

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

School of Theoretical Physics  
12 JAN 2004  
DUBLIN INSTITUTE FOR  
ADVANCED STUDIES  
16 Burlington Rd. Dublin 4 Ireland

# ANNUAL REPORT 2000



P.N. 11640

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

School of Theoretical Physics  
12 JAN 2004  
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ADVANCED STUDIES  
10 Burlington Rd. Dublin 4. Ireland

*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 2000*

## Summary of the Annual Report of the Work of the Constituent Schools for the year ended 31 December 2000

### *School of Celtic Studies*

One new book was published by the School during the course of the year, and there were four reprints. Lectures were given regularly by members of staff and by research scholars both at the School, and at conferences in Ireland, Scotland, Wales, England, Belgium, Germany, Poland and the United States. The Annual Symposium/Tionól was held on 24-25 November. The statutory public lecture was given by Professor Fergus Kelly.

The complement of research scholars appointed for a year from 1 October comprised three from Ireland, two from the United States and one from Russia.

### *School of Theoretical Physics*

The primary areas of research were theoretical particle physics, statistical mechanics and applied probability theory. In particle physics, the main developments were the study of Weyl gauging and conformal invariance and of Wess-Zumino-Witten theory. In statistical mechanics, the main developments were the study of the random energy model and connections with error-correcting codes, and the investigation of the invariant measure for Anderson localisation on two lines. In the field of applied probability theory, progress was made on asymptotics of queue lengths, random sampling and early detection.

Two Mathematical Symposia were held during the year. In December, Professor T C Dorlas gave the Statutory Public Lecture on "Localisation and Quantum Hall Effect." A total of twenty three researchers visited the School for varying periods of time. A total number of 31 lectures, seminars and courses were given by the members of the School. In addition, 29 seminars were given at the School by visitors.

The year 2000 was unfortunately a tragic year for the School. We record with regret the death of Professor Lochlainn O'Raiheartaigh on November 18<sup>th</sup>.

### *School of Cosmic Physics*

The quinquennial external review of the School took place in February. The new parallel cluster was officially launched in November. Extensive work was put into the development of School and Institute strategy documents throughout the year. In the *Astrophysics Section* considerable effort was put into refining the calibration of the data from the Ultra Heavy Cosmic Ray Experiment and removing systematic effects. The work on cosmic rays in the atmosphere, and the resultant health implications for commercial aircraft flight, continued and received a boost with the awarding of a further EU contract to continue the studies through the period of solar maximum. A notable result in the star formation group was the development by Lery and coworkers of a global model for outflows from young stars which appears to offer a number of advantages over the conventional ones. This theoretical work was backed up by ground based and HST observational studies, including the first optical spectra of a jet from a young star obtained with the space telescope. An interesting application of the involutory symmetry of the ideal gas Euler equations to the simulation using high power laser implosion facilities of supernova remnants was discovered and published.

Galactic nuclei, evolving stellar populations and massive stars constituted the main research focus for the *Astronomy Section* in Dunsink Observatory. As in recent years, the emphasis has been on high-energy (X-ray) observational data. The nuclear and stellar population contributions to the total X-ray output were studied for several individual galaxies (such as M32, NGC 3147, NGC 4552). A substantial computer simulation programme that evaluates the X-ray emission of an evolving stellar population was advanced and can soon be applied to extragalactic star formation regions. Individual massive stars were investigated and the class properties of certain Wolf-Rayet type stars were determined. The exploitation of Archival Research assumed a larger scale during the year. The Optical Monitoring Camera for the INTEGRAL satellite was largely completed and is ready for launch. The Open Nights at Dunsink Observatory keep attracting school groups and members of the general public. Restoration work

has been carried out for some of the historical instruments in Dunsink.

Research in the *Geophysics Section* mainly concentrated on studies offshore in the Rockall Trough, and onshore in southeast and southwest Ireland. In the RAPIDS III project the quality of the large volume of data is very high and modelling of the four profiles continued with preliminary whole crustal models on two of the profiles completed. Of particular note from the deep-tow sidescan sonar project, TRIM, was a detailed study of an extensive population of carbonate mounds. A theoretical model was developed which predicts the observed size and shape distribution of the population, and allows an age profile to be determined. Onshore, inversion of the seismic data in the LEGS experiment revealed the structure of the Leinster Granite and provided the first detailed information on the seismic response of Caledonian granites. A 3-D model for the crust of southwest Ireland was developed using off-line seismic data from the VARNET project and our existing gravity data. Further afield, data acquisition in the Hawaiian Plume experiment continued throughout the year.

Annual Report of the work of the  
Institute and its Constituent Schools  
presented by the Council for the year  
ended 31 December 2000

*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 2000.*

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 2000.
- 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 2000.

*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,  
U.C.D., M.R.I.A.; D. Spearman,  
President, Royal Irish Academy, M.A.  
(Dubl.), Ph.D. (Cantab), F.T.C.D.,  
M.R.I.A., Member Academia Europaea;  
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. (until 30/6/00); M.  
Atiyah, O.M., F.R.S. (from 1/7/00); G.  
Wrixon, B.E., M.S., T.M.S.c., Ph.D.,  
M.R.I.A., President, N.U.I., Cork (from  
1/7/00); J. T. Lewis, B.Sc., Ph.D.,  
M.R.I.A.; L. Drury B.A., Ph.D.(Cantab),  
M.R.I.A.; C. Morawetz B.A., M.S., Ph.D.  
(until 30/6/00); B. Ó Madagáin, B.A.,  
Ph.D., M.R.I.A.; M. Ó Murchú, M.A.  
(Dubl.NUI), Ph.D., M.R.I.A. (until  
24/3/00); F. Kelly, B.A., Litt.D. (from  
24/3/00).

*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.; Fergus Kelly, B.A., Litt.D;

*Appointed Members*

P. de Priondargást, M.A. (until 31/3/00);  
A. Harrison, M.A., Ph.D (until 31/3/00);  
M. Ní Bhrolcháin, M.A., Ph.D. (until  
31/3/00); M. P. Ní Chatháin, M.A., Ph.D.  
(until 31/3/00); N. Ní Dhomhnaill (until  
31/3/00); M. Ní Neachtain, M.A., H.  
Dip.; L. P. Breatnach, M.A., (Dubl.,  
N.U.I.), Ph.D., F.T.C.D. (from 1/4/00); D.  
Ó Baoill, M.A., Ph.D., A.T.O. (from  
1/4/00); P. Ní Óráin, B.Ed. (until  
31/3/00); C. Ó Ceoinín, M.A. (until  
31/3/00); C. Ó Gráda, M.A., Ph.D., Dip.  
European Studies (until 31/3/00); J.  
Murphy (until 31/3/00); M. Uí Ainín  
(until 31/3/00); Ú. Uí Bheirn, M.A., Ph.D.  
(until 31/3/00).

*Governing Board of the School of Theoretical Physics**Chairman*

C. Morawetz, B.A., M.Sc., Ph.D. (until 31/3/00); M. Atiyah, O.M., F.R.S. (from 1/4/00).

*Senior Professors*

J.T. Lewis, B.Sc., Ph.D., M.R.I.A.; L. O'Raifeartaigh, M.Sc., Ph.D., M.R.I.A. (until 18/11/00); T. Dorlas, M.Sc., Ph.D.

*Appointed Members*

A. C. Breslin, B.Sc., M.Sc., Ph.D.; J. V. Pulé, D.Phil., D.Sc., M.R.I.A. (from 1/4/00); J. Browne, B.E., M.Eng.Sc., Ph.D., D.Sc., F.I.E.I. (until 31/3/00); J.C.I. Dooge, M.E., M.Sc., C.Eng., D.Sc., S.C.D., F.I.E.I., F.A.S.C.E., F.I.C.E., F.A.G.U., D.Agr.Sc., M.R.I.A.; B. Finnucane, B.Sc., Ph.D. (until 31/3/00); N. Marshall, B.Comm., A.C.A. (until 31/3/00); A. Montwill, M.Sc., Ph.D. D.Sc. (until 31/3/00); W. Reville, B.Sc., Ph.D. (until 31/3/00); T. D. Spearman, President of Royal Irish Academy, M.A. (Dubl.), Ph.D. (Cantab), F.T.C.D., M.R.I.A., Member Academia Europaea (until 31/3/00).

*Governing Board of the School of Cosmic Physics**Chairman*

A. Khan, B.Sc., Ph.D. (until 31/3/00); G. Wrixon, B.E., M.S., T.M.Sc., Ph.D., President, N.U.I, Cork (from 1/4/00).

*Senior Professors*

L.O.C. Drury, B.A., Ph.D.(Cantab), M.R.I.A.; A.W.B. Jacob, M.A., M.Sc., Ph.D., A.R.A.S., M.R.I.A.; E.J. A. Meurs, B.Sc., M.Sc., Ph.D.

*Appointed Members*

Aftab Khan, B.Sc., Ph.D.; M. Bailey, B.A., M.A., M.Sc., Ph.D. (from 1/4/00); S. McMurry, B.Sc., D.Phil, C.Phys., M.Inst.P (from 1/4/00); O. Glaser, M.Sc., Ph.D., C.Eng., F.I.E.I. (from 1/4/00); P. K. Carroll, M.Sc., D.Sc., Ph.D., F.Inst.P., M.R.I.A. (until 31/3/00); B. Harvey, M.A., H.D.E., F. Bis. (until 31/3/00); M. T. Lago, M.Sc., Ph.D. (until 31/3/00); M. F. Mulcahy,

M.Sc., Ph.D. (until 31/3/00); H. Sheehan, B.S., M.A., Ph.D. (until 31/3/00).

**II. Administrative Staff of the Institute***Registrar*

John Duggan, B.Sc.

*Senior Administrative Officer*

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

*Finance Officer*

Angela Stubbs (until 31/12/00)  
Cecil Keaveney (from 13/12/00)

*Assistant Finance Officer*

Ronan Byrne

*Clerks*

Noreen Granahan; Helena Moynihan; Tony Broderick; Eibhlín Nic Dhonncha (until 31/3/00).

*Temporary Administrative Staff*

Kathy Carr  
Séamus Ó hUallacháin, Acting Senior Administrative Officer (from 18/1-26/5/00)  
Fearghal Murray (until 20/6/00)  
Gillian Doherty (from 17/7/00)  
Mary Broderick (from 17/4/00-31/7/00)  
Margaret Loughman (from 1/8/00)

*Maintenance Officer – contract basis*

Roger Jones

Annual report of the Governing Board of  
the  
School of Celtic Studies  
for the year ending 31 December 2000  
adopted at its meeting of 27 September  
2001

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## 1 Staff, Research Scholars, Research Associates

### 1.1 Staff

Rolf Baumgarten (Professor)  
Fergus Kelly (Director)  
Malachy McKenna (Assistant Professor)  
Siobhán Ní Laoire (Academic Librarian)  
Aoibheann Nic Dhonnchadha (Assistant Professor)  
Pádraig Ó Macháin (Assistant Professor)  
Máirtín Ó Murchú (Senior Professor)  
Michelle O Riordan (Publications Officer)

### 1.2 Non-establishment staff

Brian Ó Curnáin (on contract at Research Assistant level)  
Grace Toland (Library cataloguing; part-time)  
Ann O'Gorman (Secretary, part-time to 31 March)  
Eibhlín Nic Dhonncha (School Administrator from 1 April)  
Niamh Walsh (Assistant Librarian)

### 1.3 Research Scholars

Jacqueline Borsje (to 30 September)  
Roisín McLaughlin  
Angela Gleason  
Gerald Manning  
Caitríona Ó Dochartaigh  
Alexander Falileyev  
Tom Berger (from 1 August)

### 1.4 Visiting Senior Professor

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

### 1.5 Professor Emeritus

Proinsias Mac Cana

### 1.6 Research Associates

(year of first appointment)

Dr Gwenllian Awbery, University of Wales, Cardiff (1990)  
Professor Liam Breatnach, Coláiste na Tríonóide, Baile Átha Cliath (1999)  
Dr John Carey, National University of Ireland, Cork (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 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, National University of Ireland, Cork, (1991)  
 Professor Ruairí Ó hUiginn, National University of Ireland, Maynooth (1999)  
 Professor Pádraig Ó Néill, The University of North Carolina at Chapel Hill (1990)  
 Dr Brynley 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.)

- Bronagh Ní Chonaill (University of Oxford)  
 Prof R. Mark Scowcroft (Catholic University of America)  
 Dr Morfydd E. Owen (University of Wales)  
 Dr Aidan Doyle (University of Gdansk, Poland)  
 Prof Pádraig Ó Néill (UNC Chapel Hill, USA)  
 Dr Hugh Fogarty (Harvard University, USA)  
 Prof Nancy Stenson (University of Minnesota, USA)  
 Dr Paolo Taviani (Rome, Italy)  
 Dr Rolf Ködderitzsch (University of Bonn)  
 Dr Tatyana Mikhailova (Moscow State University)  
 Dr Mary Valante (Appalachian State University, USA)  
 Dr Dan Tipp (University of Wales)  
 Prof Ann Dooley (University of Toronto)  
 Dr Doris Edel (University of Utrecht)

- Dr Bernhard Maier (University of Bonn)  
 Dr Peter Busse (Centre for Advanced Welsh and Celtic Studies)  
 Dr Ursula Marmé (University of Bonn)  
 Prof Melita Cataldi (University of Turin)  
 Dr Cathy Swift (University of Liverpool)

## 2 Research

During 2000 research for publication continued in the fields covered by the staff's expertise, ie. manuscript studies, medical texts, Early Irish law, Early Modern Irish verse, spoken language studies, bibliography. In addition to research being conducted internally, there was 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*. He designed an experimental bibliographical website.

Fergus Kelly continued work on his forthcoming edition of a Legal Treatise by Giolla na Naomh Mac Aodhagáin for the Early Irish Law Series. Prepared edition of legal commentary on *drochrosc* 'the evil eye' for *Celtica* 24. See also Seminars, and Outside activities and contributions to scholarship.

Malachy McKenna completed his edition of *The spiritual rose*; worked on an article entitled 'Grammatical gender in a nineteenth-century Ulster text'. See also Outside activities and contributions to scholarship.

Proinsias Mac Cana completed several articles on Irish and Welsh literary and textual topics and continued work on a number of features of Irish and Welsh syntax, the latter in collaboration with T. Arwyn Watkins. See also Outside activities and contributions to scholarship.

Siobhán Ní Laoire continued research on aspects of stylistic variations and register in Modern Irish.

Aoibheann Nic Dhonnchadha worked on Irish medical Manuscripts. Assistant Director of the Irish Script on Screen project (ISOS). See also Outside activities and contributions to scholarship.

Brian Ó Curnáin continued work on Connacht Irish dialects including field trips to Conamara and East Galway. Continued work on a forthcoming monograph on the Irish of Iorras Aithneach, Co. Galway. Continued work on a monograph of the Irish of the parishes of An Caisleán Gearr and Baile



an Chláir. See also Outside activities and contribution to scholarship.

Pádraig Ó Macháin continued work on Irish Manuscripts and Verse Traditions; cataloguing work on Irish manuscripts in the National Library of Ireland; Director of Irish Script on Screen (ISOS): supervised digitisation of Irish Manuscripts in TCD Library, and co-ordinated the operation of this co-operative project between DCU, TCD and DIAS. Director of Tionól, November (24 - 5). See also 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 Ó Direáin's investigation of the Irish of Aran.

Michelle O Riordan continued work on a book entitled *Ruling the margins: the polity of the poet in a bardic world*

## 2.2 Research Scholars

Tom Berger continued research on Early Irish, Welsh, and English Poetry with emphasis on lyric poetry.

Jacqueline Borsje continued research on 'Signs of Doom. Supernatural attendants of Fate in early Irish texts'. See also Outside activities and contribution to scholarship.

Alexander Falileyev continued with his edition of the Welsh version of Walter of Henley and with his general Indo-European studies. See also Outside activities and contributions to scholarship.

Angela Gleason worked on her PhD thesis 'Games and Entertainment in Early Ireland'. See also Outside activities and contributions to scholarship.

Gerald Manning continued with the preparation of an edition of the law text entitled 'Miadslechteae'. Began preparation of an article on the unpublished marginalia in the Book of Leinster to be completed for the next volume of *Celtica*. See also Outside activities and contributions to scholarship.

Roisín McLaughlin continued research for a book on Early Irish Satire. See also Outside activities and contributions to scholarship.

Caitríona Ó Dochartaigh continued her work on the edition of lines 3693-4980 of *Saltair na Rann*.

## 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 Michelle O Riordan.

The following item was published in 2000:

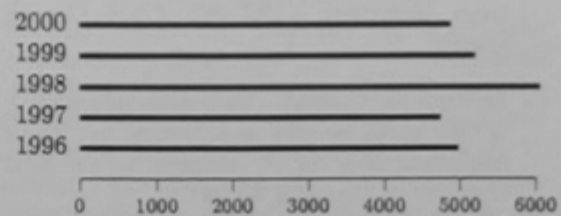
Stefan Zimmer, *Studies in Welsh Word-formation* xxi + 696pp. ISBN 1 85500 188 8

The following publications of the School were reprinted: I.P. Sheldon-Williams with the collaboration of Ludwig Bieler, *Iohannis Scotti Eriugena Periphyseon* (De diuisione naturae), Liber primus (1968), Catalogue J 2.7 [repr. 1978]. Ludwig Bieler with a contribution by Fergus Kelly, *The Patrician texts in the Book of Armagh* (1979), Catalogue J 2.10. Fergus Kelly, *Early Irish Farming* (1997), Catalogue F 4.4 [repr. 1998] Liam Price, *The Place-names of Co. Wicklow*, Volume 6 The barony of Shillelagh (1958), Catalogue E 5.1.6 [repr. 1975]

## 4 Booksales

The classified and annotated catalogue of the School of Celtic Studies publications was updated and distributed. Promotion of publications (Eibhlín Nic Dhonncha) was through advertising in *Books Ireland, Comhar, Saol, Slógadh, An tOireachtas: clár na féile, Lámhleabhar An Choláiste Ollscoile, Baile Átha Cliath* etc.

The number of books sold during 2000 was 4861. The comparable figures for the preceding years were 5187 for 1999, 6046 for 1998, 4732 for 1997, 4978 for 1996. 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.

## 6 Events

### 6.1 Lecture

- The Statutory Public Lecture for the year 2000 was delivered by Fergus Kelly (School of Celtic Studies) on 24 November, at National University of Ireland, Dublin, entitled 'The Early Irish Wisdom-texts: Origins and Ethos'.

### 6.2 Annual Symposium/Tionól 2000

The Annual Symposium/Tionól was held on 24–25 November, incorporating as a key feature the Statutory Public Lecture (see above). In addition, the following papers were read:

- Roisín McLaughlin (School of Celtic Studies): 'A threat of satire by Tadhg mac Dáire Mheic Bhruaideadha'.
- Patricia Ronan (National University of Ireland, Maynooth): 'Some aspects of *Echtra Nerai*'.
- Séamas Ó Direáin (National University of Ireland, Cork): 'Foinsí agus faisnéis: ag bailiú sonraí faoi na canúintí in Oileáin Árann'.
- Joe Ó Labhraí (Ollscoil Naomh Mhuire, Béal Feirste) 'Lámhscríbhinn chaillte? Seanmóirí Hugh McFadden c.1801-68), Cloch Cheann Fhaola'.
- Bronagh Ní Chonaill (University of Oxford): 'From "three worths of a foetus" to "three receptions of a child": children in the legal tradition of Medieval Wales'.
- Máirín Ní Dhonnchadha (National University of Ireland, Galway): 'Irard mac Coisse and his *airec menman*'
- Brian Ó Curnáin (School of Celtic Studies): 'Gaeilge cainteoirí a rugadh idir 1960 agus 1970 in Iorras Aithneach'.
- Paul Russell (Radley College, Oxford): 'Lex scripta est tenenda: new thoughts on the Latin laws of medieval Wales'.

- Roibeard Ó Maolalaigh (University of Edinburgh): 'Forchanúnachas, idircheantair agus forbairt stairiúil -ich agus -idh deiridh i nGaidhlig an iardheiscirt'
- Caoimhín Breatnach: (National University of Ireland, Dublin): 'The *Míniugad* recension of *Lebor Gabála*: a reappraisal of the manuscript tradition'.
- Art Hughes (University of Ulster): 'Multiple variants of the LASID questionnaire from a single area: a case study from mid-Down'.
- Donnchadh Ó Corráin (National University of Ireland, Cork): 'The Irish law of succession: another visit'.

### 6.3 Seminars

- Fergus Kelly (School of Celtic Studies) continued his Seminar on the Legal Treatise by Giolla na Naomh Mac Aodhagáin (weekly, from 17 January – 28 February); (weekly, 26 October – 20 November). Also Seminar on legal commentary on *drochrosc* 'the evil eye' (weekly, 27 November – 4 December).

## 7 Outside activities and contributions to scholarship

### 7.1 Activities

Lectures were delivered by: Fergus Kelly, 'In the footsteps of Rudolf Thurneysen: Old Irish law-texts and wisdom-texts' University of Bonn (May); 'Justice in ancient Ireland' University of Bonn (May); 'A talk on early Irish farming' on the occasion of the 25th anniversary of the founding of the Irish Agricultural Museum, Irish Farm Centre (June); 'Early Irish social institutions' for colloquium on Social Institutions of the Indo-European peoples, Royal Irish Academy (October); Statutory public lecture on 'The early Irish wisdom-texts: origins and ethos' National University of Ireland, Dublin (November)

Malachy McKenna went on a series of field-trips to investigate the Irish of Rann na Feirste; appointed to *Coiste Náisiúnta Léann na Gaeilge*; took part in a documentary, to be shown on French Television, on the life of Roparz Hemon; contributed to a series of programmes on the history of Irish food, to be shown on RTÉ.

