuscripts in the Falvey Memorial Library, Villanova University, Pennsylvania* (W. J. Mahon). Aoibheann Nic Dhonnchadha continued work on cataloguing medical manuscripts in Trinity College Dublin. P. de Brún worked on the second edition of volume III of the *Catalogue of Irish manuscripts in the British Museum*.
- Bibliographical work was continued by Rolf Baumgarten on the (database) *Bibliography of Irish linguistics and literature* for screen use as well as conventional publication. He prepared a sample intended for test use on the Library's computer. Seán Ó Cearnaigh

(Research Scholar) continued work on his *Bibliography of the printed material in the Irish language 1571-1700*, intended for publication in the *Bibliographical studies* series (General editor: R. Baumgarten).

- Fergus Kelly continued work on his *Early Irish farming*, intended for publication in the *Early Irish law series* (General editor: F. Kelly).

2.2 Other research and editing

Work intended for publication by the School was continued by Máirtín Ó Murchú on a description of west Perthshire Gaelic; Seán Ó Súilleabháin on an edition of Rísdeard Pluincéad's Latin-Irish dictionary (1662); Rolf Baumgarten on an early version of *An leabar gabála*; Brian Ó Cuív (Professor Emeritus) on the catalogue of Irish manuscripts in the Bodleian Library Oxford. Pádraig de Brún prepared for publication his monograph *Scriptural instruction in the vernacular: the Irish Society and its teachers, 1818-1827*.

Editorial/supervisory work towards publication by the School was done by Máirtín Ó Murchú on the *Survey of Gaelic dialects of Scotland* (ed. Cathair Ó Dochartaigh), and *Scéal an Haicléara* (ed. Nancy Stenson); Pádraig de Brún on *Aibidil Gaoidheilge & Caiticíosma* (ed. Brian Ó Cuív), *The genealogical poem on Uí Fhiachrach by Giolla Iosa Mór Mac Fhir Bhisigh* (ed. Tomás Ó Concheanainn), and *The spiritual rose* (ed. Malachy McKenna); Proinsias Mac Cana on *Ystoria Gereint uab Erbin* (ed. R. L. Thomson); Máirín Ní Dhonnchadha (Chief Editor) on various manuscripts submitted for publication.

Other research:

Proinsias Mac Cana on a history of Welsh syntax, to be published jointly with T. Arwyn Watkins, and on topics in medieval Irish literary tradition. Rolf Baumgarten on aspects of Early Irish syntax. Malachy McKenna on an edition of three poems in *The spiritual rose*, and on 'Towards a lexical phonology and morphology of spoken Ulster Irish'. Siobhán Ní Laoire on register and stylistic variation in Modern Irish. Aoibheann Nic Dhonnchadha on Early Modern Irish medical writings. Pádraig Ó Macháin on an edition of the poems of Fearghal Óg Mac an Bhaire. Seán Ua Súilleabháin on dialects of Munster Irish. Máirín Ní Dhonnchadha on the status of women in early medieval Ireland.

Brian Ó Cuív revised further proofs of his edition of *Aibidil Gaoidheilge & Caiticíosma* by Seán Ó Cearnaigh (1571).

2.3 Research Scholars' work

Seán Duffy worked on *Ireland in the Middle Ages* (to be published in the series *British history in perspective*), on the provenance of the chronicle known as the 'continuation' of the annals of Nicholas Trevet, and on the Irish material in the *Histoire des Ducs de Normandie et des Rois d'Angleterre*. Máire Ní Mhaonaigh continued work on *Cogad Gáedel re Gallaið*, and on the Early Modern text *Nósa Ua Maine*. Brian Ó Curnáin worked on *Gnéithe de Ghaeilge Chonamara*.

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 for publication and typesetting was directed by Pádraig de Brún and Michelle O Riordan, assisted by Emma Ryan. 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.

The following items were published in 1993:

- *Iohannis Scotti Eriugena 'Carmina'*, edited by Michael W. Herren. 1993. viii + 179 pp, pls. (Scriptores Latini Hiberniae, 12) ISSN 0332-4214; ISBN 1-85500-162-4. Ir£15.

Twenty-five poems by, and 16 poems (Appendix) possibly by, Johannes Scottus Eriugena (fl. 847-870), critically edited, with introduction, English translation, commentary, and indexes.

- *Scéala Scoil an Léinn Cheiltigh: Newsletter of the School of Celtic Studies*, ed. Rolf Baumgarten. No. 6, May 1993. 33 pp. ISSN 0790-9853. Free.

Contains inter alia an appreciation of 'Nessa Ní Shéaghda, 1916-1993' by Máirtín Ó Murchú; a contribution on 'The Welsh of north Pembrokeshire' by Gwennlian Awbery; 'Irish studies theses 1992' by the Editor.

- *The death-tales of the Ulster heroes*, by Kuno Meyer. 1993 (orig. publ. in 1906, 1937², by

the Royal Irish Academy, Todd lecture series, 14). vii + 53 pp. ISBN 1-85500-171-3. Ir£5.

With 'Further addenda and corrigenda' as found in Meyer's own copy.

- *Fianaigeacht: being a collection of hitherto unedited Irish poems and tales relating to Finn and his fiana; with an English translation*, by Kuno Meyer. 1993 (orig. publ. in 1910, 1937², by the Royal Irish Academy, Todd lecture series, 16). xxxi + 115 pp. ISBN 1-85500-172-1. Ir£10.

With 'Further addenda and corrigenda', from ZCP 8.599, translated from the German.

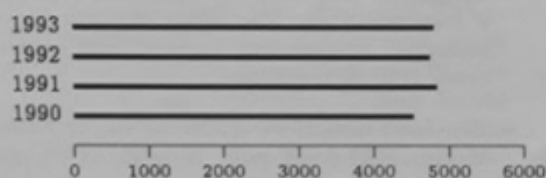
- *School of Celtic Studies: Publications in Celtic Studies, Catalogue 1992 / Scoil an Léinn Cheiltigh: Foilseacháin sa Léann Ceilteach, Catalog 1992*. 54 pp.

The following publications of the School were reprinted: *A grammar of Old Irish* (R. Thurneysen; Catalogue no. E 1.2); *Fingal Rónáin* (D. Greene; no. F 5.15); *Irish dialects and Irish-speaking districts* (B. Ó Cuív; no. E 2.4).

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*, *Archæology Ireland*, *Slógadh*, etc. The number of books sold during 1993 was 4818. 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 4755 for 1992, 4844 for 1991, 4533 for 1990. 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

Acquisitions policy, under the direction of Siobhán Ní Laoire (Librarian), centered on building the collection in its core areas. Some 480 new and replacement items were added, as well as several new subscriptions to periodicals. A special cabinet was acquired for the School's map collection, and their conservation, repair and indexing was initiated. For the purpose of creating an integrated computerized library system the Heritage Library Management System was acquired and customized. Additional services to members of the School included new accession lists, inter-library loans and bibliographic searching.

Malachy McKenna organized an archive, with catalogue, of the School's dialect tapes (with copies on cassette and DAT).

6 Events

6.1 Lectures

- The Statutory Public Lecture for the year 1993 was delivered by Dr Gwenllian Awbery (University of Wales, Cardiff), on 26 November 1993, at Trinity College Dublin, entitled 'Does Welsh have a future?'
- A lecture entitled 'Towards a complete understanding of the Celtiberian inscription of Botorrita', was delivered by Professor Dr Wolfgang Meid (Universität Innsbruck), on 13 May 1993.

6.2 Annual Symposium /Tionól 1993

The Annual Symposium/Tionól was held on 20-21 November, incorporating as a key feature the Statutory Public Lecture. In addition, the following papers were read:

- An tSiúr Déaglán de Paor (Presentation Convent, Bagenalstown, Co. Carlow): 'Saint Patrick's spiritual pilgrimage'.
- Pádraig Ó Cearbhaill (An Oifig Logainmneacha): 'Cluain Abhála agus logainmneacha gaolmhara'.
- John Carey (Queen's University Belfast): 'A reading of Amairgen's first poem'.
- Antain Mac Lochlainn (University of Ulster, Coleraine): 'Aindrias Mac Cruitín, file'.

- Roibeárd Ó hÚrdail (University College Cork): 'Complex syllable nuclei: dialectal variation in diphthong phoneme inventories in Modern Irish'.
- Seosamh Watson (University College Dublin): 'Canúintí Albanacha Cheap Breatainn: a gcomharthaí sóirt'.
- Terence McCaughey (Trinity College Dublin): 'On first looking into Bedell's Bible'.
- Neil Buttimer (University College Cork): 'Cogadh Sagsana Nuadh sonn: a report on the American Revolution'.

7 Outside activities and contributions to scholarship

7.1 Activities

Lectures were delivered by Máirtín Ó Murchú to Fondúireacht an Phiarsaigh (April), General Council of County Councils (May), and Regional Seminar of Local Authorities (July); by Proinsias Mac Cana, 'Les analogues insulaires de la légende de Mélusine', University of Bordeaux (April), 'The idea of sacred places in early Irish tradition', Celtic Studies conference, Amsterdam (April), 'The Celtic heritage', Linenhall Library, Belfast (June), 'Ideoleg y Celtiaid mewn llun a llên', Welsh National Eisteddfod (August); by Malachy McKenna, M.Phil. course on 'Generative phonology and morphology', Language and Communication Centre, Trinity College Dublin (March-April); by Aoibheann Nic Dhonnchadha, 'Early Modern Irish plant-names: an introduction to the manuscript sources', Fifteenth Forum of the University of Wales Centre for Advanced Welsh and Celtic Studies, Aberystwyth (June), 'Sláinte agus easláinte na mban: léargas ar théacsanna leighis na Gaeilge', Párlaimint na mBan, Dublin (September), and lectures on various aspects of Irish medical texts to Acadamh na Lianna, in Rinn Ó gCuanach (October), Conradh na Gaeilge, Craobh na Rinne, Rinn Ó gCuanach (December), Royal Academy of Medicine in Ireland (Section of the history of medicine), Dublin (December); by Pádraig Ó Macháin, 'Tadhg Dall Ó hUiginn: foinse dá shaothar', Léachtaí Cholm Cille, Maynooth (February); by Siobhán Ní Laoire, 'Singers and songs: aspects of the Irish song tradition', M.Phil. in Irish Studies seminar, University College Dublin (November); by Máirín Ní Dhonnchadha, 'Adomán's *Lez Innocentium*: why Europe's first law on

behalf of women was enacted', 21st Conference of Irish Historians, Belfast (May), 'The date and target of the great Gaelic satire *Aislinge Meic Con Glinne*', 8th Conference of Medievalists, Maynooth (June), 'Filíocht na Scol: an inscne mar dhoras feasa', Comhdháil Litríocht na Nua-Ghaeilge, University College Galway (October), 'The gender discourse of *flaith* and *ollamh* in *dán díreach*', M.Phil. in Irish Studies seminar, University College Dublin (November); by Brian Ó Cuív, 'Ómós d'Eoin Mac Néill', Conradh na Gaeilge, Baile Átha Cliath (March), and 'Conradh na Gaeilge agus an Stát, 1912-1940', Raidió na Gaeltachta (April). Malachy McKenna acted as External Examiner in Irish Studies, University of Ulster (June). Brian Ó Cuív continued his activities as Chairman of the *Corpus apocryphorum Hiberniae* publication project, 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.

Lectures by Research Scholars included Seán Duffy, 'Ireland and Wales in the later Middle Ages', Medieval and Renaissance Society, University College Cork (February), 'A new source for King John's Irish expedition, AD 1210', 7th Irish Conference of Medievalists, Maynooth (June), 'The Welsh lords of north County Dublin', Fingal Historical Society Summer School (August); Máire Ní Mhaonaigh, 'Nósa Ua Maine: the historical background', 8th Colloquium on Medieval Welsh Law, Gregynog (April); Seán Ó Cearnaigh, 'Gaelic incunabula: printed books in the Irish language before 1700', Medieval Studies seminar, University College Cork (February).

7.2 Scholarly publications

Máirtín Ó Murchú, 'Aspects of the societal status of Modern Irish', *The Celtic languages*, ed. M. J. Ball (London) 471-90; 'Some general observations [on the standardization of Irish]', *Teangeolas* 32, 59-61. Proinsias Mac Cana, Co-editor of *Ériu* 44; 'Ir. *buaball*, W. *bual* "drinking horn"', *Ériu* 44, 81-93; 'On the early development of written narrative prose in Irish and Welsh', *Études celtiques* (1991 [1993]) 28, 51-67. Pádraig de Brún, 'The Irish Society's Bible teachers, 1818-27: index of places', *Éigse* 26 (1992 [1993]) 131-72. Fergus Kelly, 'Early Irish law: the present state of research', *Études celtiques* 28, 15-23. Rolf Baumgarten, Co-editor of *Ériu* 44. Seán Ua Súilleabháin, Review of Francisco X. Alarcón, aistrithe ag G. Rosenstock, *De*

amor oscuro: *Um an ngrá dorcha*, in *Comhar* 52, 1 (Eanáir) 21-2. Siobhán Ní Laoire, 'Traditions of spoken language study in Ireland', *Irish review* 14, 65-73. Michelle O Riordan, 'The native Ulster mentalité as revealed in Gaelic sources 1600-1650', *Ulster 1641*, ed. Brian Mac Cuarta (Belfast) 60-91. Brian Ó Cuív, 'Ómós d'Eoin Mac Néill', *Feasta*, Aibreán, 4-9.

Accepted for publication / in the press:

Máirtín Ó Murchú, 'Celtic Studies, Dublin School of' (*The encyclopedia of language and linguistics*). Proinsias Mac Cana, 'Notes sur les analogues insulaires de la légende de Mélusine' (*Mélanges F. Kerlouegan*); 'Narrative openers and progress markers in Irish' (memorial volume for Brendan O Hehir); 'Y canu mawl yn Iwerddon' (*Llên Cymru*); 'Y canu mawl yn Iwerddon cyn y Normaniaid'; 'Compounds and collocations of synonyms in early Welsh'; 'Mythology and the oral tradition: Ireland' (*The Celtic world*, Routledge). Aoibheann Nic Dhonnchadha, 'Medical manuscripts in Early Modern Ireland' (*Proceedings of the 14th Congress of the British Society for the History of Medicine*). Máirín Ní Dhonnchadha, 'Caillech and other terms

for veiled women in medieval Irish texts' (*Éigse*). Brian Ó Cuív, 'The concepts of "correct" and "faulty" in medieval Irish bardic tradition'; 'Three short texts relating to the infancy of Christ' (*Apocryphal texts on the infancy of Christ*, Brepols); 'A Modern Irish infancy narrative in verse' (*ibid.*).

Research Scholars' publications included Seán Duffy, *Ireland 600-1169: an island of saints and scholars?* School textbook history of pre-Norman Ireland, London: Longman (Questions in Irish History, 2); 'Pre-Norman Dublin: capital of Ireland?', *History Ireland* 1, no. 4 (Winter) 13-18; Review of G. W. S. Barrow, *Scotland and its neighbours in the Middle Ages* (London 1992), *The Innes review* 44 (Spring) 104-7. Máire Ní Mhaonaigh 'Einige Bemerkungen zu den Verbalstambbildungen in *Cogad Gaedel re Galluib*', *Akten des Ersten Symposiums deutschsprachiger Keltologen*, hg. M. Rockel und St. Zimmer (Tübingen) 161-82. Seán Ó Cearnaigh, *An Stad: croílár na hAthbheochana*, Baile Átha Cliath: Comhar; edited *Poetry Ireland review*, 39: *contemporary poetry in Irish*, Dublin: Poetry Ireland.

IV. Annual Report of the Governing Board of the School of Theoretical Physics for the year ending 31 December 1993 adopted at its meeting of 20 December 1994.

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: G. da Costa (Brazil), C. Ford (England) from 1 October, S. Hughes (Ireland) from 1 October, D. McMullan (England) to 30 September, D.J. O'Connor (Ireland), A. Patrick (Russia) to 7 May, P. Ruelle (Belgium) to 30 April, I. Tsutsui (Japan) to 30 November.

POSTDOCTORAL FELLOWS: F. Krahe (Germany) from 23 June, N. O'Connell (Ireland) from 1 October, C. Stephens (England) from 1 October. Graduate Students: R. Russell (Ireland) from 1 October, F. Toomey (Ireland) from 1 October.

RESEARCH ASSOCIATES: Re-appointed to 31 December 1993:

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: T. Garavaglia, B. Goldsmith, P. Houston, M.J. Tuite

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. Otewill

U.C. IRVINE: P. McGill

METEOROLOGICAL SERVICE: P. Lynch

DEPT. OF FINANCE: A.J. Curran

UNAFFILIATED: G.M. O'Brien

VISITING SCIENTISTS: N. Anagelescu (Bucharest) 5-18 December, A. Chakrabarti (France) 12-19 September, P. Crehan (Kyoto) 17-24 October, T. Dorlas (Swansea) 19-21 December, D. Evans (Swansea) 1-10 January, R. Flume (Bonn) 24 March - 2 April, G.W. Ford (Ann Arbor) 3-28 June, V.I. Gaiduk (Moscow) 2 October - 3 December, C. Graham (Simon Fraser, Canada) 15 March - 23 December, A.S. Holevo (Moscow) 27 April - 11 May, G. Jorjadze (Tbilisi) 17 September - 15 November, S. Kamefuchi (Tokyo) 22 July, C. King (Northeastern Univ.) 21 December, F. Krahe (Zürich) 3-10 May, Y. Kubyshin (Barcelona) 29 June - 11 July, B. Kümmerer (Tubingen) 23-26 May, M. Lavelle (Mainz) 28 May - 5 June, A. Leznov (Moscow) 15-22 April, P. McGill (Chapel Hill) 17-24 May, P. McGill (Lyon) 12-17 December, W. McGlinn (Notre Dame) 27 December - , A. Martin-Löf (Stockholm) 18-25 April, W. May (Arizona) 1-15 July, J. Moser (ETH, Zürich) 16-22 August, J. Noble (U.C.C.) 14-15 January, 10 February, 4-5 March, 22-23 April, 16-17 June, 9-10 December, N. O'Connell (Edinburgh) 11-16 May, P. O'Leary (U.C.G.) 7-8 April, N. Ó Murchadha (U.C.C.) 20-22 December, C. Pfister (Lausanne) 15-26 June, R. Poghossian (Yerevan) 20 November - 4 December, V.B. Priezzhev (Dubna) 6 August - 4 September, P. Robinson (Hull) 17 June, I. Sachs (ETH, Zürich) 8 July, R. Sasaki (Durham) 29 May - 5 June, R.N. Sen (Beersheba) 3 September, G.D. Slade (Canada) 23-25 November, A.I. Solomon (Open University) 1-5 March, 20-21 December, W. Spence (Melbourne) 15-18 June, C. Stephens (Utrecht) 18-28 March, 26 August - 2 September, S.-N. Tamaryan (Yerevan) 20 November - 9 December, W. Thirring (Vienna) 20 September, P. Upton (Oxford) 9-31 October.

