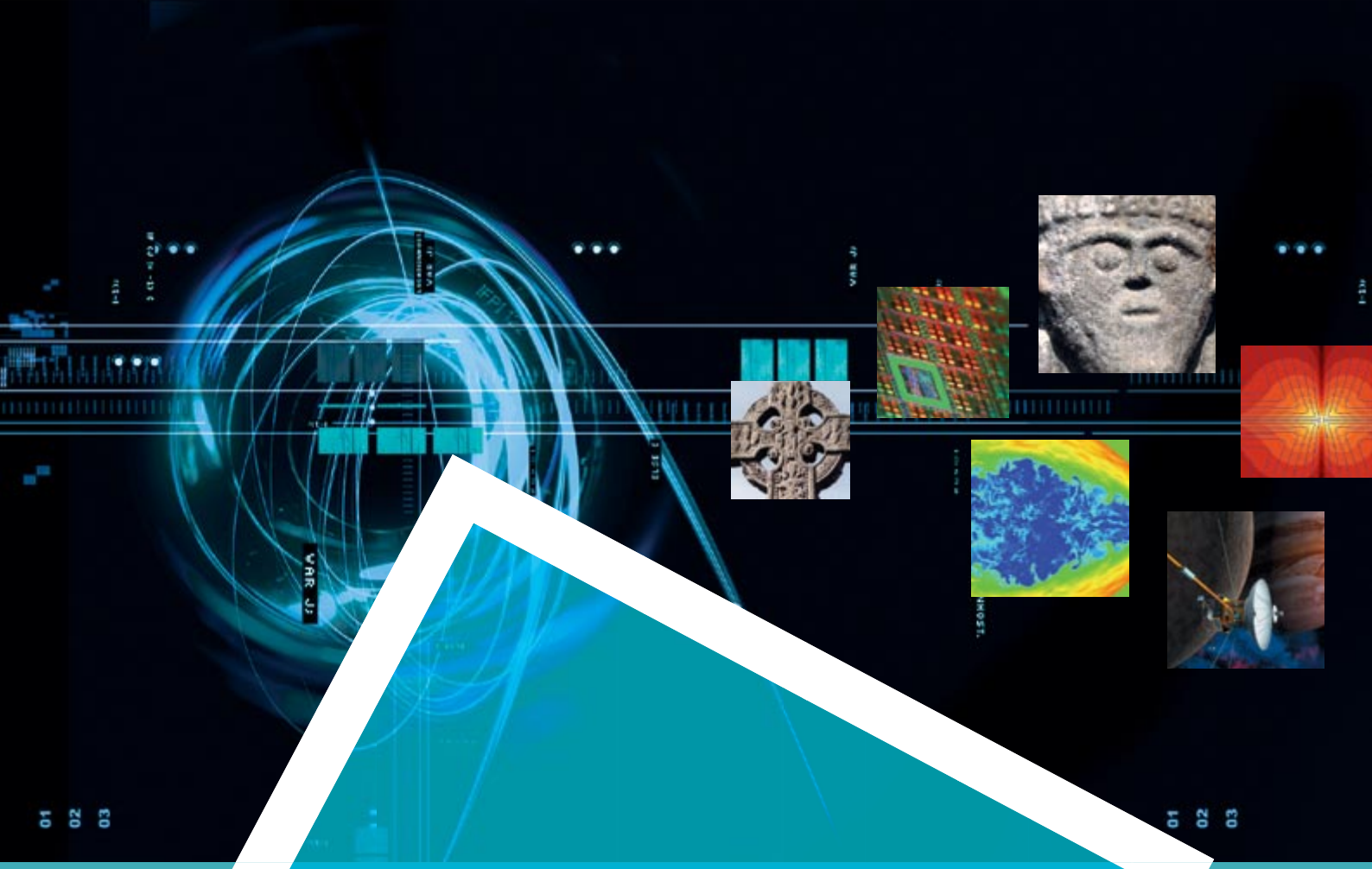


Dublin Institute for Advanced Studies

Institiúid Ard-Léinn Bhaile Átha Cliath

RESEARCH REPORT **2004**

Contents

School of Celtic Studies

School of Cosmic Physics – Astronomy and Astrophysics

School of Cosmic Physics – Geophysics

School of Theoretical Physics

School of Celtic Studies

1 Research Work

Annual report of the Governing Board of the School of Celtic Studies for the year ending 31 December 2004 adopted at its meeting of …….

Foireann agus Scoláirí/ Staff and Scholars

Ollúna Sinsearacha/Senior Professors: Liam Breatnach (Director), Fergus Kelly, Máirtín Ó Murchú

Ollúna/Professors: Malachy McKenna, Pádraig Ó Macháin

Ollúna Cúnta/Assistant Professors: Aoibheann Nic Dhonnchadha, Siobhán Ní Laoire (Academic Librarian), Roibeard Ó Maolalaigh (Bibliographer), Michelle O Riordan (Publications Officer)

Cúntóir Taighde/Research Assistant: Brian Ó Curnáin

Scoláirí/Scholars: Margo Griffin-Wilson, (to 30 October) Jenifer Ní Ghrádaigh, Clare Downham, (to 30 October) Nicholas Evans, Eoghan Ó Raghallaigh (from 1 October)

Leabharlannaithe Cúnta/Assistant Librarians: Andrew Clinch (to March) Charlotte Dillon (from April), Grace Toland (part-time)

Riarthóir Scoile/School Administrator: Eibhlín Nic Dhonncha

Foireann Theicniúil/Technical Staff: ISOS: Colin Dunn (to April), Anne Marie O'Brien, IT support: Andrew McCarthy (part-time), Gavin McCullagh (part-time)

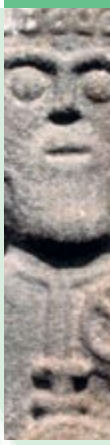
1.1 Taighde/Research

Taighde ar chanúintí/Dialect studies

Brian Ó Curnáin worked on a monograph of the Irish of Galway and Connaught, and carried out field-work in central Connemara, the Joyce Country and East Galway. He also continued work on *The Irish of Iorras Aithneach, Co. Galway*, which included the completion of a recording of sample speakers with transcriptions for a CD to accompany the book. He continued work on a monograph of the Irish of the parishes of An Caisleán Gearr and Baile Chláir. He also continued the video recording of children in Connemara between the ages of one and four years who have a command of the Irish language. 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 preparation of two publications – *The Irish of Rann na Feirste: phonetics* and *Seanchas Rann na Feirste*. He has completed the phonetic transcription of a number of folk-tales for the volume of *The Irish of Rann na Feirste: phonetics* and has continued work on the description of the consonant system and on historical developments in the phonetics of the dialect. Copies of the manuscript of the publication *Seanchas Rann na Feirste* have been sent to two readers and work has begun on implementing changes which were suggested by the readers. A concordance of the material in the book was created and converted into an index to the text. The recordings which are to accompany the book were digitised and copied to CDs. A number of field trips were made to Rann na Feirste to research specific details of the phonetics and grammar of the dialect. Máirtín Ó Murchú continued work on the Gaelic of West Perthshire.

Teangeolaíocht stairiúil, etc./Historical linguistics, etc.

Proinsias MacCana worked on features of Irish and Welsh syntax.



Roibeard Ó Maolalaigh continued his work on a book-length study of the Historical Vowel Phonology of Gaelic.

Eagráin de théacsanna/Textual editions

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

Visiting Professor Mark Scowcroft continued his work on an edition of the second recension of Lebor Gabála Éirenn.

Pádraig Ó Macháin continued work on the Osborn J. Bergin papers. Research scholar Margo Griffin-Wilson continued work on her edition of *The wedding poems of Dáibhí Ó Bruadair* and has prepared a complete bibliography. The edition has been submitted and read by Professor Pádraig Ó Macháin and the manuscript will be submitted to the publications committee in due course.

Taighde ar an stair/Historical studies

Research scholar Clare Downham continued her research towards her projected two-volume publication on the history of the royal Viking dynasty of Dublin. This is intended to supersede the last comprehensive account of this dynasty by Charles Haliday, *The Scandinavian Kingdom of Dublin*, second edition (Dublin 1884). She also published five articles during the year. Research scholar Jenifer Ní Ghrádaigh continued her research on 'The Irish Romanesque: patronage and pilgrimage issues', in Clonmacnoise as well as analysing the foreign influences (especially from Scandinavia) apparent in Irish architecture of the time. Other research included work on antiquarianism related to the above issues. Research scholar Nicholas Evans undertook research on the sources for entries about Britain in the Irish annals, A.D. 660-800. This has been written up as an article and hopefully will be published in the Journal of Celtic Studies. He also did research on how contemporary chronicles were kept and how news spread in medieval Ireland and Scotland. Research scholar Eoghan Ó Raghallaigh worked on the forthcoming corpus of bardic poetry for the HEA-funded Irish-Scottish Academic Initiative. He also continued his research on editions of poems from the Nugent Manuscript. Daniel McCarthy of the Department of Computer Science, Trinity College Dublin, carried out research for his forthcoming book on the development of the Irish annals. Michelle O Riordan worked on her book *Ruling the margins: the polity of the poet in a bardic world*. In late 2004 she Beta-tested the CDROM of Corpus na Gaeilge, *1600 – 1882: The Irish Language Corpus for the Royal Irish Academy*.

Dlíthe na mBreithiún/Early Irish legal studies

Gerald Manning (Research Scholar 1999-2002) continued his seminar at the Institute on the law-text *Míadshlechtae*, and completed two further sections of this text. Liam Breatnach continued his seminar on the law-text *Córus Bésgnai*. His *Companion to the Corpus Iuris Hibernici* was sent to readers and final corrections and additions were made.

Clárú lámhscríbhinní/Cataloguing of manuscripts

Pádraig Ó Macháin continued work on producing a definitive catalogue of the papers of Osborn J. Bergin held in the Archive of the School of Celtic Studies. Aoibheann Nic Dhonnchadha continued work on the first fasciculus (twenty-eight medical manuscripts) of the *Catalogue of Irish manuscripts in Trinity College Dublin*. This will be available in book form in 2005. Ten draft descriptions from this *Catalogue* are already available on-line as part of the ISOS project.

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

Work continued on this project under the direction of Pádraig Ó Macháin.

On 29th June Professor Ó Macháin attended by invitation the International Digitisation Conference in Dublin Castle. This conference was organised as part of Ireland's Presidency of the European Union.

An innovation this year was the organisation and hosting by ISOS of the 'Digital Image, Digital Text' colloquium which took place at the Institute on 4th December.

A total of twelve papers were read, covering such subjects as digital storage, digital mark-up, word-matching, and reviews of current projects. The papers attracted an average attendance of sixty people, drawn from the scholarly, scientific and archival communities.

The following is a list of speakers and papers:

John Byrne: 'The 1872 online catalogue of Trinity College, Dublin'.

Ronan Cunniffe and Andrew McCarthy: 'The long-term storage of digital material'.

Colin Dunn: 'The interface of text and image'

Beatrix Faerber and Julianne Nyham: 'New avenues for CELT: linking text and dictionaries'.

Anthony Harvey: 'The Dictionary of Medieval Latin from Celtic Sources'.

Annette Kelly: 'Co-ordination of digitisation in Europe'.

Damian McManus: 'The Irish-Scottish Academic Initiative: Bardic Poetry'.

Noel O'Connor and Alan Smeaton: 'Word matching using single closed contours'.

Pádraig Ó Macháin: 'Irish Script on Screen'.

Gregory Toner: 'The electronic Dictionary of the Irish Language'.

See also Part 1 of the Annual Report.

1.3 Tionscnamh Bibleagrafaíochta/ Bibliography project

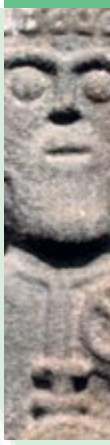
Roibeard Ó Maolalaigh continued work on the *Bibliography of Irish Linguistics and Literature Project*, including ongoing development of the new database. He edited and supervised digitisation of *Bibliography of Irish Linguistics and Literature 1942-72*: this digitisation was completed and launched in November on CD format and website (http://bill.celt.dias.ie/vol3/).

Margo Griffin-Wilson assisted in proofreading on the *Bibliography of Irish Linguistics and Literature 1942-72: E-Bill*.

1.4 Eagarthóireacht/Editing

Fergus Kelly: co-editor, *Celtica* 25; editorial work on Arndt Wigger, *Caint Ros Muc* I and II (published in June), and on Alexander Falileyev, *Welsh Walter of Henley* (due for publication in 2005).

Malachy McKenna: co-editor, *Celtica* 25; returned corrected proofs of two articles of *Celtica* 25 to Professor Eric Hamp along with substantial amount of new hand-written material for inclusion in one of the articles. Due to the complex nature of this new material incorporating it into the original article was very time consuming. *Celtica* 25 is due for publication in 2006.



Liam Breatnach: co-editor, *Ériu* 54.

Proinsias Mac Cana: co-editor, *Ériu* 54.

Siobhán Ní Laoire advised on a phonetic pronunciation guide for the award-winning children's book *Chingles from the east* by Patricia Murphy, Poolbeg 2004.

Aoibheann Nic Dhonnchadha: comh-eagarthóir, *An Linn Bhuí: Iris Ghaeltacht na nDéise* imleabhar 8.

Brian Ó Curnáin: editorial work with Roibeard Ó Maolalaigh on E-Bill: *Electronic Bibliography (1986) Bibliography of Irish Linguistics and Literature 1942-71*, compiled by Rolf Baumgarten. Edited and proof-read various articles by Roibeard Ó Maolalaigh. Refereed an article by David Sankoff, William Labov, and Anthony Kroch for the publication *Language Variation and Change*.

Pádraig Ó Macháin: comh-eagarthóir, *An Linn Bhuí: Iris Ghaeltacht na nDéise* imleabhar 8; Founded and edited *Ossory, Laois and Leinster* Volume 1.

Roibeard Ó Maolalaigh: editorial work on *The wedding poems of Dáibhí Ó Bruadair* (Margo Griffin-Wilson).

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. Computerised editing for publication and type-setting was directed by Michelle O Riordan. The following were published in 2004:

Arndt Wigger, *Caint Ros Muc Imleabhar I: Téacs*, 2 pláta + léarscáil + xxx + 406 pp.

ISBN 1 85500 193 4. *Imleabhar II: Foclóir v* + 566 pp. ISBN 1 85500 194 2.

Rolf Baumgarten (compiled) Roibeard Ó Maolalaigh (edited) *Electronic Bibliography of Irish Linguistics and Literature* 1942 – 71. CD. ISBN 1 85500 189 6.

Athchlónna/Reprints

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

Lambert McKenna, S.J. *The Book of O'Hara: Leabhar Í Eadhra* (1951, repr. 1980). Catalogue F3.8.

Cecile O'Rahilly, *Táin Bó Cúailnge: recension I* (1976). Catalogue F 2.13.

A.G. Van Hamel, *Immrama* (1941). Catalogue F 5.10.

Liam Price, *The place-names of Co. Wicklow Vol. IV The barony of Shillelagh* (1958 repr. 1975). Catalogue E 5.1.6.

Ludwig Bieler, *The Patrician texts in the Book of Armagh* (1979). Catalogue J 2.10

Seán Mac Airt and Gearóid Mac Niocaill, *The Annals of Ulster* (to A.D. 1131) (1983). Catalogue G.9.

Cecile O'Rahilly, *Táin Bó Cúailnge from the Book of Leinster* (1967 repr. 1984). Catalogue F 2.11.

Séamus Ó hInnse, *Miscellaneous Irish annals* (A.D. 1114 – 1437) (1947 repr. 2001). Catalogue G 4.

Rudolf Thurneysen, *Scéla mucce Meic Dathó* (1935, repr. 1986). Catalogue F 5.6.

1.6 Díolachán leabhar/ Sale of books

The classified and annotated catalogue of the School of Celtic Studies publications was updated and distributed and also inserted on the Web Site (www.celt.dias.ie).

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.

The number of books sold during 2004 was 3,800. The comparable figures for the preceding years were 6,333 for 2003, 4,090 for 2002, and 6,213 for 2001.

1.7 Foilseacháin/Publications

Liam Breatnach: *A Companion to the Corpus Iuris Hibernici* (forthcoming). 'On satire and the poet's circuit', in *Unity in Diversity. Studies in Irish and Scottish Gaelic Language, Literature and History*, ed. Cathal G. Ó Háinle and Donald Meek (Dublin 2004) 25-35.

Clare Downham: 'The Vikings in Southern Ui Neill to 1014', *Peritia* 17-18 (2004) 233-55. 'Eric Bloodaxe – axed? The mystery of the last Scandinavian King of York', *Mediaeval Scandinavia* 14 (2004) 51-77. 'The good, the bad, and the ugly – portrayals of Vikings in the Fragmentary Annals of Ireland', in *The Medieval Chronicle* III, ed. Erik Kooper (Amsterdam, 2004) 27-39. 'The historical importance of Viking-Age Waterford', *The Journal of Celtic Studies 4* (2004) 71-96. 'The career of Cearbhall of Osraighe', *Ossory, Laois and Leinster* 1 (2004) 1-18.

Margo Griffin-Wilson: 'Mythical and Local Landscapes in Dáibhí Ó Bruadair's wedding *crosántacht "Iomdha sgéimh ar chur na cluana"* submitted for possible publication in *Celtica*. 'Bedding and Blessing in Toirdhealbhach Ó Conchobhair's Wedding Poem *"Slán ma do phósadh"*', submitted for publication in *Éigse.*

Fergus Kelly: 'Thinking in threes: the triad in early Irish literature', *Proceedings of the British Academy* 125 (December 2004) 1-18, 'Giolla na Naomh mac Duinnshléibhe Mheic Aodhagáin', in *Royal Irish Academy Dictionary of Irish Biography* (forthcoming), 'Ireland's use of native woodland in medieval times', in *Proceedings of Ireland's Native Woodland Conference*, 8-11 September (forthcoming).

Proinsias Mac Cana: 'Ireland and Wales in the Middle Ages: an overview', in the proceedings of the Ireland and Wales Conference, Lampeter, ed. Jonathan M. Wooding. 'Praise-poetry in Ireland before the Normans', *Ériu* 54 (forthcoming).

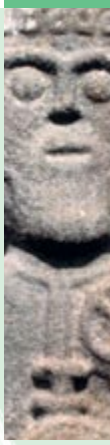
Jenifer Ní Ghrádaigh: "'But what exactly did she give?': Derbforgaill and the Nuns' Church at Clonmacnoise", in *Clonmacnoise Studies* Vol. 2, ed. Heather A. King, (Dublin 2004), 175-207.

Siobhán Ní Laoire: '*Celtica*', in Frank Sewell and Alan Titley (ed.) *The history of the Irish book. Vol. 2: The printed book in Irish, 1567-2000*, Oxford University Press (forthcoming).

Aoibhheann Nic Dhonnchadha: 'Eagarthóir, téacs agus lámhscríbhinní: Winifred Wulff agus an Rosa Anglica' in Ruairí Ó hUiginn (eag.) *Oidhreacht na lámhscríbhinní:* Léachtaí Cholm Cille xxxiv (Maigh Nuad 2004) 105-147.

'Téacs ó scoil leighis Achaidh Mhic Airt', *Ossory, Laois and Leinster* 1 (2004) 50-75.

Pádraig Ó Macháin: "A llebraib imdaib": cleachtadh agus pátrúnacht an léinn, agus déanamh na lámhscríbhinní', Ruairí Ó hUiginn (eag.), Oidhreacht na lámhscríbhinní Léachtaí Cholm Cille 34 (Maigh Nuad 2004) 148-78. 'David Rothe's attestation in favour of William Brennan', *Ossory, Laois and Leinster* 1 (2004) 202-3. 'Filíocht Athairneach II' *An Linn Bhuí* 8 (2004)



165-75. 'Dhá théacs dlí', in John Carey et al. (ed.) *Cín Chille Cúile: texts, saints and places: essays in honour of Pádraig Ó Riain* (Aberystwyth 2004) 309-15. *Six years in Galmoy: rural unrest in County Kilkenny* 1819-1824 (Dublin 2004).

Roibeard Ó Maolalaigh: *Electronic Bibliography of Irish Linguistics and Literature 1942-71* (editor) CD format and web (http://bill.celt.dias.ie/vol3/). Transliterations of 11 Scottish Gaelic texts in *The Collections of Rudolf Trebitsch; Celtic Recordings – Ireland, Wales, Brittany, Isle of Man, and Scotland (1907-09)*, book and 3 CDs, ed. by Gerda Lechleitner and Ulla Remmer ([Wien]: Verlag der Österreichischen Akademie der Wissenschaften, 2004), 71-79. Completed book-length: *'An Author – Short-Title Index of 'Bibliography of Irish Linguistics and Literature 1942-71*. Review of *Rannsachadh na Gàidhlig 2000: Papers Read at the Conference "Scottish Gaelic Studies 2000", University of Aberdeen 2-4 August 2000 (2002)*, ed. by Colm Ó Baoill and Nancy R. McGuire, in *Zeitschrift für celtische Philologie* 54, 210-19.

Michelle O Riordan: *'Exaggerated reports of the "death of Ireland',* Battle of Kinsale 400th Anniversary commemorative volume, ed. Hiram Morgan (Wicklow 2004) 301-310.

1.8 Leabharlann/Library

Current and retrospective cataloguing continued and records were made available on the Online Public Access Catalogue. Acquisitions continued in subject areas relevant to the research needs of the School. Regular updates on recent accessions and current periodicals were issued and research and bibliographic queries from members of the School and from visitors were dealt with.

1.9 Imeachtaí/Events

Léacht Reachtúil Poiblí/Statutory Public Lecture

This year's Statutory Public Lecture was delivered by Professor Tomás Ó Cathasaigh of the Department of Celtic Languages and Literatures, Harvard University. The title of the lecture was 'The body in *Táin Bó Cúailnge*'. It was delivered as part of Tionól 2004, in University College, Dublin on Friday 19th November to a large audience.

Léachtaí eile/Other Lectures

Tionól/Annual Symposium 2004

The School's annual conference, Tionól 2004, was organised by Professor Pádraig Ó Macháin, assisted by Eibhlín Nic Dhonncha, and took place on 19 and 20th November. Over the two days, total of sixteen papers were delivered by scholars representing twelve institutions and drawn from three continents.

The attendance at the Tionól averaged ninety to one hundred people per session. This was an increase on previous years, and is an index to the growth in popularity of the Tionól as an important event on the scholarly calendar.

The following is a list of speakers and papers:

Jacqueline Borsje (University of Utrecht):
'Fear personified: *úatha* in early Irish texts'.

Caoimhín Breatnach (NUI, Dublin): 'The transmission of the Rawlinson B 502 version of *Sex Aetates Mundi* and a poem on the Convention of Druimm Cete'.

Liam Breatnach (School of Celtic Studies): 'A tale of poets'.

Marion Deane (University of Ulster): 'Birth of Cú Chulainn – birth of culture'.

Roy Flechner (Oxford University): 'On some 'local' sources of the *Hibernensis*'.

Patricia Kelly (NUI, Dublin): 'The monastery of Tallaght': some new evidence'.

Dan McCarthy (Trinity College): 'the identity and contribution of hand H2 to TCD 1282 (AU)'

Jim McCloskey (University of California, Santa Cruz): 'Comhréir an chlásail neamhfhinidigh i gcanúintí Gaeilge na Mumhan'.

Neil McLeod (Murdoch University, Australia): 'Liability and causation in Brehon Law: Bretha Étgid'.

Muireann Ní Bhrolcháin (NUI, Maynooth): 'Gormlaith – who were they?'

Máire Nic Mhaoláin (An Gúm): 'Dornán iasachtaí sa Ghaeilge'.

Meidhbhín Ní Úrdail (NUI, Dublin) 'The eighteenth-century Annals of Inisfallen'.

Brian Ó Curnáin (School of Celtic Studies): 'Gaeilge Pharráiste an Chaisleáin Gheairr'.

Paul Russell (Cambridge University): 'The accessory in Irish and Welsh Law'.

Richard Mark Scowcroft (Catholic University, Washington): 'Leabar Gabála Glind da Locha'.

Jürgen Uhlich (Trinity College): 'The registers of Echaid's daughter in *Fingal Rónáin*'.

Seiminéir/Seminars

Gerald Manning: weekly seminar in Spring on the Old Irish law-text entitled *Míadshlechtae* 'rank-sections' (D. A. Binchy, *Corpus Iuris Hibernici* 582.32-589.32).

Liam Breatnach: weekly seminar throughout the year on the Old Irish law-text entitled *Córus Bésgnai* 'the arrangement of customary regulation' (D. A. Binchy, *Corpus Iuris Hibernici* 520.1-536.27), and a weekly seminar in Autumn/Winter on Early Irish verse.

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

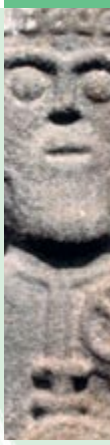
Liam Breatnach: 'An anecdote on satire', A Symposium on Celtic Studies, Uppsala 21-22 May 2004.

