



# DIAS

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

# ANNUAL REPORT 1994

School of Theoretical Physics

26 AUG 1997

DUBLIN INSTITUTE FOR  
ADVANCED STUDIES

16 Burlington Rd., Dublin 4, Ireland.



P.N. 2703

*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 1994*

P.N. 2703

*Summary of the Annual Report of the Work of the  
Constituent Schools for the year ended 31 December 1994*

*School of Celtic Studies*

The School of Celtic Studies continued its work on manuscript cataloguing, text editing and bibliography. Its most significant publication was Brian Ó Cuív's edition of *Abidil Gaoidheilge & caiticíosma* by Seán Ó Cearnaigh. The original appeared in 1571 and was the first book in Irish to have been published in Ireland. It was a first for the School also in that, as befitted this important Irish incunabulum, an exact facsimile of the original was digitally reproduced and printed opposite the edited text. Pádraig de Brún and Michelle O Riordan contributed substantially to the preparation of the volume.

The annual TIONÓL and statutory public lecture were the main public events organized by the School in 1994.

*School of Theoretical Physics*

Forty-one 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-six seminars were held at DIAS and joint seminars with other third level institutions took place. Members of the School gave fifteen lectures in Ireland. The statutory public lecture was given at Trinity College Dublin by Professor J.T. Lewis (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 forty conferences abroad.

*School of Cosmic Physics*

The research activities of the **Cosmic Ray Section** fall into a few main areas. In theoretical studies of

shocks, jets and other aspects of astrophysical gas dynamics some of the more significant results were the suggestion of a new and very natural explanation for the anomalous line ratios seen in shock-excited molecular hydrogen spectra from star formation regions, a simple explanation for why supernova remnant shocks do not become cosmic ray dominated and progress in the numerical modelling of stellar jets with cooling. Preparations for the launch of the Infrared Space Observatory continued, and Institute staff assisted with ground based calibration measurements and the writing of software systems for the photometer (ISOPHOT). Nuclear track detector studies continued to be dominated by the problems in the analysis of the Ultraheavy Cosmic Ray Experiment, although with an interesting spin-off in the area of dosimetry at aviation altitudes. In observational studies of star formation suggestive spectroscopic evidence was found for the existence of discs around Herbig Ae/Be stars and also for residual dust around post T Tauri stars.

The main thrust of the **Geophysics Section** research continues to be in seismology and in studies of the earth's gravity field. These two fields are often complimentary because structures usually have both seismic and gravity signatures which can be correlated. Major seismic fieldwork took place in Kenya early in the year when the Section took part in an international experiment to study the southern Kenya Rift. Results of an earlier phase were published during the year too. Important results from the RAPIDS project were also published for the northeastern Atlantic where a new model explains the development of the basins with a mechanism radically different from that previously postulated by other research groups. COMBO, a controlled source study of the earth's core-mantle boundary was delayed, at a late stage, after most of the preparations had been completed. However, work has begun using other sources in the meantime. The gravity work has advanced considerably, with increasing use being made of satellite gravity data. Studies have been carried out in more detail onshore and on a less-detailed, but broader sweep, offshore. In both cases, seismic and gravity data have been combined.

The **Astronomy Section** experienced a time of change during 1994. After an interval of eighteen months, E.J.A. Meurs took up office as the new Senior Professor and head of Dunsink Observatory.

Extensive work was required to refurbish Dunsink Observatory and Dunsink House (where the research work is concentrated) to modern standards, and to establish a competitive research unit. Much of this had been achieved by the end of the year. Following a decision of the Governing Board, a future role as a Science Expo was conceived for Dunsink Observatory, implying a redirection of some existing staff members. As a prelude, the impacts of comet SL9 on Jupiter were featured in three special Open Nights at the observatory, which were attended by a capacity audience of about 300 people and which attracted considerable media attention. Several regular Open Nights were also held during the year, with the appreciated support of the Irish Astronomical Society. Along with the changes in scientific leadership in Dunsink new areas of research have been introduced. The strongest emphasis is now on extragalactic studies, currently with special attention to X-ray investigations. For the instrumentation work an interest in optical cameras for transient sources has emerged, with the INTEGRAL satellite as main focus.

*Annual Report of the work of the Institute and its Constituent Schools presented by the Council for the year ended 31 December 1994.*

*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 1994.*

*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 1994.*
- 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 1994.

### **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., L.L.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 Bhaldráithe, M.A., Ph.D., D.Litt., M.R.I.A.; J. T. Lewis, B.Sc., Ph.D.; E. F. Fahy, M.Sc., Ph.D.; A.W.B. Jacob, M.A., M.Sc., Ph.D.

### **Governing Board of the School of Celtic Studies**

#### *Chairman*

T. de Bhaldráithe, 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. O Coileáin, M.A., Ph.D. (Harv.); P. Ó Fiannachta, M.A., M.R.I.A.; S. Ó Tuama, 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'Raiifeartaigh, 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. Tóibin, 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; Eibhlín Nic Dhonncha.

Annual report of the Governing Board of  
the  
School of Celtic Studies  
for the year ending 31 December 1994  
adopted at its meeting of 1 February 1996

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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 McMorow (Secretary of the School)  
Aoibheann Nic Dhonnchadha (Assistant Professor; manuscript studies and Irish medical texts)  
Máirín Ní Dhonnchadha (Chief Editor; also Irish textual and literary studies)  
Siobhán Ní Laoire (Librarian; also textual and sociolinguistic studies)  
Pádraig Ó Macháin (Assistant Professor; manuscript studies and bardic verse)  
Máirtín Ó Murchú (Senior Professor; Director of the School; special responsibility for spoken language studies)  
Michelle Ó Riordan (Publications Officer; also historical studies)  
Seán Ua Súilleabháin (Research Assistant; lexicography)  
Emma Ryan (Publications Secretary)

### 1.2 Temporary / Part-time and Retired Staff

- Cathair Ó Dochartaigh (Computer Consultant, to 31 July 1994)  
Eunice Delaney (Library, from September 1994)  
Grace Toland (Library, from November 1994)  
Brian Ó Cuív (Professor Emeritus)

### 1.3 Research Scholars

- Seán Ó Cearnaigh (to 31 August 1994)  
Caoimhín Breatnach (to 30 September 1994)  
John Higgins (to 30 September 1994; without income)  
Brian Ó Curnáin  
Brian Ó Catháin  
Dorothee Tratnik  
Petra Sabine Hellmuth (from 1 October 1994)  
Thomas O'Loughlin (from 1 October 1994)  
Peter Smith (appointed as from 1 October 1994; uptake deferred until 1995)  
John Carey (from 1 October 1994, part-funded by CURIA)  
Kaarina Hollo (from 1 October 1994, funded by CURIA)



#### 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 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 (1990)  
 Professor T. Arwyn Watkins, University College, Dublin (1989)

#### 1.6 Visiting Scholars

(Only overseas scholars are included in the following list. In addition to these, the School accords library and research facilities to Irish-based scholars when it holds materials which the scholars' own institutions, or the major public libraries in Dublin, lack.)

- Jacqueline Borsje (Free University of Amsterdam)  
 Dr Melita Cataldi (University of Turin)  
 Prof Dr Johan Corthals (Universität Hamburg)  
 Dr Ann Dooley (University of Toronto)  
 Clara Ferranti (University of Macerata)  
 Inge Genee (University of Amsterdam)  
 Professor Eric P. Hamp (University of Chicago)  
 Gisbert Hemprich (University of Freiburg)  
 Dr Rolf Ködderitzsch (Universität Bonn)  
 Prof Seamus McElwain (Bunkyo Women's College, Tokyo)  
 Setsuko Mori McElwain (Bunkyo Colleges, Tokyo)  
 Toshi Matsuoka (Hosei University, Tokyo)  
 Ann Mulkern (University of Minnesota)  
 Annette Pehnt (University of Freiburg)  
 Dr Nancy Stenson (University of Minnesota)  
 Dr Olivier Szerwiniack (Institut de Recherche et d'Histoire des Textes, Paris)  
 Christophe Vielle (Catholic University of Louvain)

## 2 Research

During 1994 research for publication continued in the fields of manuscript studies, bibliography, medical texts, Early Modern Irish verse, lexicography. Editorial/supervisory work was done for projects undertaken by members of staff and research scholars, as well as outside scholars (see below), in the areas of Irish and Scottish Gaelic dialect studies and various other projects of the School's statutory publishing range.

### 2.1 Primary project areas

- P. de Brún worked on the second edition of volume III of the *Catalogue of Irish manuscripts in the British Museum*. 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); on the *Catalogue of the Gaelic manuscripts of Scotland* (Ronald Black); on the *Catalogue*

of Irish manuscripts in the Falvey Memorial Library, Villanova University, Pennsylvania (W. J. Mahon); on *Clár lámhscríbhinní Gaeilge Choláiste Ollscoile Chorcaí: cnuasach an Phaoraigh agus cnuasaigh eile* (B. Ó Conchúir). Aoibheann Nic Dhonnchadha continued work on cataloguing medical manuscripts in Trinity College Dublin.

- Bibliographical work was continued by Rolf Baumgarten on the (data base) *Bibliography of Irish linguistics and literature*. Seán Ó Cearnaigh (Research Scholar) continued work on his *Bibliography of the printed material in the Irish language 1571-1700*, for publication in the *Bibliographical studies series* (General editor: R. Baumgarten).
- Fergus Kelly continued work on his monograph *Early Irish farming: the evidence of the law-texts*, 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 Seán Ó Súilleabháin on an edition of Rísdeard Pluincéad's Latin-Irish dictionary (1662); Brian Ó Cuív (Professor Emeritus) on the catalogue of Irish manuscripts in the Bodleian Library Oxford; Pádraig de Brún on the preparation for publication of *Scriptural instruction in the vernacular: the Irish Society and its teachers, 1818-1827*, and (with Pádraig Ó Macháin and T. Matsuoka) on indexes for the proposed reprint of *Irish grammatical tracts* (ed. O. Bergin); Máirín Ní Dhonnchadha on (the background to) *Cáin Adomnáin*.

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); Proinsias Mac Cana on *Gereint uab Erbin* (ed. R. L. Thomson); Pádraig de Brún on *The spiritual rose* (ed. Malachy McKenna); he also directed the editing/typesetting of *Aibidil Gaeilge & caiteicíosma* (ed. Brian Ó Cuív); Rolf Baumgarten on *Studies in Welsh word formation* (Stefan Zimmer); Máirín Ní Dhonnchadha (Chief Editor) on various manuscripts submitted for publication, and as a member of the Editorial Subcommittee; Pádraig Ó Macháin assisted with the general publishing programme.

### Other research:

Proinsias Mac Cana on the history of Welsh syntax, to be published jointly with T. Arwyn Watkins, and

on a number of Insular Celtic lexical items and syntactic structures with reflexes in British and Irish. Rolf Baumgarten on aspects of Early Irish syntax. Aoibheann Nic Dhonnchadha on Early Modern Irish medical writings. Pádraig Ó Macháin on Early Modern Irish verse. Seán Ua Súilleabháin for an essay on folk survivals of paganism. Máirín Ní Dhonnchadha on women's history in Ireland. Brian Ó Cuív on material for publication by Brepols in a volume on Irish apocrypha.

## 2.3 Research Scholars' work

Brian Ó Curnáin continued work on *Gnéithe de Ghaeilge Chonamara*. Brian Ó Catháin worked on *Scéalta Joe Mháirtín Uí Phlathhearta: teanga agus béaloideas Inis Oírr*. Dorothee Tratnik completed her work on *Filíocht Chonchúir Mháistir Uí Ríordáin*; she did fieldwork on the vocabulary of the Irish of Cape Clear as part of a comparative study of the vocabulary of Munster dialects.

## 3 Publishing

As one of its statutory functions, in addition to research and publication by its own staff, the School provides for the assessment, 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 1994:

- *Aibidil Gaeilge & caiteicíosma: Seán Ó Cearnaigh's Irish primer of religion, published in 1571*, ed. Brian Ó Cuív. 1994. x + 246 pp. ISBN 1-85500-163-2. Ir£15.  
Edition, having facsimile of original work on facing pages, with introduction, notes, and full glossary, of the first Irish book printed in Dublin; also including reproduction and edition of the unique broadsheet printing in Dublin in 1571 of the poem *Tuar feirge foighide Dhé* by Pilib (Bocht) mac Cuinn Chrossaigh (Ó hUiginn).
- *Scéala Scoil an Léinn Cheiltigh: Newsletter of the School of Celtic Studies*, ed. Rolf Baumgarten. No. 7, October 1994. 29 pp. ISSN 0790-9853. Free.

Contains inter alia a programmatic essay by Donnchadh Ó Corráin, entitled 'Early Irish history: some debatable points', and 'Irish studies theses 1993' by the Editor.

- *Betha Colaim Chille / Life of Columcille, compiled by Maghnas Ó Domhnaill in 1532; edited and translated from manuscript Rawlinson B 514 in the Bodleian Library, Oxford, with introduction, glossary, notes, and indexes, by A. O'Kelleher and G. Schoepferle. 1994 (orig. publ. in 1918 by University of Illinois). lxxviii + 516 pp., pl. ISBN 1-85500-173-X. Ir£30.*
- *School of Celtic Studies: Publications in Celtic Studies, Catalogue 1993/1994 / Scoil an Léinn Cheiltigh: Foilseacháin sa Léann Ceiltigh, Catalóg 1993/1994. 54 pp.*

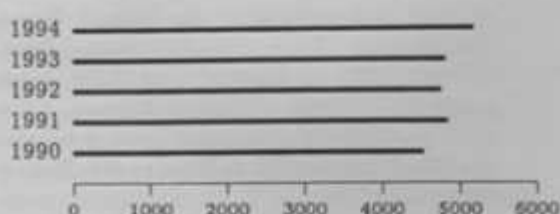
The following publications of the School were reprinted: *A grammar of Middle Welsh* (D. Simon Evans; Catalogue no. H 2.0); *Táin bó Fraích* (Wolfgang Meid; no. F 5.22); *An introduction to Irish syllabic poetry* (Eleanor Knott; no. F 3.2).

#### 4 Booksales

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

Promotion of publications was through advertising in *Books Ireland*, *Comhar*, *An Saol*, *Slógadh*, etc. Exhibitions of the School's publications were set up at the International Conference on Language in Ireland (University of Ulster at Jordanstown), 22-24 June 1994, by Siobhán Ni Laoire, and in University College Galway, 26-30 September 1994, by Rolf Baumgarten.

The number of books sold during 1994 was 5175. 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 4818 for 1993, 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 Ni Laoire (Academic Librarian), was directed towards strengthening coverage in the subject areas relevant to the research needs of the School. Binding of periodicals and treatment of older materials continued. The pilot computerised cataloguing project was completed with the professional assistance of Eunice Delaney, and a programme of current and retrospective cataloguing was put in train using the Heritage Library Management System. Additional services to members of the School included accession lists, inter-library loans and bibliographic searching. Visiting scholars were provided with library services.

#### 6 Events

##### 6.1 Lectures

- The Statutory Public Lecture for the year 1994 was delivered by Thomas O'Loughlin (School of Celtic Studies), on 25 November 1994, at University College Dublin, entitled 'The view from Iona: Adomnán's mental maps'.

##### 6.2 Annual Symposium / Tionól 1994

The Annual Symposium/Tionól was held on 25-26 November, incorporating as a key feature the Statutory Public Lecture. In addition, the following papers were read:

- Roibeárd Ó hÚrdail (University College Cork): 'Interlingual morphemic blending (a case from Cléire) and thoughts on Irish-English language-contact'.
- Aidan Breen (School of Celtic Studies) and Dan McCarthy (Trinity College Dublin): 'An unusual annalistic entry for 1055: an Irish observation of the Crab Nebula?'.

- Máirtín Ó Briain (Coláiste na hOllscoile, Gaillimh): 'Loscadh agus luaith le sruth (*Corpus iuris Hibernici* I 285.21-2)'.
- Eoghan Mac Éinri (University of Uppsala) and Ciarán Ó Duibhín (Queen's University Belfast): 'A computer database for the *Linguistic atlas and survey of Irish dialects*'.
- Art Hughes (Queen's University Belfast): 'Ulster negative *char* from Old Irish *níon ro* rather than a Scottish import: synchronic cartographic evidence for a fundamental Middle Irish split'.
- Mícheál Mac Craith (Coláiste na hOllscoile, Gaillimh): 'A *bhean chridhe chompánta*: freagra fileata Eochaidh Uí Eodhasa'.
- Dónall Ó Baoill (Institiúid Teangeolaíochta Éireann): 'Fuaimníú na Gaeilge agus réamhrá *IGT* I'.
- Johan Corthals (Universität Hamburg): 'Immathchor na Ailella 7 Airt'.

## 7 Outside activities and contributions to scholarship

### 7.1 Activities

Lectures were delivered by:

Siobhán Ní Laoire, 'Broadcast News: a stylistic analysis of news reports on Raidió na Gaeltachta', International Conference on Language in Ireland, University of Ulster at Jordanstown (June); by Máirín Ní Dhonnchadha, 'The feudal lord and his professional poet: a changing gender discourse', First Conference of Irish Studies at University of Notre Dame, Indiana (April); 'Gaelic literary tradition and the professional poet', Canadian Association of Irish Studies, Erindale College Mississauga, Ontario (May).

Malachy McKenna gave an M.Phil. course on 'Generative phonology and morphology', Center for Language and Communication Studies, Trinity College Dublin.

Proinsias Mac Cana acted as External Examiner at the Department of Anglo-Saxon, Norse, and Celtic, University of Cambridge (June); he was elected an Honorary Foreign Member of the Royal Gustavus Adolphus Academy, Sweden (July). Malachy McKenna acted as External Examiner in Irish Studies, New University of Ulster.

Brian Ó Cuív acted as chairman at the symposium (11 March 1994) on 'Boccaccio's *Decameron*: from Florence to Kerry', held in the Royal Dublin Society under the auspices of Istituto Italiano di Cultura, and gave an opening address entitled 'A tribute to the memory of James Stewart'. He delivered a lecture entitled 'A millenium of Irish linguistic tradition' at the Department of Celtic Languages and Literatures of Harvard University (14 October 1994).