Aoibheann Nic Dhonnchadha, 'The Irish translation of Bernard of Gordon's *Lilium medicine*:

translator, scribes and textual transmission', at the Fourth International Congress of Fifteenth century studies held in Antwerp, (2-7 July); 'Medical treatises in Irish', to the Biological Society, Royal College of Surgeons in Ireland, (October);

Brian Ó Curnáin, 'Polygenesis of a third plural pronoun in West Galway Irish' at Dialect 2000, Queen's University Belfast (August); 'The Gaeltacht, linguistic and cultural background' to visiting undergraduates during the first semester 2000-2001 Óstán na Páirce, Galway;

Pádraig Ó Macháin, 'Though earth and sky looked dreary: Young Ireland growing old' John Keegan Memorial Lecture, Dunamasa Theatre Portlaoise, (October);

Proinsias Mac Cana, 'Croesaniaid and crosáin: literary outsiders'. Centre of Advanced Welsh and Celtic Studies/University of Wales, Aberystwyth (April); 'Literary and cultural connections between Ireland and Wales in the Middle Ages', University of Wales Lampeter (July);

Lectures by Research Scholars: Jacqueline Borsje, 'Monsters in Early Irish texts: the problem of evil' Webster University, St. Louis, USA (March); 'The meaning of *túathcháech* in early Irish texts' Annual conference of the Celtic Studies Association of North America, USA (March); 'Cooking magic: witches and warriors in early Irish texts or: In search of a fairy from a lost text' Gregynog Hall, Newtown, Wales (April);

Alexander Falileyev, 'Walter of Henley and Wales' Wales and the Welsh 2000; Aberystwyth, Wales (April); 'Pre-Norman Wales: Languages in Contact?' 3rd International Congress of Dialectologists and Geolinguists, Lublin, Poland. (July) 'Indo-European Hospitality, Pokorny's \**ghosti-*, and Early Onomastics'. Royal Irish Academy Indo-European Colloquium, Dublin. (October) 'Aspects of Indo-European Hospitality', National University of Ireland, Cork. (November)

Angela Gleason, 'Gaming and gambling in early Ireland'. 34th International Conference for Medievalists. Kalamazoo, Michigan U.S.A. (June); 'Fairs and Festivals in pre-Viking Ireland', Games and Festivals in Classical Antiquity'. Edinburgh (July); 'The development of the Irish language at home and abroad' University of Southern Maine, St. Joseph's College, Maine. (August); 'Camanachd: Scottish shinty or Irish hurling? The origin and evolution of the Gaelic game'. The Irish-Scottish Academic Initiative. Dublin (September); 'Horse racing in early Ireland; evidence from the sagas and the laws'. (December);

Gerald Manning, Carrying out quality checks on manuscript images produced for ISOS project.

Roisín McLaughlin, 'Early Irish satire and the language of invective' guest lecture on M. Phil course, Trinity College, Dublin; 'Palaeography and Early Modern Irish Prose' Trinity College, Dublin; 'Entertainment in Early Ireland' Cairde na Cruite annual Summer School;

Caitríona Ó Dochartaigh, Litríocht agus Cultúr na Gaeilge 'Aistriúchán agus Cultúr san 18ú haois' Comhdháil 2000, Gaillimh.

## 7.2 Scholarly publications

Fergus Kelly, 'Early Irish cattle' in *Kerry cattle: a miscellany* (published by Kerry Cattle Society, Cahermore, Co. Kerry) 36-9; 'Trees in early Ireland' in *Irish forestry; Journal of the Society of Irish Foresters* (vol. 56, no. 1, 1999 [2000]); 39-57. Editorial work on Stefan Zimmer, *Welsh word-formation* (launched 10 November). Editorial work on Brian Ó Cuív, *Catalogue of the Irish manuscripts in the Bodleian Library, Oxford* vol. 1. Co-editor of *Celtica* 24

Rolf Baumgarten, co-editor of *Ériu* 51.

Proinsias Mac Cana, 'Notes on structure and syntax in *Fled Bricrenn*', in *Fled Bricrenn reassessments*, ed. Pádraig Ó Riain (London: Irish Texts Society); 70-91. 'Cú Chulainn: penser la violence', in *Violence et société en Bretagne et dans les pays celtiques*, Actes réunis par Jean-Yves Carlier (Centre de recherche Bretonne et Celtique: Brest); 29-35 'Celtic goddesses of sovereignty', in *Goddesses who rule*, ed. Elizabeth Bernard and Beverly Moon (Oxford: New York); 85-99. Co-editor of *Ériu* 51.

Malachy McKenna, Co-editor of *Celtica* 24.

Pádraig Ó Macháin, 'Tomás na Sop agus Tadhg Ó hÁinle'. *An Linn Bhui* 4; 146-8 (with Thomas F. Overlander) 'Michael Cavanagh of Cappoquin, 1822-1900', *Decies*; 56, 97-122. (with Cristófaí Mac Íomhaire, Aoibheann Nic Dhonnchadha, Alan F. Smeaton) 'The ISOS project - A digital library of Irish scripts on screen', *Proceedings of the 6th Annual Conference of the North American Association for Celtic Language Teachers* (Limerick); 71-6. 'Sir Walter Scott's Irish manuscript', *Scottish Gaelic Studies* 20; 147-55

Aoibheann Nic Dhonnchadha, 'Medical writing in Irish', in *Irish Journal of Medical Science*, vol. 169, number 3 (July-September); 217-220,

Brian Ó Curnáin, 'Review of *A Dictionary of Ulster Place-Names*, P. McKay; Belfast 1999, in *Éigse* 32, 166-169

Research Scholars' publications:

Jacqueline Borsje, 'Zeemonsters en de mythische dimensie van de zee', *Madoc* 13 (2000) 268-276; 'Omens, ordeals and oracles: on demons and weapons in early Irish texts', *Peritia. Journal of the Medieval Academy of Ireland* 13 (2000), 224-248; 'Women in Columba's Life, as seen through the eyes of his biographer Adomnán', in Anne-Marie Korte (ed.) *Women and miracle-stories. A multidisciplinary Exploration*, (Brill, 2000) 87-122; 'De waarheid van verhalen', *Kabats* (2000/2001). 14-16.

Alexander Falileyev, *Etymological Glossary of Old Welsh* Tübingen: Niemeyer 2000. 'Another Reflex of PIE \*skei- in Celtic' in: *Studia Indogermanica Lodziensia II* (FS I.R.Danka). Lodz 2000, 153-159. 'A commentary to Just. XXXII, 3. 6-9', in: *Proceedings of the XXVIII Conference St. Petersburg University* 2000. 'Old Welsh data in Pokorny's *Indogermanisches etymologisches Wörterbuch*', in: *Proceedings of the Academy of*

*Science* 59/6 (2000), 45-48. 'A Note on an Interesting Irish Word', in: *Language: Theory, History, Typology* (GS V.Yarceva). Moscow: Editorial URSS 2000, 188-191. 'Common Slavic \*kols'; Welsh *pall, pallaf*', in: N.N. Kzanskij, ed. *Colloquia classica et indo-europeica II*. St. Petersburg: Aletya 2000. 'Ovid and Wales', in: *Indoeuropeiskoye yazykoznanie i klassicheskaya filologiya* 4 (2000), 115-117. Review, G.Isaac, *The Verb in the Book of Aneirin. Studies in Syntaz, Morphology and Etymology*. Tübingen: Max Niemeyer 1996. in: *Voprosy jazykoznanija*, 2000 (4), 144-149. On the Adverbial Usage of Adjectives in Brittonic Languages. In: G. Evans, B. Martin and J. Wooding, eds., *Origins and revivals: Proceedings of the First Australian Conference of Celtic Studies*. University of Sidney 2000, 37-43

Angela Gleason, *Helicon's Encyclopedia of Ireland*: 22 entries.

Annual Report of the Governing Board of the School of Theoretical Physics for the year ending 31 December 2000 adopted at its meeting on 31 July 2001.

### 1. Staff, Scholars and Research Associates

#### Senior Professors:

John T. Lewis (Director from 1 January 1975), Lochlainn S. O'Raifeartaigh (died 18 November), T.C. Dorlas from 1 January

#### Assistant Professors:

Fergal Toomey to 31 March, Raymond Russell to 31 March

#### Librarian:

Ann Goldsmith

#### Secretary:

Margaret Matthews

#### Systems Administrator:

Ian Dowse to 31 March, N. Brady from 1 November, D. O'Connell from 1 November

#### Visiting Professors:

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

#### Scholars:

M. Dukes (Ireland) from 1 October, P. Ferreira (Portugal) from 1 October, J. Pawlowski (Germany) to 30 September, J. Teschner (Germany) to 31 July, T. Takenaga (Japan) from 1 October, T. Tsukioka (Japan) from 1 October, S. Vinnakota (India), P. Watts (USA).

#### European Union Fellows:

M. Corluy (Belgium) to 31 October

#### Feodor Lynen Fellow AvH Foundation:

O. Jahn (Germany) from 16 June

#### Microsoft Research Fellow:

K. Laevens (Ghent) to 30 September

#### Graduate Students:

S. Coffey (Ireland) to 30 June, M. Dukes (Ireland) to 30 September, K. Duffy (Ireland) to 31 July, E. Heron (Ireland), B. McGurk (Ireland) to 30 September.

#### Research Associates:

Re-appointed to 31 December 2002:

TCD: P.S. Florides, J. Miller, D. Weaire; UCD: A. Ottewill, J.V. Pulé, W.Sullivan; NUI, MAYNOOTH: M. Daly, B. Dolan, D. Heffernan, C.Nash, A. O'Farrell, J.A. Slevin, D.H. Tchrakian; NUI, CORK: M. Vandyck; NUI, GALWAY: J. Burns, M.J. Conneely, P. O'Donoghue, M.P. Tuite DIT: T. Garavaglia, D. Gilbert, M. Golden, B. Goldsmith, P. Houston, M.J. Tuite; DCU: E. Buffet, J. Burzlaff, E. O'Riordan; UL: R.H. Critchley, 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; Department Of Finance: A.J. Curran; Schlumberger Cambridge Research: B. Lenoach; Intern. Centre For Theoretical Physics, Trieste: J. Chela-Flores; Unaffiliated: M. Barman, D.J. Bradley, F. Freire, G.M. O'Brien, D. Ó Mathúna

#### Visiting Scientists:

H. Banerjee (Calcutta) 6-9 August, N. Björkman (Telia AB, Sweden) 23-26 February, C. Ford (DESY, Germany) 25 September - 2 October, G.W. Ford (Univ. Michigan, USA) 29 May - 3 July, Y. Jiang (Telia AB, Sweden) 10-11 April, A. Latour-Henner (Telia AB, Sweden) 23-26 February, D. Litim (Heidelberg) 31 May - 6 June, G. Moore (Rutgers Univ., USA) 25 May, R.F. O'Connell (Baton Rouge, USA) 26 May - 14 August, D. O'Connor (Mexico) 14-24 August, E. Pechersky (Moscow) 1-15 May, A. Perelomov (Moscow) 22 March - 2 May, B. Persson (Telia AB, Sweden) 22-24 February, C. Pfister (Lausanne) 9-13 October, 23-25 November, V.B. Priezzhev (JINR, Dubna) 19 November - 17 December, I. Sachs (Germany) 4-21 September, O. Schnetz (Erlangen) 17-20 July, V. Skrypnyk (Keiv, Ukraine) 3 October - 3 November, A.I. Solomon (Open University, UK) 15 March, P. Sutcliffe (Univ. Kent, UK) 5 July, Y. Suhov (Cambridge) 28 March - 3 April, E. Thomas (Groningen) 20-26 November, N.Vvedenskaya (Moscow) 27 March - 10 April.

### 2. General

We record with regret the death of Professor Lochlainn O'Raifeartaigh on November 18. He was a Scholar from 1956-1957, a Student from 1957-59, Professor from 1960-1968 and Senior Professor from 1968.

Professor L. O'Raifeartaigh was awarded the Wigner medal in August for his 'pioneering contributions to particle physics'.

### 3. Research and Study

#### 3.1 Theoretical Particle Physics

Dr. J. Burzlaff studied solitons in field theories. The scattering of magnetic monopoles in  $SU(2)$  Yang-Mills-Higgs theory and in particular the breaking of the combined symmetry of time inversion and 90 degrees rotation was investigated. An expansion in the distance parameter was given for Abrikosov vortices in upper conductors, and used to study the scattering of vortices.

Prof. Chela-Flores conducted research in the interdisciplinary field of astrobiology. His research project was devoted to Solar System exploration.

Dr. B. Dolan carried out research in the following areas: the quantum Hall effect, chaotic renormalisation group flow in Potts models and non-commutative geometry.

Dr. P. Ferreira studied the possibility of charge and colour breaking in the minimal supersymmetric model at the one-loop level. This involved the computation of mass matrices for all particles in the model when vacuum expectation values other than those of the neutral Higgs fields are present.

Dr. O. Jahn, with Drs. Pawlowski and Sreedhar and with Prof. O'Raifeartaigh, studied the problem of formulating lattice field theories with fermions in a chirally symmetric way. They established a topological obstruction that makes clear why conventional approaches must fail. He also investigated the relation between instantons, monopoles and vortices in non-Abelian gauge theories.

Dr. J.M. Pawlowski's research was concerned with non-perturbative effects and topological degrees of freedom in quantum field theory, in particular in Yang-Mills theories: (a) Exact renormalisation group equation in Yang-Mills theories: he investigated the formulation for gauge theories, both in a gauge invariant formulation and a version with an explicit

breaking of gauge invariance during the flow; (b) Instantons on the torus: topological defects are supposed to play a major role in the understanding of the infra-red region of QCD. An infra-red safe version of QCD can be formulated on the torus. The corresponding topological defects were studied. (c) Liouville theory: quantum Liouville theory shows a remarkable duality in the coupling constant which is missing on the classical level. This duality was studied within a path integral formulation.

Dr. K. Takenaga studied supersymmetric quantum field theories in multiply connected space by taking into account the possible topological effect of the space.

Prof. D.H. Tchrakian continued his study of  $SO(N)$  ( $N$  less than or equal to  $d$ ) gauged  $d$ -dimensional  $O(d+1)$  Sigma models in  $d$ -dimensional Euclidean space. He also demonstrated monopole catalysis of Baryon number decay classically in a combined Georgi-Glashow and Shyrme model. He constructed Schwarzschild-like and Reissner-Nordstrom-like and de Sitter solutions of the most general superposition of gravitational hierarchies in all dimensions.

Dr. J. Teschner carried out research on models for strings and D-branes on curved backgrounds, on noncompact conformal field theories and in particular Liouville theory,  $H^1$ , - WZNW with or without boundary. He also worked on noncompact quantum groups.

Dr. T. Tsukioka investigated the generalized gauge theory which may play an important role in constructing lattice gravity theory together with matter fields. He studied the generalization of the geometry of the supersymmetric gauge theory. He investigated the generalized topological Yang-Mills theory from the topological field theory point of view. He quantized the two-dimensional version of the generalized topological Yang-Mills action and showed that the instanton gauge fixing led to a twisted  $N=2$  supersymmetric action. He pointed out that the fermionic ghost fields could be interpreted as Dirac-Kähler fermion fields which is a natural framework of the lattice fermion formulation.

He also studied noncommutative differential geometry. He showed that the grading structure

of the noncommutative geometry was accommodated by the quaternions in the framework of generalized gauge theory. He also constructed the spontaneously broken Weinberg-Salam model using the graded Lie algebra  $SU(2/1)$  as the gauge algebra.

Dr. S. Vinnakota completed a study of the two-exponential Liouville theory by establishing the uniqueness of the three-point function using the translational invariance of the path integral measure and the self-consistency of the two-point functions. He showed that the maximal kinematical invariance group of fluid mechanics is larger than the Galilei group and is in fact a twelve parameter group called the Schrödinger group, this explains the duality observed between numerical simulations of supernova explosions and inertial confinement plasma implosions.

Dr. P. Watts carried out research on noncommutative geometry in string theory, on the Randall-Sundrum model in AdS, and on classical  $W$ -gravity and  $W$ -supergravity.

### 3.2 Applied Probability Theory

Professor Lewis continued his work on applications of Large Deviation Theory to Queueing Theory and to Information Theory.

Mr. S. Coffey carried out research on Markov chains and genetic algorithms. He also worked on queue management techniques and on the use of genetic algorithms to find optimal parameters for the random early detection algorithm.

Dr. K. Duffy completed work with Professors Sullivan and Lewis on the logarithmic asymptotics of the tail of the stationary queue length distribution in the presence of a Large Deviations Principle on regularly varying scales. He completed work with Professor Toomey on the many sources asymptotic. He evaluated the concave rate-function for a two state source whose sojourn-times are distributed via a Weibull distribution. He also completed work on his Ph.D. thesis.

Dr. M. Dukes spent the first part of the year completing his Ph. D. thesis entitled 'Counting and Probability in Matroid Theory'. He then worked with Prof. Dorlas on solving various models in statistical mechanics. He also carried

out research on matroid theory and combinatorics.

Ms. E. Heron worked on writing programs to calculate the shape functions and admission functions numerically for various traffic models. She ran simulations to investigate random early detection mechanisms. She also worked on her masters thesis entitled 'Integration defined using product measures'.

Dr. B. McGurk continued his research on the Large Deviations of random sampling, leading to the submission of his Ph.D. thesis.

Prof. R. Russell worked on the joint research project on Random Early Detection (RED) with Telia Research. This consisted of developing a software simulation platform for performing RED-based experiments and for applying entropy-measurement schemes to improving its performance. He also used the platform to investigate various algorithms for Discrete Event Simulation and to verify analytic bounds on their performance.

Dr. W. Sullivan continued his work with Professor Pfister relating dimension theory to problems in statistical physics. He also worked with Professor Lewis and Dr. Duffy on asymptotics of certain queues.

Prof. F. Toomey carried out research on the general theory of linear Galois connections and on the relations between order theory and scheduling systems. He also carried out a simulation study of flow control in queueing systems.

### 3.3 Classical Statistical Mechanics

Prof. T.C. Dorlas continued his research on the solution of spin glass models and their application to error-correcting codes. He also worked on Anderson localisation, in particular in one dimensional strips with possible application to carbon nanotubes.

### 3.4 Quantum Statistical Mechanics

Professor Lewis continued his work with Professors Ford and O'Connell on applications of the Quantum Langevin Equation.

### 3.5 Quantum Theory and Quantum Electronics

Dr. M.J. Conneely worked on the energy levels and classification of triply excited states of 3-electron systems.

Dr. A.I. Solomon used group theoretical methods in the analysis of quantum 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. E. Buffet carried out research in the areas of mathematical finance and credit risk.

Dr. D.J. Gilbert worked on the spectral theory of Schrödinger operators, differential equations and asymptotic methods and the mathematical aspects of circuit theory, design and test.

Dr. J.M. Golden investigated linear viscoelastic boundary value problems where the boundary regions vary in time. He also studied the thermodynamics of viscoelastic solids.

Dr. P. Lynch worked on initialization methods for numerical weather prediction and the dynamics of low-order Hamiltonian systems.

Dr. E. O'Riordan worked on the application and modification of the Shishkin mesh to solve numerically various classes of singularly perturbed partial differential equations. His main aim was to provide detailed proofs of sharp theoretical error bounds associated with these numerical methods.

After the completion in 1999 of a unified framework for Lie and covariant differentiation of spinor fields, a new operation was introduced by Dr. M. Vandyck, called 'D-differentiation', which contains, among others, Lie and covariant differentiation as special cases. He is currently working on a research monograph in this area.

### 3.7 Pure Mathematics

Dr. B. Goldsmith investigated the unit sum numbers of Abelian groups and modules. He also looked at various types of minimality in Abelian groups.

Prof. A.G. O'Farrell worked on pervasive function spaces in the early part of the year. Then he worked, with M.A. Sanabria-Garcia, on polynomially-convex hulls.

Dr. N. O'Connell investigated the spectral properties of large random unitary matrices. He also looked at the connections between random matrices, directed percolation and queues.

### 3.8 History of Science

Dr. D. Ó Mathúna worked on the Bernoulli project as scientific contributor/editor. He also worked on a projected book on classical mechanics.

## 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) was prepared and circulated to a mailing list of approximately 350 research institutes and university departments throughout the world. As far as possible, copies of the preprints were sent out in response to requests. Many of the reports appeared later as publications. (See section 9:4).

#### DIAS-STP-00

- 1: B. Dolan: Duality in the Quantum Hall Effect - the role of electron spin.
- 2: R. Russell: A note on representation by max-plus matrices.
- 3: P. Watts: Derivatives and the role of the Drinfel'd twist in noncommutative string theory.
- 4: L. O'Raifeartaigh, J.M. Pawłowski & V.V. Sreedhar: The two-exponential Liouville theory and the uniqueness of the three-point function.
- 5: Yu.M. Suhov & N.D. Vvedenskaya: Fast Jackson-type networks with dynamic routing.
- 6: T.C. Dorlas & J.R. Wedagedera: The phase diagram of a spin glass on a tree with ferromagnetic interactions.
- 7: K. Duffy & F. Toomey: Large Deviations and transient multiplexing at a buffered resource.
- 8: F. Lenz, M. Thiess, J. Nagele & L. O'Raifeartaigh: Phases and residual gauge symmetries of Higgs models.