Clare Downham: 'The historical importance of Viking-Age Waterford', 18th conference of Irish medievalists, Kilkenny (June). 'Vikings in Leinster before 1014', Hy Kinsella Conference, Borris, Co. Carlow (September).

Nicholas Evans: 'The Irish Annals as Evidence for Medieval Scholarly Activity', Old Irish Department, NUI, Cork (March). 'The Distribution of News in Medieval Ireland; the Evidence of the Irish Chronicles in the Tenth and Eleventh Centuries', Kilkenny Conference of Irish Medievalists (June). 'The Distribution of News in Medieval Ireland and Scotland: the Evidence of the Irish Chronicles in the Tenth and Eleventh Centuries', Medieval Scottish Studies Seminar, University of Glasgow (December).

Margo Griffin-Wilson: 'Mythical and Local Landscapes in Dáibhí Ó Bruadair's wedding crosántacht *"lomdha sgéimh ar chur na cluana"*, Harvard Celtic Colloquium, Harvard University, (October). 'Bedding and Blessing in Toirdhealbhach Ó Conchobhair's Wedding Poem, *"Slán ma do phósadh"*', Harvard University: the Barker Humanities Centre and Department for Celtic Languages and Literatures (February).

Fergus Kelly: 'The Old Irish Triads', Inaugural meeting of Trinity College Dublin Old Irish Society (February). 'An introduction to Brehon law', Law Society of Ireland



(June). 'Litigation in Brehon law', Law Society of Ireland (July). 'Early Irish land-law', Law Society of Ireland (July). 'Offences in Brehon law', Law Society of Ireland (July). 'Brehon law in modern times', Law Society of Ireland (July). 'Ireland's use of native woodlands in medieval times', Ireland's Native Woodland Conference, Galway-Mayo Institute of Technology, Galway City (September). 'Early Irish (Brehon) law', Hy Kinsella Conference, Borris, Co. Carlow (September).

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

Siobhán Ní Laoire: 'Foinsí don ainilís dioscúrsa sa Ghaeilge chomhaimseartha', Taighde agus Teagasc, St Mary's University College, Belfast (January). 'Radio soap opera as sociolinguistic data', Sociolinguistics Symposium 15, University of Newcastle (April).

Jenifer Ní Ghrádaigh: 'Bréifne Romanesque: evidence for Tigernán Ua Ruairc's architectural patronage?', Dublin Medieval Society (May). 'Fresh evidence from the sketchbooks of James Graves', Irish Medievalists Conference, Kilkenny (June). 'Early Irish Art and Architecture European Romanesque and Gothic', National Gallery of Ireland (December). On-site talks at Dysert O'Dea, Corcomroe and Iniscealtra. Accompanied Dr Niamh Whitfield's Morley Medieval Trip (June).

Brian Ó Curnáin: 'Gaeilge an Chaisleáin Gheairr' Áras Phobail Mhionlaigh, Féile Gaeltachta Mhionlaigh (March). 'Socheolaíocht na Gaeilge', guest speaker at the Fifth Language and Politics Symposium: Taking Stock in the Literature, Sociolinguistics and Legislation of Minority or Regional Languages in Northern Ireland, the Republic of Ireland, and Scotland, Queen's University Belfast (September). 'An clásal coibhneasta in Iorras Aithneach, Co. na Gaillimhe', Teangeolaíocht na Gaeilge 8, Coláiste Phádraig Droim Conrach, Baile Átha Cliath (May). 'Tomás Ó Ceallaigh, Baile an Phoill, An Caisleán Gearr, Cathair na Gaillimhe', Tionól Scoil an Léinn Cheiltigh, Baile Átha Cliath (November).

Pádraig Ó Macháin: 'Nessa Ní Shéaghdha: saol agus saothar', NUI Maynooth, Léachtaí Cholm Cille, (April). 'Early and late: hidden jewels in some Scottish Manuscripts', University of Aberdeen, Testing the Pen Conference (August); 'Irish Script on Screen', Digital Image, Digital Text Conference, DIAS (December).

Roibeard Ó Maolalaigh: 'Cha téid mi a dh'iarraidh iasad suacain is cha toir mi iasad suacain seachad': *s(o)uxr-* na Gaillise agus *suacan* na Gàidhlige', Teangeolaíocht na Gaeilge 8, Coláiste Phádraig, Druim Conrach, Baile Átha Cliath (May). 'The Mock Elegy "Ab an Aonaigh": A Scottish Composition?', Rannsachadh na Gàidhlig 3, University of Edinburgh, (July). 'The History and Contribution to Celtic Scholarship of the School of Celtic Studies, Dublin Institute for Advanced Studies', Postgraduate Day Conference, National University of Ireland, Maynooth.

1.11 Cúrsaí in ollscoileanna Éireannacha/Courses in Irish universities

Nicholas Evans: tutor for the first-year Medieval History course in the National University of Ireland, Dublin.

Fergus Kelly: course on 'Early Irish (Brehon) law', Hilary and Trinity terms '04, School of Irish, Trinity College, Dublin.

Malachy McKenna: two courses (i) Donegal Irish (with special emphasis on the Irish of Rann na Feirste), (ii) the phonetics of Irish, Scoil na Gaeilge, Coláiste na Tríonóide, Baile Átha Cliath.

Siobhán Ní Laoire: One module for students on Level 3 NCVA diploma course for Stiúrthóirí Naíonraí: 'Pleanáil teanga' (Jan – May).

Michelle O Riordan: Taught a twelve week course NG234 – 'Caoineadh Art Uí Laoghaire' Roinn na Nua-Ghaeilge, Ollscoil na hÉireann, Gaillimh.

1.12 Scrúdaitheoireacht sheachtrach, 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 (including one PhD thesis, one MLitt thesis and one MA thesis); external examiner, School of Irish, Trinity College Dublin (PhD thesis); member of external quality review panel of the Department of Early and Medieval Irish, National University of Ireland Cork (11-14 January).

Malachy McKenna: external examiner of PhD thesis: Ciarán Mac Murchaidh, *Seanmóirí Uí Ghallchóir: téacs agus cúlra,* NUI Maynooth.

Siobhán Ní Laoire: external examiner or the NCVA diploma course module on Sociolinguistics for Irish Language preschool leaders (Stiúrthóirí Naíonraí).

Roibeard Ó Maolalaigh: external examiner for undergraduate and postgraduate Degree courses at the Department of Celtic, University of Glasgow; external examiner (undergraduate and postgraduate) Celtic Department, Queen's University, Belfast; External examiner for the Dr. H.H. Stewart Scholarship and Prizes in Irish, National University of Ireland.

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

Suíomh gréasáin/Website of the School of Celtic Studies

For developments on the School's website (www.celt.dias.ie), managed by Professor Pádraig Ó Macháin and by Andrew McCarthy, see Part 1.

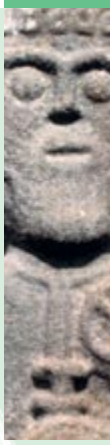
Teilifís agus raidió/Television and radio

Siobhán Ní Laoire contributed on aspects of repertoire, transmission, style and competition in traditional singing to several episodes of the series 'The Raw Bar' (Hummingbird production for RTÉ television).

Pádraig Ó Macháin took part in various interviews throughout the year on Raidió Teilifís Éireann and Raidió na Gaeltachta. Also radio interviews on KCLM and Midlands 103 radio stations. Performed launch of *Laois Heritage Society Journal*, Volume 2, at Stradbally Hall.

A lecture by Brian Ó Curnáin, 'Gaeilge an Chaisleáin Ghearr', at which Mr Tomás Ó Ceallaigh, the last remaining Irish speaker from Baile an Phoill, Caisleán Gearr, Co. na Gaillimhe, was the guest speaker, was recorded by Raidió na Gaeltachta. He also took part in a recording by Nuacht RTÉ (radio) on Tomás Ó Ceallaigh on the occasion of the annual Tionól. He did various interviews for Raidio Teilifís Éireann and Raidio na Gaeltachta on Arndt Wigger's publication *Caint Ros Muc*.

Roibeard Ó Maolalaigh took part in a BBC television recording on Gaelic Song. He also contributed to an RTÉ radio programme on aspects of Celtic Studies. He was also the Presiding Officer at *Pàrlamaid nan Oileanach/Gaelic Youth Parliament*, Armagh 14-16 March, organised by Ioimairt Cholm Cille.



Michelle O'Riordan assisted with background material for a radio programme on Bardic Poetry by request of Jo Howard, assistant producer, RTÉ Cork.

1.14 Coistí seachtracha/Outside committees

Proinsias Mac Cana: chairman of the Editorial Board of the Royal Irish Academy *Dictionary of Medieval Latin from Celtic Sources*; ball de Choiste Náisiúnta Léann na Gaeilge (Acadamh Ríoga na hÉireann); Chairman, Editorial Board of the Royal Irish Academy Dictionary of Irish Biography; member, Publications Committee, Royal Irish Academy; member of the Academia Europaea; honorary foreign member, American Academy of Arts and Sciences; honorary foreign member, Gustavus Adolphus Academy, Uppsala; member, Board of Management, Centre Culturel Irlandais, Paris.

Fergus Kelly: elected member of the Royal Irish Academy.

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

Siobhán Ní Laoire: member of the organising committee of Sociolinguistics Symposium 16.

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

Brian Ó Curnáin: ball de Choiste do thogra Gaeilge Oirthear na Gaillimhe (Roinn na Nua-Ghaeilge, Ollscoil na hÉireann, Gaillimh).

Pádraig Ó Macháin: member of Diocese of Ossory, William Carrigan Commemoration Committee.

1.15 Cuairteoirí agus Comhaltaí/ Visitors and Associates

Ollúna Cuairte/Visiting Professors

Professor Thomas Charles-Edwards (University of Oxford) worked on his forthcoming edition of *Bretha Comaithchesa* 'judgements of neighbourhood' for the Early Irish Law Series.

Professor Eric Hamp (University of Chicago) worked on linguistic articles for the School journal *Celtica.*

Professor Mark Scowcroft (Catholic University of America) worked on his forthcoming edition of *Lebar Gabála* 'the Book of Invasions'.

Professor Nancy Stenson (University of Minnesota, USA).

Professor Arndt Wigger (University of Wuppertal) worked on his forthcoming two-volume *Caint Ros Muc.*

Dr Jonathan M. Wooding (University of Wales, Lampeter) worked on a new Annotated Bibliography for the reprint of A. G. Van Hamel, *Immrama,* Catalogue F. 5.10.

Dr Thomas O'Loughlin (University of Wales, Lampeter) carried out editorial work on Díaz y Díaz, *De ordine creaturarum* (ed. Marina Smith).

Professor Brynley Roberts, former Director of the National lLibrary of Wales, worked on the forthcoming publication *Breuddwyd Maxen Wledig* for the Medieval and Modern Welsh series.

Professor Niall McLeod (Murdoch University, Australia) carried out research on Early Irish law.

Comhpháirtithe Taighde/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 Cambridge (1989).

Professor D. Ellis Evans, University of Oxford (1990).

Professor William Gillies, University of Edinburgh (1989).

Professor Geraint Gruffydd, Centre for Advanced Welsh and Celtic Studies, Aberystwyth (1989).

Professor Eric P. Hamp, University of Chicago (1989).

Anthony Harvey, Royal Irish Academy (2004).

Professor Michael Lapidge, University of Cambridge (1988).

Professor Donald MacAulay, University of Glasgow (1989).

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

Dr Jacqueline Borsje (University of Utrecht, The Netherlands).

Dr Lisabeth Buchelt (Boston College, USA).

Dr Melita Cataldi (University of Turin, Italy).

Dr Johan Corthals, (University of Hamburg).

Piero De Gennaro (Turin, Italy).

Pia Dewar (University of Aberdeen).

Amy Eichhorn-Mulligan (University of Oxford).

Professor Markku Filppula (University of Joensuu. Finland).

Professor William Gillies (University of Edinburgh).

Kicki Ingridsdotter (University of Uppsala, Sweden).

Professor Catherine McKenna (City University of New York).

Bronagh Ní Chonaill (University of Glasgow).

Professor Tomás Ó Cathasaigh (Harvard University, USA).

Dr Ingrid Sperber (University of Uppsala).

Dr David Stifter (University of Vienna, Austria).

Dr Mary Valante (Appalachian State University, USA).

Marcela Vondrová (The Czech Republic).

Mark Zumbuhl (University of Glasgow).

Professor emeritus

Proinsias Mac Cana (Died 21 May 2004)

School of Cosmic Physics – Astronomy and Astrophysics

1 Research Work

1.1 Astronomy

1.1.1 Gamma Ray Burst Afterglows

E.J.A. Meurs, B. Jordan, M. Smyth, P. Ward, L. Norci, and R. Cunniffe (DIAS-STP) with B. McBreen (UCD) and F. Zerbi (Brera Observatory, Milan)

In a collaboration led by Brera Observatory (Milan-Merate, Italy), Dunsink Observatory participated in placing an automatic telescope, the REM (Rapid Eye Mount), at ESO in Chile that primarily will search for afterglows of Gamma Ray Bursts. The instrument features an electronic camera controller, for a Near-Infrared Camera, that was supplied by Dunsink Observatory.

Commissioning of the REM Telescope continued, which involved also replacing a troublesome cryogenic pump. Subsequently, REM contributed its first observational results to the GCN Bulletins.

The REM Telescope has now been following several Gamma Ray Bursts, mostly on triggers by the INTEGRAL satellite. After its successful launch in October 2004, the Swift satellite has been providing very regular triggers and the procedures for efficient collaboration of REM with the Swift triggers are being sorted out at the moment.

After attending a REM training meeting for a week in Brera Astronomical Observatory in Merate, Milan, a Dunsink Scholar (P. Ward) took on responsibilities for telescope operations for typically one in six weeks. The responsibilities include managing the night observing schedule (including observing a number of standard sources for the purpose of inter-instrument calibration), monitoring the performance of the telescope (weather conditions etc.) and notifying relevant persons in the case of a system error.

The telescope is set up to observe automatically the prepared schedule, except in the case of a GRB alert (by a space borne alert system), in which case the telescope automatically observes the target. Also the on site operating system REMOS will e-mail relevant parties, ourselves included, with a GRB alert announcement.

1.1.2 High-resolution spectroscopy of circumstellar matter surrounding Gamma Ray Bursts

P. Ward and E.J.A. Meurs with F. Fiore (Rome Astronomical Observatory)

High resolution spectroscopy of GRB afterglows has been carried out using the UVES instrument on ESO's VLT. Echelle spectra taken of the afterglow of GRB 021004 have been reduced and analysed using the MIDAS software package with UVES pipeline installed. FITLYMAN is the line fitting program within MIDAS, which was used to fit simultaneously multiple line components to the inputted spectra. Hence column densities were derived for a number of redshift systems within the afterglow, showing the circumburst environment to be a complex kinematic system. Constraints on the ionisation status of the medium could also be made, allowing the conclusion that the GRB went off in a medium dominated by a Wolf-Rayet precursor stellar wind.

The group have been expanding on some recent ideas concerning GRB energetics, in particular beaming, and its potential as a GRB distance estimator. This involves research of distance estimates of GRBs relying on as few observable quantities as possible. The basis of this relies on the concept of beaming, whereby the emission from the GRB is not isotropic but preferentially beamed

within a cone. When a correction for the beaming is applied, the bursts are likely to provide a standard candle that can be used for distance determinations.

Interesting features include a break in the light curve, which occurs at a certain moment t_j when relativistic effects slow down.

Figure 1 shows how a correlation between break time t_j and redshift z are affected by variations in circumburst density n. This correlation could potentially be useful as distance estimator.

1.1.3 Nuclear activity in the Hubble Deep Fields

M. Walpole and E.J.A. Meurs with A. Fernandez-Soto (Valencia)

Photometric redshifts indicate that high redshift galaxies in the Hubble Deep Fields (HDFs) show a distinct lack of very blue and highly luminous galaxies. As these are the characteristics normally expected for galaxies with pronounced nuclear activity, the group have been investigating the level of activity in those galaxies. As a first step in this project, spectral energy distributions for galaxies of several morphological types were used to construct several observable quantities for the HDF galaxies.

1.1.4 Infrared Space Observatory observations of Wolf-Rayet and Starburst galaxies

B. O'Halloran with B. McBreen (UCD), L. Metcalfe (Vilspa) and R. Laureijs (ESTEC)

Wolf-Rayet (WR) galaxies are those galaxies in the integrated spectra of which a broad emission feature at 4686 Angstroms has been detected. This feature has a width (Full Width at Half Maximum) of about 10-20 Angstroms and is a typical signature of WR stars. Though Seyfert galaxies and active galactic nuclei (AGN) generally show a He II emission line, WR galaxies can be distinguished from them by their relatively narrow nebular emission lines. WR galaxies are found exclusively among emission line (EL) starburst galaxies, where the photoionisation of the nebular line is stellar in origin. They exhibit a very blue continuum which is indicative of a large population of young hot massive stars. The broad HeII emission feature is very prominent in the spectra of Galactic and LMC WR stars.

Processing and analysis of Infrared Space Observatory images and spectra of the infrared luminous galaxy Markarian 297 and the starburst galaxy Haro 1 was finalised during the year. A likely remnant of two colliding galaxies, Markarian 297 exhibits widespread strong star formation throughout the system. It is

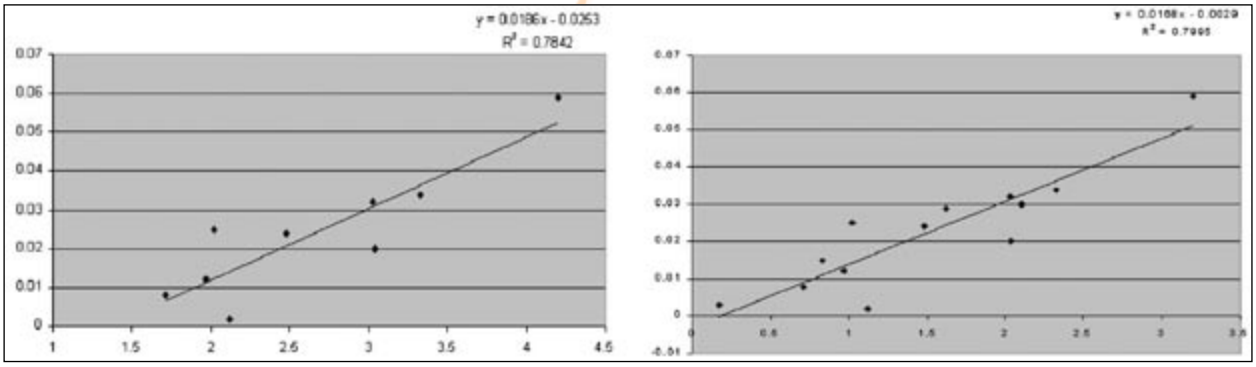


Figure 1: Plots of a function based on t_j against redshift z. The two plots show how varying circumburst density affects the correlation.

expected to develop into a starburst nucleus galaxy and a ring galaxy. In the case of Haro 1, using a combination of ISO and IRAS flux densities, a dust model based on the sum of two modified blackbody components were successfully fitted to the available data. These models were then used to calculate new values for the total Infrared luminosity and the size of the various dust populations. From this it follows that Haro 1 is home to only a compact burst of star formation and that the presence of an active nucleus is not required.

ISO observations of a further four WR galaxies were used to study the star formation activity in these galaxies and to derive dust models. Only one of these four galaxies, NGC 6764, could harbour an active nucleus together with a compact burst of star formation.

1.1.5 Preparation for analysis of WMAP and Planck data

C. del Burgo with J. Tauber (ESTEC)

Software for handling 'Healpix' images was retrieved, for use on analysis of WMAP satellite data. The software is further needed for use on future Planck satellite data. The intention is to investigate the correlation between dust emission and molecular gas.

1.1.6 Dust properties of the TMC-2 molecular cloud

C. del Burgo with R. Laureijs (ESTEC)

ISOPHOT observations have been analysed at 120 and 200 microns of a 31 arcmin x 57 arcmin region, including the Taurus Molecular Cloud TMC-2, with optical extinction ranging between ca. 0.5 and 11 magnitudes. The Far-Infrared emission is separated into the warm and cold components using the ISOPHOT data and IRAS ISSA maps at 60 and 100 microns. This separation is based on the very different morphologies of the 60 and 200 micron emission maps, that are used as spatial templates of the warm and cold components, respectively. The warm component presents an averaged colour temperature of around 19 K and colour temperature variations of few Kelvin across the observed area. The colour temperature map of the cold component is nearly uniform with a mean temperature of 12.5 K. The optical depths at 200 micron of the warm component and cold component were determined. Changes in the optical properties of the dust grains indicate a Far-Infrared emissivity which is a few times greater than that of the diffuse interstellar medium. The optical depth at 200 microns appears to be a powerful tracer of dense cores.

1.1.7 Colliding wind binaries and X-ray emission from the R 136 cluster in the Large Magellanic Cloud

L. Norci, J. Hartwell and E.J.A. Meurs

Using an in-house population synthesis programme the group have simulated the X-ray emission output of a realistic stellar cluster with reference to the giant star forming region R 136 in the Large Magellanic Cloud. A stellar population composed of single stars and binaries was assumed and several prescriptions for the X-ray emission of several categories of object have been adopted. Since the R 136 cluster is a very young cluster with an age between 1-2 Myr, no supernova can yet have occurred and therefore interacting close binaries with a compact companion have not been produced either. In this situation, colliding wind binaries would produce the X-ray sources with the highest luminosities.

In the simulations (Figure 2) it is assumed that the most luminous X-ray sources in R 136 are colliding wind binaries, but that the two most luminous sources observed in the Chandra X-ray data are in fact multiple sources, since there is clear evidence for this for at least one of them.

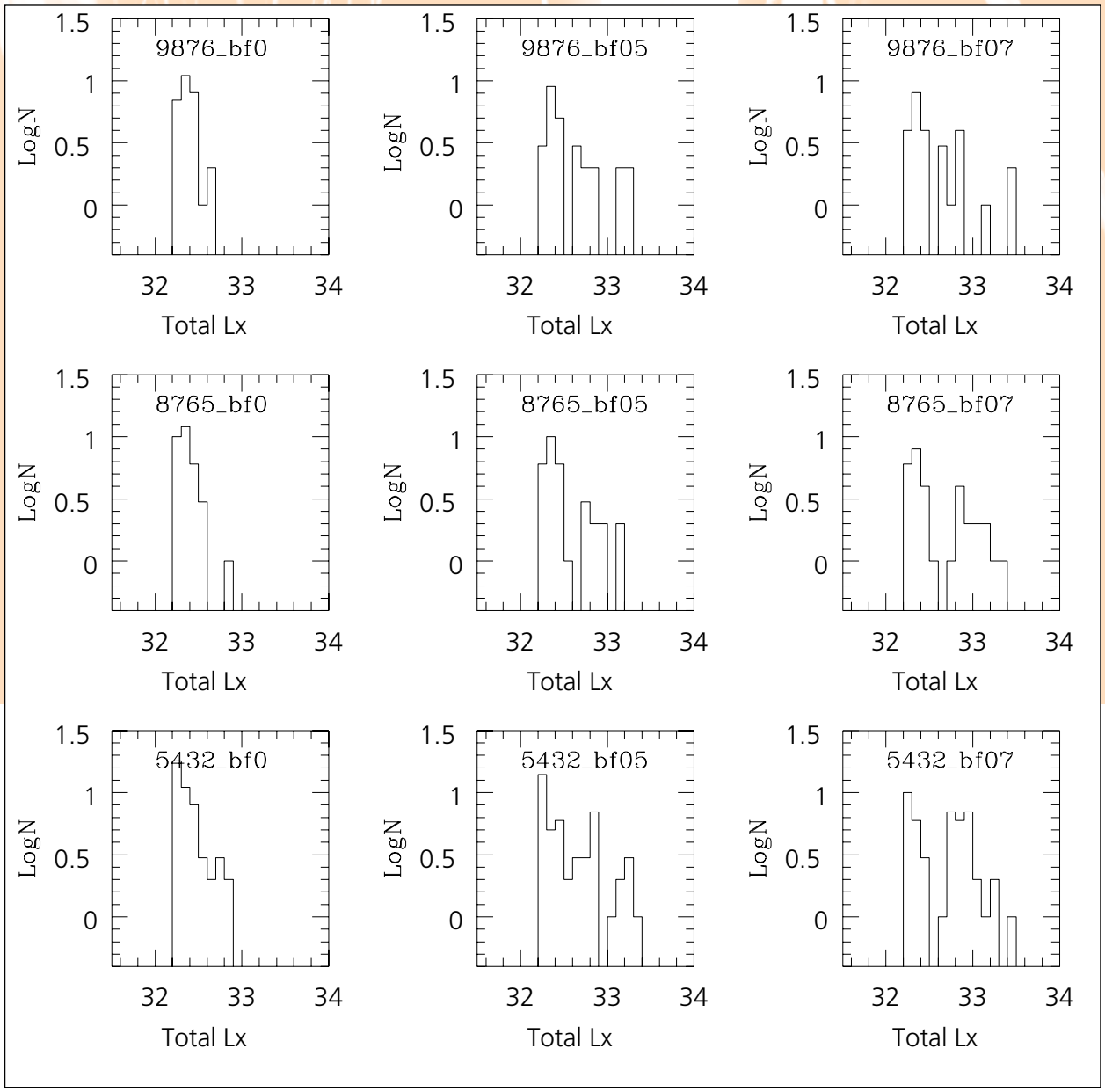


Figure 2: Simulation of the distribution of X-ray luminosities in the range of the observed Chandra sources; results are shown for three different initial mass distributions, including in the bottom row the simulation which is thought to be more representative of the top masses in this cluster. From left to right an increasing number of binaries has been included in the stellar population, respectively binary fractions 0.0, 0.5 and 0.7. The simulations show that a substantial number of binaries must be present if the top of the observed X-ray luminosity distribution is produced by colliding wind binaries.