Lectures by Research Scholars included Caoimhín Breatnach, 'Cath Fiontrágha', Léachtaí Cholm Cille 25, Dún Chaoin (March 1994); 'Oidheadh Chloinne Uisnigh?', First International Conference on the Ulster Cycle Tales, Belfast and Emain Macha (April 1994), and Eighth Irish Conference of Medievalists, Maynooth (June 1994). Brian Ó Catháin, 'Scéalaíocht Árann' at a seminar organized by Iontaobhas na nOileán (Éire) in Árainn (1 May 1994); he attended and moderated a session of the conference '(Re)Oralisierung' organised by Hildegard Tristram at the University of Freiburg (23-25 June 1994). Dorothee Tratnik, 'Fearg Dé ar phobal na nGael', at the conference 'Litríocht agus cultúr na nGaeilge', University College Galway (October 1994).

### 7.2 Scholarly publications

Máirtín Ó Murchú, 'Celtic Studies, Dublin School of', *The encyclopedia of language and linguistics*, ed. R. E. Asher et al. (Pergamon Press, 1994) 2.495-6. Proinsias Mac Cana, Co-editor of *Ériu* 45; 'The historical present and the verb "to be"', *Ériu* 45 (1994) 127-50; 'Y canu mawl yn Iwerdon', *Llên Cymru* 18, 38-52; 'Dáithí Ó hUaithne', *Dáithí Ó hUaithne: cuimhní cairde*, ed. P. Mac Aonghusa agus Tomás de Bhaldraithe (Baile Átha Cliath) 9-30; review of Dáithí Ó hÓgáin, *Myth, legend and romance: an encyclopedia of the Irish folk tradition* (London, 1990), *Béaloides* 60/61 (1992/93) 307-10; his *Celtic mythology* was published in Hungarian translation. Rolf Baumgarten, Co-editor of *Ériu* 45; 'Cr(a)ide h.e. . . and the Early Irish copula sentence', *Ériu* 45 (1994) 121-6. Máirín Ní Dhonnchadha, 'Two female lovers', *Ériu* 45 (1994) 113-19. Seán Ua Súilleabháin, 'Gaeilge na Mumhan', *Stair na Gaeilge in omós do Phádraig Ó Fiannachta*, ed. Kim McCone et al. (Maigh Nuad) 479-538. Michelle O Riordan, 'Political poems in the seventeenth-century crisis', *Ireland, from Independence to Occupation 1641-1680*, ed. Jane Ohlmeyer (Cambridge) 112-27.

Brian Ó Cuív, 'The concepts of "correct" and "faulty" in medieval Irish bardic tradition', *Indogermanica et Caucasica: Festschrift für Karl Horst Schmidt zum 65. Geburtstag*, ed. R. Bielmeier und R. Stempel (Berlin/New York) 395-406.

Accepted for publication / in the press:

Máirín Ní Dhonnchadha, 'Caillech and other terms for veiled women in medieval Irish texts' (*Éigse* 28); 'The *Lex Innocentium*: Adomnán's Law for women, clerics and youths, 697', (*Proceedings of the 21st Conference of Irish Historians*); *Filíocht na Scol* (a chapter for the new syllabus for Secondary Schools); entries in *The Oxford companion to Irish literature*. Brian Ó Cuív, five articles in id.; 'Metrical features

in de Brún's "Coiméide Dhiaga Dante"', (*Miscellanea Celtica in memoriam Heinrich Wagner*). Malachy McKenna, 'Towards a lexical phonology and morphology of spoken Ulster Irish', (*ibid.*).

Research Scholars' publications included Caoimhín Breatnach, review of Ian Hughes, *Stair Nicoméid*, Irish Texts Society, 55 (London, 1991), *Éigse* 27 (1993) 162-7; 'Oidheadh Chloinne Uisnigh', *Ériu* 45 (1994) 99-112; 'The historical context of *Cath Fiontrágha*', for *Éigse* 28; review of Caoimhín Mac Giolla Léith, *Oidheadh Chloinne hUisneach*, Irish Texts Society, 56 (London, 1992), for idem. Brian Ó Catháin, 'Nóta ar R in áit N i nGaeilge Árann', *Éigse* 27 (1993) 98-100.



Annual Report of the Governing Board of the School of Theoretical Physics for the year ending 31 December 1994 adopted at its meeting of 16 February 1996.

## 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), S. Hughes (Ireland) to 31 May, D.J. O'Connor (Ireland), M. Rakowski (U.S.A.) from 1 July.

POSTDOCTORAL FELLOWS: F. Krahe (Germany), N. O'Connell (Ireland) to 30 September, C. Stephens (England) to 14 August.

GRADUATE STUDENTS: M. Huggard (Ireland) from 1 October, R. Russell (Ireland), F. Toomey (Ireland), C. Walsh (Ireland) from 1 October.

RESEARCH ASSOCIATES: Re-appointed to 31 December 1994.

TCD: P.S. Florides, N. O'Connell (from 1 October), B.K.P. Scaife, D. Weaire

UCD: D.J. Judge, P. O'Donoghue, A. Ottewill, J.V. Pulé, W. Sullivan

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

UCC: M. Vandyck

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

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

DCU: M. Barman, E. Buffet, J. Burzlaff, N. Duffield

LIMERICK UNIV.: R.H. Critchley, J. Kinsella, S. O'Brien

CARLOW RTC: D. O Sé

OPEN UNIVERSITY: A.I. Solomon

OXFORD UNIVERSITY: R.G. Flood

U.C. IRVINE: P. McGill

METEOROLOGICAL SERVICE: P. Lynch

DEPT. OF FINANCE: A.J. Curran

SCHLUMBERGER CAMBRIDGE RESEARCH : B. Lenoach

INTERN. CENTRE FOR THEORETICAL PHYSICS, TRIESTE : J. Chela-Flores

UNAFFILIATED: G.M. O'Brien

VISITING SCIENTISTS: I. Barashenkov (Capetown) 19-24 June, F. Brandt (Amsterdam) 12-19 October, J. Chela-Flores (Trieste) 12 April - 4 June, 31 October - 18 November, S. Crosby (Cambridge) 28-29 June, D. Daley (Canberra) 17-21 December, D. Dhar (Bombay, & Cambridge) 12-15 June, P. Dolan (Imperial College, London) 31 March, C. Donnelly (Edinburgh) 6-8 April, D.E. Evans (Swansea) 22-30 October, M. Fisher (Maryland) 24-27 January, J.N. Flavin (U.C.G.) 28-31 March, W. Ford (Ann Arbor) 1-30 June, F. Freire (Heidelberg) 9-16 April, J. Gaite (Madrid) 25 September - 5 October, B. Gorman (Florida) 14-17 July, C. Graham (Canada) 5 May - 23 December, B. Hambly (Edinburgh) 6-8 April, F. Holland (U.C.C.) 31 March, B. Hu (Maryland) 29 May - 1 June, S. Jacka (Warwick) 9-10 June, C. King (Northeastern Univ., USA) 4-18 August, I. Leslie (Cambridge) 28-29 June, H. Maassen (Nijmegen) 17-23 January, D. McAuley (Cambridge) 28-29 June, P. McGill (North Carolina) 5-24 September, W. McGlenn (Notre-Dame) 1 January - 1 August, K.T. Mahanthappa (Boulder, Colorado) 21-28 April, I.D. Marshall (Leeds) 16-30 May, L. Mikheev (Denmark) 22-27 January, R.F. O'Connell (Louisiana) 9-30 June, 1-8 August, C. Pfister (Lausanne) 21-30 March, 9-14 November, V. Priezhev (Dubna) 6 May - 4 June, A.V. Razumov (Moscow) 20 May - 18 June, W. Rühl (Kaiserslautern) 20-24 April, Y. Shnir (Belarus) 17 February - 3 March, W.I. Skrypnik (Kiev) 7 November - 7 December, R. Sorkin (Syracuse) 18-28 May, M. Sortais (Lausanne) 2 February, B. Straughan (Glasgow) 28-31 March, P. Upton (Oxford) 15-30 January, D. Wilkie (London) 9-10 June.

## 2 General

A group of twenty eight students and two lecturers from the University of Groningen in the Netherlands visited the school on 17 May. They listened to lectures by Professors from both the School of Theoretical Physics and the School of Cosmic Physics on the different aspects of research carried out at the Institute. After lunch they visited Dunsink Observatory.

## 3 Research and Study

### 3.1 Theoretical Particle Physics

The work of Prof. L. O'Raifeartaigh on the exhaustivity of canonical reductions of Wess-Zumino theories initiated in the previous year was continued in collaboration with Prof. W. McGlenn and Dr. G. da Costa and the results were strengthened, leaving only a small margin for non-canonical reductions. In particular it was shown that for integral reductions of the theories based on  $SL(n, R)$  (which were the accepted prototypes) only the canonical constraints of grade less than two could be relaxed. The proof of this result is quite complicated and to date only a first draft has been made. To show that at least one non-trivial non-canonical example exists, a model in which a constraint at grade three-halves was relaxed, was constructed. A letter describing this model has since been published. A difficulty with the model is that it admits an element of the W-algebra with negative conformal weight, and while this is acceptable classically, it might lead to some problems of unitarity in the quantized version. Accordingly, the construction of a model that avoids this difficulty by relaxing only grade-one constraints is presently being investigated. The collaboration with Professors Balachandran, Sorkin and McGlenn on the derivation of the spin-statistics correlation and other properties of quantum field theory (such as the existence of Wess-Zumino two-forms) was continued. An important new and simplifying ingredient was the use of Morse theory to determine the homology groups that play the central role in this analysis. A paper on this subject has just been completed and sent for publication.

The main thrust of research in the past year, however, was in preparation of a book on the origins of gauge theory. The formulation of gauge-theory, especially non-abelian (non-commutative) gauge theory, and its application to the fundamental interactions has been one of the major developments in theoretical physics this century. The book is limited to the development up to the mid-fifties, when the theory was brought to its present form (and not with the later applications to interactions) and is intended to contain the key seminal papers and a commentary. Thus the work consisted of following the thread of the mathematical and physical developments that led from Einsteinian gravity to the present theory and of translating the more important and relevant papers of the 1920's, by Weyl, Schrödinger, London, Klein, Kaluza and Fock.

Dr. G. da Costa continued his research on solutions of the Yang-Baxter equation from representations of the algebra  $BH_n$  and invariants of knots. He also finished work on a project called "Feynman's Conjecture".

Prof. J. Chela-Flores worked on a project mainly devoted to the discussion of certain concepts that may have played a relevant role in the pathway that led to the origin and evolution of the progenote. The topics chosen to include are: the origin of chirality of protein amino acids, the origin of translation, and the origin of genome.

Dr. B. Dolan worked on the analysis of geometrical aspects of the renormalisation group in quantum field theory and statistical mechanics.

Dr. C. Ford researched applications of the renormalisation group to field theory and in particular to multiscale problems. With Prof. L. O'Raifeartaigh he worked on investigating interacting WZNW models in conformal field theory.

Dr. T. Garavaglia carried out research on Higgs signals in Hadron colliders.

Dr. F. Krahe carried out research in the causal construction of massive Yang Mills fields. He also worked on the classification of interactions and homological methods.

Dr. C. Nash continued his research in quantum field theory, differential topology and cryptology.

Dr. C. Stephens collaborated with Dr. D.J. O'Connor on the project "Crossover Behaviour in Field Theory" (Human Capital and Mobility Project ERB 4001GT930823). With M. van Eijck (Amsterdam) they showed how to calculate the critical temperature and critical amplitudes in relativistic  $\lambda\phi^4$ -theory. With F. Freire (Heidelberg) they completed an investigation of the specific heat in a film geometry. With A. Bray (Manchester), they completed work on dimensional crossover in the  $N \rightarrow \infty$  limit of an  $O(N)$  model. They made good progress in developing a field-theoretic renormalization group capable of exhibiting the cross-over between first-order and second-order phase transitions.

In addition to his collaboration with Dr. C. Stephens, Dr. D.J. O'Connor worked on topological field theories. With C. Nash (Maynooth), he worked on Ray-Singer Torsion on lens spaces and BRST quantization on product spaces.

### 3.2 Classical Statistical Mechanics

The work of Prof. J.T. Lewis on Large Deviation Theory continued in collaboration with Dr. C.-E. Pfister and Dr. W.G. Sullivan. The new proof of the equivalence of ensembles, announced at the Advanced Research Workshop in Leuven in 1993 led to the development of a framework for proving conditional limit theorems. There was intense activity which yielded by the end of the year the manuscript of a paper which was submitted for publication. This work is an outcome of an earlier investigation by Lewis and Pfister of the interconnections between large deviation rate-functions and thermodynamic entropy.

Dr. E. Buffet carried out research into directed polymers with complex potential.

### 3.3 Quantum Statistical Mechanics

The long-standing collaboration of Prof. J.T. Lewis with Prof. G.W. Ford and Prof. R.F. O'Connell continued with work on the long-time asymptotics of the spin-boson model.

Prof. A. Solomon worked on the use of group theoretical methods applied to the analysis of quantum systems, including condensed fermion systems, and quantum optics, especially coherent and squeezed states of light. He also worked on the application of quantum groups to the analysis of deformed systems in physics, especially optics.

### 3.4 Quantum Theory and Quantum Electronics

Dr. T. Garavaglia carried out research on quasi-invariants for non-linear quantum oscillators.

### 3.5 General Relativity and Gravitation

Dr. M. Vandyck continued his work on extending solutions of Einstein's equations to low-energy superstring theories and observational consequences of some cosmological solutions have been derived.

### 3.6 Applied Mathematics

The Dublin Applied Probability Group is an informal association of Research Associates of the School who are attempting to apply skills acquired in basic research in Statistical Mechanics to other areas. In 1994, a team led by Prof. J.T. Lewis and Dr. N.G. Duffield tackled the problem of resource allocation in ATM (Asynchronous Transfer Mode) networks. The team included Dr. N. O'Connell, Research Fellow, and two graduate students, Mr. R. Russell and Mr. F. Toomey. The team worked on the practical application of an idea arising from the basic research of Lewis and Pfister on the interconnections between large deviation rate functions and thermodynamic entropy. A proposal entitled "The Entropy of an Arrivals Process: a Tool for Estimating Quality-of-Service Parameters in ATM Traffic" was presented at the 11th U.K. Teletraffic Symposium in March. This led to the team being invited to publish a full-length paper with the same title in a special issue on the fundamentals of networking of the IEEE Journal of Selected Areas in Communications. The preparation of this paper involved the testing of algorithms on computer simulations of ATM traffic and on traces of real traffic obtained from the experimental ATM network in the Cambridge University Computer Laboratory. It required also a substantial amount of work on the statistical properties of the estimators; this aspect of the work was directed by Dr. N. O'Connell. In addition, members of the team were engaged on basic research on the Large Deviation Theory of Queueing Systems.

Dr. E. Buffet studied martingale methods in finance.



Dr. J. Buzlaff continued his study of extended objects. With A. Chakrabarti and D.H. Tchrakian, vortices were found and studied in a generalised Abelian Higgs model. With F. Abdelwahid he investigated the scattering process of vortices in superconductors. Furthermore, with K. Arthur, the energy-momentum tensor for optical solitons was derived.

Dr. M. Golden worked on linear viscoelastic boundary value problems where the boundary regions vary in time.

Dr. P. Lynch investigated numerical techniques for use in numerical weather prediction and their application to operational forecasting.

Dr. Ó Sé researched statistical process control and computer simulation.

Mr. R. Russell worked with the other members of the Dublin Applied Probability Group (DAPG) on applications of large deviations to queueing theory, mainly writing fast computer simulations to verify theoretical work, and improving methods of estimating large deviation properties from data. He collaborated with A. White (TCD) in investigating the applicability of the thermodynamic formalism to general equilibrium theory in economics. He also started exploring the transformation of large deviation principles under random time-changes with a view to solving particular problems which arose in the course of DAPG's research.

Mr. F. Toomey, in collaboration with other members of the DAPG, used large deviation theory to study queueing systems with finite waiting room. He also worked on the estimation of queueing properties of telecommunications traffic and on the computer simulation of queueing systems.

Dr. M. Vandyck has now completed the study of Lie and covariant differentiation of spinor fields. The relationship with superspace will be investigated in the coming years.

### 3.7 Pure Mathematics

Dr. J. Burns researched the close relationship of the character theory of Lie groups and the Morse-Bott theory of symmetric spaces. He also carried out research in the area of Baer-invariants of finite groups.

Prof. A. O'Farrell worked on singularities, extension problems, approximation problems and dynamical systems. This included collaborative

work with F. O'Cairbre, T. Dowling, D. O'Keeffe, A. O'Reilly and R. Watson.

Prof. P. McGill continued working on problems in probability: branching processes, local time, Wiener-Hopf factors for matrices, Hamiltonian systems in infinite dimensions, large deviation estimates and 2-parameter estimates.

Dr. N. O'Connell studied the application of large deviation theory to queueing networks. He also researched genealogical processes.

Dr. M. Rakowski collaborated with D. Birmingham (Amsterdam) on a study of topological field theories using discrete lattice methods. A new series of lattice models was constructed, which in three spacetime dimensions reduced to the Dijkgraaf-Witten invariant. In a separate project, Dr. Rakowski studied duality transformations in lattice gauge theory models on lattices with nontrivial topology. Extra topological modes in the dual theory were found to be in correspondence with certain cohomology classes, and a complete expression for the dual partition function was established.

## 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-94-

- 01: J.T. LEWIS, C.-E. PFISTER, & W.G. SULLIVAN: The equivalence of ensembles for lattice systems: some examples and a counterexample.
- 02: M.A. VAN ELJCK, & C.R. STEPHENS: The finite temperature renormalization group applied to  $\lambda\varphi^4$  theory and QCD.
- 03: J.T. LEWIS: The Mu-Delta project: multiplexor design tools and algorithms.
- 04: D. Ó MATHÚNA: Jacques II Bernoulli and the problem of the vibrating plate.
- 05: B. DOLAN: Co-variant derivatives and the renormalisation group equation.