- 9: W.M.B. Dukes: Counting rank-2 matroids.
- 10: W.M.B. Dukes: The Microsoft congestion pricing and network games bibliography.
- 11: C. Ford, J.M. Pawłowski, T. Tok & A. Wipf : ADHM construction of instantons on the torus.
- 12: K. Duffy: On the Large Deviations of a class of stationary on/off sources which exhibit long range dependence.
- 13: N.D. Vvedenskaya, E.A. Pechersky & Yu. M. Suhov: Large deviations in some queueing systems.
- 14: J. Burzlaff & E. Kellegher: Expansion in the distance parameter for two vortices close together.
- 15: J. Teschner & B. Ponsot: Clebsch-Jordan and Racah-Wigner coefficients for a continuous series of representations of  $U_q(sl(2, R))$ .
- 16: L. O'Raiheartaigh & V.V. Sreedhar: The maximal kinematical invariance group of fluid dynamics and explosion-implosion duality.
- 17: F. Freire, D.T. Litim & J.M. Pawłowski: Gauge invariance and background field formalism in the exact renormalisation group.
- 18: J.M. Pawłowski: 2-Loop consistency in the exact RG approach to non-Abelian gauge theories.
- 19: J.M. Pawłowski: On Wilsonian flows in gauge theories.
- 20: T.C. Dorlas & J.R. Wedagedera: Large Deviations and the random energy model.
- 21: E.I. Ivashkevich, A.M. Povolotsky & V.B. Priezzhev: Exact velocity of dispersive flow in the asymmetric avalanche process.
- 22: T. Garavaglia: Covariant relativistic quantum theory.
- 23: L. O'Raiheartaigh, J.M. Pawłowski & V.V. Sreedhar: On the duality of quantum Liouville field theory.

#### 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 *Localisation and the Quantum Hall Effect* was delivered by Prof. T.C. Dorlas in University College Dublin, Belfield on 7 December.

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

- H. Banerjee (SAHA Institute, Calcutta) *Chiral anomalies revisited*
- M. Dukes *Counting matroids: from 93 'til infinity.*
- V. Priezzhev (Moscow) *Bethe Ansatz solution for the one-dimensional avalanche process.*
- W. Skrypnik (Kiev, Ukraine) *Long-range order in non-equilibrium systems of interacting Brownian linear oscillators.*
- E. Thomas (Groningen) *Path integrals in discrete time.*
- A. Wipf (Jena) *Abelian projections.*

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

- J. Burzlaff (DCU) *On 90 degrees soliton scattering in field theories.*
- B. Dolan (NUI, Maynooth) *Non-commutative geometry and star-products on coset spaces.*
- B. Dolan (NUI, Maynooth) *Report on the Rutherford Laboratory meeting.*
- P. Ferreira *Charge and colour breaking bounds revisited.*
- C. Houghton (TCD) *Larger and larger skyrmions.*
- O. Jahn *Relation between instantons and monopoles in QCD.*
- D. O'Connor (Cinvestav, Mexico City) *Matrix models and non-commutative geometry.*
- J. Pawłowski *ADHM in a box.*
- A. Perelomov (Moscow) *Quantum Calogero-Sutherland systems: an overview.*

- V.V. Sreedhar *Explosion-implosion duality.*
- T. Tsukioka *Generalized gauge theory: an overview.*

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

- Prof. J.T. Lewis: Lectures on *Probability and Measure*
- Prof. T.C. Dorlas: Lectures on *Quantum Computing*; Lectures on *Statistical Mechanics*

#### Seminars

- B. Dolan (NUI, Maynooth) *The quantum Hall effect and high  $T_c$  superconductors - symmetries of strongly interacting theories.* (UCD)
- D.G. Gilbert (DIT) *The location of points of spectral concentration for Schrödinger operators with short range potentials.* (DCU)
- V.V. Sreedhar *Explosion-implosion duality.* (UCD)
- J. Teschner *Solvable models for strings on nontrivial backgrounds.* (TCD)
- J. Teschner *Solving Liouville theory via noncompact quantum groups.* (UCD)

#### 5.5 Lecture Courses and Seminars given abroad

- J. T. Lewis *Lectures on Large Deviation Theory* (Technical University, Budapest)

#### Seminars

- J. T. Lewis *Large deviation theory and statistical thermodynamics.* (Versailles)
- L. O'Raiifeartaigh *Thirty Years of Supersymmetry.* (Minnesota) *Asim Barut Memorial Lecture.* (Istanbul)
- T.C. Dorlas *Complete localisation in a strong magnetic field.* (Prague)
- S. Coffey *Random early detection.* (Stockholm)
- B. McGurk *Queues, random graphs and percolation theory.* (Bristol)
- J.M. Pawłowski *Duality in Liouville theory.* (Bad Honnef) *An introduction to Wilsonian flows.* (Erlangen) *Wilsonian flows and universality in gauge theories.* (Heidelberg) *On Wilsonian flows in gauge theories.* (Rome)
- R. Russell *Experiments with the RED simulation tool.* (Stockholm)

- J. Teschner *The Liouville boundary problem.* (Princeton, Chicago, Pasadena, Harvard, Montreal) *Solvable models for strings and branes on curved backgrounds.* (Bad Honnef)
- K. Takenaga *Supersymmetry in multiply connected spaces.* (Kyoto)
- F. Toomey *Flow control in queueing systems.* (Harlow)
- S. Vinnakota *Explosion-implosion duality.* (Chennai, Calcutta, Bangalore, Kanpur), The Schrödinger Group, (Hyderabad)

#### 6. Activities of Members of DIAS-STP

##### 6.1 Activities within Ireland

Dr. M. Dukes: The Mathematical Intervarsities, DCU, 11 March

Dr. J.M. Pawłowski: 7th Irish Quantum Field Theory Meeting, TCD, 26-27 May

Dr. J. Teschner: 7th Irish Quantum Field Theory Meeting, TCD, 26-27 May

Dr. P. Watts: 7th Irish Quantum Field Theory Meeting, TCD, 26-27 May

##### 6.2 Activities outside Ireland

Prof. J.T. Lewis: Adjudicating Panel, Brussels, 14-16 March; Teli Research Institute, Stockholm, 20-22 March; Meeting to Celebrate 60<sup>th</sup> Birthday of Prof. R.L. Hudson, University of Nottingham, 3-4 May; Meeting to Celebrate 60<sup>th</sup> birthday of Prof. A. Verbeure, University of Leuven, 17-21 May; Meeting of EPSRC, Swindon, UK, 26 September; Budapest Technical University, Hungary, 27 September - 6 October; Examine Ph.D. Thesis and deliver seminar, INRIA, Versailles, France, 15-17 November.

Prof. L. O'Raiifeartaigh: XXIII Colloquium on 'Group Theoretical Methods in Physics', JINR, Dubna, Russia, 31 July - 7 August; 'Thirty Years of Supersymmetry', University of Minnesota, Minneapolis, USA, 10-20 October; Delivered the 'Asim Barut Memorial Lecture', Bogazici University, Istanbul, Turkey and Feza Gürsey Institute, Istanbul, Turkey, 23-30 October.

Prof. T.C. Dorlas: Workshop 'Mathematical Methods in Quantum Theory', Prague, 15-18

May; XIII International Congress of Mathematical Physics, Imperial College, London, 17-22 July.

Mr. S. Coffey: Telia Research Institute, Stockholm, 20-22 March.

Mr. I. Dowse: AT&T Laboratories, San Jose, USA, 7-17 February; Nortel, Harlow, UK, 20 March.

Mr. M. Dukes: HP-Microsoft Workshop, Bristol, 10-15 September.

Ms. E. Heron: Telia Research Institute, Stockholm, 20-22 March; HP-Microsoft Workshop, Bristol, 10-15 September.

Mr. B. McGurk: HP-Microsoft Workshop, Bristol, 10-15 September.

Dr. J.M. Pawłowski: Desy, Zeuthen, 4-9 February, 18-25 June; Workshop 'Nonperturbative Aspects of Gauge Fields and Strings', Jena, 10-12 February; Workshop 'Beyond the Standard Model', Bad Honnef, 20-24 February; Institute for Theoretical Research, Heidelberg, 25 February - 4 March, 1-7 July; Institute for Theoretical Physics III, Erlangen 26-30 June; 2nd Workshop 'Exact RG Group', Rome, 17-23 September.

Prof. R. Russell: AT&T Laboratories, San Jose, USA, 7-17 February; Nortel, Harlow, UK, 20 March; Telia Research Institute, Stockholm, 20-22 March.

Dr. K. Takenaga: Conference 'Fundamental problems and applications of quantum field theory', Yukawa, Kyoto, Japan, 17-22 December.

Dr. J. Teschner: Workshop 'Beyond the Standard Model', Bad Honnef, 20-24 February; IAS, Princeton, 25-28 March; University of Chicago, 28 March - 4 April; Caltech, Pasadena, 4-11 April; Workshop 'Applications of Integrability', Montreal, 11-20 April; Harvard University, 20-25 April.

Prof. F. Toomey: Nortel, Harlow, UK, 20 March; UK Teletraffic Symposium, Harlow, UK, 22-24 May.

Dr. S. Vinnakota: Institute of Mathematical Sciences, Chennai, India; Saha Institute of Nuclear Physics, Calcutta, India; S.N. Bose National Centre for Basic Sciences, Calcutta, India; The Indian Association for the Cultivation of Science, Calcutta, India; The Raman Research Institute,

Bangalore, India; The Indian Institute of Science, Bangalore, India; The Indian Institute of Technology, Kanpur, India, December; DAE Symposium, University of Hyderabad, India, 18-21 December.

Dr. P. Watts: Conference 'String Theory at the Millenium', Caltech, 12-15 January.

## 7 Symposia

Two Mathematical Symposia were held during the year, 31 March - 1 April, and 19-20 December. The attendance (20 in March, 40 in December) included professors, lecturers, and graduate students from the Irish universities and other third-level and research institutes, and from Institutes abroad, and members of the scientific schools of DIAS.

Lectures were given as follows:

### March

#### Review Lectures:

- Prof. D. Heffernan (NUI Maynooth) *Universality and scaling in chaotic attractor transitions.*
- Prof. L. O'C Drury (DIAS) *Implosion explosion duality and the laboratory simulation of supernova explosions.*

#### Lectures:

- Prof. A.I. Solomon (Open University) *Canonical transformations, quantum optics and quantum groups.*
- Dr. J. Pawłowski (DIAS) *Flow equations in quantum field theory.*
- Dr. J. Appleby (DCU) *Asymptotics of linear convolution integro-differential equations.*
- Mr. D. Malone (TCD) *Self-affine tiles and dilation equations.*

#### Short Talks:

- Dr. J. Murray (UCD) *The group algebra of a finite symmetric group.*
- Ms. E. Byrne (NUI Cork) *Groebner bases over Galois rings.*
- Dr. S. O'Brien (Univ. of Limerick) *Flow over non-flat substrates.*
- Dr. J. Foy (TCD) *A derivation of quantum logic.*
- Mr. R. Ivanov (NUI Galway) *Generalized moonshine and Abelian orbifolds.*

- Dr. N. O'Sullivan (UCD) *Localizations of soluble groups.*

## December

## Review Lectures:

- Prof. P. Feehan (TCD) *Gauge theory and the topology of smooth four-manifolds.*
- Prof. R. Aron (TCD) *On zeroes of polynomials.*

## Lectures:

- Mr. R. Ivanov (NUI Galway) *Generalised moonshine and Abelian orbifolds.*
- Dr. J. Foy (TCD) *Quantum logic from physical principles.*
- Dr. E. Byrne (NUI Cork) *Lifting decoding schemes over a Galois ring.*

## Short Talks:

- Prof. A.I. Solomon (Open University) *Introduction to quantum control.*
- Dr. M. Mathieu (QUB) *Spectrally bounded operators that are Jordan homomorphisms.*
- Dr. P. Lynch (Met. Eireann) *Stepwise precession of the resonant swinging spring.*
- Dr. J. Appleby (DCU) *Asymptotic stability of Ito-Volterra equations.*
- Dr. T. Murphy (TCD) *A Noetherian property of the symmetric groups.*
- Mr. S. Ó hÓgáin (DIT) *Aspects of minimality in Abelian groups.*

## 8 Visitors

As in previous years, visitors from abroad came to the School for short or long periods, for discussions with School's members, to give seminars, and to avail of the School's library resources for their research work.

For lectures given by visitors, see sections 5.2 and 5.3

## Short visits (up to one week):

H. Banerjee (Calcutta) 6-9 August; N. Björkman (Telia AB, Sweden) 23-26 February; C. Ford (DESY, Germany) 25 September - 2 October; Y. Jiang (Telia AB, Sweden) 10-11 April; A. Latour-Henner (Telia AB, Sweden) 23-26 February; D. Litim (Heidelberg) 31 May - 6 June; G. Moore (Rutgers Univ., USA) 25 May; B. Persson (Telia AB, Sweden) 22-24 February; C. Pfister (Lausanne) 9-13 October, 23-25 November, O.

Schnetz (Erlangen) 17-20 July, A.I. Solomon (Open University, UK) 15 March, P. Sutcliffe (Univ. Kent, UK) 5 July, Y. Suhov (Cambridge) 28 March - 3 April, E. Thomas (Groningen) 20-26 November.

## Longer visits:

G.W. Ford (Univ. Michigan, USA) 29 May-3 July, R.F. O'Connell (Baton Rouge, USA) 26 May-14 August, D. O'Connor (Mexico) 14-24 August, E. Pechersky (Moscow) 1-15 May, A. Perelomov (Moscow) 22 March-2 May, V.B. Priezzhev (JINR, Dubna) 19 November-17 December, I. Sachs (Germany) 4-21 September, V. Skrypnik (Keiv, Ukraine) 3 October-3 November, N. Vvedenskaya (Moscow) 27 March - 10 April.

## 9 Publications

## 9.1 Books

E. Buffet, J. Caslin & A. Patrick: *Stochastic Modelling. Monograph, Institute of Actuaries, 2000.*

D. Ó Mathúna: *The Bernoulli Project - historic origins, development of mathematical works and the evolution of the Bernoulli edition. Die Bernoulli-Edition, Basel, 2000.*

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

None published.

## 9.3 Theses

K. Duffy: *Logarithmic asymptotics in queueing theory and risk theory. Ph.D. Thesis. University of Dublin 2000*

W.M.B. Dukes: *Counting and probability in matroid theory. Ph.D. Thesis. University of Dublin 2000*

B. McGurk: *Random sampling and Large Deviations. Ph. D. Thesis. University of Dublin 2000*

## 9.4 Contributions to periodical and other publications

T.C. Dorlas & J.R. Wedagedera: *Rigorous solution of a mean-field spin glass model. J. Appl. Math. & Stoch. An. 13 (2000) 147-160.*

L. O'Raifeartaigh, J.M. Pawłowski & V.V. Sreedhar: On the duality of quantum Liouville field theory. *Intern. J. Mod. Phys. B* **14** (2000) 2401-2409.

F. Freire, D.T. Litim & J.M. Pawłowski: Gauge invariance and background field formalism in the exact renormalisation group. *Phys. Lett. B* **495** (2000) 256-262.

L. O'Raifeartaigh, J.M. Pawłowski & V.V. Sreedhar: The two-exponential Liouville theory and the uniqueness of the three-point function. *Phys. Lett. B* **481** (2000) 436-444.

J. Burzlaff: Statics and dynamics of Abrikosov vortices and of related vortices. *Proc. 31st. Symposium on Theoretical Physics, Torun 1999, Rep. Math. Phys.* **46** (2000) 55-61.

B. Dolan: Duality in the Quantum Hall Effect - the role of electron spin. *Phys. Rev. B* **62** (2000) 10278.

B. Dolan: Derivation of the semi-circle law from the law of corresponding states. *Phys. Rev. B* **62** (2000) 15359.

#### 10 Library

Approximately one hundred and fifty new titles were added to the library stock during the year; one hundred and thirty current periodicals were taken, of which approximately fifty were received by gift or under exchange arrangements. Due to the increased use of bulletin boards for publication of preprints only a few were received by post.

Annual Report of the Governing Board of the School of Cosmic Physics for the year ending 31 December 2000 adopted at its meeting on 31 July 2001.

### 1. Staff, Scholars and Associates

#### Senior Professors:

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

#### Professors:

A. Thompson, D. O'Sullivan, T.P. Ray.

#### Assistant Professors:

P.W. Readman, B.M. O'Reilly (contract basis), I. Elliott (with retrospection to 01 July 98).

#### Research Assistants:

Three vacancies.

#### Experimental Officers:

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

#### Visiting Scientists:

B. Austin (Hydrosearch), D. Bartlett (National Radiological Protection Board (NRPB), UK), P. Basford (Pasmacon), C.J. Bean (Department of Geology, UCD), P. Beck (Austrian Research Center (ARCS), Austria), S. Bennett (Department of Geology, TCD), E. Benton (University of San Francisco, USA), J-F Bottollier (Institute for Nuclear Safety and Protection (IPSN), France), N. Buttmore (Dept of Mathematics, TCD), J. Chamberlain (Phillips Petroleum), M. Critchley (ERA/Maptec), O. Dardis (UCD), C.J. Davis (Joint Astronomy Center, Hawaii), A.L. Densmore (Department of Geology, TCD), V. Dwarkadas (University of Sydney, 17 May - 15 June), J.N. González Pérez (Istituto de Astrofísica de Canarias), Th. de Graauw (SRON, Groningen, NL), C. Jarlskog (CERN, Switzerland), F. Kennedy (CAPTEC, Ireland), T. Lagrange (CERN, Switzerland), L. Lindborg (Swedish Radiation Protection Institute (SSI), Sweden), U. Locatelli (University of Milan), K.-H. Mack (Istituto di Radio Astronomia, Bologna), R. Mundt (Max Planck Institute for Astronomy, Heidelberg), M. Murphy (University of New South Wales, Australia), R. Pasqualli (Department of Geology, TCD), W.E.A. Phillips (Department of Geology, TCD), D. Praeg (UCD), J. Schutte (GFZ Potsdam), C. Solla (Department

of Geology, TCD), L. Tommasino (Agenzia Nazionale per la Protezione dell'Ambiente (ANPA), Italy), U. Schrewe (Physikalisch Technische Bundesanstalt (PTB), Germany), P.M. Shannon (Department of Geology, UCD), M.I. Wilkinson (Institute of Astronomy, Cambridge, UK), I. Woelbern (GFZ Potsdam, 13-23 June), L. Yun (Astronomical Observatory, Lisbon), W. Zeilinger (Institute of Astronomy, Vienna).

#### Technical and Clerical Staff:

A. Byrne, A.M. Callanan, E. Clifton, P. Daly, W. Dumpleton, E. Flood, A. Grace-Casey, C.M. Horan, S. Ledwidge (part-time job-sharing basis from 01 October), L. Quigley, M. Smyth, H. Sullivan, G. Wallace, (two vacancies).

#### Scholars:

M. Carr, O. Carroll (from 01 October), J. Cunniffe, J. Donnelly, G. Fennell (from 01 October to 31 December), J.A. Hodgson, M. Landes (until 31 March), K. McGrane (without stipend), F. McGroarty (from 01 October), L. Norci (from 17 January), A. O'Brien (without stipend, until 30 June), V. Unnithan (without stipend, until 31 March), Z. Zang (until 30 June), D. Zhou.

#### Project Supported Positions:

S. Annibaldi (Turbulent Fusion Plasmas), F. Bacciotti (European Space Agency Fellow, until 30 September), R. Butler (University College Galway, until 28 January), T. Lery (Enterprise Ireland), F. McGroarty (DIAS/Enterprise Ireland, from 01 October), G.D. Mackenzie (RAPIDS III), E. Parizot (TMR Astrophysics Network, until 31 August).

#### Professores Emeriti:

H.A. Brück (to 04 March)\*, T. Kiang, T. Murphy.

#### Research Associates:

C.J. Bean (UCD), D. Corcoran (UL), T. Downes (TCD/DCU), P. Duffy (UCD), A.J. Keane (ITB), R. Keary (GSI), A. Lawrence (Edinburgh), B. McBreen (UCD), J. Makris (Hamburg), P. Morris (British Antarctic Survey), N.P. Murphy (BP), F. Murtagh (QUB), W.E.A. Phillips (TCD), V.F. Polcaro (IAS, Frascati), C. Prodehl (Karlsruhe), P.M. Shannon (UCD), M. Wilkinson (Oxford).

#### Project Students:

E. Doherty (TCD, from 01 October to 31 December).

**Vacation Students:**

C. Heverin (UCD, until 14 April), S.T.F. Jacob (TCD, until 14 April).

\*H.A. Brück died on 04 March 2000.

## 2 Research Activities in the Astrophysics Section

### 2.1 Strange transport in electrostatic drift wave turbulence

*S V Annibaldi and L Drury with G Manfredi (Nancy), K Hopcraft (Nottingham) and R Dendy (Culham)*

The anomalous transport of test particles in the Hasegawa-Mima model of drift wave turbulence was studied numerically. In addition to the electrostatic potential obtained by solving the Hasegawa-Mima equation, other auxiliary fields, in particular the Weiss field which measures the relative importance of shear and vorticity, were used in analysing the particle transport. Trapping vortices and zonal flow patterns similar to those observed in planetary atmospheres were found depending on the parameters used. Finite Larmor radius effects have been included and shown to strongly inhibit transport when the Larmor radius of the test particle is comparable to the size of the dominant structures.

These studies show strongly non-diffusive transport in certain parameter regimes. Some of these characteristics can be reproduced by random walk models with power law fluctuating step numbers. Analytical investigations of such models showed that they can produce power-law tails when the underlying process is isotropic, but that if the walk is biased they give exponential decay except in the bias direction where again there is a power-law tail.

### 2.2 Spherical box models of particle acceleration.

*L Drury and E Parizot*

The so-called "box model" for particle acceleration at shocks, originally developed for planar shocks to allow a simple treatment of such effects as synchrotron losses, has been extended to a time-dependent spherical version suitable for use in discussing particle acceleration in supernova remnants. Remarkably, an approximate analytical integration of the equations is possible. The resulting theory substantially clarifies a number of questions

concerning the shape and position of the upper cut-off to the accelerated particle energy spectrum.