It is concluded that the luminosity distribution of the remaining Chandra X-ray point sources is accounted for by the simulated population of colliding wind binaries by assuming a very high binary fraction, around 1.0, for the cluster stellar population.

1.1.8 Comparative spectroscopic study of LBVs in M33

L. Norci with V.F. Polcaro, R.F. Viotti (IAS, Rome), R. Gualandi (Loiano Observatory), and C. Rossi (Istituto Astronomico Universitadi Roma)

New spectroscopic observations of four variable stars in the Local Group galaxy M33, together with photometric measurements, were obtained at the Asiago and Loiano observatories. The four stars are so-called S Doradus variables, which belong to the class of Luminous Blue Variables (LBVs), and include Romano's star GR290 that this group have studied already. These stars represent a short-lived, late stage in the evolution of very massive stars. The spectroscopic and photometric variability of these objects may e.g. be caused by a variable dust envelope. The purpose of the new observations is to examine correlations between photometric and spectroscopic quantities that can elucidate the cause of the variations.

1.1.9 Studies of B[e] stars

L. Norci and E.J.A. Meurs with V.F. Polcaro (IAS, Rome), S. Bernabei (Loiano Observatory), A. Miroshnichenko (University of Toledo, USA) and S. McBreen (ESTEC)

A collaboration was started to study B[e] stars. These objects lack certain spectral lines typical of Be stars (B emission line stars) and are surrounded by warm dust. Spectroscopic observations of several of these stars were obtained at the Loiano and McDonald observatories. One of the stars observed is HD 34921, the counterpart of the X-ray source 1H0521+373 (= 4U0515+38), which had been studied by this group already. The spectrum of this star exhibits an HeII emission line that is indicative of an accretion disk and thus points at a collapsed companion that probably is responsible for the X-ray transient associated with HD 34921. This is confirmed by the short term variability of the HeII line.

1.1.10 The origin of runaway stars

C. Melody, L. Norci and E.J.A. Meurs with M. Wilkinson (IoA, Cambridge)

OB runaway stars are young massive stars which have left their parent clusters with high velocities. Runaways are ejected due to gravitational encounters at an early dense phase of the cluster's life; as the cluster expands and evolves this mechanism becomes less effective. At this point an alternative mechanism for producing runaway stars, namely that of a supernova in a binary system which results in the system gaining a high velocity and leaving the cluster, takes over as the more massive stars begin to end their lives, after a few million years, in supernova explosions. In order to investigate fully these two scenarios the group use an N-body code to study cluster dynamics and investigate the details of binary evolution paying particular attention to supernova characteristics such as natal kick velocities.

They have been utilising S. Aarseth's NBODY6 code to explore the cluster ejection mechanisms for runaway production. The reliability of results was assessed by comparing with the simulations of Leonard & Duncan (1988), who assumed the cluster stars to have equal masses and the binaries to have equal binding energies. They determined the number of stars that become unbound from a simulated cluster with characteristic runaway velocities.

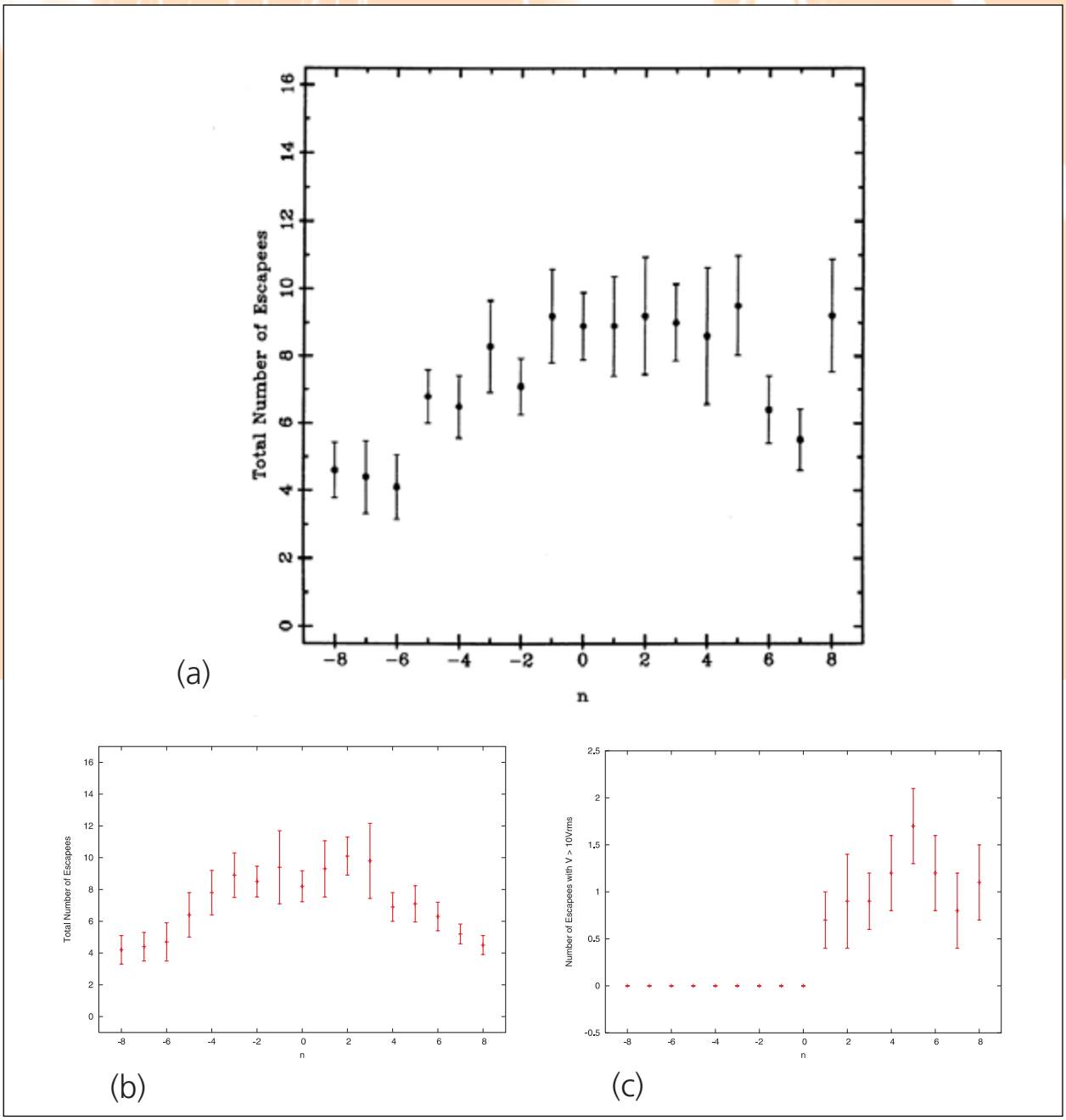


Figure 3: (a) Results from Leonard & Duncan (1988) show the mean total number of escaping systems. (b) & (c) Results from the DIAS simulations. (b): mean total of escaping systems from the N-body clusters after 25 crossing times. These values are shown as a function of n, a quantity defining the binary binding energy. (c): mean number of escaping systems with a velocity ten times that of the initial root mean squared velocity. The error bars are standard errors of the mean.

Figures 3(a) and 3(b,c) show the results of the Leonard & Duncan (1988) and of the present set of simulations respectively. The results obtained are very comparable, although some slight differences are present, which are probably due to the fact that in the version of the code being used by us takes better account of stellar evolution.

This comparison has allowed the group to define a course to improve further on the Leonard & Duncan simulations. In the latter, an arbitrary cut-off velocity for the determination of runaway status is assumed, whereas they intend to determine the type of ejection process, binary-binary interaction, binary-single interaction, single-single interaction etc. and the timescale for these interactions.

They are also making the simulations more realistic by assuming a spectrum of stellar masses and binary binding energies in order to obtain a statistical assessment of the typical number, mass and timescale of runaway ejection.

1.1.11 Detecting compact companions to runaway stars with GAIA

C. Melody, E.J.A. Meurs and L. Norci

In connection with the expectation that runaway stars resulting from a supernova in a binary may be accompanied by the neutron star remnant, the feasibility of detecting neutron star companions to OB runaways using astrometric techniques was considered with reference to the very high accuracies expected for the proposed Gaia astrometric satellite.

For an illustrative sample of classical OB runaway stars, the group examined the capability of the upcoming Gaia satellite to detect compact companions by the use of astrometric techniques. For the OB runaway stars in this sample they estimated initial system parameters and considered the modifying evolutionary effects of mass transfer and supernova explosion of the primary. The possible system configurations that follow from this, and the expected Gaia accuracy, determine the likelihood of detecting a movement of the photo-centre due to an unseen companion. As the size of the natal kick imparted to the core of the exploding star is increased the overall probability of detecting a neutron star companion decreases as more systems become disrupted. The overall detection probabilities for the illustrative sample range from 2% to 27%, which imply that within a distance of approximately 5kpc from the Sun up to 48 detections of compact companions to runaway stars can be expected.

1.1.12 Northern Hemisphere CCD Camera

B.D. Jordan, M. Smyth and E.J.A. Meurs

B. Jordan and N. Smith (C.I.T.) travelled to the Abastumani Observatory, Georgia, in May of this year to finalise the commissioning of the APOGEE CCD camera and filter wheel on the 1.25m telescope. A press release was issued to the local media by the Secretariat of the Georgian Academy Of Science, Tbilisi, to announce the collaboration between the Irish astronomers and the Abastumani Observatory. There was some media interest in the visit and a press conference was held with radio and TV interview at the Georgian Academy of Science in Tbilisi.

Commissioning was somewhat hampered by poor weather conditions but the major problems were identified and resolved. The programme of monitoring of quasars and blazars was undertaken but the camera suffered some damage during an electric storm in July. While being repaired in Dublin, it became apparent that the PCI computer camera interface was particularly

vulnerable to damage from electric surges due to the long cable connection from the camera on the telescope to the computer which is installed in the telescope control room. This problem was corrected by remounting the computer on the telescope in close proximity to the camera head. The camera head is now connected to the computer using a very short cable and a VGA and keyboard extender box was provided in the telescope control room. After the necessary repairs were carried out the equipment was returned to Abastumani. This is a collaboration with B. McBreen (UCD), N. Smith (CIT) and O. Kurtinadze (Georgian Academy of Science).

1.2 Astrophysics

1.2.1 Conservative numerical schemes

L Drury

A novel method of integrating systems of conservation laws was devised in which the solution manifold is evolved in such a way that the conservation is manifest in the discretised scheme. The method has the interesting feature of placing dependent and independent variables on an equal footing and can follow the evolution up to the point of shock formation (and even formally through it) without dissipation. The stability properties look promising, but remain to be investigated.

1.2.2 RXJ1713.7-3946

L Drury and the HESS collaboration

HESS observations of the southern hemisphere supernova remnant RXJ1713.7-3946 revealed for the first time a resolved morphology for a Galactic high-energy gamma-ray source and provided unambiguous evidence for the acceleration of charged particles to energies of at least 10^{14} eV in the shell of this remnant. The observations are in good agreement with the predictions made a decade ago by Drury, Aharonian and Voelk (1994) and were featured in a letter to Nature.

1.2.3 Propagation of Cosmic Rays in the Galaxy

C. Combet, J. Donnelly and L. Drury

Measurements of ultra-heavy cosmic rays at GeV energies help address the question of their source (nucleosynthetic s- and r-processes). Heavy Cosmic Rays (HCRs) detected near the Earth are accelerated from regions that are closer to us on average than those giving rise to light cosmic ray (CR) nuclei. A two zone diffusion model was used to study the impact of the local interstellar medium (under-dense medium encompassing a scale ~ 100 pc) on abundances of propagating primary and secondary stable nuclei. The connection between heavy and light abundances was investigated as far as Fe. A general trend was found of decreasing ultra-heavy cosmic rays (UHCR) abundances relative to HCR ones. This could have an impact on the level of r-processes required to reproduce the data. Further analysis is being carried out to compare the modelled fluxes with those measured by the Ultra-Heavy Cosmic Ray Experiment (UHCRE).

This project was supported by Enterprise Ireland (under the Ulysses Programme) for collaborative work with D. Maurin (CEA, Saclay) and E. Vangioni-Flam (IAP, Paris).

1.2.4 The Earliest Stages of Star Formation

D. Froebrich, T.P. Ray, T. Lery, C. del Burgo and G.C. Murphy

Statistical studies of the very earliest stage of star formation (Class 0) suffer from a paucity of objects. Hence small number statistics is, and probably always

will be, a major problem for such analyses. The project, to assemble a complete catalogue of known Class 0 sources from the literature and to collect all available broad-band photometric data, was continued. About 100 objects were found and in about 60% of cases it was possible to carry out a proper determination of source properties (bolometric temperature and luminosity and envelope mass). It was found that about 25% of the objects are under-luminous compared to the rest, suggesting different mass accretion history. All the collected data were made publicly available (www.dias.ie/protostars) on a web-based catalogue. This catalogue will be updated regularly and included in the planned JETSET database (Froebrich, in collaboration with Lery, Ray, Dudzinski and O'Connell (TCD)). The analysis of the spectral energy distributions of a number of these sources, using radiative transfer calculations, was continued (Froebrich, in collaboration with Rengel (Tautenburg), Hodapp (IfA Hawaii), Wolf (Heidelberg), and Eislöffel (Tautenburg)).

Numerical simulations of star formation are now able to predict the rate at which mass infalls onto protostellar cores. These simulations allow one, in conjunction with an evolutionary scheme, to test whether various models are able to predict observational properties of protostars caught in the act of formation. A Kolmogorov-Smirnov test was applied to compare model and observational distributions for Class 0 protostars. In general rather poor agreement of models with observations was found although a number of arbitrary parameters, in evolutionary models, could be constrained. It was also found 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 25 and 50 thousand years (Froebrich, in collaboration with Schmeja (Potsdam), Klessen (Potsdam) and Smith (Armagh)). The numerical simulations of turbulent clouds can further be used to arrange young embedded clusters into an age sequence (Froebrich, in collaboration with Schmeja (Potsdam) and Klessen (Potsdam)).

Star formation takes place not only in giant molecular clouds but also in small isolated globules. In such places the radiation driven implosion mechanism might be triggering star formation. A number of small globules in the IC1396 region were investigated. Here the globules, and the forming stars therein, are influenced by the radiation of an O-star. A clear dependence of the globule mass from the distance of the O-star was found, as well as a tendency that denser clusters are formed closer to the O-star (Froebrich, in collaboration with Murphy, Scholz (Tautenburg) and Eislöffel (Tautenburg)). A new project was started to investigate the IMF in one of the globules (IC1396W) in detail down to the brown dwarf regime, in order to learn if it differs from the IMF of stars forming in large clouds. Observing time in the NIR and sub-mm was awarded for this project next year (Froebrich, in collaboration with Davis (JAC Hawaii), Scholz (Tautenburg), Hodapp (IfA Hawaii), Smith (Armagh) and Rengel (Tautenburg)).

New born stars are always embedded in clouds of gas and dust. Tracing these dust clouds and their properties not only uncovers possible sites of ongoing star formation but helps to understand fragmentation processes which finally lead to the initial mass function. The determination of dust properties (e.g. extinction, opacity, temperature) will help us understand feedback mechanisms and determine absolute brightnesses of the forming stars. Using the DIAS computational facilities a Galactic Plane Relative Extinction Map was created from 2MASS data, using star counts in a 3.5'x3.5' sized box every 20" and a co-centred 1x1 degree control field (Froebrich, in collaboration with

Murphy, Ray and Scholz (Tautenburg)). Catalogues of all detected globules and star clusters in these maps are in preparation (Froebrich, in collaboration with Ray, Scholz (Tautenburg) and del Burgo). A much more sophisticated method for determining extinction, especially needed for extended clouds and extinction measurements in the optical, is in preparation (Froebrich in collaboration with del Burgo and Jeffery (Armagh)).

1.2.5 Probing the Central Engine of Young Stars

E.T. Whelan and T.P. Ray

In comparison to what is known about the large-scale manifestations of outflows (see below), very little is know about how such outflows are launched. Traditionally probing this region has proved difficult and direct imaging is challenging due to contamination by stellar radiation. Intermediate resolution spectroscopy helps to overcome this problem but the spatial resolutions achievable are not satisfactory as the angular scale of the "engine" is typically a few tens of milliarcseconds for the nearest star forming regions. This is where the technique of spectro-astrometry comes to the fore. Spectro-astrometry simply translates as a measurement of the position of the centroid of a flux distribution as a function of wavelength (hence velocity for a line), producing what is referred to as a "position spectrum". While the width of the profile is determined by the seeing, how accurately one can determine the centroid of the emission is, in theory for fixed seeing, limited only by the strength of the observed signal to noise ratio. Hence spectro-astrometry can provide the observer with spatio-kinematic information on angular scales better than the seeing. Whelan with Ray and Davis (JAC Hawaii) have applied this technique to accurately map the near-infrared Paschen β emission of a number of Classical T Tauri stars. Optical forbidden emission lines are the traditional tracers of outflows close to the source (~ 100AU), yet Paβ forms much closer still thus it can be used to map this region on much smaller spatial scales. Results reveal that Paβ is a strong tracer of high velocity material in jets. HI lines have previously been thought to primarily trace the infall of material onto the central star and the intensity of these lines have therefore been used to predict mass accretion rates. Using spectro-astrometry Whelan et al. were able to disentangle the outflow component within the Paβ line demonstrating that at least part of this line cannot be attributed to accretion. At the same time, it was found that the outflow component does not contributes significantly to the overall line flux. It follows that the original estimates of mass accretion rates, based on Paβ emission, are still reasonably accurate.

A second interesting result from this study is that dust holes were found in the disks of two T Tauri stars, namely V536 Aql and LkHα 321 using their bipolar outflows as probes. In the majority of cases only blue-shifted optical forbidden emission is detected close to the source of many protostellar jets. This is caused by the redshifted emission being hidden by the obscuring effect of the circumstellar disk. However for the two source mentioned above, both blue and redshifted displacements in the permitted Paβ line were measured, while only blue-shifted offsets in the forbidden lines, which form much further out, were seen. It is suggested that inner dust holes in the disks of these sources may result in the redshifted flow being observed through the disk. It is debatable whether these dust holes are caused by coagulation of dust grains to larger size objects in disks or if they are cleared by a newly-formed orbiting planetary body.

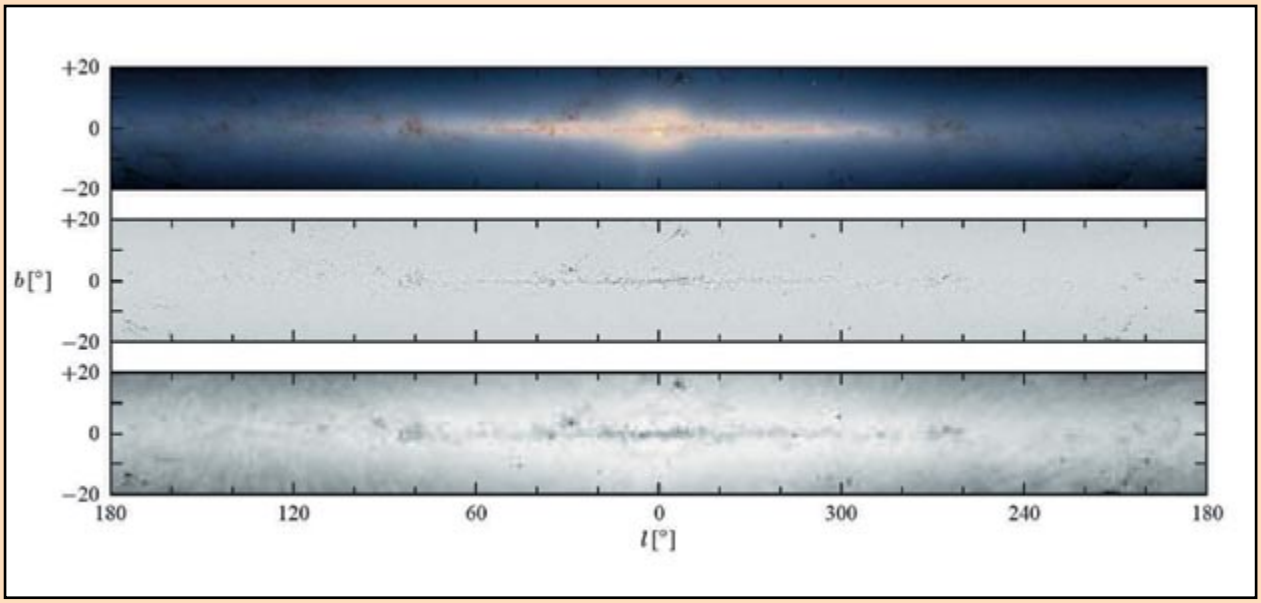


Figure 4: JHK colour composite of the star count map (top), relative extinction map obtained from the J-band data (middle) and three sigma noise due to the non-uniform distribution of stars in the relative extinction maps for J (bottom). The noise is displayed in linear scale from zero (white) to 0.7 mag (black) of optical extinction.

1.2.6 Outflows from Young Stars

T.P. Ray, D. Froebrich, D. Coffey, F. McGroarty, E.T. Whelan, T. Lery, C. Combet, G.C. Murphy

Coffey with Ray and Downes (Dublin City University) produced a detailed study and analysis of multi-epoch Hubble Space Telescope/Wide Field Planetary Camera 2 images of the XZ Tauri binary, and its outflow, covering the period from 1995 to 2001. These reveal not only dynamical and morphological evolution of the XZ Tauri outflow but also that the suspected outflow source, XZ Tauri North has flared in EXor-type fashion. In particular their proper motion studies suggests that the recently discovered bubble-like shock, driven by the the XZ Tauri outflow, is slowing down (its tangential velocity decreasing from approximately 150 kms^{-1} to 120 kms^{-1}). Simulations were also presented of the outflow itself, with plausible ambient and outflow parameters, that appear to reproduce not only the dynamical evolution of the flow, but also its shape and emission line luminosity.

During the protostellar phase of their evolution, young stars heavily interact with their parental cloud core and the surrounding interstellar medium. Understanding these processes will ultimately give us insights into feedback mechanisms of star formation and its efficiency. In a detailed study the near-infrared emission from one of the youngest known protostellar outflows (HH211-mm) was modelled. Here a sequence of bowshocks formed by episodic ejection events and propagating into the surrounding medium was used (Froebrich, in collaboration with O'Connell (Armagh), Smith (Armagh), Davis (JAC Hawaii), Eislöffel (Tautenburg)).

Coffey with Ray, Bacciotti (Arcetri Observatory), Eislöffel and Woitas (Tautenburg Observatory) have continued their Hubble Space Telescope survey of jets from young stars to determine whether they rotate. Observations were made of the bi-polar jets from the T Tauri stars TH 28 and RW Aur, and the blue-shifted jet from LkHα321, using the Space Telescope Imaging Spectrograph (STIS). It was found that the forbidden emission lines (FELs) show distinct and systematic velocity asymmetries of 10 – 25 (± 5) kms^{-1} at a distance of 0".3 from the source, representing a (projected) distance of 40 AU along the jet in the case of RW Aur, 50 AU for TH 28, and 165 AU in the case of LkHα321. These velocity asymmetries are interpreted as rotation in the initial portion of the jet where it is accelerated and collimated. For the bi-polar jets, both lobes appear to rotate in the same direction, i.e. they have opposite helicity. Values obtained were in agreement with the predictions of MHD disk-wind models.

