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

ANNUAL REPORT
1998

P.N. 8845

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 1998

P.N. 8845

Summary of the Annual Report of the Work of the Constituent Schools for the year ended 31 December 1998

School of Celtic Studies

Two new books were published by the School during the course of the year, and there were five reprints. Lectures were regularly given by members of staff and by Research Scholars both at the School, and at conferences in Ireland, England, Europe, Australia and the United States. The Annual Symposium/Tionól was held on 20-21 November. The statutory public lecture was given by Professor Máirtín Ó Murchú.

The complement of Research Scholars appointed for a year from 1 October comprised two from Ireland, two from the United States, one from Canada, one from the Netherlands, and one from Sweden. Another Research Scholar was funded by the Spanish Ministry of Education and Culture.

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-seven scientists from abroad visited the School during the year.

Mathematical symposia were held at Easter and at Christmas; twenty-four seminars were held at DIAS and joint seminars with other third level institutions took place. Members of the School gave five lectures in Ireland. The statutory public lecture was given at Trinity College by Professor A. Ekert (University of Oxford).

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; they participated in seven conferences abroad.

School of Cosmic Physics

The ***Astronomy Section*** continued with a variety of projects, in particular on the nuclei and evolving stellar populations in galaxies. High-resolution X-ray data were used to search for low-level active cores in galaxies of the Local Group around us. An interesting case was made for a nuclear source in the Andromeda galaxy companion M32. Similar attempts to find evidence for active cores in a number of infrared-strong galaxies with high levels of X-ray emission were initiated using the Japanese ASCA and Italian SAX X-ray satellites. Evidence for high-energy flares that may occur in the nuclei of normal galaxies was sought from the Public Archive data of the ROSAT satellite. Evolving young stellar populations were modelled with a computer programme that monitors their high-energy (i.e. X-ray) output. Voids in the distribution of galaxies in the Universe were examined for any material content that may be noticeable by absorbing soft X-rays. Other projects in this area dealt with the interaction between gas and individual galaxies within clusters of galaxies. The design work on the Optical Monitoring Camera for the upcoming INTEGRAL satellite has progressed to include the Engineering Model, which is undergoing extensive tests. The public information activities at Dunsink Observatory benefitted from the recently opened interactive visitors facility. Towards the end of the year, the Office of Public Works started recoppering the two domes of the Observatory.

In the ***Astrophysics Section*** the experimental cosmic ray physics group made significant progress towards completing the primary data extraction from the Ultra-Heavy Cosmic Ray Experiment. The star formation group continued with hydrodynamic and magnetohydrodynamic simulations of young stellar object jet propagation. Observational work concentrated on the Serpens star forming region where several new sources were detected. The dosimetry group continued its study of cosmic ray exposure on commercial aircraft. The theory group found new criteria for the occurence of "pile-ups" in shock accelerated spectra with synchrotron losses and refined its interpretation of the cosmic ray chemical composition. In fusion plasma studies evidence of supra-diffusive and highly anisotropic transport was found in the Hasegawa-Mima model of drift wave turbulence.

In the ***Geophysics Section*** there was progress off-shore with interpretation of side-scan sonar data (the GLORIA system) from the Rockall Trough and the gathering of more detailed side-scan sonar information on the Rockall margins using a deep-towed TOBI system. The former system sees features with dimensions of the order of 50 metres while TOBI resolves features about ten times smaller. The images produced by side-scan sonar give us information about, for example, slope failures, underwater canyons and carbonate mounds. In seismology, a new development was the deployment of fourteen seismic stations in an active seismic zone overseas (the Gulf of Corinth in Greece). The study of earthquake swarms in the

Gulf of Corinth will serve to elucidate how larger earthquakes may develop. Research using gravity data gathered by the Section continued to produce correlations which indicate that the techniques could play an important part in mineral explor. ion.

Annual Report of the work of the Institute and its Constituent Schools presented by the Council for the year ended 31 December 1998.

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 1998.

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 1998.

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 1998.

The Council of the Institute

Chairman

D. Donnelly, D.Sc., Ph.D., M.R.I.A., F.I.C.I., C.Chem., F.R.I.C.

Ex-Officio Members

A. Cosgrove, B.A., Ph.D., President, University College, Dublin; M. Herity, 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.; T. 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.

Members Appointed by the Governing Boards of Constituent Schools

A. Khan, B.Sc., Ph.D.; J. T. Lewis, B.Sc., Ph.D.; E.J.A. Meurs, B.Sc., M.Sc., Ph.D., C. Morawetz B.A., M.S., Ph.D.; B. Ó Madagáin, B.A., Ph.D., M.R.I.A.; M. Ó Murchú, M.A. (Dubl.NUI), Ph.D., M.R.I.A.

Governing Board of the School of Celtic Studies

Chairman

B. Ó Madagáin, B.A., Ph.D., M.R.I.A.

Senior Professors

M. Ó Murchú, M.A.(Dubl.NUI), Ph.D., M.R.I.A.

Appointed Members

P. de Priondargást, M.A.; A. Harrison, M.A., Ph.D; M Ní Bhrolcháin, M.A., Ph.D.; M. P. Ní Chatháin, M.A., Ph.D.; N. Ní Dhomhnaill; M. Ní Neachtain, M. A., H. Dip.; P. Ní Óráin, B.Ed.; C. Ó Ceoinín, M.A.; C. Ó Gráda, M.A., Ph.D., Dip. European Studies; J. Murphy; M. Uí Ainín; Ú. Uí Bheirn, M.A., Ph.D.

Governing Board of the School of Theoretical Physics

Chairman

C. Morawetz, B.A., M.S., Ph.D.

Senior Professors

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

Appointed Members

A. C. Breslin, B.Sc., M.Sc., Ph.D.; J. Browne, B.E., M.Eng.Sc., Ph.D., D.Sc., F.I.E.I.; J.C.I. Dooge, M.E., M.Sc., C.Eng., F.I.E.I., F.A.S.C.E., D.Agr.Sc.; B. Finnucane, B.Sc., Ph.D.; N. Marshall, B.Comm., A.C.A.; A. Montwill, M.Sc., Ph.D. D.Sc.; W. Reville, B.Sc., Ph.D.; T. D. Spearman, M.A., Ph.D. (Cantab), M.R.I.A., Member Academia Europaea, F.T.C.D.

Governing Board of the School of Cosmic Physics

Chairman

A. Khan, B.Sc., Ph.D.

Senior Professors

L. O'C. Drury, B.A., Ph.D.; A.W.B. Jacob. M.A., M.Sc., Ph.D.; E.J. A. Meurs, B.Sc., M.Sc., Ph.D.

Appointed Members

P. K. Carroll, M.Sc., D.Sc., Ph.D., F.Inst.P., M.R.I.A.; B. Harvey, M.A., H.D.E., F. Bis.; M.T. Lago, M.Sc., Ph.D.; M. F. Mulcahy, M.Sc., Ph.D.; M. O'Connor, F.C.C.A, B.L., Dip. in Bus. Studies (to 23/06/98); H. Sheehan, B.S., M.A., Ph.D.

II. Administrative Staff of the Institute

Registrar

John Duggan, B.Sc.

Executive Officer

Mary Burke, B.A., Grad. IPD.

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 1998 adopted at its meeting of 19 Nov. 1999

Contents

1 Staff, Research Scholars, Research Associates

1.1 Staff

Rolf Baumgarten (Professor; special responsibility for bibliography, and director of promotion)

Pádraig de Brún (Professor; to 31 December, resigned)

Fergus Kelly (Senior Professor, appointed 22 May; special responsibility for Early Irish law texts, and director of events)

Malachy McKenna (Assistant Professor; spoken language studies)

Siobhán Ní Laoire (Academic Librarian; also textual and sociolinguistic studies)

Aoibheann Nic Dhonnchadha (Assistant Professor; manuscript studies and Irish medical texts)

Pádraig Ó Macháin (Assistant Professor; manuscript studies and bardic verse)

Máirtín Ó Murchú (Senior Professor; special responsibility for spoken language studies)

Michelle O Riordan (Publications Officer; also historical studies)

1.2 Non-establishment staff

Órla Nic Aodha (Assistant Librarian; to 30 August, resigned)

Cora Gunter (Assistant Librarian; part-time from 13 July, full-time from 14 September)

Brian Ó Curnáin (on temporary employment at Junior Research Assistant level)

Grace Toland (Library cataloguing; part-time)

Joan Sutton (Secretary; part-time)

1.3 Research Scholars

Petra Sabine Hellmuth (to 31 September)

Karen Jankulak

Mary A. Valante

Jacqueline Borsje

Róisín McLaughlin

Ingrid Sperber

Catherine Swift

María del Henar Velasco López (funded by Ministerio de Educación y Cultura, Spain)

Angela Gleason (from 1 October)

1.4 Visiting Senior Professor

Professor Donnchadh Ó Corráin (National University of Ireland, Cork)

1.5 Professores Emeriti

Brian Ó Cuív

Proinsias Mac Cana

1.6 Research Associates

(year of first appointment)

Dr Gwenllian Awbery, University of Wales, Cardiff (1990)
Dr John Carey, Harvard University (1990)
Professor Thomas Charles-Edwards, University of Oxford (1990)
Professor Toshio Doi, Nagoya Women's University (1991)
Professor 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, National University of Ireland, Dublin (1991)
Professor Donnchadh Ó Corráin, University College, Cork (1991)
Professor 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)
Professor Richard Sharpe, University of Oxford (1988)
Professor Robert L. Thomson, University of Leeds (1991)
Professor Calvert Watkins, Harvard University (1990)
Professor T. Arwyn Watkins, National University of Ireland, Dublin (1989)

1.7 Visiting Scholars

(Only overseas scholars who availed of library and research facilities 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 are lacking in the scholars' own institutions and in the major libraries in Dublin.)

Dr Melita Cataldi (University of Turin)
Prof T. M. Charles-Edwards (Jesus College, Oxford)
Prof Johan Corthals (University of Hamburg)
Dr Aidan Doyle (University of Lublin, Poland)
Prof David Dumville (University of Cambridge)
Hugh Fogarty (Harvard University)
Prof Eric P. Hamp (Chicago)
George Klee (Theological College, New York)
Dr Ursula Marmé (University of Köln)
Prof Toshi Matsuoka (Hosei University, Tokyo)
Dr Máire Ní Mhaonaigh (St John's College, Cambridge)
Dr Kenneth E. Nilsen (St Francis Xavier University)
Dr Mícheál Ó Flaithearta (University of Uppsala)
Cristina Olsen (Graduate Theological College, Berkeley)
Prof Pádraig Ó Néill (University of North Carolina)
Elena Parina (Russian State University for Humanities)
Prof R. Mark Scowcroft (Catholic University of America)
Dr Peter Smith (University of Bonn)
Prof Nancy Stenson (University of Minnesota)
Dr Jonathan M. Wooding (University of Sydney)
Prof Stefan Zimmer (University of Bonn)

2 Research

During 1998 research for publication continued in the fields covered by the staff's expertise, viz. manuscript studies, medical texts, Early Irish law, Early Modern Irish verse, spoken language studies, bibliography. In addition to research being conducted internally, there is editorial supervision of work submitted by outside scholars in a number of fields for which the School has statutory responsibility.

2.1 Staff

Rolf Baumgarten continued work on the (database) *Bibliography of Irish linguistics and literature*, and

worked on an intranet trial version. He continued research on Early Irish syntax and medieval Irish etymology. He did editorial work on *Studies in Welsh word formation* (Stefan Zimmer), to be published by the School. He collected the material for, and printed (TEX), the 1997 Annual Report.

Pádraig de Brún continued work on *Scriptural instruction in the vernacular: the Irish Society and its teachers, 1818–1827.* Disk conversion, typesetting, production of CRC and oversight of publication of Martha Bayless and Michael Lapidge (eds) *Collectanea pseudo-Bedae*, intended as Scriptores Latini Hiberniae, 14. See also Outside activities and contributions to scholarship.

Fergus Kelly continued preparing an edition of the legal treatise attributed to Giolla na Naomh mac Duinn Shléibhe Mheic Aodhagáin, *CIH* ii 691–9. He is co-editing *Celtica* 23 with Michelle O Riordan, and *Celtica* 24 with Malachy McKenna. Supervision of Angela Gleason's work on 'Sport and entertainent in Early Ireland'. See also Tionól, Seminars, and Outside activities and contributions to scholarship.

Proinsias Mac Cana continued research on topics of Welsh and Irish historical syntax, as well as on several Irish literary topics. He prepared an extended essay on the history of the Irish College in Paris and its connections with the Irish language and Irish language studies. See also Lectures, and Outside activities and contributions to scholarship.

Malachy McKenna completed draft edition of *The spiritual rose* and referred it to the reader (Prof Ruairí Ó hUiginn). He organized a Conference on Irish dialects, *Comhdháil do chanúintí na Gaeilge* (May). See also Outside activities and contributions to scholarship.

Siobhán Ní Laoire continued research on aspects of stylistic variation and register in Modern Irish. She was awarded the degree of PhD by the National University of Ireland, Dublin, for a dissertation entitled *Aspects of stylistic variation in Modern Irish.* See also Outside activities and contributions to scholarship.

Aoibheann Nic Dhonnchadha worked on medical manuscripts. See also Outside activities and contributions to scholarship.

Brian Ó Cuív revised the descriptions of 57 manuscripts for his catalogue of Irish manuscripts in the Bodleian Library, Oxford; added two appendices. Indexes of (a) initial lines of verse, (b) incipits of prose texts, and general index, as well as a general introduction, were compiled. Format for the work was designed and was approved by Dr B. B. Barker-Benfield of the Bodleian Library and a specimen was produced. See also Outside activities and contributions to scholarship.

Brian Ó Curnáin continued work on Galway and Connacht Irish dialects including field trips to Conamara and East Galway. He assisted in editing Arndt Wigger, *Caint Chonamara, I: Ros Muc.* See also Tionól, and Outside activities and contributions to scholarship.

Pádraig Ó Macháin continued work on the catalogue of Irish manuscripts in the National Library of Ireland. He prepared the Statutory public lecture 1997 for publication. See also Publishing, Tionól, and Outside activities and contributions to scholarship.

Máirtín Ó Murchú supervised work on A. Wigger's proposed publication *Caint Chonamara, I: Ros Muc*; he continued as editor of Ó Maolaithe's account of the Irish of Mionlach, Co. Galway, and as supervisor of Duran's investigation of the Irish of Aran. See also Lectures.

2.2 Research Scholars

Jacqueline Borsje continued research on the idea of Fate in Early Irish literature. See also Tionól, Seminars, and Outside activities and contributions to scholarship.

Petra Sabine Hellmuth finished her thesis 'Edition and critical analysis of the Old and Middle Irish recensions of The tragic death of Cú Roí mac Dáire *Aided Chon Roí.* See also Tionól, Seminars, and Outside activities and contributions to scholarship.

Karen Jankulak, see Tionól, Seminars, and Outside activities and contributions to scholarship.

Róisín McLaughlin worked on an edition of a collection of Old and Middle Irish satirical verse, mainly from *Mittelirische Verslehren.* See also Tionól.

Ingrid Sperber continued preparing an edition and translation of the Dublin collection of *Vitae sanctorum Hiberniae.* See also Outside activities and contributions to scholarship.

Catherine Swift continued her work on an edition, with commentary, of Tírechán's seventh-century Hiberno-Latin *Collectanea.* See also Tionól, and Seminars.

Mary A. Valante, see Tionól, and Outside activities and contributions to scholarship.

María del Henar Velasco López did research on Greek and Latin sources for the study of Celtic religion and mythology. See also Outside activities and contributions to scholarship.

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. 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 1998:

- Martha Bayless and Michael Lapidge (eds), *Collectanea pseudo-Bedae*, Scriptores Latini Hiberniae, 14, Dublin: School of Celtic Studies, Dublin Institute for Advanced Studies, 1998. xiii + 329 pp. ISBN 1-85500-160-8; ISSN 03332-4214. Ir£18 [Catalogue no. J 2.14].

  Contributors: Michael Lapidge, 'The origin of the *Collectanea*'; Martha Bayless, 'The *Collectanea* and medieval dialogues and riddles'; Neil Wright, 'The sources of the *Collectanea*'; Richard Marsden, 'The biblical text of the *Collectanea*'; Mary Garrison, 'The *Collectanea* and medieval florilegia'; Andy Orchard, 'The verse-extracts in the *Collectanea*'; Peter Jackson, 'Herwagen's lost manuscript of the *Collectanea*. –

  Text and translation, Commentary, Indexes.

- Pádraig Ó Macháin, *Téacs agus údar i bhfilíocht na Scol.* Baile Átha Cliath: Scoil an Léinn Cheiltigh, Institiúid Ard-léinn Bhaile Átha Cliath, 1998. viii + 50 pp, pbk. ISBN 1-85500-185-3. Ir£5 [Catalogue F 1.7].

The following publications of the School were reprinted:

Sheila Falconer, *Lorgaireacht an tSoidhigh Naomhtha* (1953), Catalogue F 2.6 [repr 1997].

James Carney, *Poems on the O'Reillys* (1950), Catalogue F 3.7 [1997]

Pádraig de Brún, Breandán Ó Buachalla and Tomás Ó Concheanainn, *Nua-dhuanaire I* (1971), Catalogue F 3.11.1 [1997].

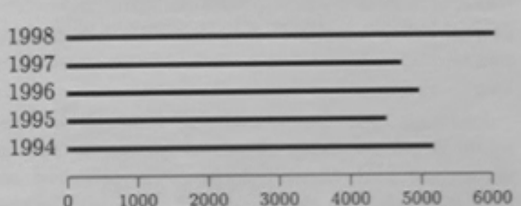
Fergus Kelly, *A guide to early Irish law* (1988), F 4.3.

Rudolf Thurneysen, *A grammar of Old Irish* (1946), E 1.2.

4 Booksales

The classified and annotated catalogue of the School of Celtic Studies publications from its beginning was updated and distributed.
Promotion of publications (Rolf Baumgarten) was through advertising in *Books Ireland*, *Comhar*, *An Saol*, *Slógadh*, *An tOireachtas: clár na féile*, etc.

The number of books sold during 1998 was 6046. 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 4732 for 1997, 4978 for 1996, 4508 for 1995, 5175 for 1994. The ca. 900 copies of the *Newsletter* (ed. Rolf Baumgarten) that have since 1987 been annually distributed worldwide are not taken into account. The following chart is a projection of the above figures.



5 Library

Under the direction of the Academic Librarian, Siobhán Ní Laoire, current and retrospective cataloguing continued and records were made available on the Online Public Access Catalogue. Acquisitions continued in subject areas relevant to the research needs of the School. Regular updates on recent accessions and current periodicals were issued and research and bibliographic queries, from members of the School and visitors alike, were dealt with. Shelving for maps and infill shelving in the library proper are still awaited and storage problems therefore remain.

6 Events

6.1 Lectures

- The Statutory Public Lecture for the year 1998 was delivered by Máirtín Ó Murchú (School of Celtic Studies) on 20 November 1998, at the National University of Ireland, Dublin, entitled 'The Society for the Preservation of the Irish Language'.

- A Public Lecture entitled 'The Irish College, Paris, and the Irish language' was delivered by Proinsias Mac Cana (School of Celtic Studies) on 3 June 1998, at the Dublin Institute for Advanced Studies.

6.2 Annual Symposium/Tionól 1998

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

- Mary Valante (School of Celtic Studies): 'Pre-Norman charters in Ireland'.
- Cathy Swift (School of Celtic Studies): 'Early medieval grave-slabs and the language of their inscriptions'.
- Máire Ní Mhaonaigh (University of Cambridge): 'Three Gormlaiths in one: the creation of a composite literary character'.
- Diarmuid Ó Sé (National University of Ireland, Dublin): 'The development of the f-future in Modern Irish'.
- Caoimhín Breatnach (National University of Ireland, Dublin): 'Oidheadh Chloinne Lir: text and context'.
- Brian Ó Curnáin (Scoil an Léinn Cheiltigh): 'Tá /R/ i gConnachta'.
- Roisín McLoughlin (School of Celtic Studies): 'Aspects of satire and the language of invective'.
- Fergus Kelly (School of Celtic Studies): 'Legal terms for the lower grades in early Irish society'.
- Jacqueline Borsje (School of Celtic Studies): 'Omens and ordeals: on demons and weapons in early Irish texts'.
- Pádraig Ó Macháin (School of Celtic Studies): 'Some Irish manuscripts from County Waterford'.
- Art Hughes (University of Ulster): 'Na claochluithe tosaigh sa Nua-Ghaeilge scríofa: athbhreatnú sioncrónach'.
- Séamas de Barra (An Gúm): 'An bheathaithnéis ag Pilip Barún ar Bhrian "Merriman" Mac Con Mara (1836)'.

6.3 Seminars

- Fergus Kelly (School of Celtic Studies) continued his Seminar on the legal treatise attributed to Giolla na Naomh mac Duinn Shléibhe Mheic Aodhagáin, starting from *CIH* ii 692.10) (weekly, from 22 January); starting from *CIH* ii 693.28) (weekly, from 22 October).
- Caitlin Quinn (Columbia University, New York): '*Merugud Uilix maic Leirtis*: a *speculum principis*?' (11 February).
- Catherine Swift (School of Celtic Studies): 'St Patrick and the kings of Tara: patterns of commemoration' (11 March).
- Karen Jankulak (School of Celtic Studies): 'The cult of the Cornish St Petroc in Brittany' (25 March).
- Petra S. Hellmuth (School of Celtic Studies): '*Aided Chon Roí*: the story of a story' (8 April).
- Jacqueline Borsje (School of Celtic Studies): 'An eye for an eye: the idea of Fate in *Togail Bruidne Da Derga*' (22 April).

