Dublin Institute for Advanced Studies

Institiúid Ard-Léinn Bhaile Átha Cliath

RESEARCH REPORT **2005**

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School of Celtic Studies

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1 Research Work

Staff and Scholars

Senior Professors: Liam Breatnach (Director), Fergus Kelly, Máirtín Ó Murchú.

Professors: Malachy McKenna, Pádraig Ó Macháin.

Assistant Professors: Aoibheann Nic Dhonnchadha, Siobhán Ní Laoire (Academic Librarian; to December), Michelle O Riordan (Publications Officer).

Bibliographer: Alexandre Guilarte (from August).

Dialectologist: Brian Ó Curnáin.

Bergin Fellow: Roisín McLaughlin.

Scholars: Jenifer Ní Ghrádaigh, Nicholas Evans, Eoghan Ó Raghallaigh, Brent Miles (from October).

Assistant Librarians: Charlotte Dillon, Grace Toland (part-time) to October, Órla Ní Chanainn (from March).

School Administrator: Eibhlín Nic Dhonncha.

Technical Staff : ISOS: Anne Marie O'Brien.

IT support: Andrew McCarthy (part-time), Gavin McCullagh (part-time) until August. Stephen McCullagh (part-time) from August.

1.1 Taighde/Research

Dialect Studies

Brian Ó Curnáin continued his work on the Irish of Galway and Connaught, and carried out field-work in central Connemara. He worked on the index for his monograph of *The Irish of Iorras Aithneach, Co. Galway*. He continued video recording of children between the ages of two and five years who have a command of the Irish language in Connemara. Siobhán Ní Laoire worked on stylistic variation in Modern Irish (West Galway dialects) within the frameworks of sociolinguistics and discourse analysis, focussing in particular on hitherto unreported informal, interactional data and utilising a comparative, international perspective. Malachy McKenna continued his work on *The Irish of Rann na Feirste: Phonetics*. He researched an article entitled 'An Index to the

Rann na Feirste material in *The Linguistic Atlas and Survey of Irish Dialects*' for publication in *Celtica* 25.

Máirtín Ó Murchú continued work on the Gaelic of West Perthshire.

Textual editions

Roisín McLaughlin prepared her book entitled *Studies in Early Irish Satire* for publication. She submitted her PhD thesis, *A Critical Edition of Mittelirische Verslehren III*, to Trinity College Dublin.

Visiting Professor Mark Scowcroft continued his work on an edition of the second recension of *Lebor Gabála Érenn*. Visiting Professor Nancy Stenson worked on a series of grammar/exercise books for learning Irish, and an article on changing meanings of the verb 'faigh' in Modern Irish.

Historical studies

Research scholar Jenifer Ní Ghrádaigh continued her ongoing research into the architecture of twelfth-century Clonmacnoise and its patrons, artistic connections between Ireland and Europe in the twelfth century, iconographic significance of architectural and sculptural features, and the position of the *saer* 'wright' in early Irish law.

Research scholar Nicholas Evans completed work on a forthcoming article which should be published in 2006 in *The Journal of Celtic Studies*. He has also been researching and writing chapters for a monograph entitled *Recording and Re-interpreting History in Medieval Irish Chronicles*. Three chapters were completed this year, on 'The Structuring of History in the 'Chronicle of Ireland', 'The Chronology of Irish and Scottish History 431-730', and 'The Original Chronology of the Irish Chronicles, ca 550-730'. Research undertaken for conference papers in Reading and at the Tionól on the development of the portrayal of the kingship of Ireland and the Uí Néill will be used in a forthcoming chapter.

Research scholar Eoghan Ó Raghallaigh continued working on his thesis entitled *Poems from the Nugent Manuscript*.

Research scholar Brent Miles began work on a monograph on the study of Latin epic in Ireland and the classical translations of Middle Irish.

Michelle O Riordan continued work on her book *Irish Bardic Poetry: Rhetorical Reality* to be submitted to Cork University Press for publication in 2006.

Early Irish legal studies

Fergus Kelly continued his work on edition of a Legal Treatise attributed to Giolla na Naomh Mac Aodhagáin (d. 1309), and on an Old Irish text on legal disputes within marriage (*Corpus Iuris Hibernici* i 144.5–150.16).

Gerald Manning (Scholar 1999-2002) continued his seminar at the Institute on the Old-Irish law-text *Míadslechtae*. Liam Breatnach continued his seminar on the Old-Irish law-text *Córus Bésgnai*. His book, *A Companion to to the Corpus Iuris Hibernici*, was published in June.

Cataloguing of manuscripts

Pádraig Ó Macháin began work on correcting and preparing for publication William Mahon's catalogue of Irish Manuscripts in Villanova University, Pennsylvania. Aoibheann Nic Dhonnchadha carried out research on Early Modern Irish medical texts.

1.2 Meamram Páipéar Ríomhaire/ Irish Script on Screen (ISOS)

Work continued under the direction of Pádraig Ó Macháin. Digitisation of the Franciscan Collection of Irish Manuscripts in UCD was completed; these have now been processed and are on display on the ISOS website. Mac Fhirbhisigh's 'Book of Genealogies', held in UCD Library (Additional Irish MS 14) was also digitised, and is now on display. Work began on upgrading the huge database and archive of digitised material held by ISOS.

1.3 Tionscnamh Bibleagrafaíochta/ Bibliography project

Alexandre Guilarte continued work leading to the completion of the fourth volume of the bibliography.

1.4 Eagarthóireacht/Editing

Fergus Kelly: Co-editor of *Celtica* 25. He carried out editorial work on Brynley Roberts, *Maxen Wledig*, on Alexander Falileyev, *Welsh Walter of Henley*, and on Díaz y Díaz, *De Ordine Creaturarum*.

Malachy McKenna: Co-editor of *Celtica* 25;

Liam Breatnach: Co-editor of *Ériu* 55. He carried out editorial work on Elmar Ternes, *The Phonemic Analysis of Scottish Gaelic*.

Aoibheann Nic Dhonnchadha: (with Pádraig Ó Macháin), *An Linn Bhuí: Iris Ghaeltacht na nDéise* imleabhar 9.

Michelle O Riordan: Arranged for reprinting School of Celtic Studies publications.

Pádraig Ó Macháin: Co-editor of *An Linn Bhuí: Iris Ghaeltacht na nDéise* imleabhar 8. He founded and edited *Ossory, Laois and Leinster* Volume 1, and edited and prepared for publication *Index to Carrigan's History of the Diocese of Ossory* (Kilkenny).

1.5 Foilsitheoireacht/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. The following books were published in 2004:

Liam Breatnach, *A Companion to the Corpus Iuris Hibernici*, Early Irish Law Series volume 5, xvi + 499 pp. ISBN 1 85500 184 5.

Brynley F. Roberts, *Breudwyt Maxen Wledic*, Medieval and Modern Welsh Series volume 11, xcviii + 81. ISBN 1 85500 182 9.

Reprints

The following reprints were seen through the press by the School's Publications Officer, Michelle O Riordan:

F. Kelly, *A Guide To Early Irish Law* (Catalogue F4.3).

E. Knott, *An Introduction To Irish Syllabic Poetry Of The Period 1200—1600* (F3.2)

M. A. O'Brien (ed.), *Corpus Genealogiarum Hiberniae* (G7.1).

L. Bieler (ed.), *Four Latin Lives of St. Patrick: Colgan's* Vita Secunda, Quarta, Tertia, *and* Quinta (J2.8).

I. P. Sheldon-Williams (ed.), *Iohannis Scotti Eriugenae Periphyseon (De Diuisione Naturae, Liber Tertius)* (J2.11).

1.6 Díolachán leabhar/Sale of books

Promotion of publications was effected by the School Administrator, Eibhlín Nic Dhonncha, through advertising in *Books Ireland, National Concert Hall Annual Brochure, Comhar, Saol, Foinse, Lá, Conradh na Gaeilge: Clár Seachtain na Gaeilge, An tOireachtas: Clár na Féile, Lámhleabhar An Choláiste Ollscoile, Baile Átha Cliath, Library News,* and various articles in national and international newspapers.

1.7 Foilseacháin/Publications

Liam Breatnach: *A Companion to the Corpus Iuris Hibernici,* Early Irish Law Series volume 5, xvi + 499 pp.

'Miscellanea Hibernica: 1. Old Irish *tráigid* (ebbs, recedes). 2. The Simplex *serbaid*. 3. *do-maisi* and a Detail of Syncope', in Bernadette Smelik, Rijcklof Hofman, Camiel Hamans and David Cram (eds) *A Companion in Linguistics: a Festschrift for Anders Ahlqvist on the Occasion of his Sixtieth Birthday* (Nijmegen 2005) 141-51.

Nicholas Evans: 'Irish Chronicles as Sources for the History of Northern Britain, A.D. 660-800' *The Journal of Celtic Studies* 5 (forthcoming). Entries on 'Áedán mac Gabráin', 'Annals and Chronicles', 'Scotti/Scots', 'Scottish Influence', in *Medieval Ireland. An Encyclopedia*, ed. Seán Duffy (New York and London; Routledge).

Fergus Kelly: 'The Horse in Early Irish Society', in *The Irish Draught Horse: A History* (ed. Mary McGrath and Joan C. Griffith, The Collins Press, Cork) 30-39 'The Use of Ireland's Woodland in Medieval Times', in Ireland's Native Woodlands (Conference Proceedings, Galway, 8-11 September 2004, ed. Cara Doyle) 54-59 (CD-Rom issued in by Woodlands of Ireland, Cabinteely House, The Park, Cabinteely, Dublin 18).

Malachy McKenna: *Seanchas Rann na Feirste: Is fann guth an éin a labhras leis féin*, xvi + 180 pp. + 6 CDs. This publication was launched in Belfast in November, and in Donegal in December.

Roisín McLaughlin: 'A Threat of Satire by Tadhg (mac Dáire) Mac Bruaideadha' *Ériu* 55, 37-57. 'Metres in *Mittelirische Verslehren* III' *Ériu* 55, 119-36.

Jenifer Ní Ghrádaigh: 'Fragments of a Twelfth-Century Doorway at the Church of St Multose, Kinsale?', *Journal of the Royal Society of Antiquaries of Ireland* 133 (2003) 68-77. 'Temple Finghin, and Two Unusual Voussoirs from Clonmacnoise', *Archaeology Ireland*, Vol. 19, No. 3 (Autumn 2005) 26-31.

Aoibheann Nic Dhonnchadha: 'Winifred Wulff (1895-1946): Beatha agus Saothar' in Brian Ó Catháin (eag.) *Scoláirí Léinn: Léachtaí Cholm Cille 35* (Maigh Nuad 2005) 191-250.

Pádraig Ó Macháin: 'More Than Meets the Eye: Some Aspects of a Digitisation Project', *Irish Society for Archives Newsletter* (March 2005) 1-3. 'Nessa Ní Shéaghdha', in Brian Ó Catháin (ed) *Scoláirí Léinn: Léachtaí Cholm Cille 35* (Maigh Nuad) 69-103. 'Beatha bheag Dhéagláin', *An Linn Bhuí* 9, 22-33. *'Like Sun Gone Down: Selections from the Writings of John Canon O'Hanlon'* (with Tony Delaney, Kilkenny 2005).

Michelle O Riordan: 'Ireland 1600-1800', forthcoming in Palgrave History of Ireland 2007.

1.8 Leabharlann/Library

There were over 170 new acquisitions of core titles in Celtic Studies, including monographs, research reports, festschrifts and conference proceedings. Additional publications were supplied through long-established standing orders. The library appreciates the Institute's publications exchange partners and is grateful for the various books received from generous donors.

The library added four titles to its journals list, which now exceeds 130 current titles. These were: *Gath, Irish Archives,* and two new titles, *Ossory, Laois and Leinster* and *Studi Celtici*. In addition, the library bought the back set of *Comhar* from 1942-2000, and the first twelve volumes (for the years 1897 to 1918) of *Zeitschrift für celtische Philologie*.

To complement the print collection the library established access to subscription-based electronic resources, including the *Acta Sanctorum* database, and the online Brepols Medieval bibliographies and encyclopaedias.

Staff borrowed over 250 books from the library. Through the inter-library loan service a further 28 monograph titles and 19 serial articles were supplied to staff. The library made its

facilities available to 75 recorded external visitors from Ireland and abroad. Bibliographic and information requests were answered by library staff, in person, via correspondence and over the telephone. Further progress was made in the current and retrospective cataloguing of the collection.

1.9 Imeachtaí/Events

Statutory Public Lecture

This year's Statutory Public Lecture was delivered by Professor Liam Breatnach, Director of the School of Celtic Studies. The title of the lecture was 'Mediaeval Irish Law and Mediaeval Irish Literature'. It was delivered as part of the Tionól 2005, in Trinity College, Dublin on Friday 18th November to a large audience (circa 130).

Other Lectures

On Saturday 9th April the School of Celtic Studies hosted 'Teangeolaíocht na Gaeilge IX', a one-day conference on Irish and Scottish Gaelic linguistics.

In cooperation with Cumann Merriman the School organised and hosted a lecture on the 1st of December as part of the bicentennial commemoration of the death of Brian Merriman. The lecture, 'Cambridge Add. MS 6562: Merriman's Manuscript', was given by Dr. Liam P. Ó Murchú of University College Cork (Scholar 1975-8).

Tionól 2005

The School's annual conference, Tionól 2005, was organised by Professor Pádraig Ó Macháin, assisted by Eibhlín Nic Dhonncha, and took place on the 18th and 19th November. Over the two days, a total of eighteen papers was delivered by scholars representing ten institutions. The attendance at the Tionól averaged eighty to one hundred people per session.

The following is a list of speakers and papers:

Katja Ritari (University of Helsinki)
'What makes Irish saints sacred?'.

Marion Deane (University of Ulster)
'The debate: *Feis Tigi Becfholtaig*'.

Elizabeth White (University of Cambridge)
'*Scéla na Esérgi*: scholastic humanism in medieval Ireland'.

Jenifer Ní Ghrádaigh (School of Celtic Studies)
'Interpreting a fragmentary legal text on the *saer*'.

Nicholas Evans (School of Celtic Studies)
'The Uí Néill and the development of the Early-Medieval Irish chronicles'.

David Stifter (University of Vienna)
'Endlicher's Glossary: a document of Late Gaulish'.

Caomhín Breatnach (NUI, Dublin) '*Tóruigheacht Dhiarmada agus Ghráinne*; text, transmission and language'.

Peter McQuillan (University of Notre Dame)
'The idea of "suairceas" in the 17th and 18th centuries in Irish'.

Gerald Manning (NUI, Dublin)
'On restoring the text of the poem *Suidiugad Tige Midchúarta'*.

Geraldine Parsons (University of Cambridge)
'The manuscript tradition of *Acallam na Senórach'*.

Roisín McLaughlin (School of Celtic Studies)
'A Middle Irish textbook on *Auraicept na hÉces'*.

Morfydd Owen (Centre for Advanced Welsh and Celtic Studies, Aberystwyth, Wales)
'Gael agus Gall agus Breatnach: the poetry of Hywel ab Owain Gwynedd'.

Caroline McGrath (University of Ulster)
'The apple in early Irish literature'.

Jim Doherty (Trinity College, Dublin)
'The Stella Maris error'.

Donnchadh Ó Corráin (NUI, Cork)
'The Irish nota .h. for Ua, Uí etc.: an explanation'.

Gwenno Angharad Elias, '*Llyfr Cynyr ap Cadwgan:* the legacy of a medieval family of clerics and lawyers'.

Tom O'Loughlin (University of Wales, Lampeter)
'The inscription on the Ardagh Chalice: its liturgical setting'.

Neil McLeod (Murdoch University, Australia)
'The saga of Fergus mac Léti'.

Meidhbhín Ní Úrdail (NUI, Dublin)
'Athchuairt ar an *gCúirt'*.

Seminars

Liam Breatnach held a weekly seminar on the Old Irish law-text *Córus Bésgnai*, as well as a weekly seminar on Old Irish verse.

Gerald Manning held a weekly seminar in Spring on the Old Irish law-text *Míadslechtae*.

Roisín McLaughlin gave a weekly seminar, beginning in Autumn reading the Middle Irish metrical tract Mittelirische Verslehren III.

1.10 Léachtaí (foireann agus scoláirí)/ Lectures (staff and scholars)

Nicholas Evans: 'The Uí Néill and the development of the Early Medieval Irish Chronicles', Tionól, Dublin Institute for Advanced Studies; November. 'The Use of World Histories in Early Medieval Gaelic Chronicles', The Medieval Chronicle, Reading; July. 'The Chronology of Irish and Scottish History, 431-730', Conference of Irish Medievalists, Kilkenny; June.

Fergus Kelly: 'Trouble at home: a early Irish law-text on disputes within marriage', 27th Annual California Celtic Studies Conference, University of California, Berkeley; March. 'Grain-crops, vegetables and cultivated fruit in Early Christian Ireland: the continental connection', École des Hautes Études en Sciences Sociales, Paris; May. '*Bechbretha* and bee-keeping in ancient Ireland', Apimondia Ireland 2005: World Conference of bee-keepers, Royal Dublin Society; August.

Jenifer Ní Ghrádaigh: 'Interpreting a fragmentary legal text on the *saer*', Tionól 2005 Dublin Institute for Advanced Studies; November. 'Bishop, king, queen: pawns and players in Irish Romanesque architecture', Hunt Museum Medieval lecture series; November. 'Romanesque eclecticism: Irish artistic contacts with Wales and the Welsh Marches', The March in the Medieval West: NUI, Dublin; September. 'A Spiritual investment: Patronage and Workshop in the Irish Romanesque', Making and Meaning: the 5th International Conference of Insular Art: Trinity College Dublin; August. 'What is particularly Irish about Irish Romanesque: Architecture and its Sculpture', 2nd Annual Irish Lecture, Morley College London; May.

Aoibheann Nic Dhonnchadha: 'Winifred Wulff (1895-1946): Beatha agus Saothar' Léachtaí Cholm Cille, Ollscoil na hÉireann, Maigh Nuad; April.

Brian Ó Curnáin: '"Críost lér gineadh as", an clásal coibhneasta san ardréim in Iorras Aithneach', Comhdháil *Teangeolaíocht na Gaeilge IX*, Scoil an Léinn Cheiltigh; April.

Pádraig Ó Macháin: 'The life and work of John Canon O'Hanlon', Laois Heritage Society; May. 'Eirke, Fertagh and Glashare', Kilkenny Archaeological Society; May. 'A mhná guileam tré Ghlais Áir', Mullinahone Kickham Weekend; August. 'Stradbally, St. Louis, and Sandymount: the life and work of John Canon O'Hanlon', Royal Irish Academy; September.

1.11 Cúrsaí in ollscoileanna Éireannacha/ Courses in Irish universities

Nicholas Evans tutored first-year History at National University of Ireland, Dublin.

Fergus Kelly gave a weekly lecture on 'Early Irish law', to second and third year students, School of Irish, Trinity College Dublin (Michaelmas term).

Malachy McKenna gave two courses in the School of Irish, Trinity College, Dublin: (i) Canúintí na Nua-Ghaeilge and (ii) Bunfhoghraíocht na Nua-Ghaeilge.

Eoghan Ó Raghallaigh gave a course on Palaeography to 4th year students in Trinity College, Dublin.

Michelle O Riordan chaired a session of the Memory and History Seminar in the Institute of Irish Studies in Queen's University Belfast and delivered a post-graduate Seminar on readings of Irish bardic poetry to the Doctoral Programme of the Institute of Irish Studies in National University of Ireland, Galway.

1.12 Scrúdaitheoireacht sheachtarach, etc./ External examining etc.

Liam Breatnach: external examiner, Department of Old and Middle Irish, NUI Maynooth.

Fergus Kelly: external examiner, Department of Old and Middle Irish, School of Irish, National University of Ireland, Galway (PhD thesis); extern member of Selection committee for Chair in Early and Medieval Irish, University College Cork (July); Brian Ó Curnáin: external examiner, NUI, Galway (PhD thesis).

1.13 Na meáin chumarsáide agus aithne phoiblí/Media and public awareness

Website of the School of Celtic Studies

The school of Celtic Studies website (www.scs.dias.ie) continued to develop under the direction of Professor Pádraig Ó Macháin and Andrew McCarthy. There was an increase of 40% on the number of visitors to the site. The main development this year was the inclusion on the site of the Database of Bardic Poetry, compiled over many years by Dr Katharine Simms of Trinity College, Dublin and generously made available to the School by her.

Television and radio

Malachy McKenna was interviewed on the programme Blas for BBC Radio Northern Ireland about his publication Seanchas Rann na Feirste. The five hundred copies of his publication were sold out within four months of the first launch.

Pádraig Ó Macháin took part in various interviews throughout the year on Raidió Teilifís Éireann and Raidió na Gaeltachta.

Brian Ó Curnáin took part in various interviews on Raidió na Gaeltachta in connection with his research on Mionlach agus an Caisleán Gearr, Gaillimh.

Michelle O Riordan assisted with background material for a television production on the Flight of the Earls.

1.14 Coistí seachtracha/Outside committees

Jenifer Ní Ghrádaigh: Honorary General Secretary of the Royal Society of Antiquaries of Ireland.

Aoibheann Nic Dhonnchadha: Ball de Choiste Náisiúnta Léann na Gaeilge, Acadamh Ríoga na hÉireann.

Pádraig Ó Macháin: Member of the Editorial Advisory Board, *Journal of Celtic Studies*.

1.15 Cuairteoirí agus Comhaltaí/ Visitors and Associates

Visiting Professors

Professor Eric Hamp (University of Chicago).
Professor Mark Scowcroft (Catholic University of America).
Professor Nancy Stenson (University of Minnesota, USA).
Professor Brynley F. Roberts (former Director of the National Library of Wales).

Professor Markku Filppula (University of Joensuu, Finland.
Professor Neil McLeod (Murdoch University, Western Australia).
Professor James McCloskey (University of California, Santa Cruz).

Research Associates

Dr Gwenllian Awbery, University of Wales, Cardiff (1990)
Dr John Carey, National University of Ireland, Cork (1990)
Professor Thomas Charles-Edwards, University of Oxford (1990)
Professor Toshio Doi, Nagoya Women's University (1991)
Professor David N. Dumville, University of Aberdeen (1989)
Professor D. Ellis Evans, University of Oxford (1990)
Professor William Gillies, University of Edinburgh (1989)
Professor Geraint Gruffydd, Centre for Advanced Welsh and Celtic Studies, Aberystwyth (1989)
Professor Eric P. Hamp, University of Chicago (1989)
Dr Anthony Harvey, Royal Irish Academy (2004)
Professor Michael Lapidge, University of Cambridge (1988)
Professor Donald MacAulay, University of Glasgow (1989)
Professor James McCloskey, University of California, Santa Cruz (2004)
Professor Toshitsugu Matsuoka, Hosei University, Tokyo (1991)
Dr Martin McNamara, MSC, Milltown Institute of Theology and Philosophy (1989)
An tOllamh Tomás Ó Con Cheanainn, Ollscoil na hÉireann, Baile Átha Cliath (1991)
An tOllamh Donnchadh Ó Corráin, Coláiste na hOllscoile, Corcaigh (1991)
An tOllamh Ruairí Ó hUiginn, Ollscoil na hÉireann, Má Nuad (1999)
Professor Pádraig Ó Néill, The University of North Carolina at Chapel Hill (1990)
Dr Brynley F. Roberts, National Library of Wales, Aberystwyth (1990)
Professor R. Mark Scowcroft, Catholic University of America (1990)
Professor Richard Sharpe, University of Oxford (1988)
Professor Robert L. Thomson, University of Leeds (1991)
Professor Calvert Watkins, Harvard University (1990)
Professor Morfydd Owen, Centre for Advanced Celtic and Welsh Studies (2003)
Dr Tom O'Loughlin, University of Wales, Lampeter (2003)

Scoláirí Cuairte / Visiting Scholars

Overseas scholars (apart from those listed above under Visiting Professors) 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.

