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

ANNUAL REPORT
1997

P.N. 7474

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

Annual Report of the work of the
Institute and its Constituent Schools
presented by the Council to the
Minister for Education in respect of
the year ended 31 December 1997

P.N. 7474

Summary of the Annual Report of the Work of the Constituent Schools for the year ended 31 December 1997

School of Celtic Studies

Three new books were published by the School during the course of the year, and there was one reprint. Many articles were published outside the School by members of Staff and by Research Scholars. Lectures were regularly given by members of Staff and by Research Scholars both at the School and at conferences in Ireland, Britain, Europe and the United States.

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

School of Theoretical Physics

Forty-one research workers from the universities or other institutes of research or higher education (mainly in Ireland) were admitted as Research Associates of the School; thirty-two scientists from abroad visited the School during the year.

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

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

School of Cosmic Physics

There were two significant developments in the ***Astrophysics Section*** during the year. Firstly, with the construction of the DIAS Pleiades cluster, it became possible to develop and run large parallel computational simulations locally. Secondly, work on theoretical aspects of controlled thermonuclear fusion commenced in collaboration with DCU and UCD. These initiatives link the section to recent Irish developments in high performance computing and plasma physics, and complement the well established activities in star formation and high energy astrophysics.

While the previous year had been one of extremely active experimental work in the ***Geophysics Section***, 1997 was a year of steady progress in data processing, interpretation and publishing the results. A notable publication was the Bulletin from the Continental Rifts Workshop held in the Institute in March. This will provide the basis for further international research in the world's rifts and oceanic margins. A number of other publications served to elucidate the structure and development of the Kenya Rift, a mantle thermal anomaly was discovered west of Ireland, important conclusions about the nature of the core-mantle boundary under the Pacific produced a new model for that most prominent structural horizon in the Earth, and, nearer home, dramatic structural variations were found in the upper mantle under the Iapetus Suture Zone in SW Ireland. This latter feature was a complete surprise and is still to be adequately explained.

The ***Astronomy Section*** continued its new lines of research and was fortunate to acquire another two research students in the Autumn, while the Fulbright Visiting Professor came to the end of his period at Dunsink. The investigations on active galactic nuclei, large-scale structure and massive stars led to several finished projects that are being prepared for publication. New projects on archival research with X-ray data, for nuclear activity in galaxies and observational cosmology, were started. Further observation time on X-ray satellites has been secured. Retired Professor T. Kiang was inspired to take up an old problem of his, now tackled with new methods and computational possibilities. The work on the Optical Monitoring Camera for the INTEGRAL satellite progressed considerably, in collaboration with colleagues at UCD. The new interactive Visitors Facility at Dunsink Observatory was officially opened and will add to the attraction of this renowned Observatory for school groups and the general public.

School of Cosmic Physics Golden Jubilee Year

This year was the Golden Jubilee Year of the School of Cosmic Physics. On Thursday 20 March 1997, the President of Ireland, Her Excellency Mary Robinson attended a reception in St Patrick's Hall, Dublin Castle, to open the Golden Jubilee commemorations of the School, which was established in 1947. Professor Evert Meurs,

Director of the School and Ms Eimhear Clifton, Astrophysics Section, performed string duets, including pieces by Gliere, during the arrival of the guests. The programme commenced with a presentation of prizes to the winners of an essay competition for secondary schools on the subject of *Cosmic Physics*. The members of the judging panel were Dr Helena Sheehan, School of Communications, DCU (School of Cosmic Physics Board Member), Dr Tom Ray, Astrophysics Section, School of Cosmic Physics and Dr Peter Readman, Geophysics Section, School of Cosmic Physics.

The President was greeted on arrival at Dublin Castle by the Chairman of the Governing Board, Professor Aftab Khan with the Director of the School and was escorted directly into St Patrick's Hall. Professor Khan welcomed the President and the assembled guests and gave a short address in which he emphasised the international reputation of the School. He then invited Professor Denis O'Sullivan, Astrophysics Section, to present his painting, entitled *The Cosmos* to Her Excellency. This impressionistic water colour symbolises the message of the Dublin Institute for Advanced Studies logo, *Inmensum Peragramus*, in general and various fields of research in the school in particular. After the presentation, the President responded with an address to the assembled guests in which she particularly emphasised the value of the school to the general culture of Ireland.

Following the address of the President, Professor Meurs presented a special illustrated history of the School which was produced for this occasion and which included origin of the School, background, profiles of senior staff, early scientific work and recent research. This history was entitled *The First 50 Years -- The School of Cosmic Physics -- Dublin Institute for Advanced Studies* and featured on its cover a detail from Professor O'Sullivan's *The Cosmos*. Copies of the history were distributed to all the guests present. Finally, Professor Meurs announced the end of the formal proceedings, following which the platform party joined the guests until Her Excellency departed.

In addition to the commemorations at Dublin Castle, two international scientific meetings were organised to mark the Jubilee. The Geophysics Section hosted a conference on *Lithospheric Structure, Evolution and Sedimentation in Continental Rifts* during March (see Section 7.1), while the Astronomy and Astrophysics Sections held a two-day Symposium on *High-energy Interactions between Evolving Stellar Populations and their Environment in our own and other Galaxies* during October (see Section 7.2). Near the end of the Jubilee year the improved Visitors Facility at Dunsink Observatory was opened by the Minister for Science and Technology.

Annual Report of the work of the Institute and its Constituent Schools presented by the Council for the year ended 31 December 1997.

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 1997.

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 1997.

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 1997.

The Council of the Institute

Chairman

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

Ex-Officio Members

A. Cosgrove, B.A., Ph.D., President, University College, Dublin; M. Herity, President, Royal Irish Academy, M.E., Ph.D. (Leeds), D.Sc. F.I.E.E., F.I.M.A., F.I.E.E.E., F.I.E.I., M.R.I.A.; T. N. Mitchell, M.A., Ph.D., Litt.D., L.L.D., D.Hum.L., F.R.C.P.I.(Hon.), Hon. F.R. C.S.I., M.R.I.A., Provost, Trinity College, Dublin.

Members Appointed by the Governing Boards of Constituent Schools

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

Governing Board of the School of Celtic Studies

Chairman

B. Ó Madagáin, B.A., Ph.D., M.R.I.A.

Senior Professors

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

Appointed Members

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

Governing Board of the School of Theoretical Physics

Chairman

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

Senior Professors

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

Appointed Members

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

Governing Board of the School of Cosmic Physics

Chairman

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

Senior Professors

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

Appointed Members

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

II. Administrative Staff of the Institute

Registrar

John Duggan, B.Sc.

Executive Officer

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

Finance Officer

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

Assistant Finance Officer

Angela Stubbs.

Clerks

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

Annual report of the Governing Board of the School of Celtic Studies for the year ending 31 December 1997 adopted at its meeting of 27 January 1999

Contents

Dr Pádraig Ó Néill, The University of North Carolina at Chapel Hill (1990)
Dr Brinley F. Roberts, National Library of Wales, Aberystwyth (1990)
Professor R. Mark Scowcroft, Catholic University of America (1990)
Dr Richard Sharpe, University of Oxford (1988)
Professor Robert L. Thomson, University of Leeds (1991)
Professor Calvert Watkins, Harvard University (1990)
Professor T. Arwyn Watkins, University College, Dublin (1989)

1.7 Visiting Scholars

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

Dr Melita Cataldi (University of Turin)
Prof David Dumville (Cambridge)
Prof Eric P. Hamp (Chicago)
Prof Raymond Hickey (University of Essen)
Dr Kaarina Hollo (Harvard University)
Britta Irslinger (University of Freiburg)
Prof Seamus McElwain (Bunkyo Women's College, Tokyo)
Setsuko Mori McElwain (Bunkyo Women's College, Tokyo)
Dr Ursula Marmé (University of Köln)
Prof Toshi Matsuoka (Hosei University, Tokyo)
Dr Tatyana Mihailova (University of Moscow)
Dr Máire Ní Mhaonaigh (University of Cambridge)
Joseph Nugent (University of California, Berkeley)
Breandán Ó Cróinín (Catholic University of Lublin)
Dr Thomas O'Loughlin (University of Wales, Lampeter)
Ikuko Sannomiya-Ikegami (Japan)
Dr Stefan Schumacher (University of Innsbruck)
Prof Edgar M. Slotkin (University of Cincinnati; longterm Visiting Scholar)
Dr Peter Smith (University of Bonn)
Dr Nancy Stenson (University of Minnesota)
Prof Dr L. C. Hildegard Tristram (University of Freiburg)
Prof Yoko Wada (Kansai University)
Prof Raymond E. White (University of Arizona)
Dr Arndt Wigger (University of Wuppertal)
Margaret M. Williams (Columbia University, New York)
Dr Jonathan M. Wooding (University of Sydney)

2 Research

During 1997 research for publication continued in the fields covered by the staff's expertise, viz. manuscript studies, medical texts, Early Irish law, Early Modern Irish verse, spoken language studies, bibliography. In addition to research being conducted internally, there is editorial supervision of work submitted by outside scholars in a number of fields for which the School has statutory responsibility.

2.1 Staff

Rolf Baumgarten continued work on the (database) *Bibliography of Irish linguistics and literature*. He continued research on Early Irish syntax, and medieval etymology. He did editorial work on *Studies in Welsh word formation* (Stefan Zimmer), including a short stay in Bonn. See also Outside activities.

Pádraig de Brún completed editorial/typesetting work on vol. I of the *Survey of the Gaelic dialects of Scotland* (ed. Cathair Ó Dochartaigh) and saw the volume through the press. Disk conversion and typesetting of text and translation for Bayless and Lapidge (eds) *Collectanea pseudo-Bedae*, intended as Scriptores Latini Hiberniae, vol. 14. He continued preparation for publication of his *Scriptural instruction in the vernacular: the Irish Society and its teachers, 1818–1827*. See also Outside activities and contributions to scholarship.

Fergus Kelly prepared an edition of the legal treatise attributed to Giolla na Naomh mac Duinn Shléibhe Mheic Aodhagáin, *CIH* ii 691–9). See also Publications, Seminars, and Outside activities and contributions to scholarship.

Proinsias Mac Cana continued research on aspects of the history of Welsh and Irish syntax as well as working on an edition of *Fled Bricrenn* and on literary topics in Irish and Welsh. See also Outside activities and contributions to scholarship.

Malachy McKenna continued work on the edition of *The spiritual rose*. See also Seminars, and Outside activities and contributions to scholarship.

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

Aoibheann Nic Dhonnchadha worked on medical manuscripts.

Brian Ó Cuív continued work on the revision of his catalogue of Irish manuscripts in the Bodleian

Library, Oxford; visited the Library to discuss with Dr David Cooper the use of the manuscript descriptions in the Imaging Project on Internet. See also Outside activities and contributions to scholarship.

Brian Ó Curnáin continued work on a Galway Irish dialect (and on Connacht dialects in general), including a short field trip. See also Research Scholars' work.

Pádraig Ó Macháin continued research on the Irish manuscripts in the National Library of Ireland. See also Lectures (Statutory public lecture), and Outside activities and contributions to scholarship.

Máirtín Ó Murchú supervised work on A. Wigger, *Caint Chonamara, I: Ros Muc*; began an editorial revision of P. Ó Maolaithche, *Canúint Mhionlaigh*, for publication.

2.2 Research Scholars

Jacqueline Borsje started research on the idea of Fate in early Irish literature. See also Outside activities and contributions to scholarship.

Petra Sabine Hellmuth continued research on the prose-tales of the tragic death of Cú Roí mac Dáire, *Aided Chon Roí*. See also Tionól, and Outside activities and contributions to scholarship.

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

Róisín McLaughlin commenced work on the preparation for publication of her M.Litt. (Trinity College, Dublin) thesis 'Early Irish satire'.

Brian Ó Curnáin continued work on a Galway Irish dialect (and on Connacht dialects in general); assisted A. Wigger, *Caint Chonamara, I: Ros Muc*, forthcoming. See also Outside activities and contributions to scholarship.

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

Catherine Swift: An edition, with commentary, of Tírechán's seventh-century Hiberno-Latin *Collectanea*; A study of the inscriptions and stylistic affinities of pre-Norman Irish sculpture with a view to learning more about the environment in which these monuments were created. See also Outside activities and contributions to scholarship.

Mary A. Valante continued work on 'Economy and urbanism in Viking-age Ireland' (Ph.D. thesis, Pennsylvania State University). See also Seminars, and Outside activities and contributions to scholarship.

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

3 Publishing

As one of its statutory functions, in addition to research and publication by its own staff, the School provides for the assessment, editing, and publishing of books and papers by outside scholars.
Computerised editing for publication and typesetting was directed by Pádraig de Brún and Michelle O Riordan, assisted by Emma Ryan. Computer consultant was Dr W. G. Sullivan of University College, Dublin. Book design was under the expert guidance of Professor Bill Bolger of the National College of Art and Design.

The following items were published in 1997:

- Fergus Kelly, *Early Irish farming: a study based mainly on the law-texts of the 7th and 8th centuries* AD, Early Irish law series, 4. 1997. xix + 751 pp, illus. ISBN 1-85500-180-2; ISSN 0790-4657. Ir£16.

- Robert L. Thomson (ed.) *Ystorya Gereint uab Erbin*, Medieval and Modern Welsh series, 10. 1997. lxxxiii + 206 pp. ISBN 1-85500-179-9; ISSN 0332-4230. Ir£15.

- Cathair Ó Dochartaigh (ed.) *Survey of the Gaelic dialects of Scotland: questionnaire materials collected for the Linguistic survey of Scotland, I: Introductory essays.* 1997. xiv + 178 pp, map, figs, tabs. ISBN 1-85500-165-9. Ir£25.

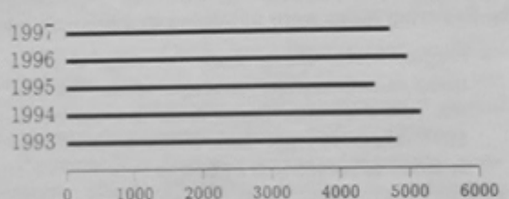
  Foreword by William Gillies, Editor-in chief. I. The Survey in context: 1. Background and European setting, by Eric P. Hamp; 2. The history of the Survey, by William Gillies. II. Implementation: 3. The Scottish Gaelic dialect questionnaire; 4. Survey fieldwork; 5. Informants and locations; 6. Fair copies and publication; 7. Phonetic symbolization. — This volume completes the set of five volumes (vols II–V: The phonetic record, were published in 1994), ISBN 1-85500-170-5, Ir£100 (see Catalogue E 3.6 – E 3.6.5).

The following publication of the School was reprinted:
G.S.M. Walker (ed.) *Sancti Columbani opera*, 1957 (reprs 1970, 1997), Scriptores Latini Hiberniae, 2. (Catalogue J 2.2)

4 Booksales

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

The number of books sold during 1997 was 4732. This figure was calculated from end-of-year stock-taking figures after appropriate deduction of additions etc. during the year. The comparable figures for the preceding years were 4978 for 1996, 4508 for 1995, 5175 for 1994, 4818 for 1993. The ca. 900 copies of the *Newsletter* (ed. Rolf Baumgarten) that have since 1987 been annually distributed worldwide are not taken into consideration. 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. The pamphlet and offprint collection was rehoused in a library annex but storage problems remain acute. No progress was made in regard to provision of shelving for maps and infill shelving in the library proper despite repeated representations to the Registrar's office.

6 Events

6.1 Lectures

- The Statutory Public Lecture for the year 1997 was delivered by Pádraig Ó Macháin (Scoil an Léinn Cheiltigh) on 28 November 1997, at Trinity College, Dublin, entitled 'Ar thóir téacs agus údair i bhFilíocht na Scol'.

6.2 Annual Symposium/Tionól 1997

The Annual Symposium/Tionól was held on 28–29 November, incorporating as a key feature the Statutory Public Lecture (see above). In addition, the following papers were read:

- Petra S. Hellmuth (School of Celtic Studies): 'The larger-than-life hero Cú Roí mac Dáire: an ascetic pacifist?'.
- Aideen O'Leary (University College, Cork): 'The contents of the biblical history in *An Leabhar Breac*'.
- Nicholas Williams (University College, Dublin): 'An aspect of Cornish syntax'.
- Karen Jankulak (School of Celtic Studies): 'The medieval names of the territorial divisions of Cornwall'.
- Donnchadh Ó Corráin (University College, Cork): 'The Vikings in ninth-century Ireland and Scotland: revisions'.
- Henar Velasco López (Visiting Scholar, School of Celtic Studies): 'Christian Heaven — pagan Otherworld'.
- Fergus Kelly (School of Celtic Studies): 'What were the *cnoe gnóe* 'beautiful nuts' of the Old Irish law-texts?'.
- Caitríona Ó Dochartaigh (University of Cambridge): ' "Save me, Lord, as you saved Daniel from the lions": observations on *Saltair na rann*'.
- Colm Lankford (Dublin): '*Bríatharogam* in its biblical setting: a new theory'.

6.3 Seminars

- Fergus Kelly (School of Celtic Studies): 'An Irish law text (the legal treatise attributed to Giolla na Naomh mac Duinn Shléibhe Mheic Aodhagáin, *CIH* ii 691–9)' (weekly, 23 October – 11 December).
- Mary A. Valante (School of Celtic Studies): 'Urbanised or civilised? The Vikings in Ireland 914–1014' (20 October).

- Brian Ó Curnáin (School of Celtic Studies): 'Register in an Irish dialect: Pádraig, Fionn, amhráin is caointe' (3 November).
- Edgar Slotkin (University of Cincinnati; Visiting Scholar, School of Celtic Studies): 'Mac Cécht's lethal armpit' (17 November).
- Malachy McKenna (School of Celtic Studies): 'Gender in a nineteenth-century text' (8 December).

7 Outside activities and contributions to scholarship

7.1 Activities

Lectures were delivered by:
Rolf Baumgarten, 'Irish hagiography and medieval etymology', International conference on hagiography, Cork (April).

Fergus Kelly, 'Celtic law', Department of Celtic languages, Harvard University (March); 'Do the Old Irish law-texts help the archaeologists?', Royal Society of Antiquaries of Ireland (December).

Proinsias Mac Cana co-organized a two-day conference, March 27–28, at Collège des Irlandais, Paris, and at Université Paris XII at Créteil on the topic 'Mélusines continentales et insulaires' and delivered a paper on 'Les analogues irlandais de la légende de Mélusine' (the proceedings of the conference are in the press); 'Celtic literature' in the series marking the centennial year of Celtic Studies at Harvard.

Malachy McKenna gave M.Phil. courses on Phonology and Morphology, Center for Language and Communication Studies, Trinity College, Dublin.

Lectures by Research Scholars:
Jacqueline Borsje, 'Women in Columba's *Life* as seen through the eyes of his biographer Adomnán', Eleventh Irish conference of medievalists, Maynooth (July); 'Monsters and the Waters of the Deep', Workshop 'Towards a theoretical framework of the study of monsters in Anglo-Saxon and Old Norse literature', Rijksuniversiteit Groningen (August).

Petra Sabine Hellmuth, 'Aspekte der altirischen Erzählung vom Tode des Cú Roí mac Dáire, *Aided Chon Roí*', Zweites deutsches Keltologensymposium, Bonn (April); 'The structure of the tale of The Death of Cú Roí mac Dáire, *Aided Chon Roí*', Nineteenth Annual University of California Celtic Studies conference, Berkeley (March).

Karen Jankulak, 'Fingar/Gwinear/Guigner: an "Irish" saint in medieval Cornwall and Brittany', International conference on hagiography, Cork (April).

Brian Ó Curnáin, 'Draíocht uimhreacha: anailís shóinseálach ar dheilbhíocht iolra an ainmfhocail i gcanúint Iorras Aithneach', Teangeolaíocht na Gaeilge, II, Coláiste Phádraig, Má Nuad (April); 'Variables in Irish phonology and morphology: linguistic and sociolinguistic implications', Second Conference of Celtic languages, University College, Dublin (June).

Catherine Swift, 'Ogam stones in the time of St Patrick', Medieval History Society, University College, Dublin; Ogam stones in early Ireland', History seminar, St Patrick's College, Maynooth; 'The bishop versus the mother and child: a study of Tully cross, Co. Dublin', Eleventh Irish conference of medievalists, Maynooth (July); 'The early medieval kingdoms of the north-west', International conference on Columba and his churches, Magee College, Derry (of which she was also the convener; July); 'Ireland in the time of St Ninian', Cumbernauld History Society conference, Scotland.

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

María del Henar Velasco López, 'Panorama del estudio de las lenguas célticas en Irlanda', Sociedad Española de Lingüística: XXVII Simposio, Palma de Mallorca (December).

7.2 Scholarly publications

Rolf Baumgarten, 'Heinrich Wagner: a bibliography', *Miscellanea Celtica in memoriam Heinrich Wagner*, ed. Séamus Mac Mathúna and Ailbhe Ó Corráin (Acta Universitatis Upsaliensis: Studia Celtica Upsaliensia 2, Uppsala 1997) 355–66; Co-edited *Ériu* 48.

Pádraig de Brún, 'An Irish manuscript of eighteenth-century Meath', accepted for *Ríocht na Midhe*.

Fergus Kelly, *Early Irish farming*, see Publications above; 'Eugene O'Curry', and 'Níall Noígíallach', accepted for *New dictionary of national biography*.

Proinsias Mac Cana, 'Irish *ba marb*, Welsh *bu farw* "he died"', *Zeitschrift für celtische Philologie* 49/50 (1997) 469–81; 'Prosimetrum in insular Celtic literature', *Prosimetrum: cross-cultural perspectives on narrative in prose and verse*, ed.

Joseph Harris and Karl Reichl (Woodbridge) 99–130; 'The Irish language', *Ireland in the coming times: essays to celebrate T. K. Whitaker's 80 years*, ed. Fionán Ó Muircheartaigh (Dublin) 327–41; 'Gnéithe den chéasta sa Nua-Ghaeilge' (le Dónall P. Ó Baoill), *Dán do oide: essays in memory of Conn R. Ó Cléirigh, 1927–1995*, ed. Anders Ahlqvist and Vera Capkova (Dublin) 265–80; 'Notes on periphrasis with verbal noun and verb "to do" in Middle Welsh', *Miscellanea Celtica in memoriam Heinrich Wagner*, ed. Séamus Mac Mathúna and Ailbhe Ó Corráin (Acta Universitatis Upsaliensis: Studia Celtica Upsaliensia 2, Uppsala 1997) 183–96; '1. *Insula Fortium* : *Ynys y Kedeirn/Kedyrn*', 2. *lethenach/leathanach* "page" ' (Varia III), *Ériu* 48, 273–6; Review of Bo Almqvist agus Dáithí Ó hÓgáin, *Skálda: éigse is eachtraíocht sa tSean-Lochlainn* (Baile Átha Cliath 1995), *Béaloideas* 64/65 (1996/97) 375–7; Co-edited *Ériu* 48.

Malachy McKenna, 'Towards a lexical phonology and morphology of spoken Ulster Irish', *Miscellanea Celtica in memoriam Heinrich Wagner*, ed. Séamus Mac Mathúna and Ailbhe Ó Corráin (Acta Universitatis Upsaliensis: Studia Celtica Upsaliensia 2, Uppsala 1997) 259–75; 'Palatalization and labials in the Irish of Torr, Co. Donegal', to be published in proceedings of *Comhdháil do theangeolaíocht na Gaeilge (1996)* (Má Nuad).