Using STIS an image intensity radial-velocity cube of the bipolar jet from RW Aur has been made using a series of slits parallel to the outflow direction. Again rotation velocities were found, consistent with the transverse slit velocity data reported above. The sense of rotation is anticlockwise looking from the tip of the blue lobe down to the star. Rotation is more evident in the [OI] and [NII] forbidden lines and at the largest sampled distance from the axis. It was estimated that the angular momentum transported through the jet is at least two thirds, and possibly all, of that needed to be removed from the disk for accretion to proceed at the independently determined rates. The magnetic lever arm, defined by the ratio of r_A/r_0 of the corresponding Alfvènic and foot-point radii, is between 3.5 and 4.5. These values are in the range predicted by the models, and suggest that some heating must be provided at the base of the flow. The group have also derived the ratio B_ϕ/B_p of the toroidal and poloidal components of the magnetic field respectively at the observed location. This ratio is around 4 at 30 AU from the axis in the red lobe and -9 at 20 AU in the blue lobe. Thus the toroidal component is dominant, as predicted by magnetic collimation models.

Outflows from new born stars can be several parsecs in length and hence associated shocked emission may be observed at large separations from the actual source. It is hence difficult for many observed Herbig-Haro bow-shock or emission features to be immediately associated with individual sources. One method to search for the sources is to measure the proper motion of these emission features and back project to locate their origin. This was done by McGroarty, Froebrich and Ray for a number of emission knots in the vicinity of intermediate mass stars and a number of driving sources were found.

Lery with Combet, Murphy, A. Rosen (DCU), and T. Downes (DCU) have been modelling outflows and infalling gas around protostars, in particular the jets and molecular outflows that can be observed in the process of star formation. They have developed analytical solutions to the problem of molecular outflows using the transit model developed by Lery. A study of the parameter space of the problem gives information about the dynamics of the molecular outflows to be expected for a given central mass and opacity. Secondly, they have used the latter solutions as the ambient medium in which a protostellar jet propagates and run numerical simulations (using 3D AMR MHD codes) of such systems to see how the structure of the ambient medium (e.g., a density gradient) affects the kinematics and morphology of the jets.

1.2.7 Modelling of Jets in Laboratory Experiments

T. Lery and S. Leygnac

One of the big issues in numerically simulating complex astrophysical systems is the description of radiation. In a three dimensional system with large variations of the optical depth, the full treatment of radiative transfer demands a lot of computing time. Lery and Leygnac are focusing on the study of radiative transfer in high Mach number shocks similar to those created in laboratory experiments with laser or z-pinch experiments. The objective of this work is to better understand the coupling between the radiation and the hydrodynamics and to estimate the consequences of approximate treatments of radiation.

1.2.8 Rotation of Young Stars

D. Froebrich

Rotation is one of the most fundamental parameters of newborn stars. Together with measures of magnetic activity, it gives us insights into the formation mechanism and internal structure. Very little is known about rotation and magnetic activity in very low mass ($<0.4M_{\odot}$) stars (also referred to as VLM stars). In a multi-filter/telescope campaign, photometric time series in I, J and H of a VLM object were obtained. A detailed analysis of the light-curves in all three filters led to the conclusion that spots on such objects are cooler that the photosphere and that the assymetrically distributed spots cover only about 5% of the surface. This might be explained by a change from a shell to a distributed dynamo in the VLM regime (Froebrich, in collaboration with Scholz (Tautenburg) and Eislöffel (Tautenburg)).

1.2.9 Disks Around Weak-Line T Tauri Stars

À. Gras-Velázquez and T.P. Ray

Analysis was completed of new infrared photometric data taken by the Infrared Space Observatory (ISO), in combination with 2MASS near-infrared photometry, of 12 weak-line T Tauri stars (WTTS). These young stars have traditionally not been expected to have any circumstellar material but approximately 75% were found to have an infrared excess indicative of circumstellar disks. The presence of circumstellar matter around both classical and weak-line T Tauri stars, and the similarity in their ages, suggests all low-mass stars are born with disks which may evolve at different rates. The DIAS sample could be a "missing link" between extreme WTTS, selected through X-ray surveys and classical T Tauri stars. Thus there may be a continuous spectrum of stars from the classical to weak T Tauri phases, rather than two distinct separate classes.

The infrared excesses have been modelled using radiative transfer codes, based on Monte Carlo techniques, in collaboration with C. Walker and K. Woods (St. Andrews). This has allowed the sizes of the disks to be constrained along with the approximate dimensions of the inner dust gaps detected in half of the WTTSs. Such gaps may be a tell-tale sign of planetary formation.

1.2.10 Broad Absorption Line Quasars

D. Froebrich

The identification of unusual quasars and their detailed analysis is an important tool for a deeper understanding of various aspects of quasar formation and quasar-galaxy connection. Spectroscopic and NIR broad band observations of a faint high-priority quasar candidate from the Variability and Proper Motion Survey (VPMS)

revealed it to be one of the rare Iron Low Ionisation Broad Absorption Line (FeLoBAL) quasars. No evidence of substantial dust reddening could be found. Hence, this object probably also belongs to the rare class of Broad Absorption Line (BAL) quasars with partial covering of different regions of the continuum source as a function of velocity. In addition the object is radio-loud (Froebrich, in collaboration with Meusinger (Tautenburg), Irwin (Cambridge), Scholz (Potsdam), Laget (Marseille) and Haas (Bochum)).

Stacking of digitised photographic plates is a very efficient tool to improve the limiting magnitude of the VPM survey. A new project was started to apply this method to Tautenburg photographic plates to improve the statistics of the quasar sample. This program is important since no colour information is used to select the quasars, hence the intrinsic colour distribution can be studied free from selection effects (Froebrich, in collaboration with Meusinger, Tautenburg) and Kohnert (Tautenburg, University Leipzig)).

1.2.11 Gamma Ray Bursts from the first generation of stars

D. Coffey

Gamma ray bursts (GRBs) are the most energetic eruptions known in the Universe. Instruments such as Compton-GRO/BATSE and the GRB monitor on BeppoSAX have detected more than 2700 GRBs and, although observational confirmation is still required, it is now generally accepted that many of these bursts are associated with the collapse of rapidly spinning massive stars to form black holes. Consequently, since first generation stars (Population III) are expected to be very massive, GRBs are likely to have occurred in significant numbers at early epochs. 'Xred' is a space mission concept designed to detect these extremely high redshifted GRBs, in order to probe the nature of the first generation of stars and hence the time of re-ionisation of the early Universe. Coffey with M. Krumpe (Astrophysikalisches Institut Potsdam) and others have demonstrated that the gamma- and x-ray luminosities of typical GRBs render them detectable up to extremely high redshifts (z=10-30), but that current missions such as HETE and SWIFT operate outside the observational range for detection of high redshift GRB afterglows. To redress this problem, they have presented a complete mission design at an ESA summer school from the science case to the mission architecture and payload. The latter comprised three instruments, namely a wide field x-ray camera to detect high redshift gamma-rays, an imaging x-ray telescope to determine accurate coordinates and extract spectra, and an infrared spectrograph to observe the high redshift optical afterglow. Such a mission would be expected to detect and identify for the first time GRBs with z>10, thereby providing constraints on properties of the first generation of stars and the history of the early Universe.

1.2.12 DOSMAX

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

Final measurements and analysis were completed by mid-year and an extensive report was prepared at DIAS for submission to the European Union by November 30th. Earlier in the year, at meetings in Dublin and Rome, agreement was reached on all outstanding matters regarding interpretation of the large data base accumulated during the 51 month project. Along with an earlier contract, also coordinated by DIAS, the project succeeded in determining the radiation dose received by air-crew and frequent travellers from galactic cosmic rays and solar energetic particles throughout a whole solar cycle. The WG5 group set

up by the European Commission published a special report on the results of worldwide investigations in this area and included detailed accounts of the DOSMAX project. The combined results will serve as a reference for government agencies concerned with radiation protection and legislation in Europe and beyond.

1.2.13 The Matroshka Experiment

D. O'Sullivan

Detectors, measuring the galactic and solar energetic particle radiation at the location of the kidney and heart of a tissue equivalent human dummy, are being exposed in space on board the International Space Station (ISS). Following launch in January 2004, the system was mounted outside the ISS in March. The aim of the experiment is to improve the measurement of radiation exposure of astronauts in free space. It is due to be recovered from orbit in Sept 2005 after which measurements and analysis will begin at DIAS. This will be a major study of radiation affects on many of the organs in the human body in low Earth orbit. The project is coordinated by DLR, the German Aerospace Agency.

An extension of the Matroshka-1 experiment, Matroshka-2 was proposed to ESA during the year. It is planned to carry out further investigations with the Matroshka human phantom in space in the period 2005-2008. A decision is expected early in 2005.

1.2.14 DOBIE

D. O'Sullivan

This is collaboration with the Belgian SCK/CEN Nuclear Research Centre and the Academy of Science of the Czech Republic. The aim is to measure absorbed and equivalent radiation doses in biological samples exposed in space. A proposal submitted under the ILSRA life science programme of ESA was selected for a definition study and the experiment is expected to be launched into Earth orbit in 2005. Some detectors to be employed on the mission were calibrated during the year in preparation for the investigation in space.

2 Publications

2.1 Refereed Journals

1. Aharonian, F., A. G. Akhperjanian, K.- M. Aye, A. R. Bazer-Bachi, M. Beilicke, W. Benbow, D. Berge, P. Berghaus, K. Bernlöhr, O. Bolz, C. Boisson, C. Borgmeier, F. Breitling, A. M. Brown, J. Bussons Gordo, P. M. Chadwick, V. R. Chitnis, L.-M. Chounet, R. Cornils, L. Costamante, B. Degrange, A. Djannati-Ataï, L. O'C. Drury, T. Ergin, P. Espigat, F. Feinstein, P. Fleury, G. Fontaine, S. Funk, Y. Gallant, B. Giebels, S. Gillessen, P. Goret, J. Guy, C. Hadjichristidis, M. Hauser, G. Heinzelmann, G. Henri, G. Hermann, J. A. Hinton, W. Hofmann, M. Holleran, D. Horns, O. C. de Jager, I. Jung, B. Khélifi, N. Komin, A. Konopelko, I. J. Latham, R. Le Gallou, M. Lemoine, A. Lemière, N. Leroy, T. Lohse, A. Marcowith, C. Masterson, T. J. L. McComb, M. de Naurois, S. J. Nolan, A. Noutsos, K. J. Orford, J. L. Osborne, M. Ouchrif, M. Panter, G. Pelletier, S. Pita, M. Pohl, G. Pühlhofer, M. Punch, B. C. Raubenheimer, M. Raue, J. Raux, S. M. Rayner, I. Redondo, A. Reimer, O. Reimer, J. Ripken, M. Rivoal, L. Rob, L. Rolland, G. Rowell, V. Sahakian, L. Saugé, S. Schlenker, R. Schlickeiser, C. Schuster, U. Schwanke, M. Siewert, H. Sol, R. Steenkamp, C. Stegmann, J.-P. Tavernet, C. G. Théoret, M. Tluczykont, D. J. van der Walt, G. Vasileiadis, P. Vincent, B. Visser, H. J. Völk, & S. J. Wagner: Very high energy gamma rays from the direction of Sagittarius A*. *Astronomy and Astrophysics* **425** (2004) L13

2. Aharonian, F., A. G. Akhperjanian, K.-M. Aye, A. R. Bazer-Bachi, M. Beilicke, W. Benbow, D. Berge, P. Berghaus, K. Bernlöhr, O. Bolz, C. Boisson, C. Borgmeier, F. Breitling, A. M. Brown, P. M. Chadwick, V. R. Chitnis, L.- M. Chounet, R. Cornils, L. Costamante, B. Degrange, O. C. de Jager, A. Djannati-Ataï, L. O. '. Drury, T. Ergin, P. Espigat, F. Feinstein, P. Fleury, G. Fontaine, S. Funk, Y. A. Gallant, B. Giebels, S. Gillessen, P. Goret, J. Guy, C. Hadjichristidis, M. Hauser, G. Heinzelmann, G. Henri, G. Hermann, J. Hinton, W. Hofmann, M. Holleran, D. Horns, I. Jung, B. Khélifi, N. Komin, A. Konopelko, I. J. Latham, R. L. Gallou, M. Lemoine, A. Lemière, N. Leroy, T. Lohse, A. Marcowith, C. Masterson, T. J. L. McComb, M. de Naurois, S. J. Nolan, A. Noutsos, K. J. Orford, J. L. Osborne, M. Ouchrif, M. Panter, G. Pelletier, S. Pita, M. Pohl, G. Pühlhofer, M. Punch, B. C. Raubenheimer, M. Raue, J. Raux, S. M. Rayner, I. Redondo, A. Reimer, O. Reimer, J. Ripken, M. Rivoal, L. Rob, L. Rolland, G. Rowell, V. Sahakian, L. Sauge, S. Schlenker, R. Schlickeiser, C. Schuster, U. Schwanke, M. Siewert, H. Sol, R. Steenkamp, C. Stegmann, J.- P. Tavernet, C. G. Théoret, M. Tluczykont, D. J. van derWalt, G. Vasileiadis, P. Vincent, B. Visser, H. J. Volk, & S. J. Wagner: Calibration of cameras of the H.E.S.S. detector. *Astroparticle Physics* **22** (2004) 109

3. Aharonian, F. A., A. G. Akhperjanian, K.-M. Aye, A. R. Bazer-Bachi, M. Beilicke, W. Benbow, D. Berge, P. Berghaus, K. Bernlöhr, O. Bolz, C. Boisson, C. Borgmeier, F. Breitling, A. M. Brown, J. Bussons Gordo, P. M. Chadwick, V. R. Chitnis, L.-M. Chounet, R. Cornils, L. Costamante, B. Degrange, A. Djannati-Ataï, L. O. Drury, T. Ergin, P. Espigat, F. Feinstein, P. Fleury, G. Fontaine, S. Funk, Y. A. Gallant, B. Giebels, S. Gillessen, P. Goret, J. Guy, C. Hadjichristidis, M. Hauser, G. Heinzelmann, G. Henri, G. Hermann, J. A. Hinton, W. Hofmann, M. Holleran, D. Horns, O. C. de Jager, I. Jung, B. Khélifi, N. Komin, A. Konopelko, I. J. Latham, R. Le Gallou, M. Lemoine, A. Lemière, N. Leroy, T. Lohse, A. Marcowith, C. Masterson, T. J. L. McComb, M. de Naurois, S. J. Nolan, A. Noutsos, K. J. Orford, J. L. Osborne, M. Ouchrif, M. Panter, G. Pelletier, S. Pita, M. Pohl, G. Pühlhofer, M. Punch, B. C. Raubenheimer, M. Raue, J. Raux, S. M. Rayner, I. Redondo, A. Reimer, O. Reimer, J. Ripken, M. Rivoal, L. Rob, L. Rolland, G. Rowell, V. Sahakian, L. Saugé, S. Schlenker, R. Schlickeiser, C. Schuster, U. Schwanke, M. Siewert, H. Sol, R. Steenkamp, C. Stegmann, J.-P. Tavernet, C. G. Théoret, M. Tluczykont, D. J. van der Walt, G. Vasileiadis, P. Vincent, B. Visser, H. J. Völk, & S. J. Wagner: Highenergy particle acceleration in the shell of a supernova remnant. *Nature* **432** (2004) 75

4. Bacciotti, F., T. P. Ray, D. Coffey, J. Eislöffel, & J. Woitas: Testing the Models for Jet Generation with Hubble Space Telescope Observations. *Astrophysics and Space Science* **292** (2004) 651

5. Coffey, D., F. Bacciotti, J. Woitas, T. P. Ray, & J. Eislöffel: Rotation of Jets From T-Tauri Stars: New Clues From HST/STIS Observations. *Astrophysics and Space Science* **292** (2004) 553

6. Coffey, D., T. P. Downes, & T. P. Ray: The evolution and simulation of the outburst from XZ Tauri – A possible EXor?. *Astronomy and Astrophysics* **419** (2004) 593

7. Coffey, D., F. Bacciotti, J. Woitas, T. P. Ray, & J. Eislöffel: Rotation of Jets from Young Stars: New Clues from the Hubble Space Telescope Imaging Spectrograph. *Astrophysical Journal* **604** (2004) 758

8. Combet, C. & T. Lery: Effects of Magnetic Field and Opacity on Self-Similar YSO Flow Models. *Astrophysics and Space Science* **292** (2004) 525

9. Covino, S., F. M. Zerbi, G. Chincarini, M. Rodonó, G. Tosti, L. A. Antonelli, P. Conconi, G. Cutispoto, E. Molinari, L. Nicastro, E. Palazzi Burderi, S. Campana, G. Crimi, J. Danzinger, P. D'Avanzo, A. Di Paola, E. Di Stefano, A. Fernandez-Soto, P. Filiatre, F. Fiore, D. Fugazza, G. Gentile, P. Goldoni, G. Israel, B. Jordan, D. Lorenzetti, B. Mc Breen, E. Martinetti, R. Mazzoleni, N. Masetti, A. Melandri, S. Messina, E. Meurs, A. Monfardini, G. Nucciarelli, J. Paul, E. Pian, E. Rol, P. Saracco, S. Sardone, M. Stefanon, L. Stella, L. Tagliaferri, V. Testa, S. Vergani, F. Vitali, P. Ward, & A. Zaccardo: The Multi-frequency Robotic facility REM: first results. *Astronomische Nachrichten* **325** (2004) 543

10. Drury, L. O.: Current Status of Shock Acceleration Theory. *Journal of Korean Astronomical Society* **37** (2004) 393

11. Lery, T., C. Combet, & G. Murphy: The Environment of YSO Jets. *Astrophysics and Space Science* **293** (2004) 263

12. McGroarty, F. & T. P. Ray: Classical T Tauri stars as sources of parsec-scale optical outflows. *Astronomy and Astrophysics* **420** (2004) 975

13. McGroarty, F., T. P. Ray, & J. Bally: Parsecscale Herbig-Haro outflows from intermediate mass stars. *Astronomy and Astrophysics* **415** (2004) 189

14. Meurs, E. J. A. & M. C. A. Rebelo: SN contributions to GRB lightcurves. *Nuclear Physics B Proceedings Supplements* **132** (2004) 324

15. O'Connell, B., M. D. Smith, C. J. Davis, K. W. Hodapp, T. Khanzadyan, & T. Ray: A near-infrared study of the bow shocks within the L1634 protostellar outflow. *Astronomy and Astrophysics* **419** (2004) 975

16. O'Sullivan, D., D. Zhou, E. Semones, W. Heinrich, & E. Flood: Dose equivalent, absorbed dose and charge spectrum investigation in low Earth orbit. *Advances in Space Research* **34** (2004) 1420

17. Takami, M., A. Chrysostomou, T. P. Ray, C. Davis, W. R. F. Dent, J. Bailey, M. Tamura, & H. Terada: Detection of a warm molecular wind in DG Tauri. *Astronomy and Astrophysics* **416** (2004) 213

18. Kiang, T.: Time, distance, velocity, redshift: A brief history of changes in basic physical concept. *Chinese Astronomy and Astrophysics* **28** (2004) 273

19. Kiang, T.: Time, Distance, Velocity, Redshift: a brief history of changes in the basic physical concepts. *Acta Astronomica Sinica* **45** (2004) 288

20. Kiang, T., Y.-F. Wu, & X.-F. Zhu: Rhombic Cell Analysis. II. Application to the IRAS/PSCz Catalogue. *Chinese Journal of Astronony and Astrophysics* **4** (2004) 209

21. Whelan, E. T., T. P. Ray, & C. J. Davis: Paschen beta emission as a tracer of outflow activity from T-Tauri stars, as compared to optical forbidden emission. *Astronomy and Astrophysics* **417** (2004) 247

22. Woitas, J., J. Eislöffel, F. Bacciotti, & T. P. Ray: Rotation and Excitation Properties of Jets from Young Stellar Objects. *Astronomische Nachrichten Supplement* **325** (2004) 6

2.2 Conference Proceedings and Non-refereed Publications

1. Coia, D., B. McBreen, L. Metcalfe, A. Biviano, B. Altieri, Y. Mellier, S. Ott, J. P. Kneib, & B. O'Halloran: Luminous Infrared Galaxies in the Cluster cl 0024+1654. *Baltic Astronomy* **13** (2004) 638–641

2. Combet, C., G. Murphy, & T. Lery: Flows around High and Low Mass Forming Stars. *SF2A-2004: Semaine de l'Astrophysique Francaise* (2004) 213

3. Cunniffe, J., E. J. A. Meurs, & A. Golden: Efficient data mining in the X-ray sky background. ASP Conf. Ser. 314: *Astronomical Data Analysis Software and Systems (ADASS) XIII* **314** (2004) 812

4. Donnelly, J., A. Thompson, D. O'Sullivan, L. O. Drury, & K.-P. Wenzel: A montecarlo analysis of the cosmic-ray charge abundance spectrum from the ultra-heavy cosmic-ray experiment. *COSPAR, Plenary Meeting* (2004) 2970

5. Drury, L. O.: Particle Injection and Acceleration at Supernova Remnant Shocks. *COSPAR, Plenary Meeting* (2004) 2492

6. Fitzsimmons, A., D. D. Balam, Q. Parker, A. Hales, F. McGroarty, T. Ray, N. Walton, J. Vink, A. Fitzsimons, P. Rodriguez-Gil, D. Mislis, J. Tedds, D. Russell, M. Rosenthal, N. Loaring, S. C. Lowry, A. Boattini, & G. D'Abramo: Minor Planet Observations [950 La Palma]. *Minor Planet Circulars* **5090** (2004) 4

7. Froebrich, D. & A. Scholz: The Enigmatic Outflow Alignments in Small Globules: a Case Study of IC 1396 W. *Baltic Astronomy* **13** (2004) 483

8. Gossens, O., Vanhavere, F., Leys, N., O'Sullivan, D., Zhou, D., Spurny, F., Yukihara, E., Gaza, R., McKeever, S.W.S., Radiation Dosimetry for a Microbial Experiment on the International Space Station, *Proceedings of the 14th International Conference on Solid State Dosimetry, Yale University, Radiation Protection Dosimetry.*

9. Gras-Velázquez, À. & T. P. Ray: Do Weak-Line T Tauri Stars have Circumstellar Material?. *Baltic Astronomy* **13** (2004) 543

10. Israel, G. L., S. Covino, E. Kuulkers, F. M. Zerbi, G. Chincarini, M. Rodonó, L. A. Antonelli, P. Conconi, G. Cutispoto, E. Molinari, L. Nicastro, G. Tosti, L. Burderi, S. Campana, C. Campeggi, G. Crimi, R. Cunniffe, J. Danzinger, A. di Paola, A. Fernandez-Soto, F. Fiore, F. Frontera, D. Fugazza, G. Gentile, G. Ghisellini, P. Goldoni, B. Jordan, D. Lazzati, D. Lorenzetti, D. Malesani, E. Martinetti, N. Masetti, R. Mazzoleni, B. M. Breen, A. Melandri, S. Messina, E. Meurs, A. Monfardini, G. Nucciarelli, M. Orlandini, J. Paul, E. Palazzi, E. Pian, P. Saracco, S. Sardone, A. Simoncelli, M. Stefanon, L. Stella, L. Tagliaferri, M. Tavani, V. Testa, S. Vergani, & F. Vitali: IR-brightening of GX339-4. *The Astronomer's Telegram* **243** (2004) 1

11. Israel, G. L., S. Covino, G. Tosti, V. Testa, M. Stefanon, E. Molinari, P. Conconi, F. M. Zerbi, G. Chincarini, M. Rodono, L. A. Antonelli, G. Cutispoto, L. Nicastro, L. Burderi, S. Campana, C. Campeggi, G. Crimi, R. Cunniffe, J. Danziger, A. P. di, A. Fernandez-Soto, F. Fiore, F. Frontera, D. Fugazza, G. Gentile, G. Ghisellini, P. Goldoni, B. Jordan, D. Lazzati, D. Lorenzetti, D. Malesani, E. Martinetti, N. Masetti, R. Mazzoleni, B. McBreen, A. Melandri, S. Messina, E. Meurs, A. Monfardini, G. Nucciarelli, M. Orlandini, J. Paul, E. Palazzi, E. Pian, P. Saracco, S. Sardone, A. Simoncelli, L. Stella, G. Tagliaferri, M. Tavani, S. Vergani, & F. Vitali: GRB 040223: REM IJK observations. *GRB Circular Network* **2531** (2004) 1

12. Lery, T.: A self-similar view of massive star formation. *EAS Publications Series* **13** (2004) 81

13. McGroarty, F., T. P. Ray, & J. Bally: Parsec-Scale Outflows from – Mass Sources and Classical T Tauri Stars. *Baltic Astronomy* **13** (2004) 528

14. Meurs, E. J. A.: Astronomy in Ireland. *ASSL Vol. 310: Organisations and Strategies in Astronomy, Vol. 5* (2004) 103

15. Meurs, E. J. A., Collins, P.: Dark Bursts and the optical upper limit distribution. *Astronomical Society of the Pacific Conference Series* 312, 229