7 Outside activities and contributions to scholarship

7.1 Activities

Lectures were delivered by:
Fergus Kelly, 'Early Irish law', History Society, University of Dublin (January); 'Early Irish law', Celtic Society, National University of Ireland, Maynooth (January); 'Early Irish farming', Historical Society, National University of Ireland, Galway (March); 'The Old-Irish law-tracts: texts and transmissions', Irland und Europa Conference, Konstanz (March); 'The conflict between English and Brehon Law after the Anglo-Norman Invasion', Thomas More Conference, National University of Ireland, Maynooth (July); 'The beliefs and mythology of the early Irish, with special reference to the Cosmos', Conference of the Astronomical History Association, School of Cosmic Physics, Dublin Institute for Advanced Studies (August).

Malachy McKenna gave M.Phil. courses on Phonology and Morphology, Center for Language

and Communication Studies, Dublin University (January, February).

Aoibheann Nic Dhonnchadha, 'Doctors and patients in the Gaelic medical texts', conference of the Irish Committee of Historical Sciences, University of Limerick (May).

Siobhán Ní Laoire, 'Aspects of stylistic variation in Modern Irish', three lectures at the School of Irish, Dublin University (January/February).

Brian Ó Curnáin, 'Tréith de Ghaeilge Mhionlaigh agus máguaird', Teangeolaíocht na Gaeilge III, Ollscoil Náisiúnta na hÉireann, Gaillimh (April); 'Polygenesis of a third plural pronoun in West Galway Irish', Convergence and Divergence of Dialects in a Changing Europe, European Science Foundation Network, University of Reading (September).

Pádraig Ó Macháin, 'John Fleming', Dungarvan Museum Society, Dungarvan (January); 'The manuscript tradition of Sliabh gCua', Éigse Shliabh gCua, Touraneena, Co. Waterford (August).

Lectures by Research Scholars:

Jacqueline Borsje, 'Kijken met een heroïsch en een monastiek oog: betrokkenheid en distantie bij het lezen van oude Ierse teksten', conference of the Nederlands Genootschap voor Godsdienstwetenschap, and Nederlandse Onderzoekschool voor Theologie en Religiewetenschap, Heeze (May).

Karen Jankulak, 'Breton Vitae and political need in the Cartulary of Sainte-Croix de Quimperlé', Third Annual Celtic Conference, University of Sydney Centre for Celtic Studies (July); 'Celtic England: Cornwall', session The territorial framework of English medieval settlement: a comparative approach, International Medieval Congress, University of Leeds (July); 'Saint Pérec en Haute et en Basse Bretagne:l'introduction et la répansion de son culte', Colloque du Centre International de Recherche et de Documentation sur le Monachisme Celtique, Landévennec, Brittany (July); 'Cults, parishes, and the personality of the early British churches', Centre for Continuing Education, University of Sydney (February).

Mary A. Valante, 'Taxation tolls and tribute: the legal language of economics and trade in Viking-age Ireland', Harvard Celtic Colloquium, Cambridge (May).

7.2 Scholarly publications

Rolf Baumgarten, co-edited *Ériu* 49.

Pádraig de Brún, 'An Irish manuscript of eighteenth-century Meath', *Ríocht na Midhe* 10 (1999) 86–91; '*IGT* citations—some additional identifications', *Ériu* 49 (1998) 175–6..

Proinsias Mac Cana, 'Complex adjectival predicates in Insular Celtic', in Jay Jasanoff et al. (eds) *Mír curad: studies in honour of Calvert Watkins* (Innsbruck, 1997) 439–50; co-edited *Ériu* 49.

Brian Ó Cuív, 'The Irish Texts Society and the development of Irish language scholarship', in Pádraig Ó Riain (ed) *The Irish Texts Society: the first hundred years*; revised proofs of 'Elegy on Féilim Mac Maghnusa Méig Uidhir', to be published in *Celtica* 23.

Research Scholars' publications:

Jacqueline Borsje, 'Kijken met een heroïsch en een monastiek oog: betrokkenheid en distantie bij het lezen van oude Ierse teksten', *Nederlands theologisch tijdschrift* 52 (1998) 265-82; 'Een Iers lot', *Kabats* 1998/1999, nr 1, 3–5.

Petra Sabine Hellmuth, 'A giant among kings and heroes: some preliminary thoughts on the character of Cú Roí mac Dáire in mediaeval Irish literature', *Emania* 17 (1998) 5–11.

Karen Jankulak, review of Nicholas Orme, *English church dedications*, *Journal of ecclesiaticl history* 49 (1998) 531–2.

Ingrid Sperber, 'The Live of St Ciarán of Saigir', in William Nolan and Timothy P. O'Neill (eds) *Offaly: history and society (Dublin, 1998) 131–52.*

Mary A. Valante, 'Re-assessing the Irish "monastic town" ', Irish historical studies 31 (1998) 1–18.

María del Henar Velasco López, 'Diodoro V, 28, 5–6, y la creencia del alma entre los celtas', Actas del IX Congreso Espanol de Estudios Clásicos (Madrid, 1998) 249–54.

Annual Report of the Governing Board of the School of Theoretical Physics for the year ending 31 December 1998 adopted at its meeting on 18 May 1999.

1 Staff, Scholars and Associates

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

ASSISTANT PROFESSORS: Fergal Toomey from 1 July, Raymond Russell from 1 July

LIBRARIAN: Ann Goldsmith

SECRETARY: Margaret Matthews

SYSTEMS ADMINISTRATOR: Ian Dowse

EMERITUS PROFESSOR: James R. McConnell

VISITING PROFESSORS: N. O'Connell BRIMS, Bristol. Ch.-E. Pfister EPF Lausanne

SCHOLARS: E. Ivashkevich (Russia) to 30 April, J. Pawlowski (Germany), O. Schnetz (Germany) to 31 March, J. Teschner (Germany) from 1 November, S. Vinnakota (India), P. Watts (USA).

EUROPEAN UNION FELLOWS: M. Corluy (Belgium)

GRADUATE STUDENTS: S. Coffey (Ireland) from 1 October, M. Dukes (Ireland), K. Duffy (Ireland), M. Huggard (Ireland), B. McGurk (Ireland), C. Walsh (Ireland).

RESEARCH ASSOCIATES: Re-appointed to 31 December 1999:

TCD: P.S. Florides, D. Weaire

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

NUI, MAYNOOTH: M. Daly, B. Dolan, D. Heffernan, F. Freire, C. Nash, A. O'Farrell, J.A. Slevin, D.H. Tchrakian

NUI, CORK: M. Vandyck

NUI, GALWAY: J. Burns, M.J. Conneely, M.P. Tuite

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

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

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

IT, CARLOW: D. O Sé

AT & T: N. Duffield

OPEN UNIVERSITY: A.I. Solomon

OXFORD UNIVERSITY: R.G. Flood

LAB. DE PROBABILITIES, LYON: 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, D. O'Mathúna

VISITING SCIENTISTS: A. Anantharam (Univ. of California, Berkeley) 3-31 May, F. Buccella (Naples) 19-24 May, A.P. Balachandran (Syracuse) 20-26 May, J. Bockenhauer (Swansea) 14-21 February, A. Bracken (Queensland) 22 June - 16 October, J. Conlon (Ann Arbor) 23-25 February, H.D. Doebner (Claustal-Zellerfeld) 20-24 May, A. Ekert (Oxford) 30-31 October, D. Evans (Swansea) 14-21 February, H. Firth (Orkney) 7-9 April, C. Ford (Jena) 7-15 June, G.W. Ford (Michigan) 8 June - 10 July, A.J. Ganesh (BRIMS) 4-8 August, F. Lenz (Erlangen) 22-24 May, D. Litim (Barcelona) 3-13 May, P. McGill (Lyon) 1-8 September, W. McGlinn (Notre Dame) 12 January - 3 June, M. Magro (Lyon) 20-25 May, J. Martin (Cambridge) 23-24 March, L. Michel (IHES, France) 20-24 May, R. Musto (Naples) 20-24 May, M. Newell (Galway) 7-9 April, D.J. O'Connor (Mexico) 30 July - 30 August, R.F. O'Connell (Louisiana) 7 June - 16 August, N. O'Connell (BRIMS) 4-10 April, 31 July - 16 August, 18-22 December, D. Olive (Swansea) 20-24 May, E. Pechersky (Moscow) 31 August - 28 September, C. Pfister (Lausanne) 22-27 January, 10-15 December, B. Ponsot (Montpellier) 23 November - 14 December, V.B. Priezzhev (Dubna) 12 October - 9 November, G. Procissi (BRIMS) 3-8 August, A. Raina (Tata Institute) 5-11 February, R. Rivers (Imperial College) 17 June, M. Roughan (Melbourne) 12-15 April, I. Sachs (Durham) 22-24 October, W. Skrypnik (Kyiv) 12 October - 10 November, A.I. Solomon (Open University) 8-9 April, N. Straumann (Zurich) 20-24 May, E.C.G. Sudarshan (Austin, USA) 20-24 May, Yu. Suhov (Cambridge)

6-21 September, J. Teschner (Montpellier) 10-17 May, A. Verbeure (Leuven) 23-25 February, N. Vvedenskaya (Moscow) 2 September - 3 October, K.C. Wali (Syracuse) 20-24 May, J. Wess (München) 23-25 February, 20-24 May, A. Wilch (Brussels) 17-26 May, A. Wipf (Jena) 20-25 May.

2 General

On 1 May, the Minister for Science and Technology, Noel Treacy, T.D., presided at the launch by Professor Roger Needham, FRS, Director of Microsoft Research Laboratories, Cambridge, of a joint European research initiative with the School. Microsoft Research will fund a Research Fellowship at Fitzwilliam College, Cambridge; the holder will spend half the year in Cambridge and half at DIAS-STP. The first holder is Koenraad Laevens (Ghent).

A three-day conference in honour of Professor Lochlainn O'Raifeartaigh was held from 21-23 May in Trinity College Dublin. (see Sect. 9).

A two-day meeting on *Quantum Computation* was held on 30-31 October, organised jointly by NUI Maynooth, TCD and DIAS.

3 Research and Study

3.1 Theoretical Particle Physics

Prof. O'Raifeartaigh's work on the N-point functions for Wess-Zumino-Witten and Liouville systems mentioned in the 1997 report was continued in collaboration with J. Pawlowski and S. Vinnakota. It was shown that the duality symmetry that appears in the quantum version of the Liouville theory can be traced to the fact that the relationship between the quantized conformal weight and momentum is two-to-one, in contrast to the classical theory in which it is one-to-one. In a paper just completed, it has been shown that, with a modified treatment of the zero-mode integration, the duality can be incorporated in the path-integral formulation of the quantum theory from the beginning. Work on other aspects of this subject is underway. The derivation of Noether currents for supersymmetric theories is difficult because of the space-time nature of the symmetry. This is particularly true for the Effective Lagrangian of the Seiberg-Witten model which involves quartic powers of the fermion fields. Work on the derivation of the Noether currents for this model, begun last year in collaboration with A. Iorio, M. Magro and I. Sachs was continued and has been largely successful in that the supersymmetric Noether currents have now been found. A resume of the results is in course of preparation. Work was begun in collaboration with Professors F. Lenz and M. Thies of the University of Erlangen and J. Nagele of MIT on the question of how quarks and gauge-fields are released from confinement in the broken phase of a Higgs potential. Work on the history of gauge theory, with emphasis on the role of dimensional reduction, was carried out in collaboration with Professor N. Straumann, University of Zurich. The work is now complete and will be published shortly in Reviews of Modern Physics. A second historical project, namely a short biography of Walter Heitler, who was senior professor at the DIAS until 1949, was prepared in collaboration with Professor G. Rasche, University of Zurich. This work will be published in a forthcoming book on Irish Mathematicians of this century being prepared by Prof. K. Heuston of Queen's University.

Prof. Chela-Flores worked on the project 'Testing the Drake equation in the solar system'which is devoted to the discussion of the transition bacteria-eukaryote.

Dr. Dolan carried out research on field theory in particle physics, general relativity and condensed matter.

Dr. Pawlowski carried out research in the following areas : a study of non-perturbative effects in gauge theories at zero and finite temperature with the Wilsonian renormalisation group; path integral quantisation of conformal field theory; instantons on the Torus and quantisation on the torus; geometrical effective action (gauge theories without ghost).

Prof. Tchrakian worked in the following areas : interaction energy of Abelian Higgs vortices; interaction energy of usual monopoles, as well as generalised monopoles; quantisation of Skyrme system in $1+1$ dimensions; gauging of Skyrme models and study of bifurcation and general study of sphalerons.

Dr. Teschner studied string theory on

curved backgrounds, solvable models involving e.g $SL(2,C)/SU(2)-WZNW$ model or Liouville theory. He also studied the deformation of wave-equations as a model for nonlocal gravitational effects, e.g. Black hole on two dimensions.

Dr. Vinnakota investigated the quantisation of two-dimensional Liouville field theory using the path integral, on the sphere, in the large radius limit. The general form of the N-point functions of vertex operators was found and the three-point function was derived explicitly. It was shown that the two dimensional lattice of poles of the coefficients of the three-point functions has its origin in the duality of the quantum mechanical Liouville states and this duality was incorporated in the path-integral by using a two-exponential potential.

Dr. Watts developed an algebraic approach to the examination of pure W_4 gravity. He extended the usual W_3 gravity theory to include supersymmetry. He also started to examine the role of D(-1)-Branes on the vacuum of superstring theory.

3.2 Applied Probability Theory

Work continued on the MEASURE project supported by a Long Term Research contract with the European Commission under its programme for research in information technology (ESPRIT). The organisations involved in the project are : DIAS-STP, Cambridge University Computing Laboratory and Telia Research (a wholly-owned subsidiary of Telia AB, the Swedish telecommunications company). The work involves applying Large Deviation theory to problems of resource allocation in broad-band networks and in computer operating systems. The theoretical work is the responsibility of the group in DIAS-STP under the leadership of Prof. Lewis. The novel aspect of the proposal is the method to be used for determining the rate-function of an arrivals process. The parametric modeling of the process is by-passed by use of direct estimation of the rate-function.

Nine tasks were completed in 1998, the final year of the contract: Methodology Comparison; Realisation of Estimators, Performance Evaluation and Demonstration in a Public ATM Network; Performance Evaluation and Demonstration in an ATM Local Area Network; Realisation of Estimators, Performance Evaluation and Demonstration in the NEMESIS operating system. The DIAS-STP group made major contributions in all of these tasks.

Professor Lewis continued his collaboration with Dr. Sullivan on the application of Large Deviation Theory to Queueing Theory. With Professor Pfister, they continued their work on the application of Large Deviation Theory to ergodic theory, investigating the Hausdorff dimension of the set of generic points associated with a stationary probability measure.

Mr. Corluy worked on the calculation of overflow probabilities for the queue used to multiplex a large number of ATM connections described with the standard parameters peak cell rate, sustain cell rate and burst tolerance. The main objective was the calculation of the rate function for the associated arrival process, using the method of random time changes.

Mr. Coffey began research into random early detection and other congestion avoidance algorithms in a TCP/IP setting.

Mr. Duffy worked on the non-parametric measurement of effective bandwidths, on mixing conditions in Large Deviations and on applications to telecommunications.

Mr. Dukes has carried out research in the following areas : flow identification in networks; various problems in queueing theory; connectivity in random matroids and combinatorics of matroid enumeration.

Ms. Huggard continued her work on weighted fair queueing schemes.

Mr. McGurk examined the Large Deviations of samples chosen randomly from a stochastic process. He was also involved in continued investigations of measurement based connection admission control in telecommunications networks.

Dr O'Connell studied topological aspects of Large Deviation theory and applications to combinatorial optimisation, random matrices and queueing theory.

Prof. Russell defended his Ph.D. Thesis, entitled *The Large Deviations of Random Time-Changes*, and continued to work on topics arising from it, such as proving sample-path large Deviation principles and the construction of Galois connections over suitable lattices. He worked on the analysis and implementation of Connection Admission Control algorithms for ATM networks; this involved devising refinements to the basic statistical estimation schemes and testing

them in simulations both in software and in a combined software/hardware test environment. He wrote a proposal for joint research work with Telia Research; the work to be done consists of applying some of the results of the MEASU. E project to Random Early Detection in IP routers. He started on the work by writing a software simulation designed to test various RED algorithms. Jointly with Professor Toomey, he designed a lecture course on "Order theory and its Applications", the course will be taught to Sophisters in the School of Mathematics, Trinity College, Dublin.

Prof. Toomey worked on Large Deviation theory, the theory of linear Galois connections and on measurement-based resource allocation.

3.3 Classical Statistical Mechanics

Professor Lewis continued his collaboration with Professor Pfister and Dr. Sullivan in an effort to clarify the concept of weak dependence, introduced by them in their investigation of the problem of the Equivalence of Ensembles.

3.4 Quantum Statistical Mechanics

Prof. Lewis continued his collaboration with Profs. Ford and O'Connell, investigating some aspects of Quantum optics.

3.5 Quantum Theory and Quantum Electronics

Prof. 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 looked at the application of quantum groups to the analysis of deformed systems in physics, especially optics.

3.6 Applied Mathematics

Dr. Golden worked on linear viscoelastic boundary value problems where the boundary regions vary in time and on the thermodynamics of viscoelastic solids.

3.7 Pure Mathematics

Dr. Goldsmith carried out further investigations into the unit sum numbers of rings and modules. He also studied certain classes of torsion-free modules wherein members of the class have anti-isomorphic endomorphism rings.

Dr. Vandyck continued study of Lie and covariant differentiation of spinors. A bundle formulation was developed, which justifies, and sheds light onto, the tensorial methods employed previously.

4 Research Reports

Research work during the year was written up in the first instance in research reports. A list 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 11.4).

DIAS-STP-98-

-1: E.V. Ivashkevich: Correlation functions of dense polymers and $c = -2$ conformal field theory.

-2: C. Ford, U.G. Mitreuter, T. Tok, A. Wipf & J.M. Pawlowski: Monopoles, Polyakov-loops and gauge fixing on the torus.

-3: D.F. Litim & J.M. Pawlowski: Flow equations for Yang-Mills theories in general axial gauges.

-4: L. O'Raifeartaigh & V.V. Sreedhar: Path integral formulation of the conformal Wess-Zumino-Witten → Liouville reduction.

-5: L. O'Raifeartaigh & V.V. Sreedhar: Path integral formulation of the conformal Wess-Zumino-Witten → Toda reductions.

-6: E.V. Ivashkevich, A.M. Povolotsky, A. Vespignani & S. Zapperi: Dynamically driven renormalization group applied to sandpile models.

-7: B.P. Dolan: Duality and the modular group in the quantum Hall effect.

-8: D.F. Litim & J.M. Pawlowski: On gauge invariance and Ward identities for the Wilsonian renormalisation group.

-9: D.F. Litim & J.M. Pawlowski: On general axial gauges for QCD.

-10: B.P. DOLAN: Modular invariance, universality and crossover in the quantum Hall effect.
-11: P. WATTS: Ward identities and anomalies in pure W_4 gravity.
-12: W.M.B. DUKES: Connectivity in random matroids.
-13: A.J. BRACKEN & G.F. MELLOY: Localizing the relativistic electron.
-14: L. O'RAIFEARTAIGH & G. RASCHE: Walter Heitler.
-15: L. O'RAIFEARTAIGH & N. STRAUMANN: Early history of gauge theories and Kaluza-Klein theories.
-16: W.I. SKRYPNIK: On quantum systems of particles with pair long-range magnetic interaction in one dimension equilibrium.
-17: L. O'RAIFEARTAIGH, J.M. PAWLOWSKI & V.V. SREEDHAR: Duality in quantum Liouville theory.
-18: W.M.B. DUKES & C. WALSH: Note on the tail of the overflow-time distribution.
-19: W.M.B. DUKES: The absent minded scouts dilemma.
-20: J.T. LEWIS, C.-E. PFISTER & W.G. SULLIVAN: How to encode a stationary source.
-21: J.T. LEWIS: (Andrejewski Lectures) Thermodynamic probability theory: some aspects of Large Deviations.

5 Seminars, Review Lectures, Series, Courses

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

Seminars and lectures were given also under the auspices of the Dublin Particle Theory Group by the School's members and visitors.

5.1 Statutory Public Lecture

The statutory public lecture entitled *Quantum computation : theory and experiments* was delivered by Professor A. Ekert (University of Oxford) in Trinity College Dublin on 30 October.