2 General

There was a new development in the work of the School : Professor Lewis and Dr. N.G. Duffield (DCU) succeeded in obtaining funding for a project entitled Mu-Delta : Multiplexor Design Tools and Algorithms. This project is funded in part by Mentec Computer Systems (Dun Laoghaire) and in part by the European Community under the Operational Programme for Industry 1989-1993 channelled through the EOLAS Higher Education - Industry Cooperation Scheme. The funding provides support for one post-doctoral fellow and two graduate students.

3 Research and Study

3.1 Theoretical Particle Physics

Over the past five years the main line of research of the particle physics group has been on the reduction of WZNW systems (which are the standard non-trivial 2-dimensional conformally-invariant systems) to conformally-invariant, non-linear, integrable systems. One of the interests of such reductions is that the reduced symmetry algebras are W-algebras (conformal algebras of primary fields). A long standing question in such reductions is whether the so-called canonical reductions exhaust the set of reductions that produce W-algebras. In the last year the group, consisting of L. O'Raiheartaigh, I. Tsutsui and G. da Costa, have concentrated on this question. The results to date show that while the canonical reductions do not quite exhaust the set they leave little room for exceptions. A tight quantitative bound for the possibilities is obtained and within this bound a non-trivial exception (which has other interesting properties such as a field with negative conformal spin) has been constructed.

A second line of research has been the work on the topological properties of quantum field theory, in particular on the topology of the spin-statistics theorem, which is carried out in an NSF collaboration with the Universities of Syracuse and Notre Dame. The new development in this area was the use of Morse theory to characterize the particle-anti-particle spaces. This turned out to be a very efficient and intuitive

way of elucidating the homology of these spaces, which is the crucial property from the topological point of view.

A third line of research, begun this year, was into the origins of gauge-theory, which is the mathematical structure underlying the known fundamental physical interactions. In spite of its importance, the origins of gauge-theory are rather obscure and the relevance of many contributions are only now beginning to be appreciated. The problem is to unravel the line of development and put the various contributions in proper perspective. Initial work has been summarized in a number of short articles (see publications).

Dr. G. da Costa studied knot theory and solutions of the Yang-Baxter equation.

Dr. B. Dolan carried out research into the renormalisation group in field theory and statistical mechanics.

Dr. T. Garavaglia carried out research into gluon gluon fusion and production of Higgs bosons and in rapidity gauge physics for LHC.

Dr. D. McMullan studied the quantizing non-linear theorem.

Dr. C. Nash carried out research on differential topology and quantum field theory and also on geometric quantisation of gauge systems and geodesic flow and the renormalisation group.

Dr. C. Stephens with Dr. D.J. O'Connor investigated using renormalization group techniques to the physics of systems with scale dependent effective degrees of freedom. In collaboration with Dr. P. Upton they applied their techniques to inhomogeneous systems where a position dependent renormalization must be used. Dr. Stephens has been working with Drs. O'Connor and M. van Eijck on furthering the use of their techniques in relativistic finite temperature field theory. He has been finishing work, in collaboration with F. Freire, on applying their methods to dimensional crossover of the specific heat and to investigate the notion of a generalised "hyperuniversality" applicable to crossovers.

Dr. Tchrakian worked with Drs. Piette, Zalarzewski and Müller-Kirsten on modification of the 0(3) sigma model, supporting localised instanton and sphaleron fields as solutions. He also worked with Drs. O'Brien and Burzlaff on asymptotic solutions of the SO(4)-Higgs model, and numerical integration of the field equations. He was involved with research into Skyrme-like

gauge field models with non-selfdual instantons in all even dimensions with Dr. Burzlaff. He worked on non-selfdual solutions of symmetry-breaking Skyrme-like models in all dimensions with Drs. Müller-Kirsten and Zimmerschied. He is involved in ongoing research on Lüscher-Schechter solutions to the hierarchy of YM models in $4p$ dimensions and the hierarchy of sigma-models in $2p$ dimensions and on computation of the action for a dilute gas of $SO(4)$ -Higgs instantons.

Dr. I. Tsutsui, in collaboration with Dr. McMullan, studied inequivalent quantizations on coset spaces G/H .

3.2 Classical Statistical Mechanics

Prof. Lewis completed his work with Dr. Pfister (Lausanne) on thermodynamic aspects of large deviation principles. Together with Dr. Sullivan they continued their work on large deviations, concentration of probability measures and the equivalence of ensembles.

Dr. E. Buffet carried out research into polymers in random media.

Dr. A. Patrick studied the thermodynamic properties of directed polymers on regular lattices. He also studied magnetization profiles, surface tension and related properties of ferromagnets on regular lattices with inhomogeneous boundary conditions.

3.3 Quantum Statistical Mechanics

Prof. Lewis continued his collaboration with Profs. Ford and O'Connell on applications of the Quantum Langevin Equation.

3.4 Quantum Theory and Quantum Electronics

Prof. A.I. Solomon studied the application of groups and quantum groups to quantum optics and condensed matter models.

3.5 General Relativity and Gravitation

Dr. Vandyck studied circular cosmic strings with Drs. McManus and Hughes. With Dr. Hurley he studied the differentiation of spinor fields in space-time with general connections.

3.6 Applied Mathematics

Work began on the Mu-Delta project. This arose from a proposal by Prof. Lewis and Dr. Duffield to apply large deviation principles to some queueing problems which arise in statistical multiplexing. Together with Dr. O'Connell, Mr. Russell and Mr. Toomey, they began an investigation of methods for performance evaluation of telecommunications networks.

Dr. Buffet studied some problems in queueing theory.

Dr. Burzlaff studied the scattering of vortices in a superconductor, using the Ginzburg-Landau equations. He also studied energy-momentum and the forces between optical solitons in an optical fibre. With Dr. Tchrakian, he studied, new solutions of generalised Yang-Mills theories.

Dr. T. Garavaglia worked on classical and quantum invariants for non-linear accelerator systems.

Dr. Golden worked on viscoelastic boundary value problems.

Dr. Lynch worked on the development of computer models for numerical weather predicting.

3.7 Pure Mathematics

Dr. J. Burns studied the topology of compact symmetric spaces and the connection with representation theory. He also studied minimal surfaces with internal symmetries.

Dr. B. Goldsmith worked on the transitivity properties of Abelian groups and also on endomorphism rings and automorphism groups of Abelian groups and modules over valuation domains.

Prof. A. O'Farrell continued to work on problems of approximation and extension in real and complex analysis. He set up a small working group with Drs. O'Cairbre and O'Reilly to study dynamical systems. He worked on the computation of analytic capacity and its affine invariance properties with Dr. Dowling.

Prof. P. McGill worked on applications of the stochastic calculus to problems in probability.

Dr. P. Ruelle studied the general $Sl(2, \mathbb{R})$ structure of Hamiltonian reductions of WZWN theory.

3.8 History of Science

Dr. Ó Mathúna studied the work of Jacques II Bernoulli in the historic development of the theory of structural mechanics.

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. (See section 9.3). DIAS-STP-93-

- 01: N.G. DUFFIELD: Exponential bounds for Markovian queues.
- 02: L. FEHÉR, L. O'RAIFEARTAIGH, P. RUE-
LLE, & I. TSUTSUI: On the completeness of
the set of classical w -algebras obtained from
DS reductions.
- 03: M. LAVALLE, & D. MCMULLAN: A new
symmetry for QED.
- 04: M. LAVALLE, & D. MCMULLAN: On
quark confinement.
- 05: M. LAVALLE, & D. MCMULLAN: On the
physical propagators of QED.
- 06: A.N. LEZNOV, & L. O'RAIFEARTAIGH:
The discrete symmetry chain of self-dual
equations and its exact integrability in the
case of fixed end-points.
- 07: G.A.T.F. DA COSTA: Lattice models and
algebras of weights.
- 08: G.A.T.F. DA COSTA: Yang-Baxterization
and the BH algebra.
- 09: M.P. TUIITE: On the relationship between
monstrous moonshine and the uniqueness of
the moonshine module.
- 10: V.I. GAIDUK, V.V. GAIDUK, & J.Mc
CONNELL: The complex susceptibility of
liquid water as a two-potential system of
reorienting polar molecules.
- 11: R.S. ELLIS, J. GOUGH, & J.V. PULÉ:
The large deviation principle for measures
with random weights.
- 12: M. LAVALLE, & D. MCMULLAN: Gauge
choices and physical variables in QED.
- 13: L. FEHÉR, L. O'RAIFEARTAIGH, & I.
TSUTSUI: The vacuum preserving Lie
algebra of a classical w -algebra.
- 14: D. MCMULLAN, & I. TSUTSUI: On the
emergence of gauge structures and general-
ized spin when quantizing on a coset space.
- 15: D. HEFFERNAN, & P. JENKINS: The
formation and evolution of fractal structure
within chaotic attractors.
- 16: D. HEFFERNAN, P. JENKINS, & M. DALY:
 $F(\alpha)$ spectrum of pruned Baker's map.
- 17: M. DALY, & D. HEFFERNAN: Chaos in a
resonantly kicked oscillator.
- 18: D. O'CONNOR, & C.R. STEPHENS: Ef-
fective critical exponents for dimensional
crossover and quantum systems from an en-
vironmentally friendly renormalization
group.
- 19: D. O'CONNOR, & C.R. STEPHENS: Envi-
ronmentally friendly renormalization.
- 20: K. ARTHUR, & J. BURZLAFF: Energy and
momentum of an optical soliton.
- 21: D. MCMULLAN, & I. TSUTSUI: BPST in-
stanton and spin from inequivalent quanti-
zations.
- 22: C. NASH, & D. O'CONNOR: BRST
quantisation and the product formula for the
Ray-Singer torsion.
- 23: F. ABDELWAHID, & J. BURZLAFF: Exis-
tence theorems for 90° vortex-vortex scat-
tering.
- 24: J.T. LEWIS, C.-E. PFISTER, & W.G.
SULLIVAN: Large deviations and the
thermodynamic formalism: a new proof of
the equivalence of ensembles.
- 25: M.A. VAN EIJCK, D. O'CONNOR, & C.R.
STEPHENS: Heating field theory the
"environmentally friendly" way!
- 26: G.A.T.F. DA COSTA, & L. O'RAIF-
EARTAIGH: Non-trivial non-canonical W -
algebras from Kac-Moody reductions.
- 27: D.H. TCHRAKIAN: Skyrme-like models in
gauge theory.
- 28: J. BURZLAFF, & D.H. TCHRAKIAN: Non-
self dual solutions of gauge field models in
 $2N$ dimensions.
- 29: B. PIETTE, H.J.W. MÜLLER-KIRSTEN,
W.J. ZAKRZEWSKI, & D.H. TCHRAKIAN:
A modified Mottola-Wipf model with in-
stanton and sphaleron fields.
- 30: N.G. DUFFIELD, & N. O'CONNELL: Large
deviations and overflow probabilities for the
general single-server queue, with applica-
tions.

- 31: V.I. GAIDUK, V.V. GAIDUK, T.A. NOVSKOVA, & B.M. TSEITLIN: Dielectric response and a phenomenon of a narrow band absorption for a classical rotor in a double well potential.
- 32: M.A. VANDYCK: On the damped harmonic oscillator in the de Broglie-Bohm "Hidden-Variable" theory.
- 33: J.T. LEWIS, & C.-E. PFISTER: Thermodynamic probability theory: some aspects of large deviations.

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 "Origins of the gauge theory of the fundamental interactions" was delivered by Prof. L. O'Raifeartaigh at University College Dublin in December.

5.2 Seminar and review lectures given at DIAS-STP

- Prof. N. Angelescu (Bucharest) *The generalized spherical model of a disordered ferromagnet*
- Dr. D. Botvich (DCU) *Euler space-time scaling limit for random walk in the positive quadrant of an N-dimensional lattice*
- Dr. P. Crehan (Kyoto) *When are vector-fields Hamiltonian?*
- Dr. N.G. Duffield (DCU) *Exponential bounds for queues with discrete Markovian arrivals*
- Prof. D.E. Evans (Swansea) *Subfactors from solvable lattice models*
- Prof. A.S. Holevo (Moscow) *On the structure of covariant dynamical semigroups*
- Prof. J. Jorjadze (Tbilisi) *Motion of a particle on an $SL(2,R)$ manifold*
- Dr. F. Krahe (Zürich) *Anomalies in finite QED*
- Dr. F. Krahe (DIAS) *Reduction of $Q^3/Phys \geq 0$ to $Q^2/Phys \geq 0$*
- Dr. F. Krahe (DIAS) *Casual perturbation theory for gauge theories*
- Dr. Y. Kubyshin (Moscow, & Barcelona) *Multidimensional models and their physical implications*
- Prof. B. Kümmerer (Tübingen) *Free evolutions for open quantum systems*
- Dr. M. Lavelle (Mainz) *Sick and healthy prescriptions for axial gauges*
- Prof. J.T. Lewis (DIAS) *Equivalence of ensembles : examples and counterexamples*
- Prof. A. Martin-Löf (Stockholm) *A solution of the Petersburg paradox*
- Prof. P. McGill (Chapel Hill) *Path properties in supercritical branching*
- Prof. P. McGill (Lyon) *Annealing and upper functions*
- Dr. J. Noble (UCC) *Lyapunov spectrum of evolution with random potential*
- Dr. J. Noble (UCC) *Intermittency and the great leap of faith*
- Dr. N. O'Connell (Edinburgh) *The genealogy of near-critical branching processes*
- Dr. N. O'Connell (DIAS) *The Poisson clumping heuristic*
- Dr. A. Patrick (DIAS) *Large deviations in the spherical model*
- Prof. Ch. Pfister (Lausanne) *An isoperimetric inequality and the shape of droplets in the region of coexistent phases*
- Prof. V.B. Priezzhev (JINR, Dubna) *Spanning trees : new problems and applications*
- Dr. P. Robinson (Hull) *The dynamical stark effect and the quantum stochastic calculus*
- Mr. J. Sachs (ETH, Zürich) *Chiral symmetry breaking in extended gauged Thirring model*

- Prof. R. Sasaki (Durham) *Toda field theory*
- Prof. G.D. Slade (Cambridge) *The connective constant for self-avoiding walks*
- Prof. G.D. Slade (Cambridge) *Collapse transition for a self-attracting walk*
- Dr. W. Spence (Melbourne) *Covariant canonical methods for 2-d models*
- Prof. W. Thirring (Vienna) *Quantum ergodic theory*
- Dr. P.J. Upton (Oxford) *The bubble model for correlation functions and droplet singularities*

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

- Dr. G. da Costa (DIAS) *The path integral in multiply connected spaces*
- Dr. B. Dolan (Maynooth/Hanover) *Potential flow of the renormalisation group*
- Dr. B. Dolan (Maynooth) *Co-variant derivatives and the renormalisation group*
- Dr. C. Ford (DIAS) *The effective potential and the renormalisation group*
- Dr. D. McMullan (DIAS) *Gauge structures in gauge theories*
- Dr. C. Nash (Maynooth) *Three dimensional quantum field theory and topological invariants*
- Dr. C. Nash (Maynooth) *BRST quantization and Ray-Singer torsion formulae*
- Prof. R. Poghossyan (Yerevan) *A recurrence relation method for calculating the structure constants of operator algebras in 2D conformal field theory*
- Dr. D.H. Tchrakian (Maynooth) *Qualitatively different Maxwell and Chern-Simons vortices*
- Dr. I. Tsutsui (DIAS) *Gauge structures in gauge theories II*

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

- Prof. L. O'Raiifeartaigh *Symmetry principles in field theory* M.Sc. Course, Dublin Universities.

- Dr. E. Buffet (D.C.U.) *How to gamble if you must* D.C.U., November.
- Dr. E. Buffet (D.C.U.) *The method of coupling for Markov chains* D.C.U., 30 November - 7 December.
- Dr. J. Burns (U.C.G.) *Twistor theory of compact symmetric spaces*. U.C.G.
- Dr. J. Burzlaff (DCU) *Topologically non-trivial solutions of non-linear partial differential equations* D.C.U., February.
- Dr. J. Burzlaff (DCU) *Existence theorems for 90 deg vortex-vortex scattering* D.C.U., 13 September.
- Dr. N. Duffield (DCU) *Bounds, bandwidths and broadband networks*, D.C.U., February.
- Dr. B. Goldsmith (DIT) *The trace of a finite Abelian group - an application to digraphs*, Dublin, August.
- Dr. C. Nash (Maynooth) *Quantum field theory*, M.Sc. Course, T.C.D.
- Dr. A. Patrick (JINR, Dubna, & DIAS) *Neural networks*, D.C.U., February.
- Prof. A.I. Solomon (Open University) *Visual metaphors - mathematics and the media*, U.C.D., February.
- Prof. A.I. Solomon (Open University) *Quantum groups and quantum optics*, U.C.D., February.
- Dr. M. Vandyck (UCC, & RTC Cork) *Bell's inequalities and the interpretation of quantum mechanics*, U.C.C., January.
- Dr. M. Vandyck (UCC, & RTC Cork) *Cosmic strings and time-travel machines*, U.C.C., May.