Brian Ó Cuív, 'Metrical features in De Brún's *Coiméide dhiaga Dante*', *Miscellanea Celtica in memoriam Heinrich Wagner*, ed. Séamus Mac Mathúna and Ailbhe Ó Corráin (Acta Universitatis Upsaliensis: Studia Celtica Upsaliensia 2, Uppsala 1997) 139–47; 'An appeal to Philip III of Spain by Ó Súilleabháin Béirre, December 1601', *Éigse* 30 (1997) 18–26; '*Becca na delba a cht delb Dé*', *Cothú an dúchais*, eag. M. Mac Conmara agus É. Ní Thighearnaigh (Baile Átha Cliath 1997) 136–48; 'Tomás de Bhaldraithe agus a chuid staidéir', *Tomás de Bhaldraithe: cuimhní cairde*, eag. P. Mac Aonghusa (Baile Átha Cliath 1997) 48–52; 'An tAthair Peadar Ua Laoghaire's translation of the Old Testament', *Zeitschrift für celtische Philologie* 49/50 (1997) 643–52; 'Athbheochan an Oireachtais', *Cuimhní cinn an Oireachtais*, eag. S. Mac Mathúna (Baile Átha Cliath 1997) 6–9.

Pádraig Ó Macháin, 'Patrick Carmody, Irish scholar', *Decies* 53 (1997) 133–43; 'Irish and Scottish traditions concerning *Ceathrar do bhí ar uaigh an fhir*', *Éigse* 30 (1997) 7–17; 'Additions to the Melleray collection of Irish manucripts', ibid. 92–108; Review of *Celtica Helsingiensia: proceedings from a symposium on Celtic studies*, ed. A. Ahlqvist et al. (Commentationes humanarum litterarum 107, Helsinki 1996), ibid. 230–1; Review of *Tuath is tighearna : Tenants and landlords — an anthology of Gaelic poetry of social and political protest from the Clearance to the Land Agitation (1800–1900)*, ed. Donald E. Meek (Scottish Gaelic Texts Society 18, Edinburgh 1995), ibid. 231–2; Review of *Duanaire Colach 1537–1757*, eag. Colm Ó Baoill (Obar-Dheathain 1997), ibid. 232–3.

Máirtín Ó Murchú, 'Ceann easna agus pairifín: printís an scoláire', *Tomás de Bhaldraithe: cuimhní cairde*, eag. P. Mac Aonghusa (Baile Átha Cliath 1997) 53–62; Review of *Stair na Gaeilge in ómós do Pádraig Ó Fiannachta*, eag. McCone et al. (Maigh Nuad 1994), *Éigse* 30 (1997) 171–195; 'Irish language studies in Trinity College Dublin', *Hermathena: quartercenteneray papers 1992* [1997].

Research Scholars' publications:
Jacqueline Borsje, 'The movement of water as symbolised by monsters in early Irish texts', *Peritia* 11 (1997) 153–70; Review of *Female stereotypes in religious traditions*, ed. Ria Kloppenborg and Wouter J. Hanegraaff (Studies in the history of religions 66, Leiden etc. 1995), *Nederlands theologisch tijdschrift* 51, 3 (1997) 233–4; 'Het Lot in vroegmiddeleeuwse Ierse literatuur', *Nieuwsbrief van het Nederlands Genootschap voor Godsdienstwetenschap* 1997–1998, nr 12, 6–7.

Petra Sabine Hellmuth, '*Aided Chon Roí* im Gelben Buch von Lecan: die Geschichte eines Todes als Lebensretter?', accepted for proceedings of the 'Zweites deutsches Keltologensymposium, Bonn 1997', Buchreihe der Zeitschrift für celtische Philologie.

Karen Jankulak, 'Dafydd ap Llywelyn, *brenin cywrennin*: Einion Wan's *Dadolwch Dafydd ap Llywelyn*', *Australian Celtic journal* 6, forthcoming; 'Dinham, family of, c. 1250–1457/58', *New dictionary of national biography*, forthcoming; 'Fingar/Gwinear/Guigner: an "Irish" saint in medieval Cornwall and Brittany', *Proceedings of the International conference on hagiography, Cork, 9–13 April 1997* (Four Courts Press, forthcoming).

Brian Ó Curnáin, '*Draíocht uimhreacha*: anailís shóinseálach ar dheilbhíocht iolra an ainmfhocail i gcanúint Iorras Aithneach', *Ériu* 48, 161–204; Review article of H. Hartmann, T. de Bhaldraithe and R. Ó hUiginn, *Áirneán: eine Sammlung von irischen Texten aus Carna, Co. na Gaillimhe* I, II (Buchreihe der Zeitschrift für celtische Philologie 13, 14, Tübingen 1996), accepted for *Éigse*.

Ingrid Sperber, 'Lives of St Finnian of Movilla: British evidence', *Down: history and society*, ed. L. Proudfoot (Dublin 1997) 85–102.

Catherine Swift, Review of Edel Bhreathnach,

Tara — a selected bibliography (Dublin 1995), *Ríocht na Midhe* 9, 3, 12–27; *Ogam stones and the earliest Irish christians*, Maynooth monographs, series minor, 2 (Maynooth); Co-editor of proceedings of the International conference on Columba and his churches, Derry 1997.

Mary A. Valante, 'Re-assessing the Irish "monastic town" ', accepted for *Irish historical studies*. Co-winner of the 1997 Irish Chiefs' Prize in History for 'Turf fights and family feuds: relations among the major Norse settlement in Ireland'.

María del Henar Velasco López, Review of Kim McCone, *Towards a relative chronology of ancient and medieval Celtic sound change* (Maynooth 1996), *Minerva* 11 (1997); 'Loegaire y los muertos armados', *Homenaje a A. Montenegro* (Universidad de Valladolid, forthcoming); *El tema del prado verde en la escatología indoeuropea*, Ph.D. Valladolid 1993 (Universidad de Valladolid, forthcoming).

Annual Report of the Governing Board of the School of Theoretical Physics for the year ending 31 December 1997 adopted at its meeting on 9 June 1998.

1 Staff, Scholars and Associates

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

LIBRARIAN: Ann Goldsmith

SYSTEMS ADMINISTRATOR: Ian Dowse from 30 June

SECRETARY: Margaret Matthews

EMERITUS PROFESSOR: James R. McConnell

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

SCHOLARS: C. Chryssomalakos (Greece) to 31 July, E. Ivashkevich (Russia) from 1 May, D.J. O'Connor (Ireland) to 31 January, J. Pawlowski (Germany) from 1 October, I. Sachs (Switzerland) to 30 September, O. Schnetz (Germany) from 1 May, S. Vinnakota (India), P. Watts (USA) from 1 September.

POSTDOCTORAL FELLOWS: M. Magro (France) to 30 September.

GRADUATE STUDENTS: M. Corluy (Belgium) from 1 October, M. Dukes (Ireland) from 22 July, K. Duffy (Ireland), M. Huggard (Ireland), B. McGurk (Ireland), R. Russell (Ireland), F. Toomey (Ireland), C. Walsh (Ireland).

RESEARCH ASSOCIATES: Re-appointed to 31 December 1999:

DIAS: D. O'Mathúna

TCD: P.S. Florides, D. Weaire

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

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

UCC: M. Vandyck

UCG: J. Burns, M.J. Conneely, M.P. Tuite

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

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

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

CARLOW RTC: D. O Sé

AT, & T: N. Duffield

OPEN UNIVERSITY: A.I. Solomon

OXFORD UNIVERSITY: R.G. Flood

LAB. DE PROBABILITIES, LYON: P. McGill

METEOROLOGICAL SERVICE: P. Lynch

DEPT. OF FINANCE: A.J. Curran

SCHLUMBERGER CAMBRIDGE RESEARCH : B. Lenoach

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

UNAFFILIATED: G.M. O'Brien

VISITING SCIENTISTS: F. Baccelli (France) 4-6 September, C. Bachas (France) 16-23 May, J. Balog (Budapest) 18 June - 1 July, R. Capouilla (Mexico) 24 June - 2 July, J. Chela-Flores (Trieste) 18 November, S. Crosby (Cambridge) 2-3 January, F. Delduc (ENS, Lyon) 12-20 July, L. Fehér (Bonn) 5 May - 31 August, G.W. Ford (Ann Arbor) 25 May - 29 June, C. Graham (Canada) 6 October - 22 December, O. Gulinsky (Moscow) 6-27 October, J. Guven (UNAM, Mexico) 17 June - 3 September, I. Lundy (Adelaide) 6-7 August, D. MacKernan (Brussels) 18-19 September, R. Musto (Naples) 4-10 September, N. O'Connell (Brims) 11-18 May, 17-24 November, R.F. O'Connell (Louisiana) 2 June - 3 August, D. O'Connor (Mexico) 30 June - 7 July, 14-21 July, E. Pechersky (Moscow) 11 April - 11 May, C. Pfister (Lausanne) 29 April - 2 May, 1-10 October, V. Priezzhev (Dubna) 22 September - 6 November, A. Pukhalsky (Moscow) 9-27 June, D. Rose (Cambridge) 16-20 November, I. Sachs (Durham) 10-17 November, O. Schnetz (Germany) 14 January - 14 February, V. Shrypnik (Kiev) 19 November - 15 December, I. Tsutsui (Tokyo) 13-17 August, S. Turner (Cambridge) 2-10 October, G. Vitiello (Salerno) 14-17 May, N. Vvedenskaya (Moscow) 15 April - 15 May, R. Werner (Braunschweig) 25-28 November,

2 General

A one-day conference was held on 22 March to celebrate the centenary of the birth of J.L. Synge (see Sect. 8).

3 Research and Study

3.1 Theoretical Particle Physics

Prof. O'Raifeartaigh in collaboration with Dr. Sreedhar completed work on the path-integral formulation of WZW-Toda reduction for the Liouville case and extended it to the general abelian Toda cases. Two papers on this subject are in course of publication. Work on the N-point functions for Wess-Zumino-Witten and Liouville systems begun earlier in collaboration with Drs. Sachs and Wiesendanger was continued in collaboration with Drs. Pawlowski and Sreedhar. Knitchnik-Zamolodchikov type equations were derived for the Liouville theory and it was shown that the zero modes are of central importance. The previous year's work on the uniqueness of the Seiberg-Witten Ansatz, in collaboration with Prof. Flume and Drs. Magro, Sachs and Schnetz, raised the question as to whether the Noether and central charges could be derived for the effective Lagrangian. Work on this subject is nearing completion. The Seiberg-Witten Ansatz has been checked at the one- and two- instanton levels by a number of groups using direct computations. Although the results of these computations agree with the SW result, their theoretical justification is rather shaky. A program for putting all instanton computations on a sounder basis was initiated but is still in its early stages.

Prof. Chela-Flores research was mainly devoted to the discussion of the hypothesis that the transition bacteria-eukaryote is an imperative consequence of the laws of physics, chemistry and biology, given the appropriate planetary of satellite environment.

Dr. Dolan looked at geometrical aspects of field theory in general relativity, relativistic quantum field theory and statistical mechanics. He also studied the renormalisation group and geometry.

Dr. Garavaglia studied signals for Higgs detection.

Dr. Magro in collaboration with Prof. O'Raifeartaigh and Dr. Sachs considered the uniqueness of the effective Lagrangian for $N = 2$ supersymmetric QCD. They also began a study on the central charge of the supersymmetry algebra for pure Yang-Mills theory.

Dr. Pawlowski studied the quantisation of non-abelian gauge theories on the torus, gauge fixing on the torus and instantons on the torus. He also studied Wilsonian flow equations in gauge theories. He researched instantons in SUSY, duality, and β-function of SUSY-gauge theories.

Dr. Sachs carried out an in depth study of the different aspects of the low energy effective action in Yang-Mills theory with extended supersymmetry. In particular the inclusion of matter fields was analysed. The instanton contributions to the effective action and the superalgebra of the latter were worked out. He also studied black holes and string theory. He analysed the greybody spectrum and the thermodynamical entropy of 3-dimensional anti-desitter black-holes and found that it is described by a conformal field theory.

Dr. Schnetz studied connections between perturbative quantum field theories, knot theory and transcendental numbers.

Prof. Tchrakian carried out research in the following areas. The $SO(d)$ gauging of the $O(d+1)$ sigma models. The $U(1)$ gauged Skryme model. Thermal transition rate in the Skyrmed $O(3)$ sigma model. Interaction energy of generalised Abelian Higgs vortices. Interaction energy of generalised monopoles. Calculation of the fluctuation determinant in the purely Skyrmelike $O(3)$ sigma model.

Dr. Vandyck continued study of the problem of covariant differentiation of spinors.

Dr. Watts continued his research into the existence of (-1)-branes in type IIB supergravity and into the algebraic treatment of anomalies in W_N-gravity theories. He started looking into instanton calculation of superpotential in $N = 2D = 1 + 3$ supersymmetric theory.

3.2 Applied Probability Theory

Work continued on the MEASURE project supported by a Long Term Research contract

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

Six tasks were completed in 1997: comparative study of traffic characterization; comparative study of estimators; estimator development for public ATM networks; estimator realization for local ATM networks; demand characterization for the Nemesis operating system; estimator development for the Nemesis operating system. The DIAS-STP group made major contributions in all of these tasks. Work continued on the development of a near-optimal connection-acceptance-control algorithm. The intellectual property rights arising from this work have been protected by filing a patent application in the names of Cambridge University, DIAS and Telia.

Prof. Lewis continued his collaboration with Dr. Sullivan. They completed work on the asymptotic behaviour of the tail of the probability distribution of the length of a queue in an infinite buffer. In particular, they studied the case where the arrivals process has long-range dependences. With Professor Pfister, they continued their work on the application of large deviation theory to ergodic theory. They obtained a new proof of Kakutani's Theorem on the existence of generic points for stationary measures.

Mr. Corluy carried out a literature study of traffic policing (PAR, SPAR, RCBR) of ON-OFF sources. He also studied Large Deviation theory.

Dr. Duffield worked in the following areas of the mathematics of telecommunications : data traffic, measurement and analysis; performance analysis for admission control, bandwidth sharing, network pricing and video smoothing; inference of remote traffic characteristics; Large Deviation theory and applications.

Mr. Duffy studied Large Deviation theory, idempotency and their connection to one another.

Mr. Dukes considered problems in multimedia operating systems. He also carried out research into Matroid theory and the possible application of Large Deviations to it.

Ms. Huggard continued her study of scheduling algorithms in computer operating systems. She also investigated resource allocation for multimedia applications.

Mr. McGurk developed C code to simulate connection admission control on an ATM switch. Using the simulator, he investigated the use of Large Deviation theory in a CAC algorithm. The resulting algorithm was tested with a variety of different parameters and call arrival processes. He also worked on trying to prove a Central Limit Theorem for products of random topical operators, using the Large Deviation result proved by Toomey earlier in the year.

Mr. Russell worked on Large Deviation theory and order theory, and on the estimation of Large Deviation properties of long-range dependent processes. He developed some general principles for transforming Large Deviation principles, by refining the standard Contraction Principle and by applications of the principle to random time-changes. He also studied Galois connections and gave a construction of the space of all adjunctions between continuous Heyting algebras . He investigated the estimation of Large Deviation properties and queueing properties of long-range dependent traffic using extensive simulation experiments.

Dr. Sullivan, in collaboration with Profs. Lewis and Pfister worked on applications of the theory of Large Deviations to problems in information theory and queueing theory.

Mr. Toomey worked on Large Deviations in stochastic discrete event systems.

Mr. Walsh calculated the worst case traffic that satisfies leaky bucket constraints, under various criteria of badness.

3.3 Classical Statistical Mechanics

Dr. Buffet studied polymers with random charges. A representation of the free energy in terms of local time was obtained.

3.4 Quantum Statistical Mechanics

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

3.5 Quantum Theory and Quantum Electronics

Dr. Conneely studied atomic physics and multiply excited states of few electron atoms.

Dr. Garavaglia studied quantum mechanical properties of virtual Z-Bosons.

Prof. Solomon studied the properties of exotic photon states formed from conventional or deformed photons. He also looked at the Hubbard model for high T_c superconductivity and the quantum Hall effect.

3.6 Applied Mathematics

Dr. Buffet studied models of financial markets with heterogeneous agents.

Dr. Burzlaff continued his study of extended objects in gauge theories. Together with Dr. Kellegher he derived asymptotic expansions for static vortices. With Dr. Zakrzewski he studied the scattering of CP^N solitons in the collective coordinate approximation. He described magnetic monopoles close together in the scattering process in collobaration with Dr. Abdelwahid.

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

Dr. Lynch carried out research in numerical weather prediction. He worked on the development and implementation of a digital filtering initialization scheme in the HIRLAM model.

3.7 Pure Mathematics

Dr. Goldsmith investigated Abelian groups and modules with an emphasis on endomorphisms.

4 Research Reports

Research work during the year was written up in the first instance in research reports. A list of titles of these reports (preprints) were prepared and circulated to a mailing list of approximately 350 research institutes and university departments throughout the world. As far as possible, copies of the preprints were sent out in response to requests. Many of the reports appeared later as publications. (See section 10.3).

DIAS-STP-97-

-1: K. Arthur, G. Roche, D.H. Tchrakian, & Y. Yang: Skyrme models with self-dual limits: $d = 2, 3$.

-2: A. Chakrabarti, & D.H. Tchrakian: Spherically symmetric instantons of the scale invariant $SU(2)$ gauged Grassmannian model in $d = 4$.

-3: K. Arthur, & D.H. Tchrakian: $SO(3)$ gauged soliton of an $O(4)$ sigma model on R_3.

-6: M. Magro, L. O'Raifeartaigh, & I Sachs: Seiberg-Witten effective Lagrangian from superconformal ward identities.

-7: L. O'Raifeartaigh: On instanton computations in N = 2 supersymmetric gauge theory.

-8: F. Freire, & D.F. Lithim: Finite temperature phase transition and cross-over in scalar QED.

-9: C. Chryssomalakos: Drinfeld twist for quantum $su(2)$ in the adjoint representation.

-10: D. Birmingham, S. Sen, & I. Sachs: Three dimensional black hole and string theory.

-11: A.A. Puhalskii: Moderate deviations for queues in critical loading.

-12: F. Delduc, L. Fehér, & L. Gallot: Nonstandard Drinfeld-Sokolov reduction.

-13: L. O'Raifeartaigh, & V.V. Sreedhar: Conformally invariant path integral formulation of the Wess-Zumino-Witten $\rightarrow$ Liouville reduction.

-14: C. Ford, & I. Sachs: On the canonical equivalence of Liouville and free fields.

-15: N. Bjorkman, A. Latour-Henner, A. Miah, S. Crosby, I. Leslie, M. Davey, R. Russell, & F. Toomey: Exploring the queueing behaviour of ATM switches.

-16: J.T. Lewis, & R. Russell: An introduction to large deviations for teletraffic engineers.

-17: C. Walsh, & N.G. Duffield: Predicting QOS parameters for ATM traffic using shape-function estimation.

-18: S. CROSBY, I. LESLIE, B. MCGURK, J.T. LEWIS, R. RUSSELL, & F. TOOMEY: Statistical properties of a near-optimal measurement-based CAC algorithm.

-19: B. MCGURK, & R. RUSSELL: Simple bounds for queues fed by Markovian sources: a tool for performance evaluation.

-20: B. MCGURK, & C. WALSH: Investigations of the performance of a measurement-based connection admission control algorithm.

-21: J.T. LEWIS, R. RUSSELL, F. TOOMEY, B. MCGURK, S. CROSBY, & I. LESLIE: Practical connection admission control for ATM networks based on on-line measurement.

-22: M. HUGGARD, F. TOOMEY, P. BARHAM, S. CROSBY, & N. STRATFORD: Measurement based admission control and resource allocation for multimedia applications.

-23: B.P. DOLAN: Renormalisation flow and geodesics on the moduli space of four dimensional $N = 2$ supersymmetric Yang-Mills theory.

-24: J. BURZLAFF, & W.J. ZAKRZEWSKI: CP^2 soliton scattering : the collective coordinate approximation.

-25: K. ARTHUR, G.M. O'BRIEN, & D.H. TCHRAKIAN: Towards a Coulomb gas of instantons of the SO(4) X U(1) Higgs model on R_4.

-26: W.G. SULLIVAN, & J.T. LEWIS: On the Duffield-O'Connell asymptotics for single-server queues.

-27: J.T. LEWIS, CH.-E. PFISTER, & W.G. SULLIVAN: Generic points : a large deviation theory approach.

-28: E.V. IVASKEVICH, & V.B. PREIZZHEV: Introduction to the sandpile model.

-29: E.V. IVASHKEVICH: Symmetries of the stochastic Burgers equation.

5 Seminars, Review Lectures, Series, Courses

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

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

5.1 Statutory Public Lecture

The statutory public lecture entitled *Quantum computing* was delivered by Prof. R. Werner (Braunschweig) in University College Dublin, Belfield on 27 November.

5.2 Seminar and review lectures given at DIAS-STP

- Prof. F. Baccelli (INRIA, France) *Rare events for stationary processes.*
- Prof. F. Delduc (ENSLAPP, France) *Supersymmetric integrable hierarchies.*
- Dr. N. Duffield (AT, & T) *Recovery from rare congestion events.*
- Dr. I. Lundy (Adelaide) *Theoretical population genetics of spatially structured populations.*
- Dr. D. MacKernan (Brussels) *The choice of observables in the probabilistic description of deterministic chaos.*
- Prof. R. Musto (Naples) *New tetrad formalism in general relativity.*
- Dr. N. O'Connell (BRIMS, Bristol) *Can we exploit partial symmetry in large deviation theory?*
- Prof. V. Priezzhev (Dubna) *Reaction-diffusion systems and self-organised criticallity.*
- Prof. A. Pukhalsky (Moscow) *Large deviations of semimartingales.*
- Mr. D. Rose (Cambridge) *The Poisson-Independence hypothesis and the modelling of large queueing networks.*
- Mr. R. Russell *The large deviations of random time-changes.*
- Dr. O. Schnetz *Knots, numbers and Feynman graphs.*
- Mr. F. Toomey *Rare events in stochastic discrete event systems.*
- Dr. S. Turner (Cambridge) *Heavy traffic and large networks.*
- Dr. S. Turner (Cambridge) *Large deviations and fast simulation.*

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

- Dr. D. Birmingham (UCD) *State sum models and simplicial cohomology.*
- Dr. B. Dolan (Maynooth) *Renormalisation flow and geodesics in $N = 2$ supersymmetric Yang-Mills theory.*
- Dr. T. Garavaglia (DIT) *Low mass Higgs detection at LHC.*
- Dr. M. Kirchbach (Darmstadt/Mainz) *Is the eta meson a Goldstone boson?*
- Dr. I. Sachs *Seiberg-Witten effective action from superconformal word-identities.*
- Prof. S. Sen (TCD) *K3 surfaces and duality.*
- Dr. V.V. Sreedhar *Spin, statistics and Yang-Baxter algebra in Chern-Simons gauge theory.*
- Dr. V.V. Sreedhar *Conformally invariant path integral formulation of the Wess-Zumino-Witten to Liouville reduction.*

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

- Prof. J.T. Lewis Course on Probability Theory (TCD)
- Prof. L. O'Raifeartaigh *M.Sc course on Gauge Theory* (DIAS)
- Dr. I Sachs *Lectures on Supersymmetry* (TCD, 3 lectures)
- Mr. F. Toomey *Large Deviations of product of random max-plus matrix operators* (Waterford)

5.5 Seminars, Lectures and Courses given abroad

- Prof. J.T. Lewis *Generic points for stationary measures : a Large Deviation Theory approach* (BRIMS, Bristol) *Equivalence of ensembles : applications to information theory* (Cambridge) *Can entropy-based CAC algorithms work when the traffic is Hursty?* (Oberwolfach)
- Prof. L. O'Raifeartaigh *Seiberg-Witten theory* (Yerevan,Erlangen, Regensburg)
- Ms. M. Huggard *A queue-server paradigm for the Nemesis operating system* (Cambridge) *Measurement based admission control and resource allocation for multimedia applications* (Cambridge)
- Dr. E. Ivashkevich *Self-organised criticality* (Taipei)
- Mr. R. Russell *Simple bounds for queues fed by Markovian sources: a tool for performance evaluation* (St. Malo) *Random time-changes in queueing theory* (Cambridge)
- Dr. M. Magro *Uniqueness of Seiberg-Witten effective Lagrangian* (Annecy, Saday) *Introduction to Seiberg-Witten theory* (Orsay) *The Seiberg-Witten theory* (Montpellier, Marseille) *Seiberg-Witten effective Lagrangian from superconformal ward identities* (Paris)
- Dr. J. Pawlowski *Flow equations, gauge invariance and the $U(1)$-problem.* (Barcelona)
- Dr. I Sachs *Uniqueness of the Seiberg-Witten effective action.* (Imperial College, Bad Honeff) *Low energy effective actions in supersymmetric QCD.* (Jena) *Duality from superconformal ward identities.* (Cambridge)
- Mr. F. Toomey *Mathematical aspects of statistical multiplexing.* (4 lectures, Cambridge)
- Mr. C. Walsh *Predicting QoS paramters for ATM traffic using shape-function estimation.* (Manchester) *Investigations of the performance of a measurement-based connection admission control algorithm.* (Ilkley)

6 Activities of Members of DIAS-STP

6.1 Activities within Ireland

PROF. J.T. LEWIS: National Innovation Conference 'Partnerships for Success ', Limerick, 10 December

MR. K. DUFFY: ALEPEDES convention, Waterford, 7-9 September.