5.2 Seminar and review lectures given at DIAS-STP

- A. Anantharam (Univ. of California, Berkeley) *Optimal routing control : game theoretic approach.*
- A. Bracken (Queensland) *Localizing the relativistic electron.*
- C. Ford (Jena) *Instantons on the torus.*
- D. Litim (Barcelona) *On flow equations for YM-theories in general axial gauges.*
- J. Martin (Cambridge) *Fast Jackson networks.*
- V.B. Priezzhev (JINR, Dubna) *The upper critical dimension of self-organized criticality.*
- R. Rivers (Imperial College) *Can we learn about the early universe from condensed matter experiments?*
- M. Roughan (RMIT and Univ. of Melbourne) *Real-time measurement of self-similar traffic.*
- W. Sullivan (UCD) *Talagrand's concentration of probability (I) (via Large Deviations).*
- W. Sullivan (UCD) *Talagrand's concentration of probability (II).*
- W. Sullivan (UCD) *Talagrand's concentration of probability (III).*
- F. Toomey *Finite buffered queues.*
- N. Vvedenskaya and E. Pechersky (Moscow) *Large deviations and queueing theory.*

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

- D. Birmingham (UCD) *Three dimensional Black Holes in string theory.*
- B. Dolan (NUI, Maynooth) *The modular group and the Quantum Hall effect.*
- F. Freire (TCD) *The 'classical' limit of the quantum Boltzmann equation.*
- A. Lewis (NUI, Maynooth) *Logarithmic conformal field theory.*
- J. Pawlowski *On the quantisation of chiral gauge theories.*
- A. Raina (Bonn/Tata Institute) *Geometry and the operator product expansion in conformal field theory.*

- O. Schnetz *Knots, numbers and Feynman graphs.*
- S. Vinnakota *Duality in quantum Liouville theory.*
- J. Teschner (Montpellier) *Structure constants, spectrum and fusion rules in the SL(2,C)/SU(2) model.*
- J. Teschner *The two-dimensional noncommutative Black Hole.*
- P. Watts *Anomalies in W_N gravity.*
- A. Wilch (Brussels) *Non-linear representations and cohomology.*

5.4 Lecture Courses and Seminars given in Ireland by members of DIAS-STP

- Prof. J.T. Lewis *Large Deviation theory and information theory.* (Seminar, DCU) *Course 412 : Probability theory.* (TCD)
- Prof. L. O'Raifeartaigh *Gauge theory.* (M.Sc. course, DIAS)
- Mr. K. Duffy *An introduction to Large Deviations.* (Course in DIAS)
- Profs. R. Russell & F. Toomey *Course 422 : Order Theory and its Applications.* (TCD)
- Dr. M. Vandyck *Clifford algebras and spinors in physics.* (NUI Cork)

5.5 Seminars, Lectures and Courses given abroad

- Prof. J.T. Lewis *The Andrejewski Lectures :Three Lectures on Thermodynamic probability theory - some aspects of Large Deviations.* (Göttingen, repeated at Leipzig and Cardiff) *Forty Lectures on Large Deviation Theory and its appications.* (TU Budapest) *Statistical Multiplexing* (TU Budapest)
- Profs. Lewis, Russell & Toomey *A three hour Tutorial on Large Deviation Theory* (Sigmetrics '98, Madison, Wisconsin)
- Prof. L. O'Raifeartaigh *Seiberg Witten theory.* (Sussex) *Anomalies in quantum field theory.* (Wuppertal)
- Dr. J. Pawlowski *On a gauge invariant Wilsonian RG.* (Bad Honnef) *On gauge invariances and Ward identities for the Wilsonian RG.* (Montpellier) *On gauge invariant flows.* (Faro) *Path integral quantisation of Liouville theory.* (Jena) *On consistent and covariant anomalies in chiral gauge theories.* (Wien) *On flow equations for non-abelian gauge theories.* (Heidelberg) *On Wilsonian flows in non-abelian gauge theories.* (Eerlangen) *Path integral quantisation of Liouville theory.* (Zeuthen)
- Prof. R. Russell *Sample-path Large Deviations of weakly dependent processes.* (Nottingham)
- Prof. F. Toomey *Large Deviations in a clan of stochastic discrete event systems.* (Nottingham, Tel Aviv, Israel) *Linear Galois connections in queueing systems.* (Cambridge)
- Dr. P. Watts *Effective W_3 supergravity.* (Oxford)

6 Activities of Members of DIAS-STP

6.1 Activities within Ireland

MR. K. DUFFY: Maths Intervarsity, Galway, 28 February - 1 March.

MR. M. DUKES: Maths Intervarsity, Galway, 28 February - 1 March.

MR. B. MCGURK: Maths Intervarsity, Galway, 28 February - 1 March.

DR. S. VINNAKOTA: Fifth Irish Quantum Field Theory Meeting in Honour of the 65th Birthday of Prof. L. O'Raifeartaigh, 21-23 May.

MR. C. WALSH: Maths Intervarsity, Galway, 28 February - 1 March.

DR. P. WATTS: Fifth Irish Quantum Field Theory Meeting in Honour of the 65th Birthday of Prof. L. O'Raifeartaigh, 21-23 May.

6.2 Activities outside Ireland

PROF. J.T. LEWIS: Discussions with C.P.T., London, 9 January; Telia Research, Stockholm, 21-22 January; ESPRIT Project, Cambridge, 22-23 January; Telia Research, Stockholm, 19-22 February; University of Glasgow, 11 March; Computer

Laboratory, Cambridge, 16-18 March; Probability Workshop, Nottingham, 20-22 April; Leuven, 15-20 May; Andrezewski Lectures, Leipzig and Göttingen, 26 May - 4 June; Cambridge 10 June; Performance/Sigmetrics '98, Madison, Wisconsin, 20-25 June; Telia, Stockholm, 13-17 July; Microsoft, Cambridge, 10 August; Telia, Stockholm, 23-25 August; Cambridge, 7-9 September; Budapest, 27 September - 10 October; Cardiff, 22-23 October; Telia Research, Stockholm, 17-20 November; Budapest, 1-5 December.

PROF. L. O'RAIFEARTAIGH: University of Sussex, January; Ecole Normale Superieure de Lyon, 1-28 April; Graduierten College Meeting, Wuppertal, Germany, 6 July; Summer School on New Symmetries in Condensed Matter and Statistical Physics, Villa Gualino, Torino, 16-22 August; Summer School on Spontaneous Symmetries Breaking, Zuoz, Switzerland, 18 August; Institute for Scientific Interchange Foundation, Torino, Italy, 13-14 September; 40th Anniversary of Institut des Hautes Etudes, Bures-sur-Yvette, October; Senior Humboldt award, Erlangen and Jena, 1 November - 31 December; Meeting of the Mittel-Deutsches Combo, December; Workshop on Strong-Interaction Physics, Jena, December.

MR. M. CORLUY: Probability Workshop, Nottingham, 19-24 April.

MR. I. DOWSE: Computer Laboratory, Cambridge, 16-18 March; Telia, Stockholm, 13-17 July.

MR. K. DUFFY: Computer Laboratory, Cambridge, 16-18 March; Probability Workshop, Nottingham, 19-24 April.

MR. M. DUKES: Computer Laboratory, Cambridge, 16-18 March.

MS. M. HUGGARD: Computer Laboratory, Cambridge, 16-18 March.

MR. B. MCGURK: Computer Laboratory, Cambridge, 16-18 March; Probability Workshop, Nottingham, 19-24 April.

DR. J. PAWLOWSKI: Beyond the standard model, Bad Honnef, 1-4 March; Frankfurt, 24 February - 18 March; University of Barcelona, 27 June - 1 July; QCD '98, Montpellier, France, 2-8 July; University of Barcelona, 9-10 July; SUSY '98, Oxford, 11-17 July; Workshop on the Exact RG, Faro, Portugal, 10-12 September; Jena, Germany, 24-27 September; Quantisation, Generalised BRS Cohomology and Anomalies, Wien, Austria, 28 September - 10 October; Heidelberg, Germany, 11-16 October; Erlangen, Germany, 8-10 December; Zeuthen, Germany, 11-14 December; Workshop on Strong Interacting Gauge Theories, Jena, Germany, 15-18 December.

PROF. R. RUSSELL: Computer Laboratory, Cambridge, 16-18 March; Probability Workshop, Nottingham, 19-24 April; Performance/Sigmetrics '98, Madison, Wisconsin, 20-25 June; Telia, Stockholm, 13-17 July; Telia, Stockholm, 23-25 August; Cambridge, 7-9 September; Telia Research, Stockholm, 17-20 November.

DR. S. VINNAKOTA: First Workshop in Mathematical Physics of Montpellier and Visit to Orsay, Paris, 17-23 January; Introductory School on String Theory, ICTP, Trieste, 6-20 June.

PROF. F. TOOMEY: Computer Laboratory, Cambridge, 16-18 March; Probability Workshop, Nottingham, 19-24 April; Performance/Sigmetrics '98, Madison, Wisconsin, 20-25 June; Informs '98, Tel Aviv, Israel, 27 June - 6 July; Telia, Stockholm, 13-17 July; Stochastic Networks Workshop, Cambridge, September; Cambridge 7-9 September.

MR. C. WALSH: Computer Laboratory, Cambridge, 16-18 March; Cambridge, 7-9 September.

DR. P. WATTS: PASCO8-98, Northeastern University, Boston, MA, 22-29 March; Strings '98, University of California, 18 June - 1 July; SUSY-98, Oxford, 11-17 July.

7 Symposia

Two Mathematical Symposia were held during the year, 8-9 April and 21-22 December. The attendance (20 in April, 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:

April

Review Lectures:

- Prof. J.T. Lewis *The entropy analogy : a progress report.*
- Prof. M. Newell (NUI Galway) *On Sanov groups.*

Lectures:

- Dr. W. Sullivan (UCD) *Generic points.*
- Dr. N. O'Connell (BRIMS, Bristol) *The law of averages : a modern perspective.*
- Mr. H. Firth (Orkney Sci. Foundation) *Schrödinger's waves - searching for the sources.*
- Prof. A.I. Solomon (Open Univ.) *Coherent states and the Stieltjes moment problem.*

Short Talks:

- Dr. D. Gilbert (DCU and Sheffield Hallam University) *Spectral analysis of Schrödinger operators.*
- Mr. M. Davey (Cambridge) *Low density parity check codes.*
- Dr. R. Timoney (TCD) *On positivity of elementary operators.*
- Dr. T. Murphy (TCD) *Triality.*
- Dr. P. Watts *3 - Branes and spacetime geometry.*
- Dr. P. Dolan (Imperial College) *Why general relativity needs a proper theory of asymptotics.*

December

Review Lectures:

- Dr. M. McGettrick (NUI Galway) *Min-plus linearity and statistical mechanics.*
- Dr. N. O'Connell (BRIMS, Bristol) *Thermodynamic aspects of dynamical systems.*

Lectures:

- Dr. S. O'Brien (UL) *A mathematical model for instabilities in the coating of cylindrical light bulbs.*
- Dr. R. Timoney (TCD) *Completely positive operators.*
- Dr. J. Gough (NUI Maynooth) *Large Deviations and multifractal spectra.*
- Dr. T. Murphy (TCD) *Triality.*

Short Talks:

- Mr. M. Mackey (UCD) *Compactifications of symmetric spaces.*
- Dr. M. Mathieu (QUB) *Automatic continuity of Lie homomorphisms on C^*-algebras.*
- Prof. J. Flavin (NUI Galway) *Mathematical symposium, 40 years old : the first symposium and its genesis.*
- Prof. P. Lambert (Univs. Alaska and Limerick) *A simple sequence in the unit square with interesting distribution.*
- Dr. J. Murray (UCD) *Necessary and sufficient conditions for the existence of real 2-blocks.*
- Ms. A. Crosbie (TCD) *The Trinity/Queen's high performance computing collaboration.*

8 Mini-symposium

A mini-symposium on "Queuing Theory" organised by the Applied Probability Group was held from 5-7 August. The following lectures were delivered.

- N. O' Connell *On the fluctuations of partial sums of iterates of chaotic maps.*
- K. Duffy *Mixing conditions for sample path LDPs.*
- C. Walsh *Worst case traffic from sources constrained by leaky buckets.*
- G. Procissi *On the build-up of large queues in a queuing model with fractional Brownian motion input.*
- M. Huggard *A review of some results for fair queuing systems.*
- A.J. Ganesh *Large deviations behaviour of the fixed point of $./G/1$ queues.*

9 Conference

A conference in honour of Professor Lochlainn O'Raifeartaigh was held from 21-23 May in the Maxwell Lecture Theatre, Trinity College Dublin. This conference was organised by the Fifth Irish Quantum Field Theory Meeting and 55 delegates attended. The following lectures were delivered.

- H.D. Doebner *On non-linear modifications of quantum mechanics.*
- N. Straumann *Non Abelian black holes and self gravitating solitons : a sequence of surprises.*
- A.P. Balachandran *Discrete quantum physics.*
- C. Nash *Topology and quantum field theory.*
- T. Sherry *The quantum mechanical path integral as a calculational tool in quantum field theory.*
- K. C. Wali *Geometrisation of particle interactions.*
- S. Sen *Geometric discretisation.*
- F. Bucella *Neutrino masses and baryogenesis in SO(10).*
- A. Wipf *Field theories on the torus.*
- D. Birmingham *Black holes and string theory.*
- T.D. Spearman *Sir William Rowan Hamilton : Mathematician.*
- L. Michel *Symmetries.*
- E.C.G. Sudarshan *Spin and statistics.*
- D. Olive *Duality.*
- J. Wess *more than 20 years with supersymmetry.*
- R. Musto *Reminiscences.*

10 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):

F. Buccella (Naples) 19-24 May,
A.P. Balachandran (Syracuse) 20-26 May,
J. Bockenhauer (Swansea) 14-21 February,
J. Conlon (Ann Arbor) 23-25 February,
H.D. Doebner (Claustal-Zellerfeld) 20-24 May,
A. Ekert (Oxford) 30-31 October,
D. Evans (Swansea) 14-21 February,
H. Firth (Orkney) 7-9 April,
A.J. Ganesh (BRIMS) 4-8 August,
F. Lenz (Erlangen) 22-24 May,
P. McGill (Lyon) 1-8 September,
M. Magro (Lyon) 20-25 May,
J. Martin (Cambridge) 23-24 March,
L. Michel (IHES, France) 20-24 May,
R. Musto (Naples) 20-24 May,
M. Newell (Galway) 7-9 April,
N. O'Connell (BRIMS) 4-10 April, 31 July - 16 August, 18-22 December,
D. Olive (Swansea) 20-24 May,
C. Pfister (Lausanne) 22-27 January, 10-15 December,
G. Procissi (BRIMS) 3-8 August,
A. Raina (Tata Institute) 5-11 February,
R. Rivers (Imperial College) 17 June,
M. Roughan (Melbourne) 12-15 April,
I. Sachs (Durham) 22-24 October,
A.I. Solomon (Open University) 8-9 April,
N. Straumann (Zurich) 20-24 May,
E.C.G. Sudarshan (Austin, USA) 20-24 May,
J. Teschner (Montpellier) 10-17 May,
A. Verbeure (Leuven) 23-25 February,
K.C. Wali (Syracuse) 20-24 May,
J. Wess (München) 23-25 February, 20-24 May,
A. Wipf (Jena) 20-25 May.

Longer visits:

A. Anantharam (Univ. of California, Berkeley) 3-31 May,
A. Bracken (Queensland) 22 June - 16 October,
C. Ford (Jena) 7-15 June,
G.W. Ford (Michigan) 8 June - 10 July,
D. Litim (Barcelona) 3-13 May,
W. McGlinn (Notre Dame) 12 January - 3 June,
D.J. O'Connor (Mexico) 30 July - 30 August,
N. O'Connell (BRIMS) 31 July - 16 August,
R.F. O'Connell (Louisiana) 7 June - 16 August,

E. Pechersky (Moscow) 31 August - 28 September,
B. Ponsot (Montpellier) 23 November - 14 December,
V.B. Priezzhev (Dubna) 12 October - 9 November,
W. Skrypnik (Kyiv) 12 October - 10 November,
Yu. Suhov (Cambridge) 6-21 September,
N. Vvedenskaya (Moscow) 2 September - 3 October,
A. Wilch (Brussels) 17-26 May.

11 Publications

11.1 Books

None published

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

None published.

11.3 Theses

R. Russell: The Large Deviations of Random-Time Changes. *Ph.D. Thesis, TCD.*

F. Toomey: Large Deviations in a Clan of Stochastic Discrete Event Systems. *Ph.D. Thesis, TCD.*

11.4 Contributions to periodical and other publications

J.T. Lewis, R. Russell, F. Toomey, B. McGurk, S. Crosby & I. Leslie: Practical connection admission control for ATM networks based on on-line measurement. *Computer Communications* **21**(1998)1585-1596.

J.T. Lewis, C.-E. Pfister & W.G. Sullivan: How to encode a stationary source. *Proc. IEEE Information Theory Workshop, Killarney, Ireland, 22-26 June 1998, pp86-87.*

L. O'Raifeartaigh: Hidden symmetry. *Proc. PSI Summer School on Hidden Symmetries and Higgs Phenomena, ed. D. Graudenz, Paul Scherrer Institute, 1998.*

L. O'Raifeartaigh: Review of Seiberg-Witten theory. *Proc. of Conference on Lie Theory and its Applications in Physics II, eds. H. Doebner, V. Dobrev and J. Hilgert, World Scientific, 1998.*

L. O'Raifeartaigh & V.V. Sreedhar: Conformally invariant path integral formulation of the Wess-Zumino-Witten → Liouville reduction. *Nuc. Phys. B* **520**(1998)513.

L. O'Raifeartaigh & V.V. Sreedhar: Path integral formulation of the conformal Wess-Zumino-Witten → Liouville reduction. *Phys. Lett. B* **425**(1998)291.

L. O'Raifeartaigh & V.V. Sreedhar: Path integral formulation of the conformal Wess-Zumino-Witten → Toda reductions. *Nucl. Phys. B* **529**(1998)547.

B.P. Dolan: Renormalisation group flow and geodesics on the moduli space of four dimensional $N = 2$ supersymmetric Yang-Mills theory. *Phys. Lett. B* **418**(1998)107.

M. Huggard, F. Toomey, P. Barham, S. Crosby & N. Stratford: Measurement based admission control and resource allocation for multimedia applications. *Proceedings Multimedia Computing and Networking 1998, San Jose. California, January 1998.*

N. O'Connell: Queue lengths and departures at single-server resources. *Stochastic networks : Theory and Applications, edited by F.P. Kelly, S. Zachary & I. Zeidens. Oxford University Press, 1996.*

N. O'Connell: Large deviations for departures from a shared buffer. *J. Appl. Prob.* **34**(1997)753-766.

C. Ford, U.G. Mitreuter, T. Tok, A. Wipf & J.M. Pawlowski: Monopoles, Polyakov loops and gauge fixing on the torus. *Ann. Phys.* **269**(1998)26-50.

D.F. Litim & J.M. Pawlowski: Flow equations for Yang-Mills theories in general axial gauges. *Phys. Lett. B* **435**(1998)181-188.

D.H. Tchrakian, H.J.W. Mueller-Kirsten & F. Zimmerschied: Skyrme sphalerons of an $O(3)$ sigma model and the calculation of the transition rates at finite temperature. *Fort. der Phys.* **46**(1998)147-187.

K. Arthur, Y. Brihaye & D.H. Tchrakian: Interaction energy of generalised Abelian Higgs vortices. *J. Math. Phys.* **39**(1998)3031.

Y. Brihaye & D.H. Tchrakian: Solitons/ Instantons in d-dimensional $SO(d)$ gauged $O(d+1)$ Skyrme models. *Nonlinearity* **11**(1998)891-912.

B. Kleihaus, D.O'Keeffe & D.H. Tchrakian: Calculation of the mass of a generalised monopole. *Phys. Lett. B* **427**(1998)327.

D. O'Keeffe, D.H. Tchrakian & Y. Yang: Sigma models coupled to Abelian gauge fields. *J. Math. Phys.* **39**(1998)5824.

H. Mueller-Kirsten, S. Tamarian, D.H. Tchrakian & F. Zimmerschied: Dilute instanton gas in an $O(3)$ Skyrme model. *Phys. Lett. B* **438**(1998)136-146.

B. Kleihaus, J. Kunz & D.H. Tchrakian: Interaction energy of 'tHooft-Polyakov monopoles. *Mod. Phys. Lett. A* **13**(1998)2523-2529.

12 Library

Approximately two hundred and forty 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.

Annual Report of the Governing Board of the School of Cosmic Physics for the year ending 31 December 1998 adopted at its meeting on 30 September 1999.

1 Staff, Scholars and Associates

SENIOR PROFESSORS: L.O'C. Drury, A.W.B. Jacob, E.J.A. Meurs (Director).

PROFESSORS: A. Thompson, D. O'Sullivan (from 01 April), T.P. Ray(from 01 April).

ASSISTANT PROFESSORS: P.W. Readman, B.M. O'Reilly (contract basis).

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

EXPERIMENTAL OFFICERS: T.A. Blake, B.D. Jordan, J.Walsh (computer manager, contract basis).

VISITING SCIENTISTS: L.A. Antonelli (Osservatorio Astronomico di Roma, Monte Porzio Catone, Italy, 24 November - 01 December), B. Bates (Queens University Belfast, 24 March), C.J. Bean (UCD), R. Coker (University of Arizona, 28 July), P. Dufton (Queens University Belfast, 25 March), G. Doyle (Armagh Observatory), R. Giacconi (European Southern Observatory, Germany, 11-13 November), W. Heinrich (University of Siegen, Germany), D. Johnman (Satellite Services BV, the Netherlands, 16-17 July), N. Kenyon (Southampton), M.A. Khan (Leicester), U. Locatelli (Observatoire de la Côte d'Azur), C. Madsen (European Southern Observatory, 27-29 October), F. Masson (Karlsruhe and Montpelier), G. Miley (Leiden Observatory, the Netherlands, 12-13 November), F. Murtagh (University of Ulster, 10 March), M. Norman (Department of Astronomy, University of Illinois, Urbana), C. Prodehl (Karlsruhe), S. Ramadurai (Tata Institute of Fundamental Research), P.M. Shannon (UCD), L. Tommasino (ANPA, Rome).