5.5 Seminars, Lectures and Courses given abroad

- Prof. J.T. Lewis *Large deviations and the equivalence of ensembles* (Nottingham) *Equivalence of ensembles for classical lattice systems* (Edinburgh) *A new proof of the equivalence of ensembles* (Leuven) *Large deviations and conditional limit theorems* (Toulouse) *The Mu-Delta project: estimating quality of service parameters* (Cambridge)
- Prof. L. O'Raiifeartaigh *Toda systems as constrained linear systems* (Texas) *The dawning of gauge theory* (Trieste, Niigata)

- *The emergence of gauge theory* (Israel)
- *The origins of the gauge interactions* (Syracuse)
- *Semi-classical methods in QM and QFT* (Erlangen)
- *WZNW-reductions* (King's College, London, Yukawa, Tokyo)
- *Origins of gauge theory* (Bonn, Yukawa)
- Dr. J. Burzlaff *Vortex-vortex scattering* (Kaiserslautern)
- Dr. B. Dolan *The renormalisation group and potential flow* (Bad Honnef, Bonn, Germany) *A geometrical interpretation of R.G. Flow* (Hamburg; Desy).
- Dr. N. Duffield *Bounds for overflow probabilities in Markovian queueing models* (Cambridge)
- Dr. T. Garavaglia *Search for intermediate mass Higgs particle* (SSC)
- Dr. B. Goldsmith *On endomorphisms and automorphisms of some pure subgroups of the Baer-Specker group* (Oberwolfach)
- Dr. P. Lynch *Digital filters for numerical weather prediction* (Copenhagen) *Initialization of Lewis Fry Richardson's Forecast using a digital filter* (Bracknell)
- Prof. P. McGill *Excursions and matrix factors* (Lyon) *Path properties in supercritical branching* (Warwick, Swansea) *Multiplicative martingales in supercritical branching* (Strasbourg) *Uniqueness for a non-linear heat equation* (Kaiserslautern) *Harmonic functions with non-linear boundary condition* (Queen's Univ., Belfast).
- Dr. D. McMullan *Gauge structures in gauge theories* (Mainz)
- Dr. N. O'Connell *Large deviations and overflow probabilities for the general single-server queue* (Cambridge)
- Dr. D.J. O'Connor *Environmentally friendly renormalization* (Kaiserslautern, Heidelberg, Oxford)
- Prof. A. O'Farrell *Tangent stars* (Prague)
- Dr. D. Ó Mathúna *Jacques II Bernoulli and the problem of the vibrating plate* (Zaragoza, Spain)
- Dr. A. Patrick *Magnetization profiles in the spherical model with "±"- boundary conditions* (Berlin) *A second critical point in the spherical model of a ferromagnet* (Leuven)

- Prof. A.I. Solomon *Quantum optics: from groups to quantum groups* (Paris, UNAM Mexico) *Generalised q-Bosons* (Dubna)
- Dr. D.H. Tchrakian *Skyrme-like gauge field models* (Montepulciano, Siens)

6 Activities of Staff and Associates

6.1 Activities within Ireland

- DR. J. BURNS: "Mathematical Heritage of Sir. William Rowan Hamilton", Conference, T.C.D., August;
- DR. B. GOLDSMITH: "Mathematical Heritage of Sir. William Rowan Hamilton", Conference, T.C.D., August; Irish Mathematical Society, Cork, September.
- DR. C. NASH: Irish Mathematical Society, Cork, September.
- PROF. A. O'FARRELL: Irish Mathematical Society, Cork, September.
- PROF. A.I. SOLOMON: U.C.D. Mathematical Society Inaugural Lecture and Seminar, 17-19 February.

6.2 Activities outside Ireland

- PROF. J.T. LEWIS: Quantum Probability Meeting, Nottingham, 28 March - 3 April; Heriot-Watt University, Edinburgh, 1-4 June; Isaac Newton Institute for Mathematical Sciences, Cambridge, 30 June - 16 July; KUL Instituut voor Theoretische Fysica, Leuven 18-25 July; Colloque "Journées de Probabilités", CNRS Laboratoire de Statistique et Probabilités, Toulouse, 13-18 September; ATM Course, Cambridge, 21-24 September; Stochastic Networks Workshop, Cambridge, 17 December;
- PROF. L. O'RAIFEARTAIGH: Nato Workshop, Univ. of Texas, 4-8 January; Salamfest - highlights of Particle and Condensed Matter Physics, ICTP, Trieste, 2-12 March; Technion, Haifa, 13-15 March; Mathematical Physics towards the XXI st. Century, Beersheva Univ., Israel, 14-19 March; Walifest - New Directions in the

- Application of Symmetry Principles, Syracuse Univ., 13-15 May; King's College, London, 8 June; International Workshop on Symmetry Methods in Physics, Dubna, 6-10 July; Bonn, 7 October; Topics in Field Theory, Univ. of Erlangen, Kloster Banz, 6-18 October; Symmetries in Science VI, Niigata, Japan, 12-14 November; Yukawa Inst., Uji, 16 November; Yukawa Inst, Kyoto, 19 November; Inst. Nuclear Science, Tokyo, 22 November.
- PROF. J.R. MCCONNELL: Trends in Physics, Firenze, Italy, 14-17 September; Lanczos Conference, University of Raleigh, North Carolina, 10-18 December.
- DR. E. BUFFET: Random Spatial Processes, Newton Institute, Cambridge, 4-16 July; Mathematics of Finance, Royal Society, London, 10-11 November.
- DR. J. BURNS: Group representations and complex analysis, C.I.R.M., Luminy, France, August - September.
- DR. J. BURZLAFF: University of Kaiserslautern, 19-23 July.
- DR. B. DOLAN: Institute for Theoretical Physics, Hannover, January - September; Strings and Conformal Field Theory, I.C.T.P., Trieste, April; Bad Honnef, Bonn, May.
- DR. N. DUFFIELD: Stochastic Networks Workshop, Cambridge, 17 December;
- DR. C. FORD: Rutherford Laboratory Conference, 15-17 December.
- DR. T. GARAVAGLIA: Workshop on Physics, Super Collider, Argonne National Lab., 2-5 June; Particle Accelerator Conference, APS/IEE Washington DC, March.
- DR. M. GOLDEN: Simon Fraser Univ., Burnaby, B.C., Canada, 27-31 December.
- DR. B. GOLDSMITH: Oberwolfach Meeting on Abelian Groups, August; Oxford, December.
- DR. P. LYNCH: Danish Meteorological Institute, Copenhagen, 22-26 March; Meteorological Office, Bracknell, 18 May; HIRLAM Technical and Scientific Committee, Danish Meteorological Institute, Copenhagen, 19-23 July; Scientific Advisory Committee of the European Centre, 22-24 September; Fifteenth Meeting of the European Working Group on Limited Area Modelling, Czech Hydrometeorological Institute, Prague, 4-8 October; Policy meeting on developments in research relating to short range NWP, Meteo-France, Toulouse, 28-29 October; HIRLAM Advisory Committee Meeting, Meteo-France, Toulouse, 2 November; Workshop on Numerical Weather Prediction, Meteo-France, Toulouse, 3-5 November; KNMI, De Bilt, December. Meteorological Office, Bracknell, 18 May.
- PROF. P. MCGILL: Univ. North Carolina, Chapel Hill, January - September; Cambridge, Swansea, Warwick, 1-15 October; Lyon, France, 15 October - 30 November; Strasbourg, 2 December; Kaiserslautern, 7 December; Queen's Univ., Belfast, 9 December.
- DR. D. McMULLAN: University of Mainz, 20-27 March.
- DR. C. NASH: Institute for Physics, Karlsruhe; Institute for Mathematics, Göttingen; Institute for Physics, München.
- DR. N. O'CONNELL: Mathematical Models in Finance, Royal Society, London, 9-11 November; Stochastic Networks Workshop, Cambridge, 17 December.
- DR. D.J. O'CONNOR: Institute for Theoretical Physics, Utrecht, 22 April - 11 May, 27 July - 8 August; Institute for Theoretical Physics, Amsterdam, 1 November - 1 December; Oxford 3 December.
- PROF. A. O'FARRELL: Charles University, Prague, 7-13 July; Function Theory Meeting, Open University, September.
- DR. D. Ó MATHUNA: XIXth. International Congress of History of Science, Zaragoza, Spain, 22-29 August.
- DR. A. PATRICK: Inst. für Angewandte Analysis und Stochastic, Berlin, 18-22 March; Inst. voor Theoretische Fysica, Katholieke Universiteit Leuven, 22-29 March.
- PROF. A.I. SOLOMON: Haifa Technion, Israel, 6-21 March; Univ. of Paris VI, 25 March; Dubna, Russia, 3-9 July; Haifa Technion, Israel, 3-12 October.
- DR. C. STEPHENS: Instituut voor Theor. Fys., Utrecht, 10-26 November; Rutherford Laboratory Conference, 15-18 December.

- DR. D.H. TCHRAKIAN: Palaiseau, June; Constraint theory and quantisation methods, Montepulciano, Siena, June; Kaiserslautern, August.
- F. TOOMEY: Workshop on Stochastic Networks, Cambridge, 16-18 December.
- DR. I. TSUTSUI: Universität Bonn, 6-10 October.

7 Symposia

Two Mathematical Symposia were held during the year, 7-8 April and 20-21 December. The attendance (25 in April, 42 in December) included professors, lecturers, and graduate students from the Irish universities and other third-level research institutes, and from institutes abroad, and members of the scientific schools of DIAS.

Lectures were given as follows:

April

Review Lectures:

- Prof. R. Aron (Kansas Univ., & UCD) *Algebras of analytic functions*
- Dr. A. Ottewill (Oxford) *Black hole evaporation*

Lectures:

- Dr. D. McMullan (DIAS) *Gauge structures and quantisation*
- Dr. N. Duffield (DCU) *Bounds and bandwidths for Markov multiplexers*
- Mr. E. Coleman (DIT) *Reduced products: some applications in algebra, analysis and set-theory*
- Dr. P. O'Leary (UCG) *Maple and undergraduate teaching*

Short Talks:

- Dr. P. Dolan (Imperial College) *Alternative infinities*
- Dr. A. Patrick (DIAS) *Magnetization profiles in the spherical model*

December

Review Lectures:

- Dr. P. Lynch (Met. Service) *Digital filters*
- Prof. A. O'Farrell (Maynooth) *Chaos in a laser system*

Lectures:

- Prof. N. Ó Murchadha (UCC) *Spherical gravitational collapse*

- Dr. S. Kalyana Rama (TCD) *Singularities in low energy four dimensional strings*
- Prof. C. King (Northeastern Univ.) *Classical geometry and quantum gauge theory*
- Dr. T. Dorlas (Swansea) *Generalised eigenfunctions*

Short Talks:

- Dr. N. O'Connell (DIAS) *Large deviations and overflow probabilities for the single-server queue*
- Dr. F. Krahe (DIAS, & Zürich) *Causal construction of gauge theories*
- Prof. A. Wood (DCU) *Asymptotics of the spectral function for high order ordinary differential equations*
- Dr. T. Murphy (TCD) *Fermat's last theorem*
- Mr. M. Goodman (DIT) *The universe: a holistic approach*
- Prof. A.I. Solomon (Open Univ.) *Gauss and the real laser*

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):

- A. Chakrabarti (France) 12-19 September,
- P. Crehan (Kyoto) 17-24 October,
- T. Dorlas (Swansea) 19-21 December,
- S. Kamefuchi (Tokyo) 22 July,
- C. King (Northeastern Univ.) 21 December,
- F. Krahe (Zürich) 3-10 May,
- B. Kümmeler (Tubingen) 23-26 May,
- A. Leznov (Moscow) 15-22 April,
- P. McGill (Chapel Hill) 17-24 May,
- P. McGill (Lyon) 12-17 December,
- A. Martin-Löf (Stockholm) 18-25 April,
- J. Moser (ETH, Zürich) 16-22 August,
- J. Noble (U.C.C.) 14-15 January, 10 February, 4-5 March, 22-23 April, 16-17 June, 9-10 December,
- N. O'Connell (Edinburgh) 11-16 May,

P. O'Leary (U.C.G.) 7-8 April,
 N. Ó Murchadha (U.C.C.) 20-22 December,
 P. Robinson (Hull) 17 June,
 I. Sachs (ETH, Zürich) 8 July,
 R. Sasaki (Durham) 29 May - 5 June,
 R.N. Sen (Beersheba) 3 September,
 G.D. Slade (Canada) 23-25 November,
 A.I. Solomon (Open University) 1-5
 March, 20-21 December
 W. Spence (Melbourne) 15-18 June,
 C. Stephens (Utrecht) 26 August - 2
 September,
 W. Thirring (Vienna) 20 September.

Longer visits:

N. Angelescu (Bucharest) 5-18 December,
 D. Evans (Swansea) 1-10 January,
 R. Flume (Bonn) 24 March - 2 April,
 G.W. Ford (Ann Arbor) 3-28 June,
 V.I. Gaiduk (Moscow) 2 October - 3
 December,
 C. Graham (Simon Fraser, Canada) 15
 March - 23 December,
 A.S. Holevo (Moscow) 27 April - 11 May,
 G. Jorjadze (Tbilisi) 17 September - 15
 November,
 Y. Kubyshin (Barcelona) 29 June - 11 July,
 M. Lavelle (Mainz) 28 May - 5 June,
 W. McGlenn (Notre Dame) 27 December - ,
 W. May (Arizona) 1-15 July,
 C. Pfister (Lausanne) 15-26 June,
 R. Poghossian (Yerevan) 20 November - 4
 December,
 V.B. Priezhev (Dubna) 6 August - 4
 September,
 C. Stephens (Utrecht) 18-28 March,
 S.-N. Tamaryan (Yerevan) 20 November - 9
 December,
 P. Upton (Oxford) 9-31 October.

9 Publications

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

9.1 Books

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

None published.

9.3 Contributions to periodical and other publications

- T.C. Dorlas, J.T. Lewis, & J.V. Pulé: The full diagonal model of a Bose gas. *Commun. Math. Phys.* **156**(1993)37-65.
- L. O'RaiFeartaigh: Spin-statistics and topology. *Symmetries in Science VI: From rotation group to quantum algebras*, Plenum Press
- L. O'RaiFeartaigh, N. Staumann, & A. Wipf: Aharonov-Bohm effect in presence of superconductors. *Foundations of Physics* **23**(1993)703.
- L. Fehér, L. O'RaiFeartaigh, & I. Tsutsui: The vacuum preserving Lie algebra of a classical w -algebra. *Phys. Lett. B.* **316**(1993)275-281.
- L. Fehér, & I. Tsutsui: On the Lagrangian realization of the WZNW reductions. *Phys. Lett. B.* **294**(1992)209-216.
- *L. O'RaiFeartaigh: Conformal reduction of WZNW theories by first-class constraints. *Foundations and Symmetries, Proc. IInd International Wigner Symposium, Goslar, Germany, 1991*, eds. H.D. Doebner et al. *World Scientific 1993*, p. 138
- *L. O'RaiFeartaigh: General WZNW-Toda reductions. *Proceedings XIX International Colloquium on Group Theoretical Methods in Physics, Salamanca, Anales de Fisica, Monografias, Vols. 1 and 2*, eds. M.A. del Olmo et al. *CIEMAT/RSEF, Madrid, 1993*
- J.-L. Gervais, L. O'RaiFeartaigh, A.V. Razumov, & M.V. Saveliev: Gauge-conditions for constrained WZNW-Toda systems. *Phys. Lett. B* **301**(1993)41.
- Y.P. Kalmykov, & J. McConnell: Extended rotational diffusion and dielectric relaxation in liquid solutions. *Physica A* **193**(1993)394-412.