### 2.3 Implosion-explosion duality applied to the laboratory simulation of astrophysical systems.

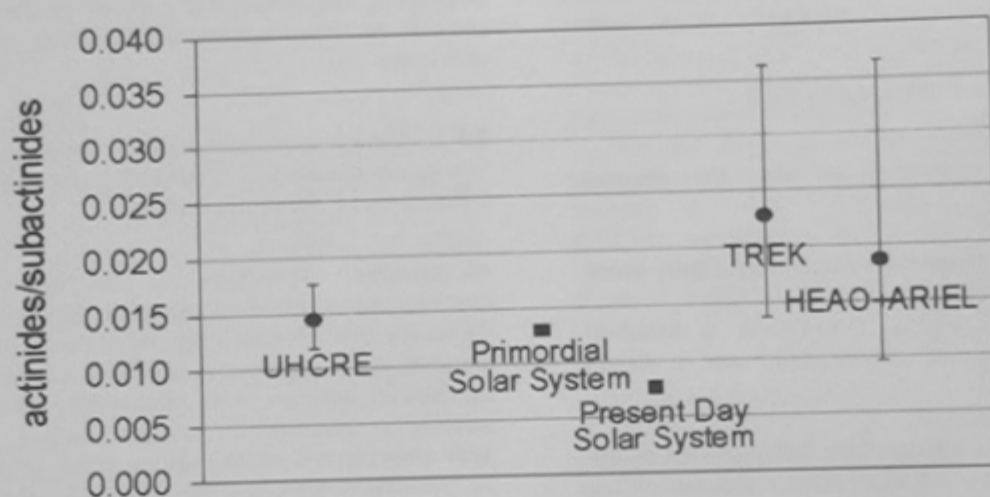
*L Drury with T Mendonca (Lisboa)*

A possible application of the remarkable involutory symmetry of ideal Eulerian gas dynamics (see last year's report) to the laboratory simulation of supernova remnants using laser implosion facilities was discussed. With a suitably constructed static target, and appropriately tailored implosion drive, it should be possible to simulate the interaction of highly structured explosion ejecta hitting an ambient medium. All the purely gas dynamical effects such as instabilities, turbulence and shock formation will be exactly reproduced, including the geometrical effects of spherical divergence, as long as the equation of state can be well approximated by a polytrope of exponent 5/3.

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

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

In the total sample of UHCRE events accumulated to date, the charge assignment error for individual cosmic ray events in the actinide region was estimated to vary from about  $\pm 1.5e$  to about  $\pm 2.5e$ . During the year, a programme was initiated to refine the UHCRE charge spectrum further, especially in the actinide region, with the ultimate objective of measuring the thorium/uranium ratio with sufficient confidence for astrophysical significance. This programme involves the utilisation of further calibration exposures with beams of ultra-heavy ions in detector plates containing cosmic ray actinide events in order to identify possible systematic errors. In particular, it involves the experimental derivation of correction factors for small systematic differences in signal from etch to etch in relevant UHCRE detector plates from the many etches employed during the entire period of UHCRE data extraction. In addition, a general review of the entire UHCRE database was undertaken and areas for verification, further measurement or further analysis were identified. Furthermore, a re-examination of the track response model (the relationship between signal



Observed and derived actinide relative abundances ( $Z > 87$ )/( $73 < Z < 88$ ).  
The UHCRE results are consistent with origin in normal interstellar gas and dust.

strength and ionisation) was pursued. The overall charge resolution is, consequently, expected to improve with a final UHCRE charge spectrum scheduled for the end of 2001. It should be emphasised that the UHCRE database contains the only statistically significant sample of cosmic ray actinides in existence at present.

The current UHCRE value for the relative abundance of cosmic ray actinides, defined as  $(Z \geq 88)/(74 \leq Z \leq 87)$ , is  $0.0144 \pm 0.0031/0.0026$ . This value is consistent with propagated primordial solar system material and hence supports the view that the origin of the cosmic ray material is predominantly normal interstellar gas and dust. During the year, updated UHCRE results for the ultra heavy cosmic ray spectrum were presented at the 33<sup>rd</sup> COSPAR Scientific Assembly and at the 20<sup>th</sup> international Conference on Nuclear Tracks in Solids.

## 2.5 The KLEM Project

A. Thompson and L. Drury with G. Bashindzhagyan et al (Moscow State University), J. Adams (NASA Marshall Space Flight Center), M. Simon (University of Siegen, Germany), A. Chilingarian (Yerevan), N. Egorov et al (Zelenograd, Russia), J. Procureur (CENBG Nuclear Research Center, France) and O. Saavedra (Torino University, Italy)

The basic objective of the KLEM Project is to directly measure the elemental energy spectra of very high energy ( $10^{11}$ – $10^{16}$  eV) cosmic rays using a

large aperture lightweight detector system in Earth orbit. As pointed out in last year's Annual Report, it is not economically feasible to achieve this scientific goal by conventional means (ie using an ionisation calorimeter) because the mass required to be deployed in Earth orbit would be very large (at least 50 tonnes). An alternative approach, using a kinematic technique, is to measure the primary particle energy by determining the angular distribution of secondaries produced in a target layer using silicon microstrip detector technology. An instrument based on this approach (KLEM) has been designed which, due to its light weight, can have a large aperture allowing a dramatically increased exposure factor and enabling the direct measurement of cosmic ray nuclei to be extended up to and through  $10^{16}$  eV. During the year, considerable progress was made in the overall project and in the development of the instrument, with the support of the Russian Space agency (Rosaviacosmos). It is planned to begin construction of a small prototype (KLEM-1,  $0.16\text{m}^2$  collecting area, less than 70kg weight and less than 90W power consumption) in 2001 with launch in 2004. The full scale instrument, with a collecting area of  $4\text{m}^2$  and a three-year exposure with launch currently scheduled for 2008, is expected to identify at least 25 particles with  $E > 10^{16}$  eV.

A significant development, towards the end of the year, was the decision to extend the project to include a low energy cosmic ray instrument,



UHS (Ultra Heavy Isotope Spectrometer), to be inserted in the KLEM target. The UHS device has a modular structure and utilises sets of silicon detectors of various thickness. The scientific objective of UHS is to measure the fluxes of ultra heavy cosmic ray isotopes with  $Z > 30$  and to investigate the composition of Solar and Anomalous cosmic ray components. The plan is to combine the two research programmes (KLEM and UHS) into one (by incorporating the UHS scientific package as part of the KLEM instrumentation) with the common name of NUCLEON. Such integration significantly decreases the total cost of programme accomplishment. The small scale NUCLEON prototype (NUCLEON-1) will thus consist of two parts, the high-energy KLEM-1 device and the low energy UHS-1 instrument, which is mounted in the KLEM-1 target. The NUCLEON Project has been included in the Russian Federal Space Research Programme under "Fundamental Space Investigations".

During the year KLEM presentations were made at the Space Technology and Applications International Forum (STAIF-2000), the American Physical Society April Meeting 2000, the 33<sup>rd</sup> COSPAR Scientific Assembly and the 17<sup>th</sup> European Cosmic Ray Symposium.

#### 2.6 Cosmic Radiation in the Earth's Atmosphere

*D. O'Sullivan, E. Flood and D. Zhou*

Work on finalising data from the IRMA-2 project was continued and analysis was completed for publication by midyear. The DIAS contribution to this work included linear energy transfer measurements and associated radiation doses for the Dublin-New York, Milan-Los Angeles, Milan-Tokyo and Rome-Rio Janeiro subsonic routes, and the London-New York Concorde route. Charge spectra of  $Z \geq 2$  nuclei were also determined on some of these routes. Comparison of data with the FLUKA Monte Carlo code and the LUIIN code were undertaken with the final results. The main achievements of the IRMA-2 project were the measurement of neutron, proton and heavy nuclei spectra at aircraft altitudes and a detailed determination of radiation dose rates as a function of altitude and latitude for subsonic and supersonic air routes during solar minimum.

A proposal (DOSMAX) to continue the work under the EC 5<sup>th</sup> Framework Programme for the

duration of solar minimum period 2000-2003, which was submitted in October 1999, with D. O'Sullivan as European Co-ordinator, was successful and DIAS was informed in February. The proposal was one of only three funded from a total of 37 proposals submitted under the Sources of Natural Radiation Category. Funding of €869,381 was awarded for a 42-month duration starting on 01 July 2000 with a contribution of €198,296 for DIAS. The team includes DIAS, ANPA (Italy), ARCS (Austria), CERN, IPSN (France), NRPB (UK), PTB (Germany) and SSI (Sweden).

Work started immediately with calibration of new detectors at the CERN reference field in July and successful discussions with Aer Lingus, British Airways, Czech and French Airlines, as well as NASA, resulted in a planned programme of exposures for DIAS detectors over the next three years. Special arrangements were made to launch detectors at very short notice during the onset of significant solar activity. In September successful exposures of DIAS detectors to high energy neutrons and protons took place at the Svedberg Laboratory in Uppsala. DIAS detectors were also exposed to heavy ions at the HIMAC accelerator in Japan.

To date preliminary measurements have already been made on a number of routes and calibration is at an advanced stage. Comparison of data with computer code predictions, including the new EPCARD code developed in the IRMA-2 project, is continuing.

#### 2.7 Space Weather

*D. O'Sullivan*

D. O'Sullivan was appointed to the European Space Agency's Working Team on Space Weather in April. Space weather is defined as conditions on the sun and in the solar wind, magnetosphere, ionosphere and thermosphere that can influence space borne and ground based technology and can endanger human life and health. The team's brief is to put forward a case for a European Space Weather Service. At present Europe depends on US and Japan for expertise and data. D. O'Sullivan was appointed Topic Leader for the area of Astronaut and Aircrew safety and his subgroup authored a report which was submitted to ESA in December.

### 2.8 A New Global Model for Outflows from Young Stars

T. Lery and T.P. Ray with A. Frank (Rochester University, New York), R.N. Henriksen (Queen's University, Ontario, Canada), J. Fiege (McLennan Laboratories, University of Toronto) and F. Bacciotti (Arcetri Astrophysical Observatory, Florence)

Powerful, highly collimated jets, surrounded by bipolar molecular outflows, are commonly observed near Young Stellar Objects (YSOs). In the usual theoretical picture of star formation, the jet is ejected from a magnetised accretion disk and the molecular outflow is driven either by the jet or by a wider wind coming from the disk. Lery et al, however, have put forward an alternative global flow model. According to their scenario, in addition to a central accretion-ejection engine driving the jet, in-falling matter that follows a circulation pattern around the central object powers the molecular outflow. The jet does not necessarily entrain this material.

They have reported, for the first time, solutions for the three different parts of this self-similar model, i.e. the jet, the in-falling envelope and the circulating matter that eventually forms the molecular outflow. Observational and physical consequences of this new global self-similar MHD model for flows around YSOs have been presented. Lery et al have shown that the model produces a heated pressure-driven outflow with magneto-centrifugal acceleration and collimation. Without pressure, only deflection can be observed in the circulation model, and there is no gain in velocity of the flow or in energy. On the other hand, when the gas is heated, more energetic outflows can be produced. The presence of the magnetic field and rotation induces anisotropies that help collimation and acceleration.

This new picture of the accretion/outflow phase provides a possible explanation for many observed properties of YSO outflows, the most important being the high mass molecular outflows from massive proto-stars. It also allows us to sketch an evolutionary sequence for the changing environment of a young star. It is suggested that this global model may apply to both low and high mass stars, where circulation and accretion-ejection may be of different relative importance.

### 2.9 Near-Infrared Spectroscopy of Proto-Stars

T.P. Ray with C.J. Davis (Joint Astronomy Center, Hawaii), L Desroches (University of Victoria, Canada) and Colin Aspin (Gemini Science Office, Oxford)

Infrared echelle spectroscopy is a powerful diagnostic of dynamic activity in the immediate vicinity of optically obscure young stars. In particular  $H_2$  and Br  $\gamma$  observations probe the orthogonal processes of outflow and in-fall respectively.

Ray et al have discovered high-velocity  $H_2$  emission lines in the extended lobes of nine outflows and, more importantly, complex  $H_2$  line emission within a few hundred Astronomical Units of their sources. They have compared these "Molecular Hydrogen Emission-Line" regions, or MHELs, to optical Forbidden Emission-Line regions (FELs) observed in classical T Tauri and some Herbig Ae/Be stars. Like the FELs, both low and high-velocity components are observed in  $H_2$ , with blue-shifted velocities of the order of 5-20  $\text{kms}^{-1}$  and 50-150  $\text{kms}^{-1}$  respectively. As in the case of FELs, low velocity components are more common than high velocity components in MHEL regions. Ray et al found high velocity  $H_2$  components were spatially more offset from their exciting sources than corresponding low velocity components, again as is the case of optical FELs. The MHEL regions (which are in all cases blue-shifted) are thought to be associated with the collimation zones of outflows.

Br  $\gamma$  emission was detected towards four of the embedded young stars observed (SVS 13, IRAS 04239+2436, HH 34-IRS and GGD 27(1)) as well as towards the T Tauri star AS 353A. These lines are all broad and symmetric, the line peaks being blue-shifted by about 30  $\text{kms}^{-1}$ . The profiles found are typical of the permitted hydrogen line profiles observed in many T Tauri stars, and probably derive from magneto-sonic accretion flows. No red-shifted absorption features (i.e. inverse P-Cygni profiles) were observed in any of the sources, however. Although predicted by accretion models, no dependence on line width with inclination angle of the system (to the line of sight) was found. Moreover no Br  $\gamma$  was detected in any of the extended flow lobes. Instead, Br  $\gamma$  emission was seen to be confined to the source and to be spatially unresolved along the flow axis.

### 2.10 Hubble Space Telescope Observations of Stellar Jets

*F. Bacciotti and T.P. Ray with R. Mundt (Max Planck Institute for Astronomy, Heidelberg) and J. Eislöffel (Karl Schwarzschild Observatory, Tautenburg)*

Although stellar jets have been recognized as an essential element of the star formation process, the mechanisms regulating their acceleration and initial collimation are not yet fully understood. In order to investigate the "central engines" of young stars with as high an angular resolution as possible ( $<0.1''$ ), a programme of spectroscopic imaging of a small sample of optically visible young stars has been undertaken using the Hubble Space Telescope (HST). The observing phase is now complete (since December) and the data are currently being analysed.

DG Tauri was the initial target for this programme and the spectra obtained were the first optical spectra of a jet from a young star obtained from space. The extraordinary richness of the HST datasets has provided important information on the physics of the acceleration/collimation region close to the source. For example, it has become clear that the flow is denser and more collimated at higher velocities: something that has been suspected on the basis of theory but confirmed for the first time by these observations. Moreover the refined 2-D maps of physical parameters in the initial section of the flow (electron temperature, ionisation fraction, etc) have been derived and analysed. Any viable theory for jet collimation and acceleration must explain such maps.

The HST data shows that the ionisation fraction rises rapidly in the jet close to the star ( $\leq 1''$ ), to reach a plateau and then slowly decreases following a recombination curve. In the same region the temperature falls by a factor 2-3 and the total density drops by one to two orders of magnitude. These results provide strong constraints on any proposed models for the formation of jets from young stars. Partial ionisation appears to be a dominant feature in the beams of such jets, and must be properly taken into account. For example, it may introduce important differences in the modelling of magnetized jets, due to collisions between charged particles and neutrals. Several theoretical groups are currently investigating how partial ionisation affects a jet. In addition the observations indicate that the gas is in a non-equilibrium ionisation state and that the

ionisation appears to be produced at the very beginning of the jet by an unknown mechanism. Thereafter it decouples from the thermal conditions, probably as a consequence of rapid expansion. Several possible mechanisms to generate the partial ionisation at the base of the flow are currently being investigated including oblique shocks, turbulent boundary layers, and heating by ambipolar diffusion. This last mechanism has been analysed in detail in collaboration with D. Galli and C. Chiuderi of the Arcetri Astrophysical Observatory (Florence).

Another very important result derived from analysing the Hubble spectra is the first tentative evidence for rotation in an outflow close to a star. Rotation is of fundamental importance in the modelling of jets and in understanding the interplay between accretion and ejection of matter in their generation. Canonical models, in fact, invoke the simultaneous action of magnetic and centrifugal forces in a rotating star/disk system threaded by open magnetic field lines (this is the so-called "magneto-centrifugal" acceleration mechanism). The Hubble data indicate azimuthal flows speeds, in the case of DG Tauri, of around 8  $\text{kms}^{-1}$  at distances of 30-40 AU from the central outflow axis. Such a result is consistent with magneto-hydrodynamic disk wind models.

### 3 Research Activities in the Geophysics Section

#### 3.1 LEGS (LEinster Granite Seismics)

*J.A. Hodgson, P.W. Readman and B.M. O'Reilly with P.S. Kennan (UCD)*

The Leinster Granite is one of the largest Caledonian batholiths in Europe. This project is attempting to define the geometry of the granite, which is an important factor in an understanding of its origin and emplacement mechanism. During this year detailed modelling and interpretation of the seismic data collected during the experiment performed in 1999, as well as some gravity modelling of existing DIAS gravity data, was undertaken. The emphasis has been on modelling the entire crustal and upper mantle structure and the relationship this has to the structure of the granite. Detailed inversion of the seismic data revealed that the granite has a layered, or sheeted, type of structure extending to a maximum depth of five kilometres. This is somewhat less than had previously been thought. A sub-surface extension to the southwest was

found, consistent with the observed Bouguer anomaly in the area. These results have provided the first detailed information on the wide-angle seismic response of granites within the Caledonian orogenic belt. When combined with additional information available on the structural geology and geochemistry of the granite they will provide a greater understanding of how such large bodies are developed and emplaced, and how their formation is linked to the development of large-scale orogenic belts.

The long length of the seismic lines, in particular the one running roughly along the axis of the granite, together with the large number of seismic records obtained from the experiment has allowed the structure of the lower crust and upper mantle to be modelled in considerable detail over much of the length of the axial line. The crustal thickness averages about 30 km, similar to that found in our previous experiments elsewhere onshore Ireland, and in Britain. One notable feature is a significant thinning of the crust to about a thickness of 28 km beneath the main granite body. The origin of this feature is not understood at this stage but it is clearly spatially related to the presence of thickened granite. Within the mid-crust a series of inclined features are interpreted as evidence of deep-seated faults. Further gravity modelling is planned and should further constrain the structural models so far developed. The graduate student working on the project, James Hodgson, has started writing his Ph.D. thesis and expects to finish next year.

### 3.2 Gravity (Investigation of onshore sediment transport routes)

*P.W. Readman and B.M. O'Reilly with colleagues from TCD*

This project, lead by A. Phillips (Geology Department, TCD), to trace the path of possible Tertiary river channels across Ireland continued during the year. The research assistant employed in TCD has compiled what eventually has turned out to be a very extensive catalogue of existing bore-hole data for the Irish Midlands. This has been fully integrated into a GIS system together with other types of data, in particular the DIAS gravity data. Interpretation of this combined dataset has taken place during the year and is continuing. The new gravity data collected in 1999 has been processed and integrated with our existing data and used to help locate the possible

channels. Further work, including some exploratory drilling and more gravity work is planned.

### 3.3 VARNET (VARiscan NETwork)

*A.W.B. Jacob, M. Landes, B.M. O'Reilly and P.W. Readman with colleagues from UCD and University of Karlsruhe*

The main effort during the year was in 3-D modelling of the seismic data collected during this project, augmented by 3-D modelling of the gravity data. New 3-D seismic processing software developed by John Hole at USGS, Menlo Park, was tested and implemented, and a 3-D gravity modelling programme was modified to run in DIAS. Although the VARNET experiment was not designed as a 3-D experiment, the large number of shots and the resulting 'fan'-shot geometry provides sufficient ray coverage for semi-quantitative 3-D seismic modelling to be attempted for the region to the south of the Shannon Estuary and for its feasibility to be assessed. The results have shown there to be a significant degree of lateral inhomogeneity over the region. Two high velocity zones of 6.4-6.6 km s<sup>-1</sup> were found beneath Dingle Bay and the Kenmare River. These may be associated with major east-west trending Variscan features. The origin of another high velocity zone dominating the Munster Basin is however less certain, although its existence is at least partially confirmed by the 3-D gravity work. The Killarney-Mallow Fault Zone was seen to have a 20 km band of rather uniform velocities of about 6.1 km s<sup>-1</sup> associated with it. The Moho surface was modelled on the basis of PmP reflections and found to rise from about 32 km under the Shannon Estuary to around 27-28 km towards the coast. Significant correlations exist with magnetotelluric measurements in the area undertaken by the Applied Geophysics Unit at UCG as part of this project.

### 3.4 AIRS (Atlantic Irish Rockall Survey)

*K. McGrane, P.W. Readman and A.W.B. Jacob with V. Unnitham and P.M. Shannon (UCD)*

The AIRS project formally finished in September 1999 although some interpretation of the GLORIA (Geologic Longe Range Inclined ASDIC) sidescan data has continued since then. In addition, analysis of marine gravity data was carried out using traditional potential field and 2-D and 2.5-D

modelling techniques, and an assessment of the Euler deconvolution technique was undertaken for two profiles for which there are existing seismic models from the earlier RAPIDS II project. The results indicated that a major NW-SE trending lineament within the Rockall Basin reflects pronounced variations in crustal structure and sedimentary thickness. These thickness variations are interpreted as the effects of cross-basin faulting along a fault zone defined by the lineament. Transverse gravity lineaments to the north of this feature are also interpreted as major cross-basin fault zones.