- 06: N.G. DUFFIELD, J.T. LEWIS, N. O'CONNELL, R. RUSSELL, & F. TOOMEY: Statistical issues raised by the Bellcore data.
- 07: N.G. DUFFIELD, J.T. LEWIS, N. O'CONNELL, R. RUSSELL, & F. TOOMEY: The entropy of an arrivals process : a tool for estimating QoS parameters in ATM traffic.
- 08: N.G. DUFFIELD, & N. O'CONNELL: Large deviations for arrivals, departures and overflow in some queues of interacting traffic.
- 09: C. FORD: Multi-scale renormalisation group improvement of the effective potential.
- 10: N. O'CONNELL: Branching and inference in population genetics.
- 12: D.D. BOTVICH, & N.G. DUFFIELD: Large deviations, the shape of the loss curve, and economies of scale in large multiplexers.
- 13: N. O'CONNELL: Large deviations in queueing networks.
- 14: R. RUSSELL, & A.G. WHITE: Entropy and general equilibrium : an approach to economic theory.
- 15: F. TOOMEY: Queue length distribution and overflow frequency in queues with finite waiting space.
- 16: N.G. DUFFIELD, J.T. LEWIS, N. O'CONNELL, R. RUSSELL, & F. TOOMEY: Estimating QoS parameters for ATM traffic using its entropy.
- 18: G.A.T.F. DA COSTA: Yang-Bacterization of BH algebra. (Revised version)
- 19: G.A.T.F. DA COSTA, & L. O'RAIFEARTAIGH: Non-trivial non-canonical W-algebras for Kac-Moody reductions. (Revised version)
- 20: J. CHELA-FLORES: Some physical problems in biology.
- 21: B.P. DOLAN: Symplectic geometry and Hamiltonian flow of the renormalisation group equation.
- 22: G. JORJADZE, L. O'RAIFEARTAIGH, & I. TSUTSUI: Quantization of a relativistic particle on the  $SL(2, \mathbf{R})$  manifold based on Hamiltonian reduction.
- 23: M.A. VAN ELICK, D. O'CONNOR, & C.R. STEPHENS: Environmentally friendly renormalization in finite temperature field theory.
- 24: A.E. PATRICK, & V.A. ZAGREBNOV: Parallel dynamics for an extremely diluted neural network.
- 25: N.G. DUFFIELD, & D.J. DALEG: Bounds and comparisons of the loss ratio in queues driven by an M/M/D source.
- 27: N.G. DUFFIELD: Economies of scale in queues with sources having power-law large deviations.
- 28: D.B. ABRAHAM, D. O'CONNOR, A.O. PERRY, & P.J. UPTON: Correlation functions on cylinders.
- 29: N. O'CONNELL: Review of 'Lectures on the coupling method', by Torgny Lindvall.
- 30: N.G. DUFFIELD, J.T. LEWIS, N. O'CONNELL, R. RUSSELL, & F. TOOMEY: Entropy of ATM traffic streams : a tool for estimating QoS parameters.
- 31: N.G. DUFFIELD, J.T. LEWIS, N. O'CONNELL, R. RUSSELL, & F. TOOMEY: Predicting quality of service for traffic with long range fluctuations.
- 32: M. RAKOWSKI: Topological modes in dual lattice models.
- 33: M.A. VAN ELICK, D. O'CONNOR, & C.R. STEPHENS: Critical temperature and amplitude ratios from a finite temperature renormalization group.
- 34: N. O'CONNELL: Queue-lengths and departures at a single-server multi-class queue.
- 35: J. CHELA-FLORES: Preservation of relics from the RNA world through natural selection, symbiosis and horizontal gene transfer.
- 36: T.C. DORLAS, N. MACRIS, & J.V. PULÉ: Localisation in single Landau bands.
- 37: T.C. DORLAS, N. MACRIS, & J.V. PULÉ: Localisation in a single-band approximation to random Schrödinger operators in a magnetic field.
- 38: M.P. TUITE: Generalised moonshine and abelian orbifold constructions.
- 39: B. DOLAN: Chaotic behaviour of renormalisation flow in a complex magnetic field.
- 40: D.J. HURLEY, & M.A. VANDYCK: On the concepts of Lie- and covariant derivatives of spinors. Part III: Comparison with the invariant formalism.
- 41: M.A. VANDYCK: Dust- and radiation-filled homogeneous and isotropic universes in four-dimensional generalised dilation-gravity theory.
- 42: F. FREIRE, D.J. O'CONNOR, & C.R. STEPHENS: The specific heat of a ferromagnetic film.
- 43: J.T. LEWIS, C.-E. PFISTER, & W.G. SULLIVAN: Entropy, concentration of probability and conditional limit theorems.

## 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 *Entropy: from the steam engine to the information highway* was delivered by Prof. J.T. Lewis on 9 December in Trinity College Dublin.

### 5.2 Seminar and review lectures given at DIAS-STP

- Prof. J. Chela-Flores (I.C.T.P., Trieste) *Some physical problems in biology*
- Prof. D. Dhar (Bombay, & Cambridge) *Deposition and evaporation of trimers on a line*
- Prof. D.J. Daley (Australian National University, Canberra) *Transactional datasets and queues*
- Dr. C. Donnelly (Edinburgh) *A multivariate test for use in the attribution of authorship*
- Prof. M.E. Fisher (Leiden and Maryland) *Phases and phase diagrams: Gibbs' legacy today*
- Dr. C. Ford *Cohomology and anomalies*
- Dr. B. Gorman (Florida State University) *Finite-range-scaling analysis of nucleation in model systems with long-range interactions*
- Dr. B. Hambly (Edinburgh) *Diffusion on fractals*
- Prof. W. Hunziker (Zürich) *Scattering theory*
- Dr. S. Jacka (Warwick) *Conditioned Markov processes*
- Prof. C. King (Northeastern Univ., U.S.A.) *A link invariant from the Chiral Potts model*
- Dr. F. Krahe *Jackiv's paper on cocycles*
- Dr. F. Krahe *Problems of non-abelian cochains*
- Dr. F. Krahe *BRST and all that*
- Dr. F. Krahe *On the algebra of ghost-fields*
- Dr. H. Maassen (Nijmegen) *Bell's inequalities: the need for a non-commutative probability theory*
- Dr. H. Maassen (Nijmegen) *A Fock space representation for the quantum Lorentz gas*
- Dr. P. McGill (UNC, Chapel Hill) *A random pursuit problem*
- Prof. W. McGlenn (Notre Dame) *The Morse theory and topology of configuration space*
- Prof. K.T. Mahanthappa (Boulder, Colorado) *Composite gauge-field models and dynamical symmetry breaking*
- Prof. K.T. Mahanthappa (Boulder, Colorado) *Supersymmetric non-linear  $\sigma$ -model in 2+1 dimension*
- Dr. I. Marshall (Leeds) *Modified systems found by symmetry reduction on  $T^*G$*
- Prof. L. Mikheev (NORDITA, Denmark) *Critical phenomena in magnetic multilayers*
- Dr. N. O'Connell *Genealogical processes*
- Prof. S. Priezhev (Dubna) *Critical exponents for boundary avalanches of a sandpile*
- Prof. S. Priezhev (Dubna) *An exactly solvable model of automobile traffic*
- Dr. M. Rakowski *State sum models and simplicial cohomology*
- Prof. W. Rühl (Kaiserslautern) *A resumé of critical  $O(N)$ -vector nonlinear sigma-models*
- Prof. S. Sen (TCD) *Localisation formulae*
- Dr. Y. Shnir (Belarus) *Atomic systems in external monopole field*
- Dr. Y. Shnir (Belarus) *Behaviour of atom like system in monopole field*
- Dr. T. Shnir (Belarus) *Problem of interaction between monopole and line current*

- Prof. W. Skrypnik (Kiev) *Gibbs states of one- and two- dimensional systems of particles with magnetic Chern-Simons type interactions*
- Mr. M. Sortais (EPFL, Lausanne) *Large deviations and the Csiszar projection*
- Mr. F. Toomey *Queues in finite buffers*
- Prof. D. Wilkie (Watson and Sons, London) *Risk theory*

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

- Prof. I. Barashenkov (Capetown) *Non relativistic Chern-Simons solitons*
- Prof. F. Brandt (Amsterdam) *The BV-antibracket cohomology and Noether's theorem*
- Dr. J. Burzlaff (DCU) *Existence theorems for 90° vortex-vortex scattering*
- Dr. G. da Costa *Knot theory and lattice algebras*
- Dr. C. Ford *The multi-scale effective potential*
- Dr. F. Krahe *Causal construction of nonabelian gauge theories*
- Dr. C. Nash *S-duality and 4-D Yang-Mills theories*

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

- Prof. J.T. Lewis *Preparing a technology business plan* Forbairt, May
- Prof. L. O'Raiheartaigh *Group theory and gauge interactions course* DIAS
- Dr. E. Buffet *The martingale theory of financial markets* DCU, October, November *Random walks and electric networks*, DCU, November
- Dr. J. Burns *On the central series of groups* U.C.G., March
- Dr. B. Dolan (Maynooth) *Geometry and the renormalisation group* T.C.D., May
- Dr. T. Garavaglia (DIT) *Quantum theory course* DIT
- Dr. P. Lynch (Met. Service, Glasnevin) *Climate modelling* U.C.D., January
- Dr. C. Nash (Maynooth) *Cryptology course* Maynooth, November

- Dr. Ó Sé (Carlow) *An introduction to statistical process control* Carlow, Swords, Wexford
- Dr. N. O'Connell *Overflow probabilities for the single server queue* D.C.U., February; T.C.D., April
- Dr. D.J. O'Connor *The renormalization group and crossover in field theory* T.C.D., May
- Dr. A. Ottewill (Oxford) *Long range quantum effects of cosmic strings* U.C.D., May
- Prof. D.H. Tchrakian (Maynooth) *Chern-Simons solitons* T.C.D., May
- Dr. M. Tuite (Galway) *Monstrous moonshine and orbifolds in string theory* T.C.D., May
- Dr. M. Vandyck (UCC) *What physics has to learn from philosophy* U.C.C., October

### 5.5 Seminars, Lectures and Courses given abroad

- Prof. J.T. Lewis *Stochastics, dynamics and complexity* (London)
- Dr. J. Burzlaff (DCU) *Existence theorems for 90° vortex-vortex scattering* (Cambridge) *Geodesic approximation of soliton-like solutions* (Kaiserslautern)
- Prof. J. Chela-Flores (Trieste) *Some physical problems in biology: aspects of the origin and structure of the first cell* (Trieste) *Beyond protein folding: towards the basis of DNA bending and folding* (Trieste)
- Dr. B. Dolan (Maynooth) *Co-variant derivatives and the renormalisation group equation* (DAMPT) *Chaotic renormalisation flow in the one-dimensional Ising model* (Southampton) *Hamiltonian flow of the renormalisation group equation*, (Southampton)
- Dr. T. Garavaglia (DIT) *Four jet signals for Higgs detection* (UCLA)
- Dr. M. Golden (DIT) *General methods for solving non-inertial viscoelastic boundary value problems* (Series of ten lectures, Udine)
- Dr. F. Krahe *Causal construction of massive Yang-Mills theories* (Aachen)

- Dr. P. Lynch (Met. Service) *Richardson's marvellous forecast* (Bergen, Norway)
- Prof. P. McGill (U.C. Irvine) *Path properties in supercritical branching* (Chapel Hill, North Carolina) *Poursuite aléatoire* (Luminy)
- Dr. C. Nash (Maynooth) *Combinatorial formulation of topological quantum field theories* (Karlsruhe)
- Dr. Ó Sé (Carlow, R.T.C.) *Graph theory and combinatorial mathematics* (Flensburg, Germany)
- Dr. N. O'Connell *The genealogy of branching processes and the age of our most recent common ancestor* (Minneapolis) *Large deviations and overflow probabilities for queueing networks* (Minneapolis) *Genealogical processes* (ICMS, Luminy) *Statistical issues raised by the Bellcore data* (Cambridge) *Overflow probabilities for the single-server queue* (Edinburgh)
- Dr. D.J. O'Connor *Crossover in field theory with applications to finite size scaling and finite temperature field theory* (Bristol, Princeton, UCLA, Moscow, Pittsburg) *Crossover in classical and quantum systems* (Protvino, Russia) *Environmentally friendly renormalization* (Essen, Wuppertal, UNAM Mexico, UCSB Santa Barbara, Syracuse) *Crossover scaling: a renormalization group approach* (Dubna) *Quantum to classical crossover in field theory* (UNAM Mexico) *Crossover in field theory with applications to finite temperature field theory and cosmology* (Mexico) *Geometry and the renormalization group* (UCSD San Diego)
- Dr. M. Rakowski *State sum models and simplicial cohomology* (Harvard, Northeastern, Illinois at Chicago, Oklahoma, Berkeley, San Diego, Davis Universities, Amsterdam)
- Mr. R. Russell *Large deviation properties of some bursty models of ATM traffic* (Cambridge)
- Prof. A. Solomon (Open Univ.) *Quantum optics; from groups to Lie groups* (UNAM) *Real lasers and other deformed objects* (Cocoyoc) *Quantum bosons as a phenomenological tool in quantum optics*

(Osaka) *Group theory in superconductivity: from BCS to the Hubbard model* (Tokyo) *A phenomenological theory of quantum optics* (Tokyo) *Numbers without end* (Nottingham)

- Dr. C.R. Stephens *Renormalization group theory of crossovers* (Oxford) *Environmentally friendly renormalisation* (Sussex, Imperial College, Lisbon) *Environmentally friendly renormalization in finite size systems* (Northumbria) *Do black holes exist?* (Adelaide)
- Mr. F. Toomey *Queues in finite buffers* (Cambridge)

## 6 Activities of Staff and Associates

### 6.1 Activities within Ireland

PROF. J.T. LEWIS: University of Limerick, 16 February; Forbairt, 31 May; INULS Conference, University College Cork, 9-11 September; Science, Technology and Innovation Advisory Council, Dublin, 19 September; P.D. Barry Conference, University College Cork, 21-22 October.

DR. J. BURNS: Groups in Galway, University College Galway, 18-20 May.

DR. E. BUFFET: Mathematics in Finance, Dublin City University, 10 June.

DR. B. DOLAN: 1st. Irish Quantum Field Theory meeting, Trinity College Dublin, May.

DR. P. LYNCH: Climate, climate variations and climate change: the Irish response, University College Dublin, January.

DR. C. NASH: 1st. Irish Quantum Field Theory meeting, Trinity College Dublin, May.

PROF. A. O'FARRELL: P.D. Barry Conference, University College Cork, 21-22 October.

DR. M. RAKOWSKI: 1st. Irish Quantum Field Theory meeting, Trinity College Dublin, May.

### 6.2 Activities outside Ireland

PROF. J.T. LEWIS: University of Cambridge, 26 January; "Rencontre de Physique Statis-



- tique", Paris, 27-28 January; 11th. UK Teletraffic Symposium, Cambridge, 23-25 March; IEE, London, 11-12 May; STATMECH-10, King's College, London, 25-27 May; ATM Networks Workshop, Bradford, 4-7 July; QCM 1994: International Workshop on Quantum Communications, Nottingham, 12-15 July; EPFL, Lausanne, 15 August - 3 September; EXPLOIT Workshop, Basel, 13-16 September; Cambridge and Queen Mary and Westfield College, London, 16-18 November; Various Institutions, Stockholm, 21-25 November; ACTS and ESPRIT projects, Budapest, 30 November - 4 December; Stochastic Networks Workshop '94, Cambridge, 15-17 December.
- L. O'RAIFEARTAIGH: Member of selection committee for Wigner-Medal for contributions to Group Theory in Physics, awarded to V. Kac and L. Moody at Conference on Group Theoretical Methods in Physics, Osaka, Japan, July; Workshop on Quantum Systems: New Trends and Methods, Minsk, Belarus, May; VI Symposium on Symmetries in Science, Kloster, Mehrerau, Bregenz, 8-16 August; Seminar on Dirac Reduction and its Quantization, Syracuse, November; University of Notre Dame, Indiana, 1 September - 31 December.
- DR. E. BUFFET: Paris Conference on Disordered Systems, 25-28 July.
- DR. J. BURZLAFF: Cambridge University, 2-10 October; Kaiserslautern, 12 October - 31 December.
- PROF. J. CHELA-FLORES: Third Trieste Conference on Chemical Evolution, Trieste, 29 August - 2 September; Sixth College of Biophysics, Trieste, 26 September - 14 October.
- DR. G.A.T.F. DA COSTA: XXVI Summer Institute, Université de Paris-Sud, 31 July - 13 August.
- DR. B. DOLAN: DAMPT, Cambridge, 14-15 April; 15th. Theoretical High Energy Physics U.K. Institute, Southampton, 28 August - 9 September; Rutherford Particle Theory Meeting, 21-23 December.
- DR. N. DUFFIELD: 11th. UK Teletraffic Symposium, Cambridge 23-25 March; Stochastic Networks Workshop '94, Cambridge, 15-17 December.
- DR. C. FORD: XXVI Summer Institute, Université de Paris-Sud, 31 July - 13 August; University of Notre Dame, 29 November - 9 December.
- DR. T. GARAVAGLIA: Research Professor, UCLA, January - September; LHC Physics Workshop, California Institute of Technology, 4-8 March.
- DR. M. GOLDEN: International Centre for Mechanical Sciences, Udine, Italy, 5-9 September; Euromech, 2nd. European Solid Mechanics Conference, Genoa, 12-16 September.
- DR. F. KRAHE: RWTH-Aachen, January; Univ. Zürich, Switzerland, January.
- DR. P. LYNCH: Bracknell 21-22 February; Analysis, Initialization and Data Assimilation, Hirlam Workshop, Norrköping, 23-24 February; Hirlam Advisory Committee, Copenhagen, 18-19 April; ECMWF Scientific Advisory Committee, 21-22 April; 75th. Anniversary Polar Front Theory, Bergen, 27 June - 1 July; Hirlam All-Staff Meeting, Oslo, 25-26 August; Scientific Advisory Committee, ECMWF, 26-28 September; Meteorological Institute, Stockholm University, 29-30 September; Advisory Committee Meeting of Hirlam, Madrid, 27-28 October.
- PROF. P. MCGILL: Bernoulli Conference, Chapel Hill, North Carolina, 19-24 June; Séminaire de Probabilités, Luminy, France, 23-29 September; Université Louis Pasteur, Strasbourg, October - December.
- DR. C. NASH: Institut für Theoretische Physik, Karlsruhe, July; Isaac Newton Institute, Cambridge, September.
- DR. Ó SÉ: Flensburg, Germany, 31 October - 4 November.
- DR. N. O'CONNELL: Mathematical population genetics, University of Minnesota, Minneapolis and University of California at Berkeley, 23 January - 16 February; Stochastic Partial Differential Equations, Edinburgh, IEE and 11th UK Teletraffic Symposium, Cambridge, 21 March - 1 April; Queen Mary and Westfield College, London, 16-28 May; ICMS, Luminy, Marseilles, 25 September - 2 October; Stochastic Networks Workshop '94, Cambridge, 15-17 December.