TECHNICAL AND CLERICAL STAFF: A. Byrne, A.M. Callanan, E. Clifton, P. Daly (part-time), W. Dumpleton, E. Flood. A. Grace-Casey, C.M. Horan, S. Ledwidge (on career break from 05 October), D. Meghen (to 06 January), L. Quigley (from 01 July), M. Smyth, H. Sullivan, G. Wallace, V. Ward (on temporary basis from 12 April to 30 May), (two vacancies).

SCHOLARS: M. Carr, F. Casey (to 30 September), J. Cunniffe, J. Donnelly, J. Hodgson, A.J. Keane (to 30 September), M. Landes, K. McGrane, L. Norci (from 15 January), A. O'Brien, S. O'Sullivan, V.Unnithan, Z. Zang, D. Zhou.

PROJECT SUPPORTED POSITIONS: S. Annibaldi (Understanding Differential Transport of Energetic and Terminal Particles in Strongly Turbulent Fusion Plasmas), F. Bacciotti (European Space Agency Fellow, from 01 September), F. Hauser (COMBONET), L. Norci (High Energy Studies of Star Formation, to 15 January), G. Manfredi (Particle Transport in Turbulent Fusion Plasmas, to 30 September), E. Parizot (TMR Astroplasmaphysics Network, from 01 September).

PROFESSORS EMERITI: H.A. Brück, T. Murphy, P.A. Wayman (to 21 December)*.

RESEARCH ASSOCIATES: C.J. Bean (UCD), M. Cawley (SPCM), D. Corcoran (DCU), P. Duffy (UCD), R. Keary (GSI), A. Lawrence (Edinburgh), B. McBreen (UCD), J. Makris (Hamburg), P. Morris (UK), N.P. Murphy (BP), F. Murtagh (Garching), W.E.A. Phillips (TCD), V.F. Polcaro (IAS, Frascati), C. Prodehl (Karlsruhe), S.C. Russell (UCD), P.M. Shannon (UCD).

PROJECT STUDENTS: E. Devine (TCD, 12 October - 31 December), J.Grimes (TCD, 24 September – 31 December), S. Mulraney (TCD, 24 September – 31 December).

VACATION STUDENTS: C. Power (TCD, 20 July – 11 September).

*P.A. Wayman died on 21 December 1998.

2 Research Activities in the Astronomy Section

2.01 Highly X-ray luminous IRAS Galaxies

E.J.A. Meurs and L. Norci with A. Antonelli (Telespazio/Monte Porzio), K. Koyama and H. Awaki (Kyoto) and V.F. Polcaro (IAS, Rome)

Several IRAS galaxies exhibit high X-ray luminosities which, in view of the generally high star formation in such galaxies, could be caused by stellar evolution products, or also by a hidden active nucleus. There could also be the combined effect of these two possibilities. Clues about the origin of the observed X-ray emission may be obtained from X-ray spectra with sufficient spectral resolution. Some cases were therefore observed in greater detail, with the ASCA and

SAX satellites. One of the galaxies observed with the SAX satellite displays clearly the 6 keV Fe line that is characteristic for scattered photons from an obscured active nucleus. A detailed analysis of its X-ray spectrum is being carried out. Another ASCA observation was performed near the end of the year.

Further optical spectra were obtained with the telescope in Loiano (Italy). These data serve to classify the spectra of the objects concerned and convey information about any long-term variation in the nuclear emission from these galaxies.

2.02 Searching for active cores in Local Group Galaxies

Z. Zang and E.J.A. Meurs

To investigate the occurrence of nuclear activity in galaxies to the lowest possible levels, several galaxies of the Local Group around the Milky Way system are being searched for central sources. These galaxies are the nearest specimens of stellar systems and can be examined to lower levels of X-ray emission than any other galaxies, with the X-ray regime of the spectrum expected to be particularly relevant for recognizing weak signs of any nuclear activity.

One of the satellites of M31 (the Andromeda Nebula), M32, was investigated in considerable detail. This small spheroidal system is known to contain a comparatively strong X-ray source coincident with its central region. Data obtained with the ROSAT HRI (High Resolution Imager) yield a positional offset for this X-ray source of ca. 9 arcsec from the optical nucleus, also after attempts to carry out precise astrometry for this exposure (looking for X-ray sources with optical counterparts with accurate absolute positions). This source appears as a single source but probably exhibits source extension. Possible interpretations of this source include a Supernova Remnant, or indeed a galaxy nucleus given that the optical positions for M32 are unreliable. The X-ray source in M32 further shows signs of luminosity-dependent spectral variability, which is being analysed in some detail.

2.03 Long-term Variability of Nuclear X-ray Sources in Galaxies

J. Cunniffe and E.J.A. Meurs

The current work continues the analysis of long term X-ray variability of galactic nuclei. The initial approach has been to select an optical magnitude limited, complete sample of galaxies from the CfA Redshift Catalogue. X-ray counterparts from the ROSAT Pointed Archive were determined from the WGA source catalogue and, where a source was imaged more than once, variabilities were calculated. The results of this show that X-ray flux variabilities of factors up to 2 are common for non-active classes of galaxy but changes greater than a factor 3 are rare. For active galaxy types, factors of up to 7.5 were found. The analysis software written to carry out the above processing is now being used to analyse an optically deeper sample of galaxies.

2.04 The contents of Voids in the Distribution of Galaxies

M. Carr and E.J.A. Meurs

Voids may be checked for the presence of absorbing material by examining spectra of galaxies from the front and back of the void and comparing for intergalactic absorption. This works only for gas once processed in stars and thus it is not possible to check for the presence of primordial material, as the X-ray absorption is largely determined by the heavier elements. As a pilot study a void was selected from the CfA redshift survey and the positions of galaxies surrounding this void were cross correlated against the WGA ROSAT point source catalogue. As the spectral resolution of ROSAT is not sufficient to give reliable spectra for most of the observations used it was then decided to calculate spectral Hardness Ratios. For the void selected, after eliminating all observations with too large offsets from the catalogue postion, 14 galaxies were left, 5 on the far side of the void and 9 on the near side. Interestingly, the results from this analysis seem to indicate the presence of some absorbing gas. Currently deeper analysis of these results is being carried out and the extension of this work to other voids from the CfA survey is being attempted.

2.05 High-energy studies of Starforming Regions in an Extragalactic Context

L. Norci and E.J.A. Meurs

Many forms of starforming regions are encountered among the extragalactic objects. Recently it has become possible to study such regions at X-ray wavelengths with appreciable spatial and spectral resolution. At these high energies interesting information can be retrieved about the evolving stellar population and its interaction with the ambient Interstellar Medium. A novel approach to interpret such data is to develop a population synthesis computer programme that monitors the X-ray active phases for each individual star (and each binary) while the stellar population evolves.

The population synthesis programme was improved and tested on the 30 Dorstellar population using published observational data. Various conditions for the starforming process were taken into account. For this purpose, the latest stellar evolution scenarios w. re incorporated.

2.06 X-ray characteristics of Starburst Galaxies

E.J.A. Meurs, M. Carr and L. Norci with E. Devine (TCD)

The X-ray properties of several Starburst galaxies were investigated with ROSAT PSPC (Position Sensitive Proportional Counter) data. New detections were obtained for several of the galaxies. Examination of their spectral hardness ratios shows that most of them exhibit rather hard X-ray spectra, probably caused by the contribution of X-ray binaries, as is typical for young stellar populations. This type of object will be studied further with appropriate population synthesis simulations.

2.07 The Galaxy Cluster A3186: a Cooling Flow Cluster in a Merging Phase?

L. Norci and E.J.A. Meurs with R. Nesci (University of Rome)

A high-resolution X-ray exposure of the galaxy cluster MS0353-7411 (A3186) was examined. The X-ray morphology indicates that possibly two subgroups can be recognized, a typical feature of recent mergers between galaxy clusters or groups. The probable gas temperature would be consistent with a small cooling flow in the inner area of the main cluster. It is intended to carry out further observations of A3186 with future X-ray facilities like the European XMM satellite.

2.08 ROSAT Survey: The Einstein EMSS Galaxy Clusters

L. Norci with H. Böhringer, R. Treumann, W. Voges (MPE, Garching) and H. Ebeling (Hawaii)

During the Einstein X-ray satellite Extended Medium Sensitivity Survey 835 serendipitous sources have been detected, of which 105 were recognised as clusters of galaxies. The ROSAT All Sky Survey offers for the first time the opportunity of a direct evaluation of the extension and shape of the X-ray emitting region. It is indeed possible to define, within the survey limits, the source extension and to carry out a sensible measurement of the background contribution. In particular, the EMSS cluster sample contains several distant clusters with low brightness distributions for which the definition of extension and background are crucial for flux determination. From the ROSAT All Sky Survey suitably sized 40x40 arcmin regions around each EMSS cluster have been extracted. A study of the morphology of these clusters has been carried out and the energy flux and luminosity in various extraction regions have been calculated for the whole EMSS cluster sample.

Further work has been performed in order to study the spectral characteristics of these objects by calculating their hardness ratios and study the correlation of these with various other cluster parameters.

2.09 Studies of Massive Stars

L. Norci with V.F. Polcaro, R. Viotti (IAS, Frascati) and C. Rossi (Istituto Astronomico Universita' di Roma)

The WO stars are a subclass of the Wolf-Rayet stars, the latter generally being believed to be the descendants of massive O stars. They experience very strong winds and very high mass loss of the order of 10^{-5} solar masses per year. The mass loss process brings nucleosynthesis products to the stellar surface. The abundances measured in Wolf-Rayet spectra confirm that these stars are in a late stage of stellar evolution. Their spectra are peculiar, with very broad emission lines. They are classified according to the prevalent emission lines that can be identified, apart from He, as N (WN stars), C (WC stars) or O (WO stars). At present the WO class includes six members of which three are in our Galaxy (Sand 4, Sand 5, MS4), one in the LMC (Sand 2), one in the SMC (Sand 1) and one in the local group galaxy IC1613 (DR 1).

The evolutionary stage of the WO stars is still being discussed. It is controversial whether they represent an evolutionary stage following the WC stage (core-He burning) or whether they are only extreme cases of WC stars. It is argued that there is no indication in favour of the WO stars being in a nuclear burning phase subsequent to core He burning and that therefore they should be classified as part of the WC stars. Moreover the small number of objects belonging to the WO class makes their separation in several WC subclasses rather unjustified, accepting that the definition of a spectral class or subclass requires the existence of a sizeable number of stars which share common spectral characteristics. In order to prove this point, existing catalogs of WC stars and the observations of the collaboration have been used.

2.10 X-ray emission from TTauri Stars

L. Norci and E.J.A. Meurs with V. Costa and T. Lago (CAUP)

Three TTauri stars (Young Stellar Objects of low mass) were examined at UV and X-ray wavelengths. Their UV continua can be explained by the sum of the stellar black body radiation plus the emission from a hydrogenic component. One of the stars requires, in addition, a third component of intermediate temperature. For all three stars, the UV emission is enhanced relatively to the Sun and seems to extend smoothly into the X-ray regime. At X-ray wavelengths, however, some differences between these stars become apparent and a variety of temperatures is found for the emitting regions. The stars did not show evidence for flaring activity during these X-ray observations, although some level of variability is present.

2.11 Optical Monitoring Camera (OMC) for INTEGRAL

B.D. Jordan, M. Smyth and E.J.A. Meurs with B. McBreen and M. Delaney (UCD) and D. Walton and P. Thomas (MSSL)

During the year the manufacture of the Engineering Model (EM) of the OMC for INTEGRAL (the INTErnational Gamma-Ray Astrophysical Laboratory) was largely completed. Printed circuit board versions of the original wire wrap Laboratory Model prototypes were produced at MSSL and housed in the EM enclosure. The final version of the Electrical Ground Support Equipment (EGSE) and its wiring harness to the OMC was also completed. The EGSE consists of the Spacecraft Interface Simulator supplied by European Space Agency and two Pentium based PCs. One PC runs the Spacecraft Interface Simulator Operating Software to control the operation of the CCD, data acquisition, thermal control, power monitoring and CCD calibration. The second PC incorporates a Video Frame Grabber and software to acquire and display images in real time. The first OMC base line EM CCDs were delivered by EEV during the last quarter of the year and preliminary acceptance tests were carried out at MSSL and Dunsink using the EGSE.

2.12 Stability of Asteroids in Resonance with Jupiter

T. Kiang with N. McEntee (TCD)

The renewed attempt to derive a Hill-type equation that will determine the first-order stability of asteroids in resonance with Jupiter within the circular model was continued this year. Summer Student Chris Power assisted with the necessary Fortran Double-Precision programmes. Further interesting results were obtained and more work is in progress.

2.13 Development of ROSAT data reduction Techniques

E.J.A. Meurs and J.Cunniffe

Several projects currently pursued at Dunsink Observatory employ X-ray data, particularly those from the ROSAT satellite. The investigation of some fundamental aspects of the X-ray data reduction that are needed in various projects has been continued. In particular, sources located in the outer regions of the ROSAT PSPC detector were investigated. This work leads to improving the understanding of the accuracy of source positions in the outer regions of the PSPC detector.

2.14 Phenomenological Profiles of Gamma-Ray Bursts

I. Elliott and E.J.A. Meurs

Information on the temporal development of gamma-ray bursts has been collated in order to place limits on emission levels during the afterglow era and to compare the characteristics of different bursts. Work has been concentrated on the gamma-ray, X-ray, optical and near-infrared data sets which are the most complete.

3 Research Activities in the Astrophysics Section

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

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

The main emphasis during the year was on the selective extraction of cosmic ray actinide events from the entire accessible collecting area of the LDEF/UHCRE solid state nuclear track detector (SSNTD) array, which is equivalent to an exposure (the product of geometry factor and time) of about 150 m^2 sr y. Having confirmed experimentally that it was significantly more efficient, a new method was employed for the post ammonia-scan phase of the event location procedure, utilising group pattern recognition rather than the multistep sequential coincidence technique previously used. By choice of selection criteria, in particular threshold values for signal strength, actinide candidates were identified and then etched, fully measured and

analysed. In practice, about 25% of the candidates were found to be actinides. This "actinide-skim" programme was devised as the most effective way of optimising UHCRE data extraction with the limited resources currently available and provides a statistical valid way of determining the relative abundance of actinides without measuring the bulk of the events of lower charge. By the end of the year, the actinide-skim procedure had been completed for a total of eighty-five UHCRE detector stacks (in addition to the fifty-eight UHCRE stacks which had been fully analysed previously), leaving a further twenty-one stacks for actinide extraction in 1999. It had been planned to finish the actinide-skim for all accessible stacks by the end of the year but a further unexpected and significant reduction in the number of staff available for optical microscopy led to further constraints on the experimental work resulting, inter alia, on the shortfall of twenty-one stacks. The total number of cosmic ray actinide nuclei now stands at 24 (derived from 143 UHCRE stacks). Based on this sample, the current UHCRE value for the relative abundance of cosmic ray actinides, defined as $(Z \geq 88)/(74 \leq Z \leq 87)$, is found to be 0.015 ± 0.004. As the actinide sample size has increased, thus reducing the statistical errors, it has become increasingly evident that the actinide to subactinide ratio is consistent with propagated primordial solar system abundances which supports the view that the origin of the cosmic ray material is predominantly normal interstellar gas and dust.

During October, exposures of four new SSNTD stacks to an ultra relativistic (158 GeV/u) lead ion beam (Z=82) were successfully carried out at CERN. Three of the stacks each employed 50 UHCRE flight spare polycarbonate detector plates giving a path length of 2.1 g cm^{-2} at $\pi/4$ incidence in each stack. The main objective in this case was the generation of experimental material for use as signal strength or track etch rate monitors (TERMs) to provide normalisation functions for the correction of small systematic differences in signal from etch to etch in current work and also for multiple cross calibration to derive retrospective correction factors for similar small systematic differences in signal in UHCRE detector plates from some earlier etches. The fourth stack incorporated 117 UHCRE flight retrieved polycarbonate detector plates, including plates containing confirmed cosmic ray actinides, plates containing actinide candidates, plates from the remaining stacks not yet "skimmed" and plates containing pre-flight and post-flight 960 MeV/u uranium calibration. All actinides and potential actinides were represented in this stack, which had a path length of 5.0 g cm^{-2} at $\pi/4$ incidence. The primary objectives in the case of this fourth stack were direct calibration of the detector polymer in the immediate neighbourhood of actinide events and direct comparison with the earliest UHCRE calibrations.

3.02 Nuclear Track Detector Response Studies

A. Thompson, D. O'Sullivan and A.J. Keane

In parallel with the UHCRE data extraction work, a continuing programme of solid state nuclear track detector (SSNTD) research has been carried out, including studies of the track response of polycarbonate to beams of relativistic ultra heavy ions. Apart from its intrinsic value, this work has the general objective of optimising the charge spectrum resolution in the UHCRE detectors. Several parts of this programme were completed during the year and presented at the 19th International Conference on Nuclear Tracks in Solids (Besançon, France) during September. In particular, [#1] the registration temperature effect (RTE) was measured for relativistic gold ions (Z=79) with beam energies of 2.0, 4.0 and 10.5 GeV/u covering a wide range of exposure temperatures (−78°C to +22°C); [#2] the inherent ionisation rate discriminating power of UHCRE polycarbonate in the relevant charge/energy region was determined by using nuclear interactions to produce platinum, iridium and osmium ions (Z=78, 77 and 76) within a 4.0 GeV/u gold (Z=79) beam and [#3] the dependence of the track etch rate (signal strength) and the bulk etch rate on etch product concentration were re-examined for etch product concentrations from zero to 5.8 g/l, employing ultra relativistic lead ions (Z=82) and ultra relativistic gold ions (Z=79) as signal sources for the track etch rate investigation.

3.03 Simulations of the Transfer of Momentum from Stellar Jets to Molecular Outflows

T.P. Downes (Utrecht and Trinity College Dublin) and T.P. Ray

While it is generally agreed that molecular outflows from young stars are accelerated by underlying stellar winds or highly collimated jets the actual mechanism of acceleration remains unknown. The most favoured model, at least for low and intermediate mass stars, is that the molecules are accelerated at jet-driven bow shocks. Through high-resolution numerical simulations, the efficiency of this mechanism in accelerating ambient molecular gas, *without causing dissociation*, has been investigated. Its efficiency was found to be surprisingly low suggesting that more momentum could be present in the underlying jet than previously thought. A comparison was also made of momentum transferring efficiencies in pulsed versus steady jets. It was found that pulsed jets, and the corresponding steady jet with the same average velocity, transfer virtually the same momentum to the ambient gas. The additional momentum ejected sideways from the jet beam in the case of the pulsed jet only serves to accelerate post-shock *jet* gas which

forms a - largely atomic sheath around the jet beam.

For both the steady and pulsing jets, a power law relationship between mass and velocity ($m(v) \propto v^{\gamma}$) similar to what is observed was found. It was also discovered that increasing the molecular fraction in the jet decreases γ in line with expectation. Finally the simulations reproduced the so-called Hubble law for molecular outflows and showed that it is almost certainly a local effect in the presence of a bow shock.

3.04 Star Formation in the Serpens Cloud

T. P. Ray

A survey of the Serpens star formation region was carried out using the new SCUBA millimetre array at the James Clarke Maxwell Telescope (JCMT) in collaboration with C. Davis and H.E. Matthews (Joint Astronomy Center, Hilo), W. Dent (Royal Observatory Edinburgh) and J. Richer (Cavendish Laboratory, Cambridge). The SCUBA survey was complemented by mapping in the CO J=2-1 line from the JCMT and optical narrow band wide field imaging using the prime focus camera of the Isaac Newton Telescope. In addition to the well-known embedded sources in Serpens, the millimetre continuum data revealed diffuse filaments extending to the north and east of the core. It was found that the spectral indices of the sources in Serpens are very low; this can only be interpreted in terms of optical depth and/or temperature effects that testify to the extreme youth and embeddedness of these stars.

Using the combined CO and optical data, a study was also made of the large-scale outflows driven by the young stars in Serpens. In addition to a number of new Herbig-Haro flows, a number of high velocity CO lobes were also seen for the first time. All of these extend radially outwards from the cluster of sub-millimetre sources in the core. A close association between the optical and molecular outflows was also identified. The data suggest that most, if not all, of the sub-millimetre sources power outflows. From these observations, a dynamical age of the whole cluster of approximately $3\ 10^4$ years is inferred. This is roughly in agreement with the hypothetical ages of these sources based on the degree of their embeddedness.

3.05 Distances to the Nearest Star Forming Regions

J. Grimes (Trinity College Dublin) and T. P. Ray

Distance estimates were found for six nearby star-forming regions, using statistically weighted parallax determinations of optically visible young stars. The parallaxes were derived from measurements made by the HIPPARCOS mission of the European Space Agency. These were amongst the first such parallax determinations and while the distances to some regions agree with previous estimates based on spectro-photometry, this was not always the case. In some instances the HIPPARCOS derived parallaxes differed by as much as 50 % from those derived from more indirect ground-based methods.

3.06 The Propagation of Jets from Young Stars

S. O'Sullivan and T.P. Ray

While the formation of stars involves the accretion of matter as one would expect, in the past twenty years it has been realised that an important role is also played by outflows. These outflows are manifested in ionised, atomic and molecular forms but in each case it seems that an ionised jet (which may be optically visible) is the primary driving force. The jets themselves are radiatively cooled and almost certainly contain magnetic fields. Current theories for their generation invoke the presence of such fields.