- J. McConnell: Application of Krylov-Bogoliulov-Mitropolsky methods to relaxation processes. *J. Molecular Liquids* **56**(1993)183-197.
- V.I. Gaiduk, B. Tseitlin, T. Novskova, & J. McConnell: Non-vanishing molecular collision times and dielectric relaxation for linear molecules. *Physica A* **197**(1993)75-97.
- Ph. Ruelle, E. Thiran, & J. Weyers: Implications of an arithmetical symmetry of the commutant for modular invariants. *Nuclear Phys. B.* **402**(1993)693-708.
- A. Patrick: On phase separation in the spherical model of a ferromagnet : quasi-average approach. *J. Stat. Phys.* **72**(1993)665-701.
- A.E. Patrick, & V.A. Zagrebnov: A probabilistic approach to parallel dynamics for the Little-Hopfield model. *J. Phys. A.* **24**(1991)3413-3426.
- *E. Buffet, A. Patrick, & J.V. Pulé: Directed polymers on trees: a Martingale approach. *J. Phys. A* **26**(1993)1823-1834.
- D. O'Connor, & C.R. Stephens: The renormalization group in curved spacetime. *Classical and Quantum Gravity* **10**(1993)S241.
- F. Freire, D. O'Connor, & C.R. Stephens: Finite temperature phase transitions in quantum field theory. *Classical and Quantum Gravity* **10**(1993)S243.
- D. O'Connor, & C.R. Stephens: Geometry the renormalization group and gravity. *Directions in General Relativity, proc. 1993 Int. Symp., Vol.1. edited by Hu, Ryan and Vishreshwara, C.U.P. '93*
- C. Nash, & D. O'Connor: Ray-Singer torsion, topological field theories and Riemann Zeta function at $s=3$. *Proceedings of the Workshop on Low-Dimensional Topology.*
- M.A. Vandyck: Weak-field Birkhoff theorem in simple supergravity. *General Relativity and Gravitation* **25**(1993)15.
- M. Chearnley, & M. Vandyck: On a terrestrial electro-motive force induced by galactic magnetic fields. *J. Electromagnetic Waves and Applications* **6**(1992)119-127.
- S.H. Hughes, D.J. McManus, & M.A. Vandyck: Weak-field gravity of circular cosmic strings. *Phys. Rev. D* **47**(1993)468-473.
- D.J. McManus, & M.A. Vandyck: Weak-field gravity of revolving circular cosmic strings. *Phys. Rev. D* **47**(1993)1491.
- M. Lavelle, & D. McMullan: The radiation class: a new set of temporal gauges. *Zeit. für Phys. C.* **59**(1993)351-356.
- M. Lavelle, & D. McMullan: On the physical propagators of QED. *Phys. Lett. B.* **312**(1993)211-214.
- M. Lavelle, & D. McMullan: Gauge choices and physical variables in QED. *Phys. Lett. B.* **316**(1993)172-174.
- M. Lavelle, & D. McMullan: A non-local symmetry for QED. *Phys. Rev. Lett.* **71**(1993)3758-3761.
- *B. Goldsmith, & P. Zanardo: On the analogue of Corner's finite rank theorem for modules over valuation domains. *Archiv der Mathematik* **60**(1993)20-24.
- B. Goldsmith, & P. Zanardo: The Walker endomorphism algebra of a mixed module. *Proc. Royal Irish Academy A* **93**(1993)131-136.
- R. Göbel, & B. Goldsmith: Cotorsion-free algebras as endomorphism algebras in L - the discrete and topological cases. *Comment. Math. Univ. Carolinae* **34**(1993)1-9.
- J. Burns: Conjugate loci of totally geodesic submanifolds of symmetric spaces. *Trans. Amer. Math. Soc.* **337**(1993)411-425.
- *A.G. O'Farrell, & R.O. Watson: Constructing C^1 extensions. *Proc. Royal Irish Academy A* **93**(1993)61-72.
- A.G. O'Farrell, & P. de Paepe: Approximation on a disc II. *Math. Z.* **212**(1993)153-6.
- D. Lord, & A.G. O'Farrell: Boundary smoothness properties of lipa holomorphic functions. *J. d'Analyse Math. (Jerusalem)* **63**(1993)1-17.
- *J. Burzlaff, A. Chakrabarti, & D.H. Tchrakian: Axially symmetric instantons in generalized Yang-Mills theory in $4p$ dimensions. *J. Math. Phys.* **34**(1993)1665.
- D.H. Tchrakian: Yang-Mills hierarchy. *Int. J. Mod. Phys. A. (Proc. Suppl.)* **3**(1993)584.
- H.J.W. Müller-Kirsten, A.V. Shurgain, & D.H. Tchrakian: A sphaleron in the $(2+1)$ - dimensional modified sigma model. *Ann. Physics* **228**(1993)146.

- J. Burzlaff, & D.H. Tchrakian: Non-self dual solutions of gauge field models in $2N$ dimensions. *J. Phys. A.* **26**(1993)L1053.
- D. Heffernan, P. Jenkins, & M. Daly: $F(\alpha)$ spectrum of pruned Baker's map. *Z. fur Naturforschung* **48A**(1993)1166-1172.
- M. Daly, B. Hawdon, D.M. Heffernan, J. O'Gorman, & P. Jenkins: Characterization of chaos. *Inter. J. Theor. Phys.* **31**(1992)1345-1362.
- A.I. Solomon, & J. Katriel: Multi-mode q-coherent states. *J. Phys. A.* **26**(1993) 5443-5447.
- A.I. Solomon, & J. Katriel: Quantum group applications in quantum optics. *Quantum symmetries, edited by H-D Doebner and V.K. Dobrev, pp 41-50, World Scientific, 1993.*
- R.J. McDermott, & A.I. Solomon: Anomalous noise reduction in q-coherent states. *Proc. of the Maryland Conf. on Squeezed States and Uncertainty Relations, August 10-13, 1993.*
- R.J. McDermott, & A.I. Solomon: General deformations of bosons and their coherent states. *Proc. of the Conference in honour of the late Prof. Ya. A. Smorodinsky, Dubna, 6-10 July, 1993.*
- * B.P. Dolan, & C. Nash: Zeta function continuation and the Casimir energy on odd and even dimensional spheres. *Commun. Math. Phys.* **148**(1992)139-152.
- B. Dolan: Integrability conditions for potential flow of the renormalisation group. *Phys. Lett. B.* **312**(1993)97-104.
- B. Dolan: Potential flow of the renormalisation group in a simple two component model. *Mod. Phys. Lett. A.* **8**(1993)3103-3110.
- B. Dolan: Quantum non-demolition of the universe. *Phys. Rev. D.* **48**(1993)3672-3676.
- F. Benatti: Deterministic quantum noise and Kolmogorov systems. *Lett. Math. Phys.* **24**(1992)31-40.

10 Library

One hundred and fifty new titles were added to the library stock during the year; one hundred and thirty current periodicals were taken, of

which approximately fifty were received by gift or under exchange arrangements. Cardbox-Plus, an information management and retrieval software package, was purchased and is to be used to computerise a lot of the day to day management of the library. The collection of books belonging to Prof. J.L.Synge has been donated to the library and a database of the titles, using Cardbox, is in the process of compilation. Databases of other book collections in the school are planned. It is envisaged that the main catalogue in the Library will be computerised within the next few years. 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.

V. Annual report of the Governing Board of the School of Cosmic Physics for the year ending 31 December 1993 adopted at its meeting of 20 October 1994.

I Staff, Scholars and Associates

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

PROFESSORS: T. Kiang (to 28 February), A. Thompson, (two vacancies)

ASSISTANT PROFESSORS: D. O'Sullivan, T.P. Ray, P.W. Readman (from 1 January)

RESEARCH ASSISTANTS: I. Elliott, (two vacancies)

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

VISITING SCIENTISTS: E. Criley (US Geological Survey), C. Domingo (UAB, Barcelona), W. Hanka (Potsdam), W. Heinrich (University of Siegen), W. Jacoby (University of Mainz), T. Lago (University of Porto), J. Luetgert (US Geological Survey), J. Makris (University of Hamburg), W. Mooney (US Geological Survey), J. Neuberg (University of Leeds), C. Prodehl (University of Karlsruhe), A. Solomon (Open University), L. Tommasino (ENEA, Rome)

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

SCHOLARS: J. Bosch, G. Byrne (from 1 September), D. Corcoran (to 31 July), M. Corcoran, T. Downes (from 1 October), K. Farrell, F. Hauser (from 1 October), A.J. Keane (from 1 October), R. Keegan (to 31 March), F. Murphy (from 1 September), I. O'Brien, C. O'Byrne (from 1 October), B. O'Reilly (from 1 September), S.P. Xiang (to 31 December).

PROJECT SUPPORTED POSITIONS: J. Byrne (IRMA), J. Eisloffel (HCM, from 1 March), F. Hauser (RAPIDS, to 30 September), A. Moorhouse (Low Mass Star Formation, to 31 March), B. O'Reilly (RAPIDS, to 31 August), S.C. Russell (ISOPHOT), I.G. van Breda (Instrumentation Project)

PROFESSORS EMERITI: H.A. Brück, C. O. Ceallaigh, T. Murphy, P.A. Wayman

RESEARCH ASSOCIATES: C.J. Bean (UCD), P.B. Byrne (Armagh), M. Cawley (SPCM), M. Hoey (UCD), R. Keary (GSI), E. Kennedy (DCU), J. Makris (Hamburg), P. Morris (BP/Independent), N.P. Murphy (BP), W.E.A. Phillips (TCD), C. Prodehl (Karlsruhe), R.M. Redfern (UCG), P.M. Shannon (UCD)

VACATION STUDENTS: John Cuniffe (TCD, 5 July - 10 September), Leon Hurst (UCD, 14 June - 10 September), David Jordan (UCD, 21 June - 20 August; 23 September - 6 October), Michael McGovern (UCD, 14 June - 30 July), Fiona McKenna (QUB, 21 June - 6 August; 23 August - 7 September; 13 September - 17 September), Barry Mc Kernan (UCD, 28 June - 10 September), Aoife O'Mongain (UCD, 14 June - 23 July; 11 - 15 October)

2 Research Activities in the Geophysics Section

2.01 Offshore Gravity and Magnetic Work

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

2.01.1 Magnetic field

Offshore potential field work during recent years has concentrated on the gravity data collected during the HOGS and COOLE projects and their merging with the land data. The magnetic data had only been examined in a very preliminary way. During this year a more detailed investigation of the magnetic data collected during the HOGS cruise was begun, in particular to ascertain whether more useful information can be obtained than from the aeromagnetic maps. Although a magnetic map

based on older surface measurements and aeromagnetic surveys already exists, the high resolution data that can be obtained from the HOGS profiles promise to show more detail which may be of geological interest, especially in the northern part of the HOGS survey area. In collaboration with P. Morris, the area around Clare Island has been examined in considerable detail where a pronounced anomaly on land may possibly extend westwards into the Atlantic. Part of the problem in analysing data of this type is that some of the anomalies are very high frequency (i.e. occur over a short distance) and so are not amenable to standard contouring techniques. Indeed it may be for this reason that some of the features of the magnetic field have not been identified. Alternative ways of analysing and presenting such data are therefore being investigated.

2.01.2 Satellite gravity

Satellite data sets derived from the sea surface altimeter measurements made by the GEOS missions have recently been released by NASA, made available by Sandwell and obtained by DIAS. Comparisons with the DIAS surface measurements have been made where there is an overlap of reliable data and so far good correspondence has been found, except that as expected the satellite measurements are considerably more smoothed so that anomalies with characteristic lengths of 20 - 40 km will be less well resolved. However the data sets provide an excellent way of looking at the regional variations, especially for the DIAS requirement of checking the seismic models obtained from the RAPIDS programme. The long transverse RAPIDS profile stretching from the Irish mainland across the Rockall Trough and Hatton Basin into the deep Atlantic has thus far been investigated. Initial gravity models based on the seismically inferred densities are very promising and indicate overall agreement with the seismic model. Further work will refine the model and will add more confidence where the seismic model is less well controlled.

2.02 Onshore Gravity

P.W. Readman and T. Murphy with C. Brown (UCG) and staff of British Geological Survey

Compilation of the 'half-inch' series of maps has continued. The work has been concentrated in the west and south-west of the country, mainly in west Cork, Co. Clare and Co. Galway.

Terrain corrections in these areas can be quite

significant and particular attention has been paid to this aspect of the work. Some new measurements were taken in Connemara and added to the existing data set. Collaboration with Colin Brown from UCG on a joint interpretation of the onshore gravity and magnetic data was started. On-going collaboration with the British Geological Survey has resulted in various processed image maps of the gravity field over and around Ireland.

2.03 Meteorology

K. Bolster

Readings and recordings of some of the meteorological elements were continued throughout the year. The resulting data sets were relayed to the Meteorological Service and published in its monthly Weather Bulletin. Enquiries are dealt with regularly and the long-term records are made available to researchers and students when requested.

2.04 The Seismic Network (DNET, ENET and DSB)

T. A. Blake, K. Bolster, C. M. Horan, A.W.B. Jacob and G. Wallace with staff of the GeoForschungsZentrum, Potsdam.

The short-period analogue and triggered digital systems continued to operate during the year. The latter continued to be logged and backed up with occasional exchange with Edinburgh of data from significant seismic events. The variable quality of the dial-up line between Merrion Square and Lyons Estate continued to cause problems, though no significant data loss has occurred. Telecom agreed to monitor the line quality on a continuous basis for the foreseeable future.

The major change in the network was the addition of a three-component VBB (Very Broad Band) station at a new site south of Tallaght. This is in an old quarry near Slievenabawnogue (DSB). It was originally intended to put it in Lyons (DLF) but the site was not satisfactory and DSB was chosen after test recordings during the summer. In the late summer and the autumn a reinforced concrete blockhouse was built for it. The station was installed in early December and, by the end of the year, had a dial-up telephone for downloading data and monitoring the system. The equipment was provided by Potsdam and is part of a widespread network they are building up. The velocity response is flat from 0.01 to 10

Hz and it is a very important addition to the seismic network in Ireland. It will enable measurements on teleseismic S-waves and on surface waves. Neither are usually possible on short-period equipment.

There were no onshore seismic events in 1993 but three were recorded in the Irish Sea. The largest of these was ML 2.1 at 03:48 on 20 July. The UK was also unusually quiet, with the largest event reaching ML 3.0 in Cumbria on 26 June. There were no "great" earthquakes (magnitude greater than 8) in the year. By far the worst one was relatively small, a magnitude 6.3 event in central India which occurred on 8 September and caused enormous casualties. The true figures may never be known but reasonable estimates were that there were 10,000 killed and 30,000 injured. It was in a poor area with low building standards. A number of requests for information were handled during the year.

2.05 KRISP 94 (Seismic Programme in Kenya)

G. Byrne, A.W.B. Jacob and G. Wallace with staff of European, United States and Kenyan Institutions

The Geophysics Section was part of a successful application to the EC to do more work in the south of Kenya. The experiment is a multi-disciplinary one with teleseismic and wide-angle seismic components, magnetotelluric and gravity measurements and geochemical sampling.

The wide-angle seismic profiling is the part that concerns the Geophysics Section and the intention is to run a 700 km line from near Mombasa on the Indian Ocean northwest to Lake Victoria. G. Byrne is to study the lower lithosphere (below the Moho) and it will be necessary to fire large and efficient shots in the water at either end of the line. A.W.B. Jacob and G. Wallace visited Mombasa and Nairobi in August to assess the feasibility of firing in the ocean and to make plans for the experimental work which is scheduled for early in 1994. The assistance of the Kenyan Navy has been promised and a 30 m patrol vessel will be available.

2.06 RAPIDS - Seismic Profiles in the Northeastern Atlantic

A.W.B. Jacob, P.M. Shannon, F. Hauser and B.M. O'Reilly with University College Dublin and the University of Hamburg

During the year this work included a sub-project called OMAR (Ocean Margins And Rifts), designed to make a comparative study of results from RAPIDS and those obtained on other continental margins. A number of scientific institutions have recently produced new data and models which go part of the way towards understanding the evolution of the very complex North Atlantic system. The particular concern of the project has been with the margins and the sedimentary basins that are a notable feature of them.

The Geophysics Section, together with University College Dublin and the University of Hamburg have gathered a fine data set along profiles which extend for 1600 km. The results from this work have changed the theories about the development of the very extensive continental margin of western Europe. In order to further develop ideas on this, results and data from analogous geological settings in other parts of the world are being studied. It is important to reinterpret the old data, rather than accept interpretations which may have been carried out a number of years ago. Interpretation methods have improved in the interim.

The differential stretching model developed for the crust, and its implications for the lower lithosphere, have provided us with a good explanation for the lack of underplating under what, at first sight, seems to be a basin that is so stretched that there should have been enormous vulcanism and underplating. That has not happened and it is likely that a similar explanation will apply to other ocean margin basins.

2.07 COMBO - the Core-Mantle Boundary Project

A.W.B. Jacob with J. Neuberg (University of Leeds) and staff of Karlsruhe, Potsdam, Hamburg and Lisbon

The proposal, originated and co-ordinated by A.W.B. Jacob, was successful and has been funded by the EC. The idea grew from some work done nearly twenty years ago. It was shown at that time that effective teleseismic signals could be generated with very small sources but it is only recently that a sufficient number of suitable seismic stations have become available. The intention is to use both observatory stations and specially deployed stations to study the earth's core-mantle boundary in more detail than has been possible before. Extra control is provided by knowing the source wavelet, its exact

position and time. The relatively uniform radiation pattern should also assist interpretation. Earthquakes are typically very non-uniform sources. A planning visit was made to the University of Lisbon and the possibility of firing on the shelf west of Portugal was explored. It is intended to observe refracted P waves, PcP waves (reflections from the core-mantle boundary), PdP waves (wide-angle reflections from the D" layer just above the core-mantle boundary) and, possibly, antipodal waves which have gone through the core and been recorded on the opposite side of the earth. These last may be observed in New Zealand. The experimental work is planned for 1994.

2.08 EUROPROBE - Major Geoscience Projects in Europe

A.W.B. Jacob

A.W.B. Jacob attended two European Science Foundation EUROPROBE Workshops during the year. At the first, in Bad Herrenalb, Germany he gave an invited lecture on COMBO. The second, in Zaborow, near Warsaw, was a continuation of the Workshop, mainly concerned with the Tornquist Zone, which took place in Denmark the previous year. New data were available and the interpretations were taken to a point where it is proposed to publish a book on the outcome. The comparative studies should be helpful to researchers working in this area. The sharpness of the structural transition at the zone makes it an interesting but relatively difficult region in which to work.

2.09 Detailed Study of Deep Reflecting Horizons

F. Murphy and A.W.B. Jacob

A project was started to study the nature of deep reflecting horizons, in particular the Moho. Its reflectivity is very variable with, surprisingly, the lower frequency signals producing more variable results.

2.10 Long-range Transmission of Airgun Signals

T.A. Blake and A.W.B. Jacob

A trial was run with repeated pulses from a large (60 litre) airgun north of Scotland in July.

The repeatability of the source may allow us to study very deep structures without the necessity for large explosive sources.

2.11 Westline - Reflection Profiling West of Ireland

P.W. Readman and F. Hauser with the Cambridge BIRPS group

BIRPS (the British Institutions reflection profiling syndicate) shot a deep penetration seismic reflection line offshore west of Ireland across the Continental - Rockall trough margin. It had been planned to use these large airgun-array shots as a source for a wide-angle reflection/refraction study along a profile across Connemara and into Co. Clare to link with our ICSSP profile. Unfortunately a combination of bad weather and operational difficulties at sea, which resulted in the shot timings not being guaranteed to sufficient accuracy, prevented the completion of the study as originally planned and instead the work was confined to one field group operating an array of 15 stations in the region of Lough Inagh in Connemara. The array consisted of a 10 km profile, together with a short 2 km transverse line. From this it is hoped to be able to obtain details of the structure of the continental shelf, and using the data from the short line transverse to the length of the profile it is planned to investigate the possibility of stacking the data from the instruments along the line in order to enhance the weak signal from the more distant sources.