- DR. D. O'CONNOR: Institute for Physics, Amsterdam, 2-19 May; International Bogoliubov Symposium, Dubna, Russia, 13 August - 9 September; University of Bristol, 23-30 October; Institute for Advanced Study, Princeton, Universities of Pittsburgh, Syracuse, Texas, Austin, California, Los Angeles, Santa Barbara, San Diego, Seattle, Washington, CALTECH, Pasadena, and Universidad Nacional Autónoma de México, 7 November - 31 December.
- DR. A. O'FARRELL: Leeds, February; Nottingham, February; Toulouse, February; UDSM, Tanzania, April; Princeton, and B.V. Universities, May; Wermerfest, Brown University, May; Salamanca, July; Lisbon, Coimbra, Evora, July; Function theory meeting, Imperial College, September.
- DR. M. RAKOWSKI: University of Amsterdam, 28 July - 11 August; Harvard, Northeastern, Illinois at Chicago, Oklahoma, UC Berkeley, UC San Diego and UC Davis Universities, 2-27 November;
- MR. R. RUSSELL: 11th UK Teletraffic Symposium, Cambridge, 23-25 March; Stochastic Networks Workshop '94, Cambridge, 15-17 December.
- PROF. A. SOLOMON: City College, New York, 8-18 March; UNAM Mexico, 19-22 March; Cocoyoc, Mexico, 22-26 March; Brighton, 11 April; Osaka, Japan, 2-9 July; Tokyo University, Japan, 9-12 July.
- DR. C. STEPHENS: Oxford and Sussex Universities, 5-15 February; Imperial College London, 7-19 March; NATO Conference, Lisbon, 19-27 March; University of Northumbria, Newcastle upon Tyne, 19 April; University of Amsterdam, 21 April - 5 May; University of Adelaide, Australia, 20-22 May;
- MR. F. TOOMEY: 11th UK Teletraffic Symposium, Cambridge, 23-25 March; Cambridge and Queen Mary and Westfield College, London, 16-18 November; Stochastic Networks Workshop '94, Cambridge, 15-17 December.

## 7 Symposia

Two Mathematical Symposia were held during

the year, 30-31 March and 20-21 December. The attendance (29 in March, 38 in December) included professors, lecturers, and graduate students from the Irish universities and other third-level and research institutes, and from institutes abroad, and members of the scientific schools of DIAS.

Lectures were given as follows:

March

Review Lectures:

- Prof. B. Straughan (Glasgow) *Improperly posed problems*
- Prof. F. Holland (UCC) *Inequalities, old and new*

Lectures:

- Dr. J.V. Pulé (UCD) *Localization in the presence of a magnetic field*
- Dr. C. Stephens (DIAS) *The renormalisation group: an overview*
- Prof. A. Wood (DCU) *Asymptotics of the M-matrix and spectral function for high order differential equations*
- Dr. F. Krahe (Zürich) *Causal construction of quantum gauge theories*

Short Talks:

- Dr. F. Ó Cairbre (Maynooth) *Dynamics of a laser system*
- Dr. D. Redmond (Maynooth) *Some mathematical problems in chemistry*
- Dr. S. O'Brien (Limerick University) *A model for the cleansing of silicon substrates*
- Dr. C. Ford (DIAS) *Feynman diagrams and the method of characteristics*
- Dr. B. Goldsmith (DIT) *Isomorphic automorphism groups*
- Prof. J.T. Lewis (DIAS) *Entropy: a useful tool in statistical multiplexing*

December

Review Lectures:

- Dr. E. Buffet (DCU) *Martingales and the stock exchange*
- Dr. B. Lenoach (SCR, Cambridge) *Hydraulic fractures: mathematical modelling and its industrial application*

Lectures:

- Dr. S. Gardiner (UCD) *Harmonic approximation and the Dirichlet problem*

- Prof. D. Daley (Canberra) *Epidemic models : stochastic and deterministic : some problems*
- Dr. S. O'Brien (Univ. Limerick) *Mathematical model for the waterproofing of telecommunications cables*
- Dr. B. Goldsmith (DIT) *Isomorphic automorphism groups of vector spaces and modules*

## Short Talks:

- Dr. E. Gath (Univ. Limerick) *Periodic orbits of area-preserving polynomial maps*
- Dr. M. Meere (UCG) *Some moving boundary problems arising from non-linear diffusion models*
- Dr. T. Murphy (TCD) *Absolute entropy*
- Prof. A. Solomon (Open Univ.) *A no-go result for a generalized exponential function*

## Software Demonstration:

- Prof. P. Quinlan (UCC) *Easytrim : a computer programme for Laplace problems using the edge-function method*

## 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):

- I. Barashenkov (Capetown) 19-24 June,
- F. Brandt (Amsterdam) 17 October,
- S. Crosby (Cambridge) 28-29 June,
- D. Daley (Canberra) 17-21 December,
- D. Dhar (Bombay, & Cambridge) 12-15 June,
- P. Dolan (Imperial College, London) 31 March,
- C. Donnelly (Edinburgh) 6-8 April,
- M. Fisher (Maryland) 24-27 January,
- J.N. Flavin (U.C.G.) 28-31 March,
- B. Gorman (Florida) 14-17 July,
- B. Hambly (Edinburgh) 6-8 April,

- F. Holland (U.C.C.) 31 March,
- B. Hu (Maryland) 29 May - 1 June,
- S. Jacka (Warwick) 9-10 June,
- I. Leslie (Cambridge) 28-29 June,
- D. McAuley (Cambridge) 28-29 June,
- K.T. Mahanthappa (Boulder, Colorado) 21-28 April,
- L. Mikheev (Denmark) 22-27 January,
- W. Rühl (Kaiserslautern) 20-24 April,
- M. Sortais (Lausanne) 2 February,
- B. Straughan (Glasgow) 28-31 March,
- D. Wilkie (London) 9-10 June.

## Longer visits:

- J. Chela-Flores (Trieste) 12 April - 4 June, 31 October - 18 November,
- D.E. Evans (Swansea) 22-30 October,
- W. Ford (Ann Arbor) 1-30 June,
- F. Freire (Heidelberg) 9-16 April,
- J. Gaite (Madrid) 25 September - 5 October,
- C. Graham (Canada) 5 May - 23 December,
- C. King (Northeastern Univ., USA) 4-18 August,
- H. Maassen (Nijmegen) 17-23 January,
- P. McGill (North Carolina) 5-24 September,
- W. McGlenn (Notre-Dame) 1 January - 1 August,
- I.D. Marshall (Leeds) 16-30 May,
- R.F. O'Connell (Louisiana) 9-30 June, 1-8 August,
- C. Pfister (Lausanne) 21-30 March, 9-14 November,
- V. Priezhev (Dubna) 6 May - 4 June,
- A.V. Razumov (Moscow) 20 May - 18 June,
- Y. Shnir (Belarus) 17 February - 3 March,
- W.I. Skrypnik (Kiev) 7 November - 7 December,
- R. Sorkin (Syracuse) 18-28 May,



P. Upton (Oxford) 15-30 January.

## 9 Publications

### 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

- N.G. Duffield, J.T. Lewis, N. O'Connell, R. Russell, & F. Toomey: Statistical issues raised by the Bellcore data. *Proceedings of the Eleventh UK Teletraffic Symposium, March 1994.*
- N.G. Duffield, J.T. Lewis, N. O'Connell, R. Russell, & F. Toomey: The entropy of an arrivals process: a tool for estimating QoS parameters in ATM traffic. *Proceedings of the Eleventh UK Teletraffic Symposium, March 1994.*
- N.G. Duffield, & N. O'Connell: Large deviations for arrivals, departures and overflow in some queues of interacting traffic. *Proceedings of the Eleventh UK Teletraffic Symposium, March 1994.*
- S.N. Evans, & N. O'Connell: Weighted occupation times for branching particle systems and a representation for the supercritical superprocess. *Canadian Math. Bull.* **37**(1994)187-196.
- G.A.T.F. da Costa, & L. O'Raifeartaigh: Non-trivial non-canonical W-algebras from Kac-Moody reductions. *Phys. Lett. B.* **333**(1994)353-363.
- L. Fehér, L. O'Raifeartaigh, P. Ruelle, & I. Tsutsui: On the completeness of the set of classical w-algebras obtained from DS reductions. *Commun. Math. Phys.* **162**(1994)399-431.
- G. Jorjadze, L. O'Raifeartaigh, & I. Tsutsui: Quantization of a relativistic particle on the  $SL(2, \mathbf{R})$  manifold based on Hamiltonian reduction. *Phys. Lett. B.* **336**(1994)388-394.
- L. O'Raifeartaigh: Path-integral WZNW-Toda reductions. *Quantum groups, integrable models and statistical systems* eds. J. Le-Tourneux and L. Vinet, World Scientific, 1994.
- L. O'Raifeartaigh: Toda systems as constrained linear systems. *Non-compact Lie groups and their applications* eds. E. Tanner and R. Wilson, Kluwer, 1994.
- L. O'Raifeartaigh: The geometrization of physics. *New directions in the application of symmetry principles to physics* ed. J. Schechter, World Scientific, 1994.
- L. O'Raifeartaigh: The emergence of gauge theory. *Mathematical physics toward the 21st Century* eds. R. Sen and A. Gersten, Ben Gurion University Press, Beersheba, 1994.
- L. O'Raifeartaigh: Anomalies. *Proceedings of 1993 Erlangen Autumn School on non-perturbative methods in physics, Erlangen Lecture Notes, 1994.*
- A. Patrick: The influence of external boundary conditions on the spherical model of a ferromagnet I: Magnetization profiles. *J. Stat. Phys.* **75**(1994)253-295.
- Ph. Ruelle: Automorphisms of the affine  $SU(3)$  fusion rules. *Commun. Math. Phys.* **160**(1994)475-492.
- Y. Kubyshin, D. O'Connor, & C.R. Stephens: Dimensional crossover from non-renormalizability to renormalizability. *Classical and Quantum Gravity* **10**(1993)2519-2530.
- C. Nash, D. O'Connor, & S. Sen: Central extensions of sphere groups and their Lie algebras. *J. Math. Phys.* **34**(1993)3269-3272.
- F. Freire, D. O'Connor, & C.R. Stephens: Dimensional reduction and the non-triviality of  $\lambda\phi^4$  in four dimensions at finite temperature. *Mod. Phys. Lett. A* **8**(1993)1779-1793.
- D. O'Connor, & C.R. Stephens: Crossover scaling: a renormalization group approach. *Proc. Royal Soc. A.* **444**(1994)287-296.

- D. O'Connor, & C.R. Stephens: Environmentally friendly renormalization. *Int. J. Mod. Phys. A* **9**(1994)2805-2902.
- D. O'Connor, & C.R. Stephens: Effective critical exponents for dimensional crossover and quantum systems from an environmentally friendly renormalization group. *Phys. Rev. Lett.* **72**(1994)506-509.
- D.B. Abraham, D. O'Connor, A.O. Perry, & P.J. Upton: Correlation functions on cylinders. *Phys. Rev. Lett.* **73**(1994)1742-1745.
- F. Freire, D. O'Connor, & C.R. Stephens: Dimensional crossover and finite size scaling below  $T_c$ . *J. Stat. Phys.* **74**(1994)219-238.
- M.A. van Eijck, D. O'Connor, & C.R. Stephens: Environmentally friendly renormalization in finite temperature field theory. *Proc. Sintra Workshop on Thermal Field Theory, 1994*
- J. Burzlaff, A. Chakrabarti, & D.H. Tchrakian: Generalised Abelian Higgs models with self-dual vortices. *J. Physics A* **27**(1994)1617.
- F. Abdelwahid, & J. Burzlaff: Existence theorems for  $90^\circ$  vortex-vortex scattering. *J. Maths. Phys.* **35**(1994)4651.
- C. Ford: Multi scale renormalization group improvement of the effective potentials. *Phys. Rev. D* **50**(1994)7531.
- D. McMullan: Constrained quantisation, gauge fixing and the Gribov ambiguity. *Commun. Math. Phys.* **160**(1994)431-456.
- D. McMullan, & I. Tsutsui: BPST instanton and spin from inequivalent quantizations. *Phys. Lett. B.* **320**(1994)287-293.
- B. Piette, B.J.W. Müller-Kirsten, W.J. Zakrzewski, & D.H. Tchrakian: A modified Mottola-Wipf model with instanton and sphaleron fields. *Phys. Lett. B.* **320**(1994)294-298.
- V.I. Gaiduk, B.M. Tseitlin, V.V. Gaiduk, & J.R. McConnell: The complex susceptibility of a two-potential system of reorientating polar molecules. *Physica A* **205**(1994)528-547.
- B. Dolan: A geometric interpretation of renormalisation group flow. *Int. J. Mod. Phys. A* **9**(1994)1261-1286.
- E. Buffet, & N.G. Duffield: Exponential upper bounds via martingales for multiplexers

with Markovian arrivals. *J. Appl. Prob.* **31**(1994)1049-1060.

## 10 Library

Two hundred and twenty eight 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. 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.

A database of the titles of Prof. Synge's collection of books was completed and a database of his publications was prepared by a vacation student. The computerisation of the main library catalogue commenced and the card catalogue has now been closed.

Annual Report of the Governing Board of School of Cosmic Physics for the year ending 31 December 1994 adopted at its meeting of 1 February 1996.

## 1 Staff, Scholars and Associates

SENIOR PROFESSORS: A.W.B. Jacob (Director), E.J.A. Meurs (from 1 April).

PROFESSORS: A. Thompson, (two vacancies).

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

RESEARCH ASSISTANTS: I. Elliott, (two vacancies).

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

VISITING SCIENTISTS: J. Betts (Old Royal Observatory, Greenwich), V. Blain (Macquarie University, Sydney), A.O. Camillas (Fabra Observatory, Barcelona), J. Edwards (Edinburgh), R. Evans (Edinburgh), S.A.G. Falle (University of Leeds), M. Fujiwara (Ochanomizu University, Tokyo), G. Hirth (Max Planck Institute for Astronomy, Heidelberg), R. Kind (Potsdam), J.X. Liu (University of Hamburg), J. Makris (University of Hamburg), L.A. Mendes Victor (Lisbon), M. Morimoto (Kagoshima University, Japan), R. Mundt (Max Planck Institute for Astronomy, Heidelberg), J. Neuberger (University of Leeds), O. Novak (Karlsruhe), T. Pointer (University of Leeds), C. Prodehl (University of Karlsruhe), M. Smyth (ROE, Edinburgh), M. Walmsley (MPI for Radioastronomy, Bonn).

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, (three vacancies).

SCHOLARS: J. Bosch (to 31 December), G.F. Byrne, M. Corcoran, T. Downes, K. Farrell, F. Hauser, A.J. Keane, P. Kelly (from 1 October to 31 October), F.E. Murphy, O. Novak (from 1 October), I. O'Brien, C. O'Byrne (to 30 September), B. O'Reilly.

PROJECT SUPPORTED POSITIONS: J. Byrne (IRMA), J. Eisloeffel (HCM, to 31 February), F. Hauser (RAPIDS), B. O'Reilly (RAPIDS), S.C. Russell (ISOPHOT), I.G. van Breda (Instrumentation Project, to 31 March).

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

RESEARCH ASSOCIATES: C.J. Bean (UCD), P.B. Byrne (Armagh), M. Cawley (SPCM), D. Corcoran (DCU), 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, 11 July - 16 September), Fergal Dalton (DCU, 25 July - 23 September), Audrey Eager (St Patrick's, 28 February - 11 March), Alison Musgrave (TCD, 4 July - 12 August), Paul Reilly (TCD, 20 June - 16 September).

## 2 Research Activities in the Cosmic Ray Section

### 2.01 Non-Equilibrium Effects in Molecular C-Shocks

#### *I. O'Brien and L. Drury*

A Monte-Carlo simulation to calculate the non-thermal level populations of  $H_2$  was developed. Calculations show that significant non-thermal populations are an inevitable result of ambipolar diffusion in low-density media and, therefore, of shocks in low-ionisation magnetised regions. This model could help to explain observed highly non-LTE  $H_2$  states in Orion and IC443.

## 2.02 Secular Evolution of Shock Structures

*K. Farrell and L. Drury*

Arising from work on earlier explicit adaptive grid algorithms, a new algorithm is in the final stages of development. Preliminary results indicate that explicit adaptive grid generation for moving features (shocks, discontinuities, etc.) is possible. Having incorporated the algorithm into a previously developed, first-order, semi-implicit hydrodynamical scheme, several tests have been conducted. For the case of a single shock, or for shocks which are (sufficiently) spatially separated, the generation of a moving adaptive grid is successful. In addition, the resolution and tracking of such structures is superior to that achieved in the older methods. The problem of interacting features has been examined also, with the conclusion that their treatment is certainly non-trivial.

## 2.03 Hydrodynamical Simulations of Jets with Cooling

*T. Downes, T. Ray and L. Drury*

A fully 2-dimensional first order explicit hydrodynamic code which takes account of radiative losses from both atomic and molecular species has been written and tested. Preliminary simulations of the HH46/47 outflow give a derived luminosity of the 2.12 micron line of molecular hydrogen which is of the same order as the observed luminosity. At present, work is underway to complete a temporally and spatially second order accurate code which will incorporate formation and dissociation of molecular hydrogen and carbon monoxide. It will then be used, in conjunction with observational results, to explore the parameter space of YSO jets in an attempt to explain the physical origins of the shocks which give rise to the observed radiative emissions.

## 2.04 Existence of Smooth Cosmic Ray Dominated Shock Structures

*L. Drury with E.G. Berezhko (Yakutsk) and H.J. Völk (Heidelberg)*

Stimulated by a discrepancy between the "simplified models" for SNR evolution including effects of particle acceleration and the recent, more detailed, models calculated by Berezhko et al, the conditions under which completely smooth cosmic ray dominated shocks can exist were

reexamined. For realistic diffusion coefficients it turns out that expanding spherical shocks cannot in general become cosmic ray dominated, in agreement with the calculations of Berezhko. The disagreement with the "simplified model" calculations was traced to a subtle problem with the choice of diffusion coefficient. These results are significant for the interpretation of supernova remnant observations.