Professor Thomas Charles Edwards (Jesus College Oxford)
Amy Eichhorn-Mulligan (University of Oxford)
Máire Ní Mhaonaigh (St. John's College, Cambridge)
Bronagh Ní Chonaill (University of Glasgow)
Matthew Hammond (University of Glasgow)
Professor William Gillies (University of Edinburgh)
Clare Downham (University of Aberdeen)
Pia Dewar (University of Aberdeen)
Dr Thomas O'Loughlin (University of Wales, Lampeter)
Jonathan Wooding (University of Wales, Lampeter)
Morfydd Owen (Aberystwyth)
Dr Jacqueline Borsje (University of Utrecht, The Netherlands)
Patricia Ronan (Bonn University)
Johan Corthals (University of Hamburg)
Stefan Schumacher (University of Vienna)
Silvia Schwaerzler (University of Vienna)
Dr David Stifter (University of Vienna)
Christine Oberaller (University of Innsbruck)
Dr Melita Cataldi (University of Turin)
Piero De Gennaro (Turin, Italy)
Father Chrysostom (Koutloumous Monastery, Greece)
Kicki Ingridsdotter (University of Uppsala, Sweden)
Johan Larsson (University of Uppsala)
Micheál Ó Flaithearta (University of Uppsala)
Nina Chekhonadskaya (Moscow State University)
Dr Lisabeth Buchelt (Boston College, USA)
Dr Mary Valante (Appalachian State University, USA)
Margo Griffin-Wilson (USA)
Mary Valante (Appalachian State University)
Diana Delia White (Rhode Island College)
Pádraig Ó Néill (University of North Carolina)
Itisako Itosoi (Tokyo, Japan)
Toshi Matsuoka (Hosei University, Tokyo)

School of Cosmic Physics – Astronomy and Astrophysics

1. General

In 2005 the process of merging the previously separate Astronomy and Astrophysics sections began in earnest although lack of good quality office space prevented all of the staff from Dunsink Observatory being moved to Merrion Square. It is hoped this problem will be overcome in 2006 with the availability of new premises. The EU funded JETSET project, led by the section, began in February. The project is for four years and employs twenty postdoctoral fellows and PhD students (three at DIAS) throughout Europe. The Professorship in Astronomy was advertised widely and attracted an excellent field. Interviews for the position were held in November and Dr. Felix Aharonian, of the Max Planck Institute for Nuclear Physics in Heidelberg, accepted the offer of the post. Dr. Aharonian will commence working in the section in the autumn of 2006.

2. Research Work

2.1 Astronomy and Astrophysics Activities

2.1.1 IAU Symposium 230: Populations of High Energy Sources in Galaxies

E.J.A. Meurs, C. O'Maoileidigh, C. Woods

Activities in Astronomy were dominated throughout the first half of the year by the preparations for IAU Symposium No 230, then the Symposium itself in the 3rd week of August (held in Dublin Castle with the kind support of the Minister for Education and Science), and subsequently by the editing of the Proceedings. The Symposium, on 'Populations of high energy sources in galaxies' was regarded by the participants as highly successful and the Proceedings are expected to become a valuable reference work. A well-attended public talk was given by the renowned astrophysicist, Prof. Geoffrey Burbidge, on the Tuesday evening of the week of the Symposium, organized by the Symposium's Local Organizing Committee in collaboration with the RIA and the Irish Times.

Participants at IAU Symposium 230 gathered in the courtyard of Dublin Castle

2.1.2 Gamma-Ray Bursts and the REM Telescope

E.J.A. Meurs, P. Ward, S. Vergani with B. McBreen (UCD), L. Norci (DCU) and F. Zerbi, G. Chincarini and E. Molinari (Brera Observatory)

Work on Gamma Ray Bursts, the most energetic explosive events in the Universe, has become well established over the last few years. Astronomy students (P. Ward and S. Vergani) have regularly supervised the operation of the automatic REM telescope in La Silla, working from Dunsink Observatory as well as from their homes (since night alerts have to be followed up as soon as possible). Gamma Ray Burst alerts come largely from the dedicated 'Swift' high energy satellite. Besides Gamma Ray Burst follow-up observations, the REM telescope carries out regular monitoring observations, for instance of specific types of galaxies with active nuclei in their centres.

2.1.3 High-resolution Spectroscopy of Circumstellar Matter Surrounding Gamma Ray Bursts

P. Ward, S. Vergani and E.J.A. Meurs with L. Norci (DCU) and F. Fiore (Rome Astronomical Observatory)

Gamma Ray Bursts for which a so-called Afterglow is detected, lasting for days to months after the burst itself, are in some cases so bright that high-resolution ('echelle'-) spectroscopy can be performed. This provides us with the means to probe the circumburst environment in great detail, showing generally a clumped gas distribution with various velocities relative to the burst itself. This provides highly interesting diagnostics for the possible progenitor stars

that exploded in a Gamma Ray Burst. After a first extensive analysis, of GRB 021004, had been completed, new data for another couple of bright Afterglows have been secured during the year. The latter spectra allow the detection of atomic fine-structure lines, which are an important diagnostic for the density of the absorbing medium.
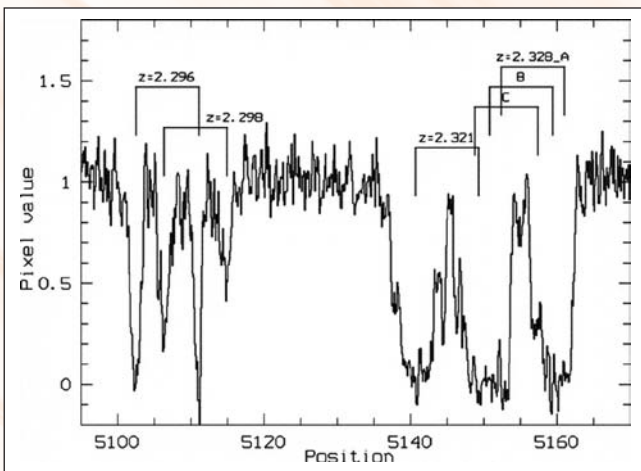
Part of high-resolution spectrum of Afterglow GRB 021004 showing six CIV doublets at redshifts around 2.3, indicating a kinematically structured circumburst medium.

2.1.4 GRB Distance Estimations

P. Ward and E.J.A. Meurs

Recent work has suggested that Gamma Ray Bursts have the potential to be used as standard candles. Taking into account that the emission from GRBs is not isotropic but rather is beamed within a cone, a quantity Q may be defined that incorporates as few observable burst parameters as possible and is directly dependent on the distance (quoted in terms of the redshift). The relationship that is obtained in this way has the potential to estimate distances for GRBs for which no Afterglow was observed. (Normally, when an Afterglow is detected, the redshift can be measured, for example via spectroscopy.)

2.1.5 Studies of Runaway Stars

C. O'Maoileidigh and E.J.A. Meurs with L. Norci (DCU) and M. Wilkinson (IoA, Cambridge)

In a feasibility study regarding the upcoming astrometric 'Gaia' satellite, it was shown that for roughly one-tenth of the known High Mass X-ray binaries (stellar systems consisting of a massive normal and a collapsed companion, a so-called neutron star), it can be expected to infer the presence of the compact companion from the orbital wobble observed for the normal star in the system (due to the two stars being in orbit around each other). This will open the way to accurate mass determinations for the neutron stars in these binaries, as well as precise orbital parameters for the systems as such. This study was further expanded to consider also the wobble detection capability of a 'SuperGaia' astrometric satellite, the concept for which had been submitted to ESA's 'Cosmic Vision' exercise. For a SuperGaia virtually all known High Mass X-ray binaries will exhibit detectable wobbles, while detections will also be possible for X-ray binaries in the Magellanic Clouds.
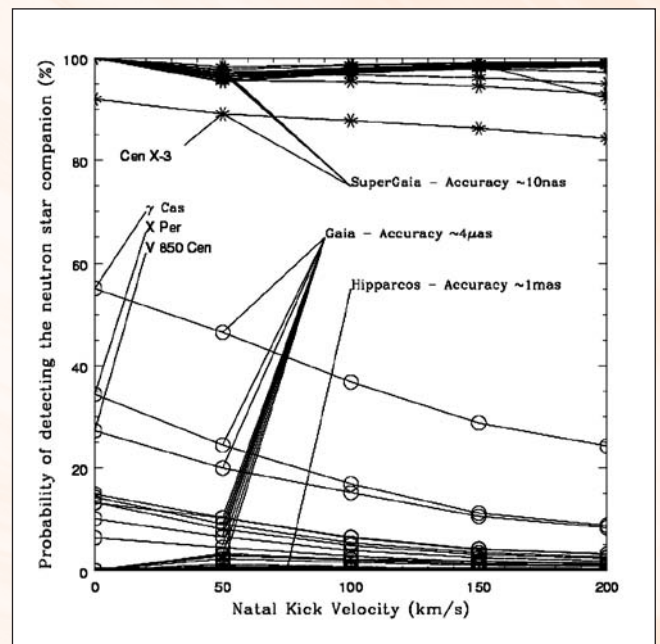
Probability to detect orbital wobble for Galactic High Mass X-ray binaries for three generations of astrometric satellites: Hipparchos (0% probability throughout), the upcoming Gaia and a future SuperGaia (the lines above 80% probability). The probabilities are shown as function of the natal kick velocities imparted on the systems by the Supernova explosions that took place in them.

This work emerged naturally from a project on the production mechanisms for 'runaway' stars, massive stars that have acquired a substantial velocity within our Galaxy. One such method concerns the Supernova explosions in which neutron stars are born, which impart substantial velocities to the system. In a general approach, dynamical simulations of small stellar groups were carried out with advanced computer codes, together with consideration of the evolutionary development of the stars involved.
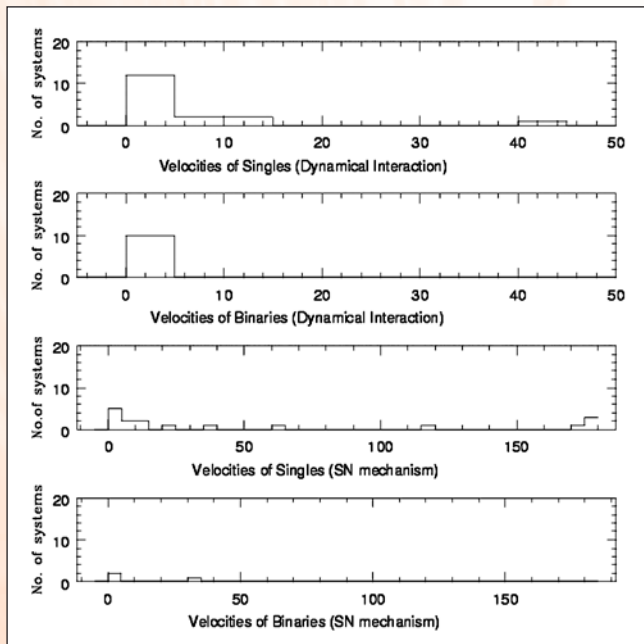
Results of simulations indicate that the typical velocities of runaway stars (above 30 km/s, horizontal scale) are more likely to be produced by Supernovae occurring in binaries than by dynamical encounters.

2.1.6 Studies of B[e] Stars

E.J.A. Meurs with L. Norci (DCU), V.F. Polcaro and R. Viotti (INAF/IAS, Rome) and A.S. Miroshnichenko (University of Toledo, USA)

A particularly interesting star, that has featured notable periods of X-ray emission in the past, has been studied with optical spectroscopy. Some emission lines in its spectrum, and the pattern of variation of these lines, suggest that the X-ray emission is due to an associated compact companion (neutron star) around which material ejected from the optically visible star settles as a so-called accretion disk. The inner parts of these disks become very hot and can emit X-rays. Further

spectroscopic data on this object have been collected during the year, leading amongst other things to reconsidering a proposed classification of this star as a particular sub-type of Be stars (which are stars of spectral type B that exhibit emission lines in their spectra).

2.1.7 The Intermediate Density Cloud LDN1780

C. del Burgo with L. Cambresy (Strasbourg Observatory)

Using infrared data from the IRAS and ISO satellites, the emission from warm and cold components of large dust grains could be separated for the small and moderately dense cloud LDN1780. Hα emission has also been observed, which correlates well with the Vis-band extinction. It is suggested that the Hα emission results from ionisation by cosmic ray particles and the infrared emission is due to silicon nanoparticles.

2.1.8 Optical Variability of Blazers

E.J.A. Meurs, P. Ward and S. Vergani with members of the REM collaboration

Certain active nuclei of galaxies that reside in elliptical systems show noticeable variability of their optical light emission. The REM telescope (see above) has monitored several such objects. These observations led to the recognition of episodes with abnormally large light variation for the blazers PKS0537-441 and 3C454.3, about which the research community was quickly informed.

2.1.9 Magnetic Fields in Star Forming Regions

R. Curran and T.P. Ray

Molecular clouds are observed to persist for much longer than their free-fall timescales, suggesting they have some form of support preventing them from collapse (at least initially). Thermal pressure is too weak in comparison to the gravitational stresses in the cloud, and current theory predicts that the support may come from the magnetic field that permeates the gas, and/or the pressure of turbulent eddies – indeed it is likely that these two mechanisms are coupled. We have used a combination of observations and modelling to assess the contributions of the magnetic field and turbulence to the support of clouds.

One of the most direct methods of detecting a magnetic field is to observe the polarised thermal emission from cold dust grains that have been aligned by the field, thus mapping its morphology in the plane of the sky. This method has been used to study the magnetic field of star forming regions like DR21(OH) in detail, using our polarimetry data from the James Clark Maxwell Telescope in conjunction with, Zeeman measurements of the (line-of-sight) magnetic field strength and intermediate resolution polarisation maps observed with the Berkeley-Illinois-Maryland-Association (BIMA) interferometer array. This has enabled a 3-dimensional impression of the magnetic field throughout the cloud to be gained. The magnetic field is found to lie predominantly in the plane-of-the-sky, in an East-West direction (perpendicular to the major-axis of the star-forming region, which has a North-South morphology). The field also remains remarkably uniform throughout the cloud. These two factors may hint at an initially strong field and collapse via ambipolar diffusion. However, analysis of the critical mass-to-flux ratio for this morphology of cloud/magnetic field indicates that the magnetic field is unable to prevent collapse.

2.1.10 Molecular Cores

R. Curran and T.P. Ray

Modelling of over twenty cores has been carried out using both Bonner-Ebert (BE) hydrostatic sphere and Penston-Larson infall models. This was done by fitting their azimuthally averaged radial density profiles. Current wisdom states that caution should be used when fitting hydrostatic models, as even dynamically evolving cores can appear in "hydrostatic disguise" and fit BE models well. Nevertheless, the central densities, scale radii and core radii (the extent of the fit) can be used as a common metric for both modellers and observers to characterise the cores. Analysis of the line-of-sight velocity dispersions calculated from the fit indicates in most cases larger velocity dispersions than are usually measured in typical high-mass star forming regions. Observations to measure the velocity dispersions in a sub-sample of these cores were recently carried out.

2.1.11 Spitzer Observations of Weak-line T Tauri Stars

À. Gras-Velázquez and T.P. Ray

Data has been acquired from the Cores to Disk (c2-D) Legacy Program, carried out by the Spitzer Space Telescope (see figure), to search for disks around weak-line T Tauri stars (WTTS). These stars are thought to be analogues of the young Sun during the first few million years of its life. The emphasis has been on reducing Multi-band Imaging Photometer for Spitzer (MIPS) data at 24 and 70 microns. Combining these new data with optical and near-infrared observations, spectral energy distributions of the WTTS have been constructed to look for infrared excess emission, tell-tail signatures of disks. Evidence has been found for circumstellar disks in 20% of the stars (of a total sample of 30). Interestingly WTTS selected by their X-ray emission are unlikely to possess disks while those chosen on the basis of their optical emission frequently do. Thus X-ray selected WTTS are essentially devoid of circumstellar matter in contrast to their optically selected counterparts. This is contrary to the commonly held belief that all WTTS do not possess disks.
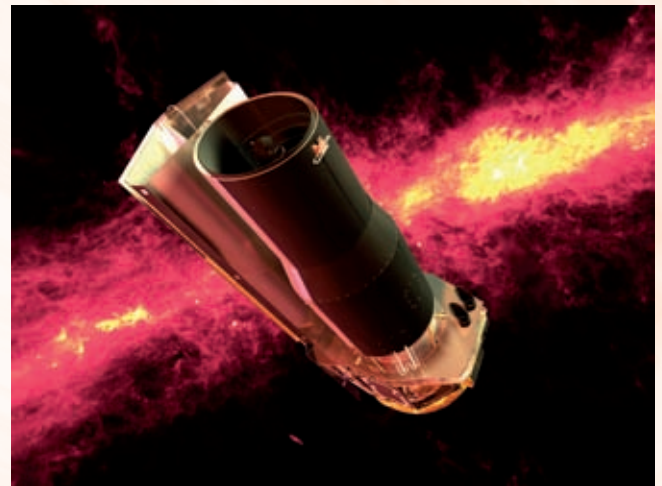
Spitzer Space Telescope. Image courtesy of NASA

2.1.12 Measuring Interstellar Extinction from Star Counts

D. Froebrich, T.P. Ray, G.C. Murphy, and A. Scholz (University of Toronto)

A study has been made of the distribution of gas and dust in several star-forming regions by means of near-infrared (NIR) extinction maps. One important property of dust is how

extinction depends on wavelength. Knowing the so-called reddening law allows us to use stellar colours to determine extinction and to measure the mass of gas and dust in a cloud. We have developed methods to determine the extinction law based on star counts and colour excess maps. Those methods have been applied to clouds in Cepheus Ophiuchus and elsewhere (see figure). A dependence of the extinction law on the column density of gas and dust was found. This is of significance for radial density profile analysis of dark clouds.
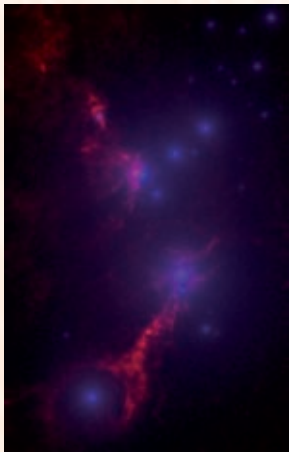
Extinction (red) in Orion as measured from star counts. The stars of Orion are shown in blue. Image D. Froebrich

2.1.13 The Youngest Stars

D. Froebrich

During the earliest stage of star formation (Class 0) protostars gain most of their final mass. We have investigated how well current models are able to predict the observational properties of these objects. Numerically derived mass accretion rates from gravo-turbulent simulations were combined with an evolutionary model of the envelope structure to obtain model evolutionary tracks for the three main observables (envelope mass, bolometric temperature and luminosity). A three dimensional Kolmogorov-Smirnov test was then applied to quantify the agreement between model predictions and observation. Monte-Carlo methods were used to constrain free model parameters. In general rather poor agreement (70%) of models and observations was found. However, we can conclude from our investigations that star formation is in essence a localised and stochastic process, governed in the majority of regions by turbulence rather than by ambipolar diffusion and that the Class 0 phase lasts between 20 and 60 thousand years.

2.1.14 Finding Hidden Clusters

D. Froebrich

Most stars form in clusters, embedded in clouds of gas and dust. We have used star counts based on the 2 Micron All Sky Survey (2MASS) point source catalogue to obtain a complete sample of all star clusters in the Galactic Plane with |b<20°|. In total 1788 cluster candidates were identified of which 86 galactic and 610 open clusters were already known (see figure). Thus we have found some 1092 new cluster candidates. For all objects radial star density profiles were fitted to obtain the size, stellar density and number of stars in the cluster. Those properties were then used to obtain a measure to classify the new candidates in our sample. It was found that about half of our new candidates are indeed new open clusters. Furthermore we found that star clusters are themselves clustered on scales of about 0.7°. This corresponds to an increased probability of finding cluster pairs on spatial scales of 10-25pc, about the size of typical molecular clouds in the Galaxy.
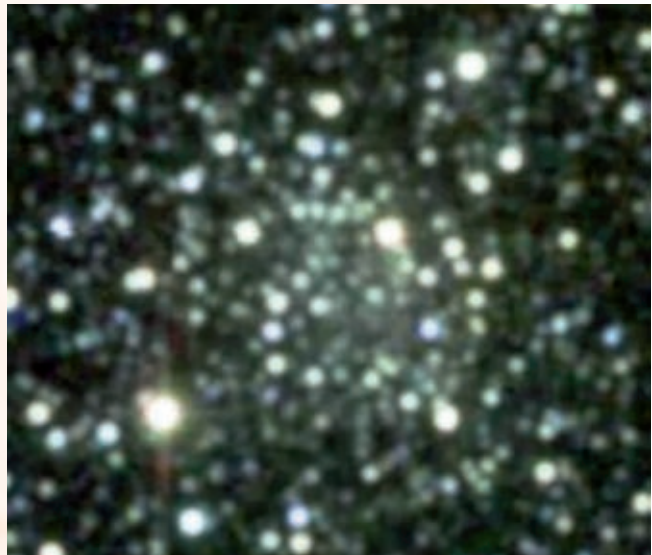
A newly discovered Milky Way cluster. Image D. Froebrich

2.1.15 Searching for Outflows from Brown Dwarfs

E. Whelan, T.P. Ray, F. Bacciotti (Arcetri), S. Randich (Arcetri), R. Jayawardhana (University of Toronto)

Brown dwarfs (BDs) are often referred to as "failed stars" because their mass is insufficient to ignite hydrogen in their cores: These objects never join the Main Sequence. At the

same time evidence has been growing that these objects accrete while young just like ordinary protostars. Moreover it was noticed that in some cases BD optical spectra contain weak forbidden lines e.g. the [OI] doublet, lines that are traditional tracers of outflow activity. Theoretically however we expect any jet or outflow from a BD to be small in angular size and to be very faint. For these reasons, we applied the novel technique of spectro-astrometry to the emission lines to search for an outflow. Our target was ρ-Oph 102, a young (few million years old) BD of about 60 Jupiter masses deeply embedded in a star formation region (see figure). Using data from the Very Large Telescope (VLT) in Chile, we were able to demonstrate that this BD was in fact driving a jet like those seen from T Tauri stars albeit on a much smaller scale. This was the first confirmation that BDs could drive outflows and resulted in a Nature paper published in June 2005. A collaborative project to look at other BD outflow candidates has commenced with Ray Jayawardhana at the University of Toronto. Proposals to observe more BDs with the VLT were successful and the observations are scheduled to be carried out in 2006.

Discovery of the first jet from a brown dwarf ρ-Oph 102 (circled in inset frame). Image courtesy of David Malin, Anglo Australian Telescope.

2.1.16 Integral Field Spectroscopy of T Tauri Star Outflows

E. Whelan and T.P. Ray

Observations of a number of outflows from classical T Tauri stars (e.g. DG Tau and RW Aur) were obtained with the integral field spectrometer OASIS on the William Herschel Telescope on La Palma. The observations were obtained under good seeing and utilizing the adaptive optic system, so they are of very high spatial resolution. The data will primarily be used to provide proper motion information, i.e. to see how the system evolve with time for comparison with models.

2.1.17 Modelling Infall and Outflow in Young Stars

T. Lery and C. Combet

Work is continuing on developing semi-analytical models that treat both infall and outflows in a coherent fashion According to these models, we consider molecular outflows to be infalling gas that has been deflected outward by the combination of pressure gradients and magnetic fields when approaching the central protostar. We have modified the original self-similar models in order to study the influence of magnetic field and opacity on the solutions. We found that outflows can exist without the presence of a magnetic field, and that infall and outflow rates increase when dust does not dominate the cooling. A complementary line of research is currently ongoing to numerically study the stability of these solutions. This work is still in progress and is performed by implementing a solution of the model into the FLASH numerical code. The latter cannot only handle magneto-hydrodynamic simulations in 3 dimensions but is fully parallelised and uses Adaptive Mesh Refinement (AMR).

2.1.18 Interacting Jets from Binary Stars and Jet Propagation

G.C. Murphy and T. Lery

Most solar-like stars form in binary systems. There may thus be a period, in the life of a young system, when two or more jets are ejected simultaneously (e.g. as seen in the system L1551-IRS 5). Simulations of what happens when such jets interact have been performed. It is found that for plausible parameters, the interaction can have strong effects on the flow. The effects of binary rotation, and conditions under which the jets could merge, have been examined.