With these ideas in mind a second order upwind scheme has been developed for multidimensional magneto-hydrodynamics (MHD). This scheme uses a linear approximation to the solution except in regions giving non-physical results where a non-linear iterative solver is employed. This code has been implemented to simulate jets embedded in, and emerging from, molecular clouds under a wide range of magnetic field configurations (e.g. longitudinal and toroidal) and was run on the DIAS Beowulf PC cluster and the TCD/Queen's IBM SP2. After testing it against benchmark problems, the code has recently been used to obtain MHD simulations of young stellar object jets.

3.07 Cosmic Rays at Aircraft Altitudes (IRMA-2 project)

D. O'Sullivan, J. Donnelly, E. Flood, R. Keegan and D. Zhou

The project, involving nine European laboratories and co-ordinated by DIAS, continued into its third year of activity. Progress was very satisfactory on many fronts. Further experimental data was obtained during the year and related calculations and analysis were extended. The DIAS work which concentrates on the investigation of neutrons, protons and heavier nuclei on flight routes of subsonic and supersonic aircraft is now at an advanced stage.

The CERN reference field which simulates the radiation field at aircraft altitudes has continued to

prove extremely helpful in the interpretation of inflight data. Good agreement has been found between observed and calculated responses for both passive and active detectors. New measurements and analysis have shown that the isotropy correction factor at the CERN field should be 0.89 and not the earlier value of 0.76. This new value resulted in the DIAS measurements being brought into excellent agreement with those of other groups despite the very different approach used.

Exposures carried out at the PSI proton accelerator in Switzerland and the neutron beam at Uppsala have been analysed. Initial results indicate that that the linear energy transfer spectra observed are similar assuming similar angular distributions for both beams. This result is important for the analysis of the cosmic ray field in the atmosphere since neutrons and protons contribute to it.

Investigation of the charge spectrum of cosmic ray primaries and secondaries at supersonic flight altitudes was continued. The charge spectrum was found to extend up to the iron region. The data will be compared with fluences predicted by the Heavy Ion Transport Code of the University of Siegen. The helium abundance measured by the DIAS group on a supersonic flight between London and New York has already been shown to be in good agreement with that predicted but new DIAS data on the heavier elements show some significant deviations.

3.08 "Box" Models of Shock Acceleration

L Drury and P Duffy with D Eichler (Ben Gurion University, Israel) and A Mastichiadis (University of Athens).

A number of authors have used, under various names, a simplified "box" model of shock acceleration to discuss the effect of additional loss processes on the spectra of shock accelerated particles. A more physical interpretation can be given based on ideas of particle fluxes and number conservation which illuminates the nature of this approximation and shows that the incorporation of additional distributed loss processes leads to an extra escaping flux component when (as is almost always the case) the diffusion coefficient is an increasing function of momentum. Using the corrected "box" model remarkably simple algebraic criteria were found for the occurrence of "pile-ups" or "cut-offs" in shock acceleration spectra subject to synchrotron (or inverse Compton in the Thompson limit) losses.

3.09 Interpreting the Cosmic Ray Chemical Composition

L Drury with D Ellison (NCSU) and J-P Meyer (CEA Saclay)

Further consideration of the interstellar gas and dust model for the origin of the Galactic cosmic rays showed that the two elements which appear somewhat anomalous in the earlier work, namely Carbon and Oxygen, could in fact be very easily explained in terms of interstellar dust chemistry. The refractory heavy elements typically condense to form gains by forming oxides and silicate minerals; this locks up an estimated 10% of the interstellar oxygen in the solid state from where it will be preferentially accelerated in the same way as the refractory elements such as iron or magnesium. The other element well known from a wide variety of astronomical evidence to form a significant grain component is Carbon. Thus the two cases which initially appeared anomalous are in fact convincing evidence for the basic validity of the hypothesis.

3.10 Transport in turbulent fusion plasmas

S V Annibaldi and L Drury with G Manfredi (Univ of Nancy) and R Dendy (UKAEA Culham).

Further studies were made of transport in the self-consistent fields calculated using G Manfredi's Hasegawa-Mima equation solver. A forcing term was added to compensate for the dissipation in the code and allow long-time studies to be carried out. Evidence of supra-diffusive transport was found.

Preliminary work was carried out on a wave action analysis of drift wave propagation. The aim is to understand using Whitham's averaged Lagrangian methods the propagation of drift modes in non-uniform and differentially rotating plasmas. There is some evidence that this may hold the key to understanding the L-H transition observed in fusion devices.

4 Research Activities in the Geophysics Section

4.01 Gravity (Mineral deposits)

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

Central Ireland contains an extensive succession of carbonate sediments, deposited in fault-bounded sub-basins, which host base metal Pb/Zn deposits. These deposits share many affinities with the Mississippi Valley-type (MVT) deposits of Tennessee, U.S.A. As underlying geological structure is obscured by thick glacial (Pleistocene) deposits potential field techniques can provide a useful insight into basement structure and the complex tectonic and sedimentary processes which control the pattern of ore mineralization.

The spacing of gravity measurements allows gravity gradient and related processing techniques to be applied to the data. These techniques accentuate high frequency changes in gravity produced by density and geometrical variations in the Carboniferous cover sequence and in the Caledonian basement. Gravity derivative maps have been produced and used to demonstrate the spatial relationship between the mineralization and a network of "Caledonian" NE–SW-trending and interconnecting weaker NNE–SSW- and subtle NW–SE-trending gravity lineaments.

The higher frequency components of gravity field (magnitude and direction of the horizontal gradient) and its analytic signal have been examined in more detail. These show a high correlation with carbonate facies variations in the sedimentary cover and structure within both the Caledonian basement and the cover sequence. In particular a correlation between the extent of Waulsortian mudbank carbonate facies and higher frequency gravity variations which define these lineament orientations was demonstrated. These results show that the reactivation of basement structure in extension strongly influences the formation of the Waulsortian lithofacies. The very common association between high gravity gradients, mineralized fault zones and mudbank complexes may be linked to the same tectonic pulses which drove the mineralizing fluids.

Besides the spatial distribution of both economic and sub-economic deposits their genetic affinity is also highly correlated with the gravity variations, with breccia-style MVT deposits occurring in regions where gravity trends transverse to the main NE-SW Caledonian gravity fabric are more prominent. The migration pathways of the mineralizing fluids and the trapping of the fluids was largely controlled by Variscan re-activation of the older Caledonian basement template. The correlations demonstrate that these techniques could play an important part particularly in the earlier phase of exploration strategy.

4.02 The Seismic Network (DNET, ENET and DSB)

T.A. Blake, F. Hauser, C.M. Horan, L. Quigley, G. Wallace and A.W.B. Jacob

There were no onshore events in Ireland during the year. However, three offshore events were of interest. One was in the Porcupine Seabight at 20:47 on 14 May, magnitude 3.0 ML, one in the Irish Sea on 31 August at 12:23, 2.0 ML, and one on Rathlin Island on 04 December at 03:22, 1.7 ML.

The largest UK event occurred near the island of Jura, West of Scotland, on 03 May. The magnitude was 3.5 ML, and it was felt MSK intensity IV.

Larger events observed on the DIAS network included a 5.7 Mb event in the Azores on 09 July which resulted in deaths and injuries, as did two events in Turkey (5.8 Mb on 27 June and 5.0 Mb on 04 July). All these were moderate earthquakes, the impact on people and buildings reflecting poor building standards, often due to lack of finance. For comparison, the 1984 event felt by many in Ireland although it was near the Welsh coast, had a magnitude of 5.4 ML.

Two major impact events, also very moderate in size, which occurred in the Afghanistan/Tajikistan border region on 04 February (6.1 ML) and 31 May (5.9 ML) resulted in over 6000 deaths and very extensive damage. In another case, a magnitude 5.8 Mb event in Papua New Guinea on 17 July caused an underwater slump which, in turn, generated a tsunami ("tidal wave") which caused casualties and extensive damage in coastal areas.

The previous two paragraphs highlight the fact that earthquakes may harm no one in remote areas but be devastating if shallow and near centres of population. There are about 3000 events annually which are larger than the smallest (5.0 Mb) damaging event mentioned above. Most of these events go almost completely unnoticed.

In September the ENET Geostore recorder (a 14-channel analogue instrument about 20 years old) was replaced by a PR2400 digital recorder made by Earth Data Ltd. In addition, a new three-component seismometer was installed at the recording point at ECP, though a Willmore MKIIIA vertical seismometer, of the type that has been used in the network for many years, was retained for comparison as a spare channel was available. With larger (2.1 Gb) disks now available, the six-channel recorders used for ENET and DNET can run for a week between disk changes.

Discussions were held with Met Eireann, which has operated the WWSSN station (VAL) at the Valentia Observatory for over thirty years, concerning the possible replacement of the old equipment with modern broad-band equipment. It is important to keep VAL running.

At the Young Scientist exhibition in January, visitors to the Institute stand were able to listen to, and view onscreen, a selection of earthquakes copied from Geophysics archives. Younger visitors could also produce their own earthquakes and see the effects on screen. Enquiries were received at various times during the year and were answered by Geophysics Section staff.

4.03 VARNET (VARiscan NETwork)

F. Hauser, A.W.B. Jacob, M. Landes and P.W. Readman with staff of UCD, Karlsruhe University, Copenhagen University and GFZ Potsdam

The project has been a successful and wide-ranging multi-disciplinary one and already has provided unexpected results. One was that there is a major seismic boundary beneath where the Iapetus Suture zone crosses Ireland. This trends NE/SW roughly from Co. Louth to the Shannon Estuary and marks the closing of the Iapetus Ocean, an earlier ocean than the present Atlantic which is still opening. It is not easy to explain why such sharp lateral changes in the seismic velocity structure, which may imply equally sharp density discontinuities, should persist in the upper mantle for so long, though if the velocities are anisotropic it may be that density variations are minimal. The Iapetus Ocean closed over 400 million years ago.

Other work concerning the Section has involved detailed investigation of the crustal structure on seismic profiles from the Old Head of Kinsale to Galway Bay and also across West Cork and Kerry. On the western profile, which is already published, a complex structure has been defined.

A sedimentary layer, 5-8 km thick, is underlain by an upper-crustal layer of variable thickness, with a base generally at a depth of 10-12 km. Two mid-crustal layers have been observed and a lower crustal layer below 22 km. The Moho (lower limit of the crust) varies between 30 and 32 km depth.

A low-velocity zone, which coincides with a well-defined gravity low, is observed in the central part of the region and is modelled as a Caledonian granite which intruded upper-crustal basement. The granite may have acted as a buffer to northward-directed Variscan thrusting. The Dingle-Dungarvan Line (DDL) marks a major change in sedimentary and crustal velocity and structure. It lies immediately to the north of the velocity and gravity low, and shows thickness and velocity differences in many of the underlying crustal layers and even in the Moho. This suggests a deep, pre-Variscan control of the structural development of this area. The model is compatible with thin-skinned tectonics, which terminated at the DDL and which incorporated thrusts involving the sedimentary and upper-crustal layers.

4.04 RAPIDS - Seismic Profiles in the Northeastern Atlantic

F. Hauser, B.M. O'Reilly, P.W. Readman, A.W.B. Jacob, P.M. Shannon (UCD) and J. Makris (Hamburg)

The last major paper from the current phase of the RAPIDS programme to carry out wide-angle seismic studies of crustal structures west of Ireland was published in 1998. Preparations were already underway to continue work in this complex continent-ocean transition zone through negotiations with the Rockall Studies Group (see the TRIM project).

Crustal and sedimentary structures have been resolved in the Hatton Basin (west of Rockall) and across the Hatton continental margin (HCM) east of magnetic anomaly 24 and the structure of the oceanic crust west of the anomaly has been determined. Gravity data have also been used.

A two-layer sedimentary sequence is present both in the Hatton Basin and across the continental margin (HCM). The lower layer is interpreted as pre-Eocene synrift sediments and the boundary between it and a younger post-rift sequence suggests an erosional unconformity surface. The sedimentary structure is distinctly different from that in the Rockall Trough where a third, intermediate, layer has been found. The underlying three-layer crust varies from 30 km thick under the Rockall Bank to about 15 under the Hatton Basin. The crust is thinnest below the Hatton Bank, where the lowest crustal layer thins to below the seismic resolution limit. Below the HCM a region of thick lower crust with anomalously high velocity (Vp about 7.2 km/sec) is resolved by the seismic and gravity data. It is connected to a region of oceanic crust which is thicker than that in the Iceland Basin.

These relationships between the thick lower crust below the HCM and the oceanic crust in the Iceland Basin are interpreted as evidence for magmatic underplating. The inferred unconformity surface between the synrift and postrift layers may be due to regional uplift driven by upwelling of hot asthenosphere before anomaly 24 time.

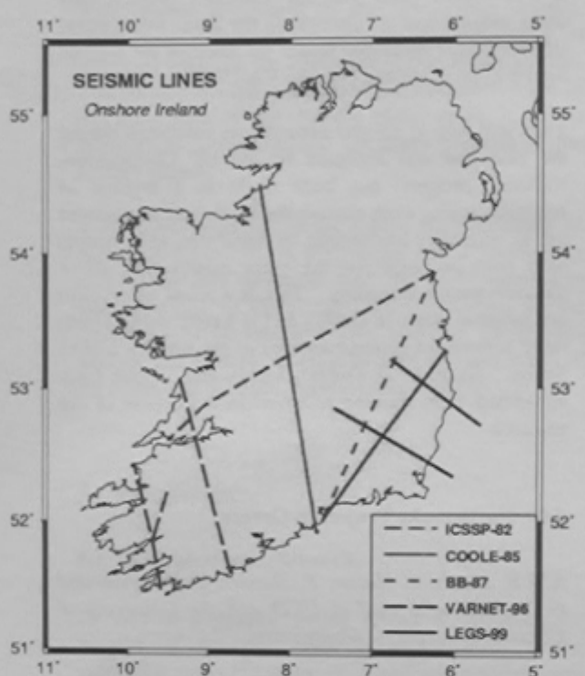
4.05 AIRS (Atlantic Irish Regional Survey) using GLORIA (Geological Long Range Inclined Asdic)

P.W. Readman, K.McGrane and A.W.B. Jacob with P.M. Shannon (UCD), V. Unnithan (UCD) and R. Keary (GSI)

The interpretation of the GLORIA data has been correlated with variations in the regional gravity derived from satellite altimetry and with the results from the gravity modelling, in order to access the importance of crustal structural fabrics on recent sedimentation patterns within the Rockall Trough.

The structural template for offshore Ireland is dominated by a NE-SW tectonic grain, established during the Caledonian orogeny and reactivated throughout the Phanerozoic. This basement structure is resolved as a NE-trending gravity fabric which changes

in orientation to ENE westwards into the Atlantic. This orogenic strike-swing reflects oblique closure of "promontory" and "re-entrant" features along the Iapetus passive margin, with younger sediments draped or moulded onto the margins during the closure. This regional crustal fabric has controlled the geometry of the Rockall Trough. A series of NW-trending gravity lineaments transverse to the regional Caledonian



gravity fabric cut across the Rockall Trough and Porcupine Basin and coincide with major offsets along the basin margins. To understand the geological nature and source depths of these lineaments, Euler deconvolution was carried out. The solutions within the trough resolve variations in crustal thickness and geometry at depths of five to eight km. Similar source depths obtained for lineaments across the Porcupine region may reflect changes in basement structure. The presence of transfer faults which accommodated different amounts of extension along the basin axes is suggested by the results. The interplay between the transfer faults and the main basin-bounding faults controlled canyon formation and subsequent submarine fan sedimentation patterns.

It is believed that this fault interaction has influenced the formation and development of canyon systems imaged by long-range GLORIA sidescan sonar data, which incise the south eastern margin. Canyons in this region are predominantly oblique to the basin margin defining NE-SW, ENE-WSW and NW-SE trends. The most spectacular system occurs in the southernmost part of the margin. Measuring 40 to 50 km across and having a runout distance of approximately 80 km, it is comparable in size to some of the large-scale canyon systems mapped by GLORIA along the United States Economic Exclusive Zone. The oblique orientation of these canyons across the regional slope parallel underlying tectonic trends resolved by gravity. Acting as lines of structural weakness across the basin slope, it is thought that canyon incision and development occurred preferentially along these tectonic trends acting as major loci for sediment input to the basin.

4.06 TRIM (TOBI Rockall Irish Margins)

P.W. Readman, B.M. O'Reilly, A.W.B. Jacob, P.M. Shannon and other DIAS and UCD staff

TRIM is a project undertaken as part of the Petroleum Infrastructure Programme (PIP) sponsored by a consortium of oil companies; the Rockall Studies Group (RSG). The project was co-proposed by the Dublin Institute for Advanced Studies and the Geology Department of University College. The overall objective of the project was to investigate the margins of the Rockall Trough using a deep-towed sidescan sonar (30 kHz) instrument (TOBI, provided by the Southampton Oceanography Centre) and 3.5 kHz hull-mounted profiler. Canyons, slope failure features and cold water carbonate mounds are of particular interest.

The cruise took place from 23 June to 27 July, using the Dutch research vessel R.V. Pelagia. The survey area concentrated on the eastern margin of the Rockall Trough and a smaller area on the western margin. In total 3100 line-km of TOBI and 3700 km of 3.5 kHz profiler data were collected. A mosaic of the data was made on board during the cruise and from this a preliminary interpretation of the TOBI record was made.

The more dramatic features encountered during the cruise included: (1) A very extensive region of slope failure on the western margin of the Rockall Trough. A variety of slope instability features including rotational slump scars and tabular slide surfaces were imaged. (2) An extensive series of canyons, most of which have not previously been mapped, along the eastern margin. The major ones of these were previously imaged in the GLORIA (AIRS) survey, but the TOBI data has much refined the observed details and detected new smaller canyons. (3) A large array of carbonate mounds in the upper slope regions of the NW shoulder of the Porcupine Bank. The mounds occur both as clusters and as elongate arrays, with evidence of current flow

between the mounds. (4) Bedforms indicative of contour-parallel current flow occur on both margins.

This preliminary interpretation will be continued in 1999 when a digital mosaic will be prepared which will be more precisely geographically registered, and which will allow further image processing.

4.07 LEGS (Leinster Granite Seismics)

P.W. Readman, J. Hodgson, B.M. O'Reilly and other Geophysics Section Staff

The main wide-angle seismic experiment in this project was postponed until March 1999 because of a delay in the manufacture and delivery of the seismic recording instruments to the University of Texas at El Paso. A pilot seismic study using quarry blasts, site finding, shot location finding, permissioning and analysis of other data (including gravity data) was undertaken during the year.

The pilot study was carried out during March/April 1998 and was aimed at defining the seismic transmission properties of the granite and its country rocks. This study used ten DIAS digital recording instruments and 3-component (4 Hz) seismometers. Quarry blasts from Arklow, Belgard and Windmill Hill quarries were recorded with the instruments deployed at two km intervals over a 60 km profile stretching NNW from Arklow to Windmill Hill. The experiment was successful and a partially reversed seismic traverse across the granite was obtained. Quarry blasts, although not an ideal seismic source indicated evidence of a reflecting zone and a fairly good estimate of the P-wave velocities to the east and west of the granite was acquired. The most important point demonstrated by the study was that the transmission of seismic energy occurs from the country rocks into the granite and beyond. The feasiblility of a large scale seismic experiment with small controlled sources involving a single deployment of instruments along one long axial line and two shorter transverse lines across the granite was confirmed. Despite their small size, controlled sources are much more efficient than quarry blasts.

In the gravity-based analysis a series of gravity anomaly and gradient maps have been produced for the granite and the surrounding rocks. Gravity modelling (2.5-D) and one-dimensional Euler deconvolution techniques were also applied to a series of profiles across the granite and used to derive (non-unique) gravity models as an insight into the sub-surface geometry and thickness of the granite. The results suggest that the granite body (or bodies) deepen to the south and west, and that the maximum depth to the base is 7 to 10 km. These constraints on the likely geometry of the granite will be important in the final design of the instrument deployment pattern for the main experiment.

4.08 COMBO (the Core Mantle Boundary project)

A.W.B. Jacob and F. Hauser with staff of Lisbon, Leeds, Karlsruhe and Potsdam

In a combined study with the VARNET project, very sharp and unexpected changes in the lower lithospheric structure were measured under the trace of the Iapetus Suture Zone in Ireland (see the VARNET section).

The Final Report for this project was submitted during the year and was accepted by the EU Commission. Valuable progress has been made in a number of scientific topics even though the work was not carried out as originally envisaged. In particular, new models have been proposed for the lower mantle, just above the core-mantle boundary. This is a result of detailed and original work, in Dublin and in Leeds, using a very large network of seismic stations in the western United States. Students in Dublin, Leeds and Lisbon have benefitted from training received in the course of the research.

4.09 Earthquake Project in Greece

A.W.B. Jacob, C. Horan, F. Hauser, J. Hodgson and G. Wallace with staff of UCD and the University of Ulster at Coleraine (coordinators)

Following the award of a research contract by NERC to the University of Ulster at Coleraine (J. McCloskey), A.W.B. Jacob and G. Wallace joined him and C.J. Bean from UCD in a visit to N. Melis (University of Patras) for discussions and a seismic site survey north and south of the Gulf of Corinth in Greece in February. This is an area of constant earthquake activity and offers a suitable laboratory for studying small-scale activity that may lead to a larger event. Fourteen of the nineteen seismic stations in the temporary network, which operated from April to November, were provided by the Geophysics Section and Section staff took part in that deployment in April, a repair and testing visit in July, and the recovery of instruments in November.