MR. M. DUKES: ALEPEDES convention, Waterford, 7-9 September.

Ms. M. Huggard: ALEPEDES convention, Waterford, 7-9 September.

Dr. M. Magro: Fourth Irish Quantum Field Theory meeting, Dublin, May.

Mr. B. McGurk: ALEPEDES convention, Waterford, 7-9 September.

Mr. R. Russell: ALEPEDES convention, Waterford, 7-9 September.

Dr. I Sachs: Fourth Irish Quantum Field Theory meeting, Dublin, May.

Mr. F. Toomey: ALEPEDES convention, Waterford, 7-9 September.

Mr. C. Walsh: ALEPEDES convention, Waterford, 7-9 September.

6.2 Activities outside Ireland

Prof. J.T. Lewis: ESPRIT-MEASURE review meeting, Cambridge, 5-8 February; 14th. U.K. Teletraffic Symposium, Manchester, 24-26 March; MEASURE Meeting, Cambridge 15-17 April; TMR Networks panel, Brussels, 20-22 April; MEASURE Meeting, Cambridge, 28-29 April; School of Mathematics, EPFL, Lausanne, 12-23 May; BRIMS, Bristol 28-29 May; Cambridge, 2 June; Hewlett-Packard, Bristol, 28-29 June; University College Swansea, 7-11 July; MEASURE meeting, Cambridge, 1-2 September; Statistical Modelling of Physical Systems, Cambridge, 8-15 September; RITE Project, San Francisco, 2-4 October; BRIMS, Bristol, 8 October; Cambridge University Computer Laboratory and Microsoft Research, Cambridge, 20-21 October; Cambridge MEASURE management, 24-25 November; Ericsson Teletraffic Workshop, Budapest, 30 November - 3 December; Oberwolfach, Germany, 14-18 December.

Prof. L. O'Raifeartaigh: Conference to celebrate Sixieth Birthdays of J.Patera and P. Winternitz, Montreal, Canada, 8-11 January; Naples and Salerno, 28 April - 4 May; VIII Regional Conference on Theoretical Physics, Yerevan, Armenia, 26 June - 5 July; Group Theory in Physics, Dubna, Russia, 26 July - 4 August; Lie Algebraic Methods in Physics, Clausthal, Germany, 18-21 August; Graduate Student Study Days, Erlangen and Regensburg, Kloster Banz, Bavaria, 18-21 September; Memorial Meeting for Prof. A. Salam, ICTP Trieste, 27-29 November; SISSA, Trieste, 1-5 December.

Mr. M. Corluy: Antwerp, 1-8 November.

Mr. I. Dowse: Cambridge meeting, 31 August - 2 September; MEASURE Management meeting, 23-25 November.

Mr. K. Duffy: MEASURE Review meeting, Cambridge, 6-7 February.

Ms. M. Huggard: MEASURE review meeting, Cambridge, 6-7 February, 31 August - 2 September; Stochastic Networks Workshop, Cambridge, 12 December.

Dr. I. Ivashkevich: Statphys. - Tapei- 1997, Taipei, Taiwan, 2-12 August.

Dr. M. Magro: ENSLAPP, Annecy France, 6 January; Tours, 12 February; ENSLAPP, Lyon France, 13-20 February; CEA, Saday, 21-24 February; LPTHE, Orsay, 25 February; IPN, Orsay, 27 February; LPM, Montpellier, 17 April; CPT, Marseille, 18 April; Tours, 25-27 April; LPTHE, Paris, 28 April.

Mr. B. McGurk: MEASURE Review meeting, Cambridge, 6-7 February; MEASURE Management meeting, Cambridge, 15-17 April; IEEE ATM '97, Lisbon, May; Performance Tools '97, St. Malo, June; ATM Networks '97, Ilkley, 21-23 July; Cambridge, 31 August - 2 September; MEASURE management meeting, Cambridge, 23-25 November;

Dr. J. Pawlowski: Jena, 19-20 November; Barcelona, 26 November - 7 December; Annual Theory Meeting, Rutherford, 15-17 December.

Mr. R. Russell: MEASURE Review meeting, Cambridge, 6-7 February; MEASURE Management meeting, Cambridge, 15-17 April; Cambridge Computer Laboratory, 28-29 April; IEEE ATM '97, Lisbon, June; Cambridge, 2 June; Performance Tools '97, St. Malo, France, 3-6 June; Mathematical Physics Conference in honour of Prof. J.T. Lewis, Swansea, 7-12 July; Cambridge, 31 August - 2 September; Cambridge 9-12 September; MEASURE management meeting, Cambridge, 23-25 November; Stochastic Networks Workshop, Cambridge, 12 December.

DR. I. SACHS: Imperial College, London, 15-17 January; Beyond the Standard Model, Bad Honeff, Germany, 2-7 March; Jena, 10-14 March; Non-perturbative aspects of Quantum Field Theory, Cambridge, 22 April - 2 May; Strings '97, Amsterdam, 16-21 June.

DR. O. SCHNETZ: Strings '97, Amsterdam, 16-21 June.

MR. F. TOOMEY: MEASURE Review meeting, Cambridge, 6-7 February; Cambridge Computer Laboratory, 28-29 April; IEEE ATM '97, Lisbon, June; Cambridge, 2 June; Performance Tools '97, St. Malo, France, 3-6 June; Mathematical Physics Conference in honour of Prof. J.T. Lewis, Swansea, 7-12 July; Cambridge, 31 August - 2 September; MEASURE meeting, Cambridge, 28 October - 5 November; MEASURE management meeting, Cambridge, 23-25 November; Stochastic Networks Workshop, Cambridge, 12 December.

DR. S. VINNAKOTA: Fifth Nordic Meeting on Supersymmetry, Uppsala, Sweden, 16 November - 2 December.

MR. C. WALSH: 14th UKTS, Manchester, 24-26 March; MEASURE Management meeting, Cambridge, 15-17 April; 5th IFIP Workshop on ATM networks, Ilkley, 21-23 July.

7 Symposia

Two Mathematical Symposia were held during the year, 20-21 March and 22-23 December. The attendance (30 in March, 38 in December) included professors, lecturers, and graduate students from the Irish universities and other third-level and research institutes, and from institutes abroad, and members of the scientific schools of DIAS.

Lectures were given as follows:

March

Review Lectures:

- Prof. M. van den Berg (Bristol) *Heat equation on the arithmetic von Koch snowflake.*
- Prof. J. Rawnsley (Warwick) *Poisson manifolds.*

Lectures:

- Dr. J.V. Pulé (UCD) *Localised and extended states for random Landau Hamiltonians.*
- Dr. W. Sullivan (UCD) *Normal numbers, ergodicity and large deviations.*
- Mr. D. Malone (TCD) *A multi-resolution approach to the Fourier transform.*
- Dr. D. Kelly-Lyth (KCL) *Wavelets and Fuchsian groups.*

Short Talks:

- Dr. J. Gough (Maynooth) *The Stratonvich interpretation of quantum stochastic theory.*
- Mr. A. Kinsella (DIT) *Linear functions of sorted random data.*
- Dr. M. Mathieu (Maynooth) *Jordan triple homomorphisms of C^*-algebras.*
- Dr. S. O'Brien (UL) *Surface tension effects in liquid films.*
- Dr. B. Nolan (DCU) *A characterisation of strong wave tails in curved space-time.*

December

Review Lectures:

- Dr. K. Hannabuss (Oxford) *Sound and Symmetry: Applications of group representation theory to sound recording.*
- Mr. R. Russell (DIAS) *Adjunctions everywhere: a review of galois connections.*

Lectures:

- Dr. M. Mathieu (NUI, Maynooth) *How to use local multipliers to study operators on C^* algebras.*
- Dr. A. Patrick (DCU) *Mathematics for derivatives trading.*
- Dr. B. Nolan (DCU) *How to embed a point mass in an isotropic universe.*
- Dr. E. Flanagan (Cornell) *Negative energies in quantum field theory.*

Short Talks:

- Prof. A. Wood (DCU) *Spectral asymptotics for high order differential equations.*
- Mr. M. Hayes (UL) *The coating profile in front of a step, resulting after spin-coating.*
- Dr. H. Joyce (U. Jyvaskyla) *How large can an invisible set be?*
- Dr. S. O' Brien (UL) *Film flow in a rotating cylinder.*

- Dr. M. McGettrick (Ecole des Mines, Paris) *Idempotent semirings and train-scheduling.*
- Prof. M. Newell (UCG) *On Sanov Groups.*

8 Conference

A one day conference to celebrate the centenary of the birth of *John Lighton Synge* was held on Saturday 22 March in The Joly Lecture Theatre in Trinity College Dublin. The following lectures were delivered.

- Prof. N. Hitchin, FRS (Cambridge) *Einstein's equations and the quaternions.*
- Prof. R. Bott (Harvard) *On characteristic classes of imbeddings.*
- Prof. C. Morawetz (NYU) *John Lighton Synge.*
- Prof. W. Israel (Edmonton) *The internal geometry of black holes : from J.L. Synge to the present day.*
- Prof. Sir M. Berry, FRS (Bristol) *Quantum mechanics, chaos and the prime numbers.*

9 Visitors

As in previous years, visitors from abroad came to the School for short or long periods, for discussions with School's members, to give seminars, and to avail of the School's library resources for their research work. For lectures given by visitors, see section 5.2

Short visits (up to one week):
F. Baccelli (France) 4-6 September,
C. Bachas (France) 16-23 May,
R. Capouilla (Mexico) 24 June - 2 July,
J. Chela-Flores (Trieste) 18 November,
S. Crosby (Cambridge) 2-3 January,
I. Lundy (Adelaide) 6-7 August,
D. MacKernan (Brussels) 18-19 September,
R. Musto (Naples) 4-10 September,
N. O'Connell (Brims) 11-18 May,
17-24 November,
D. O'Connor (Mexico) 30 June - 7 July,
14-21 July,
C. Pfister (Lausanne) 29 April - 2 May,
D. Rose (Cambridge) 16-20 November,
I. Sachs (Durham) 10-17 November,
I. Tsutsui (Tokyo) 13-17 August,
G. Vitiello (Salerno) 14-17 May,
R. Werner (Braunschweig) 25-28 November,

Longer visits:
J. Balog (Budapest) 18 June - 1 July,
F. Delduc (ENS, Lyon) 12-20 July,
L. Fehér (Bonn) 5 May - 31 August,
G.W. Ford (Ann Arbor) 25 May - 29 June,
C. Graham (Canada) 6 October -
22 December,
O. Gulinsky (Moscow) 6-27 October,
J. Guven (UNAM, Mexico) 17 June -
3 September,
R.F. O'Connell (Louisiana) 2 June -
3 August,
E. Pechersky (Moscow) 11 April - 11 May,
C. Pfister (Lausanne) 1-10 October,
V. Priezzhev (Dubna) 22 September -
6 November,
A. Pukhalsky (Moscow) 9-27 June,
O. Schnetz (Germany) 14 January -
14 February,
V. Shrypnik (Kiev) 19 November -
15 December,
S. Turner (Cambridge) 2-10 October,
N. Vvedenskaya (Moscow) 15 April - 15 May,

10 Publications

10.1 Books

L. O'Raifeartaigh: Dawning of gauge theory. *Princeton University Press, 1997.*

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

None published.

10.3 Contributions to periodical and other publications

J.T. Lewis, C.-E. Pfister, R.P. Russell, & W.G. Sullivan: Reconstruction sequences and equipartition measures : an examination of the asymptotic equipartition property. *IEEE Transactions on Information Theory* **43**(1997)1935-1947.

N. Bjorkman, A. Latour-Henner, A. Miah, S. Crosby, I. Leslie, M. Davey, R. Russell, & F. Toomey: Exploring the queueing behaviour of ATM switches. *Peformance Evaluation, Vols 27 and 28 (1996) pp89-98, North Holland.*

J.T. Lewis, & R. Russell: An introduction to large deviations for teletraffic engineers. *Performance 96 Tutorials, Laboratoire de Reseaux de Communication, EPFL, 1997.*

C. Walsh, & N.G. Duffield: Predicting QOS parameters for ATM traffic using shape-function estimation. *Proc. 14th. IEE UK Telefraffic Symposium (UKTS 1997).*

S. Crosby, I. Leslie, B. McGurk, J.T. Lewis, R. Russell, & F. Toomey: Statistical properties of a near-optimal measurement-based CAC algorithm. *Proc. IEEE ATM '97, Lisbon, Portugal, 1997.*

B. McGurk, & R. Russell: Simple bounds for queues fed by Markovian sources: a tool for performance evaluation. *Computer Performance Evaluation, Modelling Techniques and Tools, Lecture Notes in Computer Science 1245, Springer. (Proc. 9th. Intern. Conf., St. Malo, France, June, 1997).*

B. McGurk, & C. Walsh: Investigations of the performance of a measurement-based connection admission control algorithm. *Proc. 5th IFIP Workshop on Performance Modelling and Evaluation of ATM Networks, July 1997, Yorkshire, England.*

F. Toomey: Statistical properties of a near-optimal measurement based CAC algorithm. *Proc. IEEE ATM '97.*

L. O'Raifeartaigh, I. Sachs, & C. Wiesendanger: Weyl-gauging and conformal invariance. *Nucl. Phys. B* **495**(1997)433.

R. Flume, M. Magro, L. O'Raifeartaigh, I Sachs, & O. Schnetz: Uniqueness of the Seiberg-Witten effective Lagrangian. *Nucl. Phys. B* **494**(1997)331-345.

M. Magro, L. O'Raifeartaigh, & I Sachs: On the Uniqueness of the effective Lagrangian for $N = 2$ SQCD. *Nucl. Phys. B* **508**(1997)433-448.

W. McGlinn, & L. O'Raifeartaigh: Completeness of canonical reductions from KM to w algebras. *Nucl. Phys. B* **503**(1997)688.

J. Chela-Flores: A search for extraterrestrial eukaryotes: biological and planetary science aspects. *Astronomical and Biochemical Origins and the Search for Life in the Universe. Eds. C.B. Cosmovici, S. Bowyer and D. Werthimer. Editrice Compositore : Bologna 1997, pp 525-532.*

B. Dolan: Geodesic renormalisation group flow. *Intern. J. Mod. Phys. A* **12**(1997)2413.

B. Dolan, & K.P. Haugh: A co-variant approach to Ashtekar's canonical gravity. *Class. Quantum Gravity* **14**(1997)477.

E. Buffet, & J.V. Pulé: A model of continuous polymers with random charges. *J. Math. Phys.* **38**(1997)5143-5152.

D.H. Tchrakian: Topologically stable lumps in $SO(d)$ gauged $O(d+1)$ sigma models in d dimensions : $d = 2, 3, 4$. *Lett. Math. Phys.* **40**(1997)191-201.

J. Spruck, D.H. Tchrakian, & Y. Yang: Multiple instantons representing higher-order Chern-Pontryagin classes. *Commun. Math. Phys.* **188**(1997)737-751.

K. Arthur, G.M. O'Brien, & D.H. Tchrakian: Towards a Coulomb gas of instantons of the SO(4) X U(1) Higgs model on R_4. *J. Math. Phys.* **38**(1997)4403-4421.

D.H. Tchrakian, & T.N. Tomaras: Maxwell-Chern-Simons gauged non-relativistic $O(3)$ sigma model with self-dual vortices. *Mod. Phys. Lett. A* **12**(1997)2691.

11 Library

Approximately three hundred new titles were added to the library stock during the year; one hundred and thirty current periodicals were taken, of which approximately fifty were received by gift or under exchange arrangements. As in previous years, offprints and preprints were received from many scientific institutes and university departments at home and abroad, either

directly or in response to requests. Computerisation of the main author catalogue was completed.

Annual Report of the Governing Board of the School of Cosmic Physics for the year ending 31 December 1997 adopted at its meeting on 15 October 1998.

1 Staff, Scholars and Associates

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

PROFESSORS: A. Thompson, (two vacancies).

ASSISTANT PROFESSORS: D. O'Sullivan, B.M. O'Reilly (from 01 May, contract basis), T.P. Ray, P.W. Readman.

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

EXPERIMENTAL OFFICERS: T.A. Blake, B.D. Jordan, W.-M. Tai (to 31 March), J. Walsh (from 01 March, computer manager, contract basis).

VISITING SCIENTISTS: L. Adams (University of New South Wales), D. Bartlett (National Radiological Protection Board, England), C.J. Bean (UCD), T. Bopp (18 June), M. Burton (University of New South Wales), V.M. Costa (CAUP, 02-21 June), J. Dyson (University of Leeds), F. Falle (University of Leeds), W. Heinrich (University of Siegen, Germany), N. Kenyon (Southampton), M.A. Khan (Leicester), T. LeBas (Southampton), S. Lilly (University of Toronto, 17-18 June), J. McCloskey (University of Ulster), P. Maguire (Leicester), T. Mason (Armagh Planetarium, 27 November), J. Mechie (Potsdam), G. Meesen (University of Ghent, Belgium), M. Micono (University of Turin), F.E. Murphy (Ottawa), F. Murtagh (University of Ulster, 04 October), K. O'Brien (University of Arizona, USA), C. Prodehl (Karlsruhe), A. Raga (University of Mexico, UNAM), G. Ranalli (Ottawa), T.P. Shah (Rutherford Appleton Laboratory), P. Shannon (UCD), K. Stammler (Erlangen), C. Tadhunter (University of Sheffield, 02-04 October), J. Tedds (University of Leeds), M. Wilkinson (Oxford University, 02-04 October), R.E. White (University of Arizona, Fulbright Professor, to 30 June).

TECHNICAL AND CLERICAL STAFF: G. Broderick (to 15 May), A. Byrne, A.M. Callanan, E. Clifton, P. Daly (part-time), W. Dumpleton, E. Flood, A. Grace-Casey, C.M. Horan, S. Ledwidge, D. Meghen, M. Smyth, H. Sullivan, G. Wallace, (three vacancies).

SCHOLARS: G.F. Byrne (to 31 July), M. Carr (from 01 September), F. Casey (from 01 October), J. Cunniffe (from 01 September), J. Donnelly, T. Downes (to 30 November), K. Farrell (to 30 September), J. Hodgson (from 01 October), A.J. Keane, M. Landes, K. McGrane, F.E. Murphy (to 28 February), O. Novak (to 30 June), A. O'Brien, B.M. O'Reilly (to 30 April), S. O'Sullivan, A. Scally (to 30 September), V. Unnithan (from 01 October), Z. Zang, D. Zhou.

PROJECT SUPPORTED POSITIONS: C.J. Davis (Jets from Young Stars, to 30 June), F. Hauser (COMBONET), L. Norci (High Energy Studies of Star Formation), G. Manfredi (Particle Transport in Turbulent Fusion Plasmas, from 01 March), M. Mond (Stability of Astrophysical Shockwaves, from 18 August to 17 November).

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

RESEARCH ASSOCIATES: C.J. Bean (UCD), P.B. Byrne (Armagh, to 16 September)*, M. Cawley (SPCM), D. Corcoran (DCU), P. Duffy (UCD), R. Keary (GSI), A. Lawrence (Edinburgh), B. McBreen (UCD), J. Makris (Hamburg), P. Morris (UK), N.P. Murphy (BP), F. Murtagh (Garching), W.E.A. Phillips (TCD), V.F. Polcaro (IAS, Frascati), C. Prodehl (Karlsruhe), S.C. Russell (UCD), P.M. Shannon (UCD).

PROJECT STUDENTS: L. Johnston (TCD, 01 October - 31 December), R. Lynch (TCD, 01 October – 31 December).

VACATION STUDENTS: S. Jacob (TCD, 31 May-12 September), A. O'Lorcain (14 July - 29 August), N. McEntee (TCD, 30 June - 22 August), D. O'Connell (TCD, 18 June - 29 August), C. Power (TCD, 01-20 June).

*P.B. Byrne died on 16 September 1997.

2 Research Activities in the Astrophysics Section

2.01 Possible Signatures of Dust Acceleration

L. Drury with D. Ellison (NCSU)

One interesting consequence of the dust grain model for explaining the cosmic ray composition data is that Supernova remnants must accelerate interstellar dust grains. It would be a striking confirmation of the theory if direct evidence for such accelerated grains could be found. Unfortunately this is not easy, however one possibility is to look for Doppler broadening of nuclear deexcitation lines from nuclides trapped in grains. In this context the recent observation of anomalously broad Al26 lines from the Galactic centre appears interesting, however initial estimates suggest that dust acceleration alone is unlikely to explain the observations.

2.02 ISOPHOT observations of SNRs

L. Drury with R. Tuffs (MPIK) and I. Rasmussen (DSRI)

The ISOPHOT instrument on ISO has been used to observe a number of Galactic supernova remnants, mainly Cas-A and Tycho. In Cas-A the grating spectrograph, PHOT-S, has revealed extensive highly structured line emission in the mid-IR with strong lines of Argon and Sulphur. There is some evidence for a weak underlying continuum which may be infra-red synchrotron emission. Photometry and mapping in the far-IR indicate the presence of newly condensed cold dust in the interior of the remnant.