16. Meurs, E. J. A.,: Estimates of optical afterglow emission levels for dark bursts, *Astronomical Society of the Pacific Conference Series* 312, 232

17. Meurs, E. J. A., Norci, L.: GRBs and SNae, *Astronomical Society of the Pacific Conference Series* 312, 291

18. Palazzi, E., N. Masetti, F. M. Zerbi, E. Molinari, G. Tosti, G. Chincarini, S. Covino, A. P. di, D. Fugazza, V. Testa, M. Rodonó, L. A. Antonelli, P. Conconi, G. Cutispoto, L. Nicastro, L. Burderi, S. Campana, C. Campeggi, G. Crimi, R. Cunniffe, J. Danzinger, A. Fernandez-Soto, F. Fiore, F. Frontera, G. Gentile, G. Ghisellini, P. Goldoni, G. Israel, B. Jordan, D. Lazzati, D. Lorenzetti, D. Malesani, E. Martinetti, R. Mazzoleni, B. M. Breen, A. Melandri, S. Messina, E. Meurs, A. Monfardini, G. Nucciarelli, M. Orlandini, J. Paul, E. Pian, P. Saracco, S. Sardone, A. Simoncelli, M. Stefanon, L. Stella, L. Tagliaferri, M. Tavani, S. Vergani, & F. Vitali: GRB040106: optical observations with REM+ROSS. *GRB Circular Network* **2511** (2004) 1

19. Ray, T.: What Role Do Magnetic Fields Play in Jets from Young Stars?. *APS Meeting Abstracts* (2004) 1002

20. Rengel, M., D. Froebrich, S. Wolf, & J. Eislöffel: Modelling the Continuum Emission from Class 0 Protostellar Sources. *Baltic Astronomy* **13** (2004) 449

21. Schmeja, S., R. S. Klessen, D. Froebrich, & M. D. Smith: Star Formation in Turbulent Molecular Clouds: Mass Accretion and Evolution of Protostars. *Astronomische Nachrichten Supplement* **325** (2004) 26

22. Whelan, E. T., T. P. Ray, &C. J. Davis: Near-Infrared Studies of Outflows and Jets from Young Stellar Objects. *Baltic Astronomy* **13** (2004) 522

23. Woitas, J., J. Eislöffel, F. Bacciotti, D. Coffey, & T. P. Ray: Hst/stis Observations of Rotation of T Tauri Jets. *Baltic Astronomy* **13** (2004) 533

2.3 Preprints

1. Coffey, D., T. P. Downes, & T. P. Ray: The Evolution and Simulation of the Outburst from XZ Tauri – A Possible EXor?. *ArXiv Astrophysics e-prints* (2004) arXiv:astroph/0402635–

2. Combet, C., D. Maurin, J. Donnelly, L. O'C Drury, & E. Vangioni-Flam: Spallation dominated propagation of Heavy Cosmic Rays and the Local Interstellar Medium (LISM). *ArXiv Astrophysics e-prints* (2004) arXiv:astro-ph/0412015–

3. Fiore, F., V. D'Elia, D. Lazzati, R. Perna, L. Sbordone, G. Stratta, E. J. A. Meurs, P. Ward, L. A. Antonelli, G. Chincarini, S. Covino, A. Di Paola, A. Fontana, G. Ghisellini, G. Israel, F. Frontera, G. Marconi, L. Stella, M. Vietri, & F. Zerbi: A flash in the dark: UVES/VLT high resolution spectroscopy of GRB afterglows. *ArXiv Astrophysics e-prints* (2004) arXiv: astroph/ 0409717–

4. Froebrich, D.: Which are the youngest protostars? Determining properties of confirmed and candidate Class 0 sources by broad-band photometry. *ArXiv Astrophysics e-prints* (2004) arXiv:astro-ph/0410044–

5. Froebrich, D., A. Scholz, J. Eislöffel, & G. C. Murphy: Star formation in globules in IC1396. *ArXiv Astrophysics e-prints* (2004) arXiv:astro-ph/0411706–

6. McGroarty, F. & T. P. Ray: Classical T Tauri stars as sources of parsec-scale optical outflows. *ArXiv Astrophysics e-prints* (2004) arXiv:astro-ph/0404016–

7. Rengel, M., K. Hodapp, D. Froebrich, S. Wolf, & J. Eisloeffel: Submillimetre continuum emission from Class 0 sources: Theory, Observations, and Modelling. *ArXiv Astrophysics e-prints* (2004) arXiv: astroph/0410146–

8. Woitas, J., F. Bacciotti, T. P. Ray, A. Marconi, D. Coffey, & J. Eisloeffel: Jet rotation: launching region, angular momentum balance and magnetic properties in the bipolar outflow from RWAur. *ArXiv Astrophysics eprints* (2004) arXiv:astro-ph/0411119–

2.4 Theses

1. Benton, E., "Radiation Dosimetry at Aviation Altitudes and in Low Earth Orbit", University College Dublin PhD Thesis

2. Donnelly, J., "Platinum and Beyond: Studies of Ultra-heavy Nuclei in Galactic Cosmic Rays", Dublin City University PhD Thesis

3. McGroarty, F., "Morphology and Kinematics of Parsec-scale Outflows from Young Stars", Dublin City University PhD Thesis

3 Events

3.1 Lectures Organised by the School

3.1.1 Merrion Square Seminar Series

A new in-house seminar series (the TGIF Series) was started on the 13th August. Every week alternating seminars on Geophysics and Astrophysics were held. On a number of occasions external speakers were invited. The series was organised by D. Froebrich and A. Moorkamp.

Detailed list of speakers:

13 August
David W. Eaton, University of Western Ontario: Teleseismic studies of the Grenville orogen, Canada

20 August
Max Moorkamp, DIAS: Magnetotellurics and geodynamics: Measuring mantle flow from the surface

27 August
Dirk Froebrich, DIAS: 1, 2, 3, 4, ...many – Astrophysics via star counts

3 September
Ute Weckmann, DIAS: Understanding geophysical imprints of suture zones: high electrical conductivity coupled with anisotropy

17 September
Fiona McGroarty, NUI Maynooth: Parsec-scale outflows from young stars

24 September
Van Chuong Do, DIAS: ISLE – Irish Seismological Lithospheric Experiment: A teleseismic study across the Caledonian Suture Zone in Ireland

1 October
Agueda Gras-Velazquez, DIAS: WTTS circumstellar disks and the eternal questions where do we come from and are we alone?

8 October
Dmitry B. Avdeev, DIAS: Three dimensional electromagnetic modelling and inversion from theory to application

14 October
Dazhuang Zhou, DIAS: Radiation field measured in low earth orbit with CR-39 detectors

22 October
Gareth C. Murphy, DIAS: Modelling astrophysical jets

29 October
Tadashi Yamasaki, DIAS: Simple one-dimensional modelling study on sedimentary basin formation

5 November
Fr Pat Farnan: Rolling back the years

12 November
Simon Jeffery, Armagh Observatory: Asteroseismology of pulsating subdwarf B stars

19 November
David Golden, DIAS: An introduction to the DIAS computer clusters

26 November
Brian O'Reilly, DIAS: Ireland's deep-water coral reefs and global climate change

3 December
Alexander Scholz, Thüringer Landessternwarte Tautenburg: Rotation and variability of very low mass objects

10 December
David Maurin, CEA Saclay: Cosmic ray nuclei in our galaxy

3.1.2 Dunsink Seminars

C. del Burgo (ESTEC):
The far-infrared signature of dust in high-latitude regions (1 June)

M. Sawicki (Dominion Astrophysical Observatory):
Hunting for galaxy evolution with Keck deep imaging (4 June)

Brenda Frye (Princeton University):
Multiply lensed high-z galaxies (3 March)

Colin Melody (Dunsink Observatory):
On the feasibility of detecting compact companions to runaway stars with GAIA (30 April)

P. Ward (Dunsink Observatory):
A flash in the dark: UVES/VLT high resolution spectroscopy of GRB afterglows (8 September)

C. Melody (Dunsink Observatory):
On the feasibility of detection of NS companions to OB runaways using Gaia astrometry (8 September)

3.1.3 Symposia, Conferences, Workshops

- E-Infrastructure Reflection Group meeting, Dublin.
  The e-Infrastructure Reflection Group, an advisory committee of the EU, meets twice a year in whichever country holds the presidency of the EU. During the Irish presidency in the first half of 2004 the meeting was held in Dublin under the chairmanship of Dr Richard Hirsh from Science Foundation Ireland. The CosmoGrid project provided substantial support for the organisation of this meeting which was held in the Royal Irish Academy.
- EGEE (Enabling Grids for E-Science in Europe).
  The inaugural meeting of this major FP6 project was held in Cork in conjunction with the first public CosmoGrid meeting.

- CosmoGrid Conferences. Two CosmoGrid meetings were held in April (NUI, Cork) and October (UCD in collaboration with the Astronomical Science Group of Ireland). In both cases approximately 60 participants attended.

3.2 Talks and papers presented at conferences and seminars

3.2.1 Talks and Seminars

D. Coffey
"X-red: A satellite mission concept for detecting Gamma Ray Bursts from the first generation of stars", August, Alpbach Summer School, Austria; "The evolution and simulation of the outburst from XZ Tauri", ASGI Meeting, University College Dublin, Belfield, 14 September.

C. Combet
"Flows around High and Low Mass Forming Stars", 15 June, "Semaine de l'Astrophysique Française 2004" meeting, Paris.

J. Donnelly
"A Monte-Carlo analysis of the cosmic-ray charge abundance spectrum from the ultra-heavy cosmic ray experiment", 35th COSPAR Scientific Assembly, Paris.

L. O'C. Drury
"Irish e-Infrastructure and Grid Initiatives", 15 April, Invited review at the open symposium of the European e-Infrastructure Reflection Group, Dublin; "Particle Acceleration in the Universe", 23 July, invited talk at the retirement symposium for Alan Watson, Leeds; "Conference summary and closing remarks" 29 July, Gamma-2004 International Conference, Heidelberg; "Current Status of Shock Acceleration Theory", 17 August, invited review at the 3rd Korean Astrophysics Workshop, Pusan, South Korea; "Key questions from Astrophysics", 5 November, invited talk at 6th European Workshop on Collisionless Shocks, Paris; "Astrophysics and Grid Computing", 3rd December, Symposium on the crossroads of particle physics and astrophysics, MPI für Kernphysik, Heidelberg, Germany.

D. Froebrich
"The youngest protostars – How many do we know, what can we learn?" 20 January, Seminar to the Star Formation Group at AIP Potsdam; "The youngest protostars – How many do we know – How do they accrete mass?" 27 May, Seminar at TLS Tautenburg; "Is there a law governing protostellar accretion?" 13 July, contributed talk at the Cores, Disks, Jets and Outflows 2004 Conference, Banff, Canada; "1, 2, 3, 4, ...many – Astrophysics via star counts", 27 August, TGIF Seminar DIAS; "The youngest protostars", 7 October, seminar in Armagh Observatory.

T. Kiang
"Time, Distance, Velocity, Redshift: a brief history of changes in the basic physical concepts, Second Annual Scientific Meeting of the Chinese Astronomical Society, Xiamen, 7-12 November.

E.J.A. Meurs
"Fast Near-IR searches for GRB afterglows", ASGI Spring meeting, Armagh, 2 April; "On the supernova origin of runaway stars", ESO, Garching, 13 October; "SN contributions to GRB lightcurves", GRBs in the Afterglow era, Rome, 19-22 October.

L. Norci
"On the X-ray contribution from young supernovae in starbursts", Starbursts: From 30 Doradus to Lyman break galaxies, Cambridge, 5-10 September.

C. Melody
"On the feasibility of detection of NS companions to OB runaways using Gaia astrometry", ASGI Spring meeting, Armagh, 1-4 April; "On the feasibility of detection of NS companions to OB runaways using Gaia astrometry", ASGI Autumn meeting, UCD, 10 September.

T. Ray
"Shock Formation in YSO Jets", Star Formation Workshop, Leeds, 13 January; "What Role Do Magnetic Fields Play in Jets from Young Stars?", "Exploring the Central Engines of Jets from Young Stars", Star Formation Conference, Volterra, Florence, 17 October; American Physical Society Conference on Astrophysical Jets, Savannah, Georgia 16 November.

P. Ward
"A flash in the dark: UVES/VLT high resolution spectroscopy of GRB afterglows", ASGI Autumn meeting, UCD, 10 September; "A flash in the dark: UVES/VLT high resolution spectroscopy of GRB afterglows", GRBs in the Afterglow era, Rome, 19-22 October.

3.2.2 Posters

1. Coffey, D., Bacciotti, F., Woitas, J., Ray, T.P., & Eislöffel, J., "Further evidence of rotation in stellar jets revealed by new HST/STIS spectra", in Cores, Disks, Jets and Outflows Conference 2004, Banff, Canada, July, J4, electronically available at http://www.ism.ucalgary.ca/meetings/banff/

2. Coffey, D., Bacciotti, F., Woitas, J., Ray, T.P., & Eislöffel, J., "The evolution and simulation of the outburst from XZ Tauri", at the Joint ASGI/IoP meeting, Armagh, July

3. Gras-Velázquez, À ., Walker, C. H., Ray, T. P., & Wood, K., "Observation and Modelling of Weak-line T Tauri Star Disks", in Cores, Disks, Jets and Outflows Conference 2004, Banff, Canada, July, D8, electronically available at http://www.ism.ucalgary.ca/meetings/banff/

4. McGroarty, F., Ray, T.P., Froebrich, D., "Parsec-scale optical outflows", in Cores, Disks, Jets and Outflows Conference 2004, Banff, Canada, July, J18, electronically available at http://www.ism.ucalgary.ca/meetings/banff/

5. Murphy, G.C., Froebrich, D., Scholz, A., "A galactic plane extinction map obtained from 2MASS – an embarrassingly parallel problem", in Cores, Disks, Jets and Outflows Conference 2004, Banff, Canada, C54, electronically available at http://www.ism.ucalgary.ca/meetings/banff/

6. Rengel, M., Hodapp, K.W., Froebrich, D., Wolf, S., Eislöffel, J., "Physical properties and structure of Class 0 sources", in Cores, Disks, Jets and Outflows Conference 2004, Banff, Canada, C25, electronically available at http://www.ism.ucalgary.ca/meetings/banff/

7. Whelan, E.T., Ray, T.P., Davis, C.J., "Using Paschen beta to detect the earlier stages of planet formation" at the Joint ASGI/IoP meeting, Armagh, April

8. Whelan, E.T., Ray, T.P., Davis, C.J., 2004, "Using spectro-astrometry to probe the jet launch regions of low and intermediate mass YSOs" in Cores, Disks, Jets and Outflows Conference 2004, Banff, Canada, July, J24, electronically available at http://www.ism.ucalgary.ca/meetings/banff/

4 Collaboration with wider research community

4.1 National

Lecture Courses

E.J.A. Meurs
Lecture course of nine hours on Physics of Galaxies and nine hours on Modern Developments in Astrophysics in TCD during Hilary Term.

T. P. Ray
Lecture courses "Galaxies: from the Milky Way to Quasars" (TCD, 3rd year Physics), "The Interstellar Medium" (TCD, 4th year Physics), "Exploring the Universe" (NUI, Maynooth, 1st year Astrophysics). T.P. Ray also coordinated final year astrophysics projects for TCD.

Visiting Irish Researchers

B. Coghlan (TCD), E. Cunningham (DCU), T. Downes (DCU), P. Duffy (UCD), B. Espey (TCD), E. Kennedy (DCU), B. Lawless (DCU), B. McBreen (UCD), E. McGlynn (DCU), A. Rosen (DCU) A. Shearer (NUIG).

Vacation Students – Dunsink

L. Young (Maynooth), 23 August - 10 September

4.2 International

Collaborative agreements

- The High Energy Stereo System (H.E.S.S.) collaboration is a European consortium of 19 research institutes, including DIAS, led by the Max-Planck-Institut für Kernphysik in Heidelberg.
- The Optical Monitoring Camera consortium contributes one of the four scientific instruments onboard ESA's INTEGRAL satellite (OMC PI: Dr M. Mas-Hesse, INTA, Madrid, Spain).
- The Rapid Eye Mount (REM) Telescope is a small automatic telescope that will carry out fast follow-up searches for afterglows of Gamma Ray Bursts, from ESO at La Silla, Chile. The project is led by Brera Observatory, Milan-Merate, Italy.
- Collaboration with Rome Astronomical Observatory on VLT UVES spectroscopy of circum- and interstellar matter surrounding bright Gamma Ray Bursts.
- Collaboration with Institute of Astronomy, Cambridge, UK (M.Wilkinson), to carry out simulations of evolving associations.
- Collaboration with Istituto de Astrofisica Spaziale, Rome, Italy, Loiano Observatory, Italy, Dublin City University and University of Toledo, USA, on B[e] stars.

4.3 CosmoGrid

The main goal of the CosmoGrid project is to contribute to the creation of a world-class research environment by embedding a powerful computational grid, together with the associated user skills and knowledge bases, in the Irish research system. DIAS is the lead organisation, and its research programme related to astrophysics will be a key and central element of the project centred on astrophysical objects ranging from supernova remnant (with strong collision-less shocks), forming stars (jets and outflows) to neutron stars (radiative processes). In 2004, the CosmoGrid project completed the European tender process for the UCD CosmoGrid Cluster. The contract was awarded to OCF and IBM, who undertook to supply the required 200+ processor Linux cluster with gigabit ethernet interconnect and SAN. The new cluster is to be called Rowan.

4.4 JETSET

DIAS led a successful application from ten European institutions for a Marie Curie Research Training Network known as JETSET (Understanding Jets through Simulations, Experiment and Theory). T.P. Ray is the coordinator and T. Lery the Scientific Manager. Apart from DIAS, the institutes involved are Arcetri Observatory, Rome Observatory, Tautenburg Observatory, University of Athens, University of Porto, University of Turin, University of Heidelberg, Imperial College London and the Joseph Fourier University of Grenoble. Funding is being provided for 12 PhD level Marie Curie studentships and 7 postdoctoral fellowships starting in February 2005. E. Flood (DIAS) will act as the project administrator.

The theme of the network is the confluence of astrophysical observations, theoretical and computational modelling, laser experiments and Grid technology. JETSET aims to build a vibrant interdisciplinary European research community centred on rigorous but novel approaches to plasma jet studies. The network will provide a core of top-ranking young researchers with in-depth training in these disciplines, and further break down interdisciplinary barriers by focusing research on key problems requiring a multi-faceted approach.

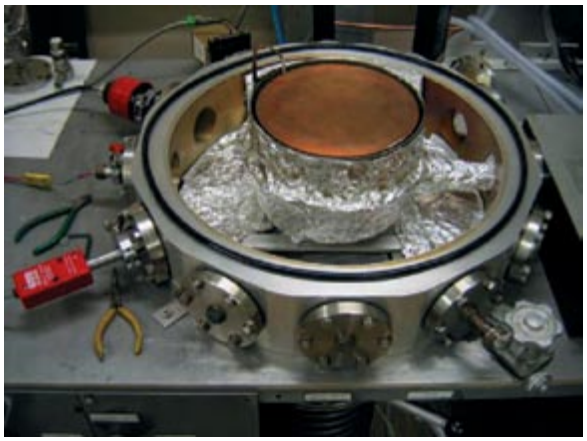


Figure 5: Plant for sealing the MIRI imager filter substrates and multi-layers in diamond-like carbon at the Multi-Layer Infrared Laboratory at the University of Reading under contract from DIAS.

The scientific goal of the network is to understand several problems pertaining to jets from young stars, from their formation and propagation to their emission, both in space and in the laboratory. The emphasis will be on the production mechanism of jets, their temporal variability, the physics and chemistry of magneto-hydrodynamic shocks, their secular evolution and the impact of jets on the surrounding medium. Together, the research groups will build a powerful set of tools, i.e. cross-validated MHD simulation codes using Grid technology, modules for calculating synthetic observations, complete set of observations of key jet properties, multi-wavelength space and ground-based observations, laser lab experiments, and theoretical models. The network will provide multidisciplinary training at the European level for the younger researchers who would acquire expertise in plasma physics, theoretical physics, observational techniques, laboratory experiments, computer science (numerical simulation techniques and Grid technology) and personal skills (management, presentation and collaborative techniques).

4.5 The Mid-Infrared Instrument – MIRI

Collaborative work led by T.P. Ray on the design (with the University of Stockholm) and manufacture of the dichroics and filters for the Mid-Infrared Instrument (MIRI) on board the James Webb Space Telescope (JWST) is continuing to schedule. E. Flood is assisting with the administration of this project. A contract was signed between DIAS and the Mid-Infrared Laboratories of the University of Reading to produce all of the required dichroics for the spectrograph and all of the

long wavelength imager filters. The shorter wavelength imager and coronagraph filters are been produced by Spectrogon in Stockholm under a separate contract with the University of Stockholm. The current schedule requires a number of representative dichroics and imager filters to be ready early in the new year for insertion in the Verification Model (VM). Towards the end of 2004, MIRI passed its Concept Design Review (CDR).

The MIRI European Consortium held a meeting in the Bedford Suite, Dublin Castle from 6-8 December. Approximately 40 people, including a number of ESA representatives attended. Dinner was hosted by DIAS for the attendees in the Coach House of Dublin Castle. E. Flood, H. O'Donnell and A. Grace assisted with the organisation.

4.6 Visiting Researchers

David Bartlett NRPB; Peter Beck, ARCS; Eric Benton *University of San Francisco*; Jean-François Bottollier-Depois, IPSN; Emma Brannigan *University of Hertfordshire*, 1-5 November, 2004; C. del Burgo ESTEC; A. Chapman *Oxford*; Antonio Chrysostomou, *University of Hertfordshire*, 1-5 November, 2004; Professor Pat Diamond, *University of California, San Diego*, 13 February; David W. Eaton, *University of Western Ontario*; S. Ferrer, *Murcia, Spain*; B. Frye *Princeton*, Luke Hager, *NRPB*; J. Hartwell *Birmingham*, Simon Jeffery, *Armagh Observatory*; Jan-Erik Kyllonen *SSI*; David Maurin, *CEA Saclay*, 16-20 August, 1-22 December; F. Murtagh *Belfast*; H. Olthof ESTEC; M. Sawicki *Dominion Observatory*; Alexander Scholz, *Thüringer Landessternwarte Tautenburg*, 3-7 December; S. Schmeja, *Astrophysikalisches Institut Potsdam*, 15-22 June; Luigi Tommasino, APAT; Frank Wissmann, *PTB*.

4.7 Research visits by School staff

C. Combet
Institut d'Astrophysique de Paris, 4-8 October

D. Froebrich
Tautenburg Observatory, 5-9 January; Potsdam, 19-21 January; Armagh, 24-25 February; Tautenburg Observatory, 24-28 May

B.D. Jordan
Abastumani Astrophysical Observatory, Georgia, 10-15 May.

E.J.A. Meurs
ESO, 12-13 October

G.C. Murphy
NASA Goddard Space Flight Center, Greenbelt, Maryland, 14-18 June

T.P. Ray
University of Hertfordshire, 3-4 May, 2004

E. Whelan
University of Hertfordshire, 4-11 May, 2004

4.8 Staff acting as external examiners

E.J.A. Meurs acted as external examiner for the PhD Thesis of J. Hartwell, Birmingham, entitled "An X-ray study of the impact of star formation: from star clusters to starbursts".

5 Public outreach activities

5.1 Public Lectures

D. Coffey
"Star formation: An introduction", Irish Astronomical Association, Belfast, February.

D. Froebrich
"1, 2, 3, 4, ...many – Astrophysics via star counts", Dunsink Observatory, 20 October/3 November; "To the moon, the stars, and beyond – measuring distances throughout the Universe, Dunsink Observatory, 17 November/1 December.

5.2 Statutory Public Lecture

The Statutory Public Lecture was held on 24 November at TCD by Dr H. Olthof of ESTEC (Noordwijk, NL), on "Huygens and Titan: from discovery to encounter", in view of the upcoming landing of the Huygens space probe on Saturn's moon Titan in January 2005.

5.3 Dunsink Open Nights

As usual the regular Open Nights programme for the general public was held twice monthly over the Winter/Spring months. Until Spring these were led by W. Dumpleton until his retirement.

From the Autumn, H. O'Donnell took over with assistance from the Astronomy and Astrophysics Section staff. Members of the Irish Astronomical Society (IAS) provided organisational support for these evenings which were well attended.

On 17 May E.J.A. Meurs gave a brief background description of the history of Dunsink Observatory for School staff.

5.4 Transit of Venus on 8 June

The transit of Venus was observed and recorded using both the Celestron 8 inch reflector and the 12.5 inch refractor. The 8 inch telescope was equipped with the Dunsink Apogee CCD camera and images were acquired and posted on the DIAS web page during the course of the transit (B.D. Jordan, M. Smyth, B. O. Halloran, C. Melody, P. Ward). The difficult weather conditions caused the images to be of varying quality. Images were also obtained in sunnier conditions, in Italy, and these have also been posted on the web-pages (E.J.A. Meurs). The original intention to analyse these pictures in conjunction did not appear feasible due to the effects of the poor Dublin observing conditions.