It was an extremely hot summer in Greece and some difficulties were experienced with the high temperatures (well over 40°C for long periods). In particular, there were extensive forest fires and some equipment was damaged in one of them. In the early stages of the deployment, earthquake activity was unusually low but a strong swarm of events occurred in

the later months, providing an extensive data take for the study.

4.10 Hawaiian Plume Project

A.W.B. Jacob with R. Kind (GeoForschungsZentrum, Potsdam - GFZ)

Following the development and acquisition of broad band seismic equipment by the Geophysics Section, there were discussions with GFZ concerning a proposed study of the Hawaiian plume in the Pacific. This feature has left a remarkable bathymetric trace of the movement of the Pacific plate above it but is surprisingly under-explored (in sharp contrast to the Iceland plume).

A.W.B. Jacob and R. Kind visited the University of Hawaii in Honolulu for discussions and a preliminary view of possible site areas, after the AGU Meeting in San Francisco in December. F. Duennebier of the University of Hawaii will join with the Geophysics Section and R. Kind in GFZ in a broad-band study of the plume and its trace, commencing in 1999.

5 Facilities

5.1 Computers and Network

As part of a general policy aimed at reducing the number of operating systems which have to be supported, users requiring PC based applications were progressively moved to NT 4.0; those machines which were not powerful enough to run under NT were replaced and the old machines recycled as X-terminals under FreeBSD. The Unix workstations in Number 5 (Merrion Square) were moved to Solaris 2.6 and one in Dunsink to RedHat Linux 5.2. Netware was phased out and replaced by Samba to provide transparent resource sharing between the Unix and PC environments.

The Beowulf cluster, running under Linux (with network patches to give improved support for MPI) gave satisfactory and reliable service throughout the year. A web site was provided for the Irish Association for High Performance Computing (http://www.iahpc.ie). JW ported MIDAS to run under FreeBSD; this was released as part of the NOV98 distribution patchlevel 1.6. Attempts to run MIDAS under Lesstif (a free Motif clone) uncovered a number of bugs which were communicated to the MIDAS development and support team in Munich.

A significant development was the establishment of HEAnet as an independent limited company providing specialist internet services to the academic community. The Institute joined HEAnet in March, initially over a 128K leased line. Towards the end of the year trials of a radio link between 5 Merrion Square and the HEAnet operations centre in Marine House were in progress. Major hardware acquisitions during the year included a new CISCO router, a DLT tape drive capable of dumping 40GB, a high-performance duplex laser printer and a 300 MHz sparc clone.

5.2 Nuclear Track Equipment

Problems with the old fume extraction equipment for the ammonia scanning facility in Track Lab #3, which became apparent at the end of last year, were investigated. It was found that extensive (and expensive) repairs and replacement of components would be necessary to correct the situation. Since the ammonia scanning requirements for the current UHCRE work have been almost completed, it was decided that it would not be worthwhile to attempt repair or replacement. Accordingly, the fume cupboard and associated equipment were disassembled and removed but the ammonia scanning facility was retained and transferred to a temporary location to be available until completion of the LDEF/UHCRE work.

The three main track detector etching tanks (150 litre capacity each) with associated equipment were maintained in continuous operation until late in the year (see below) and serviced as necessary. Replacement sub-systems or components included new ceramic heater units fitted to Etch Tank #1 and Etch Tank #2, new components fitted to the primary etch tank temperature display and recording equipment and new bearings on the main wash tank drive system. In addition, the sodium hydroxide pumping system was refurbished. The six Leitz-ASL track measuring microscope stations, the Nikon-Heidenhain track measuring microscope station and the six Nikon stereo scanning microscope systems were also maintained and upgraded as necessary during the year. In particular, a low torque fine focus control was fitted to a (second) Nikon stereo microscope, the X-Y stage motion V-ways of one of the Leitz-ASL units along with its objective turret were upgraded and the focus mechanism V-ways on one of the Nikon stereo microscopes were renewed. New standard plates for EFREF determination and monitoring were created and calibrated.

During the year, Track Lab #1 was completely refurbished and set up as a dedicated laboratory for IRMA research and associated work. As part of this process several items of equipment including the Nikon-Heidenhain track measuring microscope station were moved from Track Lab #3 to Track Lab #1.

Towards the end of the year the first stage of the transfer of etching facilities from the main building to Track Lab #3 was carried out. Etch Tank #1 was shut installation, Etch Tank #2 was maintained in continuous operation in its original location and Etch Tank #3 was decommissioned.

5.3 La Palma Observatory

5.3.1 La Palma Advisory Committee (LPAC)

There was one meeting of the La Palma Advisory Committee (LPAC) held in February. The LPAC Information bulletin appeared in April/May, to remind the community of procedures relevant to PATT deadlines and LPAC support and to present information on the results of applications and observing runs.

Enterprise Ireland (formerly Forbairt) continued to provide an annual subvention for the travel and subsistence expenses of non-DIAS observers, in view of the importance of access to the La Palma Observatory and other Particle Physics and Astronomy Research Council (PPARC) groundbased facilities by Ireland. M. Redfern (UCG) attended the Panel for Allocation of Telescope Time (PATT) committee meeting during May in Cambridge, as the Irish representative. No Irish representative on the WHT or INT/JKT TAC had yet been arranged by PATT for the December meeting; this matter to be resolved later (in 1999).

5.3.2 Observing runs in 1998

Runs are listed alphabetically, with the PATT reference numbers where applicable. Non-PATT runs, supported by DIAS, are also noted.

Callanan (UCC) et al: *Infrared studies of low mass X-ray binaries*, Keck Telescope, 1.5 nights. One of the results concerns a previously unknown line of sight companion to Aql X-1.

Callanan (UCC) et al: *Infrared photometry of quiescent black hole transients*, CTIO, five nights. The main results from this run are (a) an upper limit to the K band ellipsoidal variations of 4U 1543-47 and (b) an unsuccessful search for the IR counterpart of SGR 1900+14.

Ray (DIAS), Bally (Colorado) and Morse (Colorado): (I/98A/48) *Large Scale Herbig-Haro Flows from Luminous Young Stars*, INT, one week dark time. One night lost due to a combination of bad weather and technical problems. The new [SII] red doublet filter, purchased by DIAS from Glen Spectra, was used for a search for "superflows" from intermediate mass YSOs with the Wide Field Camera (WFC). Evidence was found that many currently almost inactive Herbig Ae/Be stars had highly energetic outflows in the past.

Smith (CIT) et al: (J/98A/20) *Quasar variability*, JKT, one week bright time. Observations could be performed for five of the nights. Almost all the target radioquiet quasars displayed variability on a night-to-night basis.

6 Seminars, Colloquia, Lectures

6.1 Statutory Public Lecture

R. Giacconi (Director General, European Southern Observatory) delivered the Annual Statutory Public Lecture for the School of Cosmic Physics. The lecture was entitled *Astronomy in the VLT Era* and took place at Trinity College Dublin (Davis Theatre), on 12 November.

6.2 Seminars and Open Lectures in the School

L.A. Antonelli (Osservatorio Astronomico di Roma): *BeppoSAX Observations of Gamma Ray Bursts*, 26 November.

R. Coker (University of Arizona): *The Galactic Center: Modelling the Central Parsec of the Milky Way*, 28 July.

R. Giacconi (European Southern Observatory): *The role of ESO in European Astronomy*, 12 November.

C. Madsen (European Southern Observatory): *Challenging Godzilla, Cyberman and the Spice Girls - Some remarks about ESO's Outreach Programme*, 28 October.

B. S. Meyer (Clemson University, South Carolina, USA): *Nucleosynthesis of the Heavy Elements*, 31 July.

F. Murtagh (University of Ulster): *New Results in Astronomical Image Processing and Information Retrieval*, 10 March.

J. Zarnecki (University of Canterbury): *The Cassini Mission to Saturn and Titan*, 03 April.

This year a series of informal internal seminars was started at Dunsink Observatory in order to establish a more structured framework for discussions of the staff and students at the observatory about the research that is carried out. These meetings can be in the form of talks about the on-going work or critical discussions of relevant research papers. The following talks were scheduled during the year:

E.J.A. Meurs, *Overview of Dunsink projects*, 18 February; I. Elliott, *Follow-up observations for γ-ray bursts at other wavelengths*, 25 March; B. Jordan, *OMC for INTEGRAL*, 27 May; E.J.A. Meurs, *Fluxes*,

Photon Indices, vF_v, etc, 16 September; Z. Zang, *The X-ray source in M32*, 07 October; J. Cunniffe, *Spatial accuracy over the PSPC field*, 25 November.

6.3 Contributions to Scientific Meetings

M. Carr: *X-raying the Voids*, Conference on Cosmology "From recombination to Garching", Garching, 02-08 August.

J. Cunniffe: *Long term X-ray variability of galactic nuclei*, IAU Symposium 194 "Activity in Galaxies and Related Phenomena", Yerevan (Armenia), 17-21 August.

L. Drury: *The Be/Fe Ratio in Halo Stars, Gamma Rays from Orion and the Origin of Cosmic Rays*, First Astroplasmaphysics Network Workshop, DIAS, Dublin, 04 March; *Comments on LiBeB production in SNRs*, Second Astroplasmaphysics Network Workshop, Dryburgh Abbey, Scotland, 14 May; *What does the Cosmic Ray Composition tell us?* Workshop on "Frontier Objects in Astrophysics and Particle Physics", Vulcano, Italy, 29 May; *Box Models and Pile-ups*, Third Astroplasmaphysics Network Workshop, Aegina, Greece, 15 October; Invited review, *A Theoretician's View of the Knee*, Schatz Retirement Symposium, FZ Karlsruhe, Germany, 10 December.

I. Elliott: *Lady Huggins - the Early Years in Dublin*, RAS Discussion Meeting on "Women in Astronomy, an Historical Perspective 1780-1940", London, 13 March.

J.A. Hodgson: *The Leinster Granite Seismic project (LEGS)*, Irish Geological Association Annual Research Meeting, Galway, 21-23 February.

A.W.B. Jacob: Invited address and paper to Symposium in honour of Claus Prodehl's 60th birthday, Karlsruhe, January 1997 (omitted from the 1997 Annual Report); *The outlook for controlled source seismology*, Invited paper to the First Spanish-Portuguese General Assembly on Geodesy and Geophysics, Almeria, Spain, 09-13 February.

A.J. Keane: *Investigation of the Response of Lexan Polycarbonate to Relativistic Ultra Heavy Nuclear Particles*, The 19th International Conference on Nuclear Tracks in Solids, Besançon, France, 29 August - 05 September.

T. Kiang: *Inherent stability and instability of Hecuba and Hilda asteroids*, IAU Colloquium 173 on "Evolution and Source Regions of Asteroids and Comets", Tatranska Lomnica, Slovakia, 24-28 August.

M. Landes: *VARNET96: Variscan and Caledonian Tectonics in SW Ireland*, Irish Geological Association Annual Research Meeting, Galway, 21-23 February; *3D insights into Variscan and Caledonian crust in SW Ireland*, AGU Meeting in San Francisco, 04-12 December.

K. McGrane: One paper and one poster at the Conference on Postgraduate Work in Progress in Marine Geology and Geophysics, Bangor, 23-24 January; *Gravity and side-scan sonar studies in the Rockall and Porcupine Troughs, offshore Ireland*, European Geophysical Society General Assembly, Nice, France, 20-24 April; *Gravity and long-range side-scan sonar studies in the Rockall Trough and Porcupine Basin*, Irish Geological Association Annual Research Meeting, Galway, 21-23 February; *Gravity fabrics and basin structure in the Rockall Trough and Porcupine Basin, offshore western Ireland*, AGU Fall Meeting, San Francisco, 04-12 December.

G. Manfredi: *Numerical evidence for gyro-Bohm scaling of ion thermal transport in toroidal Temperature-Gradient-Driven Turbulence*, The 4th Irish Fusion Symposium, UCC, 02 April; *Numerical Study of anisotropic drift turbulence and transport; Long-time behaviour of nonlinear Landau damping; Charge separation, velocity shear and suppression of turbulence at a plasma edge in the finite gyroradius guiding centre approximation*, The International Congress on Plasma Physics, Prague, 28 June - 05 July.

E.J.A. Meurs: *Large-scale structure assessed with Voronoi techniques*, Conference on "Observational Cosmology: the Development of Stellar Systems", Sesto Pusteria, 30 June -03 July; *The X-ray source associated with M32* and *High energy in TTauri stars: the future is bright*, First XMM Workshop on "Science with XMM", ESTEC, Noordwijk, 30 September - 02 October.

B.M. O'Reilly: *Evidence for a regional thermal anomaly in the continental lithosphere of the NE Atlantic from a gravity and wide-angle seismic study*, Royal Astronomical Society Discussion Meeting on the Application of Potential Field Techniques to Studies of Passive Margins, London, 12 February; *Gravity gradients and Carboniferous-hosted base-metal deposits of the Irish Midlands, and Regional thermal anomaly in continental lithosphere of the NE Atlantic from gravity and wide-angle seismic results*, Irish Geological Association Annual Research Meeting, Galway, 21-23 February; *Gravity patterns and Carboniferous base-metal ore deposits in Ireland*, European Geophysical Society General Assembly, Nice, France, 20-24 April; *Gravity variations, basement structure and Zn/Pb mineralization in the Carboniferous of central Ireland*, AGU Fall Meeting, San Francisco, 04-12 December.

B.M. O'Reilly, P.M. Shannon and A.W.B. Jacob: *Crustal structure onshore and offshore Ireland: development from palaeozoic to recent time*, invited paper to the European Geophysical Society General Assembly, Nice, France, 20-24 April.

D. O'Sullivan: *Cosmic Radiation and Air Crew Exposure – Overview of EC Research Programme*, International Conference of Cosmic Radiation and Air Crew Exposure, Trinity College Dublin, 01-03 July; *Cosmic Rays and Dosimetry at Aviation Altitudes*, The 19th International Conference on Nuclear Tracks in Solids, Besançon, France, 29 August - 05 September.

S. O'Sullivan: *MHD Simulations on a Parallel Cluster*, First AstroPlasmaPhysics TMR Network Workshop on Energetic Particle Acceleration and Propagation in Astrophysical Environments, Dublin Institute for Advanced Studies, 03-06 March; *Simulating Stellar Jets on Parallel Platforms*, IAHPC Meeting, University College Galway, 15 April; *Simulations of Jets from Young Stellar Objects*, European Commission Summer School on Dynamical MHD Phenomena in Solar and Astrophysical Plasmas, Crete, 22 June-03 July; *Numerical Simulations of the Propagation of Non-Adiabatic Magnetised Jets from Young Stellar Objects*, Protostars and Planets IV, Santa Cruz, California, 05-12 July; *Beowulf Systems*, IAHPC Meeting, Dublin Institute for Advanced Studies, 13 November.

T.P. Ray with J. Eisloeffel, R. Mundt and L. Rodriguez: Invited Review, *Collimation and Propagation of Stellar Jets*, Protostars and Planets IV, Santa Cruz, California, 05-12 July.

P.W. Readman: *Crustal extension in the Rockall Trough region: Caledonian basement controls revealed by gravity*, Royal Astronomical Society Discussion Meeting on the Application of Potential Field Techniques to Studies of Passive Margins, London, 12 February.

V. Unnithan: *Side-scan sonar images of Irish Atlantic Basins*, The 41st Irish Geological Association Annual Research Meeting, Galway, 21-23 February.

Z. Zang: *ROSAT HRI and PSPC Observations of M32*, IAU Symposium 192, Cape Town, 07-11 September.

6.4 External Seminars

L. Drury: IoPiI lecture, *Particle Astronomy*, QUB, 21 October; UL, 23 October; Dozor lecture series, Ben-Gurion University, Beer-Sheba, Israel, *Particle Astronomy; the New Cosmic Ray Physics*, 05 November; *Ion neutral friction as a limit on shock acceleration*, 11 November; *Pile-ups in shock accelerated electron spectra*, 15 November; *Interstellar dust and the cosmic ray composition*, 22 November.

I. Elliott: *Wilson of Daramona, Astronomer and Physicist*, Dept. of Physics, NUI-Maynooth, 20 November.

A.W.B. Jacob, P.W. Readman and N. Kenyon: *Preliminary results from the TRIM offshore project*, presented to the Rockall Studies Group in Statoil House, 16 September.

G. Manfredi: *Numerical evidence for gyro-Bohm scaling of ion thermal transport in toroidal Temperature-Gradient-Driven Turbulence*, Ecole Polytechnique Federale de Lausanne, 16 March.

E.J.A. Meurs: *The X-ray source associated with M32*, Osservatorio Astronomico di Roma, 11 December.

B.M. O'Reilly: *Gravity studies in the North Atlantic Region*, Department of Geology, UCD, 19 January.

D. O'Sullivan: *Investigation of the Platinum, Lead and Actinide regions of the Charge Spectrum of Galactic Cosmic Rays*, Physics Department, Berkeley, 15 April.

S. O'Sullivan: *A Multidimensional Upwind Scheme for MHD using a Non-Linear Riemann Solver*, Sterrenkundig Instituut, Utrecht, 20 April.

T.P. Ray: *Outflows and Accretion Disks around Herbig Ae/Be Stars*, Joint Astronomy Center, Hilo, Hawaii, 09 June.

P.W. Readman and P.M. Shannon: *Review of TRIM data*, Petroleum Affairs Division of the Department of the Marine, 06 October.

V. Unnithan: *Recent sedimentary features in the Rockall Trough*, Department of Geology, 30 October.

6.5 Lecture Courses

L. Drury: Course of lectures on the *Interstellar Medium* (jointly with T.P. Ray) to final year students at the Department of Physics, TCD, during Hilary term; Lecture Course 343 (*Astrophysical Gas Dynamics*) at the Department of Mathematics, TCD, during Michaelmas term.

L. Drury, E.J.A. Meurs and L. Norci together with colleagues from UCD and SPCM: Joint course of eight hours on *Topics in High-energy Astrophysics* at TCD during Michaelmas term.

E.J.A. Meurs: Lecture course of eighteen hours on *Stellar Dynamics* at TCD during Hilary term; Course of nine hours on *Physics of Galaxies* at TCD during

Hilary Term; Guidance provided for 4th year TCD physics student.

L. Norci: Course of nine lectures on *Stellar Structure and Evolution* in TCD during Hilary term; Guidance for 4th year TCD physics student.

T.P. Ray: Lecture Course on the *Interstellar Medium* with L.O'C Drury to final year students at the Department of Physics, TCD, during Hilary Term; Lecture module on the *Interstellar Medium* in the European MSc Course, Centre for Astrophysics, University of Porto, Portugal, 21-25 November: Supervision of J. Grimes, Physics Department, TCD, from September to December for her final year project using data from the HIPPARCOS mission.

6.6 Popular Lectures

I. Elliott: Presentation on *Teaching Junior Certificate Astronomy*, H.Dip.Ed. course, UCD, 17 February; *Millennium Madness*, RDS Spring Public Lectures, 19 February; *Understanding the Black Holes*, Science Week at North Dublin National School Project, Glasnevin, 04 June; *The Calendar and The Millennium*, RDS Youth Science and Arts Week, 14 July.

B. Jordan: *The OMC for INTEGRAL*, Irish Astronomical Society, 07 December.

7 Expositions, Public Facilities and Organisation of Meetings

7.1 Solar and Extra-Solar Planetary Systems School

The European Astrophysical Doctoral Network (EADN), under the chairmanship of T.P. Ray, organised a summer school supported by the European Union Training and Mobility of Researchers Programme on *Solar and Extra-Solar Planetary Systems*. The school was hosted by the Dublin Institute for Advanced Studies and held in the Burren, County Clare, during 07-18 September.

The topic of the School was selected because of the large number of new and exciting developments that have taken place within the subject over the last decade. Planets have been discovered around other stars so that the Solar System is no longer unique. Our own system is now larger than previously thought as a result of the discovery of a family of trans-Neptunian objects. A comet collided with Jupiter, giving new information about both, while many new satellites have been discovered around the larger planets. A large number of space missions have contributed to our knowledge, while a number of others in the near future will undoubtedly do so. Finally, Comet Hale-Bopp was visible to all and undoubtedly became the most observed comet in history.

The programme which, as usual for these schools, was very intensive and was divided into a series of individual courses that fell into the following broad categories: Formation of Planets, Gas Dominated Bodies, Large Solid Bodies, Small Bodies, Dynamics, Magnetic Fields and Plasmas, Space Exploration. The lecturers were: Theresa Encrenaz (Observatoire de Paris, Meudon), Alan Fitzsimmons (Queen's University, Belfast), Ingrid Mann (Max-Planck Institute for Aeronomy, Lindau), Carl Murray (Queen Mary and Westfield College, London University, London), Tom Ray (Dublin Institute for Advanced Studies), Michele Dougherty (European Space Agency), Nicholas Thomas (Max-Planck Institute for Aeronomy, Lindau) and Iwan Williams (Queen Mary and Westfield College, London University). The texts of the lectures will be published in the Springer Verlag Lecture Notes in Physics Series. As is usual at EADN Schools, all of the students made short oral presentations of their research work lasting approximately 20 minutes. Often this resulted in lively discussions and was felt by the organisers to be a very positive element of the school. The Scientific Organising Committee consisted of Iwan Williams (Scientific Director), Alan Fitzsimmons, Carl Murray, and Tom Ray. Eimear Clifton and Hilary O'Donnell (Dublin Institute for Advanced Studies) provided secretarial assistance.