2.03 Numerical Simulations of the Kelvin-Helmholtz Instability in Jets

T.P. Downes and T.P. Ray

It has been speculated that a number of features seen in astrophysical jets may be due to the non-linear growth of Kelvin-Helmholtz instabilities: for example the quasi-periodic knots and sinusoidal motion observed in both jets from active galactic nuclei and the much smaller scale jets from young stars. Although this idea has been tested in the case of extra-galactic jets, which are easier to model, Kelvin-Helmholtz instabilities are only now being numerically simulated for young stellar object (YSO) flows. This is largely due to the fact that in YSO flows one has to take account of radiative cooling.

With these ideas in mind, simulations were carried out using the code developed by T.P. Downes of slab symmetric (2-D) jets with cooling appropriate for YSO flows. It was discovered that, in general, cooling acts to increase the level of mixing between jet and ambient material through the "breaking" of Kelvin-Helmholtz waves on the surface of the jet. It was also found to increase the amount of momentum transferred from jet material to ambient material, increase the time taken for shocks to develop in the flow, reduce the strength of these shocks, and reduce the rate of de-collimation of momentum flux. Simulations were also carried out in 2.5D (cylindrical symmetry). Rather interestingly very different results were obtained for the slab and cylindrically symmetric jets in the non-linear regime because of their different energy distributions associated with the growth of the instability.

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

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

With analysis of all the ultra heavy cosmic ray events from approximately 35% of the accessible UHCRE collecting area completed, a programme for the extraction of cosmic ray actinides from the remainder of the accessible collecting area, by means of an "actinide skim" procedure, was initiated early in the year. This procedure is considered to be the most effective way of optimising data extraction for the near future, with the resources now available, since the current primary objective is to extend information on the *relative* abundance(s) of the actinides. In this regard the present sample of analysed sub-actinides is more than adequate in the context of Gaussian errors, since the abundance of actinides ($Z \geq 88$) is about two orders of magnitude less than that of the platinum–lead group ($74 \leq Z \leq 87$). The important requirement, which has been satisfied, is that the actinide skim samples be statistically fully compatible with earlier samples from completely analysed detector stacks, ie be part of the same population. The technique employs five ammonia-scanned polycarbonate detector plates from each

UHCRE detector stack, as before, to locate penetrating ultra heavy cosmic ray events. However, instead of the full etching, measurement and analysis of all these events, the signal strength (track etch rate) is determined for each event in three detector plates etched for 120 hrs. For very high ionisation events the signal strength is determined in a single 72 hr or 48 hr plate. By choice of selection criteria, in particular a threshold value for signal strength, actinide candidates can be extracted and then etched, fully measured and analysed with zero actinide loss with respect to the procedures used hitherto. During the year, the actinide-skim procedure was completed for a total of thirty detector stacks, which is less than originally planned. The shortfall was mainly due to an unexpected and significant reduction in the number of staff available for optical microscopy and also due, to a lesser extent, to work required for the completion of some other UHCRE commitments.

Recent results from the UHCRE and associated nuclear track detector response work, featuring the updated ultra heavy cosmic ray spectrum, the lead/platinum ratio and the relative abundance of actinides, were presented at the 25th International Cosmic Ray Conference (Durban, South Africa) during August.

2.05 The Production of Jets from Young Stars

S. O'Sullivan and T.P. Ray

Jets from young stars almost certainly contain magnetic fields. In fact current theories for their origin not only invoke magnetic fields as a means of generating flows from young stars but also as a means of subsequently collimating them. With these ideas in mind a second order upwind scheme for multi-dimensional magneto-hydrodynamics has been developed. This scheme uses a linear approximation to the solution except in regions giving non-physical results where a non-linear iterative solver is employed. Magnetic flux is conserved by formally including small source terms in the conservation equations. The code is parallelised under MPI for use on the Pleiades Cluster of Pentium-Pro PCs in DIAS and the TCD IBM SP2. The code, after being rigorously tested, has been used to simulate adiabatic jets from young stellar objects under the influence of magnetic fields. It is intended to include the effects of cooling shortly. The hope is that this will shed some light on the mechanism which links the generation of jets and molecular winds and the origin of high and low velocity forbidden line emission in young stars.

2.06 Stability of Shocks Modified by Particle Acceleration

L. Drury and M. Mond

The classical criteria of Dyakov and Kontorovich for the stability of shocks against corrugational perturbations and the spontaneous emission of acoustic and entropy waves were applied to the two fluid model of modified shocks. In general the shocks are stable, however for those parameters where three solutions are formally possible the intermediate solution can be shown to be always unstable thereby confirming a long-standing conjecture.

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

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

The main objective of the project is to measure the flux and energy spectra of neutrons and charged particles over a wide energy interval at aviation and mountain altitudes and to compare the results with those calculated using various cosmic ray transport codes. The results will be used to determine the exposure of aircrew to primary and secondary cosmic radiation as a function of altitude and geographical location. The project involves nine European laboratories and is co-ordinated by DIAS which is responsible for the investigation of the $Z \geq 1$ component and related linear energy transfer (LET) phenomena.

Further extensive measurements were carried out for long periods (≈300hrs) on aircraft travelling on subsonic and supersonic routes between Europe and the USA, South America and Japan. In collaboration with the GSF laboratory in Germany, detectors were also exposed at high altitude (17,000ft) on Mount Chacaltaya in Bolivia. The CERN laboratory which is one of the laboratories involved, provides a calibration facility for all members of the project through the provision of a very well defined reference field which simulates the cosmic ray field at aircraft altitudes. DIAS detectors were exposed in CERN during September. These detectors were also independently calibrated by the use of medium energy carbon nuclei at the heavy ion accelerator at

GSI, Darmstadt, and earlier with calcium and iron nuclei at the Berkeley Bevalac.

All detectors used in flight and mountain experiments have now been calibrated and the response characteristics obtained over the whole range of ionisation used in these studies. This is a very important aspect of the DIAS work and provides a significant improvement in reliability of data obtained at various altitudes and geographical locations. While the DIAS detectors rely mainly on calibration with carbon ions, the experiment at CERN allowed a comparison to be made with the detectors of the other groups involved in the project. The result of the September exposure to the CERN radiation field were in very good agreement with those obtained with tissue equivalent proportional counters employed by the University of Saarland. Thus the DIAS work at GSI and CERN has verified the reliability of the CERN field for all other experiments.

Analysis of the data obtained at altitude continued throughout the year. LET spectra in the range 5keV/μm up to ≈500keV/μm were obtained for the Rome-Los Angeles and Rome-Rio de Janeiro routes (subsonic) through the co-operation of Alitalia and further analysis was completed on the Dublin-New York (subsonic) route. Data from the British Airways Concorde route, London-New York (supersonic) was also extended and further analysis completed. In terms of dose equivalent, the Concorde data was a factor of approximately 6 times greater than the Rome-Rio de Janeiro route, with the other routes lying in between. Further analysis and refinement of techniques are continuing.

The principle of integral flux rate measurements of high LET (E≤5keV/μm) used by the DIAS group implies that these rates should scale with absolute neutron fluence rates for different flight routes. Calculations by the Siegen group have recently confirmed this and have enhanced the significance of the DIAS approach as a very reliable method in this area of research.

The second main area of research in this project is the determination of the charge spectrum of charged particles heavier than protons (Z>1) at aviation altitudes. Work on the spectrum for a subsonic flight was completed during the year following further calibration at GSI and showed that the main component was helium with nuclei extending in charge up to oxygen (Z=8). The helium flux agreed very well with that calculated using a heavy ion transport code for cosmic rays in the earth's atmosphere. This work also provided the first measurements of the ratio of dose equivalent resulting from heavy cosmic rays and their secondaries to that caused by neutrons and protons at aviation altitudes. The result showed that the contribution from Z>1 nuclei is not very significant and is less than one per cent.

Publication of results to date await conclusion of agreement with airlines involved.

2.08 Outflows from High Luminosity Young Stars

C.J. Davis and T.P. Ray

Although significant progress has been made in the study of outflows from young, low-mass stars, relatively little is known about outflows from their more massive counterparts. Indeed, only a few outflows from luminous young stars have been studied in detail at near-infrared and (sub-) mm wavelengths. To address this imbalance, a number of luminous outflow regions were imaged in molecular hydrogen emission and in some cases follow-up sub-mm observations were also obtained. The combined data provide new insight into each outflow region. Analysis of the data suggest that, although these flows are more massive and more energetic than their low-mass counterparts, they are nevertheless well-collimated, bipolar and probably jet-driven, much like low mass flows. Molecular bow shocks, driven by an underlying, possibly variable stellar jet, seem to play a major role in entraining and accelerating the ambient gas to produce the observed outflows detected at mm wavelengths.

2.09 Theoretical Studies of Particle Transport in Fusion Plasmas

L. O'C Drury, G. Manfredi, F. Casey and A. Scally with P. Duffy (UCD)

It is widely believed that radial particle transport in the edge regions of tokamaks and stellarators results mainly from small scale, essentially electrostatic, modes driven by the strong density and temperature gradients in this region of the plasma. Unfortunately the parameters of this small scale electrostatic turbulence are very hard to determine by direct diagnostic measurements. This gives added importance to studies of the basic physical processes involved in the generation and evolution of such turbulence and the resulting particle transport; studies of bulk particle transport, and in particular the differential transport of

different species, can be used as diagnostics of the underlying turbulent process, but only if we have adequate theoretical understanding of the fundamental physics. The newly formed plasma physics group in DIAS has focused on three of these areas: (1) *Transport of test-particles in a turbulent electrostatic plasma* (2) *Effect of linear waves on plasma drift turbulence* (3) *Simulation of the long term behaviour of nonlinear Landau damping.*

(1) The Hasegawa-Mima equation has been used as a simple model of drift turbulence. Its numerical solution provides the electrostatic field in which the test-particles are advanced. It is shown that nonlinear effects severely reduce cross-field transport in the direction of the density gradient ("radial"). A visually impressive diagnostic of this effect is obtained by evolving nine poloidal bands of particles with a thin radial width: during the evolution, the bands are left largely intact, with only a little mixing at the boundaries. By contrast, in the linear case, the bands are well mixed, and the particles are rather quickly distributed uniformly throughout the domain.

The effect of nonlinear coupling has been studied by gradually switching on the nonlinear term in the Hasegawa-Mima equation, using a control parameter a. For $a = 1$ the equation is fully nonlinear, while for $a = 0$ it is linear. The radial transport steadily increases as the nonlinearity is reduced. By contrast, transport in the poloidal direction is increased when the nonlinearity is switched on, although not monotonically with a. More interestingly, poloidal transport appears to be super-diffusive, i.e. $\langle x^2 \sim t^{\mu}$, with $\mu > 1$, where x is the poloidal coordinate. A preliminary estimate gives $\mu \equiv 1.5$. A similar exponent is obtained from the mean square displacement of pairs of particles from each other. The corresponding particle distribution is shown to be non-Gaussian in the nonlinear case. Thus not only is the transport in the genuinely nonlinear case highly anisotropic, it is also not diffusive.

(2) The impact of linear drift waves on the turbulent dynamics of the Hasegawa-Mima equation has been studied. Numerical experiments were carried out in a slowly decaying regime with no external forcing. When no linear waves are present, the wavenumber spectrum is isotropic, but considerably steeper than what is predicted by Kolmogorov's theory of stationary turbulence. Large scale vortices are observed, together with high values of the vorticity kurtosis.

Increasing the relative importance of the wave term results in a substantial anisotropy of the flow, with the formation of elongated structures parallel to the direction of propagation of the waves (the poloidal direction x). The large vortices disappear, as they are broken down by the shear effect introduced by the waves. The spectrum then becomes steeper in k_x (with almost no energy at large wavenumbers), and shallower in k_y, getting closer to Kolmogorov's law.

The numerical results were interpreted using a simple model of nonlinear coupling among three waves. It was shown that energy transfer can occur following either a resonant or a non-resonant (turbulent) process. The resonant process is by far less efficient, since the modes must obey a stringent condition on their frequencies. When the wave term dominates, only resonant interactions can occur, thus reducing nonlinear energy transfer. Only for modes with $k_y \gg k_x \sim 1$ is non-resonant coupling allowed, and this provides a qualitative explanation for the observed anisotropic spectra.

The above results provide further evidence that wave effects deeply modify the usual picture of homogeneous and isotropic turbulence. Since test-particle transport has been shown to be rather sensitive to the structure of the underlying turbulent fields, the effects described above have implications for the confinement of charged particles in fusion devices.

(3) In a fusion device, Landau damping in the direction parallel to the magnetic field is one of the main mechanisms of dissipation. However, Landau damping is a typically kinetic phenomenon, which is not easily introduced in the fluid equations normally used to model the large scale dynamics of tokamak plasmas. Some authors have proposed a k-dependent dissipation term, which correctly reproduces *linear* Landau damping within the framework of fluid models. This technique is nowadays widely utilised in fluid codes that study macroscopic tokamak turbulence. However, the long time behaviour of Landau damping is intrinsically nonlinear, and, in order to assess the validity of the above model, it is important to understand whether the damping will continue indefinitely, or will be eventually stopped by the nonlinearity.

In order to gain insight into this problem, the damping of an initial perturbation in a collisionless, Maxwellian plasma has been studied numerically by means of a Vlasov Eulerian code. Accurate long-time simulations (up to 1600 inverse electron plasma frequencies) show that the electric field does not decay to zero, in disagreement with recent analytical results. Instead, after some initial damping, the field amplitude starts to oscillate

around an approximately constant value, and the phase-space distribution develops a vortex structure which survives throughout the simulation.

2.10 Nuclear Track Detector Response Studies

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

The question of a possible significant relationship between signal strength (track etch rate) and etch time for relativistic ultra heavy nuclei in polycarbonate was investigated under the current experimental conditions pertaining to data extraction from the Ultra Heavy Cosmic Ray Experiment (UHCRE, see Section 2.04) detector modules. In order to do this, it was necessary to employ nuclei with sufficiently large gamma factors to be on the relativistic plateau of ionisation so that the energy loss per unit path length was constant. Sets of polycarbonate detector plates from stacks which had been exposed under temperature controlled conditions to a beam of 160 GeV/u lead ions (Z=82) at CERN and to a beam of 10.5 GeV/u gold ions (Z=79) at BNL were etched together in a single tank for six days with subsets of plates removed at 24 hr time intervals. In this way lead and gold nuclei with constant rate of ionisation loss could be followed from plate to plate with plate etch times varying from 24 hrs to 144 hrs (which bracket the etch times used for UHCRE event identification) and with other variables cancelled out. Comprehensive track measurement confirmed that the signal strengths were constant (within experimental error) over the entire range of etch times, ie no dependence of signal on etch time could be detected. Apart from its inherent value, this work is very relevant to optimisation of charge spectrum resolution in the UHCRE analysis.

Further investigation of charge resolution in polycarbonate was conducted during the year, in collaboration with the Berkeley Track Group (University of California), using BP-1 glass detector plates in composite stacks to provide ion identifications independent of the polycarbonate. Exposures to 4.0 GeV/u gold at BNL and 1.2 GeV/u uranium at GSI were employed to yield, in addition to beam nuclei, a spectrum of ions of lower nuclear charge derived from interactions within each stack. In the first case, gold, platinum, iridium and osmium events (Z=79, 78, 77 and 76) derived from the 4.0 GeV/u beam were analysed. The capacity of a detector to resolve adjacent charges in cosmic rays depends on their relative abundances. However, for equal abundances, the mean polycarbonate resolving power (FWHM/(S_1–S_2)) was found to be 87% in this charge and energy region, a region which is characteristic of UHCRE events. This is equivalent to a charge assignment error for a single cone track of ± 0.37e, which would be reduced by a factor $N^{-1/2}$ for an event with N cones, if the signal distribution is Gaussian. Once again, this indicates a remarkable *inherent* discrimination power for polycarbonate track detectors. In the second case, uranium, protactinium, thorium and lead events (Z=92, 91, 90 and 82) were analysed. However, at this relatively low energy, the electron capture and loss cross-sections for uranium were such that three charge states of uranium (92, 91 and 90) were present and indistinguishable from the corresponding nuclear species by means of a single BP-1 track. Consequently the polycarbonate resolving power in the uranium region at this energy (an energy which is *not* characteristic of UHCRE events), as measured this way, was degraded to 310%, equivalent to a charge assignment error for a single cone track of ± 1.3e. It should be emphasised that the 1.2 GeV/u GSI beam used for the present work was the highest energy uranium beam available to date. In order to pursue this work further in a region characteristic of UHCRE events it would be necessary to employ a beam of uranium ions with energy at least 3.0 GeV/u. This will not be available at any accelerator facility for several years.

2.11 The Ratio of Ortho- to Para-Hydrogen in Star Forming Regions

C.J. Davis

Hydrogen molecules exist in two forms (ortho and para), according to the alignment of the nuclear spins. An accurate method for extracting the distributions of the two forms from narrow band imaging in the 1-0 S(0), S(1) and S(2) emission lines of H_2 was proposed. All of these lines are in the near-infrared K band, thus providing the ortho and para spatial distributions with negligible extinction and model dependence. The ortho-para ratio from individual pointings to various Herbig-Haro outflows yielded values in the range 2.5 to 3.0. The vibrational temperature appears to be in the range 2000-2500 K, although rotational temperatures vary between 1100-2100K. The vibrationally-excited molecules have either (1) not been modified since their formation in a warm state or (2) have reached equilibrium through conversions within a warm state. Collisional excitation to the first vibrational level dominates, with no fluorescent component. It is suggested that collisions with atomic hydrogen in the warm shock

layers convert the ortho-para ratio to 3 locally.

2.12 Slowly Evolving Shock Structures

K. Farrell and L. Drury

Numerical schemes based on flux-vector splitting were investigated for use in conjunction with the features-tracking adaptive grid algorithm. While standard tests generally performed well, the results on almost stationary shocks were poor. It was therefore decided to revert to a total variation diminishing scheme and incorporate particle effects, initially through a standard two-fluid model.

2.13 Proper Motions of H_2 in Outflows from Young Stars

M. Micono, C.J. Davis and T.P. Ray

The star formation group carried out the first proper-motion measurements of molecular hydrogen emission features in a jet from a young star (Herbig-Haro 46/47). The largest tangential velocities were observed for H_2 knots either in, or close to, the central flow axis. Knots constituting the wings of the associated large-scale bow shocks in the ambient medium were found to move much more slowly. These results appear to be in agreement with recent numerical simulations. The first detection of variability in H_2 features for a young stellar object flow was also found. It was observed that several H_2 knots significantly changed their luminosity over the four year time base used to conduct this study. Such findings are in line with current estimates for the cooling time of gas radiating shocked H_2 emission in YSO environments.

2.14 Molecular Hydrogen Emission in Star Forming Regions

M.G. Burton

Research was carried out into the excitation of molecular clouds, analysing infrared data on the shocked emission in Orion from the new NICMOS camera on the Hubble Space Telescope, and on fluorescent emission from the "Elephant Trunks" in M16, the Eagle Nebula, obtained with the Anglo Australian Telescope. A numerical model to predict the intensity profiles of molecular hydrogen emission across fluorescently excited regions for several geometrical shapes as a function of inclination and viewing angles.

3 Research Activities in the Geophysics Section

3.01 Onshore Gravity

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

Collection of new gravity data in the southwest of Ireland has continued, using a LaCoste & Romberg gravity meter borrowed from the Geological Survey of Ireland and the Differential GPS positioning method. About 500 new measurements have so far been acquired and preliminary processing of the data has begun, including calibration of the GPS with the Ordnance Survey benchmark system. It is intended to increase the data density in the region by 2 or 3-fold so that a structural resolution similar to that obtained in the Irish Midlands should be achieved. Ultimately the results of the gravity survey will be integrated with the wide-angle seismic models from the VARNET experiments.

A series of gravity derivative maps from Ireland based on the latest Dublin Institute for Advanced Sudies and Geological Survey of Northern Ireland data sets are being investigated for use in determining the possible relationship between the occurrence of mineral deposits and gravity lineaments. In the Carboniferous basins of the Irish Midlands Pb/Zn deposits are correlated with a network of "Caledonian" NE-SW trending and interconnecting weaker NNE-SSW and subtle NW-SE trending gravity lineaments. This suggests Caledonian basement involvement in the genesis of epigenetic and syngenetic base metal deposits. The continuity of lineaments across the Carboniferous regions into older Palaeozoic terranes where they sometimes correlate with known faults appears to indicate strong Caledonian basement control on the various stages of Variscan tectonic development and related episodes of ore mineralization. These gravity methods applied to densely spaced gravity data, where the effects of overburden thickness have been removed, may be a useful tool in mapping the basement and basin-fill properties which influence ore genesis.

3.02 Offshore Satellite Gravity

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

Based on a joint analysis of the most recent release of the satellite-altimetry derived marine free-air

gravity anomalies with the wide-angle seismic models from the RAPIDS experiments, a model for the thermal structure of the lithosphere below western Eurasia has been derived. Plate-cooling models constrain the gravity contribution of the oceanic lithosphere and together with the crustal seismic geometry define the thermal structure of the continental lithosphere. The total tectonic subsidence and the regional gravity variation indicate a large thermal anomaly west of the Rockall Bank consistent with that inferred from gravity variations. This overprints an earlier thermal structure inherited from the time the Rockall Trough and Hatton Basin were extended. During the formation of the Hatton Continental Margin its influence upon tectonics and sedimentation processes would have been even more pronounced causing a greater thermal uplift than is now observed across the region.

3.03 The Seismic Network (DNET, ENET and DSB)

T.A. Blake, F. Hauser, C.M. Horan, D. Meghen, G. Wallace, A.W.B. Jacob and summer students.

In March the DNET analogue recording system was replaced with a six-channel digital system using an EDL recorder. This has a very much higher dynamic range than the old FM system. Two radio-linked outstations plus a single vertical Willmore MkIIIA and a three component short period seismometer are recorded on the six channels. The data are written to a removable disk which is processed in the playback lab in Merrion Square. A suite of computer programmes (BOOM) were developed by two summer students (D. O'Connell and S. Jacob) to assist with the processing. The network has too few stations to make automatic digital picking of events reliable, so the digital records are converted into audio records. The human ear is very sensitive to systematic signals in a noisy background when that signal is brought into the audio range.

In addition to the fixed networks, four temporary broad-band digital stations were deployed in the area of the Wicklow granites. These were operated from the summer until the end of the year. The intention is to study signals from large distant events and to invert the data to produce a crustal cross-section. This is the area in which a wide-angle controlled source experiment will later be carried out. The VARNET project has produced another comparative data set in a different geological setting and the two will be compared. The deployment was also an opportunity to test the new digital equipment.

There were no onshore or close offshore events in Ireland in 1997. One of the largest UK events (though still not very large) occurred on 16 October at 00:19 near Dartmouth in Devon (magnitude ML 3.2). Two large events occurred in NW Spain on 21 May (Mb 4.9 at 23:51 and Mb 5.3 at 23:52, only one minute later) and they were followed by many aftershocks in the next two days. Two events in central Italy on 26 September (Mb 5.5 at 00:33 and Mb 5.7 at 09:40) resulted in some deaths and large-scale damage in the epicentral area. A larger event (Mb 6.6) took place in southern Greece on 13 October.

3.04 VARNET

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

The data acquisition phase of this project was in 1996 and considerable progress was made in 1997 in interpreting seismic data collected along two long profiles and one short profile in SW Ireland. Gravity data was also gathered during 1997, to improve the coverage (see section 3.01).