The final report for the project was completed, along with a GLORIA processing manual and quick guide. A Marine Resource Series publication was also prepared for the Marine Institute

### 3.5 TRIM (TOBI Rockall Irish Margins)

*P.W. Readman, B.M. O'Reilly and A.W.B. Jacob with P.M. Shannon (UCD)*

The interpretation of the TRIM deep-tow (TOBI - Towed Ocean Bottom Instrument) sidescan data was refined during the year and final versions of the interpretation maps were completed and digitised. Detailed testing of the interpretation of the data was undertaken using the large gravity corer dataset released to the investigators by members of the Rockall Studies Group. The data from 330 individual core samples were examined, classified in detail and correlated with the interpretation based on the TOBI sidescan acoustic response and the 3.5 kHz profiler data. This confirmed both detailed and regional aspects of the interpretation and broadened our understanding of slope processes along the margins of the Rockall Trough. In addition, an assessment of slope failure hazards in the area was undertaken using these results and a knowledge of the seismic hazards west of Ireland based on our seismic network (see later).

Sonar backscatter and the character of the 3.5 kHz profiler data change systematically along the eastern margin. This variation is due to changes in sedimentological facies which reflect variations in glacially controlled mass wastage processes. Glacial influences are overwhelming in the north where a large glacio-marine sedimentary wedge is developed. Canyons are conspicuously absent and slope gradients are lowest along this part of the continental margin, while further south they are more common where the margin becomes

progressively starved of sediments. The change in morphology of the canyon systems to the south may reflect an older age for their inception. Large-scale submarine fan complexes are also developed which are probably comprised of stacked Pleistocene sediment sequences related to the advance and retreat of glaciers across the continental slope. Along the southernmost part of the margin where an extensive region of rock outcrop is present, the sediment input is lowest and the margin is most starved.

Some preliminary work in correlating the sidescan data with deeply penetrating, but lower resolution, seismic profiling data from selected regions of the Rockall Basin was undertaken with other members of the Rockall Studies Group. The results of these preliminary studies are encouraging and indicate that this type of approach could produce valuable information on the Cenozoic development of the basin and the geological history of slope-failure processes in such a deep-water basin.

The very high resolution of the sidescan data allowed specific aspects of oceanographic processes to be focussed upon. In particular, a detailed study of a carbonate mound population on the northwest shoulder of the Porcupine Bank was carried out. An analytical model for the growth of the population which incorporated biological and current flow processes was developed. This model was shown to predict the frequency distribution of mound sizes and elongations for the entire population of about 140 mounds. It also allows an age structure for the mound population to be determined, but this has yet to be rigorously tested with independent data.

It is expected that future work will involve similar more focussed studies which emphasise specific features and processes that have been identified from the sidescan investigation. This future work may involve collaboration with researchers working in related fields, and will be based on other types of oceanographic and geophysical data.

### 3.6 RAPIDS III (Rockall and Porcupine Irish Deep Seismics)

*A.W.B. Jacob and G.D. Mackenzie with P.M. Shannon (UCD) and colleagues from the University of Hamburg*

In early 1999, the RAPIDS 3 project acquired four wide-angle reflection/refraction seismic profiles

within the Irish sector of the Rockall Trough. The aim of the project is to provide a constraint on crustal and sedimentary geometries in the region and to improve the understanding of the tectonic evolution of the Irish continental margin. The project is funded as part of the Petroleum Infrastructure Programme (PIP) sponsored by a consortium of oil companies, the Rockall Studies Group (RSG).

Throughout the year (2000), data processing and 2-D travel-time modelling has continued on all four profiles with initial results being presented at two international conferences. One week was spent in Hamburg in June re-processing some of the data at GeoPro GmbH. Preliminary P wave velocity models have been completed for the sedimentary succession on three of the four profiles while preliminary whole crustal models were completed on two of the profiles. Typically a sedimentary succession of 4-5 km thick is modelled consisting of three main seismic packages (each containing a number of local units). These are generally flat lying in the centre of the Rockall Basin pinching out to the basin margins where significant structural complexities are observed. The sedimentary succession is thought to be of Late Palaeozoic to Recent age. A crust, approximately 30 km thick, consisting of three layers, and similar to that observed beneath Ireland, is modelled beneath the Porcupine and Rockall Highs. This thins considerably beneath the centre of the basin where the Moho is observed at about 12 - 15 km depth. Beneath the Rockall trough the crust appears to consist of one, or at maximum two, layers.

### 3.7 Teleseismic Study of the Hawaiian Plume

*A.W.B. Jacob, G. Wallace, C. Horan, L. Quigley and T.A. Blake with R. Kind and Ingo Woelbern from GFZ Potsdam and colleagues in the University of Hawaii*

Although geochemical and gravity measurements indicate the existence of a vigorous mantle plume beneath Hawaii, there is a lack of direct seismic evidence which would enable the modelling of the physics of the plume to be undertaken. The current project aims to do this and good progress has been made with data gathered in the first nine months of the deployment. What appears to be present is a relatively narrow but hot plume. The upper part of the plume is now better defined and the shallow (about 130 km below the surface)

low-velocity zone under Hawaii itself is being modelled in greater detail. It has been found to extend further to the southwest than an earlier study had indicated.

In June we sadly learnt of the death in a swimming accident of one of the station minders, Stanley Bucacas. Mr. Bucacas was a science teacher at Kekaha Elementary School on Kauai, and now Jim Denny has kindly agreed to take over the station at Kekaha. During October routine maintenance on the seismic recording stations in Hawaii was carried out and the station at Hana was closed down. In November, Ellen McNulty replaced Georgiana Young and she now arranges the collection of disks in Hawaii for shipment to Dublin. An information pack consisting of a booklet and CDROM explaining the project was prepared and distributed to all the station minders (landowners/teachers). This included background information, some sample waveform data of events recorded by the Hawaii stations, and software to view the events. The project has now been extended and is planned to run until the end of April 2001.

Work on refining and streamlining the data processing and archiving procedures necessary to cope with the large volumes of data that this project generates continued during the year. Direct data download from the USGS data loggers on the Big Island of Hawaii was started, with assistance from J. Luetgart of the USGS, of data recorded at the Hawaiian recording sites KHU, UXL and STC. All data from the project is currently archived on DLT magnetic tape in duplicate and stored in different locations for security reasons.

### 3.8 The Seismic Network (DNET, ENET, DSB and VAL)

*A.W.B. Jacob, T.A. Blake, G. Wallace, C. Horan and L. Quigley*

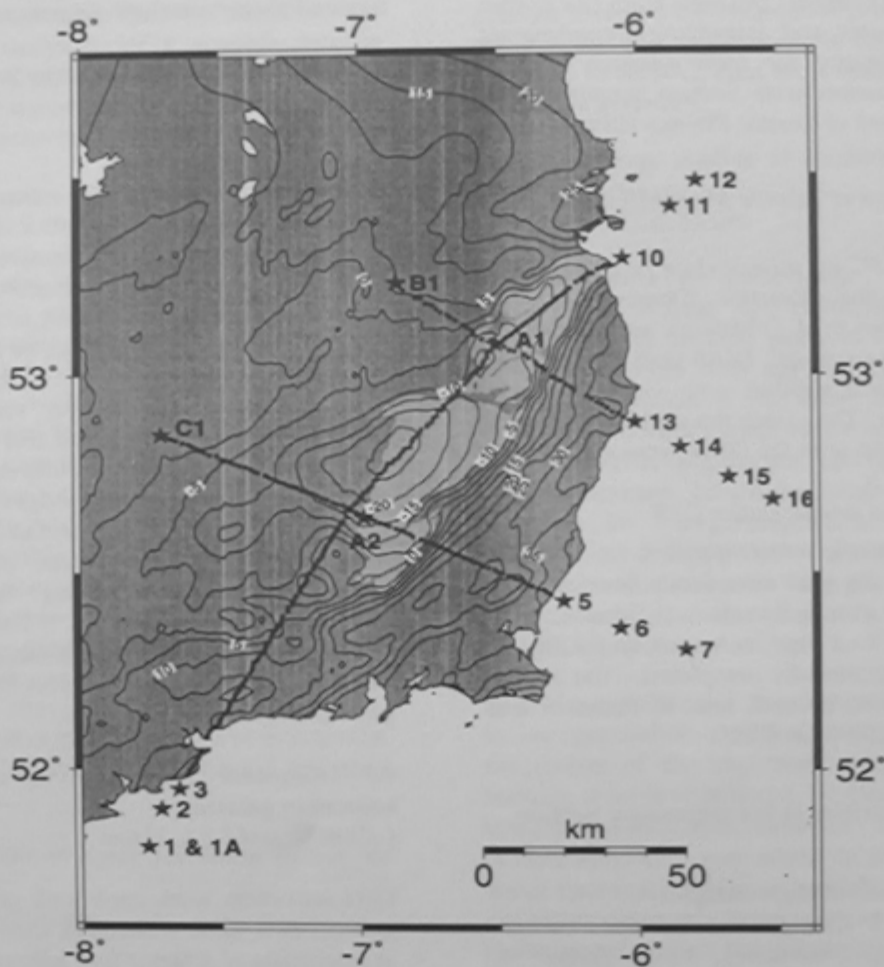
In April the seismometers and amp-mods were removed from the pits at the ECP (Carnsore Point) and ECB (Carrickbyrne) stations. It is planned to install a digital recording station at ETA (Tara Hill). Bob Miller, who had taken care of the seismic station at Carnsore Point since ENET was established in the late seventies, died on 06 July.

*Recorded events*

Two onshore events occurred in Ireland during the year but there were no felt reports for either of them. The first event was near Midleton, Co. Cork on 18 May and the second occurred near New Ross, Co. Wexford on 19 October. There were events in the Irish Sea on 17 February, 20 May, 29 September and 09 October. On 11 September an event was recorded in the Rockall

+V. No damage or injuries were reported. A number of smaller events ( $< 2.8 M_L$ ) occurred in Scotland and Wales. The North Sea / Norwegian Coast area was active with events in February ( $3.3 M_L$ ), May ( $3.6 M_L$ ), August ( $4.5 M_L$ ), October ( $3.9 M_L$ ) and December ( $4.2 M_L$  and  $4.6 M_L$ ).

There were a number of significant earthquakes during the year. Perhaps the most destructive,



Location of the LEGS seismic lines. Bouguer anomaly contours and the granite outcrop (lighter shading) also shown.

Trough with a magnitude  $2.7 M_L$ .

The largest onshore event in the UK occurred in Warwick, Warwickshire on 23 September, and had a magnitude of  $4.2 M_L$  and a felt intensity of

resulting in many casualties occurred in Southern Sumatera, Indonesia on 04 June. Having a magnitude of  $8.0 M_s$ , at least 103 people were killed and over 2000 were injured. The other large events which were felt in the epicentral

areas occurred in Sulawesi, Indonesia, 04 May, 7.5 Ms; N. Ankara, Turkey, 06 June, 6.1 Ms; Iceland, 17 and 21 June, both 6.6 Ms; Sakhalin Islands, Russia, 04 August, 7.1 Ms; W. Honshu, Japan, 06 October, 6.8 Ms; Caspian Sea, 25 November, 6.3 Ms and 06 December, 7.2 Mw.

Requests for general information on earthquakes, volcanoes etc. were received from schoolchildren. There were more specific requests from engineers (both private and public sector) and students from 3rd level colleges. Students from DIT Bolton Street (Computer and Surveying Departments) obtained assistance for their research projects through discussion with Section members and use of the School of Cosmic Physics library.

#### *Broadband station at Valentia Meteorological Observatory*

In February a PC for seismic data processing was installed at the Valentia Observatory and instruction given to M. O'Mahony and T. Sullivan in the use of the system. DIAS staff continued to provide technical support with visits in March and September. Data from the station at Valentia is being archived with the DIAS network data.

#### *Broadband digital seismic station DSB*

Major repair work was completed on the DSB station during the year after faults developed on several of the circuit boards. J. Schutte, from Potsdam spent four days in August on the repairs which were successfully completed. The station data continues to be both sent to Potsdam and archived on CDROM in DIAS.

### 4 Research Activities in the astronomy Section

#### 4.1 IRAS galaxies at high energies

*E.J.A. Meurs, J. Cunniffe and L. Norci with A. Antonelli (Rome Observatory, Monte Porzio), K. Koyama and H. Awaki (Kyoto)*

Spectral analyses covering the 1–10 keV (X-ray) region of the electromagnetic spectrum can in many instances establish the relative importance of two components that often contribute to the total X-ray output of galaxies: stellar evolution products and hidden active nuclei. These components are particularly relevant to be investigated for so-called IRAS galaxies, in which strong starformation takes place. The spectral analyses for a selection of IRAS galaxies have

been progressing during the year, using data from the ASCA and SAX satellite observatories. The detailed investigation of one particular IRAS galaxy (NGC 3147) was continued. Three separate observations obtained with the ROSAT satellite High Resolution Imager were aligned and superposed in order to achieve better signal-to-noise and the data from the ROSAT and SAX satellites were checked for any temporal variability. The earlier conclusion that most of the X-ray emission from this galaxy is to be ascribed to starburst activity remains unchanged.

#### 4.2 Searching for active cores in Local Group galaxies

*Z. Zang and E.J.A. Meurs*

Several points regarding the extensive search for high-energy signatures of active central cores in the closest galaxies were finalized. The idea behind this project is that in members of the Local Group of galaxies immediately around the Milky Way any such active cores can be revealed down to lower luminosities than can be reached for galaxies farther away. Our survey of Local Group members has indicated that only in four of the largest systems in the Group signs of nuclear activity can be found, judged from X-ray observations; these four are candidate massive Black Holes. For one of these, the Andromeda Nebula satellite M32, a new high-resolution X-ray observation was examined. The same X-ray source extension could be established for M32 that had enabled us to interpret this source as a possible weakly active nucleus.

#### 4.3 Long-term variability of nuclear X-ray sources in galaxies

*J. Cunniffe and E.J.A. Meurs*

Data reduction work continued on the elliptical galaxy NCG 4552, which had shown an increase in brightness of a factor five followed by a decay back to its previous level in Hubble Space Telescope ultra-violet data, during the ROSAT PSPC observation period June 1990 – October 1994. This may have been the result of the disruption of a star on a close flyby of the galactic nucleus. The stellar debris is expected to fuel a central massive Black Hole, which would notably lead to an increase of X-ray emission due to a short-term accretion disk being formed and high-energy radiation being visible for this duration. After analysis of data from the ROSAT satellite, this work has now been extended to cover also



available data from the ASCA, EXOSAT and Einstein satellites. A particular effort has been put into separating a possibly variable unresolved component in the nucleus from a non-varying extended component associated with the body of the galaxy. Indications for a mild variability of the central component have been found.

A broad-based search for other such stellar disruption events has started as an automated archival research project. Data from the ROSAT, EXOSAT, Einstein and ASCA satellites are retrieved and analysed for a sizeable sample comprising the brightest galaxies (to magnitude 13). The central region of the programme galaxies naturally constitutes the focus of interest.

#### 4.4 Opposite quasars

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

Quasars are among the most luminous objects in the Universe that can be seen till the greatest observable distances. They constitute therefore valuable cosmological probes. One cosmological theory dealing with a multiply connecting Universe suggests that distant objects may be visible in two approximately opposite direction on the sky. Since one case of such an opposite pair of quasars had been mentioned in the literature as possible support for this theoretical hypothesis, a more general search for opposite pairs of quasars was undertaken. Using existing catalogues of quasars, 52 candidate pairs emerged. These can be used for example for a study of their spectra, to look for any special spectral feature that both objects have in common and that would increase the likelihood that they belong together.

#### 4.5 Interpretation of X-ray Hardness Ratios for galaxies

*M. Carr and E.J.A. Meurs*

For many sources detected with the ROSAT PSPC (Position Sensitive Proportional Counter) there are not enough counts to make reliable spectra (minimum of around 1000 counts required). As an alternative to spectra one may calculate two hardness ratios (HRs), defined as ratios of photons in selected softer and harder bands of the spectra. Unfortunately it is not possible to calculate directly from these hardness ratios the amount of line-of-sight absorbing material ( $N_H$ ), which is a quantity of interest when studying the Large-Scale distribution of galaxies in the Universe. As a tool for obtaining the quantity of

$N_H$  from Hardness Ratio plots, spectra are modelled for galaxies (assuming power law spectra) with a range of values of absorbing material  $N_H$  and photon index  $\gamma$ . These simulations yield a well defined grid of points for  $N_H$  and  $\gamma$  values for a diagram of HR1 versus HR2. HRs calculated from observations can then be compared with the grid of HRs to determine, or set limits on, the amount of  $N_H$  present. This grid is being applied to data from the near and far side of Voids in the Large Scale structure of galaxies to search for evidence of processed gas in the Voids. This application is currently being extended to ROSAT data on a basic selection of galaxies in general.

#### 4.6 High-energy studies of starforming regions in extragalactic context

*L. Norci and E.J.A. Meurs*

Many types of starforming regions are encountered among the extragalactic objects. Recently it has become possible to study such regions at X-rays 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 interpreting such data is the development of a population synthesis computer programme that monitors the X-ray active phases for each individual star (and each binary) while the stellar population evolves.

Several computational improvements were made to the population synthesis programme. The description of the important evolved stages of massive stars was updated by incorporating the latest stellar evolution scenarios. The simulation of binary systems was added to the programme and a start was made with including their special evolution histories. Tests have been run on the stellar population of the giant starforming region 30 Doradus in the Large Magellanic Cloud, using published observational data; various possible conditions for the starforming process were established.

#### 4.7 The Einstein EMSS galaxy clusters

*L. Norci and E.J.A. Meurs 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. This allows sensible measurements of the source extension and 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.

The catalogue of the EMSS clusters has been updated including recent literature and the determinations of source morphology, energy flux and luminosity as well as spectral Hardness Ratios have been adjusted accordingly. An extensive literature search was carried out in order to check for any apparent source components that could be due to foreground or background objects.

#### 4.8 Studies of WO stars

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

Among the massive stars, the Wolf-Rayet stars represent an advanced stage of evolution, generally believed to be descending from the luminous and massive O stars. Notable emission lines signifying the atomic elements N, C or O have led to subtypes WN, WC and WO. The prevalence of these spectral emission lines is connected with the production of these elements by nucleosynthesis in the stellar interiors. Generally these stars exhibit very strong winds from their surfaces and experience correspondingly high mass loss.

On-going work on the spectral classification of WC and WO stars focussed on the contribution of the element helium (He) to one specific spectral feature. The blend at 465 nm consists of lines of CIII and CIV, with an additional He line that increases in strength over the WC and WO spectral classes, as the stellar temperature increases. Together with line width data the observed behaviour can be related to different height layers in the stellar winds from these stars where the emission lines are formed. Other aspects of the spectral classification of WC and WO stars that were investigated refer to the

influence of binarity and of metallicity of the stellar population in which they occur.

The likely X-ray emitting system BD+37° -1160/4U -0515+38 was examined with X-ray data from the EXOSAT and ROSAT satellites. The EXOSAT data yield a detection that provides a much smaller error box than the original data for this source from the Uhuru satellite and confirm the star BD+37° -1160 as optical counterpart. As optical spectra indicate, this is a new Be/X-ray system. The ROSAT data do not give a detection, confirming the transient nature of the source. The X-rays would be emitted when a companion Neutron Star (or possibly White Dwarf) passes in its orbit close to the optical star and interacts with circumstellar material (disk, shell, wind).

Another example of an advanced evolutionary stage of a massive star was studied with the variable star BC Cygni. This is a red supergiant, a class of stars about which relatively little is known. The red supergiants represent a crucial stage in the evolution of massive stars preceding the Wolf-Rayet and Supernova phases, according to the most recent stellar models experienced by stars with initial masses between 10 and 40 solar masses. For masses below 20 solar masses the stars end up as type II Supernovae; above this mass will end their lives as type Ib/Ic Supernovae, after passing through a Wolf-Rayet phase. A start was made with examining the group's optical spectra of this star, in order to look for evidence of so-called s-elements as recently had been discovered in another star of this type. The s-elements are products of nuclear reactions by which neutrons are added to atomic nuclei. With spectra available for another couple of red supergiants, an interesting comparison can be made in one of these cases with a similar type object that occurs in a substantially older cluster of stars and accordingly probably is an object of smaller mass.

#### 4.9 The origin of runaway stars

*E.J.A. Meurs, G. Fennell and L. Norci*

Some of the young massive stars appear to have left their places of birth at great speed, as "runaway" stars. This may have been caused either by being part of a binary system of which one member exploded as Supernova or by strong gravitational interactions with other massive stars

during an early stage shortly after their birth when they were very close together. If they are post-Supernova binaries, then the expectation is that they are accompanied in many cases by the Neutron Star that was formed at the explosion. Analysis of high-energy data, which should reveal the presence of such condensed companions, has been extended to include a complete coverage of known runaway stars for which ROSAT data are available. Also for this enlarged sample, no evidence is found for the anticipated X-ray sources corresponding to Neutron Stars. Whether this implies that gravitational ejection from dense stellar groups is the more likely mechanism for producing the runaway stars or that other factors are of influence (for example more frequent break-up of binaries during Supernova explosion than currently assumed) is not yet clear at this moment.

#### 4.10 Optical Monitoring Camera for INTEGRAL (the INTERNATIONAL Gamma-Ray Astrophysical Laboratory)

*B.D. Jordan, M. Smyth and E.J.A. Meurs with B. McBreen (UCD) and F. Quilligan (UCD)*

The Electrical Ground Support Equipment (EGSE) for the Optical Monitoring Camera (OMC) onboard the ESA INTEGRAL satellite was returned to Dublin from Madrid to carry out modifications to the "house-keeping" system. The modifications included a monitor for four extra thermistor probes installed in the OMC telescope sunshield. This work involved redesigning and replacing the current sources for all of the temperature probes. A 500 Watt D.C. power supply was provided to power the focal plane and baffle heater elements and instrument cover independently of the spacecraft power supply during tests of the Qualification and Flight models.