A special TV and time recording system was assembled and mounted on the 12.5 inch telescope to follow the transit. The system consists of an integrating TV camera to record the image and a second CCTV type camera to record the image of a real time digital clock display. The signals from both cameras are fed to a standard video tape recorder via a video mixer. The integrating TV camera was mounted in the focal plane assembly of the 12.5 inch refractor telescope and the event was displayed with the superimposed clock image on a TV monitor and recorded on videotape, thus providing an accurate time determination of ingress and egress of the transit.

6 Participation in outside committees

L. Drury
Served on the Space Science Advisory Committee of the European Space Agency, the Fachbeirat of the Max-Planck-Institut für Kernphysik in Heidelberg, the Joint Management Committee of the Armagh Observatory and Planetarium, the Council of the Royal

Irish Academy, the Academy Committee for Astronomy and Space Research, as Chairman of the Hamilton Bicentenary Committee of the RIA, and as Secretary for International Relations of the Royal Irish Academy.

B. Jordan
Was a member of the REM Technical Team.

C. Melody
Became a member of the Local Organising Committee for IAU Symposium No 230, to be held in Dublin in August 2005, with special responsibility for the web-site of the symposium and for the conference poster.

E.J.A. Meurs
Served on the Astronomy Working Group of the European Space Agency, on the REM Science Team and on the REM Proposal Evaluation Panel, on the DCU Physics Programme Board, and on the National Committee for Astronomy and Space Science of the Royal Irish Academy. He also served on the time allocation committee AO4 OTAC D2 for XMM-Newton and as expert referee for research project evaluations for the Italian Space Agency (ASI). He became Chair of the Scientific Organising Committee for IAU Symposium No 230, to be held in Dublin in August 2005.

D. O'Sullivan
Was appointed a member of the joint international ICRP/ICRU Committee on Cosmic Radiation and Air-crew and to the Review Panel of the Swedish National Space Board.

T.P. Ray
Served on the new Physical Sciences Committee of the Royal Irish Academy, the European Space Agency MIRI Steering Committee, as Chair of the Transit of Venus Committee and as Chair of the MERLIN Panel for Allocation of Telescope Time Committee under PPARC.

7 Attendance at external conferences, seminars, courses and meetings

D. Coffey
Joint ASGI/IoP meeting, Armagh, 1-3 April; Cores, Disks, Jets and Outflows 2004 Conference, Banff, Canada, 10-18 July; Birth, Life and Death of Stars, European Space Agency Summer School, Alpbach, Austria, 29 June - 6 July; ASGI meeting, University College Dublin, Belfield, 10 September.

C. Combet
EGEE meeting, Cork, 19-22 April; "Semaine de l'Astrophysique Française 2004", 14-18 June; Aussois Summer School "Dynamique des fluides et simulations numérqiues associees", 26 Sept - 1 Oct.

J. Donnelly
35th COSPAR Scientific Assembly, Paris, 18-25 July.

S. Dudzinski
Fosdem Event, Brussels, 21-23 February; System Administrator Training Course, Bristol, 10 March; Technical Conference on System Administration, Amsterdam, 26 September - 2 October.

L. Drury
SSAC, Paris, 21-22 January; Management Committee, Armagh, 17 February; Joint ASGI/IoP meeting, Armagh, 1-3 April; HESS Consortium meeting, Paris, 4-7 April; EGEE meeting, Cork, 19-22 April; HESS SNR working group meeting, Heidelberg 13-16 May; COSPAR meeting, Paris, 18-21 July; Alan Watson Symposium, Leeds, 22-23 July; Gamma-2004 meeting, Heidelberg, 26-30 July; Korean Astrophysical Workshop, 16-21 August; ESA Cosmic Vision presentations, Paris, 15-16 September; SSAC, Estec, 19-20 October; Collisionless Shocks meeting, Paris, 3-5 November; MPI Kernphysik symposium, Heidelberg, 2-3 December.

E. Flood
DOSMAX Meeting, Dublin, June; DOSMAX Meeting, Rome, 26 September - 4 October; MIRI Meeting, Dublin Castle, 6-8 December.

D. Froebrich
Joint ASGI/IoP Meeting, Armagh, 1-4 April; EGEE meeting, Cork, 19-22 April; Cores, Disks, Jets and Outflows 2004 Conference, Banff, Canada, 10-18 July; Jets and Star Formation Workshop, Armagh Observatory, 4-7 October.

A. Grace
MIRI Meeting, Dublin Castle, 6-8 December

À. Gras-Velázquez
Cores, Disks, Jets and Outflows 2004 Conference, Banff, Canada, 10-18 July.

B. D. Jordan
Birr Castle, ARTI meeting, 7 February.

T. Kiang
6-day course "Scientific English for Chinese Scientific Researchers", Urumqi Astronomical Statation, National Observatories of China, October; Second Annual Scientific Meeting of the Chinese Astronomical Society, Xiamen, 7-12 November.

T. Lery
JETSET Meeting Paris, 8-11 June; Apple Developers Conference WWDC 2004, San Francisco, 27 June - 2 July; Magnetic Fields in the Universe Conference, Angra dos Reis, Brazil, 27 November - 5 December; Laser and Plasma Institute General Meeting Paris, 8-9 December.

F. McGroarty
Joint ASGI/IoP Meeting, Armagh, 1-4 April.

C. Melody
ASGI Spring meeting, Armagh, 1-4 April; Massive stars in interacting binaries, Montreal, 15-21 August; ASGI Autumn meeting, UCD, 10 September.

E.J.A. Meurs
AWG ESA, Paris, 14-16 January; Astronomical Virtual Observatory Meeting, ESO, Garching, 26-28 January; Physics Programme Board meeting, DCU, 10 March; PhD Examination Panel, Birmingham, 17 March; ASGI Spring meeting, Armagh, 2 April; Rome Observatory, Monte Porzio, 6-19 April; REM Science Team meeting, Brera Observatory, Milan-Merate, 11 May; AWG ESA, Paris, 13-114 May; Department of Education and Science, 2 June; National Committee for Astronomy and Space Science, RIA, 3 June; Venus Transit, Rome, 6-8 June; AWG ESA, Paris, 28-30 June; ASGI Autumn meeting, UCD, 10 September; Cosmic Vision Conference, UNESCO building, Paris, 14-16 September; AWG ESA, ESTEC, 27-28 September; GRBs in the Afterglow Era, Rome, 19-22 October; XMM Newton OTAC meeting, Vilspa, Madrid, 21-23 November.

G.C. Murphy
EGEE meeting, Cork, 19-22 April; GR17 Conference, Dublin, 18th - 23 July; ASGI meeting, University College Dublin, Belfield, 10 September.

L. Norci
Starbursts: From 30 Doradus to Lyman break galaxies, Cambridge, 5-10 September.

D. O'Sullivan
DOSMAX Meeting, Rome, 24-30 September.

T.P. Ray
Star Formation Workshop, Leeds, 12-14 January; Meeting with MIRI filter/dichroic contractor, University of Reading, 3 February; MIRI European Consortium Meeting, Liege, 4-5 February; PPARC Strategy Meeting, Swindon, 12-14 May; MIRI European Consortium Meeting, Heidelberg, 24-26 May; Royal Astronomical

Society Meeting on Star Formation, London, 8-9 October: Star Formation Conference, Volterra, Florence, 16-22 October: American Physical Society Conference on Astrophysical Jets, Savannah, Georgia 15-19 November; MIRI European Consortium Meeting, Dublin Castle, 6-8 December; MIRI Oversight Committee Meeting, Abingdon, Oxfordshire, 13-14 December.

P. Ward
ASGI Spring meeting, Armagh, 1-4 April; ASGI Autumn meeting, UCD, 10 September; Gamma Ray Bursts in the Afterglow Era, Rome, 19-22 October.

E. T. Whelan
Joint ASGI/IoP Meeting, Armagh, 1-3 April; Cores, Disks, Jets and Outflows 2004 Conference, Banff, Canada, 10-18 July.

D. Zhou
COSPAR meeting, Paris, 18-21 July; DOSMAX Meeting, Dublin, June.

8 Training

Grid Site Administrators Course In September 2003, a three-day course for site administrators was co-organised by DIAS and TCD. Fifteen participants representing most of the CosmoGrid partners attended. The course took place in DIAS.

Grid-users Course
In December a two-day Introductory (GRID) Users Course was held in DIAS. There were 18 participants including researchers from Armagh, NUI Galway, UCC, UCD, DIAS and TCD.

9 Computational Resources

S. Dudzinski, D. Golden, B. Jordan, T. Lery, C. Melody, B. O'Halloran, and M. Smyth

9.1 Infrastructure

The computers infrastructure in DIAS was radically overhauled in 2004. DIAS has decided to install a unified authentication scheme for user accounts and services via OpenLDAP. The IPv6 integration is ongoing on the main network. A VoIP project is being planned and will provide a cheap and reliable alternative to analog telephony in the not too distant future. New servers and services have also been introduced to provide users with a comfortable level of disk space to facilitate their research and their need for data storage (including a twelve-fold increase), giving 7 TBytes in total.

An IT consultancy company, Lionra Support Services, was contracted to provide software support for the Dunsink LAN. A software engineer visits Dunsink for one day per month to carry out routine software maintenance tasks. On-site system administration was provided at first by B. O'Halloran, followed by C. Melody. The antenna for the Wireless Data Link was relocated to the roof of Dunsink House to improve the reliability and performance of the link.

9.2 Video-Conferencing

DIAS was equipped in 2004 to participate in the AccessGrid (http://www.accessgrid.org/) video conferencing system as an AccessGrid node. Several computer servers, video cameras, video projectors and screens, and an echo cancellation DSP unit were purchased and set up in the School. Unlike most other video conferencing systems, AccessGrid is primarily oriented towards supporting several participating sites, each with several people in attendance at each meeting. DIAS, representing the Cosmogrid consortium, has acquired a new collaborative tool called Breeze, provided by Macromedia, in order to communicate more

efficiently between the various partners. This integrated solution provides both real-time online meetings and on demand presentations and elearning courses.

10 Miscellanea

A bid to organise a Symposium of the International Astronomical Union in Dublin on a topical subject of high-energy astronomy was successful: IAU Symposium No 230 on "Populations of high energy sources in galaxies" will be held in August 2005. The Scientific Organising Committee is Chaired by E.J.A. Meurs, the Local Organising Committee by B. McBreen of UCD.

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

G. Daly continued maintenance work on the clocks at Dunsink Observatory.

W. Dumpleton and E.J.A. Meurs were interviewed for RTE Radio 1 about the Dunsink Open Nights programme. This was broadcast on 4 March.

First year Physics and Astronomy students from DCU visited Dunsink Observatory on 24 March and 28 April for a tour of observatory equipment and practical experience with astronomical data analysis software (E.J.A. Meurs, P. Ward, L. Norci).

On 23 April a group of students attending Physics and Astronomy at Groningen University (NL) visited Dunsink Observatory, as part of their tour of Ireland.

On 16 October the annual Hamilton Walk started at Dunsink Observatory.

School of Cosmic Physics – Geophysics

1. Section members

Senior Professor:
Alan Jones

Assistant Professors:
Brian O'Reilly, Peter Readman

Experimental Officer:
Tom Blake

Schrödinger Fellow:
Xavier Garcia (from December)

Senior Technical Assistants:
Clare Horan,
Gerry Wallace

Technical Assistants:
Louise Collins (nee Quigley), Jessica Spratt

Clerical Staff:
Anne Byrne

Project Staff:
Dmitry Avdeev, Senior CosmoGrid Fellow (from March), Laurent Gernigon, HADES Fellow, C.K. Rao, ISLE-MT Fellow (from January), Celine Ravaut, HADES Fellow, Ute Weckmann, Emmy Noether Fellow (from April), Tadashi Yamasaki, CosmoGrid Fellow (from June)

Scholars:
Max Moorkamp, ISLE-MT (from January), Anna Avdeeva, CosmoGrid (from March), Van Chuong Do, ISLE, Anne Chabert, HADES, Mark Hamilton, SAMTEX (from March), John Sheehan, Geodynamics (from January)

Honorary Professor:
Colin Brown, NUI, Galway

Visitors:
David Eaton, Western Ontario (Canada), Franz Hauser, Karlsruhe (Germany)

2. General

The Section grew considerably in breadth and depth during 2004 with the addition of staff, fellows and students. Two new areas were added to the Section's traditional geophysical research interests of passive and active seismology and potential fields. These were electromagnetic methods, the focus of Alan Jones' research, and geodynamic modelling, led by CosmoGrid Fellow Tadashi Yamasaki. By late 2004 there were 22 members in the Section, plus two visitors, compared to eight in the section in mid-2003. This unprecedented rapid growth of Geophysics within the School is cementing the important contribution that the School can make in Irish science. In addition, efforts were made to expand the activities of the Section to embrace major European and global initiatives and projects.

The international project that took much of the Section's resources is SAMTEX, the Southern African Magnetotelluric Experiment. SAMTEX is unparalleled in scale – it is the largest experiment of its kind ever conducted and involves scientists from academic, government and industry coming together for a common goal of elucidating early Earth history by studying the Archean tectonic history of southern Africa.

Staying within Africa, the AfricaArray project (africaarray.psu.edu), led by Professors Andy Nyblade (Pennsylvania State University) and Paul Dirks (the University of the Witwatersrand), is a unique 20-year initiative that combines education and research within the spirit of NEPAD (New Partnership for Africa's Development, www.nepad.org). As stated on the web site, "the name *"AfricaArray"* refers to an *array* of shared training programs, an *array* of shared scientific observatories, scientists across the continent working on an *array* of shared projects, and above all, a shared vision that Africa will retain capacity in an

array of scientific fields vital to the development of its natural resource sector". The Geophysics Section has indicated its strong desire to be an active participant in AfricaArray, both in terms of training and educating African students and also seeking funding to sponsor geophysical observatories in Africa.

In Europe, an initiative led by Alan Jones, together with Professors Peter Maguire (U. Leicester) and Hans Thybo (U. Copenhagen) has been proposed to European geoscientists for the formation of EuroArray (www.euroarray.org). This project will, over its envisioned 10 year lifetime, map the geological structure of Europe down to 200 km and deeper, and thereby unravel the tectonic history in a true 4-dimensional manner (3 spatial dimensions plus time).

Finally, another initiative that is gaining momentum within Europe is Topo-Europe (www.geo.vu.nl/users/topo/), led by Professor S. Cloetingh (Vrije U., Amsterdam). Topo-Europe's ultimate aim is to understand Europe's continental topography upon which we live. Continental topography is a product of the complex interaction between processes taking place deep within the Earth, on its surface and in the atmosphere. The impact of mantle- and lithospheric-scale processes affecting intraplate areas has only recently been recognised.

3. Electromagnetic activities

3.1. SAMTEX (Southern African Magnetotelluric Experiment)

A.G. Jones, X. Garcia, M. Hamilton, with Geophysics staff and colleagues from Woods Hole Oceanographic Institution (U.S.A.), the Council for Geosciences (South Africa), DeBeers (South Africa), Rio Tinto (Botswana), the University of Witwatersrand (South Africa), and the Geological Surveys of Botswana and Namibia.

The plate tectonic paradigm is a remarkably successful model describing the Earth's dominant tectonic process. There is much debate, however, concerning how far back this paradigm is a valid model to interpret the cryptic rock record. Some argue that it can be validly applied very early in Earth's history (directly after the meteor bombardment at 3.9 Ga). Others argue that plate tectonics, *sensu stricto*, is not applicable before ca. 2.5 Ga, and that other processes, such as sagduction and mantle plumes, dominated during the Archean era. Directly coupled with this question is uncertainty of the formation process of Archean-aged cratonic lithosphere. The extant, competing models reveal our limitations in fundamental information of the sub-continental lithospheric mantle, a knowledge gap that can be partially addressed through obtaining physical and geometrical information of fossil structures using geophysical imaging. To date, this has primarily been undertaken using passive seismology, but over the last eight years Jones has developed and applied deep-probing magnetotellurics (MT) for this problem, and demonstrated that MT data, when combined with other geoscientific information, provides significant constraints on formation processes.

In southern Africa, following on from the National Science Foundation's Continental Dynamics funded

Kaapvaal Project, (www.ciw.edu/mantle/kaapvaal/), the world's largest-ever land-based MT project was initiated in 2003 to study the physical properties and geometries of Archean and Proterozoic lithosphere. This multi-national, multi-institutional project is named SAMTEX, for Southern African Magnetotelluric Experiment, and has, as its primary focus, the imaging the electrical conductivity structure of the Kaapvaal craton and bounding terranes. The project was first conceived by Jones in 1996, and became possible by combining the resources of many funding sources and many groups. The consortium comprises scientists from DIAS, Woods Hole Oceanographic Institution (Woods Hole, Massachusetts, USA), the Council for Geoscience (Pretoria, South Africa), De Beers (Johannesburg, South Africa), Rio Tinto (Gaborone, Botswana), the University of the Witwatersrand (Johannesburg, South Africa), and the Geological Surveys of Botswana (Lobatse, Botswana) and Namibia (Windhoek, Namibia).

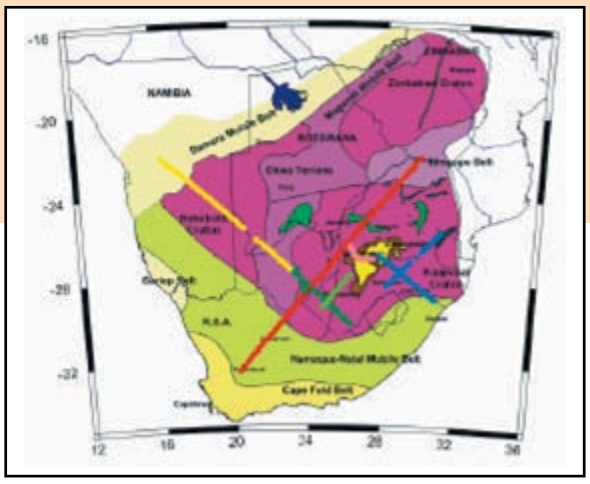


Figure 1: SAMTEX MT station map, 2003-2004

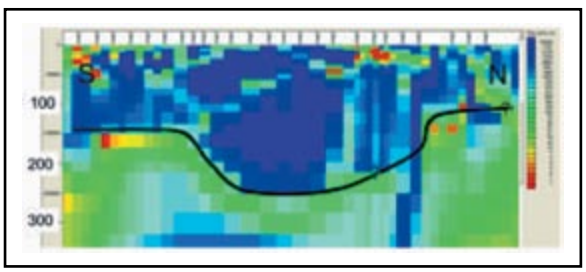


Figure 2: Preliminary 2-D model of the main NE-SW Phase I transect

MT data were acquired on Phase I in 2003 along the main NE-SW profile across the Kaapvaal craton (red squares, Fig. 1). Subsequently, MT data were acquired in 2004 along additional profiles (other coloured squares, Fig. 1). At each location, approx. 20 km apart, broadband MT (BBMT) data were acquired in the period range of 0.01 s to 1,000 s. At each third station long period MT (LMT) data were acquired, in the range 20 – 10,000 s.

A preliminary resistivity model obtained from the Phase I data is shown in Fig. 2. The dominant feature is the imaging of the topology of the base of the electrical lithosphere, with thin lithosphere (~150 km) beneath the Proterozoic mobile belts to the NE (Limpopo) and SW (Namaqua-Natal), and thick lithosphere (up to 260 km) particularly beneath the centre of the Kaapvaal craton. Other features within the model require more detailed analysis and verification. The topology of the lithosphere-asthenosphere boundary is consistent with that known from off-craton and on-craton kimberlite studies. Intriguingly, where the model exhibits greatest thickness in the centre of the Kaapvaal craton is a region absent of kimberlite magmatism, supporting the theory of W. Griffin and colleagues that kimberlites cannot generally penetrate lithosphere that is thicker than about 200 km.

3.2. ISLE-MT

C.K. Rao, M. Moorkamp, A.G. Jones.

ISLE-MT, funded by Enterprise Ireland, is a project following on from the ISLE project (see section 4.2) and is an examination of the Iapetus suture using electromagnetic methods.

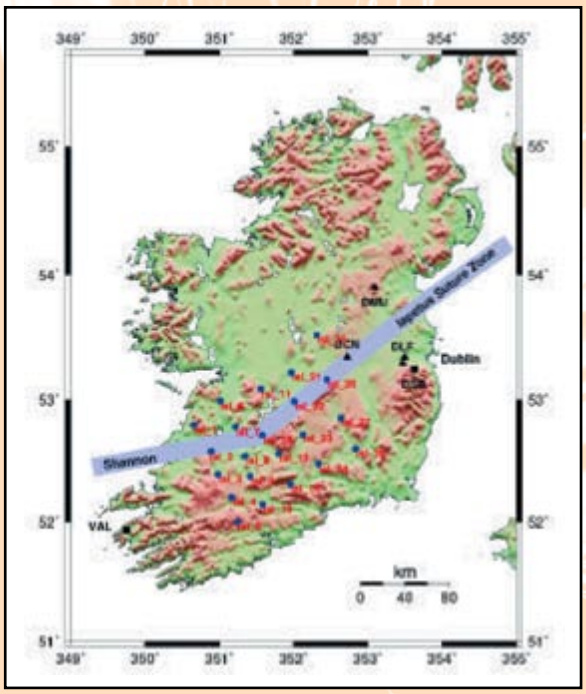


Figure 3: ISLE-MT site locations

After the initial planning and organisation phase in January 2004, field work started in mid-February. Twenty-two long-period sites were installed in south-western Ireland with an average spacing of 20 km and average recording time of three weeks. In addition broadband instruments were installed at each site for two days. Together these measurements cover the frequency range between 0.003 – 10.000 s. Field work was completed in mid-June 2004. Figure 3 shows the location of the sites measured to date.

Already after a preliminary evaluation of the first recorded data, it became obvious that the level of cultural noise is far higher than anticipated. Particularly, electric cow-fences disturbed the high frequency data severely. Due to the high farming activity all over the country, and the requirement to record close to the pre-existing seismic stations, this situation could not

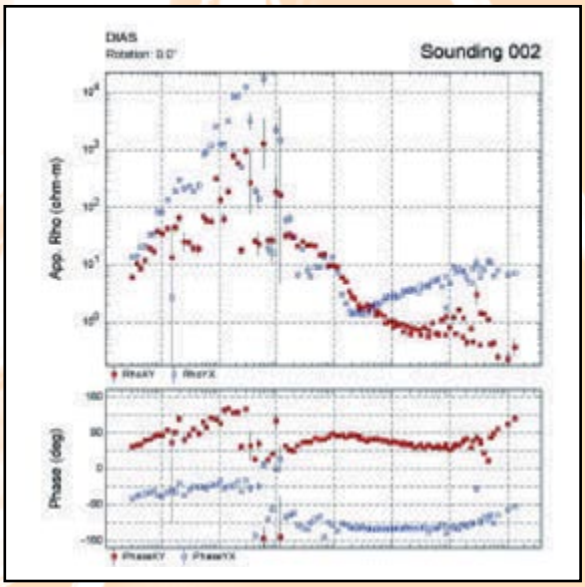


Figure 4: Noise distorted MT data from site 002 of the ISLE-MT project

be avoided during data acquisition stage. Contrary to expectations, the mild winter meant that the cows were not in the barns, as is more common, but were out in the fields. An example of the problem can be seen in Fig. 4, where the high frequency data are highly contaminated by noise.

ISLE-MT modelling

The Postdoctoral Fellow, C.K. Rao, started to analyse the long-period part of the data that was not affected by cultural noise. The analysis of these data was completed at the end of November, 2004 and the first 2-D models were obtained along various profiles of the array. An example is shown in Fig. 5 for the easternmost profile. In addition, 3-D modelling was carried out, using the code of D. Avdeev, to asses the effect of the coastline on the data. This effect was shown to be negligible for most sites.

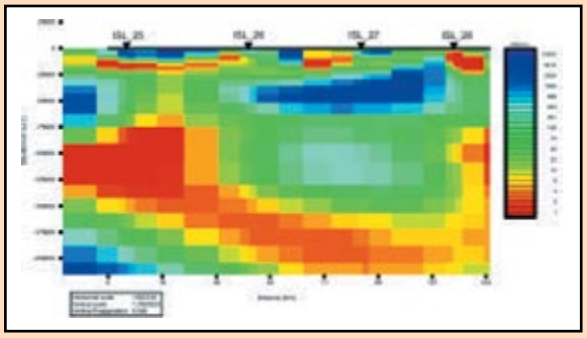


Figure 5: Preliminary model of one of the ISLE-MT profile data

A second phase of field work will be conducted in Summer, 2005. The ISLE seismic experiment has been extended north of the suspected location of the Iapetus suture zone and an extension of the MT experiment to these sites would mean better control on the electrical properties as well. Furthermore, it is desirable to increase data coverage in some critical areas of the existing array, especially if the attempts to remove the cultural noise from the existing recordings should fail. Additional measurements from an experiment that has been designed to deal with that problem can improve the near-surface resolution. This part of the experiment is currently in the planning stage.