On line A between Kinsale and north Co. Clare, the upper crustal layer, extending to a depth of 14 km is laterally variable. South of the Shannon sedimentary basins alternate with uplifted basement while, to the north of the Shannon, a basin-type structure, with surprisingly high velocities of 6.4 km/s at shallow depths, correlates well with the observed gravity field. While deeper crustal structures are also quite variable, the total crustal thickness ranges only from 29-32 km. A reflector in the upper mantle, at depths between 39 and 44 km, has also been found.

On line B, from the mouth of the Shannon estuary to SW Co. Cork, the average station spacing was even closer, only about 800 metres on average, and a relatively complex crustal structure was found over a Moho which varies only from 30-32 km in depth. A low velocity zone, which correlates quite well with a gravity low, has been found in the centre of the line and has been modelled as a Caledonian granite. Its northern edge coincides with a major change in sedimentary and basement velocity structure.

VARNET stations also recorded distant events and the P-wave residual pattern from an earthquake in

the Aleutians (end-on to line A) and a nuclear test in China (nearly orthogonal to the line) show large variations, of about 0.5 second, along this relatively short profile. In addition there is a strong correlation between these residuals and the gravity field. The correlation with the gravity field is a surprise as this normally reflects crustal rather than deeper structure. It is unlikely that the pattern may be a direct response to mantle structures but may be the result of a crustal imprint from deeper changes in the upper mantle. A full explanation has not yet emerged. The sharp structural change does coincide with the proposed Iapetus Suture Zone. This is not marked very clearly at crustal depths and it is surprising that the changes may be more marked in the mantle.

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

P.W. Readman, K. McGrane, A.W.B. Jacob and J. Vermeulen with R. Keary (GSI and Research Associate), P.M. Shannon (UCD and Research Associate) and Vikram Unnithan (UCD)

Analysis of the results of the long-range (GLORIA) side-scan sonar survey completed last year, covering approximately one quarter of a million square kilometres in the Rockall Trough and the Porcupine Basin, has continued. Many new features have been discovered and more detail and information on the known structures has been found. Large-scale slope failure scars along the southeast flank of the Rockall Trough with well developed concave geometries have been found. A NE-SW trending canyon system, oblique to the basin edge, is thought to reflect reactivated Caledonian features. At the northern end of Porcupine Bank a region of localised slumping is found. Further to the northeast where the basin margin changes orientation large elongate submarine canyons are observed. Along the western margin of the Rockall Trough the major feature imaged is the late Tertiary to Recent contourite body (the Feni Drift) formed by southwestward-directed currents. This was found to contain a number of elongate and sinuous dune-sized sedimentary features with variable crest orientations which are broadly sub-parallel to the basin margin. These structures appear as subtle lineations of intermediate backscatter on the GLORIA image. Highly saturated levels of backscatter along the toe of the western margin correspond to an extensive region of slumping which is estimated to be over 220 km in along-slope extent. Further upslope, areas of rock outcrop or sparse sedimentary cover on basement also contribute to the large backscatter which typifies this area. Debris flows and slope failure scars are also identified along the northwestern margin of the trough. The contrasting physiography between the eastern and western margins of the Rockall Trough reflects the different influences of depositional and erosional processes on the basin margins.

3.06 KRISP (Seismic programme in Kenya)

G.F. Byrne, O. Novak, A.W.B. Jacob and staff of European, United States and Kenyan Institutions

This EU contract was completed at the end of November. Overall it has been very successful and the Geophysics Section played an active part in a number of aspects of this multi-national project.

Seismic work was conducted along a line from near Mombasa to the eastern shores of Lake Victoria, a total line length of about 800 km. A 5-10 km thinning of the crust was found under the Rift beneath the southern flank of the Kenya Dome, similar to that found further north. The crust to the west of the Rift is, however, thinner and that to the east thicker, than that to the north. In the east the crust reaches a thickness of 44 km, the thickest observed in Kenya so far, and it overlies a thinned lithosphere.

The upper mantle velocities beneath the profiles have an average value of 8.2 km/s except beneath the Rift itself, where it is anomalously low (7.8 km/s). There is also a low velocity region (7.8-7.9 km/s) beneath the Chyulu-Kilimanjaro region where the crust is thickest. The reverberatory nature of the seismograms in this region suggest a heavily intruded zone at the base of the crust.

Mantle reflections have been found at depths of about 51 and 63 km beneath the western part of the line and at 55 and 68 km beneath the eastern part. Possible explanations include upper mantle shear zones, plume-head induced shearing flow, partial melting, compositional layering or flow induced anisotropy. More data will be needed to discriminate between these mechanisms.

PhD theses were completed by G.F. Byrne (a study of the upper mantle below the profile) and by O. Novak (a detailed study of the eastern crustal structure, particularly in the region of the Chyulu volcanics) and they were both awarded their

degrees in September.

3.07 RAPIDS - Seismic Profiles in the Northeastern Atlantic

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

Work has continued on this very productive project. Fifteen refereed publications and more than fifty conference contributions and publications have greatly changed the widely accepted view of the development of the Rockall Trough in particular. For example, the lithosphere under the Trough has been found to be in a very strong configuration, explaining some previously unexplained features.

Another example is that the Rockall Trough has been found to have experienced more than one significant rift episode. It contains up to 6 km of sedimentary strata and well and seismic data from adjacent basins indicate that the sedimentary succession in the basin is likely to be of late Palaeozoic to Recent age. The pre-Cretaceous sedimentary facies are suggested to be broadly similar to other Atlantic borderlands. Cretaceous and Tertiary strata show progressive sediment starvation as thermal subsidence outstripped sedimentation in the basin. Sandy facies are likely to be concentrated towards the faulted basin margins and re-entrant regions where the basin margin changes orientation. Basin modelling, based on normal incidence and wide-angle seismic profiles was shown to demonstrate that the observed seismic geometries cannot be explained by a single rift episode in the Cretaceous as has often previously been suggested. The best fitting models produced by this study suggest that the basin developed in response to rift episodes in the Permo-Triassic, Late Jurassic and Early Cretaceous periods.

3.08 COMBO - the Core-Mantle Boundary project

A.W.B. Jacob, F. Hauser, F.E. Murphy with J. Neuberg and A. O'Mongain (Leeds), C. Prodehl (Karlsruhe), R. Kind (Potsdam), L.A. Mendes-Victor and N. Dias (Lisbon)

As previously reported, this project has been an uphill battle since 1994, when the first delay, in firing very specialized underwater seismic sources west of Portugal, was experienced. It is ironic that the sources, planned by the Geophysics Section, were to be smaller by a factor of about 100 than the controlled teleseismic sources previously used. Very much smaller was not sufficiently more beautiful in the present environmental climate.

In spite of these set-backs, some excellent research was carried out, particularly in the Geophysics Section and in the University of Leeds. F.E. Murphy completed his PhD thesis and was awarded his PhD in September. The main publication from this work was highly praised by the referees and published later in the year in the Physics of the Earth and Planetary Interiors journal.

There was some very useful joint research based on the combination of crustal structure data from the VARNET project (reported above) with delay term patterns from sources in the Aleutian Islands, North Pacific and in China. Particularly clear signals were recorded at very close spacing (one km on average) along two profiles. An unexpected, and very sharp, change in upper mantle structure in the neighbourhood of the Iapetus Suture Zone was detected.

3.09 Transfrontier Seismological Project

A.W.B. Jacob, T.A. Blake and C. Horan with seismologists in nine other EU countries

This project was completed in February and a 280 page report submitted to the EU. There were, in addition, 27 other publications.

The Geophysics Section contribution included instrumentation development, rapid data exchange, particularly with our neighbours in the UK, and information on seismicity in the vicinity of Ireland. A strong case was also made for the incorporation of more detailed seismic models, fully three-dimensional where possible, into event location computer programmes.

3.10 Leinster Granite Seismic Project (LEGS)

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 granites in Europe and has been a focus of study over many years, although many questions remain.

Of crucial importance to the investigation of

emplacement mechanisms of granites is the shape and volume of the granite bodies. The gravity low associated with the Leinster Granite strongly suggests that there is considerable subsurface extension of the granite to the southwest. Structural interpretations based on gravity alone are not unique and are critically dependant on assumed density contrasts. The LEGS project, partially funded by the Basic Research Grants Programme of Forbairt, was begun in October 1997. A detailed wide-angle reflection/refraction seismic experiment will be undertaken to determine the overall size of the granite and its possible subsurface extension. The University of Texas at El Paso has kindly offered the loan of 200 digital recording seismic stations, which will allow deployment on sites at 1 km intervals along an axial line stretching from Dublin to Dungarvan. In addition, two transverse lines radiating from Arklow are currently planned. The experiment will also provide information about lower crustal structure and Moho topography. New gravity data will be collected to help define the shape and internal structure of the granite in more detail.

4 Research Activities in the Astronomy Section

4.01 Highly X-ray Luminous IRAS Galaxies

E.J.A. Meurs and L. Norci with L.A. Antonelli (ASI, Rome), K. Koyama and H. Awaki (Kyoto), D. Watson (UCD), M. Carr (TCD) and V.F. Polcaro (IAS, Rome)

Several IRAS galaxies seem to exhibit high X-ray luminosities, judged from a comparison between IRAS Point Source Catalog data and the ROSAT All Sky Survey. This could be caused by stellar evolution products, in view of the generally high star formation in such galaxies, or by a hidden active nucleus, or also could be the effect of a combination of these two possibilities. Clues about the origin of the observed X-ray emission may be obtained from X-ray spectra with sufficient spectral resolution. Two of the galaxies were therefore observed in greater detail, with the ASCA and SAX satellites. The IRAS galaxy observed with the ASCA satellite exhibits a power-law spectrum typical of active nuclei. Since both the ROSAT and the ASCA data show a positional offset between X-ray source and the IRAS galaxy, it is most likely an unrelated background source. The other galaxy, observed with the SAX satellite, displays clearly the 6 keV Fe line that is characteristic for scattered photons from an obscured active nucleus. For the near future another ASCA observation is scheduled to be carried out.

For several of the X-ray luminous IRAS galaxies optical spectra were obtained with the telescope in Loiano (Italy). These data allow better spectral classification of the objects concerned compared to data in the literature and convey information about any long-term variation of the nuclei of these galaxies. Some of the galaxies observed could straightaway be classified as active galaxies.

From a comparison of such X-ray luminous IRAS galaxies with proper active galaxies, it is seen that the less strong the level of activity, the bigger the size of the associated X-ray source. An analysis of compiled multi-wavelength data for a large sample of IRAS galaxies detected in the ROSAT All Sky Survey suggests that generally, for lesser states of activity, greater parts of the body of the galaxies contribute to the observed X-ray emission.

4.02 Searching for Active Cores in Local Group Galaxies

Z. Zang and E.J.A. Meurs

To investigate the occurrence of nuclear activity in galaxies to the lowest possible levels, a search has been conducted for central sources in smaller galaxies of the Local Group around the Milky Way system than Milky Way itself, M31 and M33, with data from the ROSAT HRI (High Resolution Imager). These galaxies are the nearest specimen of stellar systems and can be examined to lower levels of X-ray emission than any other galaxies and the X-ray regime of the spectrum is expected to be particularly relevant for recognizing weak signs of any nuclear activity.

Three satellites of M31 (the Andromeda Nebula) were in this way investigated in some detail. The small spheroidal systems NGC147 and NGC185 do not exhibit detectable nuclear sources, no clear sources associated with the main bodies of these systems, and little or no sign of any diffuse emission centered on their nuclei. M32, a closer spheroidal satellite of M31, on the other hand is known to contain a comparatively strong X-ray source coincident with its central region. The HRI data yield a positional offset for this X-ray source of ca. 9 arcsec away from the optical nucleus, also after attempts to carry out precise astrometry for this exposure (looking for X-ray sources with optical counterparts with accurate absolute positions). This source appears as a single source but exhibits source extension. Imperfect attitude solution seems not the likely cause for this, in

which case it could be a Supernova Remnant, or still a galaxy nucleus if the optical positions for M32 are unreliable.

Somewhat more detached from the Andromeda Nebula is the irregular galaxy IC1613. The known X-ray source near this galaxy has been interpreted as probably originating from a background galaxy cluster. The present analysis of the ROSAT HRI image for this galaxy clearly confirms this interpretation. IC1613 itself on the other hand does not possess a detectable source near its centre.

In addition to these smaller Local Group galaxies, already published ROSAT HRI and also PSPC data for M31 and M33 have been re-analysed, benefitting from re-processing of the raw data which usually provides better satellite attitude solution. A few aspects of the earlier analyses of these galaxies could be improved in this way.

4.03 Long-Term Variability of Nuclear X-Ray Sources in Galaxies

J. Cunniffe and E.J.A. Meurs

The availability of large amounts of archived pointed X-ray observations (of the ROSAT and other X-ray satellites) offers an interesting opportunity to carry out a variety of projects for which a substantial body of observational data is required. A study has been started of long-term variability of X-ray sources associated with normal galaxies taken from several optical catalogues of galaxies. This requires observations obtained at certain intervals of time and constitutes a different approach from that usually followed when the emphasis is on stellar X-ray sources, for which short-term variability is particularly relevant (that is, often within the timespan of individual observations). Substantial variation of the X-ray emission from a galaxy may be related to short, incidental epoches of activity in the nucleus of that galaxy, which can provide information about important issues like the mass of normally quiescent massive Black Holes residing in the cores of galaxies.

4.04 Application of Voronoi Tessellations in Astrophysics

M. Wilkinson and E.J.A. Meurs

Voronoi tessellations provide a unique partitioning of space around objects or events, so that only one point of a given distribution (e.g. galaxies or photon events) is contained in each Voronoi cell. To investigate further how information about the shape of a concentrated collection of points (such as photons constituting a source, or galaxies in large-scale filaments) can be recovered from a given 2-dimensional distribution of points, a series of simulations of photon sources was continued. After earlier simulations of homogeneously filled, elliptically shaped point distributions, this work has been extended with two-dimensional gaussian distributions, which yield objects that resemble more closely real photon sources. Again, a high degree of success in retrieving source shape parameters was obtained.

4.05 The Contents of Voids in the Distribution of Galaxies

M. Carr and E.J.A. Meurs

Following the exploratory investigations into a description of the shape of filamentary structures in the large-scale distribution of galaxies, one's attention is drawn next to the voids that are discernable in between the filaments in this structure. Preparations have been under way for a study of the possible material content of these bubbles in the Universe. Using measurements of absorbing matter as may be evident in the soft X-ray spectra of galaxies that surround a particular void, it should be possible to place limits on the amount and physical constitution of material that could be present within these voids and on the spatial distribution exhibited by such material. The observational data employed for this study are first of all archival ROSAT PSPC frames and may be supplemented by ASCA and SAX exposures.

4.06 High-Energy Studies of Starforming Regions in Extragalactic Context

L. Norci and E.J.A. Meurs

Observations at X-rays give an interesting view of starforming regions, whether nearby in our own Galaxy or further away in other stellar systems where different conditions may prevail, since in that way very specific stages of stellar evolution are highlighted. Data of this sort require careful interpretation, for which purpose a population synthesis computer programme that monitors the X-

ray active phases for each individual star (and each binary) while the stellar population evolves has been under development. Special attention is being payed to 30 Doradus, the giant starforming region in a nearby Milky Way satellite, the Large Magellanic Cloud. A considerable effort went into incorporation of the latest stellar evolution scenarios and into the transposition of theoretically calculated parameters to observable quantities. In this way, the high-energy output from a region like 30 Doradus during its evolution can be examined for several conceivable conditions for the starforming process. This same technique is being applied to reproduce the conditions in the central regions of some other nearby galaxies that are being studied for clues about low-level active cores.

4.07 X-ray Characteristics of SNRs in the LMC

L. Norci and L. Johnston (TCD)

After the explosion of a massive star at the end of its lifetime a Supernova Remnant (SNR) is left, where the expelled atmospheric layers interact with the ambient medium. During the evolution of such SNRs radiation is emitted in several wavebands, among which the X-ray regime. The gross properties of SNRs can be conveniently assessed for the Milky Way satellite LMC (Large Magellanic Cloud), in which case all objects are observed at the same distance thus allowing to examine the total SNR population present in a stellar system. All available data on X-ray characteristics and relevant physical quantities from other wavebands for LMC SNRs have been compiled from the literature. The information gathered in this way has been used to study the dependence of various observational quantities on each other, in particular their dependence on the SNR age. The diagrams obtained illustrate, more clearly than in most treatments in the literature, the evolution of the physical quantities as the SNRs age. In addition, the effects of gas masses moving outwards and sweeping up ambient material stand out very noticeably. Further, one is now in a position to attempt an empirical description for the evolution of X-ray luminosity, which will be an ingredient for the work on population synthesis to monitor the high-energy output of regions of starformation.

4.08 Galaxy Clusters: the Einstein EMSS Sample with ROSAT

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

Work has continued on relevant observational parameters for the sample of galaxy clusters from the Einstein X-ray satellite Extended Medium Sensitivity Survey as they appear in the ROSAT All Sky Survey. Besides fluxes, luminosities and sizes, the hardness ratios are also considered for an analysis of their overall X-ray properties. Several details concerning sizes in relation to neighbouring sources required attention in order to avoid unwanted confusion effects.

4.09 Studies of Massive Stars

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

Among several peculiar, massive stars in the open cluster Berkeley 87, which contains many young and heavily reddened OB stars, there features the emission line star V439 Cyg. This star dramatically changed its spectrum from late to early type in only a few decades. Some absorption lines that were still present in optical spectra taken in 1986 and 1987 have disappeared completely since 1988. The star is characterized by a strong IR excess and a peculiar position in the HR diagram (depicting luminosity against temperature). New spectroscopic data on this unique object have been analysed.

A deep study on V 439 Cyg has been performed, recovering the historical records about this object and monitoring the star over an interval of time. This has provided evidence that the red spectrum observed in 1958 is far from being a classical spectrum of a C star, as so far had been assumed. Variability is present both in the relative intensities of spectral lines and in colour. A possible explanation of the observed changes could be an episode of mass ejection, before 1958 and probably after 1941, that has created a pseudo-photosphere around this star. Only the short time scale of the cool phases and the lower V magnitude when the star was of "red colour" prevented the classification of V 439 Cyg as a "standard" LBV (Luminous Blue Variable). The hypothesis that the star is a low mass LBV is brought forward, occurring nearly at the lowest stellar mass possible for such a stage.

In addition, studies of the rare class of WO Wolf-Rayet stars have been carried on. This refers to a group of a few extreme, massive WR stars having similar spectral signatures and very high wind velocity and mass loss. Only six "Population I WO" stars are known to date in the Local Group and this small number is a clear indication of the

short time spent in this phase which, according to current models, is believed to be the latest evolutionary stage of very high mass stars (initial mass about 40 solar masses). The properties of such objects were assessed for the WO star Sand 5 (in the aforementioned Berkeley 87 cluster) and for the central object of the Planetary Nebula NGC5189. These investigations are relevant to the difficult issue of the exact evolutionary phase of the WO Wolf-Rayet stars.

4.10 X-ray Emission from TTauri Stars

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

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

4.11 Optical Monitoring Camera

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

The programme of development of the Optical Monitoring Camera for the INTEGRAL mission continued throughout the year. ESTEC have provided us with the INTEGRAL Spacecraft Computer Interface Simulator which allows full testing of the OMC laboratory models of the video processing channel, 12 bit analog-digital converter and high speed interface. These assemblies, which are in wire wrap form, and their circuit diagrams will be delivered to MSSL where printed circuit versions will be produced and incorporated into the OMC Engineering Model. The electronics for monitoring the OMC critical assembly temperatures, power supply levels and calibrating LED on/off control have been designed and tested. Work on the design of the Electrical Ground Support Equipment which is based on the spacecraft interface simulator has commenced. When complete, this equipment will be used to test the OMC engineering and flight models.

4.12 Lightcurves of Bright RR-Lyrae Stars

R. White with A.A. Henden (Flagstaff Observatory, Arizona, USA)

Work continued on the analyses of the light curves of certain field RR Lyrae variable stars. The material used comes partly from observations in Flagstaff, and partly from (additions to) the database of observations reported in the professional literature, using the facilities of the Dunsink, Strassbourg and Vatican Observatories. The resulting database will be used to determine long-range variations in the light-curves and periods of the stars.

4.13 Radial Distribution of RR Lyrae Stars in Globular Star Clusters

R. White

The analysis of the radial distributions of RR Lyrae stars in globular star clusters was completed. The overall density distributions of the clusters (for their general stellar content) were reconstructed into self-consistent radial distributions within each cluster, employing several data sources in the literature. Comparing these overall distributions with those for the RR Lyrae stars readily identifies the collapsed-core clusters.

4.14 Stability of Asteroids in Resonance with Jupiter

T. Kiang with N. McEntee (TCD)

A renewed attempt was made at deriving a Hill-type equation that will determine the first-order stability of asteroids in resonance with Jupiter within the circular model. Summer Student Niamh McEntee assisted with the necessary Fortran double-precision programming on DIAS computers. Promising first results were obtained and further work is in progress.

4.15 Development of ROSAT Data Reduction Techniques

E.J.A. Meurs, M. Carr and J. Cunniffe

Several projects currently pursued at Dunsink

Observatory employ X-ray data, particularly those from the ROSAT satellite. A start has been made in examining some fundamental aspects of the X-ray data reduction that are needed in various projects.

The definition of source position is less established for sources that are located in the outer regions of the ROSAT detectors, particularly the PSPC. PSPC and HRI exposures are being used with a number of sources distributed all over the field of view, for which accurate optical positions are available. The degree of success in retrieving source positions at large off-axis angles can be assessed from a comparison of derived X-ray positions and known optical positions.

The calibration of the PSF (Point Source Function) can be exploited to derive estimates of source size from a comparison between measured radial brightness profiles and empirical PSF. Until now, no such determination of size is implemented in the ROSAT data analysis software. The provided PSF probably precludes pursuing this outside the inner detector struts of the PSPC.

4.16 Phenomenological Profiles of Gamma-Ray Bursters

I. Elliott and E.J.A. Meurs

Although gamma-ray bursts have been known for over 30 years, only recently has evidence become available that at least some bursts originate at cosmological distances; this implies that they represent the most energetic events known in the universe. Improvements in spacecraft triangulation techniques in recent years have allowed the identification of afterglows in the X-ray, optical and radio domains. The published data are being surveyed in order to place empirical limits on the time development of the radiative fluxes associated with the gamma-ray bursts.

4.17 Early Irish Astronomy and other Archaeo-astronomy

R. White

An investigation was begun into the early Irish origins of naked-eye observational astronomy as revealed by extant artifacts in situ, folk tales and early church records archived in the Library of the DIAS School of Celtic Studies.

On Malta and Gozo, field research was carried out into the cross-quarter day illuminations by the rising Sun in the Mnajdra and Hagar Qim Temples.

5 Facilities

5.1 Computers

5.1.1 Merrion Square

There have been a number of significant changes in the computer system during the year. Firstly, the acquisition of six dual Pentium Pros has provided the basis for satisfying the School's requirement for high performance computing facilities. The six machines form a "Beowulf" cluster of networked computers, allowing the implementation in parallel of previously serial algorithms. To publicise the new cluster, a half-day seminar was held during March at Burlington Road. A second seminar was held in November on the topic of High Performance computing. Speakers were invited from both industry and academic institutions. Two Scholars (T. Downes and S. O'Sullivan) presented talks on their experience in using the cluster. At this meeting, it was agreed that there was considerable interest in high performance computing in Ireland, and as a result, the Irish Association for High Performance Computing (I.A.H.P.C) was established.