A study of jets propagating under free expansion or in an ambient medium of steeply declining density was carried out The purpose of this was to explain the highly collimated shape of astrophysical jets, which may be caused in part or wholly by the density profile of the ambient medium. In previous studies the ambient cloud into which a jet propagates has been treated as a constant density and pressure structure, whereas in reality it may have a density gradient or cavity. The cavity may be caused by the joint effects of gravitational infall and centrifugal force or by previous episodes of strong ejection from the source.

2.1.19 Non-Ideal MHD Waves and Structure Formation in the ISM

A. Lim, S. Falle (Leeds) and T. Hartquist (Leeds)

Absorption observations indicate that significant fluctuations in physical conditions in interstellar clouds exist on scales comparable to, or even smaller than, the dissipation length associated with ion-neutral friction. One proposed mechanism whereby such structure can arise is the non-linear coupling of the fast and slow MHD wave modes in a magnetically dominated region. In this model a fast-mode wave can create dense clumps in regions where the velocity gradient in the wave is negative, these clumps are typically bounded by slow-mode shocks and the amount of energy in the slow mode grows linearly with time.

Simulations have been performed of non-ideal hydromagnetic wave evolution in which ion-neutral friction plays a major role. These simulations focus primarily on cases for which the background thermal pressure is very small compared to the background magnetic pressure. For initial disturbances with wavelengths sufficiently large compared to the dissipation length the generation of high-density contrast structures is due to slow-mode wave generation following non-linear steepening of the fast-mode wave. At such wavelengths, the collisions of structures generated in this fashion leads to additional density enhancement for some ranges of the initial wave amplitude. For initial disturbances with sufficiently short wavelengths, ion-neutral damping results in the presence of slow-mode waves; for some ranges of parameters, the dissipation causes higher density contrasts than those found in the corresponding longer wavelength cases.

Large density contrasts on scales comparable to the dissipation length are found only in cases in which the wavelength of the initial perturbation is not too large. This result indicates that the observed small-scale structures may arise by the direct driving of rather short wavelength perturbations. The fact that the short wavelength waves do not propagate far before they are dissipated suggests that the decadal variations in absorption features may be due to phenomena at the surface of clouds where shear boundary layers are sources of high frequency waves.

2.1.20 MHD Simulations of Star-forming Regions

A. Lim, S. Falle (Leeds) and T. Hartquist (Leeds)

Star-forming regions of the ISM are typically observed to have a low plasma parameter, ß, and many studies of structure formation in such regions (including that above) have assumed magnetically dominated initial conditions. They have not, however, addressed the question of how such low ß regions can arise. This work consists of the study of a highly idealised situation in which a spherical cloud of gas with moderate ß is compressed by a higher external pressure. Fast magneto-hydrodynamic shocks are driven into the cloud and the near the cloud "equator" (with respect to the ambient magnetic field direction) these have the effect of compressing the magnetic field lines and raising the magnetic pressure. Radiative cooling behind these shocks then lowers the gas pressure leading to a region of low ß. The simulations show that, for an initial cloud beta of around unity, the cloud interior could can achieve a ß~0.03, which is a similar value to that observed in star-forming regions. In addition, the low ß region is seen to be in a thermally unstable state which is more conducive to the formation of dense clumps.

The magnetically dominated region is transient in nature since the cloud must eventually equilibrate its pressure with it's surroundings, however for a region the size of a Giant Molecular Cloud (GMC) the lifetime of the low ß region does not conflict with the estimates of a few million years for the ages of the stars seen in observed GMCs.

2.1.21 Equilibrium and Time-Dependent H_2 Emission

A. Lim, J. Rawlings (UCL), D. A. Williams (UCL) and Stefano Tine (UCL).

A detailed model of the H_2 molecule has been constructed leading to a time dependent cooling function that accounts for the effect of the CMB at high redshift. This involves solving simultaneous differential equations for collisional (de-) excitation and spontaneous/stimulated emission for all 212 ro-vibrational levels considered in the model. A paper giving steady state cooling function at various fixed redshifts is currently being prepared. The steady state cooling rates are obtained by iterating the above system to equilibrium over the relevant parameter space and fits to these data compare well with currently available H_2 cooling functions.

This model has been applied to the emission from H_2 formed in the chains of aligned knots that define the beams of Herbig-Haro jets. These are sometimes observed both in atomic/ionic as well as in molecular H_2 emission lines. Such objects are modelled as jets with an ejection velocity time-variability, which produces internal working surfaces that travel down the jet beam. In a series of axisymmetric gas dynamic and chemical numerical simulations it was found that, for variations with an amplitude of ~ 0.1, the internal working surfaces have appropriate conditions for H_2 to be formed (via negative and positive ion gas phase chemistry) and H_2 fractions as high as ~ 1-10% can be obtained.

This study suggests that the H_2 emission observed in the chains of knots along some HH jets could correspond to molecules formed in situ within the internal working surfaces that travel down the jet flow. Future work will involve the use of the cooling function in a time-dependent manner to study the level populations and emission from molecular gas in dynamical situations where equilibrium populations cannot be assumed both in the current epoch and at high redshift.

2.1.22 Adaptive Multi-fluid MHD Simulations of Stellar Jets Including Chemical Networks

A. Lim and S. Cabrit (Observatoire Paris, DEMIRM)

Jets from young stellar objects are widely acknowledged to be useful diagnostics of the star formation process and extensive numerical investigation of these phenomena has taken place over the last decade. Previous simulations have usually made the assumption of pure gas dynamics or ideal MHD, however there is significant observational evidence that non-ideal effects may play an important role in the behaviour of stellar jets; for example, observations of high velocity H_2 emission have led some researchers to look to so-called "C-shocks" in which the ion-neutral coupling softens the shock discontinuity and may allow molecular gas to survive into the post-shock region.

With this motivation, an adaptive non-ideal MHD code is being developed which is able to follow the chemical evolution of the gas and does not make the assumption that the inertia of the ionic component is negligible. This code will first be applied to jets, for which a large volume of previous work exists and the initial results can be placed in context. In the future, this code will be applied to regions close to the protostellar object in which some models have suggested that ambipolar diffusion is important in the jet launching process.

2.1.23 Adaptive 3D Calculations of Gravitational Instability in Proto-planetary Disks

A. Lim and M. Picket (Purdue University, Calumet)

Studies of the formation of gas giant planets in self-gravitating disks has been motivated by the recent explosion in the detection of extra-solar planets. One mechanism by which this process can take place is that of gravitational instability, in which a disk with the right physical conditions is unstable to the formation of dense self-gravitating condensations.

This project applies adaptive mesh refinement methods to simulations of protostellar disks in order to resolve more clearly the formation of the condensations (which has been a weakness in previous studies) and address the current uncertainty as to whether gravitational instability can explain the current observed preponderance of extra solar gas-giant planets.

The geometry of this problem has led to the development of a cylindrical adaptive mesh upon which the simulations will be performed. Comparisons with the Cartesian mesh will allow any effects due to grid geometry to be identified and, if necessary, techniques to minimise such effects to be developed.

2.1.24 2-D/3D Studies of MHD Waves in Isothermal and Thermally Unstable Media

A. Lim, S.Falle (Leeds) and T. Hartquist (Leeds)

This involves simulations of both isothermal media, in which the mode-coupling is the primary mechanism for the formation of density structure, and thermally unstable media, in which the mode-coupling can serve as a catalyst for cooling-driven condensation.

Initial results suggest that higher-dimensional effects (such as wave interference or focussing) make the formation of density structure significantly more likely than in the one-dimensional case for given parameters.

2.1.25 2-D/3D Studies of Dense Clumps Interacting with MHD Winds and Shocks

A. Lim, S.Falle (Leeds) and T. Hartquist (Leeds)

Some of the work described above consists of highly idealised simulations in which a clump is assumed a priori to be exposed to an environment of much higher pressure. A more realistic situation is that in which the clump is exposed to a bulk flow in its environment. Future work in this area includes simulations of clumps exposed to MHD shocks and winds to determine under what conditions a magnetically dominated region can be generated and the conditions in, and lifetime of, such a region.

2.1.26 The Extinction Power Law in Different Interstellar Environments

C. del Burgo and D. Froebrich

A study has been performed of the near-infrared extinction power-law (assumed extinction $A_\lambda \, \alpha \, \lambda^{-\beta}$) and analysed its spatial variations for different interstellar environments. These methods have been applied to study the properties of dust in the molecular cloud complex LDN 134, where variations in the dust grain size distribution have been found.

2.1.27 The Properties of Dust in the Interstellar Medium

C. del Burgo, D. Froebrich, L. Cambrésy (Strasbourg Observatory) and R. Laureijs (ESTEC)

Far-infrared observations from 60 to 200 μm of a region enclosing the Taurus Molecular Cloud TMC-2, with optical extinction A_V ranging between 0.5 (translucent) to 11 magnitudes (dense) were made. The far-infrared emission was separated into *warm* and *cold* components using ISOPHOT and IRAS data. This separation is based on the very different morphologies of the 60 μm and 200 μm emission maps. The 60 μm emission is used as spatial template of the warm component, and the 200 μm emission ($I_V(200)$) as a template for the cold component. The warm component presents an average colour temperature of approximately 20K. The cold component is nearly uniform with a mean temperature of 12.5K in the observed area. The optical depths at 200 μm ($\tau\{200\}$) of the warm component and cold component were determined. The ratios $I_V(200)/A_V$ and $\tau\{200\}/A_V$ of the cold component indicate changes in the optical properties of the dust grains, with an enhanced far-infrared emissivity with respect to the big grains in the diffuse interstellar medium. Comparisons of the emissions and $\tau\{200\}$ of the cold component with carbon monoxide measurements, which trace the molecular gas, were carried out. The cold component emission correlates very well with ^{13}CO (J=1-0) total intensity. Very good correlations between $C^{18}O$ (J=1-0) total intensity and especially $\tau\{200\}$ are found for two distinct regions, one that encloses the core TMC-2 and the other that corresponds to the northern region and also contains molecular condensations. These results confirm $\tau(200)$ as a powerful tracer of dense cores with $n(H_2) \approx 10^4$ cm^{-3}, and that the change in the properties of dust grains takes place at densities of $n(H_2) \approx 10^3$ cm^{-3}.

Far-infrared observations have also been presented between 60 and 200 μm and a near-infrared extinction map of the small moderately dense cloud LDN 1780. For an angular resolution of 4′ the visual extinction maximum is A_V = 4.4 mag. ISOPHOT data and a new release of IRAS data have been used to separate the emission from the *warm* and *cold* components of large dust grains. It has been shown that these components are spatially separated, with the cold component surrounded by the warm component. The

cold component is well correlated with the ^{13}CO (J=1-0) line integrated W_{13} that trace molecular gas at densities of 10^3 cm^{-3}. The warm component has a uniform colour temperature of around 25±1K (assuming the dust emissivity index ß=2), and the colour temperature of the cold component slightly varies between ~15.8-17.3K (ß=2, ΔT=0.5K). The ratio between the emission at 200 µm of the cold component and A_V is $I_V(200)/A_V$=12.1±0.7 MJy sr^{-1} mag^{-1}. The Hα emission (I_V(Hα) and A_V correlate very well; a ratio I_V(Hα)/A_V = 2.2±0.1 Rayleigh mag^{-1} is observed. The Hα emission of the diffuse local background of LDN 1780 of ~1.4 Rayleigh is likely due to the ionisation from OB stars of the Galactic midplane and the Scorpius-Centaurus OB association. In the cloud itself, the very good correlation between the Hα emission and the extinction for a relatively large range of column densities is likely due to the presence of a source of ionisation that can penetrate very deep into the cloud. It is suggested that the Hα emission is a result of ionisation of cosmic ray particles and extended red emission due to silicon nanoparticles.

2.1.28 HESS

L. Drury

The HESS (High Energy Stereoscopic System) collaboration of which DIAS is a member continued a very successful year of observations and published some 16 major refereed publications (including two in the journal Science). Of particular significance was the detection of another spatially resolved shell-type SNR, RXJ0852.0-4622 (the so-called Vela Junior) in addition to RXJ1713-3942.
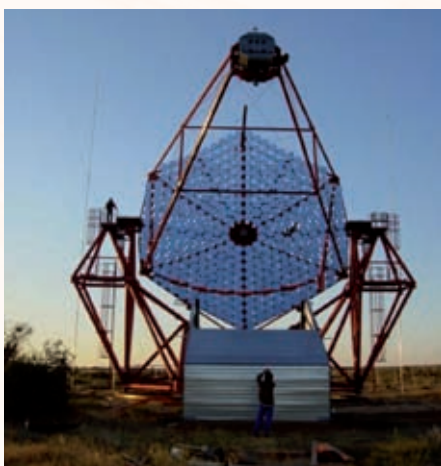
Image courtesy of the Hess Consortium

2.1.29 The Mid-Infrared Instrument (MIRI) for the James Webb Space Telescope

T.P. Ray and E. Flood

MIRI, the Mid-Infrared Instrument for the James Webb Space Telescope (JWST), will provide imaging and spectroscopy at wavelengths from 5 to 27 microns. It is an international collaboration between the European Space Agency and NASA. DIAS is part of an international consortium of European partners building the optics modules. NASA/JPL will supply the cryostat to cool the optics as well as the detectors.

Completing the MIRI Structural Model at the Rutherford Appleton Laboratory. Image courtesy of the MIRI Team.

Production of the imager filters and the dichroics for the spectrograph are progressing well under a DIAS contract with the Infrared Multilayer Laboratory at the University of Reading. The various filters are produced in batch mode that includes not only specimens for the Demonstration and Virtual Models (DM and VM respectively) but also the Flight Model (FM). Radiation testing has been performed by ESA on all filter materials to check for out-gassing and radiation damage.

Some oxidising of two filters for the imager and coronagraph was noted. In both cases germanium had been used to strengthen the multilayer. As the oxidising resulted in a loss of transmission, experiments are ongoing to seal the filters in parylene. If successful these filters will be remanufactured. Structural testing of MIRI at the Rutherford Appleton Laboratory went well (see figure).

2.1.30 Dublin Numerical Simulations Group

A. Lim

A. Lim has undertaken to create and manage a Dublin-wide "club" of those researchers involved in numerical simulations in astrophysics (some interest has also come from the Geophysics Section). This group includes workers from DIAS, TCD and DCU and will meet at DIAS roughly once a fortnight to discuss current research, work on common or individual problems, and coordinate research efforts. Initial consultations have also raised the possibility of producing a code library of well-tested algorithms (e.g. for atomic/molecular cooling, or the solution of Riemann problems) for general use. The first meetings are expected early in the new year.

2.1.31 CosmoGrid and ICHEC

L. Drury and T. Lery

DIAS and CosmoGrid are founding members of the consortium which established the Irish Centre for High End Computing with two seats on the interim board of the centre. During the year CosmoGrid, with the agreement of the HEA, agreed to contribute €700,000 towards the initial equipment purchase of ICHEC in return for access to 40% of ICHEC's facilities and part ownership of the "Walton" cluster.

2.1.32 Understanding Jets through Simulation, Experiment and Theory (JETSET)

T.P. Ray, T. Lery, F. de Colle, E. Whelan and E. Flood

The JETSET Team assembled in Villard de Lans, France

JETSET is a four-year Marie Curie Research Training Network (RTN) designed to build an interdisciplinary European research and training community centred on the study of jets, with a focus on outflows produced during stellar birth. The network brings together workers in the fields of astrophysical observations, theoretical and computational modelling, laboratory experiments, and Grid technology. JETSET is coordinated by DIAS and its creation has led to twenty new postdoctoral (Experienced Researcher) and postgraduate (Early Stage Researcher) positions in the ten partner institutions.

Commencement of the project began in February 2005 with a two-day kick-off meeting held in Rome Observatory. By the end of the year virtually all of the Experienced and Early Stage Researcher posts were filled.

3. Hamilton Bicentenary

Special significance attached to the annual Hamilton walk from Dunsink Observatory to Broome Bridge because 2005, the bicentenary of his birth, was declared by the Irish Government to be "Hamilton Year celebrating Irish Science". To mark the occasion an Irish oak tree was planted in the grounds of Dunsink by Hamilton's closest known living descendent, Michael Rowan Hamilton John O'Regan and the Nobel prize winning physicist, Stephen Weinberg.

4. Travel

D. Coffey ASGI Conference & IDL Workshop, Galway, 18-22 April;

C. Combet Collaboration with D. Maurin and E. Vangioni-Flam at the Institut d'Astrophysique de Paris, 09-14 February; Institute for Pure and Applied Mathematics Meeting "Astrophysical Fluid Dynamics, Los Angeles, 04-09 April; Protostars and Planets V Conference, Hawaii, 21 October – 04 November;

R. Curran Observing trip, Hawaii, 11-22 April; Protostars & Planets Conference, Hawaii, 21 October – 02 November;

C. del Burgo IAU Symposium 230, Dublin Castle, 15-19 August; Workshop on Sky polarisation at far-infrared to radio wavelengths, Paris, 12-15 September; ASTRO-F Observation Planning Workshop for European Open Time Users, ESAC,

Villafranca, Spain, 23 September; ASGI Autumn Meeting, DCU, Dublin, 7 October; Giving a seminar at Astrophysics Institute, Liverpool John Moores University, Liverpool, UK, 12 October; Giving a seminar at NUI Maynooth, Maynooth, 21 October; Attending a progress meeting, Groningen University, Groningen, the Netherlands, 7-9 December;

L. Drury Last SSAC Meeting Paris, 20-21 January; HESS Working Group Meeting Heidelberg, 9-12 February; Workshop on SNRs – Invited Talk, Berlin, 7-9 April; Seminar in Oxford Astrophysics Department, 24-25 May; Conference Torun, Poland, 18-24 June; 29th ICRC Conference, Pune, 1-24 August; Colloquium in Albert Einstein Potsdam, 22-29 September; Representing Ireland at 28th ICSU General Assembly Shanghai, 17-22 October;

S. Dudzinski Sysadmin Conference (Fosden 2005), Brussels, 25-27 February;

E. Flood JETSET kick-off meeting, Rome, 20-22 February;

D. Froebrich Giving a talk at ASGI Cosmo Grid meeting, Galway, 20-23 April; Work with J. Eislöffel in Tautenburg, Germany, 4-17 May; Collaboration with M.D. Smith, Armagh, 27 June; Observtion at UKIRT (5 nights) and work with C. Davis (JAC), K.W. Hodlapp (IPA) 5 days, Hilo, Hawaii, 8-27 August; Participation at Protostars & Planets V Conference in Hawaii and work and gave seminar in Toronto with A. Scholz;

T. Lery Cosmogrid Conference and Courses, Galway, Ireland, 18-21 Jan., JETSET kick-off meeting, Rome, 20-23 February; Cosmogrid/ICHEC visit to IBM research Labs in Watson, US, 6-8 March; Invited talk at the French Institute for Laser and Plasma (ILP) Conference, Autrans, France, 15-17 March; Cosmogrid Project scientist visit to Galway, 7 April; Organisation of IDL courses and Cosmogrid-ASGI joint conference in Galway, 19-22 April; DEISA Kick-off meeting, Paris, France, 9-10 May; Invited talk at a conference entitled "Grids and the Virtual Observatory", Strasbourg Observatory, France, 7-8 June; International HPC Conference, Heidelberg, Gremany, 21-24 June; IBM worldwide EMEA conference, 14-15 Sept.; HPC project presentation, DCU, 20 Sept.; HPC project presentation, UCC and Tyndall Institute, 26 Sept.; HPC project presentation, UCD, 28 Sept.; BlueGene Consortium Meeting, Edinburgh, UK, 4-6 October; HPC project

presentation, DIT and RCSI, 10 Oct.; Attending and presenting work at Protostars & Planets V Conference, Kona, Hawaii, 24-28 October; Cosmogrid/ICHEC visit to IBM research Labs, Watson, US, 21-27 November; EU research Infrastructure Conference, Nottingham 6-7 December;

E.J.A. Meurs Meeting Astronomy Working Group ESA, Paris, France, 12-13 January; Giving a seminar at DCU, Dublin, 7 April; 39th ESLAB Symposium, Noordwijk, the Netherlands, 18-23 April; Collaboration with Rome Astronomical Observatory, Rome, 3-18 May; Giving a seminar at University of Kent, Canterbury, UK, 5 July; Talk at IAU Symposium 230, Dublin Castle, 15-19 August; Talk at conference A Life With Stars, Retirement Conference E.P.J. van den Heuvel, Amsterdam, the Netherlands, 22-26 August; Talk at ASGI Autumn Meeting, DCU, Dublin, 7 October; Attending seminar on ESA and Industry, Enterprise Ireland, Dublin, 9 December;

G. Murphy RAS Meeting on Computational Astrophysics, London, 11 February; Talk at ASGI Meeting on YSO Jet Propagation, Galway, 20-23 April; Institute for Pure and Applied Mathematics Meeting "Astrophysical Fluid Dynamics, Los Angeles, 04-09 April; Scientific collaboration within the context of HPC Europa, Bologna, 16 August – 22 September; Protostars & PlanetsV Conference, Hawaii, 21-29 October;

C. O'Maoileidigh Cosmogrid IDL course, Galway, 21-22 April; MODEST 5-c N-body simulations Summer School, Amsterdam, the Netherlands, 24-30 July; IAU Symposium 230, Dublin Castle, 15-19 August; A Life With Stars, Retirement Conference E.P.J. van den Heuvel, Amsterdam, the Netherlands, 22-26 August;

T. Ray Optical Spectroscopy Meeting – RAS London, 14-16 January; Visit to JETSET partner at Imperial College and attending JETSET Kick-Off Meeting in Rome University, Rome, 18-23 February; Giving a seminar in the University of Sussex; 4 March; Attending and presenting work at Protostars & Planets V Conference, Kona, Hawaii, 19-31 October; Attended meeting on ESA and Industry, Enterprise Ireland.

S. Vergani EU Research Training Network School on GRBs: the first three hours, Santorini, Greece, 29 August-2 September; Brera Observatory, Milan-Merate, Italy, 5-9 December;

P. Ward ASGI Spring Meeting, Galway, 21-22 April; Alpbach Summer School on Dark Energy and Dark Matter in the Universe, Alpbach, Austria, 19-28 July; IAU Symposium 230, Dublin Castle, 15-19 August; EU Research Training Network School on GRBs: the first three hours, Santorini, Greece, 29 August-2 September;

E. Whelan Visit to Osservatorio Astrofisico di Arcetri for collaboration work and seminar, Florence, 21 May – 02 June; Collaborative work with Paulo Garcia, JETSET node, 8-13 November.