A cable "break-out box" was built at Dunsink to facilitate external monitoring of voltage and current characteristics for each signal and supply line to the Focal Plane Assembly. The break-out box includes special connectors and a high-speed digital oscilloscope to enable the detection and recording of electrical glitches and "out of spec" signal levels. The completed equipment was delivered to INTA, Madrid, in October and integrated with the imaging Electrical Ground Support Equipment. After inspection and acceptance tests the equipment was reinstalled in

the INTA clean room laboratory and was used for the acceptance tests of the OMC Qualification and Flight models.

A revised edition of the full documentation set for the CCD, the Focal Plane Assembly, the imaging EGSE and the house-keeping EGSE was prepared and submitted to the INTEGRAL documentation library.

## 5 Facilities

### 5.1 Computers and Network

**Astronomy Section** An underground fibre optic cable was laid between Dunsink House and the Observatory main building. The cable is terminated in an eight port Ethernet hub to provide access to the Dunsink LAN for the computers installed in the main building. A colour ink jet printer and scanner were installed in the Dunsink computer room and are available for general use. The LAN server, Ethernet switch, UPS and modems have been mounted in an equipment rack and relocated to a "server room" on the ground floor of Dunsink House. Major damage to the LAN and the telephone system occurred during a thunderstorm in May. The Ethernet switch, modems and several Ethernet interface cards had to be replaced. Extensive repairs to the telephone system were carried out. New lightning barriers have been fitted to the external telephone and modem lines.

### Astrophysics Section and Geophysics Section

The radio link to HEAnet continued to give very reliable service throughout the year. Internally, as described last year, it is clear that the network needs upgrading. Surveys were carried out and estimates obtained in preparation for a switch from old coaxial to modern UTP cabling throughout number 5 Merrion Square; this was then included as a capital item in the estimates submitted for 2001.

The existing stock of PCs and workstations was maintained and slightly expanded during the year. This involved the routine replacement of failing monitors, power supplies and fans as required as well as the installation of two new 73GB discs to provide additional storage capacity and replace old discs which were showing sporadic errors. A high capacity HP4500 laser colour printer was installed as the main colour

printer for A4 output. In addition two new laptops, a LCD projector and a high-end graphics workstation (a SGI Octane2) were purchased.

The major event of the year was the construction of a new Beowulf cluster with 32 processors housed in 16 dualprocessor rack-mounted machines. Tests revealed that performance under the FreeBSD operating system was about 10% better than under Linux or Solaris and that peak performance was 10GFlops making it the fastest research system routinely available in Ireland. The system was officially switched on by the Minister for Science and Technology, Noel Treacy TD, as part of national science week. The old Beowulf cluster machines were reused, partially as a development and testing system, and partially as emergency replacements for servers in administration and Dunsink.

On the software side there were numerous upgrades to standard packages, including major upgrades to GCC and LaTeX. The astronomical package AIPS++ was installed for a summer student. Security continues to be a major area of concern; all supported OSs required security patches during the year. The new Windows 2000 operating system was installed on one PC. First impressions were generally favourable, but problems were experienced with the driver software for a HP scanner and with the Netscape web browser. A solution to the scanner problem was eventually found and posted on the net.

## 5.2 Nuclear Track Equipment

Comprehensive solid state nuclear track detector (SSNTD) preparation and etching facilities were maintained throughout the year in Track Lab #3. These facilities were optimised to the requirements of the final stages of the LDEF/UHCRE programme and for the continuation of the IRMA work. During April, an uninterruptible power supply (UPS) was installed in Track Lab #3 to protect critical operations in the event of power outages. The equipment selected was an APC (American Power Conversion) Smart-UPS XL type SU2200XLINET unit with two additional battery packs, type UXBP48, to provide extended-run power protection. During a mission critical etching application (typically running over five days) the etch tank monitoring computer plus agitation motor plus temperature control system consume a total of 735 watts and the UPS equipment can provide this power for more than ten hours. The

effectiveness of this UPS system since installation has been excellent.

Etching equipment was maintained and serviced as necessary during the year. A new pumping system for sodium hydroxide solutions was installed. Replacement sub-systems or components for Etch Tank #1 included a new contact-thermometer unit and new agitation drive mechanisms. The high precision temperature control system was refurbished. Temperature stability continued to be better than  $\pm 0.005^\circ\text{C}$ .

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, the fine focus displacement mechanism on one of the Leitz-ASL stations in Track Lab #2 was reconditioned and the upper optical components of another Leitz-ASL station were refurbished. In addition, a Nikon stereo scanning microscope system in Track Lab #2 was completely overhauled.

## 5.3 La Palma Observatory

### 5.3.1 La Palma Advisory Committee (LPAC)

No meetings of the La Palma Advisory Committee (LPAC) were held during the year.

### 5.3.2 Observing runs in 2000

No observing runs (PATT or otherwise) were supported financially during the year.

## 6 Seminars, Colloquia, Lectures

### 6.1 Statutory Public Lecture

M.A. Khan (Department of Geology, University of Leicester) delivered the Annual Statutory Public Lecture for the School of Cosmic Physics. The lecture was entitled *Rift Valleys - Do they fall, or are they pushed?* and took place at Trinity College Dublin (Ussher Theatre, Arts Block) on 15 November. Following the example set last year, this lecture was included in the programme for the National Science Week.

### 6.2 Seminars and Open Lectures in the School

C. Davis (Joint Astronomy Center, Hilo, Hawaii): *Serpens - the Big Picture. Wide-Field Observations of Star Formation in a Dark Cloud*, 13 January.

V. Dwarkadas (University of Sydney): *The Evolution of Supernova Remnants in Circumstellar Wind-blown Bubbles*, 30 May.

J.N. González Pérez (Instituto de Astrofísica de Canarias): *The Canary Island Blazar Monitoring Program: Variability Characteristics of OJ287*, 31 October.

T. Lery (DIAS): *Infall-Accretion-Ejection, how do they coexist during star formation?*, 02 November.

K-H. Mack (IRA Bologna): *Aspects of source evolution studies: Selected examples of recent results and on-going work on large extragalactic surveys*, 16 October.

M. Murphy (University of New South Wales, Australia): *Does the fine structure constant vary in spacetime?*, 21 March.

L. Norci (Dunsink Observatory, DIAS): *The EMSS clusters in the ROSAT All Sky Survey*, 21 November.

M. Wilkinson (IoA, Cambridge): *The masses of the dark halos of the Milky Way and Andromeda Galaxies*, 13 April.

W. Zeilinger (Institute of Astronomy, Vienna): *Physical properties of barred galaxies: the kinematical behaviour of multi-component systems*, 25 January. In the series of informal internal seminars at Dunsink Observatory, the following talk was scheduled during the year:

G. Fennell (TCD), *An X-ray examination of runaway stars*, 12 July

### 6.3 Presentations to Scientific Meetings

S V Annibaldi: *Non-Gaussian Transport in Strong Plasma Turbulence* (poster paper), International Workshop "Chaotic Transport and Complexity", Carry le Rouet, France, 26-30 June.

T.A. Blake: *DIAS regional seismic network: Patterns of seismicity*, Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February.

J. Donnelly: *The Relative Abundance of Actinides in the Cosmic Radiation*, The 33<sup>rd</sup> COSPAR Scientific Assembly, Warsaw, Poland, 16-23 July; *The cosmic ray actinide charge spectrum derived from a 10m<sup>2</sup> array of solid state nuclear track detectors in earth*

*orbit*, The 20<sup>th</sup> International Conference on Nuclear Tracks in Solids, Portoroz, Slovenia, 28 August - 01 September.

L Drury: Invited talk, *Diffusive shock acceleration in SNRs*, Gamma-2000 International Symposium on High Energy Gamma-Ray Astronomy, Heidelberg, Germany, 26-30 June; Two lectures, *Particle acceleration in astrophysics and Cosmic Rays in the Galaxy*, NATO Advanced Study Institute, Predeal, Romania, 27 August - 03 September.

J.A. Hodgson: *Geophysical modelling of the Leinster Granite*, Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February; *Results of a wide-angle study of the Leinster Granite*, Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February; *A wide-angle study of SE Ireland and the structure of the Leinster Granite*, American Geophysical Union 2000 Fall Meeting (FM2000), San Francisco, 15-19 December.

A.W.B. Jacob: *A detailed receiver function study of the Hawaiian Plume conduit*, American Geophysical 2000 Fall Meeting (FM2000), San Francisco, 15-19 December.

M.A. Khan: *The lithospheric structure of the Kenya Rift as revealed by wide-angle seismic measurements*, The first Stephan Mueller conference of the European Geophysical Society (EGS), "From Continental Breakup to Collision", Grand Nirvana Hotel, Dead Sea, Israel, 11-16 June; *The deep structure of the Kenyan Rift from seismic, gravity and MT measurements*, The 31<sup>st</sup> International Geological Congress, Rio de Janeiro, Brazil, 06-17 August.

M. Landes: *VARNET-96: 3-D inversion of upper crustal seismic refraction data, SW Ireland*, Irish Geological Research Meeting, Cork, 25-27 February; *VARNET-96: A window on the Upper Palaeozoic evolution of southwest Ireland*, Irish Geological Research Meeting, Cork, 25-27 February; *A model for Caledonian crustal intraplating, granite generation and syn-tectonic emplacement in SW Ireland*, Irish Geological Research Meeting, Cork, 25-27 February.

T. Lery: *Structure and Stability of MHD Jets, Similarities and Universality in Relativistic Flows*, Mykonos, Greece, 01-05 October; *A New YSO Outflow Model, Jet Simulations and Their Emission; Emission Lines from Jet Flows*, Isla Mujeres, 13-17 November; *MHD Jets from Keplerian Rotators*,

Emission Lines from Jet Flows, Isla Mujeres, Mexico, 13-17 November.

G.D. Makenzie: *RAPIDS 3: A wide-angle seismic study of the Rockall Trough*, The XXVII General Assembly of the European Seismological Commission, Lisbon, 10-15 September; *The structure of the Rockall Trough from wide-angle seismic profiling*, American Geophysical Union 2000 Fall Meeting (FM2000), San Francisco, 15-19 December.

E.J.A. Meurs: Two contributions, *An X-ray examination of runaway stars and Simulations of the X-ray output of evolving stellar populations*, Conference on "The influence of binaries on stellar population studies", Brussels, Belgium, 20-26 August.

L. Norci: *The HMXRB System BD+37° -1160/4U -0515+38*, The 33<sup>rd</sup> COSPAR Scientific Assembly, Warsaw, Poland, 16-23 July; *WC/WO stars: a quantitative analysis of the influence of binarity and metallicity*, Conference on "The influence of binaries on stellar population studies", Brussels, Belgium, 20-26 August.

B.M. O'Reilly: *Slope instability features in the Rockall Trough, offshore Ireland*, Irish Geological Research Meeting, Cork, 25-27 February; *Carbonate mounds on the Porcupine Bank imaged with TOBI sidescan sonar*, ACES Workshop, Galway, 23 July; *Growth pattern of a carbonate mound population on the Eastern margin of the Rockall Trough, Offshore Ireland*, American Geophysical Union 2000 Fall Meeting (FM2000), San Francisco, 15-19 December.

D. O'Sullivan: *Investigation of Cosmic Rays and their Secondaries at Aviation Altitudes*, The 20<sup>th</sup> International Conference on Nuclear Tracks in Solids, Portoroz, Slovenia, 31 August; *Astronauts and Aircrew*, ESA Space Weather Workshop, ESTEC, Noordwijk, Holland, 12 December.

E. Parizot: *Galactic Cosmic Rays and the Light Elements*, The ISSI meeting on "The Astrophysics of Galactic Cosmic Rays", Bern, Switzerland, 15-19 May; *LiBeB production in Superbubbles and associated gamma-ray lines*, The 9th European and 5th Euro-Asian Astronomical Society Conference (JENAM 2000), Moscow, Russia, 29 May - 03 June.

T.P. Ray: *The Early Stages of Star Formation*, Alexander von Humboldt Foundation Meeting,

Trinity College Dublin, 24 - 26 March; *Exploring the Central Engines of Young Stars*, Emission Lines from Jet Flows, Isla Mujeres, Mexico, 13-17 November.

P.W. Readman: *A proposed palaeo-valley trending north-west across Ireland of greater antiquity and normal to a Neogene tectonic activity and normal to a Neogene palaeo-drainage pattern*, Geological Society of London, Petroleum Group, "Exhumation of Circum-Atlantic Continental Margins: Timing, Mechanisms and Implications for Hydrocarbon Exploration", London, 13-14 June; *Changes in slope failure style along the eastern margin of the Rockall trough revealed by TOBI sidescan sonar*, American Geophysical Union 2000 Fall Meeting (FM2000), San Francisco, 15-19 December.

J. Walsh: *The design, construction and aims of the new DIAS parallel cluster*, Spring meeting of the Irish Association for High Performance Computing, UCC, Cork, 08 May.

Z. Zang: *An X-ray Search for Active Cores in Local Group Galaxies*, Astronomical Science Group of Ireland (ASGI) Spring Meeting, University College Dublin, 31 March.

#### 6.4 External Seminars

S V Annibaldi: *Evidence for Stange Kinetics in Hasegawa-Mima Turbulent Transport*, Risoe National Laboratory, Risoe, Denmark, 18 January 2000; *Non-Gaussian Transport in Strong Plasma Turbulence*, Culham Science Centre, Culham, UK, 16 August 2000.

F. Bacciotti: *HST Spectroscopy of DG Tauri*, Armagh Observatory, 21 September.

L. Drury: Colloquium, *The connection between interstellar dust and cosmic rays*, Forschung Zentrum, Karlsruhe, Germany, 09 May; Gentner seminar, *Prospects for the laboratory simulation of SNR physics*, Heidelberg, Germany, 10 May; Repeat seminar, *The connection between interstellar dust and cosmic rays*, Evora, Portugal, 23 May; Astrophysics seminar, *Interpreting the Cosmic Ray Composition*, Durham, England, 14 June;

T. Lery: *A New Model for Star Formation*, Observatoire de Paris, Meudon, France, 17 March; *Importance of the Magnetic Field During AGB and PN Phases*, GRAAL, Université de Montpellier, 19 March; *Star Formation*, Observatoire de Lyon, 07

April; *Star Formation*, Observatoire de Marseille, 09 April; *Magnetic Fields in Astrophysics*, Institut d'Astrophysique Spatiale, Orsay, 19 May; *Star Formation*, Queen's University, Ontario, Canada, 21 June; *Formation of Planetary Nebulae*, Laboratoire d'Astrophysique de Montpellier, France, 11 October.

E.J.A. Meurs: *An X-ray search for active cores in Local Group galaxies*, Istituto di Radio Astronomia, Bologna, Italy, 10 January; *An X-ray search for active cores in Local Group galaxies*, Istituto di Astrofisica Spaziale, Italy, 12 January.

E. Parizot: *LiBeB nucleosynthesis and energetic particles*, Service d'Astrophysique, Saclay, France, 22 March; *LiBeB and Galactic chemical evolution*, DASGAL, Meudon, France, 23 March; *LiBeB nucleosynthesis and particle acceleration in superbubbles*, Institut de Physique Nucleaire d'Orsay, Orsay, France, 24 March.

T. Ray: *HST Imaging and Spectroscopy of Young Stars*, Department of Physics and Astronomy, University of New South Wales, Sydney, Australia, 07 April; *Early Days in the Life of a Star*, Department of Physics, University of Wollongong, New South Wales, Australia, 19 April.

#### 6.5 Lecture Courses

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 nine hours on *Stellar Dynamics* at TCD during Hilary term; Course of eight hours on *Physics of Galaxies* at TCD during Hilary Term. Guidance provided for 4<sup>th</sup> year TCD physics student.

L. Norci: Course of nine lectures on *Stellar Structure and Evolution* in TCD during Hilary term.

T.P. Ray: Lecture Course on the *Interstellar Medium* to Senior Sophister (final year) students at the Department of Physics, TCD, during Hilary Term.

L. Drury: Lecture Course 343 (*Astrophysical Gas Dynamics*) at the Department of Mathematics, TCD, during Michaelmas term.

#### 6.6 Popular Lectures

I. Elliott: Presentation on *Teaching Junior Certificate Astronomy*, H.Dip.Ed. course, UCD, 15 February; *The History of Dunsink*, lecture to the Meath Archaeological Society, 04 June; *Celestial Fireworks*, lecture at the Millennium Festival of Science, Derry, 23 September; *The Fascination of Astronomy*, lecture to the Quest Group, Rathmines, 14 December.

G. Mackenzie: *Impact Cratering*, The Stirling Astronomical Society, Stirling, Scotland, 05 May.

E.J.A. Meurs: *The expanding view of our Universe during the 20<sup>th</sup> century*, Irish Astronomical Society, 21 February; *The expanding view of our Universe during the 20<sup>th</sup> century*, Tullamore Astronomical Society, 05 March.

D. O'Sullivan: *Science and Society*, the second in a series of six lectures at the Svedberg Laboratory, University of Uppsala, Sweden, 16 September.

T.P. Ray: *What Lies Between the Stars and Us?*, Millennium Cosmos Weekend, Tullamore, County Offaly, 04 March; *Exploring the Interstellar Medium*, Irish Astronomical Society, Dublin, 20 March; *How Stars and Planets Are Made*, Science Outreach Programme, University of New South Wales, Sydney, Australia, 14 April; *Exploring Other Worlds*, Presidential Address, Trinity Astronomical Society, Trinity College Dublin, 17 October.

#### 7 Launches, Organisation of Meetings and Public Facilities

##### 7.1 Launch of New Parallel Cluster

The new UMA parallel cluster was officially switched on by the Minister for Science, Technology and Commerce, Noel Treacy TD, at a ceremony on 17 November in 5 Merrion Square. The Director of the School paid tribute to the vision, ability and enthusiasm of the former and current experimental officers in the Astrophysics section, Wai Ming Tai and John Walsh, without whom the cluster could not have been built. Two research associates of the School, C. Bean from UCD and T. Downes from DCU gave short presentations on the significance of the new cluster for their research. The Minister congratulated the School on its work and

expressed the view that it should be more widely known.

### 7.2 Irish Astronomical Staff Meetings

Observational astronomical staff in Ireland met again twice during the year at Dunsink Observatory to discuss possible future observational facilities for Ireland. These meetings were held on 22 February and 05 December.

### 7.3 Dunsink Open Nights, Visitor Facilities and Public information

The interactive Visitors' Facility in Dunsink Observatory was actively used throughout the year for demonstrations to groups (from schools and otherwise) and to visitors generally. Open Nights for the general public were held twice monthly during the winter half year, led by W. Dumbleton. Members of the Irish Astronomical Society provided organizational support on these evenings. Information services included, amongst other issues, viewing data for satellites, background to various celestial phenomena and precise timings for sunrise and sunset, Lighting Up Times, beginnings of seasons and changes between winter time and summer time.

The same thunderstorm in May that had caused damages to the Dunsink LAN and modems also affected the Exhibition Room control computer in the Observatory main building. All of the interfaces, transducers and remote control light switches for the control computer were replaced. The interconnecting cable harness from the control box to the computer was also replaced.

As a contribution to Science Week Ireland 2000 in November, the James South Refractor was on view to the public for several mornings and afternoons during that week.

## 8 External Work

### 8.1 Astrophysics Section

S V Annibaldi: Concentrated Advanced Course on Le'vy processes, Centre for Mathematical Physics and Stochastics, University of Aarhus, Denmark, 24-28 January; Collaboration meeting (J.J. Rasmussen, V. Naulin et al), Risoe National Laboratory, Risoe, Denmark, 17-20 January;

Collaboration meetings (K.I. Hopcraft), Theoretical Mechanics Division, School of Mathematical Sciences, University of Nottingham, Nottingham, UK, 03-07 April and 22-25 October; Collaboration meeting (R.O. Dendy and G. Manfredi), Culham Science Centre, Culham, UK, 14-18 August.

F. Bacciotti: Workshop on P Cygni, Armagh Observatory, 22 August; Collaborative Work on Star Formation, Armagh Observatory, 21 September.

J. Donnelly: The 33<sup>rd</sup> COSPAR Scientific Assembly, Warsaw, Poland, 16-23 July; The 17<sup>th</sup> European Cosmic Ray Symposium (ECRS2000), Lodz, Poland, 23-28 July; The 20<sup>th</sup> International Conference on Nuclear Tracks in Solids, Portoroz, Slovenia, 28 August - 01 September.

L Drury: APP Network meeting, Rowton Castle, England, 31 January - 03 February; Management Committee meeting, Armagh, 01 March; Collaboration with T. Mendonça, IST, Lisbon, Portugal, 04-09 March; Third International Conference on Laboratory Astrophysics with Intense Lasers, Houston, Texas, 28 March - 04 April; Collaboration with J. Kirk plus midterm review of network, MPI für Kernphysik, Heidelberg, Germany, 06-13 May; Colloquium, Forschung Zentrum, Karlsruhe, Germany, 09 May; Gentner seminar, Heidelberg, Germany, 10 May; ISSI (International Space Science Institute) workshop on "Astrophysics of galactic cosmic rays", Berne, Switzerland, 14-21 May, APP (AstroPlasmaPhysics) Network meeting plus seminar, Evora, Portugal, 21-25 May; Management Committee meeting, Armagh, 02 June; Discussions with the Durham gamma-ray astronomy group plus astrophysics seminar, Durham, England, 14 June; HESS consortium meeting plus gamma-2000 international symposium, Heidelberg, Germany, 24 June - 01 July; Invited talk, Heidelberg, Germany, 27 June; Secondment to CEA Saclay (minus two weeks holiday), 05 July - 24 August; NATO Advanced Study Institute, Predeal, Romania, 27 August - 03 September; NOC meeting for Hamburg ICRC, Hamburg, Germany, 13-15 September.

E. Flood: DOSMAX Meeting and Detector Calibration Exposures at CERN, 27 July - 01 August; Calibration Exposures at the Svedberg Laboratory, Uppsala, Sweden, 13-19 September.