The second major change in the School's computing facilities was the purchase of a Window's NT 4.0 Server and workstations to provide for the PC based computing needs. Some of the older Windows For Workgroup workstations were converted to run under the LINUX operating system. The purchase of a new scanner prior to the Astronomy and Astrophysics Golden Jubilee conference (see section 7.2) allowed the proceedings to be recorded while the meeting was in progress. Subsequently, a CD-ROM of the meeting in HTML format was produced. This provided a good testing environment for planned future work.

During the year there was an ongoing systematic upgrade of PC systems throughout the Geophysics Section aimed ultimately at a harmonised PC development policy. Software acquisitions included Adobe Illustrator, Visio and ERDAS Imagine for the Sun Solaris platform as a mozaic tool for the interpretation of GLORIA project data. Two field computer work-stations were developed (ENNIS and HEINZ), using Linux as the preferred operating system. These are now operational with

Seismic-Handler as the data analysis software package. Summer students Donal O'Connell and Stephen Jacob worked on the Geophysics Section home pages and on an archiving system based on CDs. The VME data from Lyons continues to be downloaded daily and the data from the Very-Broad-Band (VBB) station is collected every two weeks, archived, and copied to Potsdam.

5.1.2 Dunsink Observatory

The Dunsink LAN was maintained throughout the year. A new main server consisting of a dual Pentium 200 MHz processor with 6 GB disc drive and 256 MB user memory was installed. This will eventually replace the previous server that then will double as a work station. A Robotics 28.8 KB modem on a dial-up telephone line was installed to provide remote login facility. Two Pentium 200 MHz MMX computers with 17 inch monitors were built and installed in the computer room.

5.2 Geophysics Instruments

Station DSB had its three-component seismometer replaced with a new Streckeisen STS 2 instrument and a new GPS system was also installed. As mentioned in section 3.03, the old (19 years) analogue Geostore recording system at Lyons Farm (DLF) was replaced with an Earth Data digital system during the year. The aerial system at one of the outstations was replaced and routine maintenance of the seismic network continued throughout the year.

5.3 Nuclear Track Equipment

The six Leitz-ASL track measuring microscope stations, the Nikon-Heidenhain track measuring microscope station and the six Nikon stereo scanning microscope systems were maintained and upgraded as necessary during the year. In particular, a reconditioned linear displacement transducer and a refurbished illumination power supply module were fitted to two of the Leitz-ASL stations in Track Lab #2. Problems with the fume extraction equipment for the ammonia scanning facility in Track Lab #3, which became apparent during December, were under investigation at the close of the year.

The three main track detector etching tanks (150-litre capacity each) and associated equipment were completely overhauled during the year. Replacement sub-systems or components included a new circulation drive train fitted to Etch Tank #1 and a new heating unit fitted to Etch Tank #2. In addition, the security of the power supply to the three tanks was reviewed. It is noteworthy that the temperature stability of each of these three tanks continues to be better than ± 0.005 °C. Further work during the year included significant restoration and reconstruction of detector support structures and etching frames.

5.4 La Palma Observatory

5.4.1 La Palma Advisory Committee (LPAC)

There was one meeting of the La Palma Advisory Committee (LPAC), held in February, which met primarily to discuss the possibility that the Jacobus Kapteyn Telescope on La Palma might have to close because of budgetary restrictions. In the event, this scenario was avoided due to the decision by Portugal to join the consortium using the JKT. The budgetary situation at La Palma remains very tight, due to cut-backs in the available PPARC funding. In the course of the year the Governing Board of the DIAS School of Cosmic Physics requested that the Head of the Astronomy Section (E.J.A. Meurs) chair the LPAC, in order to provide a direct reporting link with the Governing Board, along with a review of LPAC procedures and membership definition.

Recognising the importance of access to the La Palma Observatory and other Particle Physics and Astronomy Research Council (PPARC) groundbased facilities by Ireland, Forbairt continued to provide, through the Measure Four Programme, an annual subvention for the travel and subsistence expenses of non-DIAS observers. M. Redfern (UCG) attended the Panel for Allocation of Telescope Time (PATT) committee meetings in June and December in Stratford upon Avon as the Irish representative. T.P. Ray continued to produce a twice yearly information bulletin (in March and September) to keep the community informed of changes in PATT procedures, PATT deadlines and other useful items of information.

5.4.2 Observing Runs in 1997

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

Davis, Ray (DIAS), Smith (Würzburg): (U/96B/2) *Spectroscopic Study of the Entraining Molecular Shocks in YSO Outflows*, UKIRT, three bright nights. Unfortunately this run, carried out in

January, was severely hampered by freezing conditions at the summit. Only in the third night a few spectra could be obtained.

Davis, Ray (DIAS), Smith (Würzburg): (U/97A/10) *Understanding Gas Excitation in Molecular Bow Shocks*, UKIRT, one night. This run was carried out in service mode.

Davis, Ray (DIAS): (M/97A/01) *CO 3-2 Mapping of Outflows*, JCMT, one shift. Lost to poor weather. Remote observing.

Davis, Ray (DIAS), et al: (M/97A/02) *Entrainment of Molecular Outflows in Regions of High-Mass Star Formation*, JCMT, four shifts. Excellent wide-field CO 2-1 maps of three regions obtained. Remote observing.

Davis, Ray (DIAS), et al: (M/97B/28) *SiO Mapping of Molecular Outflows*, JCMT, Implemented SCUBA backup proposal. A dozen embedded outflows from young stars were surveyed for SiO emission. Remote observing.

Hanlon (UCD), Smith (CIT), McBreen (UCD), Metcalfe (ESA): (W/97A/49) *IR Observations of Well Localised Gamma Ray Bursts*, WHT, two bright nights. The infrared detector, WHIRCAM, was used to analyse GRB error boxes for evidence of an excess number of K-band galaxies relative to the field value. Reduced detection efficiency of WHIRCAM led to some restriction in the number of error boxes imaged.

McCaughhrean (Heidelberg), Davis, Ray (DIAS), Eislöffel (Grenoble), Smith (Würzburg): *Deep, Wide-field, H_2 Imaging of Outflows from Young Stars*, Calar Alto 3.5m Telescope, three nights. Observations were conducted with OMEGA-prime, the new wide-field near-IR camera on the 3.5m telescope. Limited turn-out due to bad seeing and cloudy weather.

Ray et al. (DIAS): *A Search for Magnetic Fields in Outflows from Young Stars*, MERLIN, two Runs A + 2 Runs B + 2 Runs C. Several runs of the young star T Tauri were made using the Multi-Element Radio Linked Interferometer based at Jodrell Bank. Remote observing.

Shearer, Redfern, Butler (UCG), Penny (RAL): (J/97A/07) *Stellar Population of the Inner Regions of Selected Globular Clusters*, JKT, one grey week (plus extension). Ten nights had good seeing (< 1 arcsec or even < 0.5 arcsec) and four bad seeing. Resolution and photometric accuracy of the final images will be better than previous WHT runs.

Smith (CIT), Hanlon (UCD), Doyle (CIT), McBreen (UCD): (J/97A/06) *Rapid Optical Variability in Radio-quiet Quasars with Flat Radio Spectrum*, JKT, one grey week. Of the seven nights allocated, over five nights were clear. A self-oscillation of the primary mirror had to be overcome.

Smith et al (CIT): (J/97B/12) *Rapid Optical Variability in Radio-Quiet Quasars with Radio-loud Properties*, JKT, one week. The weather throughout the run was variable. Results affected by loss of observing time due to weather and to oscillations in primary mirror.

Callanan (UCC), Filippenko (Berkeley): *Infrared Studies of Low Mass X-Ray Binaries*, Keck Telescope, one night. A single night with superb seeing.

Of the observing runs listed above, financial support was given to the observers Davis (Calar Alto and U/96B/2), Smith (J/97A/06, J/97B/12 plus W/97A/49) and Callanan (Keck). The latter two are non-DIAS observers.

6 Seminars, Colloquia, Lectures

6.1 Statutory Public Lecture

J. Jackson (Cambridge University) delivered the Annual Statutory Public Lecture for the School of Cosmic Physics. The lecture was entitled *Exploring the Earth* and took place at University College Dublin, on 23 October.

6.2 Seminars and Open Lectures in the School

R. Sinclair (National Science Foundation): *Antarctic Research*, 11 March.

R. White (DIAS / University of Arizona): *The Machu Picchu Intihuatana Stone De-coded*, 30 April.

M. Burton (University of New South Wales): *Reflections on Molecular Hydrogen*, 08 May.

S. Lilly (University of Toronto): *The History of Galaxies in the Universe*, 17 June.

L. Allen (University of New South Wales): *Star formation in Orion*, 19 June.

J. Mechie (GeoForschungsZentrum, Potsdam): *Wide-Angle Seismic Images in Orogenic Belts*, 17 September.

G. Ranalli (Carlton University, Ottawa): *Rheology of the Earth and Geodynamics*, three seminars on 20, 21 and 22 October.

J. Tedds (University of Leeds): *Shocked Molecular Hydrogen in the Orion Bullets*, 02 December.

6.3 Contributions to Scientific Meetings

C.J. Davis: *Prompt Entrainment in the Variable Molecular Jet from RNO 15-FIR*, U.K. National Astronomy Meeting, Southampton, England, 08-10 April; *H_2 and CO Outflows Associated with Luminous Young Stars*, Leeds Workshop on High Mass Star Formation, Leeds, England, 12 June.

T. Downes: *Numerical Simulations of the Kelvin-Helmholtz Instability in Non-adiabatic Jets*, I.A.U. Symposium 182, "Herbig-Haro Outflows and the Birth of Low Mass Stars", Chamonix, France, 20-24 January; *Report on the Cornell Theory Center Virtual Course II*, Meeting on "Parallel Processing for Scientific Computing", DIAS, 12 March; *Numerical Simulations of the Kelvin-Helmholtz Instability in Radiatively Cooled Jets*, Astronomical Science Group of Ireland Autumn Meeting, DIAS, 02 October; *The Pleiades Cluster: Operational Experience of a Beowulf-type System*, Irish Association for High Performance Computing Meeting, DIAS, 19 November.

L.O'C. Drury: Invited talk, *Interstellar Dust and the Galactic Cosmic Rays*, American Physical Society meeting, Wasington DC, 19 April; *Interstellar Dust and Galactic Cosmic Rays*, ASGI Spring meeting, Belfast, 23 April; Three contributed paper presentations, *GCR Composition: volatility or FIP? SNR shock acceleration of Gas and Dust*, *Acceleration of Cosmic Ray Electrons by Ion-excited waves at Quasi-perpendicular Shocks* and *Interstellar Dust, Shock Acceleration and the Galactic Cosmic Ray Composition*, The 25th International Cosmic Ray Conference, Durban, 30 July - 06 August.

A.W.B. Jacob: *Regional Crustal Extension in the NE Atlantic: results from wide-angle Seismic and Gravity Studies*, UKGA-21 Assembly, Southampton, 02-04 April.

A.J. Keane: *A Charge Spectrum of Ultra Heavy Cosmic Ray Nuclei, including Actinides, detected on the LDEF* (poster paper), The 25th International Cosmic Ray Conference, Durban, South Africa, 01-07 August.

M. Landes: *Structural Changes in the Upper Mantle across the Iapetus Suture Zone in Ireland*, American Geophysical Union, Fall Meeting, San Francisco, 08-12 December.

K. McGrane: *Recent Slope Failure Features in the Rockall Trough, offshore Ireland*, IGA Research Meeting, Belfast, 21-23 February; *Recent Erosional and Depositional features in the Sedimentary Basins west of Ireland*, EAPG Conference, Geneva, May; *Long-range side-scan Sonar Survey of the Rockall Trough, offshore Ireland*, American Geophysical Union, Fall Meeting, San Francisco, 08-12 December.

G. Manfredi: *Numerical study of Plasma-wall Transition in a Magnetic Field*, The 8th Conference of the Irish Plasma and Beam Processing Group and 6th Symposium on Fusion Research in Ireland, St Patrick's College, Drumcondra, 03-04 April.

E.J.A. Meurs: *Highly X-ray luminous IRAS Galaxies: AGN, Starburst or Incidental*, Dutch Astronomers Meeting, Dalfsen, NL, 14-16 May; *X-ray aspects of the IRAS Galaxies*, IAU Symposium 188, Kyoto, Japan, 29 August; *Searching for AGN signatures in IRAS galaxies*, SAX Symposium, Rome, 21-25 October.

L. Norci: *V439 Cyg as a Late Phase of Stellar Evolution* (poster paper), ISOSTAR Conference, Noordwijkerhout, NL, 01-04 July; *The WO Stars: A Late Stage of Stellar Evolution*, ASGI Autumn Meeting, Dublin, 02 October; Two poster paper presentations, *Population Synthesis of 30 Dor* and *V439 Cyg as a Late Phase of Stellar Evolution*, DIAS Golden Jubilee Conference, Dublin, 03-04 October.

B.M. O'Reilly: *Wide-Angle Seismic and Gravity Study of the Lithosphere Across the Northeast Atlantic Margin*, IGA Research Meeting, Belfast, 21-23 February; *Lithospheric Structure across the NE Atlantic margin: a joint Gravity/Seismic wide-angle Study*, UKGA-21 Assembly, Southampton, 02-04 April; *Gravity Lineaments and Ore Deposits in Ireland*, The Dave Johnston Memorial Meeting, Trinity College Dublin, 08-09 November.

S. O'Sullivan: *Report on the Cornell Theory Center Virtual Course I*, Meeting on "Parallel Processing for Scientific Computing", DIAS, 12 March; *The Pleiades Cluster: Future Development*, Irish Association for High

Performance Computing Meeting, DIAS, 19 November.

P.W. Readman: *Gravity Signatures of Caledonian and Variscan Tectonics in Ireland*, IGA Research Meeting, Belfast, 21-23 February; *Crustal Tectonic Fabrics in Ireland resolved by Gravity Data*, UKGA-21 Assembly, Southampton, 02-04 April; *Palaeomagnetism of Late- and Postglacial sediments from Denmark and the Southern Baltic Sea*, IAGA Meeting, Uppsala, 04-15 August.

T.P. Ray: *Evidence for Magnetic Fields in the Outflow from T Tauri S*, I.A.U. Symposium 182, "Herbig-Haro Outflows and the Birth of Low Mass Stars", Chamonix, France, 20-24 January; Invited Review, *The Environments of Young Stars*, NATO Advanced Study Institute meeting on "Laser Guide Star Optics for Astronomy", Cargese, Corsica, 04-11 October.

P.M. Shannon: *Structural setting, Geological development and Basin modelling in the Rockall Trough*, Fifth Conference on the Petroleum Geology of NW Europe, Barbican, London, 26-29 October.

W-M. Tai: *The DIAS Pleiades Cluster*, Meeting on "Parallel Processing for Scientific Computing", DIAS, 12 March.

V. Unnithan: *Side-scan Sonar features in the Rockall Trough, offshore Ireland*, EGS General Assembly, Vienna, April.

M. Wilkinson: *Using Voronoi Techniques to determine the Shapes of Photon Sources*, ASGI Autumn Meeting, Dublin, 02 October.

Z. Zang: *X-Ray Diagnosis of the Stellar Population in small Local Group Galaxies* (poster paper), DIAS Golden Jubilee Conference, Dublin, 03-04 October.

6.4 External Seminars

T. Downes: *Numerical Simulations of the Kelvin-Helmholtz Instability in YSO Jets*, CEA Saclay, France, 24 April.

L.O'C. Drury: *Non-resonant MHD instabilities driven by strong energetic particle fluxes*, ENEA Frascati, Italy, 27 January; *Shock acceleration of interstellar dust and gas*, Goddard Space Flight Center, USA, 14 April; *Interstellar Dust and Cosmic Rays*, Instituto Astrofisica Spatiale, Frascati, Italy, 10 July; *When do shocks become unstable*, CAUP, Porto, Portugal, 05 November.

M. Mond: *Stability of Strong Shocks in Gases*, Department of Mathematical Physics, UCD, 30 October.

T.P. Ray: *What Did Our Solar System Look Like 5 Billion Years Ago?*, Cavendish Physical Society, Cambridge, 05 March.

R. White: *Astronomy through the Ages*, SPCM, 16 January; *The Distribution of RR Lyrae Stars in Globular Star Clusters*, Strassbourg Observatory, France, 04 April.

6.5 Lecture Courses

L.O'C. Drury: Course of eight Lectures on the *Interstellar Medium* at the Department of Physics, TCD, during Hilary term; *High Energy Astrophysics* lecture module in European MSc, University of Porto, Portugal, 02-09 November; Lecture Course 343 (*Astrophysical Gas Dynamics*) at the Department of Mathematics, TCD, during Michaelmas term.

E.J.A. Meurs: Lecture course of eighteen hours on *Stellar Dynamics* at TCD during Hilary and Trinity terms; Course of nine hours on *Physics of Galaxies* at TCD during Hilary Term; Guidance provided for 4th year TCD physics student.

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

G. Manfredi: Course of ten Lectures on *Mathematical Methods for Nonlinear Physics* at the Department of Mathematics, TCD.

T.P. Ray: Lecture Course on the *Interstellar Medium* with L.O'C Drury to final year students at TCD during Hilary Term.

R. White: Tutorial course for students taking the newly established Astrophysics Option in Physics, on topics of *Contemporary Observational Astronomy and Astrophysics* (Hilary and Trinity terms).

L. Drury, E.J.A. Meurs, L. Norci and D. O'Sullivan, together with colleagues from UCD and SPCM: Joint course of eight hours on *Topics in High-*

energy Astrophysics at TCD during Michaelmas term.

6.6 Popular Lectures

I. Elliott: Presentation on *Teaching Junior Certificate Astronomy*, H.Dip.Ed. course, UCD, 11 February; *Understanding the Big Bang*, Science Week at North Dublin National School Project, Glasnevin, 13 May.

K. Farrell: *Stages of Evolution of the Universe observed in the Night-time Sky*, A popular-level presentation to the general public at Lucan Community College, Co. Dublin, 10 April.

E.J.A. Meurs: *Redshifts*, Irish Astronomical Society, 20 January; *The wider public life of Dunsink Observatory*, DCU, 03 April; *What's the Trouble with Redshifts?*, TCD Astronomy and Space Society, 16 April.

T.P. Ray: *From Planets to Galaxies: Through the Looking Glass of Hubble*, sponsored by the Institute of Physics for Science Week, University of Limerick, 11 November; Queens University Belfast, 12 November; Dublin Institute for Advanced Studies, 13 November; University College Cork; 20 November.

R. White: *The Solar Observatories in the Inka Citadel at Machu Picchu, Peru*, TCD Astronomy and Space Society, 25 February; *Comets*, Dunsink Observatory, 05 March.

7 Expositions, Public Facilities and Organisation of Meetings

7.1 Golden Jubilee Conference (I)

An International Workshop on Lithospheric Structure, Evolution and Sedimentation in Continental Rifts was organized by the Geophysics Section from 20 to 22 March 1997 to mark the School of Cosmic Physics Golden Jubilee Year. The Workshop was jointly sponsored by the Institute, the International Union of Geological Sciences and UNESCO, and supported by The Royal Society, The Royal Astronomical Society, Statoil, BP and ELF. It was a considerable success and the Proceedings were published in October as Geophysical Bulletin No. 48 of the Dublin Institute for Advanced Studies. The Workshop also marked the beginning of the scientific programme of IGCP 400 (an International Geological Correlation Project) and the principal purpose was to review the state of knowledge of the main continental rifts and to identify research priorities for further action.

Fifty six scientists attended the Workshop, sixteen from Ireland and forty from Europe, Asia, Africa and North America. There was a special emphasis on the East African, Afro-Arabian, Baikal, European and Rio Grande rift systems, and on rifted passive margins. There were no parallel sessions and interdisciplinary discussion was encouraged throughout the workshop in order to compare the different rift systems, taking into account their settings and degree of evolution. On the third day the participants divided into separate working groups for each topic, coming together again in the last session to hear summaries from each group. In the Proceedings of the Workshop a number of review papers, written by rapporteurs appointed for each session, developed these summaries and made proposals for future work.

7.2 Golden Jubilee Conference (II)

A conference on "High-energy Interactions between Evolving Stellar Populations and their Environments in our own and other Galaxies" was organised by the Astronomy and Astrophysics Sections to mark the School of Cosmic Physics Golden Jubilee Year. Ten prominent speakers from Europe and the USA presented specialist reviews on 03 and 04 October, at DIAS, Burlington Road. The material presented has been collected on a CD-ROM, produced entirely in-house.

7.3 The European Astrophysical Doctoral Network

The European Astrophysical Doctoral Network (EADN), under the chairmanship of T.P. Ray, continued to organise student astrophysics mobilities within the European Union. It also arranged a summer school on "X-Ray Spectroscopy in Astrophysics", 22 September – 03 October, at the University of Amsterdam. Some 40 students attended, including a relatively large contingent from Ireland. J. van Paradijs acted as scientific director of the school which was financially supported by ERASMUS and Training and

Mobility of Researchers (TMR) funds.

7.4 The Astronomical Science Group of Ireland

The Autumn meeting of the Astronomical Science Group of Ireland (ASGI) was held in DIAS at 10 Burlington Road on 02 October. The principal invited speaker was J. Dyson from the University of Leeds who spoke on the origin of cometary nebulae. The meeting was held in conjunction with the DIAS School of Cosmic Physics Golden Jubilee conference on "High-energy Interactions between Evolving Stellar Populations and their Environments in our own and other Galaxies".

7.5 The Irish Association for High Performance Computing

During the summer there were discussions within the Astrophysics Section concerning the need to form an association to improve communication between the various groups in Ireland working on high performance computing. The Irish Association for High Performance Computing was set up at a meeting organised by Turlough Downes and Stephen O'Sullivan in November. The primary aim of the association is to promote the exchange of information and experience among those interested in high performance computing in Ireland. It was agreed that this group should cater for both industrial and academic interests and should organise regular meetings. The first committee of the association consists of a chairperson (Stephen O'Sullivan, DIAS) and a secretary (Audrey Crosbie, ICeTACT, TCD).

7.6 Dunsink Science Expo and Open Nights

The new interactive Visitors Facility in Dunsink Observatory was officially opened on 04 December 1997 (during the School of Cosmic Physics Jubilee year) by the Minister for Science and Technology, Mr Noel Treacy. School groups and the general public are introduced to our solar system with a computer-steered ceiling model. They can examine six graphically designed panels containing attractively illustrated information that ranges from solar system and sun, via stellar lives and Milky Way, to galaxies and cosmos; and they can test their new knowledge against a specially designed computer quiz. Shortly before Christmas a video projector was acquired with which a variety of informative and entertaining programmes can be presented. Another notable development is the interest of OPW in taking over the maintenance of the main observatory building and the James South dome.

As in other years, Open Nights for the general public were held twice monthly during the winter half year, led by W. Dumpleton, with the very helpful support of members of the Irish Astronomical Society. Several additional single-group visits, in the evenings and also during daytime, were organised during the year. Information services included viewing data for satellites, background to cometary appearances, and precise timings of phenomena like sunrise and sunset, Lighting Up Times, beginnings of seasons and changes between winter- and summer times.