## 2.05 Expectations from Acceleration Theory for UH Abundancies in the GCR

*L. Drury*

The surprisingly high UH, and in particular r-process, nuclear abundances in the Galactic cosmic rays (GCR) found in the preliminary analysis of the UHCRE, supported also by the earlier HEAO and Ariel-6 data, have been generally taken to imply support for the conventional supernova remnant model for the origin of cosmic rays. However an attempt to estimate, on the basis of conventional acceleration theory, the UH enhancement expected in the GCR shows that the connection is not as simple as commonly supposed. Even if the supernova ejecta are taken to be contain only pure r-process nuclides the expected enhancement in the final accelerated population of cosmic rays should be less than 10% if the conventional picture of cosmic ray acceleration is correct.

## 2.06 Abundance Studies

*S.C. Russell*

An analysis of the lithium abundances in a number of delta Scuti stars was completed this year. These stars were thought to be candidates for explaining the lithium dip in evolved F5 dwarfs. The results have 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, if anything, 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.

Research has begun on the problem of why there appears to be a large dispersion in lithium abundances in stars of the Pleiades open cluster, while stars in the Hyades cluster, which is only slightly older, show no such dispersion. It is

suspected that chromospheric emission may alter the width of the lithium resonance line traditionally used for abundance analyses. The hypothesis is being tested by observing a subordinate line of lithium formed deeper in the atmosphere, and therefore, less affected by chromospheric emission.

## 2.07 ISOPHOT

*S.C. Russell, W.M. Tai and L. Drury*

As part of the scientific support for the Infrared Space Observatory (ISO) photopolarimeter, ISOPHOT, S. C. Russell assisted with calibration measurements carried out at Dornier, Germany. This programme was highly successful, and the results were brought back to DIAS for reduction.

W.M. Tai spent several weeks at MPIA, Heidelberg, during June and July working with the other members of the Instrument Dedicated Team on the software development for the interactive analysis. This was continued at further workshop meetings held in Dublin and at Rutherford Appleton Laboratory (England) in the Autumn. The IDL software required for this work was installed on the DIAS system.

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

*D. O'Sullivan, A. Thompson, L. Drury and A. Keane with K.-P. Wenzel (ESTEC)*

It became clear during the year that the UHCRE data system needed to be revised and the entry procedures streamlined. A logical naming scheme, and a relational database structure were designed and the old files converted to the new system. The opportunity was taken to move from the old VMS system to UNIX. An automated data-entry system was written to guarantee the format of the files and carry out some consistency checks.

Detector processing and track measurement continued throughout the year. All the ultra heavy cosmic ray events satisfying "first class" selection criteria have now been fully measured in forty-five UHCRE detector stacks, representing about 27% of the accessible collecting area. In addition, about one hundred fragmenting events have been measured as part of a parallel programme, started early in the year, to

investigate the systematics of nuclear and electromagnetic interactions of ultra heavy nuclei in the experimental setup. Further calibration work was initiated by exposing temperature controlled ( $\approx -15^\circ\text{C}$ ) detector stacks to a beam of 10 GeV/nucleon Au ions at the Brookhaven National Laboratory in September and to a beam of 160 GeV/nucleon Pb ions at CERN in December. The CERN beam was the highest energy, by an order of magnitude, ultra heavy ion beam achieved to date.

## 2.09 Nuclear Track Detector Response Studies

*A. Thompson and J. Bosch*

The question of isotropy of track response to relativistic ultra heavy nuclei in polycarbonate was investigated. Multiple exposures of a lexan polycarbonate detector stack to a 10.1 GeV/nucleon Au beam was carried out at the Brookhaven National Laboratory at constant temperature and varying zenith. Analysis of several hundred measurements of signal strength was conducted but no anisotropy was detected. The track response of the polycarbonate was found to be constant within experimental error over the full zenith range. Apart from its intrinsic value this result is relevant to optimisation of charge spectrum resolution in the DIAS/ESTEC Ultra Heavy Cosmic Ray Experiment.

## 2.10 Ionising Radiation Measurements at Aircraft Altitudes (IRMA)

*D. O'Sullivan and J. Byrne*

All detectors exposed on aircraft in 1993 were retrieved and initial examination of material from each of the aircraft exposures revealed the presence of charged particle tracks in all cases. It was evident from a preliminary investigation of the data that the track density and track characteristics varied significantly from aircraft to aircraft.

Initial scanning indicated particle densities ranging from  $1.8 \times 10^{-2}$  per  $\text{cm}^2\text{hr}$  for the Concorde to  $2.4 \times 10^{-4}$  per  $\text{cm}^2\text{hr}$  for the Aer Lingus Boeing 747. Preliminary analysis, pending detector calibration scheduled for February 1995, indicated that these particles had charge values equal to 2 (Helium) or greater and thus the presence of nuclei heavier than protons was confirmed at aircraft altitudes. Details of the charge spectrum will be determined following



further studies. The contribution of these nuclei to the overall particle intensity at aircraft altitudes will be determined in order to determine the radiation hazard to passengers.

The preliminary investigation of the combined techniques of the DIAS and ANPA (L. Tommasino and co-workers in Rome) groups indicated that the combined system satisfactorily separates low energy nuclear recoil events from the main cosmic ray flux. To continue the investigation, combined detector stacks were included in further exposures on the Irish Government Jet, and on a British Airways Concorde.

### 2.11 Herbig Ae/Be Stars

*M. Corcoran and T.P. Ray*

M. Corcoran has completed the task of acquiring and analyzing data in connection with his PhD thesis project. He is investigating whether disks exist around Herbig Ae/Be stars, a topic about which there is still considerable controversy. Studying a large sample of Herbig Ae/Be stars, it was found that their forbidden line emission can be divided into high and low velocity components (hereafter referred to as the HVC and LVC respectively). Velocities for the LVCs are less than 100 km/s whereas those of the HVCs can go up to 700 km/s. Both components were discovered to coexist in what appear to be the youngest stars, i.e. those with relatively large infrared excesses. Although the number of stars displaying a HVC was found to be small, in all cases the HVC was seen to be blueshifted with respect to the stellar systemic velocity at the star. Such velocity asymmetries are readily understood in terms of an obscuring disk which occludes the redshifted component of the flow, at least close to the star.

By far the majority of stars in the sample, however, showed LVC emission alone but here also a clear bias in favour of blueshifted velocities was found, once again supporting the disk hypothesis. The extent of the material causing the obscuration can be estimated from the fact that although the blueshifted HVC can be traced right back to the star in several cases, one has to go 1-2° in the opposite direction to see any redshifted flow. Given the typical distances to these stars, this is indicative of disks around 500 - 1000 AU in size. It is interesting also to note that the HVC on larger scales was found to

correspond to a spatially extended jet in every case that was examined in detail.

### 2.12 Post T Tauri Stars

*T.P. Ray with S.V.W. Beckwith (MPIA, Heidelberg) and A. Sargent (Caltech)*

A study of Post T Tauri stars (progenitors of stars like our own Sun) in binary systems has been completed. Using IRAS data, it has been discovered that these stars are surrounded by dust, probably in the form of a disk heated by the primary OB-type star in the system. Post T Tauri stars, although older than classical T Tauri stars, have ages around 30-100 million years and have not yet reached the main sequence. Caltech Submillimeter Observatory (CSO) observations (by Ray et al) have shown no evidence for millimeter continuum emission. The inferred upper limits to the amount of dust present ( $10^{-4}$  -  $10^{-5}$  solar mass) is typically one or two orders of magnitude lower than that found around classical T Tauri stars suggesting rapid evolution of the disk before a star reaches the post T Tauri phase. Such fast evolution is consistent with the idea that planets, like Jupiter and Saturn, formed very quickly in the primitive solar nebula and that possibly through their formation they "cleared out" much of the dust in the disk.

### 2.13 Near-infrared Imaging

*T.P. Ray with C. Davis (MPIA), R. Mundt (MPIA) and J. Eisloffel (DIAS/Grenoble)*

Deep near-infrared and optical imaging of the jet source L1551-IRSS was carried out. It was found that there was only a weak spatial correlation between the optical emission, recording shocks with a velocity of approximately 40 km/s, and the shocked molecular hydrogen emission which traces lower velocity shocks. Most models predict that these shocks should be closely related. It has been suggested in the past that there is a poorly collimated outflow component from this source in addition to the jet and that it is this component, rather than the jet that drives the associated molecular outflow. However, in this work it is shown that such a model does not account for many of the observations of IRS5 and other poorly collimated flows. It is hypothesised that in certain cases like L1551-IRSS, the opening angle of the outflow varies with time and that sources like IRS5 pass through alternate phases of poor and high collimation.

### 2.14 Propagated UH Cosmic Ray Charge Spectrum

*J. Bosch and A. Thompson*

A novel method of partial deconvolution was developed and applied to the published ultraheavy cosmic ray charge spectrum observed at detector level and derived from about 15% of the collecting area of the LDEF/UHCRE detector array. The deconvoluted spectrum was then propagated back outside the experimental setup. This propagation was carried out by computing cross-sections for charge changing nuclear interactions between cosmic ray nuclei and the experiment hardware components from empirical values and semi-empirical models. The values of the resulting corrections to abundance ratios were of the same order as those of the statistical errors for the relevant sample sizes. After propagation, the Actinide relative abundance,  $(Z \geq 88)/(75 \leq Z \leq 86)$ , was  $0.038 \pm 0.010$  while the Pt/Pb ratio,  $(75 \leq Z \leq 79)/(80 \leq Z \leq 86)$ , was  $2.05 \pm 0.28$ . These results are consistent with enrichment by r-process nucleosynthesis.

### 2.15 Observing Runs

*The Star Formation Group (T.P. Ray, M. Corcoran, S. Russell, T. Downes)*

Several successful observing runs were carried out during the year. These are listed separately in Section 5.4.2.

## 3 Research Activities in the Geophysics Section

### 3.01 Offshore Gravity

*P.W. Readman and B.M. O'Reilly*

#### 3.01.1 Marine gravity

Gravity modelling of the RAPIDS profiles have continued using the COOLE and HOGS data and the marine free-air anomaly as derived from satellite altimetry. Gravity has proved to be extremely useful in corroborating and, where

seismic control is poor, in refining the seismic derived model of the RAPIDS area. The final model for the crustal and upper mantle structure has now been significantly improved. By extracting the very long wavelength variations from the satellite data it has been possible to model the lithosphere/asthenosphere boundary (LAB) out to the Mid-Atlantic Ridge and to compare this with the theoretical predictions based on the thermal history of the lithosphere. Initial calculations are very promising but further numerical modelling of the fundamental processes are required to refine the general tectonic model for the development of the North Atlantic.

#### 3.01.2 Satellite Gravity

The satellite altimetry data from the GEOS and ERS-1 missions have been reprocessed by David Sandwell and co-workers and the results made available to DIAS. The older data, although showing good overall agreement with our surface data on the continental shelf west of Ireland (COOLE and HOGS data) do not resolve the finer structure. The newer processing technique has reduced the apparent smoothing and results in a much closer correspondence between the satellite and surface measurements. This has now been merged with the land data sets so that the more detailed gravity models from the land and near-offshore regions can be continued into the Rockall Trough.

### 3.02 Onshore Gravity

*P.W. Readman and T. Murphy with staff of British Geological Survey*

A new gravity image map of Ireland and surrounding shallow seas has been compiled in collaboration with the BGS using the DIAS and Geological Survey of Northern Ireland land data sets and a variety of offshore data sources. A simulated vertical illumination has been used to highlight high frequency variations in the gravity field. The technique has been shown to be extremely effective in highlighting tectonic lineaments in the upper crust which can be correlated with its tectonic history. A detailed geological interpretation of the map was undertaken which emphasized the development of the petroliferous offshore sedimentary basins. A similar type of interpretation is now under way for onshore Ireland. This interpretation is based on analysing horizontal gravity gradients. It is intended to integrate the results of this study with

the available magnetic data for Ireland and with the regional satellite gravity for the NE Atlantic. Production of the Half-Inch Bouguer Anomaly map series has continued with the preparation for publication of manuscript maps for Sheets Number 6, 7 and 25 (North Mayo, Sligo-Leitrim and South Cork).

### 3.03 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.

### 3.04 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 three events which occurred in Ireland during 1994 were, unusually, all in the northwest. They were interesting for a number of different reasons. Two of them, on 20 August and 30 November, were in the Belcoo area of north Co. Leitrim. The third was near Clonmany in northern Co. Donegal on 21 November. All had magnitudes greater than ML 2.

The north Donegal event on 21 November was well outside the DIAS network, although it was, like the Leitrim events, recorded on the British Geological Survey stations in Northern Ireland and in southwestern Scotland. The position made it difficult to measure the depth. However the indications were that it was quite shallow. It attracted considerable attention in the area and the local press and radio were very helpful in getting people to contact DIAS and provide the reports from which the macroseismic map is produced. The small area of high intensity suggests that the event was probably no more than 5 km below the surface. This is unusual in Donegal, where events are like those in western Scotland and are often heard rather than felt, indicating both high stress-drop and a deep crustal origin. Both the Donegal events and the analogous ones in western Scotland are associated with the Great Glen Fault and its splays.

The two Leitrim events were also over magnitude ML 2. Indeed the event on 30 November was, at 2.3, the largest instrumentally recorded event in Ireland since the network began in 1978. These events are particularly interesting in that they are the first ones that can be associated with the Highland Boundary Fault Complex. It is an active fault zone in Scotland and its track can be clearly seen on processed maps of the gravity field in Ireland. The three events recorded in Ireland in 1994 all had unusual features. The historical record is certainly incomplete but to have three events over magnitude ML 2 in one year seems not to have happened in the last three hundred years. The maximum intensity, MSK IV, was in line with previous data for Irish mainland events though higher intensities may be generated by events in the Irish Sea.

### 3.05 History of Irish Seismology

*T. Murphy*

A study was undertaken into the history of the early seismology stations at Mungret, Limerick and Rathfarnham, Dublin. This has shown that unique seismometers, some previously attributed to O'Leary and some unfortunately since destroyed, were constructed by unknown makers. The theory of how they functioned is being investigated.

### 3.06 KRISP 94 (Seismic programme in Kenya)

*G. Byrne, A.W.B. Jacob, G. Wallace, T. Blake, F. Hauser, C. Horan, F. Murphy, P.W. Readman and O. Novak with staff of European, United States and Kenyan Institutions.*

Early in 1994 eight of the Geophysics Section staff (the first eight named above) travelled to Kenya to take part in a seismic profile from the Indian Ocean to Lake Victoria. The Geophysics Section is a partner in an EU Contract to study the southern end of the Kenya Rift and its flanks. Principal targets include the Chyulu Hills Quaternary volcanic field in the east, the rift itself south of the Kenya Dome, and the transition to the Archean Nyanza Craton west of the rift. Two overlapping profiles, of about 400 km each, were carried out in February, with 204 digital seismic stations being deployed at about 2 km intervals along each profile. There were 9 borehole shotpoints onshore and shots were also fired in water in Lake Victoria and in the Indian Ocean. By careful planning (in which the Geophysics



Section took a major part) of the siting, timing, and design of the shotpoints, very good signals were recorded out to about 700 km. The complete experiment involves gravity measurements (for density variations), magnetotelluric measurements (for electrical conductivity), teleseismic tomography (large-scale velocity variations in the crust and mantle) and seismic profiling, to obtain the detailed P and S wave structure of the crust and lower lithosphere. The principal interest for the Geophysics Section lies on the eastern flank crustal structure (O. Novak), including the Chyulu Hills, and the lithosphere below the Moho along the whole line (G. Byrne).

The digital records were processed in the University of Texas, El Paso, in the months following the experimental work and data became available for preliminary interpretation in July. The interpretation phase was accelerated by holding a workshop near Karlsruhe, Germany, in August. Later seismic interpretation progressed very well during the second half of the year in the three main centres. For the seismic profile these are Dublin, Karlsruhe and Leicester. The preliminary seismic models were later presented at the Fall Meeting of the American Geophysical Union in San Francisco in December. Just before that Meeting, the group had a planning and review meeting in the US Geological Survey offices in Menlo Park (California). This agreed on a plan of action for 1995 which would incorporate studies from the other disciplines in the overall interpretation.

During 1994, work on the 1990 project was published in a volume of *Tectonophysics* devoted entirely to research in Kenya. Two papers involved the Section. One concerned the structure and development of the north western flank between the Kenya and Anza Rifts. This turned out to be more complex than expected. Another paper analysed and discussed the seismic sources from both the 1985 and 1990 projects and demonstrated a clear difference in attenuation between the rift and its flanks. This appears to be mainly due to scattering but a study will be made to try and separate scattering and intrinsic attenuation effects.

### 3.07 RAPIDS - Seismic Profiles in the Northeastern Atlantic

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

The year saw substantial advances in the research. There were three contributions to the Conference on the Petroleum Geology of Ireland's Offshore Basins, which took place in Dublin in April. Later in the year, two important papers were in press.

The first paper dealt with the transition between the Erris and Rockall basins. The major bounding fault of the Erris Trough is on its western margin and the basin is separated from the Rockall Trough by a narrow horst, the Erris Ridge. The water deepens smoothly towards the centre of the Rockall Trough but, surprisingly, the crust is somewhat thicker in the centre than it is near the margin. This is thought to be due to lateral strain migration to the warmer basin margins as the centre cooled more rapidly during deformation. The crustal structure in the Rockall Trough has been formed by differential stretching of the lithosphere. In the model the lower ductile crust and mantle lithosphere are stretched over a wide region by a factor between 2 and 3. Strain focusing into a much narrower region of brittle upper crust generates severe amounts of crustal thinning (by a factor between 8 and 10) and is responsible for the fusing of the upper and mid-crustal seismic layers found beneath onshore Ireland. Syntectonic heat loss played an important part in controlling the deformation pattern.