T. Lery: Observatoire de Paris Meudon and University of Marseille, France, 23 March - 08 April; Star Formation project, Kingston, Ontario, Canada and Rochester University, New York, USA, 17 June - 11 July; CNRS School on Star Formation and Young Star Physics, Aussois, France, 16-22 September; Similarities and Universality in Relativistic Flows (SURF 2000), Mykonos, Greece, 29 September - 08 October; Emission Lines from Jet Flows, Isla Mujeres, Mexico, 13-17 November.

D. O'Sullivan: Institute of Physics Meeting, London, 19-22 January; Institute of Physics, Spring Weekend Meeting, Adare, Limerick, 14-16 April; Space Weather Meeting, Nice, France, 25-30 April; ESA Space Weather Working Team meeting, Noordwijk, Holland, 04-06 July; DOSMAX Meeting and Exposures at CERN, Switzerland, 26 July - 01 August; The 20<sup>th</sup> International Conference on Nuclear Tracks in Solids, Portoroz, Slovenia, 26 August - 09 September; Calibration Exposures at the Svedberg Laboratory, Uppsala, Sweden, 13-19 September; Space Weather Working Team meeting, Paris, France, 11-14 November; Space Weather Working Team meeting, Noordwijk, Holland, 11-14 December.

E. Parizot: APP network workshop, Rowton, UK, 30 January - 03 February; ISSI meeting on "The Astrophysics of Galactic Cosmic Rays", Bern, Switzerland, 15-19 May; The 9th European and 5th Euro-Asian Astronomical Society Conference (JENAM 2000), Moscow, Russia, 29 May - 03 June.

T.P. Ray: Joint Irish Telescope Initiative, Armagh Observatory, 28 January; Alexander von Humboldt Foundation Meeting, Trinity College Dublin, 24-26 March; Department of Physics and Astronomy, University of New South Wales, Sydney, Australia, 01 April - 07 May; Department of Astronomy, University of Cardiff, Wales and PATT, Swindon, England, 06-11 June; International Astronomical Union General Assembly and IAU Symposium 202, University of Manchester, England, 06-20 August; Astronomical Science Group of Ireland, Queen's University Belfast, 08 September; Thesis examination, Department of Astronomy, University of Cardiff, Wales, 02-03 November; Emission Lines from Jet Flows, Isla Mujeres, Cancun, Mexico, 13-17 November; Irish Radio Telescope Proposal, Birr, 20 December.

J. Walsh: Spring meeting of the Irish Association for High Performance Computing, University College Cork, 08 May; System Administrators Network two day conference, Maastricht, Holland, 23-25 May.

## 8.2 Geophysics Section

T.A. Blake: Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February; The XXVII General Assembly of the European Seismological Commission, Lisbon, Portugal, 10-15 September; American Geophysical Fall Meeting (AGU FM2000), San Francisco, 15-19 December.

J.A. Hodgson: Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February; The XXVII General Assembly of the European Seismological Commission, Lisbon, Portugal, 10-15 September; American Geophysical Fall Meeting (AGU FM2000), San Francisco, 15-19 December.

C. Horan: Gravity tutorial at Dublin Institute for Technology, Bolton Street, Dublin, 14 March; Survey Ireland Conference, Malahide, Co. Dublin, 11-12 May.

A.W.B. Jacob: The XXVII General Assembly of the European Seismological Commission, Lisbon, Portugal, 10-15 September; Hawaii project discussions, Potsdam, Germany, 12-14 December.

M.A. Khan: The 31<sup>st</sup> International Geological Congress, Rio de Janeiro, Brazil, 06-17 August.

M. Landes: Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February.

K. McGrane: Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February.

G. Mackenzie: Valeneta Meteorological Observatory, 02-04 February; Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February; RSG (Rockall Studies Group) Technical Forum, Dublin, 29 March; RAPIDS-3 data processing, Hamburg, Germany, 12-16 June; The XXVII General Assembly of the European Seismological Commission, Lisbon, Portugal, 10-15 September; American Geophysical Fall Meeting (AGU FM2000), San Francisco, 15-19 December.

B.M. O'Reilly: Seminar on The Irish Seabed Survey, Geological Survey of Ireland (GSI),

Beggars Bush, Dublin, 20 January; European Science Foundation Workshop, EUROMARINS, Sitges, Barcelona, Spain, 26-29 February; Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February; RSG (Rockall Studies Group) Technical Forum, Dublin, 28-29 March; Geological Society of London, Workshop on Atlantic Continental Margins, London, 13-14 June; ACES Workshop, Galway, 23 June; Reflections and Soundings: 40 years of Geophysics in Africa and Ireland, Galway, 23-24 June; RSG (Rockall Studies Group) Meeting on rock drill locations, Dublin, 26 July; ERDAS Users Group Meeting, Cambridge, England, September 19-20; Seabed Survey Seminar, Dublin, 17 November; Porcupine Studies Group Meeting, University College Dublin, 05 December; American Geophysical Fall Meeting (AGU FM2000), San Francisco, 15-19 December.

L. Quigley: Valentia Meteorological Observatory, 02-04 February, 07-08 March and 27-29 September; Survey Ireland Conference, Malahide, Co. Dublin, 11-12 May; GIS Ireland meeting (IRLOGI), Malahide, Co. Dublin, 17 October; Hawaii fieldwork, 23 October - 11 November.

P.W. Readman: Seminar on The Irish Seabed Survey, Geological Survey of Ireland (GSI), Beggars Bush, Dublin, 20 January; Irish Geological Research Meeting (IGRM-43), Cork, 25-27 February; RSG (Rockall Studies Group) Technical Forum, Dublin, 28-29 March; Geological Society of London, Workshop on Atlantic Continental Margins, London, 13-14 June; ACES Workshop, Galway, 23 June; Reflections and Soundings: 40 years of Geophysics in Africa and Ireland, Galway, 23-24 June; RSG (Rockall Studies Group) Meeting on rock drill locations, Dublin, 26 July; ERDAS Users Group Meeting, Cambridge, England, September 19-20; Seabed Survey Seminar, Dublin, 17 November; Porcupine Studies Group Meeting, University College Dublin, 05 December; American Geophysical Fall Meeting (AGU FM2000), San Francisco, 15-19 December.

G. Wallace: Hawaii fieldwork, 23 October - 11 November.

### 8.3 Astronomy Section

E.J.A. Meurs: Osservatorio Astronomico di Roma, Rome, 16 May - 03 June; Conference on "The influence of binaries on stellar population

studies", VU Brussels, Belgium, 20-26 August; Osservatorio Astronomico di Roma, Rome, 10-27 September.

L. Norci: Istituto di Astrofisica Spaziale, Rome, 12-22 March; Astronomical Science Group of Ireland (ASGI) Spring Meeting, UCD, 31 March; Conference on "The influence of binaries on stellar population studies", VU Brussels, Belgium, 20-26 August.

B. Jordan: OMC (Optical Monitoring Camera) and OMC Electrical Ground Support Equipment (EGSE) and non-conformance review meeting, INTA, Madrid, 09-11 February; Delivery and acceptance test of modified Electrical Ground Support Equipment, INTA, Madrid, 19-21 July; Delivery and acceptance test of OMC Flight Model and Delivery Review Board meeting, INTA, Madrid, 09-12 October; Meeting of Irish radio telescope group, Birr, 20 December.

I.Elliott: Astronomical Science Group of Ireland (ASGI) Spring Meeting, UCD, 31 March; ASGI Autumn Meeting, Queen's University, Belfast, 08 September; Physics Teaching Fair, CERN, Geneva, 06-10 November.

J. Cunniffe: Workshop "Observing with INTEGRAL", The INTEGRAL Science Data Centre, Les Diablerets, Switzerland, 27 March - 01 April; Astronomical Science Group of Ireland (ASGI) Autumn Meeting, Queen's University, Belfast, 08 September.

M. Carr: Astronomical Science Group of Ireland (ASGI) Spring Meeting, UCD, 31 March; European Space Agency Summer School "Extragalactic Astronomy and Cosmology from Space", Alpbach, Austria, 18-27 July; ASGI Autumn Meeting, Queen's University, Belfast, 08 September.

Z. Zang: Astronomical Science Group of Ireland (ASGI) Spring Meeting, UCD, 31 March.

### 9 Miscellanea

L.O.C. Drury 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 Astronomy and Space Science of the Royal Irish Academy.

A.W.B. Jacob retired as Chairman of the National Committee for Geodesy and Geophysics of the Royal Irish Academy, and continued as convenor and as a member of that committee. He also continued as a Research Associate of University College Dublin.

E.J.A. Meurs advised the Trinity Astronomy and Space Society as Honorary President. He further served on the National Committee for Astronomy and Space Science of the Royal Irish Academy and as Chairman on the La Palma Advisory Committee.

D. O'Sullivan continued to serve as Chairman of the Institute of Physics in Ireland until 16 April, when he presided over the annual Spring Meeting at Adare in Co Limerick.

P.W. Readman was elected as Secretary to the National Committee for Geodesy and Geophysics of the Royal Irish Academy. He also continued as a Research Associate of University College Dublin.

T.P. Ray served as the DIAS representative on the RIA *National Committee for Physics* and as a member of the *MERLIN Time Allocation Group* within the Panel for Allocation of Telescope Time (PATT). In addition he was elected President of the Trinity College Astronomical Society.

D. O'Sullivan was elected an Honorary Fellow of the International Nuclear Track Society for his contribution to nuclear track physics and its application to cosmic radiation, at a special ceremony in Portoroz, Slovenia, in August.

I. Elliott continued as a member of the National Committee for Science and Engineering Commemorative Plaques and as a member of the Science and Technology Committee of the Royal Dublin Society. He also continued as Chairman of the Irish Science Centres Association Network which held meetings in Birr (14 April) and at the National Botanic Gardens in Glasnevin (07 October).

D. O'Sullivan continued as chairman of the Ireland-CERN campaign committee initiated by the Royal Irish Academy. Several meetings took place with senior civil servants and others early in the year and close contact was maintained with CERN staff including the Director General. A document outlining a case for Ireland's

membership of CERN was presented to the Director of the Office of Science and Technology (OST) at a meeting with his colleagues in May. A further meeting took place in October and this was attended by CERN representatives and representatives of OST, Forfas, IDA and Enterprise Ireland. Discussions and exchange of information are continuing.

In the Astrophysics Section D. Zhou successfully defended his PhD thesis (see section 10.3). The external examiner was L. Tommasino (Agenzia Nazionale per la Protezione dell'Ambiente (ANPA), Rome, Italy).

B. Jordan represented Dunsink Observatory at the funeral of Prof. H. Brück in Edinburgh, 11 March.

J.A. Hodgson won an "Outstanding Student Presentation Award" at the American Geophysical Union Fall Meeting (AGU FM2000, San Francisco, 15-19 December) for his presentation *A wide-angle study of SE Ireland and the structure of the Leinster Granite*.

D. O'Sullivan was invited by V. Perehygin of Dubna, Russia, to be the co-ordinator of a FSU-European proposal to INTAS, following a series of communications and a meeting in August in Portoroz. The document which was drafted and finalised at DIAS was submitted in October and proposes a search for super heavy elements ( $Z \geq 110$ ) in nature using nuclear tracks in meteoric crystals, following the very significant advances in super heavy element production at Dubna in the last year or two. Successful proposals will be announced in Feb 2001.

I. Elliott's talk on "Exploring Space and Time" in the Thomas Davis series of lectures on "Science and Technology at the end of the 20<sup>th</sup> Century", originally broadcast on 03 May 1999, was repeated on RTE Radio-1 on 16 October. He also gave two interviews about Dunsink on Desmond McGuinness' local history programme on Phoenix FM; these were broadcast in October.

Dunsink Observatory prepared and manned a stand at an annual Science Fair of Enterprise Ireland in Leopardstown.

I. Elliott served as secretary to the National Steering Committee for Physics on Stage, a year-long programme under the auspices of CERN, ESA and ESO to identify innovative methods of

teaching physics. The programme involved educators from 22 European countries and culminated in a Physics Teaching Fair at CERN, 06 -10 November. Ireland contributed a well-received musical performance by a group of seven physics students. In addition, eight delegates from Ireland participated in the presentations and workshops.

C. Horan continued to give a Gravity Practical and Tutorial to Geo-Surveying students at Dublin Institute for Technology, Bolton Street (14 March).

L. Quigley continued to edit *Survey Ireland* and the *Institute of Irish Surveyors News (IIS News)*.

The Shortt Free Pendulum Slave Clock was restored to working order by J. Daly, B. Jordan and W. Dumbleton. The Master Pendulum leaf spring suspension mechanism had been damaged when the clocks were dismantled during building alterations. G. Daly has fabricated a replacement spring and restoration of the Master Pendulum is ongoing.

E. Whelan, Physics Department, TCD, was supervised by T.P. Ray from September to December for her final year astrophysics project using radio interferometer data from the Very Large Array (VLA) Archive.

Five Transition Year pupils spent a week each at Dunsink Observatory as part of their Work Experience programmes.

C. Townsend (Transition Year Student) worked with T.P. Ray on data conversion from 22 May - 02 June.

On 15 December, Mr Frank Prendergast, Head of the Department of Geomatics, DIT, Bolton Street, determined the position of the dome on the main building at Dunsink using a hand-held GPS receiver. The geodetic co-ordinates relative to the Ireland 1965 Datum are  $53^{\circ} 23' 13.7''$  N  $\pm 0.5''$ ,  $6^{\circ} 20' 15.5''$  W  $\pm 0.3''$ .

An RTE television crew visited Dunsink on 10 May to film scenes involving the comedian Brendan O'Carroll, a native of Finglas.

I. Elliott prepared 16 certificates of Lighting-up Time and other astronomical information for legal purposes. Routine information on the positions

of the Sun and Moon was supplied to architects, sporting organisations and film companies.

As a safety measure, OPW laid down heavy stone boulders around the perimeter of the paddock next to Dunsink House.

## 10 Publications

### 10.1 Refereed Publications

S V Annibaldi, G Manfredi, R O Dendy and L O' C Drury: *Evidence for strange kinetics in Hasegawa-Mima turbulent transport*, Plasma Physics and Controlled Fusion, Vol 42, pp L13-L22 (2000).

S. Appl, T. Lery and H. Baty: *Current-driven Instabilities in Astrophysical Jets. Linear Analysis*, Astron. Astrophys., Vol. 355, pp 818-828 (2000).

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## 11 Review and Strategic Planning

### 11.1 External Review

It is the policy of the School of Cosmic Physics Board to commission an external evaluation of the work of the School by an expert panel every five years, to coincide roughly with the handing over from one Board to the next. Such a quinquennial review was due in 2000 and took place on 07 and 08 February under the Chairmanship of Prof. Malcolm Longair from the University of Cambridge. The other members of

the expert review group were Professor Jacqueline Bergeron, European Southern Observatory; Professor Roger Davies, University of Durham; and Prof Nicholas Kuznir, University of Liverpool. The group were generally complimentary about the work of the School, but expressed serious concern about accommodation and staffing problems as well as a lack of clear leadership. They strongly advocated the development of a more active, strategic and science-driven approach to the management of the School. The full report is attached as an appendix to this annual report.

### 11.2 Strategic Planning

A considerable amount of time was devoted during the year to the discussion of strategy. The first strategic plan of the school, produced in 1999, provided a useful first start. At Institute level a facilitator was employed by Council to help prepare an overall Institute strategy. In parallel with this the School, following the strong recommendation of the Longair review, worked on a detailed School Strategy which was science driven and set out clear goals and benchmarks for the next five years. These discussions took much of the year, but by December a consensus had been reached within the School on the science objectives for the next five years and, although details still had to be resolved, the outline of an overall Institute strategy within which the School strategy could be implemented was beginning to take shape.



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

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**Financial Statements for year ended 31 December 2000**

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(Dublin Institute for Advanced Studies)

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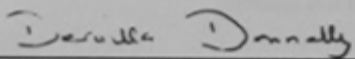
Statement of Responsibilities of the Council

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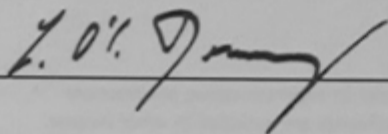
The Council of the Dublin Institute for Advanced Studies is required under section 28(2) of the Institute for Advanced Studies Act 1940 to prepare financial statements in such form as shall be approved by the Minister with the concurrence of the Minister for Finance. In preparing those financial statements 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.
- . disclose and explain any material departures from applicable accounting standards.

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)**

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**Financial Statements for year ended 31 December 2000**

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GENERAL

The Institute was established under the Institute for Advanced Studies Act, 1940. Its functions include the provision of facilities for the furtherance of advanced studies and the conduct of research in specialised branches of knowledge. It comprises three Schools - Celtic Studies, Theoretical Physics and Cosmic Physics.

ACCOUNTING POLICIES

1. Accounting Basis

The financial statements have been prepared on an accruals basis under the historical cost convention and in accordance with generally accepted practice. Financial Reporting Standards recommended by the recognised accounting bodies are adopted as they become applicable.

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 represents the unamortised value of income used for the purchase of Fixed Assets.

5. Library

Expenditure on library books and materials is written off in the year in which it is incurred.

6. Publications

Expenditure on publications is written off in the year in which it is incurred.

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

8. Euro

The accounts are stated in Irish Pounds. The Euro currency equivalent is stated for memorandum purposes only.

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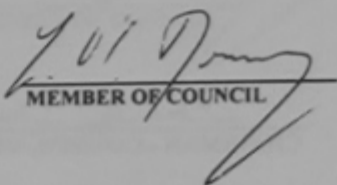
**Financial Statements for year ended 31 December 2000**

**Income and Expenditure Account**

	Notes	2000 £	2000 €	1999 £
<b>Income</b>				
Oireachtas Grant		3,568,300	4,530,806	3,336,000
Sales of Publications		41,071	52,149	41,561
School of Theoretical Physics /Administration	1	146,946	186,583	77,588
School of Cosmic Physics	1	345,168	438,273	290,706
Other	8	61,322	77,863	50,620
		4,162,807	5,285,674	3,796,475
Transfer from Capital Reserve	4	21,704	27,558	9,662
		4,184,511	5,313,232	3,806,137
<b>Expenditure</b>				
School of Celtic Studies		754,452	957,956	726,506
School of Theoretical Physics		607,966	771,957	520,008
School of Cosmic Physics		1,661,181	2,109,265	1,622,185
Administration		1,093,895	1,388,960	949,933
		4,117,494	5,228,138	3,818,632
<b>Surplus/(Deficit) for year</b>		<b>67,017</b>	<b>85,094</b>	<b>(12,495)</b>
Balance at 1 January		176,293	223,846	188,788
<b>Balance at 31 December</b>		<b>243,310</b>	<b>308,940</b>	<b>176,293</b>

The Statement of Accounting Policies and notes 1 to 12 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)

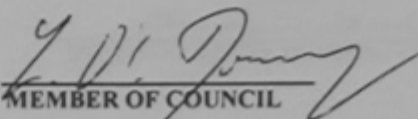
**Financial Statements for year ended 31 December 2000**

**Balance Sheet**

	Notes	2000 £	2000 €	1999 £
<b>Assets</b>				
Fixed Assets	3	535,808	680,336	557,512
Current Assets:				
Cash on Hands and at Bank		504,652	640,776	415,948
Debtors and Prepayments		160,797	204,170	124,898
<b>Total Assets</b>		<b>1,201,257</b>	<b>1,525,282</b>	<b>1,098,358</b>
<b>Less Liabilities</b>				
<u>Creditors - Amounts falling due within one year</u>				
Creditors and Accruals		243,033	308,588	254,776
Research Programmes and Fees	2	138,588	175,971	70,052
Creditors - Amounts falling due after one year	5	40,518	51,447	39,725
<b>Total Liabilities</b>		<b>422,139</b>	<b>536,006</b>	<b>364,553</b>
<b>Net Assets</b>		<b>779,118</b>	<b>989,276</b>	<b>733,805</b>
<b>Financed by:</b>				
Surplus Income and Expenditure Account		243,310	308,940	176,293
Capital Reserve	4	535,808	680,336	557,512
		<b>779,118</b>	<b>989,276</b>	<b>733,805</b>

The Statement of Accounting Policies and notes 1 to 12 form part of these financial statements.