5. Publications

5.1 Publications (Refereed Journals)

Aharonian, F., … Drury, L. O'C., …: H.E.S.S. observations of PKS 2155-304, Astronomy and Astrophysics, **430**, 865-875

Aharonian, F., … Drury, L. O'C., …: Search for TeV emission from the region around PSR B1706-44 with the HESS experiment, Astronomy and Astrophysics, **432**, L9-L12

Aharonian, F., … Drury, L. O'C., …: Very high energy gamma rays from the composite SNR G 0.9+0.1 \it Astronomy and Astrophysics, **432**, L25-L29

Aharonian, F., … Drury, L. O'C., …: A New Population of Very High Energy Gamma-Ray Sources in the Milky Way, Science, **307**, 1938-1942

Aharonian, F., … Drury, L.~O'C., …: Discovery of extended VHE gamma-ray emission from the asymmetric pulsar wind nebula in MSH 15-52 with HESS, Astronomy and Astrophysics, **435**, L17-L20

Aharonian, F., … Drury, L. O'C., …: Discovery of VHE gamma rays from PKS 2005-489, Astronomy and Astrophysics, **436**, L17-L20

Aharonian, F., … Drury, L. O'C., …: Observations of Mkn 421 in 2004 with HESS at large zenith angles, Astronomy and Astrophysics, **437**, 95-99

Aharonian, F., … Drury, L. O'C., …: Upper limits to the SN1006 multi-TeV gamma-ray flux from HESS observations, Astronomy and Astrophysics, **437**, 135-139

Aharonian, F., … Drury, L. O'C., …: Detection of TeV γ-ray emission from the shell-type supernova remnant RX J0852.0-4622 with HESS, Astronomy and Astrophysics, **437**, L7-L10

Aharonian, F., … Drury, L. O'C., …: Discovery of Very High Energy Gamma Rays Associated with an X-ray Binary, Science, **309**, 746-749

Aharonian, F., … Drury, L. O'C., …: Serendipitous discovery of the unidentified extended TeV γ-ray source HESS J1303-631, Astronomy and Astrophysics, **439**, 1013-1021

Aharonian, F., … Drury, L. O'C., …: Observations of selected AGN with HESS, Astronomy and Astrophysics, **441**, 465-472

Aharonian, F., … Drury, L. O'C., …: Discovery of the binary pulsar PSR B1259-63 in very-high-energy gamma rays around periastron with HESS, Astronomy and Astrophysics, **442**, 1-10

Aharonian, F., … Drury, L. O'C., …: A search for very high energy γ-ray emission from the starburst galaxy NGC 253 with HESS, Astronomy and Astrophysics, **442**, 177-183

Aharonian, F., … Drury, L. O'C., …: Multi-wavelength observations of PKS 2155-304 with HESS, Astronomy and Astrophysics, **442**, 895-907

Aharonian, F., … Drury, L. O'C., …: A possible association of the new VHE γ-ray source HESS J1825 137 with the pulsar wind nebula G 18.0 0.7, Astronomy and Astrophysics, **442**, L25-L29

Combet, C., Maurin, D., Donnelly, J., Drury, L. O'C., and Vangioni-Flam, E.: Spallation-dominated propagation of heavy cosmic rays and the Local Interstellar Medium (LISM), Astronomy and Astrophysics, **435**, 151-160

Del Burgo, C. and Laureijs, R.~J.: New insights into the dust properties of the Taurus molecular cloud TMC-2 and its surroundings, Monthly Notices of the Royal Astronomical Society, **360**, 901-914

Dolcini, A., … and Meurs, E.: Multiband photometry of the blazar PKS 0537-441: a major active state in December 2004-March 2005, Astronomy and Astrophysics, **443**, L33-L36

Fiore, F., …, Meurs, E.J.A., Ward, P., …: A Flash in the Dark: UVES Very Large Telescope High-Resolution Spectroscopy of Gamma-Ray Burst Afterglows.

Froebrich, D., Scholz, A., Eislöffel, J., and Murphy, G.C.: Star formation in globules in IC 1396, Astronomy and Astrophysics, **432**, 575-584

Froebrich, D., Ray, T.P., Murphy, G.C., and Scholz, A.: A Galactic Plane relative extinction map from 2MASS, Astronomy and Astrophysics, **432**, L67-L70

Gras-Velázquez, Á and Ray, T.~P.: Weak-line T Tauri stars: circumstellar disks and companions. I. Spectral energy distributions and infrared excesses, Astronomy and Astrophysics, **443**, 541-556

Lebedev, S.V., …, Lery, T.: Magnetic tower outflows from a radial wire array Z-pinch, Monthly Notices of the Royal Astronomical Society, **361**, 97-108

Lery, Thibaut, Combet, Céline, Murphy, Gareth, and Drury, Luke O. C.: Virtual MHD Jets on Grids, Astrophysics and Space Science, **298**, 375-378

Lim, A.J., Falle, S.A.E.G., and Hartquist, T.W.: The effect of dissipation on the generation of density structure by magnetohydrodynamic waves, Monthly Notices of the Royal Astronomical Society, **357**, 461-470

Lim, A.J., Falle, S.A.E.G., and Hartquist, T.W.: The Production of Magnetically Dominated Star-forming Regions, Astrophysical Journal, **632**, L91-L94

Maoiléidigh, Cóilín O'., Meurs, Evert J.A., and Norci, Laura: On the feasibility of detection of neutron star companions to OB runaways using Gaia astrometry, New Astronomy, **10**, 591-601

Meurs, E.J.A., Fennell, G., and Norci, L.: X-Ray Counterparts of Runaway Stars, Astrophysical Journal, **624**, 307-316

Meurs, E.J.A. and Rebelo, M.C.A.: SN contributions to GRB lightcurves, Nuovo Cimento C Geophysics Space Physics C, **28**, 621

Nisini, B., Bacciotti, F., Giannini, T., Massi, F., Eislöffel, J., Podio, L., and Ray, T.P.: A combined optical/infrared spectral diagnostic analysis of the HH1 jet, Astronomy and Astrophysics, **441**, 159-170

Raga, A.C., Williams, D.A., and Lim, A.J.: The Formation of H_2 in Variable Herbig-Haro Jets, Revista Mexicana de Astronomia y Astrofisica, **41**, 137-146

Ward, P., Meurs, E.J.A., et al.: A flash in the dark: UVES/VLT high-resolution spectroscopy of GRB afterglows, Nuovo Cimento C Geophysics Space Physics C, **28**, 783

Whelan, Emma T., Ray, Thomas P., Bacciotti, Francesca, Natta, Antonella, Testi, Leonardo, and Randich, Sofia: A resolved outflow of matter from a brown dwarf, Nature, **435**, 652-654

Woitas, J., Bacciotti, F., Ray, T.P., Marconi, A., Coffey, D., and Eislöffel, J.: Jet rotation: Launching region, angular momentum balance and magnetic properties in the bipolar outflow from RW Aur, Astronomy and Astrophysics, **432**, 149-160

5.2 Publications (Non-Refereed Journals)

Bacciotti, F., Ray, T.P., Eislöffel, J., Woitas, J., and Coffey, D.: The accretion/ejection paradigm of low mass stars tested with HST, Memorie della Societa Astronomica Italiana, **76**, 366

Chrysostomou, A., Bacciotti, F., Nisini, B., Ray, T.P., Eislöffel, J., Davis, C.J., and Takami, M.: The Transport of Angular Momentum from YSO Jets, Protostars and Planets V, 8156

Coffey, D.A., Bacciotti, F., Woitas, J., Ray, T.P., and Eislöffel, J.: T Tauri Jet Rotation Revealed by Optical and NUV HST/STIS Spectra, Protostars and Planets V, 8032

Combet, C. and Lery, T.: Transit Flow Models for Low and High Mass Young Stellar Objects, Protostars and Planets V, 8175

Covino, S., … Meurs, E., …: GRB 050412: IR and optical observations, GRB Coordinates Network, **3236**, 1

Covino, S., … E., Meurs, E., ..: PKS 0537-441: optical monitoring, The Astronomer's Telegram, **564**, 1

Curran, R., Chrysostomou, A., Collett, J., Aitken, D., and Jenness, T.: First SCUBA Polarimetry of Two Candidate High-Mass Protostellar Objects, Astronomical Society of the Pacific Conference Series, **343**, 185

Curran, R.L., Collett, J.L., Atkinson, J.W., Chrysostomou, A., and Aitken, D.K.: Magnetic Fields in Star Forming Regions: DR21(OH), Protostars and Planets V, 8160

D'Avanzo, P., … Meurs, E., …: GRB050509: REM NIR and optical observations, GRB Coordinates Network, **3400**, 1

Davis, C.J., Nisini, B., Takami, M., Pyo, T.S., Smith, M.D., Whelan, E., Ray, T.P., and Chrysostomou, A.: Adaptive-Optics Assisted Near-IR Spectroscopy of SVS 13 and Its Jet, Protostars and Planets V, 8065

Distefano, E., … Meurs, E., …: GRB051105B: REM optical observation, GRB Coordinates Network, **4223**, 1

Drury, Luke, O'C: Cosmic Ray Acceleration in Supernova Remnants, AIP Conf. Proc. **801**: Astrophysical Sources of High Energy Particles and Radiation, 337-344

Froebrich, D. and del Burgo, C.: Accuracy in the Determination of the NIR Extinction Power Law Index, Protostars and Planets V, 8040

Lery, T.: First Results of JETSET, a New European Research and Training Network Dedicated to Jets, Protostars and Planets V, 8070

Lery, Thibaut, Combet, Celine, and Murphy, Gareth: Star Formation Histories, AIP Conf. Proc. **784**: Magnetic Fields in the Universe: From Laboratory and Stars to Primordial Structures, 140-144

Leygnac, S., O'Sullivan, S., and Lery, T.: Radiation in YSO Jets and Shocks, Protostars and Planets V, 8394

Murphy, G.C., Lery, T., O'Sullivan, S., and Spicer, D.S.: Interacting Multiple Jets from Binary Sources, Protostars and Planets V, 8174

Nisini, B., Bacciotti, F., Podio, L., Giannini, T., Massi, F., Eislöffel, J., and Ray, T.P.: A Combined Optical/Infrared Spectral Diagnostic Analysis Applied to Jets from Young Stars, Protostars and Planets V, 8041

Norci, L. and Meurs, E.J.A.: On the X-ray contribution from young supernovae in starbursts, ASSL, **329**: Starbursts: From 30 Doradus to Lyman Break Galaxies, 54P

Piranomonte, S., … Meurs, E., ..: GRB050416B: IR observations, GRB Coordinates Network, **3281**, 1

Piranomonte, S., … Meurs, E., …: XRF 050509C: REM NIR and optical refined analysis, GRB Coordinates Network, **3427**, 1

Podio, L., Bacciotti, F., Nisini, B., Giannini, T., Massi, F., Eislöffel, J., and Ray, T.P.: Potential of a combined optical/NIR diagnostics for protostellar jets, Memorie della Societa Astronomica Italiana, **76**, 396

Ray, T.P.: Outflows from low mass young stars and brown dwarfs, Memorie della Societa Astronomica Italiana, **76**, 362

Rea, N., … Meurs, E., …: Optical and IR observations of SAX J1808.4-3658 in outburst, The Astronomer's Telegram, **515**, 1

Takami, M., … Ray, T.P., ..: Subaru IR Echelle Spectroscopy of Herbig-Haro Driving Sources, Protostars and Planets V, 8207

Testa, V., … Meurs, E., …: GRB050607: prompt REM observations, GRB Coordinates Network, **3523**, 1

Testa, V., … Meurs, E., ….: GRB050607: refined analysis of prompt REM observations, GRB Coordinates Network, **3538**, 1

Stehlé, C., Ciardi, B., Lebedev, S.V., and Lery, T.: Laboratory Models for Astrophysical Jets, SF2A-2005: Semaine de l'Astrophysique Francaise, 355

Whelan, E.T., Ray, T.P., Bacciotti, F., Natta, A., Testi, L., and Randich, S.: Spectro-Astrometry as a Probe of Outflow Activity in Brown Dwarfs, Protostars and Planets V, 8073.

School of Cosmic Physics – Geophysics

1. General

During 2005 the Section continued the growth of the previous two years with the addition of an IT technician, a fellow and a student, and the pending addition of the Professor of Seismology. John Allman joined the Section as an IT technician in early-January. Together with Stephan Dudzinski, they are modifying the network to assure firewall hardness against attack. Allman is also introducing management tools to handle the growing number of Windows-based PCs. Jones' SAMTEX extension was funded by Science Foundation Ireland. This grant is funding a Fellow, Dr. Mark Muller of South Africa, for two years, and a Scholar, Ms. Marion Miensopust of Germany, for three years.

The Professorship in Seismology was advertised widely, and interviews for the position were held on 15-16 November, 2005.

2. General Geophysics Activities

2.1 EuroArray

EuroArray continued to build interest during 2005 with workshops, presentations, and collaborative meetings. It was decided to integrate EuroArray with Topo-Europe, and push the two together at the European stage. A Topo-Europe EUROCORES proposal in the recent call was the top-rated of all 17 Life and Earth Science (LESC) proposals to the ESF, but was not funded. Indications are that a re-submission in 2006 with some areas addressed will be well received.

Workshops/Meetings:

- EuroArray workshop, Budapest, Hungary, 15-16 March

- Topo-Europe workshop, Budapest, Hungary, 17-18 March

- EuroArray Town Hall meeting, EGU2, Vienna, Austria, 26 April

- PICASSO workshop, Granada, Spain, 25-26 June

- Topo-Europe workshop, Heidelberg, Germany, 27-29 October

Presentations:

- Jones, A.G., Probing the mantle with MT. Invited paper at: EuroArray Workshop, Budapest, Hungary, 15-16 March.

- Jones, A.G., P. Maguire, and H. Thybo, EuroArray: Comprehensive high-resolution survey of the European mantle. EGU2, Vienna, 25-29 April.

- Thybo, H., A.G. Jones and P. Maguire, EuroArray: 4D Europe, The assembly of a continent. Invited paper at: PICASSO Workshop, Granada, Spain, 25-26 June.

- Jones, A.G., P. Maguire, and H. Thybo, EuroArray: Scientific objectives and technical aspects. Invited paper at: PICASSO Workshop, Granada, Spain, 25-26 June.

Proposal submissions:

- Pre-proposal submitted by Jones to SFI RFP2006 competition to fund MT work in PICASSO together with U. Barcelona colleagues.

2.2 AfricaArray

AfricaArray is growing in strength and interest. Funding of almost US$2M was secured by Prof. Andy Nyblade to train Afro-American students in South Africa and to fund African students attending courses at Penn State. It is hoped that DIAS will participate in AfricaArray not only with the educational aspects but also by providing seismological expertise in the form of sponsoring and maintaining seismic stations in Botswana.

Workshops/Meetings:

- AfricaArray workshop, Palmanova, Italy, 26-27 February.

3. Electromagnetic Activities

3.1 SAMTEX (Southern African Magnetotelluric Experiment)

AG Jones, X Garcia, M Muller, M Hamilton, M Miensopust, with Geophysics staff and colleagues from Woods Hole Oceanographic Institution (U.S.A.), the Council for Geosciences (South Africa), DeBeers (South Africa) and the University of Witwatersrand (South Africa)

The SAMTEX project continued through 2005 at the same furious pace as the previous year. With Rio Tinto becoming a project sponsor, this enabled a third phase of data acquisition to take place. Further MT data were acquired, both in the Jan-April time-frame, as part of Phase II, and in the Sept-Nov timeframe, as part of Phase III. Most sites were located in Botswana.

Proposal submissions:

■ Proposal submitted by Jones to SFI RFT2005 competition to fund Phase III of SAMTEX. Proposal funded at a level of €172,000 for 3 years.

Workshop:

■ SAMTEX Data Modelling Workshop, Dublin, 2-13 May

Paper submitted:

■ Hamilton, M., A.G. Jones, R.L. Evans, S. Evans, S. Fourie, X. Garcia, A. Mountford, J.E. Spratt, and the SAMTEX Team, Anisotropy structure of the lithosphere derived from magnetotelluric and seismic shear-wave splitting analyses in southern Africa, submitted to *Physics of the Earth and Planetary Interiors*, 8 August, 2005. Accepted pending moderate revision.

Presentations:

■ Jones, A.G., R.L. Evans, S. Fourie, S. Evans, A. Mountford, X. Garcia, J. Spratt, A.D. Chave, and the SAMTEX Team, Comparison of the electromagnetic structure of Archean cratons: Project SAMTEX. South African Geophysical Association (SAGA) meeting, Cape Town, South Africa, 14–16 September.

■ Hamilton, M., A.G. Jones, R.L. Evans, X. Garcia, C.J.S. Fourie, S.F. Evans, S.J. Webb, and the SAMTEX MT Team, Electrical anisotropy across southern Africa from MT studies. South African Geophysical Association (SAGA) meeting, Cape Town, South Africa, 14–16 September.

■ Cole, J., P. Cole, A.G. Jones, R.L. Evans, X. Garcia, C.J.S. Fourie, C. Smith, A. Mountford, S.J. Webb, and the SAMTEX MT team, Application of wavelet transform de-noising techniques to geophysical data. South African Geophysical Association (SAGA) meeting, Cape Town, South Africa, 14–16 September.

■ Muller, M.R., S.J. Webb, A.G. Jones, W.H.B. Steenkamp, P. Kowalczyk, R.L. Evans, C.J.S. Fourie, C. Smith, A. Mountford, and the SAMTEX team, Deep-crustal electrical imaging beneath the Vredefort impact structure, South Africa, using broadband magnetotellurics. South African Geophysical Association (SAGA) meeting, Cape Town, South Africa, 14–16 September.

■ Jones, A.G., R.L. Evans, X. Garcia, M.P. Hamilton, S. Evans, S. Fourie, A. Mountford, J. Spratt, A. Chave and the SAMTEX Team, A magnetotelluric survey of the Kaapvaal Craton and its surroundings: The SAMTEX experiment. Fall AGU, San Francisco, USA, 12-16 December.

■ Garcia, X., A.G. Jones, R.L. Evans, S. Evans, S. Fourie, A. Mountford, and the SAMTEX Team, The electrical lithosphere of the Archean: Insights from the Kaapvaal craton and elsewhere. Fall AGU, San Francisco, USA, 12-16 December.

3.2 ISLE-MT

CK Rao, M Moorkamp, AG Jones

The data acquired in 2004 were contaminated by the electric fences that were operational on farm land. The uncontaminated part of the data were processed and analyzed using conventional methods. The data was then subjected to the Groom Bailey decomposition technique (McNeice and Jones, 2001) for removal of distortion effects and to find the correct geoelectric strike direction. The results from 2-D inversion of the corrected responses of the eastern-most profile indicate a NW-dipping conductor at depth of 8-10 km.

The dipping conductor is indicative of a collision zone and coincides with the position of Iapetus suture zone. Based on 2-D inversion models depth sections are created. The sections show strong variations in resistivity as from east to west. The results indicated the need for further data acquisition on the eastern-most profile to extend towards the north and acquire data in between the stations occupied in 2004.

In summer 2005, new data were collected at 14 additional stations using 10 long period instruments (loaned from GFZ Potsdam) and 5 broad band instruments from DIAS. With the experience of cow fences on farm land from last year's data acquisition, this year Coillte forest lands which are relatively free from electric fences were selected. This resulted in high quality data over a wide frequency band for the first time in Ireland. Processing of the newly acquired data was completed.

The second component of the work is to investigate methods for removal of noise from the data and joint inversion of MT and teleseismic data. We examined the possibilities of adaptive filtering methods. These showed promising first results in reducing the influence of the cow-fences. Developing the joint inversion algorithm for receiver-function and magnetotelluric data is being taken up at present. First experiments with synthetic data were successful when seismic velocities and electrical conductivity change at the same depth. Further experiments with synthetic data will be conducted to evaluate how the algorithms behave when the correlation is not perfect or completely absent and how these algorithms can be used for hypothesis testing.

Presentations:

- Moorkamp, M., C.K. Rao, and A.G. Jones, Noise reduction in magnetotelluric recordings using adaptive filters. Institute of Physics in Ireland meeting, Newbridge, Ireland, 18-20 March.

- Moorkamp, M., C.K. Rao, and A.G. Jones, Noise cancellation in magnetotelluric time series using adaptive methods. EGU2, Vienna, 25-29 April.

- Moorkamp, M., C.K. Rao, and A.G. Jones, Joint inversion of magnetotelluric and receiver function data using a genetic algorithm. BGA PGM, Galway, 31 August – 2 September.

- Moorkamp, M., C.K. Rao, and A.G. Jones, Joint inversion of magnetotelluric and receiver function data. EMTF Workshop.

3.3 3D MT Modelling/Inversion

D Avdeev and A Avdeeva

An efficient solution of the 3-D MT large-scale inverse problem was the subject of our research in 2005. The solution is based on a limited-memory quasi-Newton optimization algorithm with simple bounds. The central problem of the inversion is to calculate the derivatives of the penalty function. We developed and implemented explicit expressions for these derivatives. The first preliminary results of QN inversion were obtained using a synthetic dataset.

Papers accepted:

- Avdeev, D.B., Three-dimensional electromagnetic modelling and inversion from theory to application, *Surveys in Geophysics*, **26**, 767-799, 2005.

- Avdeev, D.B., Forward modelling of EM, Invited article in *Encyclopedia of Geomagnetism and Paleomagnetism*, Eds. D. Gubbins and E. Herrero-Bervera, Springer, The Netherlands, 2005.

- Avdeev, D.B., Fast integral equation method for geoelectric forward problems, In *Electromagnetic studies of the Earth interior*, Scientific world, Moscow, pp.11-32, 2005 (in Russian).

Papers submitted:

- Avdeeva, A.D., and Avdeev, D.B., A limited memory quasi-Newton inversion for 1-D magnetotellurics, *Geophysics*, in review.

Presentations:

- Avdeev, D.B., Three-dimensional electromagnetic inversion: State-of-the-art, Cosmogrid Conference, 19 January, UCD, Dublin, Ireland.

- Avdeeva, A.D., Implementation of a quasi-Newton method for 1-D magnetotelluric inversion, 48th IGRM conference, 18-20 February, TCD, Dublin.

- Avdeev, D.B., Basics of EM inversion, SAMTEX Workshop, 16 May, DIAS, Dublin, Ireland.

- Avdeeva, A.D., A quasi-Newton inversion for 1-D magnetotellurics, BGA conference, 1-2 September, Galway, Ireland.

3.4 Slave to Bear MT Project

JE Spratt and AG Jones, with colleagues from the C.S. Lord Geoscience Centre (Yellowknife, Canada)

Unfortunately, due to NWT Government budget cutbacks for geoscience funding to the C.S. Lord Geoscience Centre the planned second phase of MT data acquisition on the Slave2Bear project did not take place. Data from the 2004 acquisition were reprocessed, re-analysed and modelled.

In preparation:

- Spratt, J.E. and A.G. Jones, A magnetotelluric transect from the Slave Craton to the Bear Province across the Wopmay Orogen. For submission to *Canadian Journal of Earth Sciences.*

3.5 Inkaba yeAfrica

U Weckmann, with colleagues from the GeoForschungsZentrum Potsdam (Germany), and the University of Cape Town (South Africa)

The MT data collected along the first part of the Agulhas-Karoo transect were reprocessed, interpreted and modelled. The obtained 2-D inversion model includes structures which were previously unknown. We were able to correlate a shallow sub-horizontal conductive band with the blackshales of the Whitehill Formation. Therefore we used lithological information of deep boreholes in the vicinity of our profile. The mid-crustal conductivities in the profile are much more difficult to interpret as direct observations are missing. Together with T. Branch from UCT we integrated magnetic and MT results to test whether a common source for both geophysical anomalies, the Beattie Magnetic Anomaly and the Southern Cape Conductive Belt, is justified. It seems that in order to explain the magnetic anomaly a large body of a magnetic rock is necessary whereas the MT model includes a comparably smaller feature, more compatible with a shear zone.

In November and December 2005 MT data were collected at 80 sites along the on-shore/offshore Agulhas-Karoo transect. Additionally, measurements (40 sites) along a 75km long profile further to the East were conducted to complement the seismic WRR data. This data set has still to be processed and analyzed.

Publications:

- Weckmann, U., O. Ritter, A. Jung, T. Branch and M. de Wit, Magnetotelluric measurements across the Beattie magnetic anomaly and the Southern Cape Conductive Belt, South Africa, submitted to *Journal of Geophysical Research.*

Presentations:

- Weckmann, U., O. Ritter, M. de Wit, A. Jung, T. Branch: Magnetotelluric Measure-ments across the Magnetic Beattie Anomaly and the Southern Cape Conductive Belt in South Africa, Poster at EGU General Assembly, Vienna, Austria, 24-29 April.

- Weckmann, U., O. Ritter, A. Jung, J. Hübert, U. Kniess, T. Branch, T. Mabidi, J. Stankiewicz, M. de Wit and R. Green, New Magnetotelluric Measurements Across The Beattie Magnetic Anomaly And The Southern Cape Conductive Belt, Inkaba yeAfrica workshop, Cape Town, 29 May - 1 June.

- Ritter, O., H. Frimmel, T. Branch, R. Green, A. Jung, M. Rohwer, T. Ryberg, A. Schulze, J. Viljoen, M. Weber, U. Weckmann, and M. de Wit, Agulhas-Karoo Geoscience Transect: Status And First Results of the Geophysical and Geological Onshore Transect, Inkaba yeAfrica workshop, Cape Town, 29 May - 1 June.