8 External Work

8.1 Astrophysics Section

C.J. Davis: U.K. National Astronomy Meeting, Southampton, England, 08-10 April; Workshop on High Mass Star Formation, University of Leeds, 11-12 June;

T. Downes: I.A.U. Symposium 182, "Herbig-Haro Outflows and the Birth of Low Mass Stars", Chamonix, France, 20-24 January; Service de Astrophysique, Saclay, France, 23-27 April.

L.O'C. Drury: Visit for discussions and seminar to ENEA Frascati, Italy, 25-28 January; Collaboration on ISO observations of SNRs at DSRI, Copenhagen, Denmark, 22-25 February; Management Committee meeting, Armagh, 28 February; HCM network meeting, Lisboa, Portugal, 04-07 March; Visit to North Carolina State University, USA, for collaboration with D. C. Ellison, 07-13 April; Visit to Goddard Space Flight Center, Maryland, USA for discussions with F Jones, E Dwek and others, 13-17 April; Attendance at American Physical Society meeting, Washington DC, USA, 17-21 April; Management Committee meeting, Armagh, 13 June; Visit to ENEA Frascati for discussions with F. Romanelli and F. Zonca, 16 June - 15 July; International Cosmic Ray Conference, Durban, South Africa, 26 July - 07 August; TeV gamma-ray workshop, Kruger National Park, South Africa, 07-12 August; IAEA Technical Committee Meeting on alpha particles, Culham, England, 07-11 September; High Energy Astrophysics lecture course, Porto, Portugal, 02-09 November.

K. Farrell: Institute of Physics (Irish Branch) Spring Meeting, Donegal, 21-23 March.

E. Flood: IRMA-2 Meeting in Stockholm, 20-25 May; CEC Cluster Meeting, Vienna, Austria, 02-05 December.

A.J. Keane: Institute of Physics meeting, Donegal, 21-23 March; The 25th International Cosmic Ray Conference, Durban, South Africa, 01-07 August.

R. Keegan: Institute of Physics Spring Meeting, Donegal, 21-23 March.

G. Manfredi: Summer School on Magnetohydrodynamic Waves in Space and Laboratory Plasmas, Koenigs-Wusterhausen, Germany, 01-12 September.

D. O'Sullivan: Cluster meeting with IRMA-2 collaborators at Seibersdorf, Austria, 23-26 January; Steering Committee of CEC projects, Munich, Germany, 10-12 March; Institute of Physics Spring Meeting, Donegal, 21-23 March; IRMA-2 meeting in Stockholm, 20-25 May; Meeting with Concorde officials and installation of new detectors, London, 27-29 June; Experimental work at CERN, Geneva, Switzerland, 24-29 September; CEC Cluster Meeting, Vienna, Austria, 02-05 December.

S. O'Sullivan: I.A.U. Symposium 182, "Herbig-Haro Outflows and the Birth of Low Mass Stars", Chamonix, France, 20-24 January; Spring Meeting of the Astronomical Science Group of Ireland, Queens University Belfast, 23 May; The 10th EADN Summer School, "X-Ray Spectroscopy in Astrophysics", Amsterdam, NL, 22 September – 03 October.

T.P. Ray: PhD thesis examination, University of Cambridge, 10 January; I.A.U. Symposium 182, "Herbig-Haro Outflows and the Birth of Low Mass Stars", Chamonix, France, 20-24 January; Cavendish Physical Society Lecture, Cambridge, 05 March; Spring Meeting of the Astronomical Science Group of Ireland, Queens University Belfast, 23 May; Workshop on High Mass Star Formation, University of Leeds, 11-12 June; Center for Astrophysics and Space Astronomy, Boulder, Colorado, 22 June – 08 August; NATO Advanced Study Institute on "Laser Guide Star Optics for Astronomy", Cargese, Corsica, 04-11 October; Science Week Exhibition, Burlington Hotel, Dublin, 09 November; University of Limerick, 11 November; Queens University Belfast, 12 November; University College Cork, 20 November; Knowth, 27 November; Royal Astronomical Society, London, 12 December.

D. Zhou: Institute of Physics Spring Meeting, Donegal, 21-23 March.

8.2 Geophysics Section

T.A. Blake: Transfrontier Project meeting, Copenhagen, 22-25 February

F. Hauser: VARNET Project meeting, Potsdam, 11-16 February; Irish Geological Association Annual Research Meeting, Belfast, 21-23 February; American Geophysical Union Fall Meeting, San Francisco, 06-14 December.

A.W.B. Jacob: Symposium in honour of Claus Prodehl, Univ. Karlsruhe, 26-28 January; VARNET Project meeting, Potsdam, 11-16 February; Transfrontier Project meeting, Copenhagen, 23-25 February; NATO Advanced Research Workshop, Moscow, 13-17 April; European Society General Assembly, Vienna, 22-27 April; KRISP project meeting, Leicester, 26-28 September; RAPIDS meeting, London, 29-30 October; Royal Astronomical Society Meeting, London, 13-14 November; American Geophysical Union Fall Meeting and visit to USGS, Menlo Park, San Francisco, 06-14 December.

M. Landes: Processing in Karlsruhe and VARNET Workshop in Potsdam, 01-16 February; Irish Geological Association Annual Research Meeting, Belfast, 21-23 February; European Society General Assembly, Vienna, 19-26 April; Data processing, Karlsruhe, 15 December to 15 January (98).

K. McGrane: Irish Geological Association Annual Research Meeting, Belfast, 21-23 February; UK Geophysical Assembly, Southampton, 01-04 April; Survey in R.V. PELAGIA west of Ireland, 21 May to 13 June; American Geophysical Union Fall Meeting, San Francisco, 06-14 December.

O. Novak: KRISP Project work in Karlsruhe, 26 March to 27 April.

B.M. O'Reilly: Irish Geological Association Annual Research Meeting, Belfast, 21-23 February; UK Geophysical Assembly, Southampton, 01-04 April; Barbican Conference on the Petroleum Geology of NW Europe Offshore Basins, 25-29 October; American Geophysical Union Fall Meeting, San Francisco, 06-14 December.

P.W. Readman: VARNET Project meeting, Potsdam, 11-16 February; UK Geophysical Assembly, Southampton, 01-04 April; American Geophysical Union Fall Meeting, San Francisco,

06-14 December.

V. Unnithan: UK Geophysical Assembly, Southampton, 01-04 April; European Society General Assembly, Vienna, 19-26 April.

8.3 Astronomy Section

M. Carr: EADN School on X-ray Spectroscopy, Amsterdam, NL, 22-30 September; ASGI Autumn Meeting, Dublin, 02 October.

J. Cunniffe: EADN School on X-ray Spectroscopy, Amsterdam, NL, 22-30 September; ASGI Autumn Meeting, Dublin, 02 October.

I. Elliott: ASGI Spring Meeting, Belfast, 23 May; AGSI Autumn Meeting, Dublin, 02 October; The George Johnstone Stoney Summer School, Dublin Castle, 20-21 September.

B. Jordan: INTEGRAL flight qualified component procurement strategy meeting, IGG Component Technology Ltd., Portsmouth, UK, 10 February; Ninth INTEGRAL OMC Consortium progress meeting, INTA, Madrid, Spain, 18-19 March; OMC Preliminary Design Review conference, INTA, Madrid, Spain, 27-29 April; INTEGRAL Spacecraft Interface Simulator Training Course, ESTEC, Noordwijk, NL, 26-29 May; Meeting to discuss EGSE design, MSSL, UK, 29 August; Tenth INTEGRAL OMC Consortium progress meeting, INTA, Madrid, 29 September - 01 October.

E.J.A. Meurs: TMR Physics Panel, Brussels, 18-21 February; European Southern Observatory, Garching, Germany, 10-13 March; Dutch Astronomers Conference, Dalfsen, NL, 14-16 May; Istituto da Astrofisica Spaziale, Frascati, Italy, 23-29 June; ISOSTAR Conference, Noordwijkerhout, NL, 30 June-05 July; TMR Physics Panel, Brussels, 22-25 July; UCD, 16 July, 14 and 15 August; X-ray Group, Kyoto University, Kyoto, Japan, 23 August-04 September; ASGI Autumn Meeting, Dublin, 02 October; SAX Symposium, Rome, Italy, 21-25 October; Istituto da Astrofisica Spaziale, Rome, Italy, 27-31 October.

L. Norci: Dutch Astronomers Conference, Dalfsen, NL, 14-16 May; ISOSTAR Conference, Noordwijkerhout, NL, 30 June-05 July; ASGI Autumn Meeting, Dublin, 02 October; SAX Syn;posium, Rome, Italy, 21-25 October.

R. White: Archaeo-astronomical field work, Malta and Gozo, 25 January-08 February; Use of the Vatican Observatory library, Vatican Observatory, Castel Gandolfo, Vatican City State, 15-28 March; Collaboration on archaeoastronomy, Department of Archaeology of the Orient and the Occident, Ecole Normale Superieure, Paris 6, France, 28 March-02 April; Library and databases at Centre des Donnees Stellaires, Strassbourg Observatory, Strassbourg, France, 02-05 April; Opening refurbished Rosse telescope, Birr Castle, Co. Offaly, 29 April.

Z. Zang: EADN Summer School on X-ray Spectroscopy, Amsterdam, NL, 22-30 September; ASGI Autumn Meeting, Dublin, 02 October.

9 Miscellanea

In the Astrophysics Section T. Downes and A.J. Keane successfully defended their PhD theses (see section 10.3). The external examiners were A. Raga (UNAM, Mexico) and W.R. Binns (Washington University, St. Louis, USA) respectively. In addition, J. Donnelly successfully defended his MSc thesis (also section 10.3).

In the Geophysics Section G.F. Byrne, F.E. Murphy, and O. Novak successfully defended their PhD theses (see section 10.3).

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 representive on the *National Committee for Physics* of the Royal Irish Academy.

A.W.B. Jacob was Co-convener with R. Kind and M. Weber (Germany) of the Symposium on "Global Seismology" at the 22nd General Assembly of the European Geophysical Society in Vienna during April and was Chairman for one of the sessions.

T.P. Ray continued to serve as the DIAS representative on the *National Committee for Astronomy and Space Research*, as President of the *Astronomical Science Group of Ireland* (until September), as Secretary of the La Palma Advisory Committee (until October) and as Chairman of the *European Astrophysical Doctoral Network*.

E.J.A. Meurs continued to serve as Honorary President of the *Trinity Astronomy and Space Society* and as a member of the *National Committee*

for Astronomy and Space Research of the Royal Irish Academy. He further served as a member of the *EU TMR Physics Panel*.

D. O'Sullivan was elected Co-chairman of the *Institute of Physics (Irish Branch)*. In addition, he was appointed to the *National Committee for Physics* of the Royal Irish Academy, as a representative of the Institute of Physics

C.J. Davis was appointed to the post of Support Astronomer at the United Kingdom Infrared Telescope on Mauna Kea, Hawaii.

T. Downes was appointed as a Post-doctoral Research Associate at the University of Utrecht.

M. Micono of the University of Turin worked in the star formation group as a visiting scientist from March until June with funding from Turin and DIAS.

I. Elliott continued as a Council member of the *Royal Dublin Society* and a member of its *Science and Technology Committee*. He served as chairman of the *Irish Science Centres Association Network* which was formed in January under the auspices of the Royal Dublin Society. For this, two meetings were organized at Dunsink Observatory: a demonstration lecture about "hands-on" science by M. Gore from Canberra (30 August) and an autumn meeting (26 September).

M.G. Burton, on sabbatical from the University of New South Wales, was a DIAS supported visiting scientist from April until June.

At the end of June R.E. White (University of Arizona) completed his period as Fulbright Visitor to Dunsink Observatory.

L. Drury and E.J.A. Meurs collaborated with TCD to provide prospective physics students with study information, on 15 November, at TCD.

A Press Information Sheet was issued by Dunsink to accompany the dramatic appearance of comet Hale-Bopp during the year. The Observatory was delighted to receive a visit by one of the discoverers of the comet, Mr T. Bopp, on 18 June.

K. Farrell organised a Comet Hale-Bopp Observing Evening at Djouce Mountain, Co. Wicklow on 10 April. Assistance was provided by Astronomy Ireland and Brendan Coyle (Dataproducts Ireland).

Dunsink hosted four Transition Year pupils during the year for their work experience placements.

Inventories for some of the historically valuable archive materials at Dunsink Observatory were prepared by library worker A. O'Lorcain.

Several film shooting sessions took place at Dunsink Observatory during the year, including a drama production partly located at Dunsink. Radio interviews included I. Elliott on Timepiece for RTE Radio (13 February); on The Leap Second for Dublin Weekend Radio (2 July); on Time for Anna Livia Radio (7 November) and E.J.A. Meurs on the newly opened visitors facility on Dublin Weekend Radio (13 December). In addition, W. Dumpleton provided occasional information on celestial phenomena through radio interviews.

Routine solar information was supplied to architects, film companies and sporting organisations during the year. Twenty-nine certified statements of Lighting-up Time were prepared for legal purposes by I. Elliott. Information from Dunsink archives was provided for several historical projects.

10 Publications

10.1 Journals and other Refereed Publications

G.F. Byrne, A.W.B. Jacob, J. Mechie and E. Dindi: *Seismic structure of the upper mantle beneath the Southern Kenya Rift from wide-angle data*, Tectonophysics, Vol 278, pp 243-260 (1997).

G.F. Byrne, A.W.B. Jacob, O. Novak with J. Mechie et al: *The structure of the Kenya Rift from wide-angle seismic measurements*, in "Geology for development within a sustainable environment" (eds. I.O. Nyambok and D.W. Ichang'i), Geological Society of Africa -- 10th Conference Proceedings, pp 287-304 (1996).

M.T.P. Corcoran and T.P. Ray: *Forbidden Emission Lines in Herbig Ae/Be Stars*, Astron. Astrophys., Vol 321, pp 189-201 (1997).

C.J. Davis, T.P. Ray, J. Eislöffel, and D. Corcoran: *Near-IR Imaging of the Molecular Outflows in HH 24-26, L 1634 (HH 240-241), L 1660 (HH 72) and RNO 15-FIR*, Astron. Astrophys., Vol 324, pp 263-275 (1997).

C.J. Davis, J. Eislöffel, T.P. Ray and T. Jennes: *Prompt Entrainment in the Variable Molecular Outflow from RNO 15-FIR*, Astron. Astrophys., Vol 324, pp 1013-1019 (1997).

D C Ellison, L O'C Drury and J-P Meyer: *Galactic Cosmic Rays from Supernova Remnants II -- Shock Acceleration of Gas and Dust*, Astrophys. J., Vol 487, pp 197-217 (1997).

A.W.B. Jacob with C. Prodehl et al: *The KRISP 94 lithospheric investigation of southern Kenya - the experiments and their main results*, Tectonophysics, Vol 278, pp 121-147 (1997).

A.J. Keane, D. O'Sullivan, A. Thompson, L.O'C. Drury and K.-P. Wenzel: *The Charge Spectrum of Ultra Heavy Nuclei, including Actinides, in the Cosmic Radiation*, Adv. Space Res., Vol 19, pp 739-742 (1997).

A.J. Keane, D. O'Sullivan, A. Thompson, L. O'C. Drury and K.-P. Wenzel: *Application and Analysis of SSNTD in the investigation of Ultra Heavy Cosmic Rays in the Dublin-ESTEC LDEF experiment*, Radiation Measurements, Vol 28, pp 329-332 (1997).

T. Kiang: *Horizon and the Question whether Galaxies that Recede faster than light are Observable*, Chinese Astronomy and Astrophysics, Vol 21, pp 1-18 (1997).

K G McClements, R O Dendy, R Bingham, J G Kirk and L O'C Drury: *Acceleration of Cosmic Ray Electrons by Ion-excited Waves at Quasi-perpendicular Shocks*, Mon. Not. R. Astr. Soc., Vol 291, pp 241-249 (1997).

G. Manfredi: *Long-time behavior of Nonlinear Landau Damping*, Phys. Rev. Lett., Vol. 79, pp 2815-2819 (1997).

J-P Meyer, L O'C Drury and D C Ellison: *Galactic Cosmic Rays from Supernova Remnants I -- A Cosmic-Ray Composition controlled by Volatility and Mass-to-Charge Ratio*, Astrophys. J., Vol 487, pp 182-196 (1997).

F.E. Murphy, J.W. Neuberg and A.W.B. Jacob: *Alternatives to core-mantle boundary topography*, Physics of the Earth and Planetary Interiors, Vol 103, pp 349-364 (1997).

R. Nesci, L. Norci: *A ROSAT HRI Observation of the Cluster MS0353-7411*, Astrophys. Lett. and Comm., Vol 36, pp 201-204 (1997).

O. Novak and M. Landes with H. Zeyen et al: *Refraction seismic investigations of the northern Massif Central (France)*, Tectonophysics, Vol 275, pp 99-177 (1997).

O. Novak, C. Prodehl, A.W.B. Jacob and W. Okoth: *Crustal structure of the southeastern flank of the Kenya Rift deduced from wide-angle P-wave data*, Tectonophysics, Vol 278, pp 171-186 (1997).

O. Novak, G.F. Byrne et al: *An integrated model for the deep structure of the Chyulu Hills volcanic field, Kenya*, Tectonophysics, Vol 278, pp 187-209 (1997).

B.M. O'Reilly, P.W. Readman and F. Hauser: *Lithospheric structure across the western Eurasian plate from a wide-angle seismic and gravity study: evidence for a regional thermal anomaly*, Earth and Planetary Science Letters, Vol 156, pp 275-280 (1997).

B.M. O'Reilly, P.W. Readman and T. Murphy. *The Gravity Signature of Caledonian and Variscan Tectonics in Ireland*, Phys. Chem. Earth, Vol 21, pp 299-304 (1996).

V.F. Polcaro, C. Rossi, R. Viotti, L. Norci: *The WO stars. III. The Planetary Nebula NGC 5189 and its O VI Sequence Nucleus*, Astron. Astrophys., Vol 318, pp 571-578 (1997).

V.F. Polcaro, R. Viotti, C. Rossi, L. Norci: *The WO stars. IV. Sand 5: A Variable WO Star*, Astron. Astrophys., Vol 325, pp 178-188 (1997).

T.P. Ray, Muxlow, T.W.B., Axon, D.J., Brown, A., Corcoran, D., Dyson, J., Mundt, R.: *Large-scale Magnetic Fields in the Outflow from the Young Stellar Object T Tauri S*, Nature, Vol 385, pp 415-417 (1997).

P.W. Readman with N. Abrahamsen: *Geomagnetic secular variation in Late Weichselian Allerod sediments from Nr. Lyngby (Denmark)*, Bulletin Geological Society of Denmark, Vol 44, pp 45-58 (1997).

P.W. Readman, B.M. O'Reilly and T. Murphy: *Gravity gradients and upper-crustal tectonic fabrics, Ireland*, Journal of the Geological Society, London, Vol 154, pp 817-828 (1997).

S.C. Russell: *More Light on RV Tauri Variables*, Astron. Astrophys., Vol 326, pp 1069-1075 (1997).

S. di Serego Alighieri, A. Cimatti, R.A.E. Fosbury, R. Hes: *Anisotropic [OIII] Emission in Radio Loud AGN*, Astron. Astrophys.,Vol 328, pp 510-516 (1997).

M.D. Smith, C.J. Davis and A. Lioure: *The Ortho and Para Fractions of Molecular Hydrogen in Protostellar Outflows and Herbig-Haro Objects*, Astron. Astrophys., Vol 327, pp 1206-1214 (1997).

N.J. Vermeulen: *Hydrography, Surface Geology and Geomorphology of the Deep Water Sedimentary Basins to the west of Ireland*, Bulletin No.2 in the Marine Resource Series of the Marine Institute, Dublin, 41 pp (1997).

10.2 Conference Proceedings

M.T.P. Corcoran and T.P. Ray: *A Spectroscopically Observed Jet from LkHα233*, in "Low Mass Star Formation -- from Infall to Outflow", Poster Proceedings of IAU Symp. 182 (eds. F. Malbet and A. Castets), pp 82-84 (1997).

C.J. Davis, T.P. Ray, D. Corcoran and J. Eislöffel: *Near-IR Imaging of Molecular Outflows from Young Stars*, UKIRT Newsletter, Issue nbr 1, p 4 (1997).

R O Dendy, L O'C Drury and G Manfredi: *Alpha-particle transport in Strong Drift Turbulence*, Proc Fifth IAEA Technical Committee Meeting on Alpha Particles in Fusion Research, JET, Culham, UK, pp 57-60 (1997).

T. Downes, T.P. Ray, and L.O'C. Drury: *Numerical Simulations of the Kelvin-Helmholtz Instability in Non-adiabatic Jets*, in "Low Mass Star Formation -- from Infall to Outflow", Poster Proceedings of IAU Symp. 182 (eds. F. Malbet and A. Castets), pp 98-100 (1997).

L. O'C. Drury: *Cosmic Ray Acceleration in SNRs*, in "The Interaction of Stars with their Environment", Proceedings of the Workshop and Spring School held at Visegrád, Hungary, 23-25 May 1996, published as Communications from the Konkoly Observatory of the Hungarian Academy of Sciences, Budapest, No.100 (Vol 12, Part 2), pp 413-419 (1997).

D C Ellison, L O'C Drury and J-P Meyer: *Interstellar Dust, Shock Acceleration and the Galactic Cosmic Ray Composition*, Proc. 25th Int. Cosmic Ray Conf. (Durban), Vol 4, pp 425-428 (1997).

A.G. Gibb and C.J. Davis: *Sub-millimetre CO Mapping of the Outflows in HH25/26*, in "Low Mass Star Formation -- from Infall to Outflow", Poster Proceedings of IAU Symp. 182 (eds. F. Malbet and A. Castets), pp 120-122 (1997).

A. Gimenez et al (with E.J.A. Meurs): *OMC: an Optical Monitoring Camera for INTEGRAL*, Proc. 2nd INTEGRAL Workshop, "The Transparent Universe", ESA SP-382, pp 613-616 (1997).

F. Hauser, M. Landes and A.W.B. Jacob with F. Masson et al: *The Variscan Front in Southwestern Ireland explored by wide-angle Seismic Profiling and Teleseimic Studies*, IASPEI General Assembly, Thessaloniki, August 1997.

A.W.B. Jacob, F. Hauser, M. Landes, P.W. Readman, B.M. O'Reilly et al: *Structural Changes in the Upper Mantle Across the Iapetus Suture Zone in Ireland: Evidence from the VARNET Project*, EOS, Vol 78, p F498 (1997).

A.W.B. Jacob with D. Delvaux and M.A. Khan: *Introduction to Lithospheric Structure, Evolution and Sedimentation in Continental Rifts* (eds. A.W.B. Jacob, D. Delvaux and M.A. Khan), Geophysical Bulletin No. 48, pp 2-5 (1997).

A.W.B. Jacob with R. Keary and P. Shannon: *Reconnaissance Survey of the Irish Continental Shelf / Shelf Edge*, Proc. Marine Institute Seminar, 20 February 1997, pp 1-2 (1997).

A.W.B. Jacob, M.A. Khan and D. Delvaux: *Foreword to Lithospheric Structure, Evolution and Sedimentation in Continental Rifts* (eds. A.W.B. Jacob, D. Delvaux and M.A. Khan), Geophysical Bulletin No. 48, p 1 (1997).