2.12 General Overseas Projects

T.A. Blake, G. Byrne, C. Horan, F. Murphy, B.M. O'Reilly and P.W. Readman

As preparation for work in Kenya in 1994 and to familiarise staff with new Reftec equipment to be used there, Geophysics Section staff worked on two projects in California. The first was the Mendocino Triple Junction project in northern California in August (TAB and CH) and the second was a project to study the roots of the Sierra Nevada in southeastern California -- the Southern Sierra Nevada Continental Dynamics Study (GB, FM and PWR). Both projects were on a scale not seen elsewhere in the world. For these north American projects the Canadian and American groups joined forces to

deploy up to 700 stations at very close spacing. With closely spaced shotpoints also, the result is very dense coverage and very detailed mapping of the lithosphere. It is worth noting that such coverage can sometimes be obtained offshore. The RAPIDS project is an outstanding example of this, with even more seismograms than were obtained in the American experiments. It was very useful experience for five members of our group.

B.M. O'Reilly was invited to visit the US Geological Survey, Menlo Park and went there for six weeks from the beginning of November. He carried out a comparative study, with W. Mooney, on the Basin and Range Province and the North Atlantic Province. These are both important extensional features. He also had discussions on anisotropy in the lower crust with W. Rabbel.

3 Research Activities in the Cosmic Ray Section

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

A. Thompson, D. O'Sullivan, J. Bosch, R. Keegan (to 31 March) and A. Keane (from 1 October) with K.-P. Wenzel (ESTEC) and F. Jansen (ESTEC).

The entire collecting area of the track detector array has now been scanned and it is clear that the sample of ultra heavy nuclei which has been collected is more than a factor of fifteen times larger than the present world data (for $Z > 73$), taken to be the combined events from the HEAO-3 and Ariel -6 experiments. However, data extraction for the bulk of the events in this collected sample remains a formidable task.

Ultra heavy cosmic ray events from about 20% of the total detector array have already been fully measured. The initial charge assignments are based on the assumption that the calibration parameters remain constant over the charge and energy region at the relevant temperature. The charge spectrum features a pronounced platinum ($Z=78$) peak, an actinide gap and a group of actinides with a thorium peak ($Z=90$). Although these results are provisional, the location of the actinide gap in the spectrum indicates that systematic error is not a major problem.

Statistical errors derived from the fitting procedures are about $\pm 0.6e$. Combining these with the errors arising from LDEF temperature cycles give charge spreads of about $\pm 0.9e$. On the basis of the sub-sample measured to date, it has been possible to produce, ahead of schedule, a preliminary value for the actinide ratio, defined as $(Z > 87)/(73 < Z < 88)$. Although statistics are still relatively small, this ratio (0.031 ± 0.009) is significantly higher than that from either present or primordial solar system abundances adjusted by first ionisation potential and propagated through an exponential path length distribution with a mean path length of 5.5 g/cm^2 . This suggests r-process enhancement at the source.

Finally it should be emphasised that progress during the year has been excellent, the project is on schedule and preliminary results have been published. In that context it may be noted that the UHCRE work was selected at the 23rd International Cosmic Ray Conference (Calgary) in July for a special Highlight Session presenting particularly interesting new results to a wider audience.

3.02 The Giotto Extended Mission (GEM) to Comet Grigg-Skjellerup

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

In situ measurements made by the Energetic Particle Analyser (EPA) during the Giotto Encounter with Comet-Grigg-Skjellerup were analysed during the year. Charged particles with energies greater than 260 keV were detected within the bowshock and also upstream and downstream of the bowshock. The observations indicate that, in addition to the pickup process further acceleration took place. An energy spectrum was derived providing species separation between protons and water group ions. It was concluded that second order fermi acceleration was most likely responsible for the higher energies (beyond the pickup limit). Ion cyclotron waves of approximately one minute period length were detected throughout the encounter although their amplitude appeared to be damped in the magnetic pileup region.

EPA sector particle measurements were used in conjunction with magnetic field measurements (from the Giotto magnetometer, MAG) to independently derive the encounter geometry, qualitatively, as East of the nucleus, tailward of the maximum ion flux.

3.03 The Energetic Particle Analyser (EPA) on the Giotto Mission to Comet Halley

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

An earlier hypothesis that, in some cases, charged microdust particles contributed to EPA energetic ion count rates during the encounter with Comet Halley has been studied further. An average charge of 38e was derived for dust particles in the mass range 10^{-17} g to 10^{-20} g. Magnetic rigidity calculations reveal that multiply charged dust particles at MeV energies would be confined to the magnetic cavity whereas singly charged ions of a few hundred keV would penetrate to the magnetic pileup region. Indications were found that a fast field reconnection process at the front side of the Halley pileup region accelerated particles to the higher observed energies. This is supported by the electric field measurements of Vega-1 and Vega-2. The EPA measurements have thus in effect extended the mass range of the Giotto dust detectors down by four orders of magnitude from their lower limit of 10^{-16} g.

3.04 The Solar Low Energy Detector (SLED) on the Phobos-2 Mission to Mars

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

Analysis of energetic charged particle flux measurement by the SLED instrument in the environment of Mars continued with emphasis on the approach phases of the spacecraft to the Martian moon Phobos. During circular orbits of Mars the spacecraft closed within a few hundred kilometres of Phobos on the tailward side every seven days approximately, while during synchronous orbits the spacecraft remained 200 to 300 km in front of Phobos. SLED observations were correlated with measurements of solar wind protons by the TAUS experiment and magnetic fields by the MAGMA instrument.

Significant flux enhancements (spikes) were recorded by SLED in the Phobos tail slightly inside the Martian bowshock. Similar spikes were observed in front of Phobos, again at the Martian bowshock. It is concluded that protons and oxygen ions escaping as neutral water molecules from Phobos are accelerated by the pickup process in the prevailing solar wind. However, further acceleration is necessary to explain the spikes and it is suggested that the probable mechanism is the shock drift process (and/or the Fermi process) since the

interplanetary magnetic field forms quasiperpendicular and quasiparallel shocks with the Martian bowshock.

3.05 Nuclear Track Detector Response Studies

A. Thompson and J. Bosch

Several exposures of polycarbonate detector stacks to a new 11.1 GeV/u gold beam at Brookhaven National Laboratory (New York State) were carried out during September. This Brookhaven beam represented the highest energy accelerator produced ultra heavy ions available to date. The objectives of the exposures include determination of the short range temperature dependence (from -20 to +20 degrees C) and isotropy of track response.

During the year the dependence of both the bulk etch rate and the reduced track etch rate (for relativistic ultra heavy ions) on the concentration of polycarbonate etched products were studied. Amongst other results it was found that onset of the bulk etch rate plateau did not coincide with the solubility saturation limit, as previously believed. In another study variation with energy and nuclear charge of the two detector related parameters (for a given energy transfer limit) in the restricted energy loss model for track response in polycarbonate were investigated. Within experimental errors the parameters were found to be constant for energies above 500 MeV/u and for charges within 10e of the platinum-lead group.

Apart from its intrinsic value all of the above work is relevant to optimisation of charge spectrum resolution in the DIAS/ESTEC Ultra Heavy Cosmic Ray Experiment.

3.06 Ionising Radiation Measurements at Aircraft Altitudes (IRMA)

D. O'Sullivan and J. Byrne

The investigation of cosmic rays and their secondaries at aircraft altitudes progressed steadily throughout the year. Negotiations with Aer Lingus resulted in permission to install DIAS detectors on a Boeing 747 and exposures were commenced in May. Following contacts with senior civil servants and officials in charge of the Government Lear Jet, detectors were also placed on that aircraft in May. With the assistance of senior officials in transport and aviation in Ireland and the UK, agreement was

reached with British Airways to install detectors on Concorde aircraft for the study of cosmic ray particles with nuclear charge greater than (or equal to) two and their secondaries. The detectors were placed on the aircraft in October and exposures started in November. With the assistance of L. Tommasino of the Rome group an exposure on Al Italia aircraft was arranged in December. All of the above exposures are scheduled for periods of seven months or less and the first examination of the detectors will take place in 1994.

Arrangements were made to expose detectors on a balloon flight launched in Canada in August and recovered at Slave Lake following a fifty hour flight at an altitude of approximately 40,000 m. Detectors provided by the Rome group were included with DIAS detectors in order to test some new ideas on particle investigations appropriate to the present project. The facilities were provided free of charge by the US National Scientific Balloon Facility at Palestine, Texas.

Preliminary analysis of calibration exposures undertaken at Berkeley in December 1992 and investigation of the balloon flight data were completed by the end of the year.

3.07 Cosmic Ray Propagation Studies

L. Drury with P. Kiraly (RMKI, Budapest)

Most work on cosmic ray propagation in the Galaxy ignores the effect of re-acceleration during propagation, and those investigations which do consider the effect usually treat it in an over-simplified form. Under an East/West mobility scheme sponsored by the Commission of the European Communities, L. Drury spent ten weeks in Hungary as a guest of the RMKI division of the Central Research Institute for Physics, Budapest, working on improved propagation calculations including more correct models of re-acceleration. Such studies are important because observed cosmic ray spectra and composition measurements have to be corrected for propagation effects before theories of cosmic ray origin can be tested.

3.08 Secular Evolution of Shock Structures and Adaptive Grids

K. Farrell and L. Drury with J. Carroll (DCU)

Numerical experimentation during the year resulted in a promising explicit adaptive grid algorithm for this project. This is currently being

incorporated into a semi-implicit hydrodynamical scheme to investigate long-term evolution of shocks modified by particle acceleration.

3.09 Shocks in Weakly Ionized Molecular Hydrogen

I. O'Brien and L. Drury with A. Moorhouse (Arcetri Observatory, Florence)

This project examines the influence of non-equilibrium excitation of hydrogen in C-type shocks and its possible influence on the shock structure. Techniques were developed to convert the thermally averaged cross-sections usually quoted in the literature to cross-sections as a function of collision velocity. Unfortunately it appears that many cross-sections required for this project are not yet available although they should be available within the next few years. It is intended to proceed with indicative calculations to determine what range of cross-sections produce significant effects.

3.10 Supernova Explosions into a Precursor Wind Bubble

L. Drury and B. McKernan

Most theoretical models of supernova explosions assume that the explosion occurs in a homogeneous undisturbed medium. While this has the advantage of simplicity, and may be a reasonable approximation in the case of type I supernovae, it is clearly inappropriate for type II supernovae where the surrounding interstellar medium is expected to have been significantly disturbed by the strong wind of the precursor star. An attempt was made to estimate the significance of this for particle acceleration by modifying the "simplified models" developed a few years ago to allow for the effects of a precursor wind bubble.

3.11 Simulations of Young Stellar Object Jets

T. Downes, T. Ray and L. Drury

Although it is clear that the emission from young stellar object (YSO) jets derives from shocks, the origin of these shocks is poorly understood. A supercomputer project has therefore begun to simulate outflows from young stars using more realistic cooling schemes than

have previously been employed. It is hoped in this way to get deeper physical insight into the formation of various features within jets and their associated bow shocks.

3.12 Protoplanetary Disks Around Herbig Ae/Be Stars

M. Corcoran and T. Ray

At present there is considerable controversy as to whether disks surround Herbig Ae/Be stars with some astronomers considering Herbig Ae/Be stars the higher mass analogues of the classical T Tauri stars, and thus surrounded by disks, while others view them as young stars shrouded in spherical halos of dust. Evidence has been found that a substantial fraction of Herbig Ae/Be stars are undergoing accretion as indicated by the observation that many of the absorption lines in these stars are filled-in, an effect known as "veiling". Moreover, in a number of cases there is an observed blue-shifted asymmetry in the forbidden emission lines consistent with obscuration by a disk.

3.13 Infrared Emission from YSO Outflows

T. Ray and J. Eisloffel with R. Mundt (MPIA, Heidelberg) and C. Davis (MPIA, Heidelberg)

Several outflows from young stars in the near-infrared have been studied using the new IRAC2 camera on the ESO/MPI 2.2m telescope in La Silla, Chile. Widespread shocked molecular hydrogen emission was found in several well-known outflows including HH1/2 and HH46/47. The derived fluxes and extent of the emission show that the molecular outflow, from HH46/47 at least, is entrained ambient gas powered by the optical outflow. Most of the emission in both HH1/2 and HH46/47 is consistent with it forming at the edge of a bow shock where the shock velocities are lowest. However, molecular hydrogen emission was also found to be associated with the internal "jet" shock or Mach disk. This discovery is more difficult to understand, and suggests that the YSO jet itself contains a substantial fraction of molecular material. By combining the results of the near-infrared molecular hydrogen emission and the proper motion measurements of the optical atomic lines, it was possible for the first time to calculate the shock velocities of the hydrogen gas directly from observation. Shock speeds of about 30-40 km/s were found, in

excellent agreement with recent model calculations.

3.14 Asymmetries in Jets from Classical T Tauri Stars

T. Ray with G. Hirth (MPIA), R. Mundt (MPIA) and J. Solf (MPIA)

A number of new jets from the classical T Tauri stars RW Tau, DO Tau and DP Tau have been discovered in a survey of the nearby Taurus-Auriga dark cloud. What is remarkable about these outflows is that the velocities of the blue-shifted and red-shifted flows from these stars differ by factors of 1.5-2.5. It is possible that the immediate environment of the star is responsible for the observed asymmetries.

3.15 Outflows from Herbig Ae/Be Stars

T. Ray and J. Eisloffel

A search for optical outflows from southern Herbig Ae/Be stars was conducted. Very few outflows from these intermediate-mass stars have been found so far, in contrast to their low-mass counterparts, the classical T Tauri stars. However, at least three new outflows were discovered in the vicinity of the Herbig Ae/Be star ν BH65B, as well as additional HH objects associated with the Herbig Ae/Be stars RCrA and TCrA.

3.16 The Infrared Space Observatory (ISO)

T. Ray, L. Drury and S. Russell

The guaranteed time proposals within the Central Programme have now been "finalised". Because of the large overheads for target acquisition and unforeseen increases in the "warming up" times for the ISO photometer (ISOPHOT) detectors, the number of targets has had to be drastically curtailed.

3.17 Star Formation

S. Russell

The ground based preparatory programme for the Infrared Space Observatory (ISO) has continued during the year. A C{18}O survey was carried out with SEST (the Swedish-ESO Submillimetre Telescope) on targets intended for

observation with ISO. Most of these targets were detected. Similarly, a VLA (very large array) survey at 3.6 cm was carried out on cold ISO targets and again there were many detections. With these results and the results of other ground based observation projects in progress around the world, used in conjunction with expected data from ISO, it is hoped that the initial stages of star formation will be unambiguously identified.

3.18 Abundance Studies

S. Russell

A number of Delta Scuti stars were observed last year with the JKT (Jacobus Kapteyn Telescope) in La Palma. These stars were thought to be candidates for explaining the lithium dip in evolved F5 dwarfs. Analysis of the results has revealed that most of these stars could not possibly lose enough mass to transform to lithium-dip stars during their lifetimes. Indeed, the higher temperature stars seem to be enriched in lithium over normal main-sequence stars. However, a small number of stars do show signs of being significantly depleted in lithium, and these occur especially in the lower temperature stars.

In January, observations on the WHT (William Herschel Telescope) in La Palma were made to observe elemental abundances in RV Tau variables in Galactic globular clusters. RV Tau variables in the field are observed to have s-process depletions similar to those seen in extreme halo red giants, but their metallicities are normal. In this project stars were selected from globular clusters so that coeval populations could be studied. If the RV Tau variables have similar metallicities to nearby red giants, but reduced s-process abundances, then it may be that their atmospheres have been over-ionised by shockwaves. If the RV tau variables appear to have reduced metallicities in the globular clusters, then it is probable that they have lost much of their hydrogen envelope. Analysis is underway.

In November, observations on the AAT (Anglo-Australian Telescope) were made of AGB stars in the Magellanic Clouds, to determine their lithium abundances. Previous work revealed that the more massive AGB stars have greatly enhanced lithium in their atmospheres, while less massive AGB stars do not. This project was intended to define more precisely the lower mass bound for this lithium enhancement to occur. It will then be possible to constrain the models of stellar structure necessary to account for this, to a

much higher accuracy. The project was highly successful, and data analysis is being carried out.

4 Research Activities in the Astronomy Section

4.01 Solar Spectroscopy

I.G. van Breda with G. Worrall (Open University)

Although microturbulence has been used in curve-of-growth analysis of chemical abundances in stellar atmospheres since the thirties, no convincing physical mechanism has been proposed to explain its origins. The Sun provides an ideal test bed for studying this phenomenon, since spectroscopy can be carried out at different positions on the disc, allowing certain model-independent studies to be made. This project uses high-resolution spectra, particularly of the NaD and MgB multiplets, obtained with the Fourier Transform Spectrometer (FTS) on the McMath telescope at Kitt Peak at selected positions across the solar disk. The FTS is ideal for this application, since not only can it be used at resolutions approaching one million, it also has a very clean, scatter-free instrumental profile. The observations extend a much more limited photoelectric set made using a two-pass grating spectrometer in the sixties by Waddell.

At around 6×10^5 points over a wavelength range of 1200 Å, for each of 25 spectra, calibration of the data has presented something of a challenge. The wavelength scale for each spectrum has been calibrated against the solar iron lines to better than 2 mÅ, most of the residual error being due to the limitations in the laboratory wavelengths. To achieve this, it has been necessary to take into account a residual non-linearity amounting to around 10 mÅ caused by the presence of a redispersing/recombining monochromator at the input of the spectrometer, which is used to limit the wavelength range of the observation.