Novel data processing

To address the issue of noise, it was decided that the postgraduate student, M. Moorkamp, would spend some of his research time on this problem and develop signal processing methods to try to deal with it. Although this was not part of the original research plan, it can lead to important developments as the problem of cultural noise in electromagnetic recordings is of general interest to the whole geoscientific community. The most promising results so far have been obtained with adaptive filtering methods. These filters are widely used in electrical engineering and medical applications and a vast literature exists for various problems.

Still there are a few problems associated with the application of these filters to magnetotelluric time-series data which will be addressed in the following months.

Joint inversion

Also during 2004, M. Moorkamp developed a first version of a joint inversion code for teleseismic and magnetotelluric data. It is being tested on synthetic data to show the feasibility of this approach and will finally be applied to data from the ISLE-MT project.

3.3. 3D MT modelling/inversion

D. Avdeev and A. Avdeeva.

The 3-D magnetotelluric (MT) inverse problem has a number of inherent problems that lends it to be extremely difficult for numerical solution even on modern computing platforms. First of all, the problem is highly non-linear and ill-posed (as are many inverse problems). Then it is large-scale, usually with tens of thousands of unknowns to be recovered. Practically, this means that the numerical solution of such a problem requires days and months using regular PCs or workstations, and a proper numerical implementation naturally requires a multi-processor framework. The theoretical basis of the 3-D MT inverse problem is unexpectedly difficulty in another unforeseen manner. Most traditional methods previously developed for numerical optimisation are simply not applicable to this large-scale problem, being prohibitive in terms of the computational time and memory required. To find an appropriate way to handle this very complex inverse problem, we have been studying the state-of-the-art in MT inversion and, more generally, numerical optimisation. Preliminary results of this study were summarised in a review paper presented to EM community at the EM Workshop in India. Several up-

to-date numerical optimisation approaches have been chosen as appropriate for the practical solution of the 3-D MT inverse problem. As the first step to solution of the full 3-D problem, we have initiated work on implementation of these approaches to the 1-D MT problem.

3.4. Slave-to-Bear MT project

J.E. Spratt and A.G. Jones, with colleagues from the C.S. Lord Geoscience Centre (Yellowknife, Canada).

The Slave-to-Bear magnetotelluric (MT) profile is a component of the Southern Bear Province Geological Mapping Project run by the C.S. Lord Northern Geoscience Centre in Yellowknife, Canada. One of the main objectives of this project is to understand the nature of the Paleoproterozoic western boundary of the Archean-aged Slave craton in the Northwest Territories of Canada. The MT component was designed in an attempt to define the lithospheric-scale geometry of the transition between the Archean Slave craton and the Bear province.

The Slave-to-Bear magnetotelluric component compliments existing MT data on the Slave craton by extending coverage to the western edge of the Slave craton and determining the lateral extend of the Central Slave mantle conductor (CSMC), a key feature in the crust-mantle relationship formed during the Archean discovered earlier by Jones.

The field component of this project took place in July of 2004 and was led by J. Spratt, with assistance from L. Collins and A. Avdeeva. Broadband and long period MT data were collected at 21 stations along a 300-km-long northwest-southeast profile from the south-central Slave craton to the Bear Province crossing the Paleoproterozoic Wopmay Orogen. Initial processing and preliminary models have been completed to date, and reveal a mildly conductive upper mantle, without the presence of the CSMC, as well as localised conductive regions within the crust of the Slave. Further processing, analysis, and modelling of these data will be undertaken by Spratt, under the guidance of Jones.

The Slave-to-Bear project is funded by the Northwest Territories government of Canada through a grant to the C.S. Lord Geoscience Centre.

3.5. Inkaba yeAfrica

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

South Africa hosts two of the Earth's largest known geophysical anomalies, the Beattie Magnetic Anomaly (BMA) and the Southern Cape Conductive Belt (SCCB), that extend for almost 1000 km in an east-west direction, and possibly continue into Antarctica and South America. In South Africa the surface expressions of these anomalies appear to coincide with the mapped boundaries of the Cape Fold Belt and the Namaqua-Natal Mobile Belt. However, the nature of both anomalies remains enigmatic. They have been interpreted as a slice of paleaooceanic lithosphere or alternatively as thrust zones, but the existence of a common source, their extent and internal structures are all unknown.

A high resolution magnetotelluric study was conducted in March 2004 by the German GeoForschungsZentrum Potsdam (GFZ) as part of the multidisciplinary integrated German-South African research project *Inkaba yeAfrica*. MT data were collected at 82 sites along a 150 km long profile with a site spacing of 2 km between Prince Albert and Fraserburg crossing the BMA and the SCCB

in their entirety. The data have been analysed and interpreted at DIAS by U. Weckmann, who is currently spending two years at the institute within her German Science Foundation Emmy Noether scholarship. Co-operation with the SAMTEX project provides the opportunity of a better understanding of cratons and their surrounding mobile belts.

With the new high resolution MT data conductivity structures can be resolved associated with both geophysical anomalies. Two-dimensional inversion models resolve the conductivity distribution of the entire crust. A zone of very high electrical conductivity (~1 Ω.m), at a depth of approximately 5-10 km, seems to be associated with the BMA. Another conductivity anomaly is located beneath the northern boundary of the SCCB, extending from the shallow crust down to approx. 15 km depth. Both conductors are inclined towards the south, which coincides with a general southward-dipping trend of mapped faults of the Cape Fold Belt and the Namaqua-Natal Mobile Belt. These high conductivity anomalies are therefore interpreted as images of tectonic structures which may have evolved during the formation of the Karoo basin. The conductivity image furthermore reveals several sub-horizontal regions of high conductivity (2 Ω.m) in the upper 5 km of the crust, which may reflect sedimentary sequences of the Karoo Basin.

4. Seismological activities

4.1. HADES

P.W. Readman, B.M. O'Reilly, C. Ravaut, L. Gernigon, A. Chabert with P.M. Shannon of UCD.

There are two main aspects to the HADES (Hatton Deep Seismic) project, which is a part of the Irish National Seabed Survey. The first is to resolve in detail the structure of the Hatton Continent-Ocean boundary and axial structure of the Hatton Basin using wide-angle seismic methods. Seismic data was recorded by 300 ocean bottom seismometers (OBS) along three profiles with a total of distance of over 1000 km. During 2004, the data were processed and formatted, and first arrivals were picked and interpreted. The close OBS and shot spacings (3 km and 120 m respectively) resulted in a vast quantity of excellent quality data. In view of this it was decided to use a first arrival tomographic inversion approach to develop an initial crustal velocity model. Features of the derived preliminary models correlate well with gravity and magnetic field variations and with the seismic stratigraphy of the margin determined by nearby seismic reflection profiles. The model that crosses the continental crust of the Hatton Basin compares well with previous wide-angle models from the RAPIDS 1 and 2 experiments, but is of far higher resolution. The main features of the upper crustal model are two topographic highs separating sedimentary basins with sediment velocities of 2.5 – 3.5 km/s. The model also resolves four high velocity (7.2 – 7.3 km/s) regions in the crust, probably related to Cenozoic magmatic underplating along the Hatton Continental Margin.

The second aspect of the project is aimed at an improved understanding of the development of the whole region by integration of the results of these data, and previous wide-angle seismic data, with other geophysical and geological data. The North Atlantic rifted margins' area is usually characterised by a combination of regional uplift, crustal extension and magmatism leading to the formation of seaward dipping reflectors. The temporal and spatial relationships of these volcanotectonic processes are usually interpreted as the response to a deep mantle anomaly. Our integration of new seismic reflection,

potential field and well calibration data has allowed a clarification of the structure and stratigraphy of the Hatton Continental Margin, and its variation along the margin.

Funding for HADES is provided by the Geological Survey of Ireland and the Irish Petroleum Infrastructure Programme.

4.2. ISLE

P.W. Readman, V.C. Do and B.M. O'Reilly with Geophysics staff, and colleagues from the University of Karlsruhe.

The ISLE (Irish Seismological Lithospheric Experiment) experiment recorded data through 2004 (see example of seismograms in Fig. 6) and is planned to continue through 2005 to obtain more high-quality events from directions at higher angles to the Iapetus Suture Zone (most of the events recorded to date originate from azimuths close to the suture direction).

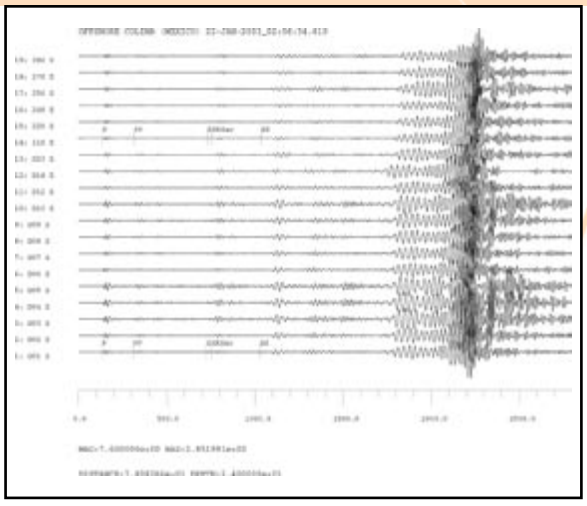


Figure 6: Example seismograms recorded by the ISLE network. Records are from a magnitude 7.6 Mexican earthquake that occurred on 22 January 2003

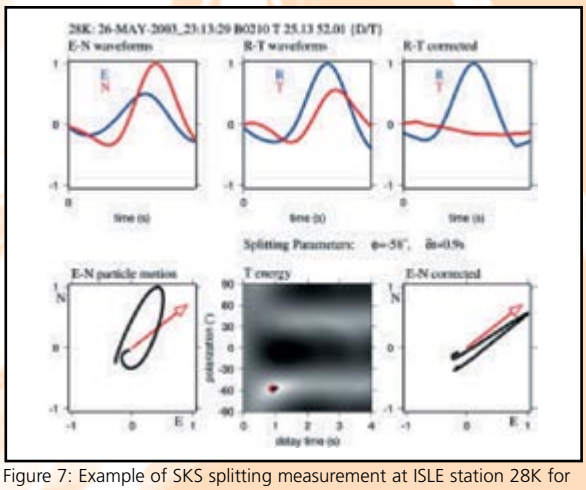


Figure 7: Example of SKS splitting measurement at ISLE station 28K for a deep focus event on 26 May 2003, Mindanao, Phillippines (Mb 6.8, epicentral distance: 108°, depth: 560 km)

Redeployment of some ISLE stations to increase the geographical coverage of the investigation further north into Co. Mayo and southwards towards the southwest coast was undertaken during the year. Detailed analysis of the data collected during 2003 (see example SKS analysis in Fig. 7) indicated that although nearly 100 teleseismic events have the correct parameters, regarding distance and azimuth, there were fewer than expected deep focus events that are necessary to produce the most reliable results from shear-wave splitting analysis.

In addition, detailed analysis of the data collected during the last ten years from the permanent broadband network stations DSB and VAL was undertaken. Also, analysis of controlled source S-wave data acquired during the VARNET experiment was started in order to investigate crustal anisotropy and its contribution to the total anisotropy observed in the ISLE teleseismic data.

The ISLE project is funded by an Enterprise Ireland Basic Research Grant.

4.3. The Seismic Network

T.A. Blake, G. Wallace, C. Horan and L. Collins.

General

The annual archiving of the previous years' waveform data from all our fixed location seismic stations was completed and stored on CD. The parameter data for all regional and teleseismic events recorded by the seismic network was transmitted to the International Seismological Commission and other agencies as usual.

The broadband digital seismic station DSB of the German GEOFON international seismic network (www.gfzpotsdam.de/geofon) continued to record efficiently, and the waveform data of the St. Stephen's Day SE Asian earthquake and tsunami from this station (the largest event recorded this year) was available on the INTERNET twenty minutes after the data had been recorded. This event generated very large public and media interest.

DNET (DLF, DCN, DMUB)

Routine repairs carried out on the network included repairs to the demodulator at Lyons Farm (DLF) in January and August and the Amp-Mod in September and November. The waveform data for DLF, and the telemetered stations DMUB and DCN, are now being recorded in the internationally-accepted miniSEED format using a recently acquired, new-generation 24-bit EDL data logger. This enables us to comply with international data recording format practices and facilitates easier international waveform data exchange with other seismic observatories.

The backup of data to DAT tapes ceased in December. Raw data are now written to DVD.

Broadband station at Valentia Meteorological Observatory (VAL)

As part of the ongoing provision of technical support, Met Éireann staff, who manage the seismic station in Valentia, visited DIAS in 27-28 September for training and general discussion of data management. Data from the station at Valentia continued to be archived with the DIAS network data. Data are now being written to CD.

Requests for information

During the year the Geophysics Section dealt with numerous requests from the media and the public relating to earthquakes in general and specific information on the location of specific events. This is particularly so in relation to high earthquake risk areas, e.g., Thailand, frequented by Irish holidaymakers. The Section sent out specific information relating to earthquakes which was requested particularly by both Primary and Secondary Schools.

Recorded events

There was a magnitude 2.1 M_L event in the Irish Sea (45 km west of Holyhead) on 10 November. Magnitude 3.1 M_L events in the UK occurred near Bridgewater, Somerset (two on 29 January) and in Oldham near Manchester on (29 February). Between October and December there were at least 39 events in the Eskdalemuir area of Scotland, the largest of which occurred on 28 November (2.9 M_L). Earthquakes occurred on the Polish/Slovak border (30 November, 4.7 Mw) and Germany (5 December, 4.6 Mw).

The magnitude 9.0 Mw Sumatra earthquake that occurred on 26 December is the third largest earthquake in the world since 1900, and an aftershock on 28 March 2005 is the fifth largest. These earthquakes were detected by all of the Irish seismic network stations.

Other significant earthquakes detected include one off the coast of Morocco (24 February, 6.4 Mw), two of the coast of Honshu, Japan on 5 December (7.2 Mw and 7.4 Mw) and one north of the Macquaire Islands (23 December, 8.1 Mw).

4.4. RAPIDS 3 and 4

B.M. O'Reilly, P.W. Readman with P.M. Shannon (UCD).

Forward modelling of the data from the RAPIDS 4 (Rockall and Porcupine Irish Deep Seismics) wide-angle profile across the Porcupine Basin was initiated in late 2004. This is a large dataset involving 65 ocean bottom seismometer positions with shots from an array of airguns at 100-150 m intervals. RAPIDS 4 was designed to test previously formulated ideas about the formation of the basin based on potential field studies and the results of the earlier RAPIDS 1-3 experiments. A preliminary model has been developed from observations of first P-wave arrivals and shows an asymmetric sedimentary sequence over a highly thinned crust. The model requires further refinement using later reflected arrivals and tomographic inversion approaches.

Acquisition of the RAPIDS 3 and 4 data was funded by the Rockall Studies Group and the Porcupine Studies Group (PSG) of the Irish Petroleum Infrastructure Programme (PIP) respectively. The interpretation is now funded by the Geological Survey of Ireland and PIP as part of the Irish National Seabed Survey.

4.5. EAGLE

B.M. O'Reilly with G.R. Keller (UTEP) and P.K.H. Maguire (Leicester) and the EAGLE Working Group.

Interpretation and modelling of the controlled source, wide-angle seismic data, gathered during the Ethiopia Afar Geoscientific Lithospheric Experiment (EAGLE), was carried out during the earlier part of the year both in Dublin and in El Paso in collaboration with UTEP colleagues. The work focused on the wide-angle seismic data acquired along a 450 km profile that runs down the rift axis. These data have been interpreted, and a crustal and sub-Moho P-wave seismic velocity model has been developed. The main features of this model are a dramatic thinning of the crust along the rift northwards towards the Afar region, which is accompanied by an increase in upper to mid-crustal velocities. An additional feature is the presence of a high velocity lower crustal body beneath the northwest margin of the rift and also a deep reflecting horizon within the upper mantle. Additional signal processing is been carried out on the data at the University of Texas at El Paso to try to improve the signal to noise ratio. This is low at larger offsets along the rift axis, and future modelling efforts await the outcome of this processing.

4.6. TRIM

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

Results from TRIM (TOBI Rockall Irish Margins), a large-scale project funded by the Rockall Studies Group (RSG) as part of the Irish Petroleum Infrastructure Programme (PIP), continued to be published and presented at conferences and meetings during the year. Two papers on slope stability processes and canyon development also reached advanced stages of preparation. An example of the sidescan image of carbonate mound populations is shown in Fig. 8.

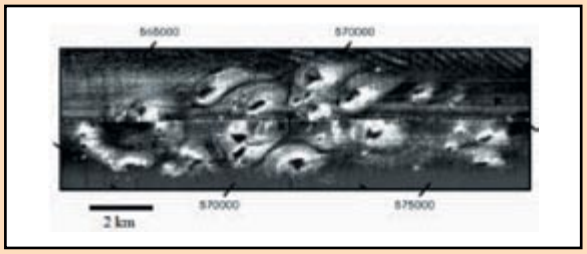


Figure 8: TOBI sidescan image of part of a carbonate mound population on the Porcupine Bank

4.7. NABASK

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

On the NABASK project (North Atlantic Basin Kinematics) the emphasis has shifted through the year from analysis of potential field data to onshore recording of an extensive wide-angle offshore seismic survey in the Porcupine Basin carried out by GEOMAR in April/May. Seven seismic stations were redeployed from the ISLE locations and installed in west Cork and the Dingle Peninsula. The data will yield information from the Irish continental shelf region and so will form an important link between RAPIDS 4 and the onshore VARNET experimental results. A preliminary inspection of the data indicates that the seismic energy from the airgun array propagated up to 150 km.

5. Geodynamic modelling

T. Yamaski, J. Sheehan, B.M. O'Reilly and P.W. Readman.

This research project started during the year with the recruitment of a research fellow in the Cosmogrid project and a School-funded research student. It is planned to implement and develop modelling codes and carry out numerical experiments on the complex rheological effects that lead to the formation of large-scale Earth structures. The initial research target will be Mesozoic/Cenozoic basin and continental margin development in the North Atlantic.

In the last few decades, many studies have discussed the importance of thermal evolution on the variability of extensional deformation of the lithosphere through temperature dependent viscosity. However, the strength of the lithosphere can be changed by several means other than temperature changes. In this project, we will examine the effect of reaction-related changes in rheological properties on the development of a sedimentary basin.

An example of the types of problems that we will study is that detailed seismic observations have revealed the presence of a high velocity zone just below the Moho that may imply magmatic underplating or serpentinisation of the peridotite beneath the extensional structure. However, it is not well understood how important these effects are for the development of basin geometry. Ultimately our target is specifically to investigate the effect of serpentinisation of mantle peridotite on the geometry of a sedimentary basin, including the effect of strain localisation in the lithosphere. Our contributions will provide new insights into the evolution of passive continental margins from the view point of lithospheric rheology, especially with respect to asymmetric extension of the lithosphere.

6. Technical/Support Activities

6.1. Technical support

G. Wallace, C. Horan, L. Collins and J. Spratt.

In addition to the maintenance, testing and shipping of field equipment (including seismic network equipment), technical staff were involved in the deployment and retrieval of the equipment and data processing for the following projects: Porcupine, ISLE and ISLE-MT, SAMTEX and Slave2Bear.

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.

The Geophysics web page is maintained by L. Collins. C. Horan assists in the production of graphics for papers, publications and posters.

6.2. Computer network

G. Wallace and T. Blake.

G. Wallace maintained the PC network and was back-up to S. Dudzinski for the main computer system. The computer network continued to expand as new staff took up position in the Institute through 2004. A policy decision was taken to move, whenever practical, computer users to a Linux/Unix based platform. In regard to software it was decided to investigate our software needs and determine if they can be met by freeware as opposed to expensive commercial products. It was agreed that closer monitoring of computer expenditure, e.g., in relation to contracts, in the hardware/software areas and looking at alternative sources for supplies would lead to greater savings in the computer budget.

7. Publications

7.1. Publications – International literature

1. **Eaton, D.W., A.G. Jones** and I.J. Ferguson, Lithospheric anisotropy structure inferred from collocated teleseismic and magnetotelluric observations: Great Slave Lake shear zone, northern Canada, *Geophysical Research Letters*, **31**, L19614, doi: 10.1029/2004GL020939.

2. **Jones, A.G.** and J.A. Craven, Area selection for diamond exploration using deep-probing electromagnetic surveying, *Lithos*, **77**, 765-782.

3. Landes, M., J.R.R. Ritter, **V.C. Do, P.W. Readman** and **B.M. O'Reilly**, Passive teleseismic experiment explores the deep subsurface of Southern Ireland, *EOS transactions AGU*, **85**, 337, 341.

4. Ledo, J., **A.G. Jones**, I.J. Ferguson and L. Wolynec, Lithospheric structure of the Yukon, Northern Canadian Cordillera, obtained from magnetotelluric data, *Journal of Geophysical Research,* **109**, B04410-1 – B04410-15, doi: 10.1029/2003JB002516, 2004.

5. Mechie, J., S.V. Sobolev, L. Ratschbacher, A. Yu. Babeyko, G. Bock, **A.G. Jones**, K.D. Nelson, K.D. Solon, L.D. Brown, and W. Zhao, Precise temperature estimation in the Tibetan crust from seismic detection of the alpha-beta quartz transition, *Geology*, **32**, 601-604.

6. **O'Reilly, B.M, P.W. Readman** and P.M. Shannon, Cold-water coral mounds: Evidence for early Holocene climate change and slope failure, *Geophysical Research Letters*, **31**, L07204 10.1029/2003GL018619.

7. O'Dowd, C.R., **D.W. Eaton**, D. Forsyth, and H.W. Asmis, Crustal structure of the Grenville Orogen in the Greater Toronto area, *Tectonophysics*, **388**, 145-159.

8. Operto S., **C. Ravaut**, L. Improta, J. Virieux, A. Herrero, and P. Dell'Aversana, Quantitative imaging of complex structures from dense wideaperture seismic data by multiscale traveltime and waveform inversion: a case of study, *Geophysical Prospecting*, **52**, 625-651.

9. **Ravaut C.,** S. Operto, L. Improta, A. Herrero, J. Virieux, and P. Dell'Aversana, Quantitative imaging of complex structures from multi-fold wideaperture seismic data by frequency domain full-waveform inversion: application to a thrust belt, *Geophysical Journal International*, **159**, 1032-1056

10. Unsworth, M., W. Wei, **A.G. Jones,** S. Li, P. Bedrosian, J.R. Booker, S. Jin, and M. Deng, Crustal and upper mantle structure of northern Tibet imaged with magnetotelluric exploration, *Journal of Geophysical Research*, **109**, B02403, doi: 10.1029/2002JB002305.

11. Weber, M., K. Abu-Ayyash, A. Abueladas, A. Agnon, H. Al-Amoush, A. Babeyko, Y. Bartov, M. Baumann, Z. Ben-Avraham, G. Bock, J. Bribach, R. El-Kelani, A. Förster, A., H.-J. Förster, U, Frieslander, Z. Garfunkel, S. Grunewald, S., H. Götze, V. Haak, C. Haberland, M. Hassouneh, S. Helwig, A. Hofstetter, K. Jeckel, D. Kesten, R. Kind, N. Maercklin, J. Mechie, A. Mohsen, F.M. Neubauer, R. Oberensli, I. Qabbani, O. Ritter, G. Rümpker, M. Rybakov, T. Ryberg, F. Scherbaum, J. Schmidt, A. Schulze, S. Sobolev, M. Stiller, H. Thoss, **U. Weckmann**, and K. Wylegalla, The crustal structure of the Dead Sea Transform, *Geophysical Journal International*, **156**, 655-681.

12. **Yamasaki, T.,** Localised rheological weakening by grain-size reduction during lithospheric extension, *Tectonophysics*, **386**, 117-145.

7.2. Publications – Others

13. **Readman, P.W.** and **B.M. O'Reilly**, A cold-water coral carbonate mound population along the western margin of the Porcupine Bank, *In:* M. Parkes (ed.) *Natural and cultural landscapes: the geological foundation*, Royal Irish Academy, Dublin, 41-44.

7.3. In Review

14. **Avdeev, D.B.,** Fast integral equation method for geoelectric forward problems, Moscow: Scientific world, submitted (in Russian).

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

16. **Avdeev, D.,** H. Utada, A. Kuvshinov, T. Koyama, Three-dimensional electromagnetic modelling of the Hawaiian hot-spot swell, *Tectonophysics*, submitted.

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

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

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

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

21. **Jones, A.G.,** and **X. Garcia**. Elecrical resistivity structure of the Yellowknife River Fault Zone and surrounding region, EXTECH-III GAC Special Volume, in press.