A.W.B. Jacob, O. Novak and G.F. Byrne with J. Mechie et al: *Controlled Source Seismic Experiments in Kenya*, in "Lithospheric Structure, Evolution and Sedimentation in Continental Rifts" (eds. A.W.B. Jacob, D. Delvaux and M.A. Khan), Geophysical Bulletin No. 48, pp 38-41 (1997).

A.J. Keane, A. Thompson, D. O'Sullivan, L. O'C. Drury and K.-P. Wenzel: *A Charge Spectrum of Ultra Heavy Cosmic Ray Nuclei, including Actinides, detected on the LDEF*, Proc. 25th Int. Cosmic Ray Conf. (Durban), Vol 3, pp 361-364 (1997).

M. Landes and A.W.B. Jacob with N.J. Vermeulen at al: *The Irish Variscides - a New Insight into an*

old Problem, EAGE 59th Conference and Technical Exhibition, 26-30 May 1997, Vol 2, pp 532-533 (1997).

M. Landes, A.W.B. Jacob, F. Masson, C. Prodehl and VARNET Research Group: *VARNET: a seismic profile across the Variscan Front and the Iapetus Suture in SW Ireland*, Ann. Geophysicae, Vol 15, p C63 (1997).

M. Landes and A.W.B. Jacob with F. Masson and C. Prodehl: *Varnet: a North-South seismic study across the Variscan Front in southwestern Ireland*, Terra Nova, Vol 9, p 380 (1997).

M. Landes and A.W.B. Jacob with F. Masson, C. Prodehl and VARNET Research Group: *Seismic profiles across the Munster Basin and the Variscan Front in SW Ireland*, Ann. Geophysicae, Vol 15, p C64 (1997).

K G McClements, R O Dendy, R Bingham, J G Kirk and L O'C Drury: *Acceleration of Cosmic Ray Electrons by Ion-excited Waves at Quasi-perpendicular Shocks*, Proc. 25th Int. Cosmic Ray Conf. (Durban), Vol 4, pp 421-424 (1997).

K. McGrane, P.W. Readman, A.W.B. Jacob at al: *Recent Erosional and Depositional features in the Sedimentary Basins west of Ireland*, EAGE 59th Conference and Technical Exhibition, 26-30 May 1997, Vol 2, pp 525-526 (1997).

K. McGrane, P.W. Readman, A.W.B. Jacob at al.: *Long-Range Side-Scan Sonar Survey of the Rockall Trough*, Offshore Ireland, EOS, Vol 78, pp F350-F351 (1997).

E.J.A. Meurs: *X-ray Aspects of the IRAS Galaxies*, Abstract Book, IAU General Assembly 23, Kyoto, Nr S188-043T, p 318. (1997).

J-P Meyer, L O'C Drury and D C Ellison: *GCR Composition: Volatility or FIP? SNR shock acceleration of Gas and Dust*, Proc. 25th Int. Cosmic Ray Conf. (Durban), Vol 4, pp 357-360 (1997).

B.M. O'Reilly and F. Hauser: *Passive Continental Margins: Present Concepts and Future Trends*, in "Lithospheric Structure, Evolution and Sedimentation in Continental Rifts" (eds A.W.B. Jacob, D. Delvaux and M.A. Khan), Geophysical Bulletin No. 48, pp 149-158 (1997).

B.M. O'Reilly, P.M. Shannon, A.W.B. Jacob, F. Hauser, P.W. Readman and J. Makris: *Structural Setting, Geological Development and Basin Modelling in the Rockall Trough*, Fifth Conference on the Petroleum Geology of NW Europe, 26-29 October 1997, p 65 (1997).

V.F. Polcaro, L. Norci: *V439 Cyg, the Red Star that became Blue*, Astrophys. Sp. Sci., Vol 251, pp 343-348 (1997).

T.P. Ray and M.T.P. Corcoran, *Do Herbig Ae/Be Stars Have Disks?*, in "Accretion Phenomena and Related Outflows", IAU Colloq. 163 (eds. D.T. Wickramasinghe, G.V. Bicknell and L. Ferrario), PASP Conference Series, pp 525-530 (1997).

T.P. Ray, T.P., Muxlow, T.W.B., Axon, D.J., Brown, A., Corcoran, D., Dyson, J., Mundt, R.: *Evidence for Magnetic Fields in the Outflow from T Tau S*, in "Herbig-Haro Outflows and the Birth of Low Mass Stars", IAU Symposium No. 182 (eds. B. Reipurth and C. Bertout), Kluwer Academic Publishers, pp 475-480 (1997).

S.C. Russell: *New Light on RV Tau Variables*, Proceedings of the Meeting on "Stellar Ecology" (23-29 June, 1996), Isle of Elba, Italy (1997).

P.M. Shannon, A.W.B. Jacob, F. Hauser and B.M. O'Reilly: *Rifting Processes at a Passive Margin in the Northeast Atlantic*, in "Lithospheric Structure, Evolution and Sedimentation in Continental Rifts" (eds A.W.B. Jacob, D. Delvaux and M.A. Khan), Geophysical Bulletin No. 48, pp 136-140 (1997).

M.D. Smith, Davis, C.J., Lioure, A.: *The Ortho and Para Fractions of Molecular Hydrogen in Outflows*, in "Low Mass Star Formation -- from Infall to Outflow", Poster Proceedings of IAU Symp. 182 (eds. F. Malbet and A. Castets), pp 178-180 (1997).

V. Unnithan, K. McGrane, A.W.B. Jacob and P.W. Readman et al: *Side-scan Sonar features in the Rockall Trough, offshore Ireland*, Annales Geophysicae, Vol 15, p C384 (1997).

M.I. Wilkinson, E.J.A. Meurs: *Finding Galaxy Filaments Using Voronoi Techniques*, in "From Quantum Fluctuations to Cosmological Structures" (eds. Valls-Gabaud et al), ASPC Series, Vol 126, pp 569-570 (1997).

Z. Zang, R.S. Warwick, E.J.A. Meurs: *ROSAT PSPC Observations of three Sculptor Group Galaxies: NGC 55, NGC 247 and NGC 300*, Ir. Astron. J., Vol 24, pp 45-46 (1997).

10.3 Books, Theses, Reports and Sundry Publications

T.A. Blake, C. Horan and A.W.B. Jacob with C.W.A. Browitt et al: *Natural and Induced Seismicity 1990-1996*, Map published by the British Geological Survey on behalf of the EU Transfrontier Group (1997).

G.F. Byrne: *Upper Mantle Structure Beneath Southern Kenya from Wide-Angle Data and Implications*, PhD Thesis, University College Dublin, National University of Ireland, 288 pp (1997).

J. Donnelly: *A Study of High Charge Cosmic Ray Particles at Civil Aviation Altitudes*, MSc Thesis, University College Dublin, National University of Ireland, 97pp (1997).

T. Downes: *Numerical Simulations of Jets from Young Stellar Objects*, PhD Thesis, Trinity College, Dublin University (1997).

I. Elliott: *The Origin of the Universe*, The Word, August 1997.

I. Elliott: Regular monthly articles on astronomy in Parent and Teacher (1997).

I. Elliott, R. Kevany and C. Power: Proceedings of the conference "Science Centres for Ireland", 19-21 June 1996, Royal Dublin Society (1997).

I. Elliott: Articles for the New Dictionary of National Biography (Oxford University Press) on the amateur astronomers John E. Gore and Laurence Parsons, fourth Earl of Rosse.

A.W.B. Jacob: *IASPEI National Correspondent's Report for 1996-1997*, 2 pp (1997).

A.W.B. Jacob and T.A. Blake with C.W.A. Browitt et al: *Final Report of the Rapid Transfer Seismic Data Exchange Network (Transfrontier Group)*, British Geological Survey Technical Report WL/97/21, Global Seismology Series, Edinburgh, 280 pp (1997).

A.W.B. Jacob with R. Kind and M. Weber: *Global Seismology*, EGS Newsletter No. 63, p 14 (1997).

A.W.B. Jacob, D. Delvaux and M.A. Khan (Editors): *Lithospheric Structure, Evolution and Sedimentation in Continental Rifts*, Communications of the Dublin Institute for Advanced Studies, Series D, Geophysical Bulletin No. 48, 172 pp (1997).

A.J. Keane: *Measurement of the Charge Spectrum of Ultra Heavy Galactic Cosmic Rays with Z > 70*, PhD Thesis, University College Dublin, National University of Ireland, 172pp (1997).

E.J.A. Meurs: *Dunsink, de sterrewacht van Dublin*, The journal of The Dutch Society in Ireland, Vol. 32, May issue, pp 12-13 (1997).

F.E. Murphy: *High Resolution Seismic Study of the Core-Mantle Boundary Region*, PhD Thesis, University College Dublin, National University of Ireland, 156 pp (1997).

F.E. Murphy and A.W.B. Jacob: *The Earth's deep mantle and the surface of the core*, The Irish Scientist Yearbook 1997, p 76 (1997).

O. Novak: *A wide-angle seismic study of the SE flank of the Kenya Rift incorporating a multidisciplinary interpretation*, PhD Thesis, University College Dublin, National University of Ireland, 128 pp (1997).

D. O'Sullivan and J. Byrne: *Detection of Neutrons and Charged Particles at Aviation Altitudes in the Earth's Atmosphere*, Euratom Report 16769, Vol 1, pp 310-319 (1997).

D. O'Sullivan and E. Flood: *Study of Radiation Fields and Dosimetry at Aviation Altitudes*, Progress Report for 1996, GSF/CEC (1997).

P.W. Readman with I.F. Smith et al: *Colour Shaded Relief Gravity Anomaly Map of Britain, Ireland and adjacent areas 1:1,500,000 scale*, British Geological Survey, Keyworth, U.K. (1997).

P.M. Shannon and A.W.B. Jacob: *Final Project Report under the Science & Technology Cooperation programme between Germany and Ireland, project MAR 11* (1997).

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

Financial Statements for year ended 31 December 1997

CONTENTS

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

Statement of Responsibilities of the Council

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

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

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

Deirdre Donnelly Chairman

Council Member

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

Financial Statements for year ended 31 December 1997

GENERAL

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

ACCOUNTING POLICIES

1. Accounting basis

The financial statements have been prepared under the historical cost convention.

2. Oireachtas Grants

Income is shown on a cash receivable basis.

3. Fixed Assets

Fixed Assets comprise the furniture, equipment, computers and motor vehicles of the Institute and are shown at cost less accumulated depreciation. The rates of depreciation, calculated on a straight line basis, are as follows :-

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

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

4. Capital Reserve

The capital reserve comprises income allocated for the purchase of fixed assets. It is written down in line with the depreciation of the related assets.

5. Library

Expenditure on library books and materials is charged to the Income and Expenditure Account. The value of such books and materials is estimated at £995,498, based on a 1994 valuation.

6. Publications

Expenditure on publications is written off in the year in which it is incurred. The estimated value of such publications on hand at 31 December 1997 was £746,366.

7. Superannuation

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

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

Financial Statements for year ended 31 December 1997

Income and Expenditure Account

	Notes	1997 £	1996 £
Income			
Oireachtas Grant		2,949,000	2,880,000
Sales of Publications		34,646	35,722
Celtic Studies Fees		0	1,125
School of Theoretical Physics	2	154,158	192,163
School of Cosmic Physics	2	270,232	527,605
Miscellaneous	8	20,754	25,737
		3,428,790	3,662,352
Transfer (to)/from Capital Reserve	4	(18,452)	(97,768)
		3,410,338	3,564,584
Expenditure			
School of Celtic Studies		652,250	639,366
School of Theoretical Physics		449,025	481,830
School of Cosmic Physics		1,363,795	1,615,834
Administration		909,927	840,154
		3,374,997	3,577,184
Surplus (Deficit) for year		**35,341**	**(12,600)**
Balance at 1 January		130,610	143,210
Balance at 31 December		**165,951**	**130,610**

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

Davida Donnelly
CHAIRMAN - COUNCIL OF THE INSTITUTE

REGISTRAR

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

Financial Statements for year ended 31 December 1997

Balance Sheet as at 31 December 1997

	Notes	1997 £	1996 £
Assets			
Fixed Assets	3	652,195	633,743
Current Assets:			
Cash on Hands and at Bank		382,302	387,378
Debtors and Prepayments		110,902	111,510
Total Assets		**1,145,399**	**1,132,631**
Less Liabilities			
Creditors - Amounts falling due within one year			
Creditors and Accruals		223,560	248,348
Research Programmes and Fees	2	65,969	79,249
Lease obligations	7	577	4,614
Creditors - Amounts falling due after one year			
Funds	5	37,147	35,490
Lease obligations	7		577
Total Liabilities		**327,253**	**368,278**
Net Assets		**818,146**	**764,353**
Financed by:			
Surplus Income and Expenditure Account		165,951	130,610
Capital Reserve	4	652,195	633,743
		818,146	**764,353**

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

Deville Donnelly
CHAIRMAN - COUNCIL OF THE INSTITUTE

REGISTRAR

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

Financial Statements for year ended 31 December 1997

Cash Flow Statement

	1997 £	1996 £
Reconciliation of Income and Expenditure Account Surplus/(Deficit) to Net Cash Inflow/Outflow from Operating Activities		
Surplus(Deficit) for year	35,341	(12,600)
Less Interest Received	(20,734)	(24,693)
	14,607	(37,293)
Increase/(Decrease) in Creditors/Funds	(27,745)	58,125
Decrease/(Increase) in Debtors	608	(82,050)
Net Cash Inflow/(Outflow) from Operating Activities	(12,530)	(61,218)
Net Decrease in Research Programmes and Fees	(13,280)	(49,826)
Returns on Investments and Servicing of Finance		
Interest Received	20,734	24,693
Capital Expenditure	(206,728)	(255,356)
Net Cash Inflow/(Outflow) before Financing	(211,804)	(341,707)
Financing		
Movement on Capital Account	18,452	97,768
Loss on Disposal	2,724	2,032
Depreciation	185,552	155,556
Cash Inflow from Financing	206,728	255,356
Net Cash Inflow/(Outflow) after Financing	**(5,076)**	**(86,351)**
Analysis of Movement in Cash and Cash Equivalents		
Balance at 1 January	387,378	473,729
Balance at 31 December	382,302	387,378
Increase/(Decrease) in Cash and Cash Equivalents	**(5,076)**	**(86,351)**

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

Daibhidh Donnelly
CHAIRMAN - COUNCIL OF THE INSTITUTE

REGISTRAR

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 31/12/1997

INCOME	Notes	School of Celtic Studies	School of Theoretical Physics	School of Cosmic Physics	Adminis-tration	1997 Total	1996 Total
		£	£	£	£	£	£
Oireachtas Grants		755,000	368,000	1,150,000	676,000	2,949,000	2,880,000
Sales of Publications		34,646	-	-	-	34,646	35,722
School of Celtic Studies		-	-	-	-		1,125
School of Theoretical Physics	2	-	154,158	-	-	154,158	192,163
School of Cosmic Physics	2	-	-	270,232	-	270,232	527,605
Miscellaneous	8	20	-	-	20,734	20,754	25,737
		789,666	522,158	1,420,232	696,734	3,428,790	3,662,352
Transfer (to)/from Capital Reserve	4	(31,082)	(36,466)	(65,057)	114,153	(18,452)	(97,768)
		758,584	485,692	1,355,175	810,887	3,410,338	3,564,584
EXPENDITURE							
Salaries, Wages and Superannuation	9	475,175	219,077	863,429	355,857	1,913,538	1,966,142
Scholarships		49,410	46,984	50,734	-	147,128	128,380
Honoraria		-	-	170	-	170	1,635
Library (incl. Microfilms)		44,489	12,861	35,194	-	92,544	124,134
Publications		30,870	-	3,549	1,877	36,296	15,060
General Administration	6	-	-	-	264,700	264,700	261,487
Travel and Survey Expenses		14,496	11,898	48,100	8,393	82,887	72,462
Symposia & Seminar Expenses		1,903	7,474	-	-	9,377	3,307
Consumable & Maintenance		-	-	25,835	-	25,835	25,956
Special Commitments and Projects		-	133,663	289,664	-	423,327	674,524
General Expenses		35,907	16,647	36,832	44,779	134,165	134,994
Golden Jubilee/Ieunet		-	-	10,288	37,454	47,742	-
Book Storage		-	-	-	8,591	8,591	7,899
Dunsink Renovation		-	-	-	-	-	252
Loss on Disposals		-	-	-	2,724	2,724	2,032
Depreciation	3	-	-	-	185,552	185,552	155,556
Leasing charges		-	421	-	-	421	3,364
		652,250	449,025	1,363,795	909,927	3,374,997	3,577,184
SURPLUS (DEFICIT) FOR YEAR		106,334	36,667	(8,620)	(99,040)	35,341	(12,600)
Balance at 1 January		78,042	(26,821)	(51,257)	130,646	130,610	143,210
Balance at 31 December		184,376	9,846	(59,877)	31,606	165,951	130,610

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

Project	Contributor	Opening Balance	Receipts	Applied as Income	Unexpended/ (Overexpended)
		£	£	£	£
Geotwin	GB fees		986	986	
HOGS	BGS				
Isophot	ESA	(3,351)		(3,351)	
Rapids	Forbairt	747			747
La Palma	Forbairt		5,000	5,000	
EADN - Erasmus/HCM	EU	25,952		27,371	(1,419)
Low Mass Star	Forbairt	(119)	9,595	4,260	5,216
Irma	EU	(7,851)		(7,851)	
Irma II	EU	(131)	21,944	22,420	(607)
LDEF	Forbairt	712		712	
Core Mantle I & II	EU	(12,304)	50,880	48,669	(10,093)
Kenya	EU	(399)	3,219	8,597	(5,777)
Kenya II	EU	2,504			2,504
BGS II	BGS	(12,131)	4,252	1,676	(9,555)
Rapids III	Forbairt	13,576		3,464	10,112
EPAS Plasma	EU	83		2,891	(2,808)
Plasma Cooperation	EU	4,651	35,250	24,638	15,263
Jet	Forbairt	4,975	3,000	11,849	(3,874)
Jet2	Forbairt		12,250		12,250
Slow Evolution	Forbairt	(578)		2,426	(3,004)
Varnet	EU	(26,788)	35,719	21,159	(12,228)
Gloria	Marine Institute	25,851	20,817	31,075	15,593
Gloria II	Marine Institute	15,185		51	15,134
Cores Nearby Galaxies	EU	5,861	1,950	2,774	5,037
High Energy	EU	14,992	22,116	40,733	(3,625)
Data Reduction	Forbairt	2,700		159	2,541
RIFTS	EU	198	3,000	3,198	
Eagle 99	EU			414	(414)
Stability of Shockwaves	EU		15,213	12,321	2,892
PECO	EU			3,385	(3,385)
Leinster Granite	Forbairt		11,200		11,200
Other Fees	Various		1,206	1,206	
		54,335	**257,597**	**270,232**	**41,700**

School of Theoretical Physics

Crossover	EU				
CNRS	EU	3,855		2,786	1,069
Esprit	EU	7,381	153,053	137,587	22,847
RITE	EU	(1,790)		3,104	(4,894)
Network Rennes	EU	15,468		3,919	11,549
Large Deviation	EU			6,302	(6,302)
Other fees	Various		460	460	
		24,914	**153,513**	**154,158**	**24,269**
Total					**65,969**

Notes to the Financial Statements

3. Fixed Assets

	Furniture & Equipment	Motor Vehicles	Computers	Total
Cost	£	£	£	£
Opening Balance 1/1/97	886,195	14,711	1,102,043	2,002,949
Additions	115,238		91,490	206,728
	1,001,433	14,711	1,193,533	2,209,677
Disposals	(5,434)		(8,534)	(13,968)
	995,999	14,711	1,184,999	2,195,709
Depreciation				
Opening Balance 1/1/97	549,492	14,211	805,503	1,369,206
Charge 1997	48,834	200	136,518	185,552
	598,326	14,411	942,021	1,554,758
Depreciation on disposals	(4,345)		(6,899)	(11,244)
	593,981	14,411	935,122	1,543,514
Net book value 31/12/97	402,018	300	249,877	652,195
Net book value 31/12/96	336,703	500	296,540	633,743

The net book value of £652,195 includes an amount of £798 in respect of assets held under finance leases.

4. Capital Reserve

	1997	1996
	£	£
Balance at 1 January	633,743	535,975
Transfer from Income and Expenditure Account		
Income allocated to acquire fixed assets	206,728	255,356
Amortisation in line with asset depreciation	(185,552)	(155,556)
Amount released on disposals	(2,724)	(2,032)
	18,452	97,768
Balance at 31 December	652,195	633,743

Notes to the Financial Statements

5. Funds

		1997 £	1996 £
These comprise:	Vernam Hull Bequest	35,345	33,760
	Carmody Fund	1,802	1,730
		37,147	35,490

The funds are held on deposit.

6. General Administration Expenses:

	1997 £	1996 £
Rent, Rates & Insurance	97,249	96,071
Premises Maintenance	48,868	57,220
Postage & Telephones	57,194	51,873
Fuel, Light & Power	46,744	40,367
Audit Fee	3,900	3,900
Sundry Supplies	10,745	12,056
	264,700	261,487

7. Leasing

Operating Leases

The premises occupied by the Institute are leased from the Office of Public Works. An additional lease was acquired in 1993 from Findlaters Ltd. for the purpose of book storage. The commitment on foot of such leases in respect of 1998 is £52,316.

Finance Leases

Included in Creditors is a liability of £577 under a finance lease.
The maturity of the above is as follows:
Under one year £577

8. Miscellaneous Income

Included under this heading is Bank Interest earned of £20,734 (1996 - £24,693) in the year.

9. Superannuation

The total superannuation payments in the year amounted to £292,134 (1996 - £315,523). The salaries and superannuation charge in the financial statements is net of contributions totalling £28,945 (1996 - £34,052).

DUBLIN INSTITUTE FOR ADVANCED STUDIES

REPORT OF THE COMPTROLLER AND AUDITOR GENERAL

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

Responsibilities of the Council and of the Comptroller and Auditor General

The accounting responsibilities of the Council of the Institute are set out in the Statement of Responsibilities of the Council on page 1. It is my responsibility, under section 28(3) of the Institute for Advanced Studies Act, 1940 to audit the financial statements presented to me by the Council and to report on them. As the result of my audit I form an independent opinion on the financial statements.

Basis of Opinion

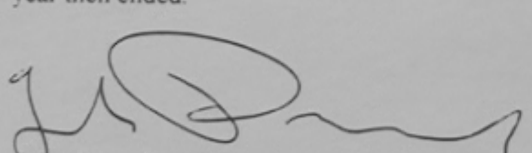
In the exercise of my function as Comptroller and Auditor General, I plan and perform my audit in a way which takes account of the special considerations which attach to State bodies in relation to their management and operation.

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

My audit was conducted in accordance with auditing standards which embrace the standards issued by the Auditing Practices Board and in order to provide sufficient evidence to give reasonable assurance that the financial statements are free from material misstatement whether caused by fraud or other irregularity or error. I obtained all the information and explanations that I required to enable me to fulfil my function as Comptroller and Auditor General and in forming my opinion, I also evaluated the overall adequacy of the presentation of information in the financial statements.

Opinion

In my opinion, proper books of account have been kept by the Council and the financial statements, which are in agreement with them give a true and fair view of the state of the affairs of the Institute at 31 December 1997 and of its income and expenditure and cash flow for the year then ended.



John Purcell
Comptroller and Auditor General
30 June 1998