The school was held in the Burren College of Art in the grounds of a renovated 16th century castle and approximately a mile from the village of Ballyvaughan. Students and lecturers were accommodated in local cottages on a shared basis. In total approximately 30 people participated.

7.2 SEAC

SEAC, the European Society for Astronomy in Culture, is an interdisciplinary body whose members represent a broad range of academic disciplines including archaeologists, historians, and astronomers. It provides a forum for interdisciplinary discussions focussing upon the practice, use and meaning of astronomy in various cultural contexts.

SEAC held its annual conference on the theme of *Astronomy, Cosmology and Landscape* from 31 August until 02 September in Trinity College Dublin. The Dublin Institute for Advanced Studies (DIAS) hosted the conference. The Organising Committee consisted of Frank Prendergast (Surveying Department, Dublin Institute for Technology), Clive Ruggles (Institute of

Irish Studies, Queen's University, Belfast) and Tom Ray (DIAS).

Professor George Eogan (Dept. of Archaeology, UCD) opened the conference. In addition to the usual contributed talks, keynote lectures were given by Gabriel Cooney from the Department of Archaeology at University College Dublin on social archaeology and prehistoric sacred landscapes in Ireland and Dan McCarthy on astronomical observations in the ancient Irish annals. On Monday, 31 August, DIAS hosted a reception for SEAC participants following a discourse given by Professor Fergus Kelly of the School of Celtic Studies on *The Beliefs and Mythology of the Early Irish with Special Reference to the Cosmos*. On Tuesday 01 September, an excursion was organised to the Boyne Valley to visit Newgrange and Knowth, the Knowth tour being conducted by Professor Eogan. After the conference finished in Dublin, most of the participants availed of an optional tour to the Southwest of Ireland where they visited the axial stone circle at Drombeg and other sites of archaeological and archaeo-astronomical interest.

7.3 The Irish Association for High Performance Computing

The aim of the Irish Association for High Performance Computing (IAHPC) is to promote the exchange of information between groups working in high performance computing in Ireland. In this area where much research is done by industry, the Association ensures that both academia and industry are represented adequately. During the year the IAHPC held two meetings, in University College Galway (15 April) and in the Dublin Institute for Advanced Studies (13 November). In connection with the Dublin Institute for Advanced Studies (DIAS) meeting, a public lecture, partly sponsored by the DIAS, was held. Stephen O'Sullivan (DIAS) acted as Chairman of the Association during the year.

The speaker for the IAHPC public lecture was Professor Michael L. Norman of the National Center for Supercomputing Applications (NCSA) and the Department of Astronomy at the University of Illinois at Urbana-Champaign. Entitled *Changing Paradigms in US Computational Science and Engineering*, it was delivered in Trinity College, Dublin on 13 November.

7.4 The First APP (AstroPlasmaPhysics) Network Workshop, Dublin, Ireland

The european network for research in AstroPlasmaPhysics (the APP network) links seven european research institutes to study "energetic particle acceleration and propagation in astrophysical environments". Bringing together plasma physicists and astrophysicists, it aims to solve outstanding problems in high energy astrophysics, such as the origin of Galactic cosmic rays, the nature of gamma-ray emitting active galactic nuclei (AGN) and the origin of ultra-high energy cosmic rays (UHECR). The network which is coordinated by John Kirk at the Max-Planck-Institut für Kernphysik (MPK), was selected for funding by the Training and Mobility of Researchers (TMR) programme and will operate for four years from 01 March 1998, under contract FMRX-CT98-0168.

The purpose of the First APP Network Workshop was to review the scientific objectives of the Network, evaluate the applicants for postdoctoral positions and discuss the administrative and contractual arrangements required for the efficient operation of the Network. The meeting took place in the conference room of DIAS at 10 Burlington Road during 03-06 March. Participants included R. Bingham, R. Dendy, L. Drury, P. Duffy, Y. Gallant, U. Gieseler, L. Hanlon, J. Kirk, S. Lucek, A. Mastichiadis, T. Mendonca, S. O'Sullivan and M. Tagger.

Two further meetings took place during the year; the Second APP Network Workshop, Dryburgh Abbey, Scotland, 12-15 May and the Third APP Network Workshop, Aegina, Greece, 13-16 October.

7.5 Dunsink Science Expo and Open Nights

The new interactive Visitors' Facility in Dunsink Observatory was actively used throughout the year for demonstrations to groups (from schools and otherwise) and to visitors generally. A finalising meeting of the committee that had prepared the exhibits was held in Dunsink on 20 March. Towards the end of the year OPW started recoppering the two domes of the Observatory.

As in other years, Open Nights for the general public were held twice monthly during the winter half year, led by W. Dumpleton, with the very helpful support of members of the Irish Astronomical Society. Several additional single-group visits, in the evenings and also during daytime, were organized during the year. Among these groups were the "Women in Technology and Science", the "International Womens' Club" and members of the "International Planetarium Society" during a post-conference tour from London. Information services included, inter alia, viewing data for satellites, background to various celestial phemomena and precise timings for sunrise and sunset, Lighting Up Times, beginnings of seasons and changes between winter and summer times.

Around the date of the Statutory Public Lecture (12 November), and partly coinciding with Science Week Ireland 1998, an exhibition kindly provided by the European Southern Observatory (ESO) was open to the

public in DIAS at 10 Burlington Road. Panels with information, videos and a model covered ESO's Very Large Telescope project (the VLT) in Chile. A special lecture was delivered by ESO's Director General, Prof. R. Giacconi, about "The role of ESO in European astronomy". After the first two weeks of November in Burlington Road the material was moved to Dunsink Observatory where it could be seen by the groups and the general public visiting the observatory.

8 External Work

8.1 Astronomy Section

M. Carr: Conference on Cosmology "From recombination to Garching", European Southern Observatory, Garching, 02-08 August.

J. Cunniffe: Astronomical Science Group of Ireland, Spring Meeting, Cork, 17 April; IAU Symposium 194 on "Activity in Galaxies and Related Phenomena", Yerevan, Armenia, 17-21 August.

I. Elliott: Astronomical Science Group of Ireland, Spring Meeting, Cork, 17 April; RAS Discussion Meeting on "Women in Astronomy, an Historical Perspective 1780-1940", London, 13 March.

B. Jordan: OMC Consortium progress meeting, INTA, Madrid, 31 May - 03 June; Electrical Ground Support Equipment configuration specification and compliance meeting, MSSL, 07-08 August; Deliverance of EGSE and cable harness, also first test of OMC Engineering Model, MSSL, 16-18 September; Acceptance tests of Engineering Model base line CCD, EEV, Chelmsford, 14-15 December.

T. Kiang: IAU Colloquium 173 on "Evolution and Source Regions of Asteroids and Comets", Tatranska Lomnica, Slovakia, 24-28 August.

E.J.A. Meurs: TMR Physics Panel, Brussels, 25-27 February; Conference on "Observational Cosmology: the development of stellar systems", Sesto Pusteria, 30 June - 03 July; First XMM Workshop "Science with XMM", ESTEC, Noordwijk, 30 September - 02 October; Istituto Astronomico, University of Rome, 07-11 December.

Z. Zang: IAU Symposium 192 on "Stellar Populations in Local Group Galaxies", Cape Town, 07-11 September.

8.2 Astrophysics Section

S.V. Annibaldi: The 35th Culham Plasma Physics Summer School, Culham, Abingdon, Oxfordshire, UK (UKAEA/Euratom Fusion Association) 06-17 July; Joint Varenna - Lausanne International Workshop on "Theory of Fusion Plasmas", Villa Monastero, Varenna, Italy, 31 August – 04 September; Collaboration visit to Culham (R. Dendy and K. Hopcraft), 09-11 November.

J. Donnelly: The16th European Cosmic Ray Symposium, Alcalá de Henares, Spain, 20-24 July.

L. Drury: Management Committee meeting, Armagh, 26 March; Visit for network cooperation to MPIK, Heidelberg, Germany, 29 March - 01 April; Workshop on "Physics at Cosmic Accelerators", Bad Liebenzell, Germany, 01-05 April; Hillas retirement symposium, Leeds, England, 06-09 April; Second Astroplasmaphysics Network Workshop, Dryburgh Abbey, Scotland, 12-15 May; Workshop on "Frontier Objects in Astrophysics and Particle Physics", Vulcano, Italy, 24-30 May; Workshop convenors' meeting, ISSI, Berne, Switzerland, 19-20 June; Meeting with NASA European representative, Forbairt, Dublin, 22 June; Visit for Network cooperation to CEA Saclay, Paris, France, 26 June - 30 July; Third Astroplasmaphysics Network Workshop, Aegina, Greece, 12- 16 October; Dozor visiting fellow, Ben-Gurion University, Beer-Sheba, Israel, 04-26 November; Schatz retirement symposium, Karlsruhe, Germany, 08-11 December.

E. Flood: IRMA-2 Contractors Meeting, Oxford, UK, 13-16 May; IRMA-2 Contractors Meeting, Munich, Germany, 02-06 December.

A.J. Keane: The 19th International Conference on Nuclear Tracks in Solids, Besançon, France, 29 August - 05 September.

G. Manfredi: Visit to the Lausanne Plasma Physics Institute (Switzerland) for scientific collaboration, 12-16 March; The 4th Irish Fusion Symposium, UCC, 02 April; The International Congress on Plasma Physics, Prague, 28 June - 05 July.

D. O'Sullivan: Institute of Physics Meeting, London, 23-25 January; Steering Committee of CEC projects, Munich, Germany, 11-13 March; Institute of Physics Spring Meeting, Waterford, 03-05 April; UHCRE, Berkeley, USA, 09-25 April; IRMA-2 Contractors Meeting, Oxford, UK, 13-16 May; The 19th International Conference on Nuclear Tracks in Solids, Besançon, France, 29 August - 05 September; IRMA-2 Contractors Meeting, Munich, Germany, 02-06 December.

S. O'Sullivan: IAHPC Meeting, Galway, 15 March; Sterrenkundig Instituut, Utrecht, 20 April – 01 May; European Commission School on Dynamical MHD Phenomena in Solar and Astrophysical Plasmas, Crete, 22 June – 03 July; Protostars and Planets III, Santa Barbara, California, 05-12 July.

T.P. Ray: Jodrell Bank, Macclesfield, Cheshire, 18-26 February; PhD thesis examination, University of Leeds, 20 February; Rutherford Appleton Laboratory, 04-06 March; IAHPC Meeting, Galway, 15 March; Panel for Allocation of Telescope Time (PATT) meeting, University of Manchester, 27 March; Spring Meeting of the Astronomical Science Group of Ireland, University College Cork, 17 April; Joint Astronomy Center, Hilo, Hawaii, 01 June – 03 July; Protostars and Planets III, Santa Barbara, California, 05-12 July; La Palma Observatory, 17-25 July; Ballyvaughan, County Clare, 26-28 August; EADN School, Ballyvaughan, County Clare, 05-12 September; Space Telescope Science Institute, Baltimore, Maryland, 17-22 October; Center for Astrophysics, Porto, Portugal, 21-25 November; PATT meeting, Stratford upon Avon; 08-09 December

D. Zhou: Institute of Physics Spring Meeting, Waterford, 03-05 April; IRMA-2 Contractors Meeting, Oxford, UK, 13-16 May.

8.3 Geophysics Section

F. Hauser: Seismic station deployment in Greece, 14-28 July; Project Meeting in Karlsruhe, 7-11 December.

J. Hodgson: Seismic station deployment in Greece, 03-17 April.

C. Horan: Seismic station deployment in Greece, 14-28 July; Seismic station recovery, Greece, 09-20 November.

A.W.B. Jacob: First Spanish-Portuguese General Assembly, Geodesy and Geophysics, Almeria, Spain, 10-13 February; Site survey and discussions re seismic network, University of Patras, Greece, 14-20 February; External examiner and project discussions, Cambridge University, 28 February to 02 March; Visit to Kenya and Tanzania re seismic array deployment, 05-19 March; European Geophysical Society General Assembly and East Africa Meeting, Nice, France, 18-25 April; RAPIDS planning meeting, Hamburg, 09-11 September; Visit to US Geological Survey, Menlo Park, California; American Geophysical Union Fall Meeting, San Francisco and University of Hawaii, Honolulu, 02-17 December.

M.A. Khan: Visit to Kenya and Tanzania re seismic array deployment, 05-19 March.

M. Landes: European Geophysical Society General Assembly, Nice, France, 18-24 April; VARNET work in US Geological Survey, Menlo Park, California, 04-22 December.

K. McGrane: Research Meeting on Ocean Sciences, Univ. N. Wales, Bangor, 22-25 January; European Geophysical Society General Assembly, Nice, France, 18-24 April; TRIM project work in Southampton and at sea, 22 June to 28 July; American Geophysical Union Fall Meeting, San Francisco, 04-12 December.

B.M. O'Reilly: Royal Astronomical Society Meeting on Passive Ocean Margins, London, 11-14 February; European Geophysical Society General Assembly, Nice, France, 18-24 April; TRIM project work in Southampton and at sea, 22 June to 28 July; American Geophysical Union Fall Meeting, San Francisco, 04-12 December.

P.W. Readman: Royal Astronomical Society Meeting on Passive Ocean Margins, London, 11-14 February; European Geophysical Society General Assembly, Nice, France, 18-24 April; TRIM project work in Southampton and at sea, 22 June to 28 July; American Geophysical Union Fall Meeting, San Francisco, 04-12 December.

V. Unnithan: TRIM project work in Southampton and at sea, 22 June to 28 July.

G. Wallace: Seismic station survey and discussions, University of Patras, Greece, 14-20 February; Seismic station deployment, Greece, 03-17 April.

9 Miscellanea

A.W.B. Jacob was elected a Member of the Royal Irish Academy. He also became a member of the *Consultative Committee for the Geological Survey of Ireland*. In addition, he continued to serve as Chairman of the *National Committee for Geodesy and Geophysics* of the Royal Irish Academy and continued as Irish National Correspondent to *IASPEI (International Association for Seismology and Physics of the Earth's Interior)*.

T.P. Ray continued to serve as the DIAS representative on the *National Committee for Astronomy and Space Research* and as Chairman of the *European Astrophysical Doctoral Network*. He also became a member of the *Panel for Allocation of Telescope Time (PATT)* serving on the radio astronomy group and of the Hubble Space Telescope Time Allocation Committee for Cycle 8.

L.O'C. Drury was appointed the Andrews' Professor of Astronomy by *Trinity College Dublin*. He also continued to serve as Vice-Chairman of the *Commission on Cosmic Rays* of the International Union of Pure and Applied Physics and as the DIAS representative on the *National Committee for Physics* of the Royal Irish Academy.

E.J.A. Meurs continued to serve as Honorary President of the *Trinity Astronomy and Space Society*. He further served on the *National Committee for Astronomy and Space Research* of the Royal Irish Academy, on the *EU TMR Physics Panel* and as Chairman on the *La Palma Advisory Committee*.

A.W.B. Jacob was co-convener (with R. Kind of Potsdam) of a Symposium on Mantle Dynamics at the *European Geophysical Society General Assembly* in Nice, France, in April and chaired one session. He was also Chairman for a session of the meeting sponsored by the National Committee for the History and Philosophy of Science on *Science in Ireland in 1798: a time of revolution*, in the Royal Irish Academy, 04 November.

D. O'Sullivan continued as Co-chairman of the *Institute of Physics in Ireland*. He continued to represent the Institute of Physics on the *National Committee for Physics* of the Royal Irish Academy.

I. Elliott continued as a Council member of the *Royal Dublin Society* and as a member of its *Science and Technology Committee*. He continued as chairman of the *Irish Science Centres' Association Network*. He became a member of the *National Committee for Science and Engineering Commemorative Plaques* which was set up under the auspices of Bord Fáilte.

A.W.B. Jacob served on various external research grant and senior appointment panels during the year. He was also external examiner for PhD candidates at the Universities of Cambridge and Leeds.

F. Bacciotti was appointed as a European Space Agency Fellow to work on Hubble Space Telescope data in the star formation group of the Astrophysics Section.

Three of the top ten cited papers in Tectonophysics for 1994 included Geophysics Section authors.

K. McGrane, at the Marine Research Meeting in Bangor, North Wales, in January, was judged to have produced the best student poster and second best talk.

Two meetings of the AIRS Steering Committee were held in 5 Merrion Square, in June and September, chaired by A.W.B. Jacob.

The School of Cosmic Physics, represented by all three Sections, played a major role on the *Institute of Physics* stand at the *ESAT Young Scientist Exhibition* in the Royal Dublin Society (RDS) during January. Nine members of the Geophysics Section shared in manning, at different times, their part of the exhibit.

An interactive system consisting of a projector, CCD camera with frame grabber and real time display was provided by B. Jordan for the *Institute Of Physics* stand at the *Young Scientist Exhibition* (RDS, January).

A poster for the AIRS project (Geophysics Section) was displayed in the RDS during *Science Week*, 22-26 October.

An Article by Cormac Sheridan on the AIRS project was published in Technology Ireland, June 1998, pp 22-24. This was based on information and illustrations supplied by the Geophysics Section.

Mr. Doug Johnman of Satellite Services BV, Holland visited Dunsink during July to assist with setting up the EGSE (Electrical Ground Support Equipment) for the OMC (Optical Monitoring Camera) for INTEGRAL.

In January, a team from RTE came to one of the Open Nights at Dunsink Observatory to shoot material for the *Léargas* programme.

During the year, four Transition Year pupils came to Dunsink Observatory for their Work Experience programmes.

Routine solar information was supplied to architects, film companies and sporting organisations during the year. Seventeen certified statements of Lighting-up Time were prepared for legal purposes by I. Elliott.

At Dunsink, B.D. Jordan with the help of J. Daly and others cleaned, reassembled and mounted the Arnold Clocks in the East Library. The Shortt Free Pendulum, Booth and Dent clocks which were dismantled and stored during building alterations have been mounted in a display area of the main building.

10 Publications

10.1 Journals and other Refereed Publications

M.T.P. Corcoran and T.P. Ray: *Wind Diagnostics and Correlations with the Near-infrared Excess in Herbig Ae/Be Stars*, Astron. Astrophys., Vol 331, pp 147-161 (1998).

M.T.P Corcoran and T.P. Ray: *Spectroscopic Discovery of a Bipolar Jet from the Herbig Ae/Be Star LkHα 233*, Astron. Astrophys., Vol 336, pp 535-538 (1998).

T. Downes and T.P. Ray: *Numerical Simulations of the Kelvin-Helmholtz Instability in Radiatively Cooled Jets*, Astron. Astrophys., Vol. 331, pp 1130-1142 (1998).

D C Ellison, L O'C Drury and J-P Meyer: Cosmic Rays from Supernova Remnants; a brief description of

the Shock Acceleration of Gas and Dust, Space Science Reviews, Vol 86, pp 203-204 (1998).

K. Farrell and L O'C Drury: *An Explicit, Adaptive Grid Algorithm for One-Dimensional Initial Va. ·e Problems*, Applied Numerical Mathematics, Vol 26, pp 03-12 (1998).

A.W.B. Jacob and P.W. Readman with F. Masson et al.: *A wide-angle seismic traverse through the Variscan of southwest Ireland*, Geophys. J. Int., Vol 134, pp 689-705 (1998).

B Klecker, R.A. Mewaldt, J.W. Bieber, A.C. Cummings, L. Drury et al: *Anomalous Cosmic Rays*, Space Science Reviews, Vol 83, pp 259-308 (1998).

E.J.A. Meurs: *X-ray aspects of the IRAS galaxies*, IAU Symp., Vol 188, pp 145-148 (1998).

J-P Meyer, L O'C Drury and D C Ellison: *A Cosmic Ray Composition Controlled by Volatility and A/Q Ratio: SNR Shock Acceleration of Gas and Dust*, Space Science Reviews, Vol 86, pp 179-201 (1998).

M. Micono, C.J. Davis, T.P. Ray, J. Eislöffel and M.D. Shetrone: *Proper Motions and Variability of the H_2 Emission in the HH 46/47 system*, Astrophys. J. (Letters), Vol 494, pp L227-L231 (1998).

M Mond and L O'C Drury: *Acoustic Emission and Corrugational Instability of Shocks modified by strong Particle Acceleration*, Astron. Astrophys., Vol 332, pp 385-390 (1998).

L. Norci, V.F. Polcaro, C. Rossi and R. Viotti: *The WO stars: a late stage of stellar evolution*, Irish Astr. J., Vol 25, pp 43-46 (1998).

B.M. O'Reilly, F. Hauser, P.W. Readman and A.W.B.Jacob with U. Vogt, J. Makris and P.M. Shannon: *The Hatton Basin and continental margin: crustal structure from wide-angle seismic and gravity data*, J. Geophys. Res., Vol 103, pp 12,545-12,566 (1998).

B.M. O'Reilly, P.W. Readman and F. Hauser: *Lithospheric structure across the western Eurasian plate from a wide-angle seismic and gravity study: evidence for a regional thermal anomaly*, Earth and Planetary Science Letters, Vol 156, pp 275-280 (1998).

D. O'Sullivan and A. Thompson: *Investigation of the Platinum, Lead and Actinide regions of the Charge Spectrum of Galactic Cosmic Rays*, New Astronomy Reviews, Vol 42, pp 331-335 (1998).

V.F. Polcaro and L. Norci: *V439 Cyg: the smallest LBV?*, Astron. Astrophys., Vol 339, pp 75-86 (1998).