- Weckmann, U., O. Ritter, T. Branch, A. Jung and M. de Wit. MT measurements across the Beattie magnetic anomaly and the Southern Cape Conductive Belt, South Africa. 21. EMTF-Kolloquium, Holle, Germany.

3.6 Marine EM

X Garcia, AG Jones

Given that 9/10th of Irish national landmass lies beneath the Atlantic Ocean, and that that area represents an untapped and virtually unknown resource, Garcia and Jones are attempting to establish a marine EM component at DIAS using Garcia's experience from WHOI and connections with WHOI scientists.

Proposal submissions:

- Pre-proposal submitted by Garcia to SFI RFP2006 competition for Bottom Ocean MT exploration of the Porcupine Basin.

- Pre-proposal submitted by Garcia to SFI RFP2006 competition for Study of Galway Bay to map channels responsible for groundwater discharges.

- Pre-proposal submitted by Brown (NUIG, with Garcia) to SFI RFP2006 competition for Multidisciplinary study of seafloor using EM, seismics, bathymetry and core sampling.

- Proposal submitted by Garcia to PIP for Multidisciplinary study of seafloor using EM, seismics, bathymetry and core sampling.

Presentations

- Garcia, X., A.G. Jones, R. Evans, and C. Brown. Marine EM studies in Ireland. 48th IGRM conference, 18-20 February, TCD, Dublin.

3.7 Other

Proposal submissions:

- Pre-proposal submitted by Jones to SFI RFP2006 competition to Project EMMVA – Electromagnetic monitoring of volcanic activity.

- Proposal submitted by Jones to Geological Survey of Canada to fund down-mine electro-magnetic measurements (together with colleagues from UB) under the auspices of TGI-3 (Targeted Geoscience Initiative, Phase 3).

3.7.1 Cork AMT survey

L Collins, JE Spratt, AG Jones, with B Higgs (UCC)

In collaboration with B. Higgs (UCC), an AMT pilot survey was carried out in an area near Middleton, Co. Cork in August with the aim to locate buried glacial valleys. Phoenix MTU recorders and Phoenix electrodes and metal rods were used. This was the first time an AMT survey has been undertaken in Ireland, so it was a learning experience. Unfortunately, the location chosen for this pilot survey was very poor from a natural-source EM perspective. It is planned to continue this work next year in an area less affected by cultural noise. In addition, as part of the DIAS-UB cooperation, E. Falgas from UB will bring to Ireland a shallow-probing controlled-source EM system (Strategem), and will undertaken comparison surveys at the same locations.

3.7.2 Birr Castle DC resistivity survey

L Collins, JE Spratt, AG Jones, with B Higgs (UCC)

An electrical resistivity survey was carried out in August in the grounds of Birr Castle with the aim of locating bedrock at depths less than 20m to allow anchorage for a radio telescope. A Campus Tigre resistivity meter and multi core cable was used. Imagepro software was used to collect the data, and Res2-Dinv to subsequently model the data. This equipment and software is the property of University College Cork, and Dr. Bettie Higgs helped us carry out the survey. The results of the survey seem to show that the sediment/bedrock interface occurs at around 12m-14m depth. It is recommended that a borehole be drilled at a central point of where the survey was carried out to check the interpretation and to calibrate the survey data.

3.7.3 INDEPTH

AG Jones

The INDEPTH project will continue with its funded 4th phase in 2007/08. Papers from Phases II and III were published in 2005.

Publications:

- Spratt, J., A.G. Jones, K.D. Nelson, M.J. Unsworth, and the INDEPTH MT team, 2005. Crustal structure of the India-Asia collision zone, southern Tibet, from INDEPTH

MT investigations. *Physics of the Earth and Planetary Interiors*, **150**, 227-237.

- Solon, K., A.G. Jones, K.D. Nelson, M.J. Unsworth, W. Wei, H. Tan, H., S. Jin, M.Deng, J.R. Booker, S. Li, P. Bedrosian, 2005. Structure of the crust in the vicinity of the Banggong-Nujiang suture central Tibet from INDEPTH magnetotelluric data. *Journal of Geophysical Research*, **110**, B10102, doi: 10.1029/2003JB002405.

- Unsworth, M.J., A.G. Jones, W. Wei, G. Marquis, S. Gokarn, J.E. Spratt, and the IN-DEPTH-MT team, 2005. Crustal rheology of the Himalaya and Southern Tibet inferred from magnetotelluric data. *Nature*, **438**, 78-81, doi: 10.1038/nature04154.

3.7.4 Lithoprobe

AG Jones

Jones is completing his legacy Lithoprobe activities with the publication of a number of major papers in review volumes and other work.

Publications:

- White, D.J., M.D. Thomas, A.G. Jones, J. Hope, B. Nemeth and Z. Hajnal, 2005. Geophysical Transect across a Paleoproterozoic Continent-Continent Collision Zone: The Trans-Hudson Orogen. *Canadian Journal of Earth Sciences*, **42**, 385-402.

- Garcia, X. and A.G. Jones, 2005. Electromagnetic image of the Trans-Hudson orogen: THOT94 transect. *Canadian Journal of Earth Sciences*, **42**, 479-493.

- Ferguson, I.J., K.M. Stevens and A.G. Jones, 2005. Electrical resistivity imaging of the central Trans-Hudson Orogen in eastern Saskatchewan, Canada. *Canadian Journal of Earth Sciences*, **42**, 495-515.

- Jones, A.G., J. Ledo and I.J. Ferguson, 2005. Electromagnetic images of the Trans-Hudson orogen: The North American Central Plains anomaly revealed. *Canadian Journal of Earth Sciences*, **42**, 457-478.

- Wu, X., I.J. Ferguson and A.G. Jones, 2005. Geoelectric structure of the Proterozoic Wopmay Orogen and adjacent terranes, Northwest Territories, Canada. *Canadian Journal of Earth Sciences*, **42**, 955-981.

- Jones, A.G., J. Ledo, I.J. Ferguson, C. Farquharson, X. Garcia, N. Grant, G.W. McNeice, B. Roberts, J. Spratt, G. Wennberg, L. Wolynec, and X. Wu, 2005. The electrical resistivity structure of Archean to Tertiary lithosphere along 3,200 km of SNORCLE profiles, northwestern Canada. *Canadian Journal of Earth Sciences*, **42**, 1257-1275.

- Ledo, J. and A.G. Jones, 2005. Temperature of the upper mantle beneath the Intermontane Belt, northern Canadian Cordillera, determined from combining mineral composition, electrical conductivity laboratory studies and magnetotelluric field observations. *Earth and Planetary Science Letters*, **236**, 258-268.

3.7.5 Other and General

Publications:

- Evans, S., A.G. Jones, J. Spratt and J. Katsube, 2005. Central Baffin electromagnetic ex-periment (CBEX) maps the NACP in the Canadian arctic. *Physics of the Earth and Planetary Interiors*, **150**, 107-122.

- Garcia, X. and A.G. Jones, 2005. A new methodology for the acquisition and processing of audio-magnetotelluric (AMT) data in the AMT dead-band. *Geophysics*, **70**, 119-126.

- Jones, A.G., Electromagnetic interrogation of the anisotropic Earth: Looking into the Earth with polarized spectacles. Submitted to *Physics of the Earth and Planetary Interiors*, 6 October, 2005.

- Jones, A.G. and X. Garcia, 2005. Electrical resistivity structure of the Yellowknife River Fault Zone and surrounding region. Gold in the Yellowknife Greenstone Belt, Northwest Territories: Results of the EXTECH III Multidisciplinary Research Project, publ. by Geological Association of Canada, Mineral Deposits Division, Special Publication, accepted, 13 May, 2004.

- Martí, A., P. Queralt, A.G. Jones and J. Ledo, 2005. Improving Bahr's invariant parameters using the WAL approach. *Geophysical Journal International*, **163**, 38-41.

- Maercklin, N., P. A. Bedrosian, Ch. Haberland, O. Ritter, T. Ryberg, M. H. Weber, and U. Weckmann, 2005. Characterizing a large shear-zone with seismic and magnetotelluric methods the case of the Dead Sea Transform. *Geophysical Research Letters*, **32**, L15303, doi:10.1029/2005GL022724.

- Ritter, O., A. Hoffmann-Rothe, P. A. Bedrosian, U. Weckmann, and V. Haak, 2005. Electrical conductivity images of active and fossil fault zones, in: Bruhn, D. and Burlini, L. (eds.) High-Strain Zones: Structure and Physical Properties, Geological Society of London Special Publications, 245, 165-186.

- Weckmann, U., A. Magunia, and O. Ritter, 2005. Effective noise separation for magnetotelluric single site data processing using a frequency domain selection scheme, *Geophysical Journal International*, **161**, 456-468.

Presentations:

- Jones, A.G., 2005. Geophysics at DIAS: overview of activities. Irish Geological Research Meeting, Trinity College Dublin, Dublin, 19-20 February.

- U. Weckmann. Phase split: evidence for mantle anisotropy? 21st EMTF-Kolloquium, Holle, Germany.

In preparation:

- Queralt, P., A.G. Jones, and J. Ledo, Electromagnetic imaging of a complex ore body, three-dimensional forward modelling, two-dimensional inversion, sensitivity tests and down-mine measurements. For submission to *Geophysics.*

4. Seismological Activities

4.1 HADES

PW Readman, BM O'Reilly, C Ravaut, L Gernigon, A Chabert with PM Shannon of UCD

On the seismic interpretation side of the HADES project (Hatton Deep Seismic) there has been progress on refining the tomography models for the two transverse lines running across the Hatton Continental Margin (HCM), as well as with the line running approximately along the axis of the Hatton Basin. With 300 Ocean Bottom Seismometer positions at ca 3 km intervals and shots every 120 m, this project produced an enormous quantity of data which has necessitated the development of a new processing and modelling methodology. Considerable effort was also directed at developing a method to define the lower crustal structure, and especially the Moho. The tomography model was used to develop a velocity model for the upper part of the crust and sedimentary layers, which was then used in a more traditional forward modelling approach to define the Moho and the base of the anomalous velocity body beneath the HCM. The geological/geophysical side of the project has progressed well with the new models being compared and integrated with other geophysical datasets, in particular vertical seismic reflection and gravity/magnetic data from the Irish National Seabed Survey data.

- First-arrival traveltime tomography was applied on the three profiles of the HADES experiment.

- The reliability of the derived tomographic models was assessed by running checkerboard tests and convergence analysis.

- For Profile 1, 100 starting models were generated randomly and inverted in order to investigate the influence of the starting model on first-arrival traveltime tomography.

- The position of the Moho interface was derived by a forward modelling technique using the traveltimes of the PmP phase (reflected phase on the moho interface).

Presentations:

- Ravaut C., Parallel computational techniques applied to inversion of wide-angle seismic datasets, west of Ireland. COSMOGRID meeting, 19 January, Dublin.

- Ravaut, C., A wide-angle seismic study of the West Hatton margin: Results of the HADES experiment. TGIF seminar. Dublin Institute for Advanced studies, February.

- Ravaut C., A. Chabert, L. Gernigon, B.M. O'Reilly, P.W. Readman and P.M. Shannon, A wide-angle seismic study of the Hatton Continental margin: Preliminary results from the HADES project. 48th Annual Irish Geological Research Meeting, Trinity College Dublin, Ireland, 18-21 February.

- Gernigon, L., C. Ravaut, P.M. Shannon, A. Chabert, B.M. O'Reilly and P.W. Readman, Contrasting styles between the structure of the West and South Hatton/Rockall Margins (Irish offshore). 48th Annual Irish Geological Research Meeting, Trinity College Dublin, Ireland, 18-21 February.

- Chabert, A., C. Ravaut, B.M. O'Reilly, P.W. Readman, P.M. Shannon, and L. Gernigon, The Hatton Basin: wide-angle seismic imaging from the HADES Experiment. 48th Annual Irish Geological Research Meeting, Trinity College Dublin, Ireland, 18-21 February.

- Ravaut C., A. Chabert, L. Gernigon, B.M. O'Reilly, P.W. Readman, P.M. Shannon, J. Makris and M. Gaye, Wide-angle seismic imaging of the west Hatton margin (North Atlantic): Results of the HADES experiment. European Geosciences Union (EGU) General Assembly, Vienna, Austria, 24-29 April.

- Gernigon, L., C. Ravaut, P.M. Shannon, A. Chabert, B.M. O'Reilly and P.W. Readman, Formation and evolution of Irish passive margins: implications for locating the transition between continental and oceanic crust. European Geosciences Union (EGU) General Assembly, Vienna, Austria, 24-29 April.

- Chabert, A., C. Ravaut, L. Gernigon, P.W. Readman, B.M. O'Reilly and P.M. Shannon, Wide-Angle Seismic imaging of the Hatton Basin. BGA PGM, Galway, 31 August - 2 September.

- Readman, P.W., P.M. Shannon, B.M. O'Reilly, C. Ravaut, A. Chabert and L. Gernigon, Deep seismic research in the Irish Atlantic. Irish National Seabed Survey, Annual Workshop, Cork, 18 November.

4.2 RAPIDS 3 and 4

BM O'Reilly, PW Readman with PM Shannon (UCD)

In the RAPIDS (Rockall And Porcupine Irish Deep Seismic) series of projects modelling of the wide-angle seismic line across the Porcupine Arch was continued and refined. An anomalous velocity body is detected beneath the basin centre, in agreement with our gravity interpretation. The crust is either very thin or absent and the presence of this body,

interpreted as serpentinised mantle, is consistent with our ideas about basin development in the NE Atlantic. These ideas will be further tested within our ongoing NABASK (North Atlantic BASin Kinematics) and the Cosmogrid rheological modelling projects.

Publications:

- O'Reilly, B.M., F. Hauser, C. Ravaut, P.W. Readman and P.M. Shannon. Crustal thinning, mantle exhumation and serpentinisation in the Porcupine Basin, offshore Ireland: Evidence from wide-angle seismic data. *Journal of the Geological Society*, London, in press.

- N.C. Morewood, P.M. Shannon, G.D. Mackenzie, P.W. Readman, B.M. O'Reilly and J. Makris, 2005. The crustal structure and regional development of the Irish Atlantic Margin region. *In: Petroleum Geology of Northwest Europe: Proceedings of the 6th Conference*, The Geological Society, London, 1023-1033.

4.3 ISLE

PW Readman, VC Do and BM O'Reilly with Geophysics staff, and colleagues from the University of Karlsruhe

The Irish Seismological Lithospheric Experiment (ISLE) continued collecting data from 6-7 broadband stations, following the phase II deployment during 2004, and two new stations were installed. Some solid results on shear-wave splitting have been obtained at both of the Irish permanent stations VAL and DSB that have been supported by the results from the temporary ISLE network.

The results indicate a component of the observed anisotropy related to the Caledonian (ca 400 Ma) closure of the Iapetus Ocean, with another second component, observed in data from earthquakes in South America, resulting from a deeper source in the mantle to the west of Ireland. At this stage a core-mantle boundary origin cannot be discounted because of the limited range of back-azimuths available in the data recorded to date. Data collection is therefore continuing in order to extend the azimuthal coverage.

Data from our previous controlled source wide-angle seismic experiment in southwest Ireland (VARNET – VARiscan NETwork) is also being used to investigate the crustal

contribution to the observed anisotropy. The results from Sg analyses give no evidence of any major difference in delay time between NS and EW components (up to 0.2 seconds, at most), i.e. there is no strong anisotropy in the upper crust, and so little contribution from the upper crust to the overall observed anisotropy (delay times average 1.2 s). We are now analysing SmS to study the anisotropy of the lower crust.

Collaboration with our Karlsruhe colleagues on the receiver function study has continued.

Publications:

■ Do, V.C., P.W. Readman and B.M. O'Reilly, 2006. Shear-wave splitting observation across southwest Ireland, *Geophysical Research Letters*, in press.

■ Landes, M., J.R.R. Ritter, B.M. O'Reilly, P.W. Readman and V.C. Do, A N-S receiver function profile across the Variscides and Caledonides of SW Ireland. *Geophysical Journal International*, under review.

Presentations:

■ Do, V.C., P.W. Readman and B.M. O'Reilly, Back-azimuthal variation of shear-wave splitting in south west Ireland, British Geophysical Association Post-grad research meeting, Galway.

■ Do, V.C., P.W. Readman and B.M. O'Reilly, Shear-wave splitting measurements from teleseismic and active-source data across the Iapetus Suture Zone in Ireland: preliminary results, EGU General Assembly Meeting, Vienna, 24-29 April.

■ Do, V.C., P.W. Readman and B.M. O'Reilly, Investigation of crustal and upper mantle anisotropy across the Iapetus Suture Zone in Ireland using shear-wave splitting analysis from teleseismic and active-source data: preliminary results, Irish Geological Research Meeting, Dublin, 18-21 February.

■ Do, V.C., P.W. Readman and B.M. O'Reilly, Deep source anisotropy revealed from back-azimuthal variation of shear-wave splitting in southwest Ireland, American geophysical Union, Fall Meeting, San Francisco, 5-9 December.

4.4 EAGLE

BM O'Reilly with GR Keller (UTEP) and PKH Maguire (Leicester) and the EAGLE Working Group

A paper was prepared on the crustal and upper mantle structure of the Northern Main Ethopian Rift using the tomographic and forward modeling results from the three controlled source seismic profiles. The implications of the results for incipient lithospheric breakup were discussed in a geological context.

Publications:

■ P.K.H. Maguire, G.R. Keller, S.L. Klemperer, G.D. Mackenzie, K. Keranen, S. Harder, B.M. O'Reilly, H. Thybo, L. Asfaw and M. Amha, 2005. Crustal structure of the Northern Main Ethiopian Rift from the EAGLE controlled survey; a snapshot of incipient lithospheric breakup. Geological Society of London, in press.

4.5 TRIM

BM O'Reilly and PW Readman

Two papers detailing results from the TRIM (TOBI Rockall Irish Margins) project were prepared and submitted during the early part of the year. Another paper detailing Plio-Pleistocene sedimentation processes on the eastern margin of the Rockall Trough is at an advanced stage of preparation.

Publications:

■ B.M. O'Reilly, P. W. Readman and P.M. Shannon, 2005. Slope failure, mass flow and bottom current processes in the Rockall Trough. *First Break*, **23**, 45-50.

■ Elliot, G.M., P.M. Shannon, P.D.W. Haughton, D. Praeg and B.M. O'Reilly, 2005. The morphology and evolution of the sediment undersupplied mid- to late Cenozoic eastern margin of the Rockall Trough, west of Ireland. *Marine Geology*, in press.

In preparation:

■ O'Reilly, B.M., P.W. Readman and P.M. Shannon. Shelf to slope sedimentation processes in the northeast Atlantic, off NW Ireland, and the impact of Plio-Pleistocene glaciations. For submission to *Marine Geology.*

4.6 NABASK

PW Readman and BM O'Reilly

The NABASK (North Atlantic Basin Kinematics) project combines our work in the Rockall, Hatton and Porcupine Basins with the aim of developing a unified development model for the Irish Northeast Atlantic offshore region. An informal presentation on our recently developed ideas about the evolution of the North Atlantic Basin System and connections with the eastern Canadian basin system was given at an invited workshop on 'Plate reconstruction of Atlantic Ireland'.

Publications:

- P.W. Readman, B.M. O'Reilly, P.M. Shannon and D. Naylor, 2005. The deep structure of the Porcupine Basin, offshore Ireland, from gravity and magnetic studies. In: Petroleum Geology of Northwest Europe: *Proceedings of the 6th Conference*, Geological Society, London, 1047-1056.

- B.M. O'Reilly, F. Hauser, C. Ravaut, P.W. Readman and P.M. Shannon. Crustal thinning, mantle exhumation and serpentinisation in the Porcupine Basin, offshore Ireland: Evidence from wide-angle seismic data. *Journal of the Geological Society*, London, in press.

Presentations:

- O'Reilly B.M. and P.W. Readman, Regional trans-Atlantic linkages between Irish and Canadian offshore basins, Petroleum Affairs Division Workshop on Plate recontruction of Atlantic Ireland, Naas, 12-14 October.

4.7 The Seismic Network

TA Blake, G Wallace, C Horan and L Collins

4.7.1 General

The east coast of Ireland on December 14th at 03:30 experienced a small earthquake estimated at 2.8 Richter Magnitude with epicentre 30 km off Wicklow Head. Its effects were felt by a large number of the population and there were 90 responses to our electronic questionnaire asking people to report what they felt. The most intense reaction to the earthquake was a 10 m cliff collapse on Killiney beach. There were no fatalities. The earthquake generated considerable public reaction in the printed and tv/radio media with media interviews being given by AG Jones and TA Blake.

4.7.2 Maintenance activities

General maintenance activities carried out during the year on DSB were as follows:

- monitoring humidity to ensure stable environment for STS2 sensor,

- monitoring of the quality of GPS signal and removal of vegetation that obscured this signal,

- replacement of the 56k modem following damage from a lightning storm,

- repairs to the Amp-Mod and transmitter cabling, and

- replacement of the seismometer at DMUB (Muff).

4.7.3 DIAS network

DIAS initiated – and has been funding when possible – the ad hoc development of a regional seismic network since 1978. A supplementary budget is now required if the network is to be developed to acceptable international standards (see below). From an already failing seismic network DIAS continues to supply important waveform data to the international seismological community.

4.7.4 DSB

Waveform data quality from DSB (the German GeoFON station operated by DIAS) continued to be good and the data are archived in both GFZ Potsdam and in DIAS. Data are downloaded directly to GFZ via 56k modem and are available via internet usually within an hour (although this has on occasion been over two hours). The data can be seen online at this address: http://www.gfz-potsdam.de/geofon/ gfn_liveseis.html. DIAS personnel collect the DAT tape of data every 4 weeks from DSB.

4.7.5 Irish National Seismic Network

AG Jones, TA Blake

The case is being made for a major rejuvenation of the DIAS seismic array and to bring into place an Irish National

Seismic Network using modern sensors with real-time data transmission, processing, analysis and archiving.

- 17 April: Case made to Chief Science Advisor, Dr. Barry McSweeney.

- 24 October: Submission to Minister of State, Mr. Batt O'Keeffe. Sent on to Mr. N. Dempsey (Minister for Communications, Marine and Natural Resources). Reply received dated 22 December (Dempsey) and 29 December (O'Keeffe).

- Need for INSN supported by Royal Irish Academy's Geosciences Committee.

4.8 Other

Pre-proposal submissions:

- Pre-proposal submitted by P.W. Readman to the SFI RFP2006 competition: The 3-D distribution of anisotropy variations below Western Eurasia from teleseismic receiver functions using a temporary broadband seismic array in Ireland.

- Pre-proposal submitted by B.M. O'Reilly to the SFI RFP2006 competition: Crustal and upper mantle structure along the axis of the Porcupine Basin from a detailed offshore/onshore wide-angle seismic experiment: implications for tectonic extension of the Earth's lithosphere.

Publications:

- Landes, M., J.R.R. Ritter, P.W. Readman and B.M. O'Reilly, 2005. A review of the Irish crustal structure and its signatures from the Caledonian and Variscan orogenies. *Terra Nova,* **17**, 111-120.

IRCSET fellowship:

- Celine Ravaut was awarded a fellowship under the IRCSET Postdocrtoral Fellowship scheme to study "Quantitative seismic imaging of the Hatton Continental margin using frequency-domain full-waveform inversion" working with P.W. Readman and B.M. O'Reilly. This will also include collaboration with members of the Cosmosgrid group and with Géosciences Azur laboratory in Nice, France.

5. Geodynamic Modelling

T Yamaski, J Sheehan, BM O'Reilly and PW Readman

Yamasaki has concentrated on studying the following topics: (1) Grain-size related rheological weak zones possibly controlling the mode of lithospheric extension, (2) the role of strain hardening on rift dynamics, (3) factors controlling the uplift of the Transantarctic Mountains in Antarctica, and (4) localized deformation in volcanic passive margins brought about by the magmatic underplating.

Publications:

- Yamasaki, T. and T. Seno, 2005. High strain rate zone in central Hoshu resulting from the viscosity heterogeneities in the crust and mantle. *Earth and Planetary Science Letters*, **232**, 13-27.