The second paper used, in addition, data from a 600 km axial line in the Rockall Trough. It found that the differential stretching model mentioned above is supported by the presence of the Moho transition zone which is stretched by a factor similar to the lower crust. The bulk stretching factor for the crust is between 4 and 6 and if the lithosphere as a whole was stretched by that amount, significant underplating would be expected. However, if the stretching factor for the lower crust in the differential stretching model is representative of lower lithospheric stretching, little or no underplating is predicted. The velocity patterns observed in the Rockall Trough do indicate that underplating is absent at the base of the crust, confirming the validity of the model. This is in marked contrast to the situation under the continental margin west of the Hatton Basin, where large-scale underplating has taken place.

### 3.08 COMBO - the Core-Mantle Boundary Project

*A.W.B. Jacob, G. Wallace and F. Murphy with J. Neuberg and A. O'Mongain (University of Leeds)*

and staff of Karlsruhe, Potsdam, Hamburg and Lisbon

This was a rather frustrating year for the COMBO project. The seismic shots were set up during the year, and planned to take place in early October, with observers ready to record in many different parts of the world. Special deployments included 200 stations in Canada and 200 stations in Siberia. At a very late stage there were difficulties with a final, new and unannounced, level of licensing for the shots and the decision was taken to delay them. Negotiations have since been undertaken to ensure that similar problems do not occur again.

On the positive side, detailed plans and preparations had been made and it should not be difficult to reactivate the project. All the materials are stored and will be available when they are needed.

While the shots have been delayed, work has begun studying events recorded on other networks, notably the northern California network which has over 500 stations. This allows techniques to be developed and used on real data.

## 4 Research Activities in the Astronomy Section

### 4.01 X-ray Morphology of a Seyfert 2 Galaxy

*E.J.A. Meurs with G. Matt, L. Piro and L.A. Antonelli (IAS Frascati), H. Fink (MPE) and G.C. Perola (IA Rome)*

The active galaxy NGC4388 (a type 2 Seyfert) was studied by means of high-resolution X-ray data obtained with the ROSAT satellite. Extended emission was discovered centered on the galaxy's nucleus, without evidence for a nuclear unresolved component. The extended emission may be the result from several discrete sources close together, or originate from thermal emission of a collisionally heated plasma. Scattering of nuclear radiation by a plasma that is ionized by the nuclear photons appears unlikely following a simple photoionization calculation. A continuation of this project is planned with lesser resolution data from the same ROSAT satellite but allowing spectral analyses.

### 4.02 Highly X-ray Luminous IRAS Galaxies

*E.J.A. Meurs*

Efforts continued to clean up the basic list of these potentially interesting objects. Several conceivable interpretations were developed, for which the basic range is between starburst processes and unrecognized active nuclei. X-ray spectra extending to higher energies than covered by the ROSAT satellite would be of great importance. For one such observation time was obtained on the ASCA satellite.

### 4.03 X-ray and Radio Properties of Quasars and Radio Galaxies

*E.J.A. Meurs with M.-H. Ulrich and S. Molendi (ESO)*

Preparatory work for a comparative study of X-ray and radio emission properties of a sample of B2 radio sources was carried out. A large fraction of the objects was detected in ROSAT All-Sky Survey data. The available interferometric radio data were collected.

### 4.04 Peripheral Cluster Gas and Tailed Radio Galaxies

*E.J.A. Meurs with L. Feretti (IRA Bologna) and L. Norci (MPE)*

The tails of radio galaxies observed in the outer regions of clusters of galaxies convey information about the peripheral gas in such clusters. In combination with X-ray data the physical state of the outer cluster gas can be assessed, which otherwise is difficult to do. Normal and high-resolution X-ray data have been obtained with the ROSAT satellite for the cluster Abell2241, which are of hitherto unattained quality. The reduction of this material was started with the intention to perform astrometric, morphological and spectral analyses.

### 4.05 HST Archive

*E.J.A. Meurs with F. Murtagh and H.-M. Adorf (ESO-ST/ECF)*

In one of the first attempts of its kind, the data collected by the Hubble Space Telescope featured in a pilot project of Archival Research. An

automated search for edge-on galaxies in HST image data was carried to the point of object morphological assessment. The steps implemented so far include image preparation, cosmic ray removal and a novel object detection technique employing wavelets. A special effort was made for the case of a high-redshift radio galaxy that appears to be surrounded by an extended halo.

#### 4.06 OB Stars and the ROSAT Archive

*E.J.A. Meurs with A. Pijpers (Amsterdam)*

X-ray detections beyond the limits of the ROSAT All-Sky Survey were attempted for a few OB stars that had been observed with previous X-ray missions but not in the ROSAT Survey. Some of these cases are included in pointed ROSAT observations and are available for inspection in the ROSAT Archive. One case showed a promising nearby emission feature but this requires confirmation from a detailed astrometric calibration of the image.

#### 4.07 Rotation of Clusters of Galaxies

*E.J.A. Meurs with J. Cunniffe (TCD)*

Appropriate numerical techniques were developed to investigate whether the available redshift data for Abell clusters of galaxies show any indication for a systematic rotation component of the cluster as a whole. While first suggestive results were obtained, a further part of this project concerns numerical simulations of galaxy clusters. A programme to produce a simulated cluster with particular spatial and kinematic distributions was conceived and implemented.

#### 4.08 Census of Nearby Galaxy Nuclei

*E.J.A. Meurs with A. Lawrence, R. Johnston (London), G. Fabbiano (CfA), M. Elvis (CfA), R. Terlevich and D. Carter (RGO)*

A comprehensive survey of the nuclei of nearby galaxies at various wavelengths was carried on while in a stage of data collection. The observations for this project include optical, radio and X-ray work.

#### 4.09 Detector Interface Design

*B.D. Jordan and M. Smyth with UCG and ICST&M (London)*

A Transputer based "Universal Detector Interface" was designed for the University College Galway Data Acquisition System. This is a flexible interface to connect various detectors with the TRIFFID Image Sharpening instrument. Funding for this work was provided by the Imperial College of Science Technology and Medicine (ICST&M).

#### 4.10 PSD Detector Development

*B.D. Jordan and M. Smyth with UCG and DRAL (UK)*

An investigation was carried out into the feasibility of using a reverse biased Position Sensitive Diode (PSD) as a robust, medium resolution, photon counting array detector which could be employed as an alternative to a delicate Imaging Photon Detector used at La Palma. Initial dark tests at Dunsink were very encouraging. Hopefully a detector constructed on this basis would be very well suited to Gamma-ray and X-ray experiments where high sensitivity is not necessarily a requirement.

#### 4.11 INTEGRAL Optical Transient Camera

*B.D. Jordan, M. Smyth and E.J.A. Meurs with B. McBreen (UCD), MSSL, DRAL and Valencia*

A proposal to build the Optical Transient Camera (OTC) for the International Gamma Ray Astrophysics Laboratory (INTEGRAL), together with University College Dublin and several other European laboratories (Mullard Space Science Laboratory, Daresbury Rutherford Appleton Laboratory and Universidad de Valencia), was submitted to the European Space Agency at the end of the year. The proposed large format camera (1024 x 2048 pixels) should provide fast optical imaging. Specifications include a spatial resolution of 8 arc seconds and a sensitivity down to 12th magnitude objects for one-second exposures. Preparations have begun for the development of hardware for an OTC Laboratory Model, which incorporates a medium format CCD mounted in a liquid nitrogen dewar and Transputer based signal processing.

## 5 Facilities

### 5.1 Computers

#### 5.1.1 Merrion Square

The VALUE contract for the installation of X-400 software was completed early in the year. A new PC and printer were obtained and installed in the front office. A number of Dell OptiPlex 100 Mhz DX4 PC systems were purchased and integrated with the network. Several additional X-terminals were purchased and the software upgraded (this resulted in a further requirement for additional memory in some of the X-terminals). An additional HP-4M laser printer was installed for general use, fortunately just before the existing printer was irreparably damaged by a leak in the flat roof of the mezzanine. Additional disc and DAT-tape capacity was installed to meet the increasing demands on the system and the standard software packages were maintained. The local internet news server was enhanced.

The leased line from 5 Merrion Square to 10 Burlington Road was upgraded to a 64K digital link with CISCO routers at each end; this considerably improved the reliability and quality of service. A considerable amount of consultation was provided to the Schools of Theoretical Physics and Celtic Studies on network planning and a SPARC server was installed in the School of Celtic Studies.

The Geophysics Section greatly enhanced its capacity for graphical colour hardcopy output by obtaining a NOVAJET II colour inkjet plotter. Both the quality of the print and the variable papersize (up to A0; 84.1cms  $\times$  118.9cms) are major assets in conference poster development. The never ceasing pressure on disk storage space was eased somewhat by the purchase of two gigabytes of extra storage space on the UNIX network for both gravity and seismic data. The Calcomp plotter was successfully transferred from the MicroVaxII to the newer and faster MicroVax 3100 to facilitate the continued production of the half-inch gravity maps. The Livermore Labs SAC and MAP software, featuring very useful digitised physical and political maps of the world, was brought on stream on the UNIX network (by the excellent work of a summer student; Fergal Dalton). There

has been a continued attempt to keep PC units upgraded by the acquisition of extra memory, doubler chips and the replacement of slow small capacity hard disks with faster larger ones.

Hardcopy production of seismograms from the DIAS network has been improved by printing postscript files from the SEISAN software to the laser printers. The software script files for data transfer from Lyons and DSB were further updated and streamlined to be more operator friendly. A systematic monthly backup procedure for the network seismic data is now in place and operating satisfactorily. The time taken for this operation has been greatly reduced by using a newly acquired HP DAT-tape system, capable of storing four gigabytes of data per tape.

#### 5.1.2 Dunsink Observatory

The Dunsink Ethernet LAN was extended and a new Router was provided. Two SPARC workstations (type 10 and 20) were installed with the Sparc-20 doubling as the Ethernet LAN server. A multimedia Gateway 4DX2 PC, with a CD-ROM drive, was purchased for use in the development of the Dunsink Expo.

### 5.2 Geophysics Instruments

The seismic networks, six short period stations (DNET and ENET) and one Very Broad Band station (DSB) were supported and serviced. This is a significant part of the workload for the Section. In addition, preparations for the COMBO project were carried out. A number of visits were made to Lisbon and Oporto during the project design phase (which incorporated some novel features) and for acquisition of materials for the marine shots. Another aspect of the work was the production of an accurate GPS-based time reference for shot timing as the existing DIAS time receivers do not work very well so far south. Two Trimble ACUTIME II satellite receivers were tested but there was a design problem which prevented them from providing sufficiently accurate time. Two GARMIN GPS20 receivers were then evaluated and these worked well. They provide one-second pulses and position is also available within the limitations of a single-station determination.

### 5.3 Track Laboratories



The track detector etching tanks and associated equipment were maintained in continuous operation and upgraded as necessary during the year. In addition, the track measuring stations along with the stereo scanning microscopes were maintained in full operational mode throughout the year.

#### 5.4 La Palma Observatory

T.P. Ray (Secretary)

##### 5.4.1 General

Members of the La Palma Advisory Committee in 1994 were T.P. Ray (Secretary), R.M. Redfern (UCG, Royal Irish Academy representative), P.B. Byrne (Armagh), E.J.A. Meurs (DIAS, School of Cosmic Physics Governing Board Representative), B. O'Donnell (Forbairt) and P.K. Carroll (UCD). T.P. Ray served as the Irish representative on the Panel for Allocation of Telescope Time (PATT) Committee which met twice during the year (June and December) in Stratford upon Avon. For the December PATT meeting, S. Russell substituted for T.P. Ray who was engaged in European Space Agency work. Following the splitting of the British Science and Engineering Research Council into several smaller units, British observatories are now funded by the Particle Physics and Astronomy Research Council (PPARC). Recognizing the importance of access to the La Palma Observatory and other PPARC astronomy facilities by Ireland, Forbairt, as in previous years, provided some financial support for travel and subsistence expenses in addition to DIAS funding.

As Secretary of the La Palma Advisory Committee, T.P. Ray continued to produce a twice yearly bulletin to keep Irish astronomers informed of changes in PATT procedures, PATT deadlines and other items of interest.

##### 5.4.2 Observing Runs 1994

Runs are listed alphabetically with the corresponding PATT reference

- Corcoran (DIAS), T.P. Ray (DIAS), et al (U/94B/77): *H<sub>2</sub> and [FeII] Observations of Molecular Outflow Sources*, UKIRT, three Bright Nights. Despite threatening storm clouds in the Pacific, the weather held up for this run and excellent data were obtained on a

number of young stellar object outflows. For example, several new shocked molecular hydrogen jets were discovered. It is hoped that these new images, when combined with spectroscopic data, will improve our understanding of how ionized jets interact with their surroundings and accelerate molecular outflows.

- Meurs (DIAS) with A. Lawrence (University of Edinburgh) et al (J/94B/24): *A Multi-wavelength Study of Nearby Galaxy Nuclei*, JKT, one Dark Week. Data from this run are currently being analysed by A. Lawrence.
- Ray (DIAS), M. Corcoran (DIAS), et al (I/94B/23): *The Forbidden Emission Line Regions of Herbig Ae/Be Stars*, INT, one Bright Week. Several Herbig Ae/Be stars (intermediate mass young stars), which on the basis of previous INT runs were expected to have optical outflows, were found spectroscopically to have extended jets. A differential technique was applied which allowed information to be obtained on sub-arcsecond scales.
- Redfern (UCG), et al (W/94A/70): *The Colour Gradient of M15*, WHT, three Grey Nights. The TRIFFID camera was used for three nights to look mainly at the centre of M15, giving more than nine hours of data on the cluster. The seeing varied from 1.1" to 0.5" before image sharpening. After processing these should give images resolving down to 0.25". The Galway Group had virtual full phase coverage of one of their targets, the X-ray source close to the core of the cluster.
- Russell (DIAS) with P. Dufton (QUB) et al (W/94B/14): *HII and B Type Star Chemical Compositions*, WHT, two Grey Nights. The weather was unfortunately bad for this run with very high winds and cloud. Only a few observations were made in connection with the main programme. Additional time on the WHT has been allocated for this project in 1995.

## 6 Seminars, Colloquia, Lectures

### 6.1 Statutory Public Lecture

P.M. Shannon (UCD and Research Associate of the Geophysics Section) delivered the Annual Statutory Public Lecture for the School of Cosmic Physics. The lecture was entitled *Offshore Sedimentary Basins in the North Atlantic* and took place in Trinity College Dublin, on 24 November.

## 6.2 Seminars and Open Lectures in the School

- Biro (University of Manchester): *Models of Time-Dependent Stellar Jets*, 21 June.
- Bonetti (University of Milan): *Recent Results on Cluster Radioactivity*, 16 June
- Duffy (Max Planck Institut für Kernphysik, Heidelberg): *Particle Acceleration and Non-Thermal Radiation from Supernova 1987A*, 10 May.
- Hirth (Max Planck Institute for Astronomy, Heidelberg): *Small-Scale Jets from Young Stars*, 3 November.
- Pointer (University of Leeds): *Modelling Seismic Reflections from the Lowermost Mantle*, 17 June.
- C.C.Porco (University of Arizona, USA): *Journey Back to Saturn -- The Search for our Origins*, 7 July.

## 6.3 Contributions to Scientific Meetings

- Byrne: *Experiment Design and Data Presentation for the KRISP 1994 Seismic Experiment*, AGU Fall Meeting, San Francisco, 5-9 December.
- Corcoran: *Forbidden Line Emission and Correlations with the Infrared Excess in Herbig Ae/Be Stars*, Conference on "Disks and Outflows around Young Stars", Heidelberg, 6-9 September.
- Downes: *Numerical Simulations of H<sub>2</sub> Emission from Stellar Jets*, Conference on "Disks and Outflows around Young Stars", Heidelberg, 6-9 September.
- O'C. Drury: *Ultra-heavy Nuclei -- Implications for Acceleration Theory*, COSPAR General Assembly, Hamburg, 11-14 July; *Supernova Remnant Shocks*, COSPAR General Assembly, Hamburg, 11-14 July; *Ultra-heavy nuclei*, The 14th European Cosmic Ray Symposium, Balatonfüred, Hungary, 28 August - 3 September; *Shell Type SNRs*, Heidelberg Workshop on Gamma-ray Astronomy, 3-7 October.
- Jacob: *The COMBO Project - a Controlled Source Study of the Core Mantle Boundary*, IASPEI General Assembly, Wellington, New Zealand, 10-21 January; *An Overview of the Results of the RAPIDS seismic project, North Atlantic*, Conference on "The Petroleum Geology of Ireland's Offshore Basins", Dublin, 21-22 April.
- Meurs: *OeBe-stars with Possible Compact Companions observed at X-rays and The Galactic Number of WR Stars produced via Close Binary Evolution*, IAU Symposium Nbr 163, Elba, Italy, 1-7 May; *Possible Evidence for a Binary Massive Black Hole in the Galactic Nucleus*, IAU Symposium Nbr 169, The Hague, 23-27 August; *HST Archive Research Tools - A Pilot Project*, JD20, IAU General Assembly, The Hague, 15-27 August.
- Novak: *Preliminary Interpretation of the KRISP 1994 Seismic Results*, AGU Fall Meeting, San Francisco, 5-9 December.
- O'Reilly: *Evolution of the Upper Mantle Beneath Stretched Continental Crust and The Crustal Structure of the Rockall Trough Differential Stretching without Underplating*, Meeting of the Irish Geological Association, Coleraine, 24-27 February; *The Erris and Eastern Rockall Troughs: Structural and Sedimentological Development*, Conference on "The Petroleum Geology of Ireland's Offshore Basins", Dublin, 21-22 April; *Fault Analysis and Modelling - an Example from the central Irish Sea, St. George's Channel Basin*, European Association of Exploration Geophysicists Assembly, Vienna, 6-10 June; *Seismic Properties of Extended Continental Lithosphere and their Petrological Implications - an Example from the Rockall Trough*, AGU Fall Meeting, San Francisco, 5-9 December.
- Ray: *Circumstellar Matter Around Post T Tauri Stars*, The 10th IAP Meeting ("Circumstellar Dust Disks and Planet Formation"), IAP, Paris, 4-8 July.
- Readman: *A Bouguer Anomaly Map of Ireland and Surrounding Waters*, Conference on "The Petroleum Geology of Ireland's Offshore Basins", Dublin, 21-22 April; *Satellite Gravity Between the Rockall Trough*

and the Mid-Atlantic Ridge, AGU Fall Meeting, San Francisco, 5-9 December.