Comparison between profiles of the Doppler cores of the lines in the same multiplet at selected positions on the disk (line statistical weights inversely proportional to μ -value) show very accurate matches at the one percent level in intensity. This implies that the source functions of lines in the same multiplet are the same at the same depth and are independent of angle, but does not imply they are independent of

wavelength. Likewise the Doppler width of the lines is not significantly dependent on angle. This is contrary to analyses that include microturbulence and require significant anisotropy (1-2 km/s), increasing towards the limb.

Although every effort was made to average out the effect of solar oscillations on the spectra, firstly by using a sufficiently large slit and also by taking each observation over the period of half an hour, residual wavelength shifts and line asymmetries remain up to around 10 mÅ (500 m/s). This agrees with similar unexplained shifts, probably due to mass motions, found in previous attempts to identify the gravitational redshift in the solar spectrum. There are also residual variations in intensity at the one or two percent level. While every effort was made to avoid active regions on the solar surface, the Sun was very active at the time of observation and it is possible that chromospheric activity may have caused some of the observed variations.

4.02 Image Sharpening Techniques

B.D. Jordan, C. O'Byrne, M. Smyth and I.G. van Breda with UCG, RAL and SAAO

Collaboration has continued throughout the year with University College Galway and the Rutherford Appleton Laboratory on the TRIFFID image sharpening system. A number of additional features were added to the processing electronics which will simplify operation of the instrument during an observing run. Firstly, a rate meter with six digit display to monitor the frequency of detected photon events and processed photon events was constructed. This monitor gives an indication of overall system performance. The detected photon events monitor can also trigger a control circuit to switch off the EHT supply voltage to the detectors in the event of accidental exposure to a bright light source. Secondly, the digital signal processing electronics rack was rewired to eliminate ground loop problems. Thirdly, all of TRIFFID's filter wheels, aperture wheels, polariser, etc were fitted with improved stepper motors and a new computer controlled system for controlling up to eight stepper motors, two iris diaphragm shutters and a Hartmann shutter were provided. Fourthly, a 16-bit precision digital-analog converter to calibrate the high speed analog-digital converters was constructed and incorporated into the TRIFFID electronics system as a diagnostic facility. Software routines were written to monitor the analog-digital converters

for linearity and monotonicity. Finally, a copy of the digital signal processing electronics comprising four 12-bit analog-digital converters, peak detector and Transputer based interface to a PC type computer was built for the Rutherford Appleton Laboratory under contract from SERC, UK.

Approval was given for the construction of a CCD camera in collaboration with RAL and SAAO. In this regard a T800 Transputer Forth system was purchased. Further orders for a CCD chip from EEV-UK and optical components for a resolution pattern projector were halted because of lack of funds. The projector is intended for use for performance evaluation of both CCD and photon counting detectors in the laboratory.

The T800 Forth, which runs on a host PC, was installed successfully, although some recompilation was necessary, since the Dunsink system uses an Inmos B004 Transputer board in place of the B008 for which the T800 Forth is configured. This system will provide a much more interactive laboratory environment than the traditional Occam used with Transputers for development of both photon counting and CCD detectors, as well as Transputer-based control systems.

5 Facilities

5.1 Computers

5.1.1 Merrion Square

T. Blake, W.M. Tai and L. Drury

At the beginning of the year, DIAS joined the Internet via IEunet Ltd. During the summer, a 64k leased line between TCD and 5 Merrion Square was installed along with a CISCO router, providing a faster Internet access. The X400 mail handling service also went into operation during the summer (part funded by the CEC VALUE programme). An X25 switching gateway was installed from ESA (Frascati), as part of the ESA Data Distribution Network.

The Cosmic Ray Section purchased several Tektronix X-terminals during the year to provide additional astronomical image display capacity. A 2.2 GB hard disk and a CD-ROM were purchased to replace the damaged 1.2 GB hard disk and the Sun CD-ROM respectively. A Sparc II and a Sparc 1+ were purchased to provide additional astronomical data reduction facilities. Two vacation students D. Jordan and L. Hurst

were employed during the summer for porting system and imaging utilities. The various standard packages (MIDAS, IRAF, TeX etc) were maintained and supplemented.

In the Geophysics Section the software product Lansmart was installed on the PC network to aid the interchange of data between PC users and to make remote disks and peripherals on the PC network accessible to all users. Grafplus continued to be used as the plot programme on PCs to produce hardcopy for seismic events recorded on the VME system (triggered short-period seismic network). The script files for the automatic download of seismic data were modified to allow automatic transfer of the data files from the PC to the Sun multiuser system as soon as the data transfer had been completed. The DOS operating system on the PC network was raised from Version 3.0 minimum to Version 5.0 and to Windows Version 3.1 A postscript version of Chiwriter (CHIPS) was installed. There has been a continuing search for good digitised world maps and associated software. The Livermore Labs SAC and MAPS software has been selected and is promising though still under development. Notification of seismic events by telex is being replaced by e-mail. Hardware acquisitions during the year included a Toshiba 486 Laptop with network connection and a modem. Disk storage on the network was increased by a further 2.4 GB. Some PC motherboards were replaced and upgraded to Intel 386 types at 40 MHz.

5.1.2 Dunsink Observatory

I. Elliott, B. Jordan and W.M. Tai

Apart from the addition of a 130 MB hard disk to one of the Tandon PC systems, the only major change was the installation of a PC as a dedicated router for the Dunsink ethernet LAN. This has resulted in a considerable improvement in reliability.

5.2 Geophysics Instruments

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

Major installation work took place at the new broad-band station at DSB. The short-period remote telemetry station at Muff (northwest of Kingscourt) had to be moved as the property was sold and the new owner wished to clear the site. Initially the station was moved to a position about 500 m away but this is unlikely to be a

long-term solution as very large radio masts nearby make it a noisy site. Mains electricity is available there but it is likely that solar panels and a more remote position will turn out to be the best solution.

5.3 Track Laboratories

A. Thompson and D. O'Sullivan with J. Daly

The three main track detector etching tanks (150 litre capacity each) and associated equipment were maintained in continuous operation and repaired as necessary during the year. New or reconditioned sub-systems or components included a thyristor control unit, a contact-thermometer unit, motor bearings, detector frames, a ceramic heating unit, and a multi-channel temperature recording system. In addition, a new small track detector etching tank (10 litre capacity) was commissioned. The six Leitz-ASL Track Measuring Stations along with the Nikon stereo scanning microscopes were also maintained and repaired. Upgrading work included the fitting of a new ASL displacement transducer, optical condenser modifications and reconditioned objective turrets. A new Nikon Optiphot track measuring microscope fitted with Heidenhain linear displacement transducer equipment was installed.

During the summer all track measuring and scanning equipment was removed from three of the track laboratories in turn, to allow for extensive renovation and refurbishment. This work was completed with all equipment replaced and fully operational by the end of July.

5.4 La Palma Observatory

T.P. Ray (Secretary)

5.4.1 General

The composition of the La Palma Advisory Committee during 1993 was T.P. Ray (Secretary), R.M. Redfern (UCG, Royal Irish Academy Representative), M. de Groot (Armagh Observatory), L. O'C. Drury (DIAS Representative), B. O'Donnell (EOLAS) and P.K. Carroll (UCD). T.P. Ray served on the Isaac Newton Group Time Allocation Committee which met twice during the year in June and December in Warwickshire and Nottingham respectively.

Ireland continues to enjoy accessibility to first class telescopes not only on La Palma but in

locations such as Chile and Australia. Allocations of time on other (i.e. non Science and Engineering research Council) telescopes are included below. Recognising the importance of access by Ireland to the La Palma Observatory, EOLAS, as in previous years, provided financial support for the project in addition to DIAS funding.

5.4.2 Observing Runs 1993

- J. Eisloffel (DIAS), T. Ray (DIAS), C. Davis (MPIA) and R. Mundt (MPIA): MPI/ESO 2.2 m Telescope, Chile, two weeks. Using the new infrared camera, IRAC2, in April on La Silla, Eisloffel observed molecular hydrogen emission at 2.12 microns in outflows from young stars. The data obtained showed a wealth of interesting details and allowed new insights into the internal shock structure of the outflows. A search for optical outflows from southern Herbig Ae/Be stars was also carried out successfully.
- B. McBreen (UCD), M. Rabbette (UCD) and N. Smith (Cork RTC): J/X/19 "Search for Rapid Variability in a Sample of Quasars at Redshifts around 1", JKT, seven nights. Broad band photometry of a number of quasars was carried out to check for short timescale variability. Out of the total of seven nights, four were good and three suffered from adverse weather conditions. The observations were made by Maura Rabbette.
- T. Ray (DIAS) and M. Corcoran (DIAS): W/X/48 "Relating Disks and Outflows from Herbig Ae/Be Stars", INT, seven nights. All seven nights of this run were clear and only one or two hours were lost due to minor problems. From these observations it appears that "veiling", i.e. filling-in, of photospheric absorption lines is important in a number of Herbig Ae/Be stars. This is indicative of accretion and supports the idea that at least some Herbig Ae/Be stars are surrounded by disks. Many of these stars appear to have been spectrally mis-classified leading to incorrect estimates of their extinction and hence luminosity.
- T. Ray (DIAS), G. Hirth (MPIA) and R. Mundt (MPIA): (W/Y/76) "Spatial and Kinematic Properties of YSOs", WHT, four bright nights. This was a very successful run which was actually spread over six nights in conjunction with commissioning time for ISIS polarimetry. It now seems clear from the observations carried out on the WHT, and earlier ones made at the Calar Alto Observatory, that the high velocity forbidden line emission in T Tauri stars is actually due to small-scale (less than 1") jets.
- M. Redfern (UCG) and A. Shearer (UCG): (LTJ/W/18) "Experiments on High Angular Resolution Imaging for Adaptive Optics and Post-Detection Processing", JKT, four nights. This project, in collaboration with C. Dainty of Imperial College London, aimed to measure atmospheric turbulence induced wavefront distortion using an 11x11 element Shack-Hartman sensor. Successful observations were made in June of simple and extended objects. Observations of the latter were important for future developments of the UCG-DIAS image sharpening camera TRIFFID. This batch of data is also being used to establish input parameters for a simple adaptive optics system for the JKT.
- S. Russell (DIAS): (A/Y/7) "Li Enhancement in AGB Stars in the Magellanic Clouds", AAT, three bright nights. The observing programme was carried out successfully, with both first and second priority objects being observed. Preliminary reductions indicated the results will be of major interest.
- S. Russell (DIAS): (W/X/14) "Abundances of RV Tau Variables in Globular Clusters M2 and M56", WHT, three bright nights. All three nights of this run were clear with excellent seeing. The aim of the programme was to observe, at high spectral resolution, RV Tau variables and red giants in two globular clusters. The instrument worked well, with no sign of the pointing jitter that beset Russell's previous run. Excellent data were obtained.

6 Seminars, Colloquia, Lectures

6.1 Statutory Public Lecture

L. O'C. Drury delivered the Annual Statutory Public Lecture for the School of Cosmic Physics. The lecture was entitled "Gamma Ray Astronomy" and took place at University College Dublin, on 14 October.

6.2 Seminars in the School

- W. Mooney (US Geological Survey, Menlo Park): "Geophysical Studies of the Crust and Lithosphere in North America - Results and Comparisons with the European Geotraverse", 1 June .
- W. Mooney (US Geological Survey, Menlo Park): "Evolution of the Earth's Lithosphere - Archean to Present", 3 June .
- J. Luetgert (US Geological Survey, Menlo Park): "Seismic Ray Tracing", 5 October .
- T. Lago (Centro de Astrofisica, University of Porto): "The Growth of Basic Science in Portugal - An Astronomical Perspective", 7 October.
- A.W.B Jacob: "The COMBO Project", Review talk to the EMSRIP meeting at EGS, Wiesbaden, 5 May; "The COMBO Project and its Relevance for EUROPROBE", Invited Lecture to the EUROPROBE Study Centre on Deep Europe at Bad Herrenalb, Germany, 19 July.
- B.M O'Reilly: "Evolution of the Upper Mantle Beneath Stretched Continental Crust - an Example from the Rockall Trough", at AGU Fall Meeting in San Francisco, 6-10 December.
- D. O'Sullivan: Highlight Talk on ultra heavy cosmic ray nuclei at the XXIII ICRC, Calgary, 19-30 July; Contributed talk on the recent results from the Dublin-ESTEC experiment on LDEF, XXIII ICRC, Calgary, 19-30 July; Contributed paper on the DIAS-ESTEC LDEF data, 3rd LDEF Post- Retrieval Symposium, Williamsburg, 8-12 November.

6.3 Contributions to Scientific Meetings

- T. A. Blake: "The 1993 Mendocino Triple Junction Seismic Experiment - Overview", at AGU Fall Meeting in San Francisco, 6-10 December.
- M. Corcoran: "Spectroscopic Evidence for Disks Around Herbig Ae/Be Stars", at The Nature and Evolutionary Status of Herbig Ae/Be Stars, Amsterdam, 25-31 October.
- L.O'C. Drury: "Ian Axford and the Origin of Cosmic Rays", MPAA colloquium in honour of Ian Axford's 60th birthday, 30 April; "Acceleration and Transport Theory", Rapporteur Talk at the XXIII ICRC, Calgary, 19-30 July; "Shock Acceleration of Energetic Particles", RMKI colloquium, Budapest, 9 September.
- J. Eisloffel: "Proper Motion Measurements in the HH46/47 Outflow", at Kinematics and Dynamics of Diffuse Astrophysical Media, Manchester, 25-31 March; "Proper Motions in Herbig-Haro Objects", at the Bohm Conference, University of Seattle, Washington State, September; "A Search for Herbig-Haro Objects Near Southern Herbig Ae/Be stars", Invited Review Talk at The Nature and Evolutionary Status of Herbig Ae/Be Stars, Amsterdam, 25-31 October.
- F. Hauser: "The Crustal Structure of the Rockall Trough - Differential Stretching Without Underplating", at AGU Fall Meeting in San Francisco, 6-10 December.
- T.P Ray: "The Circumstellar Environments of Herbig Ae/Be Stars", Invited Review Talk at Kinematics and Dynamics of Diffuse Astrophysical Media, Manchester, 21-25 March; "Near-infrared Observations of the HH46/47 Outflow", Autumn ASGI Meeting, Armagh, 24 September; "Optical Outflows from High Luminosity Young Stars", Invited Review with R. Mundt at The Nature and Evolutionary Status of Herbig Ae/Be Stars, Amsterdam, 25-31 October.
- P.W. Readman: "Southern Sierra Nevada Continental Dynamics Project - 1993 Field Observations and Interpretations", at AGU Fall Meeting in San Francisco, 6-10 December.
- S.C. Russell: "Preliminary Results from a mm-continuum Survey for the Youngest Protostars", Poster Paper at the XXVIIIth Rencontres de Moriond, XIIIth Moriond Astrophysics Meeting - The Cold Universe, Les Arcs, 13-20 March.

6.4 Lecture Courses

- L.O'C. Drury: Lecture course on Topics in Astrophysics at the TCD Department of Mathematics.
- I. Elliott: Course of sixteen lectures on Introductory Astrophysics at Junior Sophister

level to physics students in TCD during the Hilary and Michaelmas Terms; Course of ten lectures entitled "An Introduction to the Solar System" in the UCD Adult Education programme during the Autumn Term.

- D. O'Sullivan: Course of eight lectures on Cosmic Ray Astrophysics to Third Year physics students at TCD during the Hilary Term.
- T.P. Ray: Course of ten lectures on Plasma Astrophysics to Fourth Year students in TCD during Michaelmas Term.
- S.C. Russell: Adult Education course of ten lectures at UCD entitled "Birth Life and Death in the Universe".

6.5 External Seminars

- L.O'C. Drury presented a colloquium entitled "Gamma-ray Observations of Supernova Remnants" at Konkoly Observatory, Budapest on 2 September.
- A.W.B. Jacob delivered an invited lecture on the "Evolution of the Continental Margins west of Ireland" to the Irish Geological Association meeting in Trinity College, Dublin on 13 October and a talk on Super-Deep Seismic Profiling at the EUROPROBE Workshop in Zaborow, Poland, on 23 November.
- B.M. O'Reilly gave a talk entitled "The Development of the North Atlantic Region - New Insights from Wide-angle Seismic Studies" to the US Geological Survey Marine Geophysics Group in Los Altos, California, on 16 November.
- D. O'Sullivan gave a colloquium on cosmic rays at the TCD Physics Department in March and a talk entitled "Space Physics - a View from Dublin" at the Marshall Space Flight Centre, Alabama, in November.
- S.C. Russell delivered a lecture entitled "The Origin of the Elements" at UCD in May.

6.6 Popular Lectures

- I. Elliott lectured on the Junior Cycle Environment Course to H.Dip.Ed. students in the UCD Educational Department on 1

February, presented an interval talk about "Gemini" which was broadcast by RTE FM2 on 28 April and contributed to four broadcasts in the RTE Radio 1 series "Light Years Ahead" presented by Derek Mooney.

- S.C. Russell presented a talk on "Extraterrestrial Intelligences" to a meeting of Astronomy Ireland on 12 July.

7 Organisation of Meetings

7.1 IAU Colloquium 136, Stellar Photometry - Current Techniques and Future Developments

I. Elliott with C.J. Butler

The Colloquium Proceedings, in two volumes, were edited and published. The main volume, "Stellar Photometry - Current Techniques and Future Developments (Eds. C.J. Butler and I. Elliott)", was dispatched to Cambridge University Press at the end of February and appeared in print in August, just a year after the Colloquium took place. The second volume, "Poster Papers on Stellar Photometry (Eds. I. Elliott and C.J. Butler)", was printed in Dublin by Paceprint and was published by DIAS in September.