- Yamasaki, T., B.M. O'Reilly and P.W. Readman, A rheological weak zone intensified by the postrift thermal relaxation as a possible origin of strain localization associated with the reactivation of rifting. Submitted to *Tectonophysics*.

Presentations:

- Yamasaki, T., Rheological modeling of large-scale Earth structures and Cosmogrid re-sources, CosmoGrid Conference, Dublin, 19 January.

- Yamasaki, T. and H. Miura, Passive Margin Uplift Associated with Gondwana breakup possibly controlling the global climate change, IGRM, Dublin, 18-21 February.

- Yamasaki, T., Localized rheological weakening by grain-size reduction as a possible origin of asymmetric extension associated with reactivation of rifting, Vienna, EGU, Austria, 24-29 April.

- Sheehan, J., Rheology and the Porcupine Basin, BGA PGM, Galway, 31 August - 2 September.

- Sheehan, J., Rheology and the Porcupine Basin, 9th International Workshop on Numerical Modeling of Mantle Convection and Lithospheric Dynamics, Erice, Italy, 8-14 September.

Papers in preparation:

- Yamasaki, T., H. Miura and Y. Nogi, Factors controlling the flexural uplift of the Transantarctic Mountains. For submission to *Geophysical Journal International*.

- Yamasaki, T., Some remarks on the cessation of rifting under constant tectonic force: Role of strain hardening on rift dynamics. For submission to *Earth and Planetary Science Letters*.

6. Technical/Support Activities

6.1 Technical Support

G Wallace, C Horan, L Collins and JE Spratt

In addition to the maintenance, testing and shipping of field equipment (including seismic network equipment), technical staff are involved in the deployment and retrieval of the equipment and data processing for the following projects: ISLE and ISLE-MT, SAMTEX, Birr Castle DC Resistivity, and Cork AMT.

Support for the running of the seismic networks continued with management of the back up, processing and archiving of the network data and advice on and testing of new instrumentation and back-up procedures.

Maintenance and redesign of the Geophysics web page was undertaken during the year, as well as the production of graphics for papers, publications and posters.

6.2 Computer Network

J Allman

John Allman joined the Section as manager of IT from early-January. Allman's primary responsibility is the Windows-based machines within the School, and together with Dudzinski (IT Manager, Astro) providing user-support across the School and network backup.

Allman has initiated a number of procedures aimed at providing a secure and efficient network. Notable changes include:

- Implemented centralised user management so that there is one set of account details for both Linux and Windows.

- Moved all user and project data onto new dedicated "homes" servers and standardising home directories to /home/username.

- Began separating out project and personal data for ease of management and backup.

- Installed anti-virus software on all Windows desktops, keeping virus definitions and scanner software constantly up-to-date with an automated system.

- Installed a system for deploying Windows software so keeping machines up-to-date is a trivial task.

- Installed an inventory system for tracking software and hardware on all desktops (both Windows and Linux).

- Numerous network design and configuration modifications to improve security and performance, including separating services to mitigate any abuse and the installation of a firewall to filter unwanted traffic and analyse and log traffic that looks like a network-based attack.

7. Collaboration with Wider Research Community

7.1 DIAS-UB Collaboration

Collaboration continued under the auspices of the agreement between DIAS and the University of Barcelona (UB). Staff and students from UB came to DIAS for visits. Jones spent a month at UB (9 Oct. - 9 Nov.) and Moorkamp and Hamilton spent almost 3 months there (early-October to mid-December).

Whilst at UB Jones worked together with UB colleagues on two papers for submission to international journals, he played a significant role in aiding UB colleagues in their work to organize the 18th EM Induction Workshop, to be held in El Vendrell (south of Barcelona) in September, 2006, he formed a tri-national working group with DIAS-UB-UP (University of Pisa) to study volcanoes, and planned further collaborative activities.

7.2 Visitors to the Section

- Prof. David Eaton, Visiting Professor, from Department of Earth Sciences University of Western Ontario, on sabbatical leave at DIAS, November 2004 to April 2005.

- Prof. Michel Weber, Visiting Professor, from GeoForschungsZentrum Potsdam. May-July, 2005. (Dedication to DIAS in Preface to English translation of Theory of Elastic Waves by Gerhard Müller.)

- Dr Franz Hauser from the Geophysical Institute, University of Karlsruhe visited from July - September.

- Prof. W. Siripurnaporn (Bangkok, Thailand), Dr. R. Mackie (Geosystem, USA) and Dr. Y. Ogawa (TITECH, Tokyo) gave invited lectures as part of the SAMTEX Modelling Workshop, 2-13 May.

- Prof. G. Egbert (U. Oregon, USA), for a week in August to demonstrate his processing code.

7.3 Other Collaborative Activities by Section members

- Garcia continues his collaboration with Woods Hole Oceanographic Institution working on the geomagnetic observatory.

- Garcia processes marine EM data as part of the SHELF experiment. The results are going to be analysed by Phil Wannamaker at the University of Utah, as part of the SEA project in which Jones led the LMT acquisition.

8. Public Outreach

- Blake interviewed by Irish Times and RTÉ 9 o'clock News subsequent to second Sumatra event.

- Information and seismograms of December 2004 Sumatra and recent Pakistan events were sent to all ISLE station minders and landowners. Information and seismograms of the December 2004 Sumatra event was also sent to the manager of the Kerry Geopark Project.

- On 22 February Tom Blake gave a lecture to transition year students at the Loreto Convent in Crumlin on "Earthquakes and Seismology in Ireland and Robert Mallet".

9. Training Undertaken

- WinGLink training course, Milan, Italy, 8-12 May: L. Collins, M. Hamilton, J.E. Spratt, U. Weckmann.

- CorelDraw Second Level course, DIAS: C. Horan.

10. Health and Safety Measures

- First Aid training course, Burlington House, August: A. Chabert, L. Collins, M. Hamilton, J. Sheehan, J.E. Spratt.

- Document prepared by J.E. Spratt on Fieldwork Health and Safety for the SAMTEX Phase III fieldwork.

- Internal Safety Audit carried out by T. Blake (Merrion Square Safety Officer) and C. Horan (Merrion Square Staff Representative).

11. Miscellanea

X Garcia

- Presented lecture on electrical and electromagnetic methods to undergraduate students at Trinity College Dublin.

- Advisor on Marine EM methods to Providence Resource, Inc.

M Hamilton

- Presented lectures to undergraduate students at the University of the Witwatersrand.

AG Jones

- Editorial Board, *Earth, Planets and Space*.

- Associate Editor, *Journal of Geophysical Research*.

- Acting Editor, Special issue of *Physics of the Earth and Planetary Interiors* devoted to Continental Anisotropy.

- Adjunct Professor, Syracuse University, Syracuse, NY, USA.

- Adjunct Professor, Queen's University, Kingston, Ontario, Canada.

- Adjunct Professor, NUI Galway, Ireland.

- Visiting Professor, Trinity College Dublin, Ireland.

■ Visiting Scientist, Geological Survey of Canada.

■ Member, Natural Sciences and Engineering Research Council of Canada (NSERC) Grant Selection Committee for the Earth Sciences.

■ Member, Irish Geoscience Initiative Committee.

■ Webmaster, MTNet (www.mtnet.info)

BM O'Reilly

■ Editorial Board, *Irish Journal of Earth Sciences*.

PW Readman

■ Member, Consultative Committee of the Geological Survey of Ireland.

■ Titular Member, European Seismological Commission.

■ Member, Irish Geoscience Initiative Committee.

■ Member, Marine Institute Third Level Liaison Committee.

■ Panel Member, Marine Institute Marine Foresight Exercise.

■ Research Associate, UCD.

School of Theoretical Physics

1 Report on Research Work

1.1 Work by Senior Professors and Collaborators

1.1.1 Anderson Localisation

(T.C. Dorlas, J.V. Pulé & C. Dobrovolny)

The collaboration with Prof. Joe Pulé (UCD) on Anderson localisation in one-dimensional systems was continued in collaboration with a postdoctoral student, Dr. Christophe Dobrovolny. We started by computing the Lyapunov exponent of the 1-dimensional Anderson model, to second order in the disorder strength. The power series for the invariant measure, from which the Lyapunov exponent can be derived, was shown to diverge at certain values of the energy by Kappus and Wegner, and in more detail, Derrida and Gardner. In particular, they found that at zero energy, i.e. in the middle of the band, the invariant measure is discontinuous in the limit of zero disorder. In our previous work, we showed that this situation persists for two chains, and in a sense becomes worse. We now also extended a method due to Pastur to the case of several chains. We found analogous but subtly different results from those obtained by Schulz-Baldes. The origin of these discrepancies is so far unclear.

We have also extended this analysis to the nanotube, where it becomes quite complicated. However, the main conclusion is that the Lyapunov exponent behaves in the same way as the width of the tube varies as in the case of the Anderson model. The work is to be continued into 2006.

1.1.2 Long Cycles for Bose-Einstein Condensation

(T.C. Dorlas, P. Martin & J.V. Pulé)

The Feynman-Kac representation of Bose gas with interaction involves a sum over permutations due to the Bose symmetry. These permutations can be decomposed into cycles, and it was predicted by Feynman, and more precisely by Onsager and Penrose, that Bose-Einstein condensation can be characterised in the Feynman-Kac representation of the partition function, by the occurrence of very long cycles with high probability. This suggestion was proved in the case of a free gas and also for a gas with mean-field interaction, by Sütö. In collaboration with Profs. Philippe Martin (Lausanne)

and Joe Pulé (UCD), it was shown, using Large Deviation techniques, that this conjecture is also valid in the case of the perturbed mean-field model, introduced by Profs. John Lewis, Joe Pulé and myself in 1990. This result was reported in [05-05] and published in [2].

1.1.3 Quantum Information

(T.C. Dorlas & N. Datta et al.)

In collaboration with a group in Cambridge, it was shown that, in contrast with classical information, quantum information can in some cases be transported in a network over large distances in finite time and with probability 1. In a cubic lattice, for example, it was shown that the time remains finite as the dimension tends to infinity. Classically, the time tends to infinity exponentially. The exponential rate was computed explicitly for this case. The results were published in [3].

1.1.4 The Asymmetric Exclusion Process

(T.C. Dorlas & V.B. Priezzhev)

The project in collaboration with V. B. Priezzhev concerning the exact solution of this model on a ring was continued. The model had been solved previously on an infinite line by Schütz, but for the understanding of the approach to equilibrium the ring geometry is more appropriate. Previously, Priezzhev had introduced a modification of the Bethe Ansatz method which allows an exact solution of the problem on a ring. However, the resulting equations are rather complicated and it is not a straightforward exercise to derive explicit expressions for physical quantities from these. In fact, even the simple fact that the total probability of all configurations at time $t > 0$ equals 1, is not trivial to prove. This normalisation of the total probability was proved last year. We proceeded by evaluating the Bethe Ansatz expression for the probability that a particle reaches the end of the interval in time t, and we analysed its asymptotics. The result is reported in [05-08].

1.1.5 Quantum Hall Effect in Graphene

(W. Nahm & M. Leitner)

When M. Leitner joined DIAS a collaboration was started about the quantum Hall effect for relativistic fermions, the topic of her PhD thesis. Recently the existence of the effect has been demonstrated in graphene, a 2-dimensional sheet of graphite, which probably will become a major electronic material in the future. When the space and time reflection symmetries of this material are broken by magnetic impurities, spontaneous edge currents are predicted to occur at low temperature. These could be switched on and off by suitable modifications of the boundary, which would allow for very efficient nanoscale computing. Before we proceed, we are looking for reasons why the idea might not work. One potential problem is the influence of the boundary modifications on the bulk Hall currents near the edge, which conceivably might mask the change in the boundary currents. Our calculations indicate that this is not a problem, however.

1.1.6 Vanishing Theorems

(W. Nahm & F. Laytimi)

Research with F. Laytimi on vanishing theorems for ample vector bundles continued. A paper with a new vanishing theorem for the Dolbeault cohomology of bundles arising as a tensor product of exterior powers was published in [9]. It was shown that the conditions for the vanishing given by the theorem are optimal for a large range of parameters.

1.1.7 Integrable Quantum Field Theories and Quantum Groups

(W. Nahm)

Work on the characters of conformal field theories with integrable perturbations lead to algebraic equations which are satisfied by the characters of quantum groups. At the moment this relationship is hard to explain. The equations first turned up in work by Kirillov and Reshetikhin, which is quite obscure (and no longer understood even by its authors), but based on integrable lattice models, which are now being studied. Much of the fundamentals about those models is described as a bag of tricks and difficult to assimilate by newcomers to the area. To better understand it a course is given based on Baxter's book on 'solved models', where I try to rewrite the material in a more accessible form. In particular, the elliptic functions are unnecessary and can be replaced by easy algebraic geometry. It is intended to write up the course as a DIAS communication.

1.1.8 Fuzzy Physics

(Denjoe O'Connor)

Research in 2005 continued on the construction of suitable fermionic field theories on fuzzy spaces and on the preparation of fuzzy supersymmetric field theory models for Monte-Carlo simulations. Simulations were commenced on a scalar fermion model that is supersymmetric in the planar limit. This model was chosen due to its simplicity and the restriction to a supersymmetric planar limit restricts the parameter space to be explored.

Fuzzy field theories are field theories where the background space is a fuzzy one, i.e. one where the algebra of functions of a manifold is replaced by a suitable matrix algebra, with matrix dimension N, and the Laplace-Beltrami operator by a suitable Laplacian mapping matrices to matrices of the same dimension. The triple of Matrix algebra, norm $< F|F> = \frac{Tr}{N}(F^\dagger F)$ and Laplacian defines the geometry of the fuzzy space.

The fuzzy approach is ideally suited to the study of supersymmetric models as it is possible to truncate the theory to a finite number of degrees of freedom while retaining the exact supersymmetry. The ingredients are a graded matrix algebra, where the matrix entries now contain both commuting and anti-commuting (or Grassmann) entries and the trace over matrices is replaced by a supertrace.

The theoretical aspects of the research are being carried out with Brian Dolan, Seçkin Kürkçüoğlu and Marco Panero.

The simulations will be performed by Marco Panero, Xavier Martin (Tours) and Wolfgang Biedenholz and his student, Jan (of Berlin). The research will be ground breaking in that it will be the first non-perturbative study (a Monte-Carlo study) of supersymmetric models using this approach.

1.1.9 Fuzzy Physics and Monte Carlo Simulations

(Denjoe O'Connor, X. Martin, F.G. Flores and J. Medina)

Numerical work (with Fernando Garcia and Xavier Martin) was carried out on a ϕ^4 scalar field model on the fuzzy sphere. The fuzzy sphere is a discretization of the sphere through $N \times N$ matrices in which the symmetries of the space are preserved. This model presents three different phases: uniform ordered and disordered phases, as in the usual commutative scalar field theory, and a nonuniform ordered phase related to *UV-IR* mixing like non-commutative effects. We determined the coexistence lines between phases, their triple point and their scaling.

A three dimensional ϕ^4 model was studied numerically in a collaboration with Julieta Medina and Wolfgang Bietenholz and Frank Hofheinz. The regularization consists on a fuzzy sphere with radius R for the two spatial directions, plus a lattice discretised Euclidean time. We evaluated the phase diagram, where we find as in the case of the two dimensional model a disordered phase and an ordered regime which splits into uniform and non-uniform order phases. In contrast to the two dimensional model we found that there was no consistent collapse in terms of the matrix size of the different transition lines.

The behaviour of the models in different limits for large N and R leads to a commutative or to a non-commutative ϕ^4 model in flat space as far as the action is concerned. However, further work was necessary to clarify these limits in the nonperturbative setting.

A third numerical study of non-commutative gauge fields on the fuzzy sphere was commenced with Badis Ydri and Rodrigo Delgadillo. Preliminary results indicate that the model exhibits a rich phase structure with a novel phase described by a one plaquet model.

1.2 Independent Work by Fellows

1.2.1 Theoretical and Computational Studies of Field Theories on Fuzzy Supersymmetric Spaces

(S. Kürkçüoğlu)

The Supersphere $S^{(2,2)}$ is the adjoint orbit of the Lie supergroup $OSp(2,1)$ and can be expressed as the quotient $S_F^{(2,2)} \equiv OSp(2,1)/U(1)$. It is obtained through quantizing

this orbit. It is described by a finite-dimensional matrix algebra, which in the infinite-dimensional limit approaches the algebra of functions on the supersphere. $S_F^{(2,2)}$ is especially interesting since it preserves the $OSp(2,1)$ symmetry of $S^{(2,2)}$ and thereby allows an exact treatment of supersymmetry in a discrete setting. It is already known that field theories on $S_F^{(2,2)}$ can be expressed as finitedimensional matrix models. In addition, non-trivial field configurations, such as nonlinear sigma models can be formulated on $S_F^{(2,2)}$. On the more formal side, it is known that $S_F^{(2,2)}$ is endowed with an associative *-product.

The interest of the collaborators on this topic is focused on investigating the formulation of quantum field theories(QFTs) on $S_F^{(2,2)}$, with polynomial interactions. Initial focus of the research has been on obtaining a formulation, which could be readily used to apply computational techniques. For this purpose, group theoretical methods to analyze the detailed structure of the kinetic term in the action of a free real superfield has been employed. The addition of a mass and polynomial interaction terms to the free superfield action appeared as a highly nontrivial stage in this investigation, which initially was not anticipated. This problem has been partially resolved and several alternative methods are under examination to reach a fully successful outcome. The progress on this topic is being prepared as an article for publication.

1.2.2 Time-Space Non-commutativity and Waves

(S. Kürkçüoğlu, A.P. Balachandran & K.S. Gupta)

During this period, Dr. Kürkçüoğlu continued his collaborations initiated prior to his arrival at DIAS. Specifically, in collaboration with Professor A.P. Balachandran from Syracuse University (Syracuse NY, USA) and Professor K.S. Gupta from Saha Institute (Calcutta, India), Dr. Kürkçüoğlu has investigated the general theory of waves in spacetimes where time and space coordinates do not commute. Research on this topic was initially motivated by the recent developments in formulation of explicitly unitary quantum theories on non-commutative(NC) spacetime, where time and space coordinates do not commute. However, many physical predictions of this theory were the same as those of the usual quantum mechanics, while it was anticipated that new features would arise in interference phenomena. With these

motivations the physics of waves in time-space NC spaces is studied. It is well-known that waves on "commutative" spacetimes like $\mathbb{R}^d$ are elements of the commutative algebra $C^0(\mathbb{R}^d)$ of functions on $\mathbb{R}^d$. When $C^0(\mathbb{R}^d)$ is deformed to a non-commutative algebra $\mathcal{A}_\theta(\mathbb{R}^d)$ with deformation parameter θ $(\mathcal{A}_0(\mathbb{R}^d) = C^0(\mathbb{R}^d))$, waves being its elements, are no longer complex-valued functions on $\mathbb{R}^d$. Thus a generalized set of rules for their interpretation, such as measurement of their intensity, and energy is needed. The investigations first addressed this task. Subsequently, these rules were applied to interference and diffraction for $d \leq 4$ and with time-space non-commutativity. Novel phenomena are encountered. It has been found that there are circumstances under which the interference pattern is completely lost, while in other cases it is deformed and depends on the ratio $\frac{\theta w}{T}$, where θ is the NC parameter, T is the time of observation and w is the frequency of incident waves. These results are then applied to the interference of star light due to cosmic strings, and used to predict a bound on $\frac{\theta}{T}$ below which interference may be observed.

1.2.3 Fuzzy and SUSY Fuzzy Physics:

(S. Kürkçüoğlu, A.P. Balachandran & S. Vaidya)

Dr. Kürkçüoğlu together with Professor A.P. Balachandran from Syracuse University and Professor S. Vaidya from IISc Bangalore, India, have recently completed a book reviewing the developments that have happened in the past decade or so in the field of fuzzy and supersymmetric fuzzy physics [05-12]. The book is an outcome of an ongoing effort for almost two years and was initiated prior to Dr. Kürkçüoğlu's arrival at DIAS. It reviews the geometrical aspects of fuzzy spaces, as well as the theory of scalar, spinor and gauge fields on fuzzy spaces. The projective module approach to construct fuzzy solitons is also covered with examples. Since it has been placed in the preprint arXiv, it has received very encouraging feedback from the scientific community. At present the collaborators are in the process of revising it in the light of this feedback and will be contacting publishers very soon regarding its formal publication.

1.2.4 Gravity Theories on Non-commutative Spaces

(S. Kürkçüoğlu, A.P. Balachandran & T.R. Govindarajan)

Dr. Kürkçüoğlu has collaborated with Professors A.P. Balachandran, K.S. Gupta and T.R. Govindarajan (IMSC, Chennai, India) on formulation of lower dimensional gravity theories on non-commutative spaces. This research has been motivated by the recent developments due to Chaichian et al. and Aschieri et al. who reported that a so-called "twisted" Poincaré and diffeomorphism symmetry is consistent with field theories on NC spaces. To be more precise, they have demonstrated that Poincaré and diffeomorphism group act as an automorphism on the algebra of functions over the NC space, if the coproduct associated with these symmetries is suitably deformed. The collaborators recognized that these developments open possibilities for many interesting developments, one such being the study of gravity in NC spaces, already pursued to get the NC version of the Einstein-Hilbert action. However, due to the complicated nature of this action new physics is hard to extract. Thus Dr. Kürkçüoğlu and his collaborators considered that new physics could be probed first in lower dimensional gravity theories. In this regard the collaborators have succeeded in formulating a twisted generally covariant, NC gauge theory of $1 + 1$ dimensional gravity. It has been verified that this theory has the commutative AdS_2 space as a solution. In a certain contracted limit of the gauge group the NC version of the dilaton gravity theory has also been obtained. It is known that the latter has a black hole solution, and studies of the collaborators have shown that it too is a solution for their NC theory. This work was initiated during a workshop in IISc at Chennai that Dr. Kürkçüoğlu participated in during July-August. A substantial part of this work was completed during T.R. Govindarajan's visit to DIAS in the Fall and a first draft of the article discussing these results will be uploaded to the arXiv in early 2006.

The collaborators conceive this study as a first step in a long term research program. Within this program it has been foreseen that a range of related problems could be studied. In the near future investigations will be directed at the addition of matter sources, where there are some preliminary indications that novel results will emerge. At the next stage a plan to make a survey study of NC 2 + 1 gravity in terms

of suitable NC Chern-Simons theories is in order. Also in this context, obtaining concrete results on non-commutative deformations of BTZ black holes is another objective.

1.2.5 Non-commutative Conformal Symmetries

(S. Kürkçüoğlu)

Dr. Kürkçüoğlu examined how the Virasoro symmetries can be "twisted" to implement them on NC spaces. Some preliminary results in this direction have been obtained. During the course of this research a new associative *-product on the NC plane has been discovered. In addition, to its dependence on the NC parameter, this *-product also depends on the conformal dimensions of the objects being multiplied. Research at present is focused on analyzing the physical consequences of these rather technical developments.

1.2.6 Fuzzy Cosets of SU(3)

(S. Kürkçüoğlu)

In the Fall, Dr. Kürkçüoğlu initiated studies on the structure of fuzzy cosets of $SU(3)$. This study is particularly focused on the fuzzy version of the coset space $SU(3)/[U(1) \otimes U(1)]$. In this context, $SU(3)$ coherent states appropriate for this space have been obtained and ongoing research is directed at obtaining the associated *-product to better understand its geometry. These studies could be considered as the initial steps of a comprehensive study of many aspects of field theories on the fuzzy $SU(3)/[U(1) \otimes U(1)]$. In particular, it is planned to direct investigations at obtaining the appropriate fuzzy Dirac operator to introduce spinors. The index theory of such a fuzzy Dirac operator would be yet another intriguing problem, which is to be studied in the later stages of this project.