- Russell: *The Abundances of Li in delta Scuti stars - Can they Explain the Li Dip?*, ESO/EIPC Workshop on the Light Element Abundances, Elba, Italy, 23-28 May.
- Shannon: *Basin Development and Petroleum Prospectivity of the Rockall and Hatton Region*, Conference on "The Petroleum Geology of Ireland's Offshore Basins", Dublin, 21-22 April.

#### 6.4 External Seminars

- L.O'C. Drury: *Gamma-ray Observations of Supernova Remnants*, QMW, London, 18 March.
- Jacob: *Geophysical Techniques*, DCU, 28 July.
- Meurs: *The Art of Selecting IRAS Sources*, The Astronomical Institute, Innsbruck, 2 March; *OeBe-stars with Possible Compact Companions observed with Rosat*, ASGI meeting, Cork, 22 April.
- Murphy: *The Problems of Accuracy associated with GIS in Field Studies*, Field Society of Surveying, Photogrammetry and Remote Sensing, TCD, 29 April.
- O'Reilly: *Comparative Development of the N. Atlantic and the Basin and Range Province*, UCD, 7 March.

#### 6.5 Lecture Courses

- O'C. Drury: Course of nine lectures on High Energy Astrophysics (European MSc) at the University of Porto, Portugal, 17 - 29 October.
- Russell: Course of lectures on Nucleosynthesis to TCD 3rd year undergraduates; Course of lectures and tutorials on Basic Mechanics to DCU 1st year undergraduates; Adult Education course of ten lectures at UCD entitled "Birth Life and Death in the Universe".
- Ray: Course of ten lectures on Plasma Astrophysics to 4th year students in TCD during Michaelmas Term.

#### 6.6 Popular Lectures

- Elliott gave a seminar on teaching astronomy to H.Dip.Ed. students in UCD on 1 February, a lecture on *The History of Dunsink Observatory* to the Ballygall Historical Society on 9 February and gave presentations about Expo to the West Finglas Tenants and Residents Association on 12 May and to the Finglas Tourism Initiative on 28 July. He also delivered a lecture on *Our Changing View of the Universe* to Gorey Adult Education Group on 12 December.
- O'Brien delivered a lecture on *Comets at Dunsink Observatory* on 16 November.
- Russell presented a talk on *The Beginning of the Universe* to a meeting of the Irish Astronomical Society on 21 March and delivered a lecture on *Creation of the Elements* to a meeting of Astronomy Ireland on 27 June.

## 7 Expositions, Public Facilities and Organisation of Meetings

### 7.1 Dublin Science Expo

On instigation of the Governing Board of the School of Cosmic Physics, steps were taken towards establishing a Science Expo in Dunsink Observatory. A pilot project was started in January, managed by I. Elliott, which ran till October. After this, the preparations for a Science Expo were transferred to an ad-hoc Committee of the Board, chaired by the Senior Professor in Astronomy. With secondary level schools as main target, care will be taken to present a balanced, attractive programme and to consider properly marketing and business aspects of the undertaking. One move achieved this year was the relocation of the library to suitable spaces on the first floor of the Observatory.

### 7.2 EADN

T.P. Ray (as chairman) organized, with the assistance of A. Grace, a board meeting of the European Astrophysical Doctoral Network (EADN) in Dublin on 23-24 June. This meeting was attended by twelve national representatives.

The EADN is a network of some 30 universities interested in promoting the mobility of graduate astrophysics students in Europe within the EU ERASMUS scheme. It also arranges specialist summer schools aimed at a graduate audience with funding largely from the Human Capital and Mobility Programme and ERASMUS. T.P. Ray assisted in the running of this year's school (on "Plasma Astrophysics") in San Miniato, Italy, 3-14 October.

### 7.3 Dunsink Open Nights and Public Viewing

During 1994 several Open Nights were held in Dunsink Observatory, presenting an informative astronomical programme to the general public. Three special Open Nights featured the impacts of comet SL9 on Jupiter and were attended by a capacity audience of about 300 people. This attracted considerable media attention. New facilities at Dunsink included a small CCD TV camera mounted on the 12 inch South Telescope to facilitate public viewing. The Open Nights enjoyed the technical support of the Irish Astronomical Society.

## 8 EXTERNAL WORK

### 8.1 Cosmic Ray Section

- J. Byrne: Institute of Physics Meeting, Blarney, Co. Cork, 25-27 March; Collaboration work with ANPA Group, Rome, July 16-23.
- M. Corcoran: Conference (Disks and Outflows Around Young Stars), Heidelberg, 6-9 September; Observing Trip (Isaac Newton Telescope), La Palma, 12-20 December.
- T. Downes: Conference (Disks and Outflows Around Young Stars), Heidelberg, 6-9 September; The 7th European Astrophysical Doctoral Network Summer School ("Plasma Astrophysics"), San Miniato, Italy, 3-14 October.
- L.O'C. Drury: AWG meeting, Paris, 10-11 January; EIREANN meeting, HEA, 2 February; EAS and RAS joint meeting, Edinburgh, 5-8 April; AWG meeting, Paris, 3-5 May; Scientific Review Panel, Armagh Observatory, 17-18 May; AWG Meeting, Capri, 24-27 May; MPK, Heidelberg, 27 June - 9 July; COSPAR General Assembly, Hamburg, 11-14 July; 14th ECRS, Balatonfüred, 28 August - 3 September; Workshop on gamma-ray astronomy, Heidelberg, 3-7 October; Meeting (T.Hartquist), Manchester, 14 November; HCM network "Energetic Particles in Astrophysical and Space Plasmas" kick-off meeting, Neckargemünd (near Heidelberg), 7-9 December.
- K. Farrell: Institute of Physics Meeting, Blarney, Co. Cork, 25-27 March; The 7th European Astrophysics Doctoral Network Summer School ("Plasma Astrophysics"), San Miniato, Italy, 3-14 October.
- A. Keane: The 14th European Cosmic Ray Symposium, Balatonfüred, Hungary, 28 August - 4 September; Exposure of track detector stack to 160 GeV/u Pb beam, CERN, Geneva, Switzerland, 28 November - 4 December.
- I. O'Brien: IAU International School for Young Astronomers, Pune, India, 2-15 January; The 7th EADN Summer School ("Plasma Astrophysics"), San Miniato, Italy, 3-14 October; Meeting (T.Hartquist), Manchester, 14 November.
- D.O'Sullivan: Installation of Detectors on Concorde, Heathrow, 4-6 March; Institute of Physics Meeting, Blarney, Co. Cork, 25-27 March; IRMA Meeting at University of Saarland and Meeting at GSI, Darmstadt, 4-9 June; COSPAR General Assembly, Hamburg, 11-17 July; Calibration exposure at CERN and IRMA Meeting in Brussels, 28 November - 8 December.
- T.P. Ray: Foundation meeting for European MSc in Astronomy, Porto, 17-19 February; Panel for Allocation of Telescope Time (PATT), Stratford-Upon-Avon, 2-3 June; Board meeting of the European Astrophysical Doctoral Network (EADN), Dublin, 23-24 June; Max Planck Institute for Astronomy, Heidelberg (with support from the German-Irish Research Fund), 1-31 August; Infrared Satellite Observatory (ISO) Time Allocation Committee, Paris, 15-16 November; Observing Trip, La Palma, 12-20 December.



S.C. Russell: EAS and RAS joint meeting, Edinburgh, 4-8 April; ISO Mission meetings (and coordination of ISO open time proposals on star formation), Stockholm, 12-14 April; ESO/EIPC Workshop (The Light Element Abundances), Elba, Italy, 21-26 May; ISOPHOT meeting, Heidelberg, 31 May - 1 June; IAU General Assembly, Den Hague, Holland, 15-26 August; ISO photopolarimeter (Isophot) calibration work, MPIA and Dornier, Germany, 7-13 November; PATT meeting (deputising for T.P. Ray), Stratford-Upon-Avon, England, 6-8 December; ISO guaranteed time proposals data entry, ESTEC, Holland, 11-17 December; ISOPHOT meeting, Heidelberg, 18-20 December

W.-M. Tai: ISOPHOT meeting, Oxford, 13-12 December; ISOPHOT meeting, MPIA, Heidelberg, 4-21 July.

## 8.2 Geophysics Section

T.A. Blake: KRISP project, Kenya, 8-25 February; EU Transfrontier Seismic Group, Luxembourg, 7-9 November.

K. Bolster: BGS, Edinburgh, 11-16 May.

G. Byrne: KRISP project, Kenya, 8 February - 3 March; KRISP visits, Potsdam and Karlsruhe, 7-16 June; KRISP Workshop and data processing, Karlsruhe, 14 August - 9 September; AGU Fall Meeting, San Francisco, 3-11 December.

F. Hauser: KRISP project, Kenya, 9 February - 2 March; RAPIDS, Hamburg, 7-14 May; RAPIDS, Hamburg and EAEG Conference, Vienna, 29 May - 11 June; COMBO project, Portugal, 1-9 October; AGU Fall Meeting, San Francisco, 3-11 December; RAPIDS, Hamburg, 14-22 December.

C. Horan: KRISP project, Kenya, 8-25 February; SECED Meeting, London, 18-19 May.

A.W.B. Jacob: IASPEI Conference, Wellington, New Zealand, 5-22 January; KRISP project, Kenya, 6-26 February and Karlsruhe, 13-20 August; COMBO, Lisbon, 23-27 March, 30 May - 2 June, 31 August - 4 September, 29 September - 9 October; COMBO, Ottawa, 2-5 May and

Potsdam, 7-8 June; EGS General Assembly, Grenoble, 23-30 April; BGS, Edinburgh, 11-16 May; RAPIDS, Hamburg, 2-4 June; EGS Meeting, Paris, 15-16 September; BGS, Edinburgh, 12-13 October; EU Transfrontier Seismic Group, Luxembourg, 8-9 November; AGU Fall Meeting, San Francisco and USGS, Menlo Park, 1-11 December.

F. Murphy: KRISP project, Kenya, 9 February - 3 March; COMBO project, Portugal, 20 September - 14 October.

O. Novak: AGU Fall Meeting, San Francisco, 3-11 December.

B.M. O'Reilly: IGA Meeting, Coleraine, 24-27 February; RAPIDS, Hamburg and EAEG Meeting, Vienna, 29 May - 11 June; RAPIDS, Kiel, 30 June - 7 July and Hamburg, 14-22 December; AGU Fall Meeting, San Francisco, 3-11 December.

P.W. Readman: KRISP project, Kenya, 8-25 February; AGU Fall Meeting, San Francisco, 3-11 December.

G. Wallace: KRISP project, Kenya, 26 January - 3 March; COMBO, Portugal, 23-27 March, 30 May - 6 June, 31 August - 4 September and 20 September - 14 October.

## 8.3 Astronomy Section

I. Elliott: Astrofest, London, 4-6 February; AGM of the Irish Science Teachers' Association, Dundalk, 18 March; AGM of the British Association of Planetarians, Armagh, 6-8 May; Tour of science centres in Boston, Pittsburgh, Baltimore, Washington, Orlando and New York, 27 June-9 July; 25th Bi-Annual Conference of the International Planetarium Society, Cocoa Beach, Florida, 10-16 July; Official opening of the extension to Armagh Planetarium, 21 July.

B.D. Jordan: European Image Sharpening Group Meeting, Institute of Astronomy, Cambridge, 14 January; OTC consortium meeting, ESTEC, 13 September; Working visits, UCG, 7 February; 23 March; 14 April; 21 April; 17 May; 15 June; 17 October; 3 November; 7 December.

E.J.A. Meurs: Collaboration Meeting, Munich, 28-30 April; IAU Symposium Nbr 163, Elba, Italy, 1-7 May; Collaboration Meeting, Munich, 10-17 May and 28 July-3 August; IAU General Assembly, The Hague, 15-27 August; EU Panel Meeting on Large Scale Facilities, Brussels, 31 August; Collaboration Meeting, Munich, 19 September-7 October; ROSAT Users Meeting, Munich; 24 October-7 November; EU Panel Meeting on Large Scale Facilities, Brussels, 10 November.

## 9 Miscellanea

J. Eisloeffel left the Cosmic Ray Section in March to go to Grenoble Observatory with continued funding from the Human Capital and Mobility (HCM) star formation network headed by DIAS.

L.O'C. Drury continued as Chairman of the National Committee for Physics.

L.O'C. Drury continued as a member of the Commission on Cosmic Rays of the International Union of Pure and Applied Physics for another term of office.

A.W.B. Jacob continued as General Secretary and Member of Council of the European Geophysical Society.

A.W.B. Jacob was elected an Associate (Honorary Foreign Member) of the Royal Astronomical Society.

T.P. Ray represented DIAS at a meeting in Porto, at which it was decided to initiate a European Masters in Astronomy by course work and thesis. An application to ERASMUS for funding was successful and the first students were admitted to the courses in October in Porto. It is intended that the courses are held in other participating institutions, probably rotating on a two year basis. Participating institutions are, at present, the University of Porto, University College Galway, University of Lyon, the Free University of Brussels and DIAS. Thesis projects will come from the participating institutions, as well as the European Southern Observatory and Observatoire Haute Provence. It is intended to expand the group next year.

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 Chairman of the European Astrophysical Doctoral Network (EADN). He has also continued as a member of the Infrared Space Observatory Time Allocation Committee.

T.P. Ray assisted the Office of Public Works, and O. Deignan of Irish Lights, with calculations in connection with the restoration of the four faced vertical sundial near St. James Gate, Dublin.

A. Thompson continued as Chairman of the Royal Irish Academy Space Research Committee.

P.A. Wayman continued work on the history of Thomas Grubb (1800-1878) and Sir Howard Grubb (1844-1923), makers of telescopes and other scientific instruments and machines from ca. 1825 to 1925. The 27 inch Vienna refractor made by Howard Grubb in 1880-1883 was inspected during the year and an account of its construction and subsequent history has been written. A detailed account of the 12 inch refractor completed in 1853 and installed by Thomas Grubb at Dunsink Observatory, using the historic Cauchoix lens of 1829, has also been written.

A group of 30 members of the Mathematical Physics Society of the University of Groningen visited Dunsink Observatory on 17 May.

## 10 Publications

### 10.1 Journals and other Refereed Publications

J. Bosch: *A Charge and Energy Study of the Track Response of Lexan*. Nuclear Instruments and Methods in Physics Research, Vol B84, pp 357-360 (1994).

J. Bosch and A. Thompson: *A Study of the dependence of the Bulk Etch Rate and the Reduced Etch Rate on the Concentration of Etched Products of Lexan*. Nuclear Instruments and Methods in Physics Research, Vol B93, pp 57-62 (1994).

L. O'C. Drury, F. Aharonian and H. J. Völk: *The gamma ray visibility of supernova remnants - a*

test of cosmic ray origin. *Astron. Astrophys.*, Vol 287, pp 959-971 (1994).

L. O'C. Drury with F. A. Aharonian and H. J. Völk: *GeV/TeV gamma-ray emission from dense molecular clouds overtaken by supernova shells*. *Astron. Astrophys.*, Vol 285, pp 645-647 (1994).

L. O'C. Drury: *Acceleration of Cosmic Rays*. *Contemporary Physics*, Vol 35, pp 231-242 (1994).

P. Duffy, L. O'C. Drury and H. J. Völk: *Cosmic ray hydrodynamics at shock fronts*. *Astron. Astrophys.*, Vol 291, pp 613-621 (1994).

J. Eisloffel and T.P. Ray with C.J. Davis and R. Mundt: *Near-infrared Observations of the HH46/47 System*. *Astrophys. J. (Letters)*, Vol 422, pp L91-L93 (1994).

J. Eisloffel and T.P. Ray with C.J. Davis: *Near-infrared imaging of HH 1/2 in shocked molecular hydrogen and [FeII]*. *Astrophys. J. (Letters)*, Vol 426, pp L93-L95 (1994).

A.W.B. Jacob with J. Diaz et al: *A deep Seismic Sounding investigation of Lithospheric Heterogeneity and Anisotropy beneath the Iberian Peninsula*. *Iberian Lithosphere Heterogeneity and Anisotropy* (eds. J. Mezcua and E. Carreno), publ. I.G.N., Madrid, Monografia No. 10, pp 105-127 (1994).

A.W.B. Jacob, R. Veas, L.W. Braile and E. Criley: *Optimization of Wide Angle Seismic Signal-to-Noise Ratios and P-wave Transmission in Kenya*. *Tectonophysics*, Vol 236, pp 61-79 (1994).

A.W.B. Jacob with C. Prodehl, H. Thybo, E. Dindi and R. Stangl: *Crustal Structure on the northeastern flank of the Kenya Rift*. *Tectonophysics*, Vol 236, pp 271-290 (1994).

E.J.A. Meurs with G. Matt, L. Piro, L.A. Antonelli, H.H. Fink and G.C. Perola: *Extended Soft X-ray Emission in the Seyfert 2 Galaxy NGC4388 discovered with the ROSAT HRI*. *Astron. Astrophys.*, Vol 292, pp L13-L16 (1994).

T.P. Ray with G.A. Hirth, R. Mundt and J. Solf: *Asymmetries in Bipolar Jets from Young Stars*. *Astrophys. J. (Letters)*, Vol 427, pp L99-L102 (1994).

T.P. Ray and J. Eisloffel: *Optical Outflows in the Vicinity of the Southern Herbig Ae/Be Star*

*vdBH 65b*. *Astron. Astrophys.*, Vol 290, pp 605-608 (1994).

P.M. Shannon, A.W.B. Jacob, J. Makris, B. O'Reilly, F. Hauser and U. Vogt: *Basin evolution in the Rockall Region*. *First Break*, Vol 12, pp 515-522 (1994).

S.-P. Xiang: *Galaxy Formation in Dark Matter Models*. *Astron. Astrophys.*, Vol 290, pp 349-356 (1994).

S.-P. Xiang: *Cold plus Hot Dark Matter and Structure Formation of the Universe*. *Astrophys. Space Science*, Vol 211, pp 99-114 (1994).

## 10.2 Conference Proceedings

G.F. Byrne and B. Jacob with C.S. Birt et al: *Kenya Rift International Seismic Project (KRISP) 1994 Seismic Experiment - Experiment Design and Data Presentation*. *EOS*, Vol 75, p 644 (1994).