T.P. Ray with C.J. Davis, G. Moriarty-Schieven, J. Eislöffel and M.Hoare: *Observations of Shocked H_2 and Entrained CO in Outflows from Luminous Young Stars*, Astron. J., Vol 115, pp 1118-1134. (1998).

M.J. Wilkinson and E.J.A. Meurs: *Using Voronoi techniques to determine the shapes of photon sources*, Irish Astr. J., Vol 25, pp 37-40 (1998).

Z. Zang and E.J.A. Meurs: *ROSAT HRI and PSPC observations of M32*, IAU Symp., Vol 192, pp 334-337 (1998).

10.2 Conference Proceedings

T. Abramovitz, M. Landes, H. Thybo, A.W.B. Jacob and C. Prodehl: *The Tornquist and Iapetus Suture Zones: A comparison of the velocity models between MONA LISA and VARNET*, EOS, Vol 79, p F653 (1998).

V.M. Costa, M.T.V.T Lago, L. Norci and E.J.A. Meurs: *High energy in TTauri stars: the future is bright*, in "Science with XMM", the First XMM Workshop, 30 Sep-02 Oct 1998, Poster paper, Online proceedings at -- http://astro.estec.esa.nl/XMM/news/ws1/ws1_papers.html (1998).

D C Ellison, J-P Meyer and L O'C Drury: *Cosmic Rays from ISM Gas and Dust*, The 19th Texas Symposium, Paris, France, 14-18 December (1998).

C.J. Davis, T.P. Ray, J. Eislöffel and T. Jenness: *Prompt Entrainment in the Wiggling Molecular Jet from RNO 15-FIR*, JCMT Newsletter, March 1997, published electronically online at -- http://www.jach.hawaii.edu/JCMT/newsletters/n8/sci1.html (1997).

A.W.B. Jacob: *Irish Seismology*, The Observatory, Vol 118, pp 117-120 (1998).

A.J. Keane, A. Thompson and D. O'Sullivan: *Investigation of the Response of Lexan Polycarbonate to Relativistic Ultra Heavy Nuclear Particles*, Proceedings of the 19th International Conference on Nuclear Tracks in Solids, Besançon, France, 29 August - 05 September (1998).

M. Landes, A.W.B. Jacob, F. Masson, C. Prodehl, H. Thybo and the VARNET Research Group: *VARNET: a geophysical study of the Variscides and Caledonides in SW Ireland*, Annales Geophysicae, Vol 16, p C107 (1998).

M. Landes, A.W.B. Jacob, C. Prodehl and the VARNET Working Group: *VARNET: 3D insights into*

Variscan and Caledonian crust in SW Ireland, EOS, Vol 79, p F664 (1998).

K. McGrane, P.W. Readman, B.M. O'Reilly, A.W.B. Jacob and R. Keary: *Gravity and side-scan sonar studies in the Rockall and Porcupine Troughs, offshore Ireland*, Annales Geophysicae, Vol 16, p C284 (1998).

K. McGrane, P.W. Readman and B.M. O'Reilly: *Gravity fabrics and basin structuring in the Rockall Trough and Porcupine Basin, offshore western Ireland*, EOS, Vol 79, p F796 (1998).

G. Manfredi: *Long-time behaviour of nonlinear Landau damping*; The International Congress on Plasma Physics, Prague (1998).

G. Manfredi, P. Duffy, A. Scally, L. Drury and R. O. Dendy: *Numerical Study of anisotropic drift turbulence and transport*, The International Congress on Plasma Physics, Prague (1998).

F. Masson, F. Hauser, A.W.B. Jacob and M. Landes: *Lithospheric Structure across the Iapetus suture zone in Ireland: teleseismic observations along a controlled source profile*, Annales Geophysicae, Vol. 16, p C121 (1998).

F. Masson, M. Landes, C. Prodehl and A.W.B. Jacob: *VARNET: a north-south seismic study across the Variscan Front in southwestern Ireland*, Terra Nova, p 380 (1998).

H-G. Menzel, D. O'Sullivan, P. Beck and D. Bartlett: *European Measurements of Aircraft Crew Exposure to Cosmic Radiation*, The 34th Annual Meeting of Cosmic Radiation Exposure of Airline Crews, Passengers and Astronauts, Washington DC, April (1998).

E.J.A. Meurs and L. Norci: *Searching for AGN signatures in IRAS galaxies*, Nucl. Phys. B (Proc. Suppl.), Vol 69/1-3, pp 558-559 (1998).

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L. Norci, E.J.A. Meurs, V.F. Polcaro, R. Viotti and C. Rossi: *V439 Cyg as a late phase of stellar evolution*, ApSpSci, Vol 255, pp 197-198 (1998).

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P.M. Shannon, N.J. Vermeulen and A.W.B. Jacob: *Basement control on Mesozoic basin development: a comparison between offshore basins west and south of Ireland*, Proc. Geoscience 98, *Tectonics of the British Isles: Basement, Basins and neotectonics*, p 155 (1998).

M. Shoucri, G. Manfredi, P. Bertrand, A. Ghizzo, G. Knorr, E. Sonnendrucker, H. Buerbaumer, W. Entzel and G. Kamelander: *Charge separation, velocity shear and suppression of turbulence at a plasma edge in the finite gyroradius guiding centre approximation*, The International Congress on Plasma Physics, Prague (1998).

D. Zhou, M. Cavaioli, R.K. Jain, F. Spurny, R. Teodori and L. Tommasino: *Bismuth-fission detectors for high energy nucleons: I. Registration Characteristics*, Proceedings of the 19th International Conference on Nuclear Tracks in Solids, Besançon, France, 29 August - 05 September (1998).

10.3 Books, Theses, Reports and Sundry Publications

I. Elliott: *2001 and All That* The 1999 Yearbook of Astronomy (editor P. Moore), Macmillan (1998).

I. Elliott: Regular monthly articles on astronomy in "Parent and Teacher" (1998).

A.W.B. Jacob with C. Prodehl et al: *VARNET Annual Report: Integrated Studies of the Variscan Front*, Report to the EU Commission, Contract No. ERBCHRXCT940572 (1998).

A.W.B. Jacob et al: *Final Report on COMBO, a study of the Çore-mantle Boundary*, Final Report to the EU Commission, Contract No. ERBCHRXCT930313 (1998).

D. O'Sullivan, D. Zhou, J. Donnelly, R. Keegan, E. Flood and associated contractors: *Study of Radiation Fields and Dosimetry at Aviation Altitudes*, Radiation Fields, Dosimetry, Biokinetics and Biophysical Models for Cancer Induction by Ionising Radiation (ed. J. Ertel), GSF Report, Neuherberg, GSF-Bericht 12/98, pp 1-31 (1998).

D. O'Sullivan, D Zhou, J. Donnelly, R. Keegan, E. Flood and associated contractors: *Study of Radiation Fields and Dosimetry at Aviation Altitudes*, Dublin Institute for Advanced Studies (School of Cosmic Physics) Report 98-6-1, 30pp (1998).

L. Quigley: Editor, *Survey Ireland*, No. 15, 40 pp, publ. Irish Society of Surveying, Photogrammetry and Remote Sensing (1998).

P.W. Readman, B.M. O'Reilly and P.M. Shannon: *TOBI Rockall Margins (TRIM): Cruise Report, 23 June - 27 July, 1998*, Report presented to the Rockall Studies Group (1998).

P.W. Readman, B.M. O'Reilly and P.M. Shannon: *TOBI Rockall Margins (TRIM): Preliminary Interpretation Report*, Report presented to the Rockall Studies Group (1998).

R J Tuffs, C Gabriel, L O'C Drury, J Fischera, I Heinrichsen, I Rasmussen and H J Voelk: *ISOPHOT and ISOCAM observations of the Crab Nebula*, Abstracts of the Astronomische Gesellschaft meeting, Heidelberg, Germany, 14-19 September, poster P57 (1998).

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

Financial Statements for year ended 31 December 1998

CONTENTS

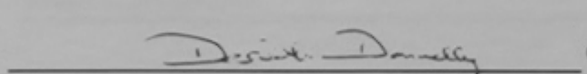
INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

Statement of Responsibilities of the Council

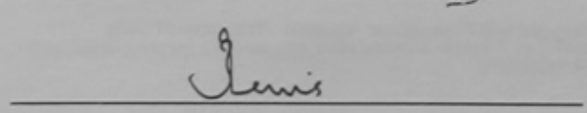
The Council of the Dublin Institute for Advanced Studies is required under section 28(2) of the Institute for Advanced Studies Act 1940 to prepare financial statements in such form as shall be approved by the Minister with the concurrence of the Minister for Finance. In preparing those financial statements 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 responsible for safeguarding the assets of the Institute and for taking reasonable steps for the prevention and detection of fraud and other irregularities. The Council is also responsible for ensuring compliance with The Prompt Payment of Accounts Act, 1997 as detailed in the notes to the accounts.



Chairman



Council Member

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

Financial Statements for year ended 31 December 1998

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 financial statements have been prepared under the historical cost convention.

2. Oireachtas Grants

Income is shown on a cash receivable basis.

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 value of such books and materials is estimated at £995,498, based on a 1994 valuation.

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 1998 was £788,024.

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. No provision is made in these financial statements for future benefits.

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

Financial Statements for year ended 31 December 1998

Income and Expenditure Account

	Notes	1998 £	1997 £
Income			
Oireachtas Grant		3,027,000	2,949,000
Sales of Publications		53,922	34,646
Celtic Studies Fees		0	0
School of Theoretical Physics	2	124,448	154,158
School of Cosmic Physics	2	193,143	270,232
Miscellaneous	8	39,348	20,754
		3,437,861	3,428,790
Transfer (to)/from Capital Reserve	4	85,021	(18,452)
		3,522,882	3,410,338
Expenditure			
School of Celtic Studies		691,815	652,250
School of Theoretical Physics		539,506	449,025
School of Cosmic Physics		1,342,298	1,363,795
Administration		926,426	909,927
		3,500,045	3,374,997
Surplus (Deficit) for year		**22,837**	**35,341**
Balance at 1 January		165,951	130,610
Balance at 31 December		**188,788**	**165,951**

The Statement of Accounting Policies and notes 1 to 9 form part of these financial statements.

CHAIRMAN - COUNCIL OF THE INSTITUTE

MEMBER OF COUNCIL

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

Financial Statements for year ended 31 December 1998

Balance Sheet as at 31 December 1998

	Notes	1998 £	1997 £
Assets			
Fixed Assets	3	567,174	652,195
Current Assets:			
Cash on Hands and at Bank		242,015	382,302
Debtors and Prepayments		191,728	110,902
Total Assets		**1,000,917**	**1,145,399**
Less Liabilities			
Creditors - Amounts falling due within one year			
Creditors and Accruals		158,141	223,560
Research Programmes and Fees	2	47,978	65,969
Lease obligations			577
Creditors - Amounts falling due after one year			
Funds	5	38,836	37,147
Total Liabilities		**244,955**	**327,253**
Net Assets		**755,962**	**818,146**
Financed by:			
Surplus Income and Expenditure Account		188,788	165,951
Capital Reserve	4	567,174	652,195
		755,962	**818,146**

The Statement of Accounting Policies and notes 1 to 9 form part of these financial statements.

CHAIRMAN - COUNCIL OF THE INSTITUTE

MEMBER OF COUNCIL

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

Financial Statements for year ended 31 December 1998

Cash Flow Statement

	1998 £	1997 £
Reconciliation of Income and Expenditure Account Surplus/(Deficit) to Net Cash Inflow/Outflow from Operating Activities		
Surplus(Deficit) for year	22,837	35,341
Less Interest Received	(23,282)	(20,734)
	(445)	14,607
Increase/(Decrease) in Creditors/Funds	(64,307)	(27,745)
Decrease/(Increase) in Debtors	(80,826)	608
Net Cash Inflow/(Outflow) from Operating Activities	(145,578)	(12,530)
Cash Flow Statement		
Net Cash Inflow/(Outflow) from Operating Activities	(145,578)	(12,530)
Net Decrease in Research Programmes and Fees	(17,991)	(13,280)
Returns on Investments and Servicing of Finance		
Interest Received	23,282	20,734
Capital Expenditure	(105,496)	(206,728)
Net Cash Inflow/(Outflow) before Financing	(245,783)	(211,804)
Financing		
Movement on Capital Account	(85,021)	18,452
Loss on Disposal	1,336	2,724
Depreciation	189,181	185,552
Cash Inflow from Financing	105,496	206,728
Increase/(Decrease)/in Cash	**(140,287)**	**(5,076)**
Analysis of Movement in Cash		
Balance at 1 January	382,302	387,378
Balance at 31 December	242,015	382,302
Increase/(Decrease) in Cash	**(140,287)**	**(5,076)**

The Statement of Accounting Policies and notes 1 to 9 form part of these financial statements.

CHAIRMAN - COUNCIL OF THE INSTITUTE **MEMBER OF COUNCIL**

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

Notes to the Financial Statements

1 Detailed Analysis of Income & Expenditure for the year ended 31/12/1998

	Notes	School of Celtic Studies	School of Theoretical Physics	School of Cosmic Physics	Adminis-tration	1998 Total	1997 Total
INCOME		£	£	£	£	£	£
Oireachtas Grants		689,000	401,000	1,197,000	740,000	3,027,000	2,949,000
Sales of Publications		53,480	-	442	-	53,922	34,646
School of Celtic Studies		-	-	-	-		
School of Theoretical Physics	2	-	124,448	-	-	124,448	154,158
School of Cosmic Physics	2	-	-	193,143	-	193,143	270,232
Miscellaneous	8	-	9,368	1,831	28,149	39,348	20,754
		742,480	534,816	1,392,416	768,149	3,437,861	3,428,790
Transfer (to)/from Capital Reserve	4	(44,772)	(16,697)	(36,851)	183,341	85,021	(18,452)
		697,708	518,119	1,355,565	951,490	3,522,882	3,410,338
EXPENDITURE							
Salaries, Wages and Superannuation	9	519,310	262,046	921,625	361,333	2,064,314	1,913,538
Scholarships		56,699	49,296	44,733	-	150,728	147,128
Honoraria		-	-	352	-	352	170
Library (incl. Microfilms)		30,402	56,227	23,311	-	109,940	92,544
Publications		36,198	-	58	3,760	40,016	36,296
General Administration	6	-	-	-	262,657	262,657	264,700
Travel and Survey Expenses		12,886	8,666	57,140	5,653	84,345	82,887
Symposia & Seminar Expenses		1,661	124	-	-	1,785	9,377
Equipment: Consumable & Maintenance		-	-	21,104	-	21,104	25,835
Special Commitments and Projects		-	147,177	239,879	-	387,056	423,327
General Expenses		34,659	15,970	30,634	70,960	152,223	134,165
Golden Jubilee/Ieunet		-	-	3,462	22,691	26,153	47,742
Book Storage		-	-	-	8,855	8,855	8,591
Dunsink Renovation		-	-	-	-	-	
Loss on Disposals		-	-	-	1,336	1,336	2,724
Depreciation	3	-	-	-	189,181	189,181	185,552
Leasing charges		-	-	-	-	-	421
		691,815	539,506	1,342,298	926,426	3,500,045	3,374,997
SURPLUS (DEFICIT) FOR YEAR		5,893	(21,387)	13,267	25,064	22,837	35,341
Balance at 1 January		184,376	9,846	(59,877)	31,606	165,951	130,610
Balance at 31 December		190,269	(11,541)	(46,610)	56,670	188,788	165,951

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

Notes to the Financial Statements

2 **Research Programmes and Fees**

School of Cosmic Physics

Project	Contributor	Opening Balance	Receipts	Applied as Income	Unexpended/ (Overexpended)
		£	£	£	£
TERM/TOBI	UCD		30,000	2,718	27,282
Gloria I & II	Marine Institute	30,727	15,113	20,275	25,565
Astroplasmaphysics	EU		45,273	20,267	25,006
Jet2	Forbairt	12,250	7,000		19,250
Leinster Granite	Forbairt	11,200	9,600	9,048	11,752
Turbulent Fusion	EU		30,108	19,418	10,690
Valentia	Met Eireann		10,000	1,144	8,856
Rapids II & III	Forbairt	10,859	1,859	6,625	6,093
High Energy	EU	(3,625)	7,851	1,486	2,740
Cores Nearby Galaxies	EU	5,037	3,639	6,729	1,947
Low Mass Star	Forbairt	5,216	2,646	6,659	1,203
HOGS	BGS		1,228	1,228	
EPAS Plasma/Slow Evol/Stability	EU	(2,920)	2,920		
Jet	Forbairt	(3,874)	3,874		
Data Reduction	Forbairt	2,541		2,541	
RIFTS	EU		463	463	
Other Fees	Various		495	495	
Irma II	EU	(607)	13,426	13,177	(358)
Hawaii	EU			453	(453)
SEAC	EU		1,078	2,596	(1,518)
Greek Project	EU			2,851	(2,851)
Eagle 99/Kenyall	EU	2,090		5,298	(3,208)
Kenya /BGS II	EU	(15,332)	10,344	9	(4,997)
Plasma Cooperation	EU	15,263		20,844	(5,581)
EADN - Erasmus/HCM	EU	(1,419)	11,330	16,466	(6,555)
Varnet	EU	(12,228)	13,111	13,528	(12,645)
Core Mantle I & II/PECO	EU	(13,478)		18,825	(32,303)
		41,700	**221,358**	**193,143**	**69,915**

School of Theoretical Physics

Network Rennes	EU	11,549		3,172	8,377
Large Deviation	EU	(6,302)	29,859	18,168	5,389
RITE	EU	(4,894)	7,739	2,845	
CNRS	EU	1,069		1,076	(7)
Esprit	EU	22,847	40,644	99,187	(35,696)
		24,269	**78,242**	**124,448**	**(21,937)**

Total **47,978**

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

Notes to the Financial Statements

3. Fixed Assets

	Furniture & Equipment	Motor Vehicles	Computers	Total
Cost	£	£	£	£
Opening Balance 1/1/98	995,999	14,711	1,184,999	2,195,709
Additions	39,708	1,800	63,988	105,496
	1,035,707	16,511	1,248,987	2,301,205
Disposals	0	(800)	(33,272)	(34072)
	1,035,707	15,711	1,215,715	2,267,133
Depreciation				
Opening Balance 1/1/98	593,981	14,411	935,122	1,543,514
Charge 1998	56,922	288	131,971	189,181
	650,903	14,699	1,067,093	1,732,695
Depreciation on disposals	0	(682)	(32,054)	(32,736)
	650,903	14,017	1,035,039	1,699,959
Net book value 31/12/98	384,804	1,694	180,676	567,174
Net book value 31/12/97	402,018	300	249,877	652,195

4. Capital Reserve	1998 £	1997 £
Balance at 1 January	652,195	633,743
Transfer from (to) Income and Expenditure Account		
Income allocated to acquire fixed assets	105,496	206,728
Amortisation in line with asset depreciation	(189,181)	(185,552)
Amount released on disposals	(1,336)	(2,724)
	(85,021)	18,452
Balance at 31 December	567,174	652,195

Notes to the Financial Statements

5. Funds

		1998	1997
		£	£
These comprise:	Vernam Hull Bequest	36,966	35,345
	Carmody Fund	1,870	1,802
		38,836	37,147

The funds are held on deposit.

6. General Administration Expenses:

	1998	1997
	£	£
Rent, Rates & Insurance	99,110	97,249
Premises Maintenance	47,890	48,868
Postage & Telephones	53,488	57,194
Fuel, Light & Power	46,471	46,744
Audit Fee	3,900	3,900
Sundry Supplies	15,698	10,745
	266,557	264,700

7. 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 1999 is £52,461.

8. Miscellaneous Income

Included under this heading is Bank Interest earned of £23,282 (1997 - £20,734) in the year.

9. Superannuation

The total superannuation payments in the year amounted to £297,837 (1997 - £292,134). The salaries and superannuation charge in the financial statements is net of contributions totalling £29,445 (1997 - £28,945).

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 Council and of the Comptroller and Auditor General

The accounting responsibilities of the Council of the Institute are set out in the Statement of Responsibilities of the Council on page 1. It is my responsibility, under section 28(3) of the Institute for Advanced Studies Act, 1940 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 judgments 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 affairs of the Institute at 31 December 1998 and of its income and expenditure and cash flow for the year then ended.

John Purcell
Comptroller and Auditor General
23 December 1999

DUBLIN INSTITUTE FOR ADVANCED STUDIES

Report of Comptroller and Auditor General pursuant to Section 13 of the Prompt Payment of Accounts Act, 1997

Responsibilities of the Council and of the Comptroller and Auditor General

The Council is obliged to comply with the Act and, in particular, is required to

- pay its suppliers by the appropriate payment date
- if payment to a supplier is late, include the appropriate penalty interest with the payment together with the information required by Section 6
- disclose its payment practices in the period in the appropriate way.

Under Section 13 of the Act, it is my responsibility, as auditor of Dublin Institute for Advanced Studies, to report on whether, in all material respects, the Institute has complied with the provisions of the Act.

Basis of Opinion

My examination included a review of the payment systems and procedures in place and checking, on a test basis, evidence relating to the operation of the Act by the Institute during the year.

I obtained all the information and explanations which I considered necessary for the exercise of my function under Section 13 of the Act.

Opinion

As a result of my examination, it is my opinion that the Institute complied in all material respects with the provisions of the Act during the year ended 31 December 1998.

John Purcell
Comptroller and Auditor General
23 December 1999