1.2.7 Regularizing NC QFTs

(S. Kürkçüoğlu, M. Panero & T.R. Govindarajan)

Recently, a collaboration was started between Dr. Kürkçüoğlu, Dr. Marco Panero and Professor T.R. Govindarajan on using nonlocal regularization techniques to study the structure of NC quantum field theories at one loop. In this approach NC parameter and the cut-off parameter are taken to be related through a dimensionless parameter η $(\theta = \eta \frac{1}{\Lambda^2})$. NC ϕ^4

theory is being used as a testing ground for developments. For all finite values of η, it is easy to see from the work of Minwalla et al. that UV-IR mixing, does not occur whereas in the limit $\eta \to \infty$ UV-IR mixing is encountered. Preliminary calculations using this new approach on NC ϕ^4 theory indicate that renormalized mass receives corrections that depend on this dimensionless parameter. Right now calculations are underway to obtain the 4-point functions of ϕ^4 theory at one loop and the aim is to construct the phase diagram of the theory as function of Λ and η and compute the β-function at this order. It is expected that this result will agree with β-function that could also be extracted from the results of loop integrals of Minwalla et al. by demanding the above relation between θ and Λ. It is also expected that these steps will help the collaborators to build a certain level of confidence to this approach and proceed to apply it to QED.

1.2.8 Non-Commutative Geometry

(M. Panero)

Non-Commutative geometry, which was originally introduced as a tool to solve the problem of divergences arising from the quantum approach to field theories, has a number of implications of physical relevance in various fields (phenomenology, quantum gravity, quantum Hall effect, string theory to mention some), which make it one of the most popular research topics in mathematics and physics today. One of the central issues arising from the non-commutative geometry approach is the mixing between ultra-violet and infra-red (UV/IR) degrees of freedom: a phenomenon which can be predicted by perturbative calculations of non-commutative theories. Research work was started, which focused on a perturbative approach to quantum field theories in non-commutative space-time, with a nonlocal regularisation; this approach may provide a link to connect the high-energy dynamics and the renormalisation group approach *à-la* Wilson-Kadanoff.

1.2.9 Fuzzy Physics

(M. Panero, Denjoe O'Connor and students)

The Fuzzy Physics approach, which gives an elegant, highly symmetric, and mathematically well-defined regularisation scheme for Quantum Field Theories, allows one to address

non-perturbative studies of field theories, providing a natural representation in terms of finite-dimensional matrix models. This setting can be studied theoretically and numerically, via Monte Carlo simulations alternative to the standard lattice approach. The work during 2005, within the group led by Prof. D. O'Connor which currently includes R. Delgadillo, F. García, H. Huet, S. Kürkçüoğlu, S. Murray and M. Panero, has involved both theoretical and numerical aspects. On the theoretical side, the research has been focused on the fuzzy formulation of the $OSp(2|1)$ and $OSp(2|2)$ models, which generalise the scalar field theories on a fuzzy sphere to a supersymmetric setting. On the numerical side, the work has been focused on the construction of the phase diagram for a supersymmetric theory defined on the $(2|2)$ superplane, using the regularisation given by the fuzzy physics approach.

1.2.10 Field Theories on Manin Plane

(T.R. Govindarajan)

Work continued on the extension of the twisted realisation of symmetries to field theories on the Manin plane and the implementation of conformal symmetries on the Manin plane was progressed.

1.3 Independent Work by Research Scholars and Students

1.3.1 The Gross-Pitaevskii Formula and Bose-Einstein Condensation

(S. Adams)

The main result obtained was the temperature dependent Gross-Pitaevskii variational formula for the so-called Hartree model in the large particle limit, where the interaction is scaled such that the system is dilute. This research work resulted in preprint [05-13]. The corresponding study of the large time limit, which is interpreted as zero-temperature limit, for finite number of particles and the large particle limit in the product ground state is in publication. In December preparation of the German Habilitation thesis at the University of Leipzig was commenced.

1.3.2 Random Walks

(S. Adams & T.C. Dorlas)

Study of a new symmetrisation procedure for a system of continuous time random walks on a lattice commenced. Here the large particle limit was studied and a large deviation principle derived. This research is still in progress.

1.3.3 Quantum Information

(A. Ghesquire)

The main area of work was in the field of quantum information and in particular on the decoherence in a two-particles system.

1.3.4 Nonzero Hall Conductivity

(M. Leitner)

To produce a nonzero Hall conductivity σ_H, a magnetic field perpendicular to the plane has always been found necessary. However relativistic systems in 2+1 dimensions with a time reversal breaking term display a nonzero Hall conductivity without external magnetic field. This fact has been attended to very little but may become important. In my research project, I study different types of such systems.

1.3.5 Bulk Physics

(M. Leitner)

For bulk devices with relativistic invariance, the use of Feynman diagram techniques for the calculation of the Hall conductivity σ_H is a good alternative to the condensed matter physics' approach and yields new geometric insights. Thus a comparison of both approaches should be useful. This was planned for a joint publication with Prof. Ruedi Seiler (TU-Berlin). We discussed my draft in Berlin during three days (16-18 March), but with his permission I finished the preprint by myself [05-14] (cond-mat/0505428). On the 2nd of July, I submitted the paper to Physical Review Letters (PRL). It was rejected on the 14th of December. The two referees didn't accept the urgency requested by PRL but suggested publication in Physical Review A. One of the referees argued that my explanation of the non-integrality of σ_H relies on the infinite depth of the Dirac so, therefore, this effect "is rather

unlikely" to be present in non relativistic solid state physics. This was disproved immediately by the articles in Nature (November 10) which reported on experiments with the new material graphene, but the referee did not want to change his mind. Graphene is a monolayer of carbon, easy to produce, which for the very first time realises a 2+1 relativistically invariant dimensional QFT (with some solid state analogue for the speed of light). For this material, an "unusual Integer Quantum Hall Effect" has been found where all the integer values are shifted by 1/2. The authors argue that the zero mass of the particles is responsible for the deviation from integrality but my investigation of massive Dirac fermions which produce an half-integer σ_H shows that this is not the crucial point. Graphene is time reversal invariant, such that the Hall effect depends on an external magnetic field. But nonsymmetric materials with a built-in magnetic field are conceivable which would be more useful than graphene.

1.3.6 Edge Physics

(M. Leitner & M.J. Gruber)

In two space dimensions, spontaneous edge currents are predicted for edge devices in the absence of both an external magnetic and electric field, when time and space inversion symmetries are broken by magnetic impurities in the material. In a strip geometry (with parallel edges of similar type), a net edge current results from a proper difference between the respective chemical potential on the two edges. The latter is achieved, e.g., by applying an external electric field in the plane, perpendicular to both edges. When boundaries at a large distance are treated separately, particles with energies between the lower gap barrier and the chemical potential support an edge current. The difference in energy can be interpreted as an internal voltage. The conductivity turns out to switch between zero and sgn(m) (in natural units), depending on the boundary condition. An updated version of DIAS-STP-04-20 will appear in Letters of Mathematical Physics in 2006.

1.3.7 Quantum Source Coding

(C. Morgan)

I began research as a pre-doctoral scholar in Quantum Information Theory under the supervision of Prof. Tony Dorlas in October 2005. Between October and the end of 2005 I have been concentrating on Quantum Source Coding, one of the primary areas of interest in Quantum Information Theory. Using the recommended text "Quantum Computation and Quantum Information" by Nielson and Chuang and working through the research paper "Source Coding in Quantum Information Theory", N. Datta and T. C. Dorlas, I have established an understanding of the fundamental concepts necessary for classical and quantum data compression.

1.3.8 Fuzzy Field Theory

(S. Murray)

Research work involved attempts at constructing a fuzzy super complex projective space. It was decided to reformulate the non-super case in terms of right actions as this may facilitate the extension to supersymmetry. To this end scalars on fuzzy CP^n and a Laplacian which gave the correct continuum eigenvalues were constructed. Presently the case of spinors is being considered.

1.3.9 Lie Algebras

(S. Ni Chiagain)

Yangians are a very important concept in mathematics. They are built upon firm mathematical foundations, but being relatively new, much about them is still unknown. I'm particularly interested in the representation theory and characters of these Yangians. As well as being of interest mathematically, these Yangians are an effective tool for solving problems in physics. In my Ph.D. work Yangians prove to be very useful in the theory of integrable models.

In 2-dimensional integrable models, scattering matrices are explicitly known. They are a function of rapidity. There's a phase for each pair of types of particles. Looking at the phase difference between rapidities ∞ and $-\infty$ gives a number, which is a matrix element of A. This is related to the work I'm doing at the moment.

In quantum field theory certain integrable models are described in terms of pairs W, Y of Dynkin diagrams of simple Lie algebras. The equations for these models are of the form $AU = V$, where $A = C(W)^{-1} \otimes C(Y)$, C denotes Cartan matrices, and W and Y are the Dynkin diagrams of simple Lie algebras of ranks m and n respectively. Moreover $U = \log X$ and $V = \log(1 - X)$, where $X = (x_{11}, \ldots , x_{mn})$. There are many possible choices for the Lie algebras W and Y, and each choice leads to a different set of equations. It seems that the resulting algebraic equations for X are solvable in terms of roots of unity. We want to be able to solve these equations in all cases. The case where both W and Y are of type A has already been studied. In this case it is possible to solve the equations using only the representation theory of Lie algebras.

Of particular interest to us is the case where $W = D_m$ and $Y = A_n$. Here the equations can be solved using the representation theory of Lie algebras and their related Yangians. In this case the characters of the group element g, in certain representations, yield the matrix elements of U, V. $g = diag(a_1, a_1^{-1}, \ldots, a_m, a_m^{-1}) \in SO(2m)$ are solutions of the equations $AU = V$. The a_i must satisfy

$$a_1^{n+2m-1} = \ldots = a_m^{n+2m-1} = 1$$

and

$$a_1^{\frac{n+2m-1}{2}} \ldots a_m^{\frac{n+2m-1}{2}} = \pm 1$$

Also $a_i \neq a_j$ and $a_i \neq a_j^{-1}$ for $i \neq j$.

The ultraviolet limit of an integrable model is a conformal field theory. Some of the corresponding values of its effective central charge, c_{eff}, have been calculated. c_{eff} is the minimal value over α of $c - 24h_\alpha$, where

$$\sum_i L(x_i^\alpha) = \frac{\pi^2}{6}(c - 24h_\alpha)$$

and L is an analytic continuation of the Rogers dilogarithm function. We want to find all values of $(c - 24h_\alpha)$. The fact that the h_α are all rational numbers has some important consequences for the scattering matrices.

In a paper by Kirillov and Reshetikhin, ("Representations of Yangians and Multiplicities of Occurrence of the Irreducible Components of the Tensor Product of Representations of Simple Lie Algebras", J. Soviet Mathematics, **52** (1990) 3156), it is claimed that the characters of irreducible Yangian representations satisfy a certain set of equations. All of our calculations agree with this conjecture.

Some work was done towards finding a dimension formula for Yangian representations, in the hope that this might be helpful in finding a Yangian character formula. To date no character formula has been found. However a recursive dimension formula was found for the irreducible Yangian characters of D_m.

In the future it is hoped to look at more complicated pairs of Dynkin diagrams, for example (B_m, A_n) and (C_m, A_n). It is known that these are closely related to the cases already studied and it is hoped that this relationship can be used to find the effective central charges in the B and C cases.

1.3.10 String Theory

(T. Tsukioka)

The formulation for string theory in higher-dimensional spacetime has been investigated. Since the extended spacetime involves two or more time coordinates, this research might be a clue for understanding the origin of time and spacetime itself. Gauge symmetries and supersymmetries were emphasised in much of the research on field theory and string theory.

In the context of the string unification, the relations between string theories in various dimensional backgrounds have been studied and it was also conjectured that all of these string theories were regarded as different phases of an underlying theory called M-theory in higher-dimensional spacetime. Meanwhile, the idea of extra time dimensions, which might be hidden dimensions, was suggested and studied. From the algebraic point of view, 10+1-dimensional supersymmetric algebra can be naturally derived from 10+2-dimensional extended supersymmetric algebra. F-theory which is formulated in 10+2-dimensional spacetime provides the geometrical origin of type IIB string theory which can not be directly connected to 10+1-dimensional M-theory. Ftheory offers not only new avenues for the upper formulation of type IIB string theory but also possibilities to consider a deep concept about spacetime. However, it seems that F-theory is a still provisional one, lacking clear dynamical principles.

The goal of this research is the construction of the unified theory at the fundamental level which should predict not only the dimensionality but also the signature of our spacetime.

With collaborator Y. Watabiki it is proposed that string models be used as devices to formulate the physics involving extra time coordinates and to search for a fundamental theory with an underlying complex nature of spacetime which would be linked to M-theory and F-theory from a higher-dimensional and more unified point of view including extra time-like dimensions.

1.4 Work by Research Associates

1.4.1 The Quantum Hall Effect

(B. Dolan & Cliff Burgess)

Dr. Dolan has continued an ongoing collaboration with Cliff Burgess of McMaster University, Hamilton, Ontario, Canada on duality and the modular group in the quantum Hall effect. The role of the modular group in quantum Hall bi-layer systems is currently being developed.

1.4.2 Non-Commutative Geometry

(B. Dolan, A. Balachandran, C Nash, D. O'Connor, & P. Presnajder)

A programme to develop closed matrix algebras approximating compact manifolds, one aim of which is numerical computation, has continued and been extended to cover complex quadrics. The analysis to supersymmetric matrix algebras is currently being extended, focusing at the moment on the supersymmetric fuzzy sphere. The finite matrix algebra geometry of the fuzzy sphere as a model for the event horizon of a 4-dimensional black hole has also been developed.

1.4.3 Higher Dimensional Field Theories

(D.H. Tchrakian)

Work was carried out in the following areas: Higher dimensional field theories, including dimensional descent: Abelian and non Abelian gauged Higgs and Skyrme field theories, including their gravitating cases; Special emphasis on higher curvature gravitational terms, as well as inclusion of (negative) cosmological constant. The following specific problems were investigated.

■ Construction of a U(1) (Maxwell) gauged Skyrmion in 3 + 1 dimensions. This is a stable soliton when the *electric* potential vanishes, and is quasistable otherwise. In the second case we succeeded in finding a static *spinning* finite energy lump. This is the only such example that does not involve stationary fields.

■ Study continued of the systems consisting of two distinct gravitating members of the Yang–Mills hierarchy, going beyond the first two members of the Yang–Mills hierarchies in dimensions $d = 6, .., 12$, extending our previous results restricted to the first two members of this hierarchy, and to dimensions $d = 6, .., 8$. Using fixed point analysis combined with numerical techniques, we established that the various solutions are characterised by three types of fixed points, at zero and infinity, Reissner–Nordstrøm type, and what we called a 'conical', this last one being a feature exclusively in dimensions 5, 9, .. etc. In this study, we restricted to Einstein–Hilbert gravity, and to regular solutions only.

Again in this area, and restricting to Einstein–Hilbert gravity, we studied such systems in the presence of a negative cosmological constant. The results are qualitatively similar to those of the usual 3 + 1 dimensional case, except that the peculiar accident in the latter case allowing finite mass solution with monopole-like rather than sphaleronlike asymptotic behaviour. Here, only the latter type exist, except in dimensions where a Pontryagin charge is defined, when their asymptotic behaviour is instanton like.

Finally, again in this area, we studied higher dimensional gravitating Yang–Mills systems, but with the gravitational term being a member of the gravitational hierarchy (e.g. Gauss–Bonnet). It was shown that the qualitative properties of the usual 4 dimensional case repeated *modulo 4p* dimensions.

■ Constructed 'monopoles' in $4p - 1$ dimensions, employing the $2p$-th members of the Yang–Mills hierarchy. The corresponding dyons were also discussed, and in a subclass of these models its existence is guaranteed.

This project is ongoing and at present we are gravitating these systems. It is planned also to apply these objects to brane theories.

- Started on the construction of axially symmetric instantons in all even Euclidean dimensions, and of axially symmetric monopoles in all odd Euclidean dimensions. In the latter case we have also considered monopole antimonopoles, and monopole antimonopole chains.

- Started the construction of axially symmetric instantons of the 4 dimensional Yang-Mills system, which unlike Witten's axially symmetric instantons are labelled by a vortex like charge *n*. This project is ongoing.

2 Publications

2.1 Papers in Refereed Journals

[1] X. Martin, R. Sorkin & Denjoe O'Connor: The random walk in generalised quantum theory. *Phys. Rev. D* **71** (2005) 024029.

[2] T. C. Dorlas & J. V. Pulé: Long cycles in a perturbed mean field model of a Boson gas. *J. Stat. Phys.* **16** (2005) 1–34.

[3] M. Christandl, N. Datta, T. C. Dorlas, A. Ekert, A. Kay & A. J. Landahl: Perfect transfer of arbitrary states in quantum spin networks. Phys. Rev. A **71** (2005), 032312.

[4] M. Panero: A numerical study of confinement in compact QED. *JHEP* **05** (2005) 066, [arXiv:hep-lat/0503024].

[5] F. Gliozzi, S. Lottini, M. Panero & A. Rago: Random percolation as a gauge theory. *Nucl. Phys*. **B719** (2005) 255-274, [arXiv:cond-mat/0502339].

[6] M. Caselle, M. Hasenbusch & M. Panero: Comparing the Nambu-Goto string with LGT results. *JHEP* **03** (2005) 026, [arXiv:heplat/0501027].

[7] B.P. Dolan: Quantum Black Holes: the event horizon as a fuzzy sphere. *JHEP* **02** (2005) 008 [arXiv: hepth/0409299].

[8] T. Tsukioka &Y. Watabiki: Quantization of Neveu-Schwarz-Ramond superstring model in 10+2-dimensional spacetime. *Int. J. Mod. Phys.* **A20** (2005) 5807.

[9] F. Laytimi & W. Nahm: A vanishing theorem. *Nagoya Math. J.* **180** (2005) 35-43.

2.2 Papers in Conference Proceedings

[10] T. C. Dorlas & R. F. O'Connell: Quantum Zeno and anti-Zeno effects: an exact model. *Proceedings of SPIE (The International Society for Optical Engineering),* **5436** (2004) 194.

[11] F. Garcia Flores, Denjoe O'Connor & X. Martin: Simulating the scalar field on the fuzzy sphere. *Proceedings of Science* LAT2005 (2005) 262, [heplat/0601012].

[12] J. Medina, W. Bietenholz, F. Hofheinz & Denjoe O'Connor: Field theory simulations on a fuzzy sphere – an alternative to the lattice. *Proceedings of Science* **LAT2005** (2005) 263, [heplat/0509162].

[13] M. Billó, M. Caselle, M. Hasenbusch & M. Panero: QCD string from D0 branes. *Proceedings of Science* **LAT2005** (2005) 309, [arXiv:heplat/0511008].

[14] M. Panero: Studying glueball masses in non-Abelian LGT with the LW algorithm. *Proceedings of Science* **LAT2005** (2005) 294, [arXiv:heplat/0509006].

[15] M. Panero: A numerical study of a confined Q anti-Q system in compact U(1) lattice gauge theory in 4D. *Nucl. Phys. Proc. Suppl.* **140**, 665 (2005),[arXiv:hep-lat/0408002].

2.3 Preprints

DIAS-STP-

[05-01] M. Caselle, M. Hasenbusch & M. Panero: Comparing the Nambu-Goto string with LGT results.

[05-02] F. Gliozzi, S. Lottini, M. Panero & A. Rago: Random percolation as a gauge theory.

[05-03] A.P. Balachandran, K.S. Gupta & S. Kürkçüoǧlu: Waves on non-commutative spacetimes.

[05-04] M. Panero: A numerical study of confinement in compact QED.

[05-05] T.C. Dorlas, P.A. Martin & J.V. Pulé: Long cycles in a perturbed mean-field model of a Boson gas.

[05-06] B. Dolan: N=2 Supersymmetric Yang-Mills and the quantum Hall effect.

[05-07] B. Dolan: Meromorphic scaling flow of N = 2 supersymmetric *SU*(2) Yang-Mills with matter.

[05-08] T.C. Dorlas & V.B. Priezzhev: Finite-time current probabilities in the asymmetric exclusion process on a ring.

[05-09] M. Panero: Studying glueball masses in non-abelian LGT with the LW algorithm.

[05-10] M. Billo, M. Caselle, M. Hasenbusch & M. Panero: QCD string form D0 branes.

[05-11] M. Caselle, M. Hasenbusch & M. Panero: On the effective string spectrum of the tridimensional Z_2 gauge model.

[05-12] A.P. Balachandran, S. Kürkçüoğlu & S. Vaidya: Lectures on fuzzy and fuzzy SUSY physics.

[05-13] S. Adams, J.B. Bru & W. König: Large systems of path-repellent Brownian motions in a trap at positive temperature.

[05-14] M. Leitner: Zero-field Hall effect in (2 + 1)-dimensional QED.

3 Programme of Scholarly Events

3.1 Lectures Organised by The School

- C.G. Callan Jr. (Princeton) *Topics in theoretical biology*. 16 May

- S. Fredenhagen (ETH, Zurich) *D-branes in CFT backgrounds*. 12 July

- O. Lisovyy (Université Angers, France) *Correlations in the 2-D Ising model on a finite lattice*. 12 July

- M. Shaposhnikov (EPFL, Lausanne) *Brane worlds and the strong CP problem*. 21 June

- T. Strobl (University Jena, Germany) *General p-form gauge theories: physics and mathematics*. 12 July

3.1.1 Seminars Organised by The Theoretical Particle Physics Group

- O. Andreev (Landau Institute for Theoretical Physics, Moscow) *Regge behaviour in gauge/gravity duality*. 14 April

- A. Chakrabarti (EP, Palaiseau, France) *Aspects of new classes of braid matrices for higher dimensions*. 10 November

- K. Gawedzki (ENS, Lyon, France) *Turbulent transport and integrable chaos*. 8 December

- T.R. Govindarajan (Institute for Mathematical Sciences, Chennai, India) *Non-commutative spacetime and unitary quantum physics*. 21 October

- T. Ichinose (Kanazawa University, Japan) *On path integral for the radial Dirac equation*. 12 October

- M.K.H. Kiessling (Rutgers University, Piscataway, USA) *Quest for an alternate QED: the Born legacy*. 7 July

- G. Landi (Universita di Trieste, Italy) *Non-commutative instantons on non-commutative spheres*. 7 April

- E. Langmann (Royal Institute of Technology, Stockholm, Sweden) *Non-commutative field theories and exactly solvable systems*. 1 December

- O. Lechtenfeld (University Hannover, Germany) *Time-space non-commutative solitons*. 29 September

- V.P. Nair (City College of the CUNY, New York) *Twistors, gluons and gravitons*. 2 December

- A. Perelomov (Institute for Theoretical and Experimental Physics, Moscow) *The systems of Calogero-Sutherland type and their generalizations*. 27 October

- M.I. Polikarpov (ITEP, Moscow) *Numerical study of QCD with dynamical fermions on the lattice*. 13 January

- M.I. Polikarpov (ITEP, Moscow) *Confinement problem from the lattice point of view*. 14 January

- R. Poghossian (Yerevan Physics Institute, Armenia) *Instantons in N=2 super Yang-Mills theory*. 21 April

- B. Sathiapalan (Institute for Mathematical Sciences, Chennai, India) *Loop variables: a proposal for a background independent formulation of string theory.* 17 November

- K. Takenaga (Osaka University, Japan) *Higgs scalars in gauge-Higgs unification.* 19 May

- S. Vaidya (Indian Institute of Science, Bangalore, India) *Lorentz-invariant non-commutative QFT.* 24 October

- J.C. Varilly (Universidad de Costa Rica, San Jose, Costa Rica) *A matrix representation of the combinatorics of renormalization.* 24 November

- D.V. Vassilevich (Max-Planck-Institut, Leipzig & St. Petersburg State University, Russia) *Heat kernel expansion in non-commutative theories (On hearing the shape of a non-commutative drum).* 28 April

- J. Verbaarschot (SUNY, Stony Brook, USA) *Random matrices, QCD and Toda lattices.* 3 November

3.2 Symposia, Conferences, Workshops Organised

The **Annual O'Raifeartaigh Lectures** in honour of the late Professor Lochlainn O'Raifeartaigh were inaugurated at the Irish Quantum Field Theory (IQFT) Meeting in Trinity College Dublin on 20 May.

The lectures sponsored by DIAS and delivered by leading specialists will form part of the Annual IQFT Meeting.