M. Corcoran and T.P. Ray: *Spectroscopic Evidence for Disks Around Herbig Ae/Be Stars*. *The Nature and Evolutionary Status of Herbig Ae/Be Stars* (eds. P.S. Thé, M.R. Perez and E.P.J. van den Heuvel), Publications of the Astronomical Society of the Pacific (P.A.S.P.), Conference Series, pp 151-154 (1994).

J. Eisloffel and T.P. Ray: *A Search for Herbig-Haro Objects Near Southern Herbig Ae/Be Stars*. *The Nature and Evolutionary Status of Herbig Ae/Be Stars* (eds. P.S. Thé, M.R. Perez and E.P.J. van den Heuvel), P.A.S.P., Conf. Ser., pp 384-385 (1994).

W.B. Jacob, P.M. Shannon, J. Makris, F. Hauser, U. Vogt and B.M. O'Reilly: *An Overview of the Results of the RAPIDS seismic project, North Atlantic*. *The Petroleum Geology of Ireland's Offshore Basins*, Dublin, pp 64-65 (1994).

E.J.A. Meurs with L. Piro, L.A. Antonelli, H.H. Fink, G. Matt and G.C. Perola: *Diffuse Soft X-ray Emission from the Seyfert 2 Galaxy NGC4388 - Implications on Scattering Models*. *New Horizon of X-ray Astronomy - First Results from ASCA* (eds F. Makino and T. Ohashi), pp 591-594 (1994).

E.J.A. Meurs and A. PETERS: *OeBe-stars with Possible Compact Companions observed at X-rays*. *IAU Symp.* 163, pp 554 - 557 (1994).

E.J.A. Meurs and E.P.J. van den Heuvel: *The Galactic Number of WR stars produced via Close Binary Evolution*. IAU Symp. 163, pp 329 - 330 (1994).

E.J.A. Meurs, F. Murtagh and H.M. Adorf: *HST Archive Research Tools - A Pilot Project*. IAU General Assembly, The Hague, Book of Abstracts, JD20, p 279 (1994).

O. Novak, G.F. Byrne and A.W.B. Jacob with KRISP Working Group: *Kenya Rift International Seismic Project (KRISP) 1994 Seismic Profiling Experiment - Preliminary Interpretation*. EOS, Vol 75, p 664 (1994).

B.M. O'Reilly, F. Hauser, A.W.B. Jacob and P.M. Shannon: *Seismic Properties of Extended Continental Lithosphere and their Petrological Implications - an Example from the Rockall Trough*. EOS, Vol 75, p 644 (1994).

B.M. O'Reilly, A.W.B. Jacob, P.M. Shannon, J. Makris, F. Hauser and U. Vogt: *The Erris and eastern Rockall Troughs - Structural and Sedimentological Development*. The Petroleum Geology of Ireland's Offshore Basins, Dublin, pp 50-51 (1994).

B.M. O'Reilly, P.M. Shannon and F. Hauser: *Fault Analysis and Modelling - an example from the central Irish Sea, St George's Channel region*. The European Association of Petroleum Geoscientists and Engineers, 6th Conference, Vienna, p 505 (1994).

T.P. Ray with R. Mundt: *Optical Outflows from Herbig Ae/Be Stars and Other High Luminosity Young Stellar Objects*. Invited review in *The Nature and Evolutionary Status of Herbig Ae/Be Stars* (eds. P.S. Thé, M.R. Perez and E.P.J. van den Heuvel), P.A.S.P. Conf. Ser., pp 237-252 (1994).

T.P. Ray: *Evidence for Disks Around Herbig Ae/Be Stars*. The Cold Universe, XIIIth Moriond Astrophysics Meeting (eds. T. Montmerle, C.J. Lada, I.F. Mirabel and J. Tran Thanh Van), Gif-sur Yvette, Editions Frontières, pp 255-259 (1994).

T.P. Ray: *Herbig Ae/Be Stars*. Invited review in *Kinematics and Dynamics of Diffuse Astrophysical Media* (ed. J. Dyson), Kluwer Academic Publishers, pp 71-86 (1994).

T.P. Ray, A.I. Sargent, S.V.W. Beckwith and C. Koresko: *Circumstellar Matter Around Post T*

*Tauri Stars*. Proceedings of the 10th IAP Meeting (Circumstellar Dust Disks and Planet Formation, eds. R. Ferlet and A. Vidal-Madjar), Gif-sur Yvette, Editions Frontières, pp 143-147 (1994).

P.W. Readman, B.M. O'Reilly and F. Hauser: *Satellite Gravity Between the Rockall Trough and the Mid-Atlantic Ridge*. EOS, Vol 75, p 156 (1994).

P.W. Readman with J.W.F. Edwards and M.J. Sankey: *A Bouguer Anomaly Map of Ireland and Surrounding Waters*. Petroleum Geology of Ireland's Offshore Basins, Dublin, pp 58-59 (1994).

S.C. Russell: *The Abundances of Li in delta Scuti stars - Can they Explain the Li Dip?*. Proceedings of the ESO/EIPC Workshop on the Light Element Abundances, Marciana Marina, Elba, Italy, 23-28 May 1994, pp 248-251.

P.M. Shannon, A.W.B. Jacob, J. Makris, B.M. O'Reilly, F. Hauser and U. Vogt: *Basin Development and Petroleum Prospectivity of the Rockall and Hatton Region*. The Petroleum Geology of Ireland's Offshore Basins, Dublin, pp 52-53 (1994).

### 10.3 Books, Theses and Sundry Publications

I. Elliott: *Skynotes* (a regular monthly article). Technology Ireland, 1994.

A.W.B. Jacob and J. Neuberger: *COMBO: A Controlled-Source Study of the Core Mantle Boundary*. International Seismological Observing Period Newsletter No. 5, p 3 (1994).

T.P. Ray, and S.V.W. Beckwith (Editors): *Star Formation and Techniques in Infrared and mm-Wave Astronomy*. Proceedings of the 5th EADN Predoctoral Astrophysics School, Lecture Notes in Physics Series, Vol 431, Springer-Verlag (1994).

P.M. Shannon and P.F. Croker: *Conference Report - The Petroleum Geology of Ireland's Offshore Basins*. First Break, Vol 12, pp 421-422 (1994).

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

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Financial Statements for year ended 31 December 1994.

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

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Statement of Responsibilities of the Council

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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 for Finance. In preparing those accounts the Council is required to:

- . select suitable accounting 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.

David D. Donnelly

Chairman

Denis

Council Member

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

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**Financial Statements for year ended 31 December 1994.**

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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.

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 £995,498.

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 1994 was £765,524.

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.

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

**Financial Statements for year ended 31 December 1994.**

**Income and Expenditure Account**

	Notes	1994 IR£	1993 IR£
<b>Income</b>			
Oireachtas Grant		2,776,000	2,632,000
Sales of Publications		37,516	35,558
Celtic Studies Fees		6,561	4,000
School of Theoretical Physics	2	41,766	19,400
School of Cosmic Physics	1	325,477	165,646
Miscellaneous	9	52,659	85,642
		<u>3,239,979</u>	<u>2,942,246</u>
Transfer from (to) Capital Account	4	(44,890)	21,574
		<u>3,195,089</u>	<u>2,963,820</u>
<b>Expenditure</b>			
School of Celtic Studies		658,051	582,953
School of Theoretical Physics		386,051	343,710
School of Cosmic Physics		1,346,861	1,130,465
Administration		617,890	578,148
Depreciation	3	96,820	96,530
Loss On Disposals		0	81
		<u>3,105,673</u>	<u>2,731,887</u>
Surplus for year		89,416	231,933
Balance at 1 January		435,994	204,061
		<u>525,410</u>	<u>435,994</u>

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

  
CHAIRMAN - COUNCIL OF THE INSTITUTE

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

**Financial Statements for year ended 31 December 1994.**

**Balance Sheet as at 31 December 1994**

	Notes	1994 IR£	1993 IR£
<b>Assets</b>			
Fixed Assets	3	256,841	211,951
Current Assets:			
Cash on Hands and at Bank		719,674	622,428
Debtors and Prepayments		68,250	58,556
<b>Total Assets</b>		<b>1,044,765</b>	<b>892,935</b>
<b>Less Liabilities</b>			
Current Liabilities			
Creditors and Accruals	6/8	229,921	213,384
Funds	5	32,593	31,606
<b>Total Liabilities</b>		<b>262,514</b>	<b>244,990</b>
<b>Net Assets</b>		<b>782,251</b>	<b>647,945</b>
<b>Financed by:</b>			
Surplus Income and Expenditure Account		525,410	435,994
Capital Reserve	4	256,841	211,951
		<b>782,251</b>	<b>647,945</b>

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

  
CHAIRMAN - COUNCIL OF THE INSTITUTE

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

**Financial Statements for year ended 31 December 1994.**

**Cash Flow Statement**

	Notes	1994 IRE	1993 IRE
<b>Operating Activities</b>			
Surplus (Deficit) per Income & Expenditure		89,416	231,933
Adjustment for Non-Operating Items			
Interest		(50,335)	(85,556)
Profit/Loss on Disposal		0	81
Movement on Capital Account		44,890	(21,574)
Adjustment for Non-Cash Items			
Depreciation		96,820	96,530
Decrease/(increase) in debtors		(9,694)	26,599
Increase/(decrease) in creditors/funds		17,524	16,989
<b>Net Cash Flow from Operating Activities</b>		<b>188,621</b>	<b>265,002</b>
<b>Returns on Investments and Servicing of Finance</b>			
Interest		50,335	85,556
<b>Investing Activities</b>			
Purchase of Fixed Assets	3	(141,710)	(75,037)
<b>Net Cash Inflow</b>		<b>97,246</b>	<b>275,521</b>
<b>Analysis of Movement in Cash and Cash Equivalents</b>			
Balance at 1 January		622,428	346,907
Net Cash Flow		97,246	275,521
<b>Balance at 31 December</b>		<b>719,674</b>	<b>622,428</b>



**Detailed Analysis of Income & Expenditure for the year ended 31/12/1994**

INCOME	Notes	School of	School of	School of	Adminis- tration	Total	1993
		Celtic Studies	Theoretical Physics	Cosmic Physics			Total
		£	£	£	£	£	£
Oireachtas Grants		656,000	361,200	1,085,400	673,400	2,776,000	2,632,000
Sales of Publications		36,926		590		37,516	35,558
School of Celtic Studies		6,561				6,561	4,000
School of Theoretical Physics	2		41,766			41,766	19,400
School of Cosmic Physics	1			325,477		325,477	165,646
Miscellaneous	9		700	1,624	50,335	52,659	85,642
		699,487	403,666	1,413,091	723,735	3,239,979	2,942,246
<b>Transfer from Capital Account</b>							
Allocated for Capital purposes		(17,610)	(23,047)	(64,408)	(36,645)	(141,710)	(75,037)
Amount released on disposals							81
Amortisation in line with asset depreciation						96,820	96,530
		681,877	380,619	1,348,683	687,090	3,195,089	2,963,820
<b>EXPENDITURE</b>							
Salaries, Wages and Superannuation	10	487,685	212,228	807,485	319,057	1,826,455	1,730,012
Scholarships		32,271	31,803	56,720		120,794	124,431
Honoraria		1,284		175		1,459	600
Library (incl. Microfilms)		30,107	47,152	31,269		108,528	98,911
Publications		66,384	172	1,010	1,701	69,267	44,135
General Administration	7				217,938	217,938	227,104
Travel and Survey Expenses		3,155	16,591	50,190	1,461	71,397	51,697
Symposia & Seminar Expenses		1,747	1,300			3,047	3,329
Equipment:							
Consumable & Maintenance				19,832		19,832	23,699
Special Commitments and Projects		5,436	52,552	348,951		406,939	204,235
General Expenses		29,982	21,307	31,229	46,675	129,193	125,723
IAU Colloquium							1,400
Book Storage					7,353	7,353	
Dunsink Renovation					23,705	23,705	
Loss on Disposals							81
Leasing charges			2,946			2,946	
		658,051	386,051	1,346,861	617,890	3,008,853	2,635,357
Depreciation	3					96,820	96,530
						3,105,673	2,731,887
<b>SURPLUS (DEFICIT) FOR YEAR</b>							
		23,826	(5,432)	1,822	69,200	89,416	231,933
Balance at 1 January 1994		144,594	4,435	49,329	237,636	435,994	204,061
Balance at 31 December 1994		168,420	(997)	51,151	306,836	525,410	435,994
Admin Contrib. to Schools		16,000	16,000	52,100	(84,100)		
Balance after contribution		184,420	15,003	103,251	222,736	525,410	

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

**Notes to the Accounts**

**1 School of Cosmic Physics - Research Programmes and Fees:**

Project	Contributor	Opening	Applied	Unexpended/	
		Balance	Receipts	as Income	Overexpended
		£	£	£	£
Seismic Survey					
at Carnsore	ESB		500	500	
HOGS	BHP		6,752	6,752	
Isophot	ESA	64	39,829	45,102	(5,209)
Rapids	Forbairt	4,043	1,450	4,722	771
La Palma	Forbairt		3,000	3,000	
EADN - HCM	EC	(911)	3,501	8,862	(6,272)
EADN - Erasmus	EC	(1,080)	37,307	26,679	9,548
Low Mass Star	Forbairt	1,418	5,216	4,491	2,143
Irma	EC	(7,091)	11,506	17,755	(13,340)
LDEF	Forbairt	4,993	2,000	4,082	2,911
Star Formation	EC	32,623	25,699	55,579	2,743
Core Mantle	EC	(2,716)	126,258	102,849	20,693
Propagation	EC	(502)	2,599	2,097	
Kenya	EC	(3,543)	31,314	33,375	(5,604)
BGS II	BGS	(3,942)		1,756	(5,698)
Rapids III	Forbairt	(982)	25,000	2,379	21,639
Iliha	EC		3,576	3,576	
EPAS Plasma	EC		12,246	805	11,441
Other Fees	Various		1,116	1,116	
		<b>22,374</b>	<b>338,869</b>	<b>325,477</b>	<b>35,766</b>

**2 School of Theoretical Physics - Research Programmes and Fees:**

Project	Contributor	Opening	Applied	Unexpended/	
		Balance	Receipts	as Income	Overexpended
		£	£	£	£
Mu-Delta	Forbairt	(2,793)	20,000	17,207	
Crossover	EC	35,984		21,493	14,491
CNRS	EC		3,824	1,703	2,121
Network Rennes	EC		9,354	1,363	7,991
		<b>33,191</b>	<b>33,178</b>	<b>41,766</b>	<b>24,603</b>

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

**Notes to the Accounts**

**3. Fixed Assets**

	Furniture & Equipment	Motor Vehicles	Computers	Total
Cost @ 1/1/94	£	£	£	£
Opening Balance	562,519	13,911	679,176	1,255,606
Additions	42,511		99,199	141,710
	605,030	13,911	778,375	1,397,316
Disposals	605,030	13,911	778,375	1,397,316
Depreciation				
Opening Balance 1/1/94	463,019	10,434	570,202	1,043,655
Charge 1994	22,903	3,477	70,440	96,820
	485,922	13,911	640,642	1,140,475
Depreciation on disposals	485,922	13,911	640,642	1,140,475
Net book value 31/12/94	119,108		137,733	256,841
Net book value 31/12/93	99,500	3,477	108,974	211,951

The net book value of £256,481 includes an amount of £14,617 in respect of assets held under finance leases

**4. Capital Reserve**

Balance at 1 January 1994	211,951
<u>Transfer from Income and Expenditure Account</u>	
Income allocated for capital purposes	141,710
Amortisation in line with asset depreciation	(96,820)
Amount released on disposals	44,890
Balance at 31 December 1994	256,841

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

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**Notes to the Accounts**

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<b>5. Funds</b>	£
These comprise:	
Vernam Hull Bequest	30,924
Carmody Fund	<u>1,669</u>
	32,593

The funds are held on deposit.

**6. Creditors and Accruals:**

Included in this heading is £96,491 contract research monies unexpended at 31 December 1994, which is credited to revenue in line with expenditure on projects. (Note 1)

**7. General Administration Expenses:**

	£
Rent, Rates & Insurance	91,356
Premises Maintenance	28,350
Postage & Telephones	54,546
Fuel, Light & Power	36,480
Sundry Supplies	7,206
	<hr style="width: 50%; margin-left: auto; margin-right: 0;"/> 217,938

**8. Leasing**

**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 1995 is £51,109.

**Finance Leases**

Included in Creditors is an amount of £14,419 liability under a finance lease.

The maturity of the above is as follows:

Under one year	£4,614
In the second to fifth year	£9,805

**9. Miscellaneous Income:**

Included under this heading is Bank Interest earned of £50,335 (1993 - £85,556) for the year.

**10. Superannuation:**

The total superannuation payments in the year amounted to £318,789. The salaries and superannuation charge in the accounts is net of contributions totalling £32,778.

**DUBLIN INSTITUTE FOR ADVANCED STUDIES**  
**REPORT OF THE COMPTROLLER AND AUDITOR GENERAL**

I have audited the financial statements on pages 2 to 9.

**Responsibilities of the Institute and of the Comptroller and Auditor General**

The Council of the Institute is responsible under Section 28(2) of the Institute for Advanced Studies Act, 1940 for the keeping of all proper and usual accounts of moneys received or expended by it. It is my responsibility, under Section 28(3) of the Act to audit the financial statements presented to me by the Council and to report on them. As the result of my audit I form an independent opinion on the financial statements.

**Basis of Opinion**

In the exercise of my function as Comptroller and Auditor General, I plan and perform my audit in a way which takes account of the special considerations which attach to State bodies in relation to their management and operation.

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.

My audit was conducted in accordance with auditing standards which embrace the standards issued by the Auditing Practices Board and in order to provide sufficient evidence to give reasonable assurance that the financial statements are free from material misstatement whether caused by fraud or other irregularity or error. I obtained all the information and explanations that I required to enable me to fulfil my function as Comptroller and Auditor General and 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 Institute's affairs at 31 December 1994 and of its income and expenditure and cash flow for the year then ended.



**JOHN PURCELL**  
**COMPTROLLER AND AUDITOR GENERAL**  
21 FEBRUARY 1996