7.2 COSPAR, 30th Scientific Assembly, Hamburg.

D. O'Sullivan.

The Committee on Space Research (COSPAR) invited D.O'Sullivan to be the main organiser for a meeting on ultra heavy cosmic ray nuclei to be held on 13 July, 1994, as part of the COSPAR 30th Scientific Assembly in Hamburg. The programme has been finalised and abstracts have been received from all contributors. Funding has also been raised to assist delegates from the former USSR and those from developing countries.

7.3 Disks and Outflows Around Young Stars, Heidelberg

T. Ray

A conference honouring Hans Elsasser (Disks and Outflows Around Young Stars) is planned

for 6-9 September 1994. The initial work of the Scientific Organising Committee (of which T.Ray is a member) was carried out during the year.

8. External Work

8.1 Geophysics Section

- T.A. Blake: EGS General Assembly, Wiesbaden, 1-7 May; Mendocino Triple Junction Experiment, California, 11 August - 7 September.
- K. Bolster: BGS, Edinburgh, 24 - 29 March.
- G. Byrne: Sierra Nevada Continental Dynamics Project, California, 8-27 September.
- F. Hauser: RAPIDS visit to Hamburg & EGS General Assembly at Wiesbaden, 21 April - 8 May; BIRPS Annual Review Meeting at Imperial College, London, 21-22 September; RAPIDS visit to Hamburg, 17-24 October; AGU Fall Meeting, San Francisco, 4-12 December.
- C.M. Horan: Mendocino Triple Junction Experiment, California, 11 August - 7 September.
- A.W.B. Jacob: BGS, Edinburgh, 24 - 29 March; RAPIDS visit to Hamburg, 21-25 April; EGS General Assembly at Wiesbaden and MEMSAC Meeting in Karlsruhe, 1-10 May; EGS Meeting with EUG in RAS London, 18-19 May; EUROPROBE Deep Europe Study Centre at Bad Herrenalb, Germany, 17-23 July; COMBO planning visit to Lisbon, 26-28 July; KRISP 94 planning visit to Kenya, 9-18 August; EGS Council Meeting, Oxford, 7-8 October; RAPIDS visit to Hamburg, 18-20 October; EUROPROBE Seismic Workshop, near Warsaw, Poland, 20-26 November; AGU Fall Meeting, San Francisco, 2-13 December.
- F. Murphy: Sierra Nevada Continental Dynamics Project, California, 8-27 September.
- T. Murphy: EGS General Assembly, Wiesbaden, 1-8 May.
- B.M. O'Reilly: RAPIDS visit to Hamburg & EGS General Assembly at Wiesbaden, 21 April - 8 May; BIRPS Annual Review Meeting at Imperial College, London, 21-22 September; RAPIDS visit to Hamburg, 17-24 October; invited visit to USGS, Menlo Park, California & AGU Fall Meeting, San Francisco, 1 November - 19 December.
- P.W. Readman: EGS General Assembly, Wiesbaden, 1-8 May; Sierra Nevada Continental Dynamics Project, California, 8-27 September.
- P.M. Shannon: RAPIDS visits to Hamburg, 21-25 April and 18-20 October.
- G.Wallace: KRISP 94 planning visit to Kenya, 3-16 August.

8.2 Cosmic Ray Section

- J. Bosch: Exposure of Track Detector Stacks, Brookhaven National Laboratory, New York State, USA, 27 August - 10 September.
- J. Byrne: IRMA Meeting, TCD, 10-11 May; Institute of Physics Meeting, Bundoran, 2-4 April; IRMA meeting, Brussels, 6-8 December.
- M. Corcoran: Conference (The Nature and Evolutionary Status of Herbig He/Be Stars), Amsterdam, 25-29 October.
- L. Drury: AWG meeting, Paris, 21 January; M2 Presentation (ESA) and AWG meeting, Paris, 26-28 April; Axford Colloquium, MP Ae, 30 April; Visiting Scientist (cosmic ray propagation problems), RMKI (Budapest), 20 June - 10 September; AWG meeting, Ascona (Switzerland), 25 June; XXIII ICRC, Calgary (Canada), 19-30 July; AWG meeting, Frascati (Italy), 14-15 September; IUPAP General Assembly, Nara (Japan), 20-25 September; Isophot meeting, Heidelberg, 27 November - 1 December.
- J. Eisloffel: Observing on the MPI/ESO 2.2 m Telescope, La Silla (Chile), 27 March - 17 April; Conference (Kinematics and Dynamics of Diffuse Astrophysical Media), Manchester, 21-26 March; Reception (Otto-Hahn Medal of the Max Planck Society), Trier (Germany), -- June;

- Collaboration work, Max Planck Institute for Astronomy, Heidelberg, 9-29 June; Center for Astrophysics, Cambridge, Massachusetts, -- September; Conference (Star Formation), Seattle, USA, 8-20 September; ASGI Meeting, Armagh, 24 September; Conference (The Nature and Evolutionary Status of Herbig Ae/Be Stars), Amsterdam, 25-31 October.
- D. O'Sullivan: IRMA Meeting, TCD, 10-11 May; XXIII ICRC, Calgary (Canada), 19-30 July; NASA LDEF 3rd Post-Retrieval Symposium, Williamsburg (USA), 8-12 November; Visiting Scientist, Marshall Space Flight Centre, Huntsville, Alabama, 14-19 November; Meeting with British Airways officials and installation of detectors on Concorde, 4-5 October.
- T.P. Ray: RAS meeting, London, 13-14 February; Conference (Kinematics and Dynamics of Diffuse Astrophysical Media), Manchester, 21-25 March; EADN Board Meeting, Thessaloniki, Greece, 19-22 May; PATT Meeting, Warwickshire, 8-10 June; Observing on INT, La Palma, 3-13 July; Max Planck Institute for Astronomy, Heidelberg, (with support from the German-Irish Research Fund), 1-31 August; ISO Time Allocation Committee, ESTEC, Holland, 13-15 September; ASGI, Armagh, 24 September; Examination of a PhD thesis, Glasgow University, October; Conference (The Nature and Evolutionary Status of Herbig He/Be Stars), Amsterdam, 25-29 October; PATT Meeting, Nottingham, 6-8 December.
- S. Russell: Observing on WHT, La Palma, 5-13 January; Conference (The Cold Universe), Les Arcs (France), 13-20 March; Visiting Scientist (HCM), University of Wales, Cardiff, 13-16 May; Observing on WHT, La Palma, 2-10 July; Discussion of PATT and HCM proposals, Queens University, Belfast, 31 August - 3 September; Isophot Meeting, London, 27 September - 1 October; Visiting Scientist, Mount Stromlo Observatory, Australia, 15 - 19 November; Visiting Scientist, University of New South Wales, Sydney, 22 - 26 November.
- W.-M. Tai: Isophot Meeting, Heidelberg, 27 November - 1 December.
- ### 8.3 Astronomy Section
- I.Elliott: The 25th Anniversary Celebrations of Armagh Planetarium, Armagh, 7 May; W.R. Hamilton Conference, TCD, 17-20 August; 25th Meeting of the JOSO Board, Graz (Austria), 7-10 October; Science and Communication Conference, DCU, 24 November.
- B.D. Jordan: Collaboration Meeting, Rutherford Appleton Laboratory (England), 5-6 August; Collaboration work, Physics Department, UCG, 5 January; 22 February; 23 March; 11 November and 19 November
- I.G. van Breda: Imaging Meeting, Rutherford Appleton Laboratory (England), 29-30 April; Collaboration Meetings, Open University (Hereford, England), 22-23 September and 17-19 November.
- ## 9 Miscellanea
- A.W.B. Jacob was appointed a member of the ILP/IASPEI group MEMSAC.
- L.O'C. Drury was re-elected to the Commission on Cosmic Rays of the International Union of Pure and Applied Physics for another term of office.
- A.Thompson was elected Chairman of the Royal Irish Academy Space Research Committee.
- A.W.B. Jacob continued as General Secretary and Member of Council of the European Geophysical Society.
- L.O'C. Drury continued as Chairman of the National Committee for Physics.
- D. O'Sullivan continued as Review Editor of "Radiation Measurements".
- T.P. Ray was elected Chairman of the European Astrophysical Doctoral Network (EADN) which comprises some thirty universities interested in promoting the mobility of graduate astrophysics students in Europe within the EU ERASMUS scheme. It also organises specialist Summer Schools aimed at a graduate audience with funding largely provided from the Human

Capital and Mobility (HCM) Programme and ERASMUS.

J. Eisloffel was awarded the Otto-Hahn Medal of the Max Planck Society in Trier, Germany, in June.

I. Elliott was elected a member of the Section for Science and its Industrial Applications of the Council of the Royal Dublin Society, in December.

T.P. Ray has continued to be the Irish representative on PATT (the Panel for the Allocation of Telescope Time), the DIAS representative on the National Committee for Astronomy, Secretary of the La Palma Advisory Committee and a member of the ISO (Infrared Space Observatory) Time Allocation Committee.

D. O'Sullivan submitted proposals to CERN and GSI (Darmstadt) on behalf of the track detector group, to undertake exposures to 160 GeV/N lead and 1.0 GeV/N bismuth beams scheduled for operation in 1994 for the first time. Both proposals have been accepted.

A. Thompson submitted a proposal to the Brookhaven National Laboratory for a series of exposures to the new 11.1 GeV/N gold beam. The proposal was accepted and the exposures were carried out during the year.

T.P. Ray, with the assistance of S. Russell, I. Elliott, T. Loughnane (Principal of Rush Secondary School) and M. Grehan (Belvedere College) nationally organised an essay competition to find a "Future Astronomer of Europe". The competition was sponsored by the EU and the European Southern Observatory (ESO). Circulars were distributed to all the secondary schools in Ireland and a large number of entries obtained. The subject of the essay was "An Observing Night on the European Very Large Telescope (VLT)". The prize for the best Irish entry was a trip to ESO Headquarters followed by a visit to their observing site in Chile where the winner was allowed to carry out observations on the New Technology Telescope. The Minister for Education, Niamh Bhreathnach, presented the awards for this competition at a ceremony in DIAS, 10 Burlington Road on the 4th November.

D. Corcoran successfully defended his PhD thesis in October.

I. Elliott and W. Dumbleton organised an Open Day at Dunsink on 24 November as part of the European Week for Scientific Culture.

10 Publications

10.1 Journals and other Refereed Publications

D. Corcoran, T.P. Ray and R. Mundt: "Optical Evidence for a Poorly-Collimated Wind from Cepheus A". *Astron. Astrophys.*, Vol 279, pp 206-213 (1993).

A.W.B. Jacob with J. Diaz et al: "A Deep Seismic Sounding Investigation of Lithospheric Heterogeneity and Anisotropy beneath the Iberian Peninsula". *Tectonophysics*, Vol 221, pp 35-51 (1993).

A.W.B. Jacob with P.M. Shannon, J.G. Moore and J. Makris: "Cretaceous and Tertiary Basin Development West of Ireland". *Petroleum Geology of Northwest Europe - Proceedings of the 4th Conference*, ed. J.R. Parker (publ. The Geological Society of London), pp 1057-1066 (1993).

A.W.B. Jacob: "Seismic Hazard in Ireland". *The Practice of Earthquake Hazard Assessment*, ed. R.K. Maguire (publ. International Association of Seismology and Physics of the Earth's Interior and the European Seismological Commission), pp 150-153 (1993).

T. Murphy with D.R. Barraclough et al: "150 Years of Magnetic Observatories - Recent Researches on World Data". *Surveys in Geophysics*, Vol 13, pp 47-88 (1992).

D. O'Sullivan and A. Thompson with S.M.P. McKenna-Lawlor, P.W. Daly, E. Kirsch, K.-P. Wenzel and V. Afonin: "Energetic Ions at comet Grigg-Skjellerup measured from the Giotto Spacecraft". *Nature*, Vol 363, pp 326-329 (1993).

T.P. Ray with S. Edwards and R. Mundt: "Energetic Mass Outflows from Young Stars". *Protostars and Planets III*, eds. E. Levy and J. Lunine (University of Arizona Press), pp 567-602 (1993).

P.M. Shannon: "Oil and gas in Ireland - exploration, production and research". *First Break*, Vol 11, pp 429-433 (1993).

A. Thompson and D. O'Sullivan with E. Kirsch, S.M.P. McKenna-Lawlor, V.V. Afonin, E. Keppler, S. Livi, H. Rosenbauer, M. Witte and K. Schwingenschuh: "Signatures of the Martian moon Phobos in the Fluxes of Energetic Particles as measured by Experiment SLED onboard Phobos-2". *Planet. Space Sci.*, Vol 41, pp 435-440 (1993).

10.2 Conference Proceedings

T.A. Blake and C.M. Horan with B.C. Beaudoin and the Mendocino 93 Working Group: "The 1993 Mendocino Triple Junction Seismic Experiment - Overview". *Eos*, Vol 74, p 431 (1993).

D. Corcoran, T.P. Ray, R. Mundt and R. Poetzel: "Herbig-Haro Emission Associated with Molecular Outflow Sources". *Stellar Jets and Bipolar Outflows*, Proceedings of the Sixth International Workshop of the Astronomical Observatory of Capodimonte (OAC6), eds. Errico and Vittone (Dordrecht, Kluwer), pp 57-61 (1993).

L. O'C. Drury: "Acceleration and Transport Theory". Rapporteur Talk at the 23rd International Cosmic Ray Conference, Calgary (Canada), July 1993, in Proceedings of the XXIII International Cosmic Ray Conference (Invited, Rapporteur and Highlight Papers), eds. Leahy, Hicks and Venkatesan (World Scientific, Singapore), pp 307-320.

L. O'C. Drury: "Ian Axford and the Problem of Cosmic Ray Origin". The Axford Colloquium, April 1993, MPAE-W-100-93-29.

J. Eisloffel: "Proper Motion in Jets from Young Stars and in Herbig-Haro Objects". *Stellar Jets and Bipolar Outflows*, Proceedings of the Sixth International Workshop of the Astronomical Observatory of Capodimonte (OAC6), eds. Errico and Vittone (Dordrecht, Kluwer), pp 109-114 (1993).

J. Eisloffel and T.P. Ray with E. Gunther, F.V. Hessman, R. Mundt, R. Poetzel, J.S. Carr and S. Beckwith: "An optical/infrared outburst in the exciting source of HH 7-11". *Stellar Jets and Bipolar Outflows*, Proceedings of the Sixth International Workshop of the Astronomical Observatory of Capodimonte (OAC6), eds. Errico and Vittone (Dordrecht, Kluwer), pp 219-220 (1993).

F. Hauser, B.M. O'Reilly, P.M. Shannon, A.W.B. Jacob and J. Makris: "The Crustal Structure of the Rockall Trough - Differential Stretching Without Underplating". *Eos*, Vol 74, p 444 (1993).

A.W.B. Jacob and F. Hauser with J. Makris and U. Vogt: "The European Margin between Ireland and the Iceland Basin". Proceedings of the 3rd International Congress of the Brazilian Geophysical Society, Rio de Janeiro, 14 pages (1993).

A.W.B. Jacob with the MEMSAC Group: "Uniform Seismic Data Recording Format Explored". *Eos*, Vol 74, p 421 (1993).

B.M. O'Reilly, F. Hauser, A.W.B. Jacob, P.M. Shannon, and J. Makris: "Evolution of the Upper Mantle Beneath Stretched Continental Crust - an Example from the Rockall Trough". *Eos*, Vol 74, p 444 (1993).

D. O'Sullivan and A. Thompson with S.M.P. McKenna-Lawlor, P.W. Daly, E. Kirsch, K.-P. Wenzel and V. Afonin: "First Results from the Energetic Particle Analyser (EPA) on the Giotto Extended Mission during P/Grigg-Skjellerup Encounter". *COSPAR Colloquia Vol 4 (Plasma Environments of Non-Magnetic Planets, edited by T.I. Gombosi)*, pp 5-7 (1993).

D. O'Sullivan: "Ultra Heavy Cosmic Ray Studies and Early Results from the Dublin-ESTEC Experiment on LDEF". Highlight Talk at the 23rd International Cosmic Ray Conference, Calgary (Canada), July 1993, in Proceedings of the XXIII International Cosmic Ray Conference (Invited, Rapporteur and Highlight Papers), eds. Leahy, Hicks and Venkatesan (World Scientific, Singapore), pp 493-502.

T.P. Ray: "Interpreting Jets from Young Stars" (Invited Review). *Stellar Jets and Bipolar Outflows*, Proceedings of the Sixth International Workshop of the Astronomical Observatory of Capodimonte (OAC6), eds. Errico and Vittone (Dordrecht, Kluwer), pp 241-255 (1993).

T.P. Ray with R. Mundt: "Interpreting Jets from Young Stellar Objects". Invited review in *Astrophysical Jets*, eds. M. Fall, C. O'Dea, M. Livio and D. Burgarella (Cambridge University Press), pp 145-175 (1993).

T.P. Ray with R. Poetzel and R. Mundt: "Herbig-Haro Outflows and Jets from High-Luminosity Young Stellar Objects". *Stellar Jets*

and Bipolar Outflows, Proceedings of the Sixth International Workshop of the Astronomical Observatory of Capodimonte (OAC6), eds. Errico and Vittone (Dordrecht, Kluwer), pp 231-234 (1993).

P.W. Readman, G. Byrne, and F. Murphy with S. Ruppert and the Sierra Nevada Continental Dynamics Working Group: "Southern Sierra Nevada Continental Dynamics Project - 1993 Field Observations and Interpretations". *Eos*, Vol 74, p 414 (1993).

S.C. Russell with P. Saraceno, C. Ceccarelli, S. Molinari, P. Andre and M.Griffin: "Millimetre Continuum Observations of YSOs - the Relationship between Circumstellar Environments and Mass Loss". The 2nd Koln-Zermatt Symposium, Switzerland, 21-24 September 1993.