The **DIAS Summer Lecture Series** in conjunction with Trinity College Dublin was held from 13 to 17 June. The speaker was Prof. P. Brosnan (SUNY Buffalo) who talked on *Motives, periods and Zeta functions.*

J.T. Lewis Memorial Conference. A conference, organised by CNRI and the Institute to honour the memory of the late J.T. Lewis, his contributions to mathematics and its applications was held from 14-17 June in the Dublin Institute of Technology.

The following talks were presented:

- David Applebaum (University of Sheffield) *Infinite-dimensional Ornstein-Uhlenbeck processes with jumps.*

- Emmanuel Buffet (Dublin City University) *Parrondo's phenomenon.*

- Jennifer Chayes (Microsoft Research, Redmond) *Phase transitions in computer science.*

- Nilanjana Datta (University of Cambridge) *Compression of data from quantum information sources.*

- Aernout van Enter (University of Groningen) *First-order transitions in classical vector models.*

- David Evans (Cardiff University) *Modular invariants and operator algebras.*

- George W. Ford (University of Michigan) *Quantum distribution functions.*

- Christopher Fuchs (Bell Labs.) *Minimal maximally-quantum alphabets.*

- Ayalvadi Ganesh (Microsoft Research, Cambridge) *Thresholds for the contact process on finite graphs.*

- Robin Hudson (Nottingham Trent University) *A net of infinitesimal rotations and its second quantisation.*

- Arthur Jaffe (Harvard University) *On the unreasonable effectiveness of physics in mathematics.*

- Frank Kelly (University of Cambridge) *Stability, routing and congestion control.*

- Christopher King (Northeastern University) *Noise correction for quantum systems in a friendly environment.*

- Hans Maassen (Catholic University of Nijmegen) *Purification of quantum trajectories and dark subspaces.*

- Vadim Malyshev (INRIA) *Problems in mathematical statistical chemistry.*

- Taku Matsui (Kyushu University) *BEC and NESS.*

- Derek McAuley (Intel Research, Cambridge)
  How I learned to love large deviations.

- Cathleen Morawetz (New York University)
  Some conservation laws and their consequences.

- Bruno Nachtergaele (University of California)
  What's new in quantum spin systems?

- Robert O'Connell (Louisiana State University)
  Do the laws of thermodynamics hold in the quantum regime?

- Neil O'Connell (University College Cork)
  Littelmann paths and Brownian paths.

- Eugene Pechersky (Russian Academy of Sciences)
  The car traffic and a single server queuing system.

- Charles-Edouard Pfister (EPF Lausanne)
  From thermodynamics to statistical mechanics. A large deviations approach to classical lattice systems.

- Vyatcheslav Priezzhev (JINR, Dubna)
  Asymmetric exclusion process: exact solutions and perspectives.

- Anatolii Puhalskii (University of Colorado at Denver)
  Queues and random graphs.

- Joe Pulé (University College Dublin)
  Long cycles in a perturbed mean field model of a Boson gas.

- John Rawnsley (University of Warwick)
  Homomorphisms of deformation quantisation.

- Mary Beth Ruskai (Tufts University)
  The complementary role of POVM's and ensembles in the capacity of quantum channels.

- Raymond Russell (Corvil)
  Measuring entropy: from statistical mechanics to IP certainty.

- Geoffrey Sewell (University of London)
  Can the quantum measurement problem be resolved within a standard Schroedinger dynamical framework?

- Robert Shorten (National University of Ireland, Maynooth)
  A story of rational functions of a complex variable, stability theory of differential equations with discontinuous right hand side, and a meeting with John Lewis.

- Wolodymyr Skrypnik (NAS of Ukraine)
  Quantum systems with exact ground states and associated random dynamics.

- Yuri Suhov (University of Cambridge)
  Anderson localisation for multi-particle lattice sytems.

- Aubrey Truman (University of Wales, Swansea)
  Real complex turbulence for Burgers equation.

- Andre Verbeure (Catholic University Leuven)
  On Bose condensation.

- Nikita Vvedenskaya (Russian Academy of Sciences)
  Dynamic routing and large deviations.

- Wilhelm von Waldenfels (University of Heidelberg)
  The Hamiltonian of the damped oscillator.

- Stephen Wills (University College Cork)
  On the construction of quantum stochastic processes.

- Andreas Winter (University of Bristol)
  Quantum information can be negative.

- Damon Wischik (University of London)
  The calculus of Hurstiness.

- Marc Yor (University of Paris)
  Back to Wiener integrals.

- Valentin Zagrebnov (University of Marseille)
  Superradiant Bose-Einstein condensation.

In April the Institute and the Hamilton Mathematics Institute, Trinity College Dublin, jointly established a distinguished lecture series in honour of the late professor J.T. Lewis. The first John T. Lewis Lectures were delivered by Professor J. Fröhlich, E.T.H. Zurich as follows :

- *Thermodynamics and statistical mechanics* 21 November

- *Bose gases and boson stars* 21 November

- *CFT, TFT and others* 23 November

- *Theory of atoms and molecules coupled to the quantized radiation field* 25 November

The **Winter Symposium** was held on 14th and 15th December. Lectures were given as follows:

- A. Fitzgibbon (Microsoft Research, Cambridge)
  Computer graphics and computer vision: Holywood's new double act.

- O. Lisovyy
  Isomonodromic deformations and holonomic quantum fields.

- T. Dorlas
  Quantum coding.

- N. Ray (University of Manchester)
  Iterated projective bundles.

- M. Leitner
  Graphene and the relativistic Quantum Hall effect.

- T. Futamase (University of Tohoku)
  Weak lensing study of a cluster mass profile, using the Subaru telescope, and its implications for the CDM structure formation scenario.

- D. Wraith (NUI Maynooth)
  Stable bundles with positive Ricci curvature.

- A. Beardon (University of Cambridge)
  Groups of conformal maps.

Statutory Public Lecture

The Statutory Public lecture was delivered by Professor Ph. A. Martin (L'Ecole Polytechnique Fédérale de Lausanne) on *Bose-Einstein Condensation: A Journey to Ultracold Matter*, 3 March in University College Dublin, Belfield.

4 Presentations at Conferences or Seminars

4.1 Talks and Papers Presented

W. Nahm:

- Talk "How good is the Bethe ansatz in integrable QFT?" at Department of Mathematics, University of Glasgow 24 January.

- Talk "Mirror symmetry for cohomology with values in vector bundles" at London Mathematical Society Durham Symposium on Geometry, Conformal Field Theory and String Theory, 22nd July - 1st August.

D. O'Connor:

- Talk "Supersymmetric models in the fuzzy approach", Humboldt University, Berlin, 3 May.

S. Adams:

- Talk "Large deviation principles for systems of Brownian motions under symmetrised distributions" at Workshop Interacting Random Processes – Satellite of the International Symposium of Mathematical Science at University of Leipzig, Germany, 30 September - 6 October.

S. Kürkçüoğlu:

- Talk "Recent developments on non-commutative diffeomorhisms and gravity" at Non-commutative Geometry and Quantum Physics Meeting, Chennai India, 14 July - 4 August.

- Talk "Waves on non-commutative spacetimes" at 12th Irish Quantum Field Theory Meeting, Trinity College Dublin, 20-21 May.

- "Waves on non-commutative spacetimes", Poster presentation at IRCSET National Symposium, Croke Park, Dublin, 3 November.

M. Leitner:

- Talk "Zero field (Quantum) Hall effect and spontaneous edge currents "at 12th Irish Quantum Field Theory Meeting, Trinity College Dublin, 20-21 May.

S. Murray:

- Informal presentation "Representation theory of the Lie supergroups $Osp(4,1)$ and $SU(2,1)$" at International Workshop on Fuzzy Physics and Non-commutative Geometry, CINVESTAV, Mexico City, 1-30 June.

S. Ni Chiagain:

- Poster on "Algebraic K-theory and partition functions in conformal field theory", at IRCSET symposium, Croke Park, Dublin, 3 November.

- Poster on "Algebraic K-theory and partition functions in conformal field theory" at Symposium, "Geometry, Conformal Field Theory and String Theory", Durham, 22 July - 1 August.

M. Panero:

- Invited talk "Numerical simulations on the fuzzy sphere", at Non-commutative Geometry and Quantum Physics workshop, Institute of Mathematical Sciences (Chennai, India), 18 July 2005.

- Poster contribution "Studying glueball masses in non-Abelian LGT with the LW algorithm", at Lattice 2005, XXIII International Symposium on Lattice Field Theory, Trinity College Dublin, 26 July.

- Invited talk "Confinement and string effects in Abelian LGT", at Tours University, France, 6 October.

- Invited talk "Effective string predictions and numerical results in the confining regime of Abelian LGT" at Humboldt University, Berlin, 8 November.

T. Tsukioka:

- Talk "Bosonic String and Superstring Models in 26+2 and 10+2-dimensional Spacetime", at Rudjer Boskovic Institute, Zagreb, Croatia, 13 May.

5 Collaboration with the Wider Research Community

5.1 National

Lecture Courses and Workshops

T.C. Dorlas:

- Course for undergraduates on *Quantum Spin Systems* for students from TCD and UCD (Academic year 2004-2005).

- Course for undergraduates on *Quantum Computing and Information* (Academic year 2005-2006).

- Co-organised the John T. Lewis Memorial Conference in D.I.T., 14-17 June 2005.

- The Winter Symposium was organised in collaboration with the IMS, on 15-16 December.

S. Adams:

- A series of seven talks on "Brownian motion, Large deviation techniques for topological vector spaces and symmetrised system of continuous time random walks" were delivered during the year.

M. Panero:

- Work has been carried out in collaboration with Dr. B.P. Dolan from N.U.I. Maynooth.

Staff Acting as External Supervisors

W. Nahm:

- Supervised minor theses of Patrick Connell and Donough Regan (both UCD). Both theses concerned Conformal Quantum Field Theory in Two Dimensions.

Denjoe O'Connor

- Ph.D. supervisor for R. Delgadillo Blando, J. Medina, F. Garcia and I. Huet. (Cinvestav, Mexico).

Staff Acting as External Examiners

Denjoe O'Connor:

- External Examiner for Ph.D. of Vivien De Beaucé, Trinity College Dublin.

- External Examiner for M.Sc. of Neil Butler, Dublin Institute of Technology.

Research Associates

- AT&T: N. Duffield

- DCU: E. Buffet, J. Burzlaff, E. O'Riordan, E. Prodanov

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

- Intern. Centre For Theoretical Physics, Trieste: J. Chela-Flores

- IT, Carlow: D. O Sé

- IT, Tallaght: N. Gorman

- Ludwig-maximiliansuniversit ät München: I. Sachs

- Meteorological Service: P. Lynch

- NUI, Cork: N. O'Connell, M. Vandyck

- NUI, Galway: J. Burns, M.J. Conneely, M.P. Tuite

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

- Open University: A.I. Solomon

- Oxford University: R.G. Flood

- TCD: P.S. Florides, J. Miller, S. Sen, S. Shatashvili, D. Weaire

- Universiteit Leiden: F. Freire

- UCD: A. Ottewill, J.V. Pulé, W. Sullivan, P. Watts

- UL: S. O'Brien

- Unaffiliated: G.M. O'Brien, D. Ó Mathuna

5.2 International

M. Panero:

Work has been carried out in collaboration with Prof. A. P. Balachandran from Syracuse University (Syracuse, USA), Prof. W. Bietenholz from Humboldt University (Berlin, Germany), Dr. M. Billó from Turin University (Turin, Italy), Prof. M. Caselle from Turin University (Turin, Italy), Prof. F. Gliozzi from Turin University (Turin, Italy), Prof. T. R. Govindarajan from the Institute of Mathematical Sciences (Chennai, India), Dr. M. Hasenbusch from Pisa University (Pisa, Italy), Dipl. Phys. S. Lottini from Turin University (Turin, Italy), Dr. X. Martin from Tours University (Tours, France), Dr. A. Rago from Milan University (Milan, Italy) and Dipl. Phys. J. Volkholz from Humboldt University (Berlin, Germany).

Visiting Researchers

Short visits (up to one week):

- A.P. Balachandran (Syracuse, N.Y.) 13-20 March

- J.-B. Bru (Johannes Gutenberg University, Germany) 24-30 July

- C. Callan (Princeton University) 16 May

- N. Datta (University of Cambridge) 8-11 May

- H. Eberle (University of Bonn) 18-25 February

- D. Evans (Cardiff University) 31 January - 4 February

- J. Fröhlich (ETH, Zurich) 19-26 November

- M. Fukuda (Cambridge) 14-18 June

- K. Gawedzki (ENS-Lyon, France) 8-10 December

- J. Guven (Univ. Nac. Autonoma de Mexico) 20-23 January

- T. Ichinose (CIRM, Marseille & Japan) 8-13 October

- G. Landi (Trieste, Italy) 6-9 April

- E. Langmann (KTH, Sweden) 29 November - 2 December

- O. Lechtenfeld (Hannover University) 26 September - 1 October

- Ph. A. Martin (L'Ecole Polytechnique Fed. de Lausanne) 28 February - 4 March

- V.P. Nair (CUNY, New York) 29 November - 3 December

- R. Poghossian (Yerevan Physics Institute, Armenia) 13-15 April

- M. Polikarpov (Inst. Theor. & Exper. Physics, Moscow) 12-15 January

- P. Presnajder (Bratislava, Slovakia) 16-26 March

- B. Sathiapalan (Institute of Mathematical Sciences, Chennai, India) 15-19 November

- Y. Suhov (University of Cambridge) 18-25 April

- Y. Suhov (University of Cambridge) 8-11 May

- K. Takenaga (Osaka, Japan) 16-22 May

- S. Vaidya (Indian Institute of Science, Bangalore) 18-25 October

- J. Varilly (University of Costa Rica) 23-29 November

- J. Volkholz (Berlin) 11-17 December

- J. Verbaarschot (Stony Brook, USA) 2-6 November

Long visits:

- P. Brosnan (SUNY Buffalo & UBC Canada) 12-21 June

- A. Chakrabarti (Ecole Polytechnique, Palaiseau, France) 9-23 November

- D.E. Evans (Cardiff University) 12-23 September

- J. Fjelstad (Cardiff University) 12-23 September

- G.W. Ford (Michigan University) 27 May - 4 July

- T. Futamase (Tohoku University, Japan) 13-21 December

- T.R. Govindarajan (Chennai, India) 23 August - 12 December

- Bo-Yu Hou (Northwest University, Xi'an, P.R. China) 22 October - 23 December

- M. Kiessling (Rutgers University) 1-15 July

- J. Medina Garcia (Cinvestav, Mexico) 27 April - 7 May

- J. Medina Garcia (Cinvestav, Mexico) 24 July - 8 August

- F. Laytimi (University of Lille) 8-19 January

- X. Martin (University of Tours) 10-21 March

- X. Martin (University of Tours) 26 October - 5 November

- X. Martin (University of Tours) 15-23 December

- P. Miranda (Mexico) 7-17 July

- R.F. O'Connell (Louisiana State University) 3 June - 31 July

- A. Perelomov (Bonn, Germany) 29 September - 29 November

- A. Povolotsky (Dubna) 5-14 December

- J. Santiago (Mexico) 7-17 July

- W. Skrypnik (Kiev, Ukraine) 5-19 June

- Y. Suhov (University of Cambridge) 19 March - 5 April

- P. Teotonio Sobrinho (Sao Paulo, Brazil) 12-20 March

- P. Castro Villarreal (Cinvestav, Mexico) 14 April - 1 September

- V. Zagrebnov (Marseille, France) 5-17 May

Research Visits by School Staff

T.C. Dorlas:

- Research visit to Centre de Physique Théorique, Marseille, 18-23 July.

- Research visit to Statistical Laboratory, University of Cambridge, 4-9 December.

W. Nahm:

- Research visit to Glasgow University, 24-25 January.

- Research visit to Lille University, 3-9 April.

- Research visit and Conference attendance, Lille University, 3-22 May.

- Research visit to Lille University, 29 May - 5 June.

Denjoe O'Connor:

- Research visit to CINVESTAV, Mexico and Ph. D. defence of Pavel Castro-Villarreal, 25 January - 5 March.

- Research visit to Berlin, 3-4 May.

- Research visit to University of Tours, France, 29 November - 2 December.

S. Adams:

- Research visit to Warwick University 3-25 January.

- Combined Research visit to University of Leipzig, University of Erlangen and University of Munich 2-22 February.

- Combined Research visit and conference attendance at the Max Planck Institute Leipzig and the University of Mainz 5 May - 21 June.

- Research visit to Prague and Leipzig 23 June - 5 July.

- Research visit to University of Leipzig (Germany) and Erwin Schrödinger Institute Vienna (Austria). Started the Habilitation at University of Leipzig. 10-19 September.

- Research visit to Charles University, Prague, 18-29 November.

- Research visit to Prague and Leipzig 2-16 December.

F. Garcia Flores:

- Research visit to University F. Rabelais, Tours, France, 6-28 February.

- Research visit to University of Tours, France, 28 November - 2 December.

S. Kürkçüoğlu:

- Research visit to Middle East Technical University, Ankara, Turkey. 16-24 August 2005.

M. Leitner:

- Research visit to Technical University, Berlin, 16-21 March.

- Research visit and Conference attendance, Lille University, 3-22 May.

M. Panero:

- Research visit to Tours University, Tours, France, 28 September - 10 October.

- Research visit to Humboldt University, Berlin, 7-14 November.

T. Tsukioka:

- Research visit to Rudjer Boskovic Institute, Zagreb, Croatia, 11-18 May.

6 Participation in Outside Committees

W. Nahm:

One of the organisers of the *XXIII International Conference of Differential Geometric Methods* in Theoretical Physics, Tianjin, China, 20-26 August. The conference had been suggested by Prof. Chern (the father of the Chern classes), but unfortunately he passed away at the beginning of the year.

S. Kürkçüoğlu:

Member of the organising committee for the *International Workshop on Fuzzy Physics and Non-commutative Geometry* held at Cinvestav Mexico City, 1-30 June.

7 Attendance at External Conferences, Workshops, Meetings and Lectures

7.1 Conferences/Workshops/Scientific Meetings Attended

T.C. Dorlas:

- Conference in memory of Prof. John T. Lewis, Dublin Institute of Technology, 14-17 June.

W. Nahm:

- LMS Durham Symposium, 23-28 July.

- XXIII International Conference "Differential Geometric Methods in Theoretical Physics", 18-29 August.

Denjoe O'Connor:

- "Fuzzy Physics and Non-Commutative Geometry" Workshop, CINVESTAV (Mexico City, Mexico), 1 June - 4 July.

- XII Irish Quantum Field Theory Meeting 2005, Trinity College Dublin, 20-21 May.

- "XXIII International Symposium on Lattice Field Theory", Trinity College Dublin, 25-30 July.

- "Renormalization Group 2005" Conference, Helsinki University, 29 August - 1 September.

S. Adams:

- DFG Conference, Research Center, Berlin, 4-8 April.

- EUROMATH Conference, Prague, 2-10 September.

- "Workshop on Random Interfaces and Directed Polymers" Max Planck Institute in Leipzig, Germany 11-19 September.

- Workshop "Interacting Random Processes" – Satellite of the International Symposium of Mathematical Science, University of Leipzig, Germany, 30 September - 6 October.

- Workshop "Bose-Einstein Condensation and Quantum Information" Erwin Schrödinger Institute, Vienna, Austria 17-21 December.

R. Delgadillo-Blando:

- XII Irish Quantum Field Theory Meeting 2005, Trinity College Dublin, 20-21 May.

F. Garcia Flores:

- "Fuzzy Physics and Non-Commutative Geometry" Workshop, CINVESTAV, Mexico, 30 May - 29 June.

- "XXIII International Symposium on Lattice Field Theory", Trinity College Dublin, 25-30 July.

S. Kürkçüoğlu:

- "Fuzzy Physics and Non-Commutative Geometry" Workshop, CINVESTAV, Mexico, 30 May - 29 June.

- Non-commutative Geometry and Quantum Physics Meeting, Chennai India, 14 July - 4 August.

- IRCSET National Research Symposium, Dublin, 3 November.

M. Leitner:

- "Journées de Geometrie Algebrique" Conference, Lille, France, 20-21 May.

S. Murray:

- XII Irish Quantum Field Theory Meeting 2005, Trinity College, Dublin, 20-21 May.

- "Fuzzy Physics and Non-Commutative Geometry" Workshop, CINVESTAV, Mexico City, 4 June - 4 July.

- Annual Theory Meeting, Grey College, Durham, 19-21 December.

S. Ní Chiagain:

- London Mathematical Society Symposium "Geometry, Conformal Field Theory and String Theory", Durham, 22 July - 1 August.

M. Panero:

■ XII Irish Quantum Field Theory Meeting 2005, Trinity College Dublin, 20-21 May.

■ J. T. Lewis Memorial Conference, Dublin Institute of Technology, 14-17 June.

■ "Fuzzy Physics and Non-Commutative Geometry" Workshop, CINVESTAV (Mexico City, Mexico), 23 June - 2 July.

■ "Non-commutative Geometry and Quantum Physics" Workshop, Institute of Mathematical Sciences (Chennai, India), 12-24 July.

■ "Lattice 2005", XXIII International Symposium on Lattice Field Theory, Trinity College Dublin 25-30 July.

■ "Lattice Field Theory Workshop", Turin University (Turin, Italy), 2-9 December.

T. Tsukioka:

■ "Lattice 2005", XXIII International Symposium on Lattice Field Theory (Lattice 2005), Trinity College Dublin, 25-30 July.

■ Corfu Summer Institute on Elementary Particle Physics (CORFU 2005), Corfu, Greece, 21-26 September.

7.2 Lectures and Organisational Meetings Attended

T.C. Dorlas:

■ Meeting with the Scientific Advisor to the Government, Dr. Barry McSweeney, 18 April.

■ Instruction meeting on PMDS, 1 September.

■ Meetings with the Scientific Advisor to the Government, Dr. Barry McSweeney, and the Director of SFI, Dr. William Harris, 7 September.

■ Workshop organised by IRCSET on "Developing Graduate Schools in Ireland", Tuesday 27th September.

■ Statutory Public Lecture of the School of Cosmic Physics, 30 September.

■ Series of lectures by Prof. Jürg Fröhlich (Zürich), 21, 23, 25 November.

S. Kürkçüoğlu:

■ Attended John T. Lewis Lectures by Professor J. Fröhlich, 21-25 November.

M. Panero:

■ Motives, Periods and Zeta Functions by Prof. P. Brosna, University of British Columbia, Vancouver, Canada, 13-17 June.

■ John T. Lewis Lectures by Prof. J. Fröhlich, ETH, Zurich, Switzerland, 21-25 November.

8 Research Grants/ External Funds Secured

T.C. Dorlas:

■ In collaboration with K. Duffy and B. Goldsmith, €50,000 was obtained from SFI for organising the John Lewis Memorial Conference, 14-17 June.

Denjoe O'Connor:

Ongoing:

■ Embark Initative Postdoctoral Fellowships were awarded to Subrata Bal and David Garcia Alvarez.

■ 2003-2006: Basic Research Grant from Enterprise Ireland for €189,000

■ 2004-2006: An Embark Initative Postdoctoral Fellowship to Seçkin Kürkçüoğlu funded by IRCSET for a period of three years with effect from 1 October.

■ Ulysses Research Visits to France (for 2005) €2,580.

■ 2002-2006: subnode of EU Research Training Network €33,000.

■ A grant for research into high performance computing in Germany was obtained in conjunction with M. Panero and W. Bietenholz.

9 Honours/Awards/
Special Achievements Received

T.C. Dorlas:

■ Reappointed as Honorary Professor in the Department of Mathematics at the University of Wales Swansea (from March 2005).

S. Kürkçüoğlu:

■ Recipient of the 2005 Doctoral Dissertation Prize of Syracuse University, Syracuse, NY, USA.

10 Public Awareness Activities

10.1 Public Lectures

W. Nahm:

■ Talk "Integrable systems, 19th and 21st century" at symposium on 'The legacy of William Rowan Hamilton: Symplectic and Contact Geometry and Hamiltonian Systems', 29 September - 1 October.

10.2 Contribution to the Media

T.C. Dorlas:

■ Wrote a reply to the OECD report on Research in Ireland.

■ Article for the "Irish Scientist Year Book 2005" entitled *Quantum secrecy, quantum clarity.*