  
CHAIRMAN - COUNCIL OF THE INSTITUTE

  
MEMBER OF COUNCIL

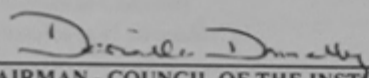
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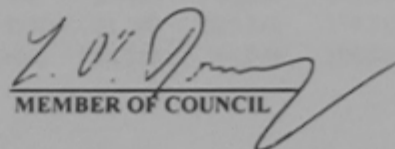
Financial Statements for year ended 31 December 2000

**Cash Flow Statement**

	Notes	2000 £	2000 €	1999 £
<b>Reconciliation of operating surplus to net cash inflow from operating activities</b>				
Surplus/(Deficit) for year		67,017	85,094	(12,495)
Interest received	8	(12,344)	(15,674)	(15,884)
Increase/(Decrease) in Creditors		(10,950)	(13,904)	97,524
Decrease/(Increase) in Debtors		(35,899)	(45,582)	66,830
Net Increase in Research Programmes and Fees		68,536	87,023	22,074
Depreciation	3	160,158	203,359	151,172
Capital Reserve Transfer	4	(21,704)	(27,558)	(9,662)
Loss on Disposal	1	2,796	3,550	66
<b>Net Cash Inflow from operating activities</b>		<b>217,610</b>	<b>276,308</b>	<b>299,625</b>
<b>Cash Flow Statement</b>				
Net Cash Inflow from operating activities		217,610	276,308	299,625
<b>Returns on investments and servicing of finance</b>				
Bank Interest Received	8	12,344	15,674	15,884
<b>Capital expenditure</b>				
Purchase of Tangible Assets	3	(141,250)	(179,351)	(141,576)
<b>Increase in Cash</b>		<b>88,704</b>	<b>112,631</b>	<b>173,933</b>
<b>Reconciliation of net cash flow to movement in net funds</b>				
<b>Increase in Cash</b>		<b>88,704</b>	<b>112,631</b>	<b>173,933</b>
Balance at 1 January		415,948	528,145	242,015
Balance at 31 December		504,652	640,776	415,948

The Statement of Accounting Policies and notes 1 to 12 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)

**Notes to the Financial Statements**

**1 Detailed Analysis of Income & Expenditure for the year ended 31/12/2000**

<b>INCOME</b>	Notes	School of Celtic Studies £	School of Theoretical Physics £	School of Cosmic Physics £	Adminis- tration £	2000 Total £	1999 Total £
Oireachtas Grants		675,668	552,598	1,411,000	929,034	3,568,300	3,336,000
Sales of Publications		40,904		167		41,071	41,561
Research Programmes and Fees	2		137,525	345,168	9,421	492,114	368,294
Other Income	8	9,029	11,358	22,994	17,941	61,322	50,620
		725,601	701,481	1,779,329	956,396	4,162,807	3,796,475
<b>Transfer (to)/from Capital Reserve</b>		(8,245)	(7,423)	(117,795)	155,167	21,704	9,662
		717,356	694,058	1,661,534	1,111,563	4,184,511	3,806,137
<b>EXPENDITURE</b>							
Salaries, Wages and Superannuation		578,694	389,013	1,049,659	369,868	2,387,234	2,348,229
Scholarships		62,929	69,200	49,963		182,092	170,952
Honoraria		1,328	100	200	1,500	3,128	1,271
Library (incl. Microfilms)		22,069	62,275	46,388		130,732	120,349
Publications		30,607	156	2,679	507	33,949	19,417
General Administration	6	5,241	2,025	5,641	335,424	348,331	269,926
Travel and Survey Expenses		24,308	23,190	51,062	5,704	104,264	94,741
Symposia & Seminar Expenses		3,055	1,082			4,137	1,840
Consumables & Maintenance							32,861
La Palma Telescope Costs				17,816		17,816	
Project Costs			52,735	388,581		441,316	356,477
General Expenses	12	26,221	8,190	49,192	205,823	289,426	242,600
Book Storage					12,115	12,115	8,731
Loss on Disposals					2,796	2,796	66
Depreciation	3				160,158	160,158	151,172
		754,452	607,966	1,661,181	1,093,895	4,117,494	3,818,632
<b>SURPLUS/(DEFICIT) FOR YEAR</b>		(37,096)	86,092	353	17,668	67,017	(12,495)
<b>Balance at 1 January</b>		210,727	3,190	(78,404)	40,780	176,293	188,788
<b>Balance at 31 December</b>		173,631	89,282	(78,051)	58,448	243,310	176,293

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

**Notes to the Financial Statements**

**1 Detailed Analysis of Income & Expenditure for the year ended 31/12/2000**

<u>INCOME</u>	Notes	School of Celtic Studies €	School of Theoretical Physics €	School of Cosmic Physics €	Adminis- tration €	2000 Total €	1999 Total €
Oireachtas Grants		857,921	701,655	1,791,600	1,179,630	4,530,806	4,235,846
Sales of Publications		51,936		213		52,149	52,772
Research Programmes and Fees	2		174,621	438,273	11,962	624,856	467,636
Other Income	8	11,464	14,422	29,197	22,780	77,863	64,274
		921,321	890,698	2,259,283	1,214,372	5,285,674	4,820,528
<u>Transfer (to)/from Capital Reserve</u>		(10,469)	(9,425)	(149,569)	197,021	27,558	12,269
		910,852	881,273	2,109,714	1,411,393	5,313,232	4,832,797
 <u>EXPENDITURE</u>							
Salaries, Wages and Superannuation		734,788	493,943	1,332,793	469,634	3,031,158	2,981,637
Scholarships		79,903	87,866	63,439		231,208	217,064
Honoraria		1,686	127	254	1,905	3,972	1,614
Library (incl. Microfilms)		28,023	79,074	58,899		165,996	152,812
Publications		38,863	198	3,402	644	43,107	24,655
General Administration	6	6,655	2,571	7,163	425,901	442,290	342,735
Travel and Survey Expenses		30,865	29,445	64,835	7,243	132,388	120,296
Symposia & Seminar Expenses		3,879	1,374			5,253	2,336
Consumables & Maintenance						0	41,725
La Palma Telescope Costs				22,622		22,622	
Project Costs			66,960	493,396		560,356	452,632
General Expenses	12	33,294	10,399	62,462	261,341	367,496	308,038
Book Storage					15,383	15,383	11,086
Loss on Disposals					3,550	3,550	84
Depreciation	3				203,359	203,359	191,949
		957,956	771,957	2,109,265	1,388,960	5,228,138	4,848,663
<u>SURPLUS/(DEFICIT) FOR YEAR</u>		(47,104)	109,316	449	22,433	85,094	(15,866)
Balance at 1 January		267,569	4,050	(99,553)	51,780	223,846	239,712
Balance at 31 December		220,465	113,366	(99,104)	74,213	308,940	223,846



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

**Notes to the Financial Statements**

**2. Research Programmes and Fees**

**School of Cosmic Physics**

<u>Project</u>	<u>Contributor</u>	Opening Balance	Receipts	Applied as Income	Closing Balance
		£	£	£	£
Astronomy X Ray(High Energy)	EU	2,740	0	0	2,740
Cores of Nearby Galaxies	EU	2,899	0	0	2,899
Stellar Evolution	Enterprise Ireland	18,480	7,920	22,808	3,592
Low Mass Star	Enterprise Ireland	67	5,498	5,565	0
EADN	EU	(6,977)	6,977	0	0
Irma II	EU	(8,309)	11,673	3,364	0
Plasma Cooperation	EU	(10,548)	(20,982)	(31,530)	0
Jet 2	Enterprise Ireland	16,105	7,042	23,147	0
Astro Plasma Physics	EU	10,537	33,662	26,440	17,759
Turbulent Fusion	EU	9,430	19,021	25,068	3,383
Unv New Sth Wales	Enterprise Ireland	1,980	0	1,980	0
Dos Max	EU	0	274,087	224,947	49,140
Jet 3	Enterprise Ireland	0	13,640	0	13,640
Hogs	Various	14,447	1,004	0	15,451
Transfrontier	EU	(4,987)	0	0	(4,987)
Core Mantle + Peco	EU	711	(9,568)	0	(8,857)
Varnet	EU	(7,739)	0	129	(7,868)
Gloria	Enterprise Ireland	8,423	15,096	19,186	4,333
Leinster Granite	Enterprise Ireland	(16,209)	5,687	(9,023)	(1,499)
Term Tobi	UCD	32,908	0	5,977	26,931
Valentia	Met Eireann	(670)	0	(670)	0
Hawaii	EU	(19,205)	20,957	1,752	0
Greek	EU	(2,743)	0	(2,743)	0
Rapids Three 'A'	EU	8,909	40,000	31,978	16,931
Eagle	EU	(3,207)	0	(3,207)	0
		<b>47,042</b>	<b>431,714</b>	<b>345,168</b>	<b>133,588</b>

**School of Theoretical Physics**

Esprit	EU	(19,996)	40,084	20,088	0
Large Deviation	EU	5,654	18,097	23,751	0
Rennes	EU	10,705	(499)	5,206	5,000
Microsoft	Microsoft	15,830	26,742	42,572	0
Rite	EU	11,828	(1,214)	10,614	0
Telia Research	Telia	(1,010)	36,304	35,294	0
		<b>23,011</b>	<b>119,514</b>	<b>137,525</b>	<b>5,000</b>

Total

**138,588**

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

**Notes to the Financial Statements**

**2. Research Programmes and Fees**

**School of Cosmic Physics**

<u>Project</u>	<u>Contributor</u>	<u>Opening Balance</u>	<u>Receipts</u>	<u>Applied as Income</u>	<u>Closing Balance</u>
		€	€	€	€
Astronomy X Ray(High Energy)	EU	3,479	0	0	3,479
Cores of Nearby Galaxies	EU	3,681	0	0	3,681
Stellar Evolution	Enterprise Ireland	23,465	10,054	28,962	4,557
Low Mass Star	Enterprise Ireland	85	6,981	7,066	0
EADN	EU	(8,859)	8,859	0	0
Irma II	EU	(10,550)	14,820	4,270	0
Plasma Cooperation	EU	(13,394)	(26,641)	(40,035)	0
Jet 2	Enterprise Ireland	20,449	8,941	29,390	0
Astro Plasma Physics	EU	13,379	42,743	33,572	22,550
Turbulent Fusion	EU	11,974	24,153	31,830	4,297
Unv New Sth Wales	Enterprise Ireland	2,514	0	2,514	0
Dos Max	EU	0	348,019	285,624	62,395
Jet 3	Enterprise Ireland	0	17,319	0	17,319
Hogs	Various	18,344	1,275	0	19,619
Transfrontier	EU	(6,332)	0	0	(6,332)
Core Mantle + Peco	EU	903	(12,149)	0	(11,246)
Varnet	EU	(9,827)	0	164	(9,991)
Gloria	Enterprise Ireland	10,695	19,168	24,361	5,502
Leinster Granite	Enterprise Ireland	(20,581)	7,221	(11,457)	(1,903)
Term Tobi	UCD	41,785	0	7,589	34,196
Valentia	Met Eireann	(851)	0	(851)	0
Hawaii	EU	(24,385)	26,610	2,225	0
Greek	EU	(3,482)	0	(3,482)	0
Rapids Three 'A'	EU	11,312	50,790	40,604	21,498
Eagle	EU	(4,073)	0	(4,073)	0
Geotwin Iliha					
		<b>59,731</b>	<b>548,163</b>	<b>438,273</b>	<b>169,621</b>

**School of Theoretical Physics**

Esprit	EU	(25,389)	50,896	25,507	0
Large Deviation	EU	7,178	22,980	30,158	0
Rennes	EU	13,593	(633)	6,610	6,350
Microsoft	Microsoft	20,100	33,955	54,055	0
Rite	EU	15,017	(1,541)	13,476	0
Telia Research	Telia	(1,282)	46,097	44,815	0
		<b>29,217</b>	<b>151,754</b>	<b>174,621</b>	<b>6,350</b>

Total

**175,971**

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

**Notes to the Financial Statements**

**3. Fixed Assets**

	<u>Furniture &amp; Equipment</u>	<u>Motor Vehicles</u>	<u>Computers</u>	<u>Total</u>
<u>Cost</u>	£	£	£	£
Opening Balance 1/1/2000	1,081,848	15,711	1,289,044	2,386,603
Additions	18,037	31,250	91,963	141,250
	1,099,885	46,961	1,381,007	2,527,853
Disposals	(5,166)	(1,800)	(401)	(7,367)
	1,094,719	45,161	1,380,606	2,520,486
<b>Depreciation</b>				
Opening Balance 1/1/2000	699,413	14,166	1,115,512	1,829,091
Charge 2000	64,097	1,647	94,414	160,158
	763,510	15,813	1,209,926	1,989,249
Depreciation on disposals	(3,358)	(886)	(327)	(4,571)
	760,152	14,927	1,209,599	1,984,678
Net book value 31/12/2000	334,567	30,234	171,007	535,808
Net book value 31/12/1999	382,435	1,545	173,532	557,512

**4. Capital Reserve**

	2000	1999
	£	£
Balance at 1 January	557,512	567,174
<u>Transfer from (to) Income and Expenditure Account</u>		
Income allocated to acquire fixed assets	141,250	141,576
Amortisation in line with asset depreciation	(160,158)	(151,172)
Amount released on disposals	(2,796)	(66)
	(21,704)	(9,662)
Balance at 31 December	535,808	557,512

**5. Creditors due after twelve months**

	2000	1999
	£	£
These comprise:		
Vernam Hull Bequest	38,642	37,855
Carmody Fund	1,876	1,870
	40,518	39,725

The available funds may only be applied in accordance with the intentions of the Trusts. The above relates to bequests made to the Institute. During the year no projects were identified to apply these funds.

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

**Notes to the Financial Statements**

**3. Fixed Assets**

	Furniture & Equipment	Motor Vehicles	Computers	Total
<u>Cost</u>	€	€	€	€
Opening Balance 1/1/2000	1,373,664	19,949	1,636,747	3,030,360
Additions	22,903	39,679	116,769	179,351
	1,396,567	59,628	1,753,516	3,209,711
Disposals	(6,559)	(2,286)	(509)	(9,354)
	1,390,008	57,342	1,753,007	3,200,357
<u>Depreciation</u>				
Opening Balance 1/1/2000	888,071	17,987	1,416,408	2,322,466
Charge 2000	81,387	2,091	119,881	203,359
	969,458	20,078	1,536,289	2,525,825
Depreciation on disposals	(4,264)	(1,125)	(415)	(5,804)
	965,194	18,953	1,535,874	2,520,021
Net book value 31/12/2000	424,814	38,389	217,133	680,336
Net book value 31/12/1999	485,593	1,962	220,339	707,894

**4. Capital Reserve**

	2000	1999
	€	€
Balance at 1 January	707,894	720,163
<u>Transfer from (to) Income and Expenditure Account</u>		
Income allocated to acquire fixed assets	179,351	179,764
Amortisation in line with asset depreciation	(203,359)	(191,949)
Amount released on disposals	(3,550)	(84)
	(27,558)	(12,269)
Balance at 31 December	680,336	707,894

**5. Creditors due after twelve months**

	2000	1999
	€	€
These comprise:		
Vernam Hull Bequest	49,065	48,066
Carmody Fund	2,382	2,374
	51,447	50,440

The available funds may only be applied in accordance with the intentions of the Trusts. The above relates to bequests made to the Institute. During the year no projects were identified to apply these funds.

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

**Notes to the Financial Statements**

**6. General Administration Expenses:**

					2000	1999
	Celtic Studies	Theoretical Physics	Cosmic Physics	Admin.	Total	Total
	£	£	£	£	£	£
Rent, Rates & Insurance				109,036	109,036	102,532
Premises Maintenance & Security				90,576	90,576	31,567
Postage & Telephones				50,238	50,238	57,457
Fuel, Light & Power				46,149	46,149	39,297
Audit Fee				5,900	5,900	5,900
Cleaning				28,731	28,731	28,110
Catering	4,453	1,530	1,730	3,020	10,733	4,362
SS&R General	788	495	3,911	1,774	6,968	701
	<u>5,241</u>	<u>2,025</u>	<u>5,641</u>	<u>335,424</u>	<u>348,331</u>	<u>269,926</u>

**7. Leasing**

**Operating Leases**

The premises occupied by the Institute are leased from the Office of Public Works. An additional lease is under negotiation for the purpose of book storage. The commitment on foot of such leases in respect of 2001 is £53,465.

**8. Other Income**

Included under this heading is Bank Interest earned of £12,344 (1999 - £15,884) in the year. Also included in other income are superannuation contributions from staff of £37,141 (1999 - £33,906)

**9. Superannuation**

The total superannuation payments in the year amounted to £242,472 (1999 - £283,277).

**10. Disclosure of Transactions**

The Council of the Institute adopts procedures in accordance with guidelines issued by the Department of Finance in relation to the disclosure of interests by Council Members and these procedures have been adhered to by the Council Members during the year. No Council Member has declared an interest.

**11. Contingent Liabilities**

The Registrar of the Institute was suspended by the Council of the Institute from that office with effect from 20 October 1998. It is not possible to anticipate the outcome of disciplinary hearings currently being conducted by the Institute or the possible financial impact of legal proceedings being taken by the Registrar.

**12. General Expenses**

					2000	1999
	Celtic Studies	Theoretical Physics	Cosmic Physics	Admin.	Total	Total
	£	£	£	£	£	£
Electrical		1,103	6,571	1,275	8,949	7,233
Internet Expenses				33,875	33,875	23,000
Stationery	6,482	3,109	5,808	9,260	24,659	21,143
Equipment Maintenance	787		1,915	2,598	5,300	10,175
Taxis/Couriers	689	585	1,670	1,441	4,385	4,601
Promotions/Lunches	182	443	2,361	173	3,159	3,559
Medical	268		372	1,572	2,212	177
Bank Charges				2,560	2,560	2,680
Training	2,785	612	6,299	9,534	19,230	11,008
Miscellaneous	5,262	197	7,438	10,604	23,501	60,404
Computer Expenses	2,522	2,119	11,449	7,293	23,383	20,201
Computer Software	1,134		3,103	8,313	12,550	28,262
Photocopier	5,639	22	2,042	862	8,565	13,926
Professional Fees	471		164	116,463	117,098	36,231
	<u>26,221</u>	<u>8,190</u>	<u>49,192</u>	<u>205,823</u>	<u>289,426</u>	<u>242,600</u>

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

**Notes to the Financial Statements**

					2000	1999
	Celtic	Theoretical	Cosmic	Admin.	Total	Total
	Studies	Physics	Physics			
	€	€	€	€	€	€
Rent, Rates & Insurance				138,448	138,448	130,189
Premises Maintenance & Security				115,009	115,009	40,082
Postage & Telephones				63,790	63,790	72,955
Fuel, Light & Power				58,594	58,594	49,897
Audit Fee				7,491	7,491	7,491
Cleaning				36,481	36,481	35,692
Catering	5,654	1,943	2,197	3,835	13,629	5,539
SS&R General	1,001	628	4,966	2,253	8,848	890
	6,655	2,571	7,163	425,901	442,290	342,735

**7. Leasing**

**Operating Leases**

The premises occupied by the Institute are leased from the Office of Public Works. An additional lease is under negotiation for the purpose of book storage. The commitment on foot of such leases in respect of 2001 is €67,887.

**8. Other Income**

Included under this heading is Bank Interest earned of €15,674 (1999 - €20,169) in the year. Also included in other income are superannuation contributions from staff of €47,161 (1999 - €43,052)

**9. Superannuation**

The total superannuation payments in the year amounted to €307,875 (1999 - €359,688).

**10. Disclosure of Transactions**

The Council of the Institute adopts procedures in accordance with guidelines issued by the Department of Finance in relation to the disclosure of interests by Council Members and these procedures have been adhered to by the Council Members during the year. No Council Member has declared an interest.

**11. Contingent Liabilities**

The Registrar of the Institute was suspended by the Council of the Institute from that office with effect from 20 October 1998. It is not possible to anticipate the outcome of disciplinary hearings currently being conducted by the Institute or the possible financial impact of legal proceedings being taken by the Registrar.

					2000	1999
	Celtic	Theoretical	Cosmic	Admin.	Total	Total
	Studies	Physics	Physics			
	€	€	€	€	€	€
Electrical		1,401	8,343	1,619	11,363	9,184
Internet Expenses				43,012	43,012	29,204
Stationery	8,231	3,948	7,375	11,758	31,312	26,846
Equipment Maintenance	999		2,432	3,299	6,730	12,920
Taxis/Couriers	876	742	2,120	1,830	5,568	5,842
Promotions/Lunches	231	562	2,998	220	4,011	4,519
Medical	340		472	1,996	2,808	225
Bank Charges				3,251	3,251	3,403
Training	3,536	777	7,998	12,106	24,417	13,977
Miscellaneous	6,681	250	9,446	13,464	29,841	76,697
Computer Expenses	3,202	2,691	14,537	9,260	29,690	25,650
Computer Software	1,440		3,940	10,555	15,935	35,885
Photocopier	7,160	28	2,593	1,095	10,876	17,682
Professional Fees	598		208	147,876	148,682	46,004
	33,294	10,399	62,462	261,341	367,496	308,038

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

I have audited the financial statements on pages 2 to 13.

**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**

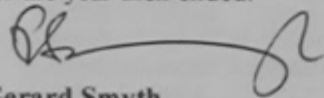
In the exercise of my function as Comptroller and Auditor General, I plan and perform my audit in a way which takes account of the special considerations which attach to State bodies in relation to their management and operation.

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 Institute 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 2000 and of its income and expenditure and cash flow for the year then ended.



**Gerard Smyth**  
for and on behalf of the  
**Comptroller and Auditor General**

9 July 2002

**DUBLIN INSTITUTE FOR ADVANCED STUDIES**

**Report of the 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, to include the appropriate penalty interest with the payment together with the information required by Section 6
- to 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.

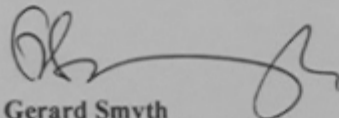
**Basis of Opinion**

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 that 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 2000.



**Gerard Smyth**  
for and on behalf of the  
Comptroller and Auditor General  
9 July 2002



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

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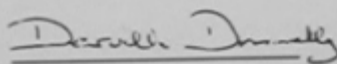
Prompt Payment of Accounts Act, 1997

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The Dublin Institute for Advanced Studies is included in the schedule to the Prompt Payment of Accounts Act, 1997. Since 2 January 1998, the Act has come into operation and the Dublin Institute for Advanced Studies has complied with the provisions of the Act. In accordance with the Act and guidelines issued by the Department of Enterprise, Trade and Employment, the following information is provided.

Procedures established to ensure compliance with the Act

The Dublin Institute for Advanced Studies has procedures in place to ensure that all invoices received are paid within the time limits specified on the Invoices or the statutory time if no period is specified. While the procedures are designed to ensure compliance with the Act, they can only provide reasonable assurance and not absolute assurance against material non-compliance with the Act. These procedures operated in the period under review. Despite the application of the adopted procedures, the Institute paid £52.58 in the form of interest during the Financial Year ending 31st December 2000.



Dervilla Donnelly  
Chairman-Council of the Institute  
25th June 2002