P.M. Shannon, A.W.B. Jacob, J. Makris, B.M. O'Reilly, F. Hauser and U. Vogt: "Passive Margin Basin Evolution in the Rockall Region, North Atlantic". The 5th Conference, European Association of Petroleum Geoscientists and Engineers, Extended Abstracts, pp 20-21 (1993).

P.M. Shannon, A.W.B. Jacob, F. Hauser, and B.M. O'Reilly with J. Makris and U. Vogt: "The Evolution of the Western Margin of the Eurasian Plate under the Northeastern Atlantic". *Annales Geophysicae*, Vol 11, p C65 (1993).

A. Thompson and D. O'Sullivan with E. Kirsch, P.W. Daly, S. McKenna-Lawlor, F.M. Neubauer and K.-P. Wenzel: "Energetic Particle Fluxes (E(H20)>60 keV) measured on board the Giotto S/C near the comets Grigg-Skjellerup and Halley". The 28th General Assembly of the European Geophysical Society (Wiesbaden), PS3-3, May 1993.

A. Thompson and D. O'Sullivan with E. Kirsch, S. McKenna-Lawlor, A. Korth, R. Schwenn and K.-P. Wenzel: "Analysis of Comet Halley's Heavy Ion and Micro-Dust Fluxes and Discussion of Possible Acceleration Processes". *COSPAR Colloquia Vol 4 (Plasma Environments of Non-Magnetic Planets, edited by T.I. Gombosi)*, pp 89-92 (1993).

A. Thompson, D. O'Sullivan, K.-P. Wenzel, J. Bosch, R. Keegan, C. Domingo and F. Jansen: "Some Early Results from the LDEF Ultra Heavy Cosmic Ray Experiment". *Proc. 23rd Int. Cosmic Ray Conf. (Calgary)*, Vol 1, pp 603-606 (1993).

10.3 Books, Theses and Sundry Publications

D. Corcoran: "Optical Outflows associated with Herbig Ae/Be Stars". PhD Thesis, Dublin City University (1993).

I. Elliott: "Skynotes" (a regular monthly article). Technology Ireland, 1993.

I. Elliott: "A Brief History of the ATIS Standard". *IAPPP Comm. No. 52*, pp 3-4, Summer 1993.

I. Elliott: "An Irish Galaxy - Astronomy in the Nineteenth Century". *Irish Studies Review*, No. 4, pp 19-23, Autumn 1993.

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INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

FINANCIAL STATEMENTS FOR YEAR ENDED 31 DECEMBER 1993

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DUBLIN INSTITUTE FOR ADVANCED STUDIES
STATEMENT OF RESPONSIBILITIES OF THE COUNCIL

The Council of the Dublin Institute for Advanced Studies is required under section 28(2) of the Institute for Advanced Studies Act 1940, to prepare accounts in such form as shall be approved by the Minister with the concurrence of the Minister of Finance. In preparing those accounts the Council is required to:

- select suitable account policies and apply them consistently;
- make judgements and estimates that are reasonable and prudent;
- prepare the financial statements on the going concern basis unless it is inappropriate to presume that the Institute will continue in operation.

The Council is responsible for keeping proper books of account which disclose with reasonable accuracy at any time the financial position of the Institute and which enable it to ensure that the financial statements comply with section 28(2) of the Act. The Council is also responsible for safeguarding the assets of the Institute and for taking reasonable steps for the prevention and detection of fraud and other irregularities.

M. LeWhitaker Chairman

Members Council Member

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

1993

GENERAL

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

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

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

ACCOUNTING POLICIES

1. Accounting basis:

The Accounts have been prepared under the historical cost convention.

2. Oireachtas Grants:

Income shown in the Accounts under this heading 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)

1993

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 1993 was £759,569.

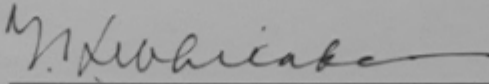
7. Superannuation:

All superannuation benefits to or in respect of employees of the Institute, under its superannuation schemes, are met out of grants in the year of payment. Contributions in respect of these schemes are netted against salaries charged in the Account. No provision is made in these accounts for future benefits.

Income and Expenditure Account
for the year ended 31 December 1993

<u>1992</u>		<u>1993</u>
£		£
<u>Income</u>		
2,483,000	Oireachtas Grant	2,632,000
35,085	Sales of Publications	35,558
3,250	Celtic Studies Fees	4,000
0	School of Theoretical Physics (Note 4)	19,400
103,537	School of Cosmic Physics (Note 4)	165,646
59,627	Miscellaneous (Note 9)	85,642
748	Profit on disposals	0
2,685,247		2,942,246
12,725	Transfer from Capital Account (Note 6)	21,574
2,697,972		2,963,820
<u>Expenditure</u>		
571,724	School of Celtic Studies	582,953
314,572	School of Theoretical Physics	343,710
1,074,468	School of Cosmic Physics	1,130,465
554,187	Administration	578,148
84,968	Depreciation (Note 5)	96,530
	Loss on Disposals	81
2,599,919		2,731,887
98,053	<u>Surplus (Deficit) for year</u>	231,933
106,008	Balance at 1 January	204,061
204,061	Balance at 31 December	435,994

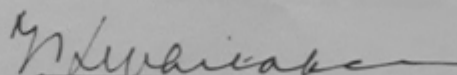
The Accounting Policies, Notes 1 to 10 and Statement form part of these accounts.


CHAIRMAN - COUNCIL OF THE INSTITUTE

Balance Sheet at 31 December 1993

<u>1992</u>			<u>1993</u>	
£	£		£	£
233,525		Fixed Assets (Note 5)		211,951
		Current Assets:		
	346,907	Cash on Hands and at Bank	622,428	
432,062	85,155	Debtors and Prepayments	58,556	680,984
<u>665,587</u>	<u> </u>	TOTAL ASSETS	<u> </u>	<u>892,935</u>
		Current Liabilities:		
	198,341	Creditors and Accruals (Note 2)	213,384	
228,001	29,660	Funds (Note 1)	31,606	244,990
<u>437,586</u>	<u> </u>	Net Assets	<u> </u>	<u>647,945</u>
		Financed by:		
204,061		Surplus Income and Expenditure Account		435,994
233,525		Capital Reserve (Note 6)		211,951
<u>437,586</u>				<u>647,945</u>

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


 CHAIRMAN - COUNCIL OF THE INSTITUTE

Cashflow Statement
for the year ended 31 December 1993

<u>1992</u>	<u>1992</u>		<u>1993</u>	<u>1993</u>
£	£		£	£
153,738		Net Cash Flow from Operating Activities (Note 7)		265,002
		Returns on Investments and Servicing of Finance		
<u>47,815</u>		Interest Received		<u>85,556</u>
201,553		Net Cash Flow from Operating Activities and Returns on Investments		350,558
		Investing Activities		
	(72,386)	Purchase of Fixed Assets	(75,037)	
	891	Sale of Fixed Assets	0	
	<hr/>	Net Cash Outflow from Investing Activities	<hr/>	<hr/>
(71,495)				(75,037)
<hr/>		Increase (Decrease) in Cash and Cash Equivalents		<hr/>
130,058				275,521
<hr/>				<hr/>

Statement 1

Detailed Analysis of Income and Expenditure
for the year ended 31 December 1993

<u>INCOME</u>	School of Celtic Studies	School of Theoretical Physics	School of Cosmic Physics	Adminis- tration	Total	1992 Total
	£	£	£	£	£	£
Oireachtas Grants	664,150	344,150	1,004,821	618,879	2,632,000	2,483,000
Sales of Publications	35,113	1	444		35,558	35,085
School of Celtic Studies (RIA)	4,000	-	-	-	4,000	3,250
School of Theoretical Physics (Note 4)		19,400	-	-	19,400	-
School of Cosmic Physics (Note 4)	-	-	165,646	-	165,646	103,537
Miscellaneous (Note 9)	86	-	-	85,556	85,642	59,627
Profit on disposals					-	748
	<u>703,349</u>	<u>363,551</u>	<u>1,170,911</u>	<u>704,435</u>	<u>2,942,246</u>	<u>2,685,247</u>
<u>Transfer from Capital Account</u> (Note 6):						
Allocated for Capital purposes	(6,595)	(11,676)	(36,323)	(20,443)	(75,037)	(72,386)
Amount released on disposals	-	-	-	81	81	142
Amortisation in line with asset depreciation					96,530	84,968
	<u>696,754</u>	<u>351,875</u>	<u>1,134,588</u>	<u>684,073</u>	<u>2,963,820</u>	<u>2,697,971</u>
<u>EXPENDITURE</u>						
Salaries, Wages and Superannuation (Note 10)	445,351	217,265	761,714	305,682	1,730,012	1,715,769
Scholarships	30,561	40,771	53,099	-	124,431	133,059
Honoraria	600	-	-	-	600	825
Library (incl. Microfilms)	16,965	45,672	36,274	-	98,911	92,619
Publications	40,015	584	2,304	1,232	44,135	47,584
General Administration (Note 3)	-	-	-	227,104	227,104	218,858
Travel and Survey Expenses	3,723	6,187	40,090	1,697	51,697	65,385
Symposia & Seminar Expenses	1,827	1,502	-	-	3,329	3,253
Equipment: Consumable & Maintenance	-	-	23,699	-	23,699	21,511
Special Commitments and Projects	4,000	19,400	180,835	-	204,235	103,628
General Expenses (incl. leunet)	39,911	12,329	31,050	42,433	125,723	112,459
IAU Colloquium	-	-	1,400	-	1,400	-
Loss on Disposals	-	-	-	81	81	-
	<u>582,953</u>	<u>343,710</u>	<u>1,130,465</u>	<u>578,229</u>	<u>2,635,357</u>	<u>2,514,950</u>
Depreciation (Note 5)					96,530	84,968
<u>SURPLUS (DEFICIT) FOR YEAR</u>	113,801	8,165	4,123	105,844	2,731,887	2,599,918
Balance at 1 January 1993	30,793	(3,730)	45,206	131,792	231,933	98,053
Balance at 31 December 1993	144,594	4,435	49,329	237,636	435,994	106,008

NOTES TO THE ACCOUNTS

1. Funds:

These comprise:	Vernam Hull Bequest	29,948
	Carmody Fund	1,658
		<u>31,606</u>

The funds are held on deposit.

2. Creditors and Accruals:

Included in this heading is £79,126 contract research monies unexpended at 31 December 1993, which is credited to revenue in line with expenditure on projects (Note 4).

3. General Administration Expenses:

Rent, Rates & Insurance	93,374
Premises Maintenance	34,929
Postage & Telephones	55,178
Fuel, Light & Power	34,168
Sundry Supplies	9,455
	<u>227,104</u>

NOTES TO THE ACCOUNTS (Cont.)

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

<u>Project</u>	<u>Contributor</u>	<u>Opening Balance</u>	<u>Income</u>	<u>Applied as Income</u>	<u>Unexpended/ (Overexpended)</u>
		£	£	£	£
Seismic Survey at Carnsore	ESB	0	500	500	0
HOGS	Robertson/Riofinex ERA/Pasminco	0	11,058	11,058	0
ISOPHOT	ESA	(1,585)	35,827	34,178	64
RAPIDS	EOLAS	2,752	3,366	2,075	4,043
La Palma	EOLAS	0	5,000	5,000	0
EADN - HCM	Stockholm Univ/EC	(1,921)	10,358	9,348	(911)
EADN - Erasmus	Stockholm Univ./EC	0	0	1,080	(1,080)
Low Mass Star	EOLAS	1,854	2,500	2,936	1,418
IRMA	European Commission	(7,203)	18,079	17,967	(7,091)
LDEF	EOLAS	(1,470)	8,000	1,536	4,994
Star Formation	EC	0	94,821	62,198	32,623
Core Mantle	EC	0	0	2,716	(2,716)
Propagation	EC	0	4,002	4,504	(502)
Kenya (Krisp 93)	EC	0	3,232	6,775	(3,543)
BGS II	BGS	(24,591)	20,648	0	(3,943)
Rapids III	FORBAIRT	0	0	982	(982)
Other Fees	Various	0	2,793	2,793	0
		<u>(32,164)</u>	<u>220,184</u>	<u>165,646</u>	<u>22,374</u>

School of Theoretical Physics - Research Programmes and Fees

<u>Project</u>	<u>Contributor</u>	<u>Opening Balance</u>	<u>Receipts</u>	<u>Applied as Income</u>	<u>Unexpended/ (Overexpended)</u>
		£	£	£	£
Mu-Delta	EOLAS	0	10,000	12,793	(2,793)
Crossover	EC	0	42,591	6,607	35,984
		<u>0</u>	<u>52,591</u>	<u>19,400</u>	<u>33,191</u>

NOTES TO THE ACCOUNTS (Cont.)

5. Fixed Assets

	Furniture & Equipment	Motor vehicles	Computers	Total
Cost	£	£	£	£
Opening Balance 1/1/93	545,445	13,911	621,482	1,180,838
Additions	17,343	0	57,694	75,037
	<u>562,788</u>	<u>13,911</u>	<u>679,176</u>	<u>1,255,875</u>
Disposals	(269)	0	0	(269)
	<u>562,519</u>	<u>13,911</u>	<u>679,176</u>	<u>1,255,606</u>
Depreciation				
Opening Balance 1/1/93	440,545	6,956	499,812	947,313
Charge 1993	22,662	3,478	70,390	96,530
	<u>463,207</u>	<u>10,434</u>	<u>570,202</u>	<u>1,043,843</u>
Depreciation on disposals	(188)			(188)
	<u>463,019</u>	<u>10,434</u>	<u>570,202</u>	<u>1,043,655</u>
Net book value 31/12/93	99,500	3,477	108,974	211,951
Net book value 31/12/92	104,900	6,955	121,670	233,525

6. Capital Reserve:

Balance at 1 January, 1993	233,525
<u>Transfer to Income and Expenditure Account</u>	
Income allocated for capital purposes	75,037
Amortisation in line with asset depreciation	(96,530)
Amount released on disposals	(81)
	<u>(21,574)</u>
Balance at 31 December, 1993	211,951

NOTES TO THE ACCOUNTS (Cont.)

7.	(a)	<u>Reconciliation of Operating Surplus/(Deficit) for the year to Net Cash Flow from Operating Activities</u>	
		<u>1992</u>	<u>1993</u>
		98,053	231,933
			Surplus/(Deficit) per Income & Expenditure
			Adjustment for Non-Operating Items:
		(47,815)	Interest (85,556)
		(748)	(Profit)/Loss on Disposal 81
		(12,725)	Movement on Capital Account (21,574)
		<u>36,765</u>	<u>124,884</u>
			Adjustment for Non-Cash Items:
		84,968	Depreciation Charges 96,530
		25,751	Decrease in Debtors 26,599
		6,254	Increase/(Decrease) in Creditors & Funds 16,989
		<u>153,738</u>	<u>265,002</u>
			Net Cash Flow from Operating Activities

(b) Analysis of Cash and Cash Equivalents and Movements During the Year

216,849	Balance at 1 January	346,907
130,058	Net Cash Flow	275,521
<u>346,907</u>	Balance at 31 December	<u>622,428</u>

8. Leasing:

(a) Operating Leases:

The premises occupied by the Institute are leased from the Office of Public Works. An additional lease was acquired in 1993 from Findlaters Ltd. for the purpose of book storage. The commitment on foot of such leases in respect of 1994 is £51,109.

(b) Finance Leases:

There were no appreciable finance leases in existence at 31 December, 1993.

9. Miscellaneous Income:

Included in Miscellaneous is Bank Interest earned of £85,556 (1992 - £47,815) for the year.

10. Superannuation:

The total superannuation payments in the year amounted to £310,828. The salaries and superannuation charge in the accounts is net of contributions totalling £29,487.

DUBLIN INSTITUTE FOR ADVANCED STUDIES

REPORT OF THE COMPTROLLER AND AUDITOR GENERAL

I have audited the financial statements on pages 1 to 10.

RESPONSIBILITIES OF THE COUNCIL AND OF THE COMPTROLLER AND AUDITOR GENERAL

As stated on page (i) the Council is responsible under Section 28(2) of the Institute for Advanced Studies Act, 1940, for the preparation of the financial statements and it is my responsibility, under Section 28(3) of the Act to audit them. As auditor I am required to form an independent opinion, based on my audit, on the statements and to report my opinion thereon.

BASIS OF OPINION

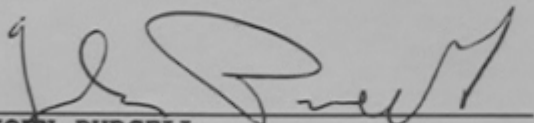
My audit was conducted in the light of my function as Comptroller and Auditor General and in accordance with auditing standards which embrace the standards issued by the Auditing Practices Board and which have particular regard to any special considerations which arise from Exchequer funding arrangements, Ministerial directives or Government policy.

An audit includes examination, on a test basis, of evidence relevant to the amounts and disclosures in the financial statements. It also includes an assessment of the significant estimates and judgements made in the preparation of the financial statements, and of whether the accounting policies are appropriate, consistently applied and adequately disclosed.

I planned and performed my audit so as to obtain all the information and explanations which I considered necessary in the exercise of my function as Comptroller and Auditor General and in order to provide me with sufficient evidence to give reasonable assurance that the financial statements are free from material misstatement. Such information and explanations have been received by me. In forming my opinion I also evaluated the overall adequacy of the presentation of information in the financial statements.

OPINION

In my opinion, proper books of account have been kept by the Council and the financial statements, which are in agreement with them, give a true and fair view of the state of the affairs of the Institute at 31 December 1993 and of its income and expenditure and cash flow for the year then ended.



**JOHN PURCELL
COMPTROLLER AND AUDITOR GENERAL**

7 NOVEMBER 1994

**TREASURY BLOCK
DUBLIN CASTLE**