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

23. **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, 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, 2005.

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

25. Ledo, J. and **A.G. Jones**, 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 Sciences Letters*, **236**, 258-268, 2005.

26. Li, T. and **D.W. Eaton**, On the roles of magnetisation and topography in the scaling behaviour of magneticanomaly fields, *Geophysical Journal International*, **160**, 46-54, 2005.

27. Martí, A., P. Queralt1, **A.G. Jones** and J. Ledo, Improving Bahr's invariant parameters using the WAL approach, *Geophysical Journal International*, **163**, 38-41, 2005.

28. Maercklin, N., P.A. Bedrosian, C. Haberland, O. Ritter, T. Ryberg, M. Weber, and **U. Weckmann**, Characterising 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, 2005.

29. Michaud, F. **A. Chabert**, J.-Y. Collot, V. Sallarès, E.R. Flueh, P. Charvis, D. Graindorge, M.-A. Gustcher and J. Bialas, Fields of multi-kilometre scale sub-circular depressions in the Carnegie Ridge sedimentary blanket: Effect of underwater carbonate dissolution?, *Marine Geology*, **216**, 205-219, 2005.

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

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

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

33. Solon, K., **A.G. Jones,** K.D. Nelson, M.J. Unsworth, and the INDEPTH MT team, 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, 2005.

34. **Spratt, J., A.G. Jones,** K.D. Nelson, M.J. Unsworth and the INDEPTH MT team, Crustal structure of the India-Asia collision zone, southern Tibet, from INDEPTH MT investigations, *Physics of the Earth and Planetary Interiors*, **150**, 227-237, 2005.

35. Vasudevan, K., **Eaton, D.** and Cook, F., Skeletonisation in the Geosciences, *Geophysical Journal International*, submitted.

36. **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, *Journal of Geophysical Research,* submitted.

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

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

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

40. **Yamasaki, T.,** and T. Seno, 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, 2005.

8. Presentations of research

8.1. Seminars

1. **Jones, A.G.,** Illuminating the Earth: Information from electromagnetic studies at depths of 100 m to 1,000 km. Invited seminar to Geophysical Association of Ireland, Dublin, 20 January.

2. **Jones, A.G.,** Lighting up the lithosphere: electromagnetic studies of the sub-continental lithospheric mantle and implications for formation processes. Invited seminar to Department of Earth Sciences, ETH, Zürich, Switzerland, 23 January.

3. **Jones, A.G.,** Classical physics illuminates the Earth, Invited seminar to Physics Department, Trinity College Dublin, Dublin, Ireland, 10 December.

4. **Ravaut C., L. Gernigon, A. Chabert,** P. Shannon, **P. Readman,** and **B.M. O'Reilly,** Structure sismique de la marge d'Hatton: Résultats préliminaires du projet HADES. GDR marges, Extension continentale et mécanismes de rupture de la lithosphère continentale, Paris, October.

8.2. Irish Geological Research Meeting

Galway, 20-22 February

5. **Jones, A.G.,** Imaging tectonic processes of the ancient Earth.

6. **Moorkamp, M., A.G. Jones** and **C.K. Rao,** Examination and removal of repetitive noise on MT time series.

7. **Readman, P.W.,** and **B.M. O'Reilly,** The deep structure of the Porcupine Basin.

8. **Do, V.C., P.W. Readman** and **B.M. O'Reilly,** A teleseismic study across the Iapetus Suture Zone: preliminary results.

8.3. European Geosciences Union Conference

Nice, France, 26-30 April

9. **Do, V.C., P.W. Readman, B.M. O'Reilly**, M. Landes, J.R.R. Ritter and F. Hauser, Shear-wave splitting observation across the Iapetus Suture Zone in Ireland: preliminary results.

10. **Jones, A.G.,** R.L. Mackie, A.D. Chave and R.L. Evans, Three-dimensional inversion of regional-scale magnetotelluric data from the Slave craton, Canada.

11. **Jones, A.G.,** D.W. Eaton, I.J. Ferguson and I. Asudeh, Joint analysis of seismic and electrical anisotropy across an ancient transcurrent fault system: Great Slave Lake shear zone, northern Canada.

12. Landes, M., F. Hauser and **B.M. O'Reilly,** Seismic refraction data onshore/offshore Ireland: from R. Mallet (1849) to ISLE 2002/3.

13. Landes, M., **V.C. Do,** J.R.R. Ritter, **P.W. Readman** and **B.M. O'Reilly,** ISLE 2002/3: A seismological study of the Caledonian Iapetus Suture Zone in Ireland.

14. **O'Reilly, B.M., P.W. Readman** and P.M. Shannon, Holocene climate change and coral mound ecosystems in the NE Atlantic.

15. **Ravaut, C., A. Chabert, L. Gernigon, B.M. O'Reilly, P.W. Readman, P.M. Shannon** and J. Makris, Wide-angle seismic imaging of the Hatton margin: preliminary results of the HADES experiment.

16. White, D.J., M.D. Thomas, **A.G. Jones,** J. Hope, B. Nemeth and Z. Hajnal, Geophysical transect across the Paleoproterozoic Trans-Hudson collisional zone, Canadian Shield.

8.4. Offshore Ireland – Petroleum Affairs Division Workshop

Dublin, July 27-28

17. **Gernigon, L.** and the **HADES** group. Basin analysis and wide-angle seismic modelling offshore Ireland.

18. **Gernigon, L.** and the **HADES** group. Rockall Hatton Plateau and Margin in a regional context.

19. Morewood, N.C., P.M. Shannon, **G.D. Mackenzie, P.W. Readman, B.M. O'Reilly,** and Makris, J. The crustal structure and regional development of the Irish Atlantic margin region.

20. **O'Reilly, B.M., P.W. Readman, P.W.** and P.M. Shannon. TRIM – TOBI Rockall Irish Margins: slope stability on the margins of the Rockall Trough from deep-tow sidescan sonar.

21. **O'Reilly, B.M., P.W. Readman** and P.M. Shannon. TRIM/TOBI – slope stability in the Rockall Trough. Holocene climate changes and coral mound ecosystems in the NE Atlantic.

22. **Ravaut, C., A. Chabert**, and the **HADES** group, Preliminary results from the HADES wide-angle seismic experiment.

23. **Ravaut, C., A. Chabert**, and the **HADES** group, Processing and interpretation of HADES wide-angle seismic data.

24. **Readman, P.W.,** Overview of the RAPIDS series of experiments.

25. **Readman, P.W.** and **B.M. O'Reilly,** Gravity and magnetic modelling in the Porcupine Basin.

8.5. Adrian Phillips Memorial Meeting

Trinity College Dublin, 11-12 September

26. Cunningham, M.J., S. Hodgson, L.M. Parsons, **P.W. Readman** and **B.M. O'Reilly,** Slope stability of the continental margin between the Goban and Brenot Spurs (Bay of Biscay).

27. **O'Reilly, B.M., P.W. Readman** and P.M. Shannon, Slope failure, sediment transport and canyon development in the Rockall Trough revealed by TOBI sidescan sonar.

28. **Readman, P.W.** and **B.M. O'Reilly,** Gravity, crustal structure and tectonics in Ireland.

8.6. British Geophysical Association Postgraduate student meeting

Liverpool, UK, 14-16 September

29. **M. Moorkamp, C.K. Rao** and **A.G. Jones,** ISLE-MT magnetotelluric measurements in south-west Ireland: Data and first results.

30. **Chabert, A.,** C. Ravaut, L. Gernigon, P.W. Readman, B.M. O'Reilly, P.M. Shannon, The Hatton Basin and Hatton continental margin: Wide-angle seismic imaging from the HADES experiment.

8.7. 17th Electromagnetic Induction Workshop

Hyderabad, India, 18-23 October

31. **Avdeev, D.,** Three-dimensional modelling and inversion from theory to application, Invited review paper.

32. **Jones, A.G., J.E. Spratt,** K. Solon, K.D. Nelson, M.J. Unsworth, B. Kidd, and the INDEPTH MT team, High-resolution MT imaging of suture zones on the Tibetan Plateau.

33. **Jones, A.G.,** J. Ledo, and J. Craven, Electrical parameter maps of Canada derived from Lithoprobe surveys.

34. **Jones, A.G.,** D.W. Eaton, I.J. Ferguson, and I. Asudeh, Joint analysis of seismic and electrical anisotropy across an ancient transcurrent fault system: Great Slave Lake Shear Zone, Northern Canada.

35. **Jones, A.G.,** R. Mackie, A.D. Chave, and R.L. Evans, Three-dimensional inversion of regional-scale magnetotelluric data from the Slave Craton Canada.

36. **Jones, A.G., J. Spratt, C. Horan, G. Wallace, M. Hamilton,** R.L. Evans, X. Garcia, A.D. Chave, E. Stettler, M. Adlem, R. Stettler, K. Raath, S. Evans and the SAMTEX MT Team, The electrical lithosphere of the Kaapvaal Craton: project SAMTEX overview and first results.

37. Martí, A., P. Queralt, **A.G. Jones** and J. Ledo, A comparison between Bahr and WAL methods.

38. Muller, M.R., S.J. Webb, W.H.B. Steenkamp, **A.G. Jones,** R.L. Evans, **X. Garcia,** A.D. Chave, W. Soyer, S. Evans, **M. Hamilton,** C.J.S. Fourie and the SAMTEX team, Uppercrustal imaging of the Archean Witwatersrand Basin, South Africa, using broadband magnetotellurics: Preliminary results.

39. **Rao, C.K., M. Moorkamp,** and **A.G. Jones,** Magnetotelluric survey across the Iapetus suture in SW Ireland: Preliminary results.

40. Unsworth, M.J., **A.G. Jones,** W. Wenbo, and J.R. Booker, Lithospheric structure of the Tibetan-Himalayan orogen: New constraints from project INDEPTH MT data.

41. Wannamaker, P.E. M.J. Unsworth, **A.G. Jones,** A.D. Chave, Y. Ogawa, and J.R. Booker, Cryptic terrane sutures, upper mantle delamination, and lithospheric physical state of the Southern Appalachians orogenic belt, Southeastern United States.

42. **Weckmann, U.,** O. Ritter, M. de Wit, A. Jung, J. Hebert, T. Branch, J. Stankiewicz, T. Mabidi, and R. Green, New magnetotelluric measurements across the Magnetic Beattie Anomaly and the Southern Cape Conductive Belt in South Africa

8.8. American Geophysical Union Fall meeting

San Francisco, USA, 13-17 December

43. **Avdeev, D.B.,** H. Utada, A. Kuvshinov, T. Koyama, 2004, Threedimensional electromagnetic modelling of the Hawaiian swell.

44. Bedrosian, P.A., N. Maercklin, O. Ritter, T. Ryberg, and **U. Weckmann**, Structure classification from the joint interpretation of seismic and magnetotelluric models. Invited.

45. **Gernigon, L., C. Ravaut,** P.M. Shannon, **A. Chabert, B.M. O'Reilly, P.W. Readman,** Contrasting styles between the structure and the magmatism of the west and south Hatton/Rockall Margins (North Atlantic Igneous Province).

46. Ritter, O., S.K. Park, P.A. Bedrosian, **U. Weckmann,** and M. Weber, Imaging the deep roots of the San Andreas Fault and the Dead Sea Fault with magnetotelluric measurements.

47. Unsworth, M.J., B. Denghai, **A.G. Jones,** and W. Wenbo, Magnetotelluric observations of crustal deformation and flow in Tibet.

48. **Weckmann, U.,** O. Ritter, M. de Wit, A. Jung, A., J. Hebert, T. Branch, J. Stankiewicz, T. Mabidi, and R. Green, New magnetotelluric measurements across the Magnetic Beattie Anomaly and the Southern Cape Conductive Belt in South Africa.

49. **Yamasaki, T.,** and H. Miura, Passive margin uplift in Antarctica possibly controlling the global climate change.

8.9. Other Conferences and Workshops

50. Bedrosian, P.A., **U. Weckmann,** O.Ritter, C. Hammer, J. Hebert, and A. Jung, Electromagnetic monitoring of the Gross Schoenebeck stimulation experiment, 64th Jahrestagung der Deutschen Geophysikalischen Gesellschaft, Berlin, Germany, 8-12 March.

51. Bedrosian, P.A., **U. Weckmann,** O. Ritter, C. Hammer, J. Hebert, and A. Jung, Electromagnetic monitoring of the Gross Schoenebeck stimulation experiment, Protokoll über das 20. Koll. Elektromagnetische Tiefenforschung, Königstein, Germany, 29 September – 3 October.

52. **Blake, T.A.,** Robert Mallet, Seismology and seismicity in Ireland, Symposium on Robert Mallet's work on the Great Neapolitan Earthquake, Italy 1857, Padua, Italy, 16-19 December. Invited.

53. Chave, A.D., **A.G. Jones,** R.L. Mackie, and R.L. Evans, Three dimensional deep electrical structure of the Slave Craton, Canada, Joint Spring AGU-CGU, Montreal, Canada, 17-21 May.

54. Craven, J.A., I.J. Ferguson, **A.G. Jones,** and T. Skulski, Roots of the Slave and Superior Provinces observed with deep-looking magnetotellurics, GAC-MAC, St. Catharines, Ontario, Canada, 12-14 May.

55. Craven, J.A., I.J. Ferguson, **A.G. Jones,** T. Skulski, Relict slabs within the roots of the Slave and Superior Provinces observed with deep-looking magnetotellurics, Joint Spring AGUCGU, Montreal, Canada, 17-21 May.

56. **Do, V.C., P.W. Readman, B.M. O'Reilly,** M. Landes, J.R. Ritter, and F. Hauser, Seismological investigation of crustal and upper mantle structure across the Iapetus Suture Zone in Ireland: preliminary results from shear-wave splitting observations, XXIX General Assembly of the European Seismological Commission, Potsdam, Germany, 12-17 September.

57. **Eaton, D.,** Mereu, R. and Dineva, S., Crustal structure of Western Lake Ontario: Implications for Precambrian basement controls on local seismicity, SSA Eastern Section, 76th Annual Meeting, Nov. 2, 2004, Blacksburg, VA, USA.

58. Elliott, G.M., D. Praeg, P.M. Shannon, P.D.W. Haughton, and **B.M. O'Reilly,** Mid to Late Cenozoic evolution of a sediment-starved slope system: the eastern Rockall Trough, west of Ireland. Deep Water Sedimentary Systems of Arctic and North Atlantic Margins, Stavanger, Norway 18-20 October.

59. Evans, S.F., R. van Buren, **A.G. Jones,** R.L. Evans, **X. Garcia**, A.D. Chave, W. Soyer, M. Hamilton, J. Cole, and the SAMTEX MT Team, Investigating the relationship between the occurrence of diamond mines and the electrical structure of the lithosphere, Geoscience Africa, Johannesburg, South Africa, 12-16 July.

60. Ferguson, I.J., X. Wu, J.A. Craven and **A.G. Jones,** Lithospheric magnetotelluric imaging in Canada: significance to diamond exploration, ASEG 17, Sydney, Australia, 15-19 August.

61. **Jones, A.G.,** Electromagnetic models of the continental lithospheric mantle. Invited paper at: Symposium on "Seismic heterogeneity in the Earth's mantle: Thermo-petrologic and tectonic implications", Copenhagen, Denmark, 26-28 February.

62. **Jones, A.G.,** J. Spratt, C. Horan, G. Wallace, M. Hamilton, R,L. Evans, X. Garcia, A.D. Chave, E. Stettler, M. Adlem, R. Stettler, K. Raath, S. Evans and the SAMTEX MT Team, The electrical lithosphere of the Kaapvaal Craton: project SAMTEX overview and first results, Geoscience Africa Congress, Johannesburg, South Africa, 12-16 July.

63. **Jones, A.G.,** Electrical models of cratonic lithosphere from deep-probing magnetotelluric experiments, 32nd International Geological Congress, Florence, Italy, 20-28 August.

64. **Jones, A.G.,** B. Davis, W. Bleeker, and H. Grütter, The Slave craton from underneath: The mantle view, Invited presentation at: Lithoprobe Celebratory Conference, Toronto, Canada, 12-15 October.

65. Keller, G.R., S. Harder, **B.M. O'Reilly,** K. Mickus, K. Tadesse, P.K.H. Maguire, and the EAGLE Working Group, A preliminary analysis of crustal structure variations along the Ethiopian Rift, The East African Rift System Evolution, Resources and Environment, Addis Ababa, Ethiopia, 20-23 June.

66. Maguire, P.K.H., M. Amha, L. Asfaw, C.J. Ebinger, E. Gashawbeza, S. Harder, G.R. Keller, K. Keranen, M.A. Khan, S.L. Klemperer, G.D. Mackenzie, T. Mammo, N. Mariita, K. Mickus, B. Oluma, **B.M. O'Reilly,** K. Tadesse, and H. Thybo, EAGLE – The controlled source seismic project, EAGLE workshop, Addis Ababa, Ethiopia, 24-26 June.

67. Mechie, J., S.V. Sobolev, L. Ratschbacher, A. Yu. Babeyko, **A.G. Jones,** K.D. Solon, L.D. Brown, and W. Zhao, Precise temperature estimation in the central Tibetan crust from identification of the alpha-beta quartz transition by Project INDEPTH seismic profiling. Joint Spring AGUCGU, Montreal, Canada, 17-21 May.

68. **Moorkamp, M., C.K. Rao** and **A.G. Jones,** ISLE-MT magnetotelluric measurements in south-west Ireland: Data and first results. BGA Student Meeting, Liverpool, 14-16 September

69. Muller, M.R., S.J. Webb, W.H.B. Steenkamp, **A.G. Jones,** R.L. Evans, X. Garcia, A.D. Chave, W. Soyer, S. Evans, **M. Hamilton**, C.J.S. Fourie & the SAMTEX team. Crustal imaging of the Witwatersrand Basin, South Africa: Preliminary results from a broad-band magnetotelluric survey, Geoscience Africa, Johannesburg, South Africa, 12–16 July.

70. **O'Reilly, B.M., P.W. Readman,** Lithospheric extension in the NE Atlantic, west of Ireland, from wide-angle seismic studies: Problems for geodynamic modelling, InterMARGINS Workshop on Modelling Extensional Deformation of the Lithosphere, Pontresina, Switzerland, 11-16 July.

71. **O'Reilly, B.M., P.W. Readman,** Pure shear in extensional basin systems: the exception rather than the rule? InterMARGINS Workshop on Modelling Extensional Deformation of the Lithosphere, Pontresina, Switzerland, 11-16 July.

72. **Ravaut, C., A. Chabert, L. Gernigon, P.W. Readman, B.M. O'Reilly,** P.M. Shannon, J. Makris, and M. Gaye, A wide-angle study of the Hatton continental margin – preliminary results of the HADES project. XXIX General Assembly of the European Seismological Commission, Potsdam, Germany, 12-17 September.

73. **Ravaut C.,** and **A. Chabert,** The HADES (Hatton Deep Seismic) project: Processing and interpretation. PAD workshop. Dublin, Ireland, August.

74. **Ravaut C., L. Gernigon, A. Chabert,** P. Shannon, **P. Readman,** and **B.M. O'Reilly,** Seismic structure of the Hatton margin, Preliminary results of the HADES project. INSS meeting in Galway, Ireland, 5 November

75. **Spratt, J.E., A.G. Jones, L. Collins,** and **A. Avdeeva,** A magnetotelluric transect from the Slave craton to the Bear Province across the Wopmay Orogen, Yellowknife Geoscience Forum, Yellowknife, Canada, 15-17 November.

76. **Weckmann, U.,** O. Ritter, M. de Wit, A. Jung, A., J. Hebert, T. Branch, J. Stankiewicz, T. Mabidi, and R. Green, New magnetotelluric measurements across the Magnetic Beattie Anomaly and the Southern Cape Conductive Belt in South Africa, Geoscience Africa Congress, Johannesburg, South Africa, 12-16 July.

77. **Yamasaki, T.**, Strengthening of the lithosphere and the cessation of rifting under constant tectonic force, 32nd International Geological Congress, Florence, Italy, 20-28 August.

8.10. Internal seminars

Conducted as part of the Friday afternoon seminar series

78. **Eaton, D.W.,** Teleseismic studies of the Grenville orogen, Canada, 13 August.

79. **Moorkamp, M.,** Magnetotellurics and geodynamics: Measuring mantle flow from the surface, 20 August.

80. **Weckmann, U.,** Understanding geophysical imprints of suture zones: high electrical conductivity coupled with anisotropy, 3 September.

81. **Do, V.C.,** ISLE – Irish Seismological Lithospheric Experiment: A teleseismic study across the Caledonian Suture Zone in Ireland, 24 September.

82. **Avdeev, D.B.,** Three-dimensional electromagnetic modelling and inversion from theory to application (a review talk), 8 October.

83. **Yamasaki, T.,** Simple one-dimensional modelling study on sedimentary basin formation, 29 October.

84. **O'Reilly, B.M.,** Ireland's deep-water coral reefs and global climate change, 26 November.

9. Collaboration with wider research community

9.1. Collaborating Institutions

During 2004 a Memorandum of Cooperation was signed between DIAS and the University of Barcelona to promote the exchange of scientists and students between the two institutions. This MoC is partially supported with funding from the Catalan Government. As part of this MoC, Prof. Alan Jones visited Barcelona in March, and Profs. P. Queralt and A. Marcuello visited DIAS in September, and UB students A. Marti and C. Aparea visited DIAS in March (for the SAMTEX Processing Workshop).

Jones and Spratt collaborated with scientists of the Geological Survey of Canada and the C.S. Lord Geoscience Centre on the Slave-to-Bear project.

There was continued collaboration with UCD and also with GeoPro in Hamburg on the RAPIDS 4 and HADES projects. These projects are part of the Irish National Seabed Survey being undertaken by the Geological Survey of Ireland. There was also collaboration with GEOMAR, a member of the Leibniz-Institut für Meereswissenschaften in Kiel during their M61/2 cruise in the Porcupine Basin.

Collaboration with the University of Karlsruhe continued on the ISLE project.

9.2. Workshops organised

SAMTEX Processing Workshop: Held at 5 Merrion Square, 15-19 March. Attended by 25 scientists and students. Invited lecturers: Dr. A.D. Chave (Woods Hole Oceanographic Institution), and Dr. Wolfgang Soyer (University of Alberta).

9.3. Visitors to the Section

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

Dr. Franz Hauser, University of Karlsruhe, Geophysical Institute, Visiting Scientist, 15 November - 18 December.

Dr. Don White, Geological Survey of Canada, Ottawa, Canada, gave presentation Geological Sequestration of Greenhouse Gases: Results from the IEA Weyburn C02 Monitoring and Storage Project on 29 November.

9.4. Other Collaborative Activities by Section members

T. Blake

- Visited British Geological Survey (Edinburgh, Scotland) in relation to seismic waveform data retrieval, 6-9 October.
- Took part in the inaugural Earth Data Users Group Meeting, Potsdam, 17 September.

V.C. Do

- Visit to the Seismological Central Observatory (SZGRF) in Erlangen, Germany, 24-30 October.

C. Horan

- Attended Irish Institution of Surveyors and Geomatics Department of Bolton Street DIT: CPD Seminar "The Impact of Ireland's 21st Century Surveying Infrastructure and further Planned Developments", 1-2 April.

B.M. O'Reilly

- Visit to Prof. Randy Keller at the University of Texas, El Paso to work on EAGLE data, 15-29 Feb.
- Attended Cosmogrid and EGEE Conferences, Cork, 18-21 April.
- Attended the EurOCEAN 2004 Conference, Galway, 10-13 May.
- Attended the East African Rift System Evolution, Resources & Environment workshop, Addis Ababa, Ethiopia, 20-23 June.
- Attended the US-Africa Workshop on Anatomy of Continental Rifts: The evolution of the East African Rift System from nascent extension (Okavango Rift Zone) to continental breakup (Afar Depression), Addis Ababa, Ethiopia , 24-26 June.
- Undertook seismic fieldwork in southwest Ireland as part of the GEOMAR Porcupine project, 4-10 May and 29 May - 1 June.

P.W. Readman

- Undertook seismic fieldwork in southwest Ireland as part of the GEOMAR Porcupine project, 4-10 May and 29 May - 1 June.
- Attended the EurOCEAN 2004 Conference, Galway, 10-13 May.
- Attended ESONET (Galway, 11 May) and CeltNet (Dublin, 24 June) stakeholder meetings.
- Attended Cosmogrid and EGEE Conferences, Cork, 18-21 April.

10. Public outreach efforts

As part of the ongoing provision of technical support, the Meteorological Éireann staff (Tom O'Sullivan and Brian Walsh) from Valentia Observatory, who manage the seismic station, visited the School in September (28th and 29th). The purpose of the visit was training and general discussion of data management. Data from the station at Valentia continues to be archived with the DIAS network data.

In August T. Blake was involved in the making of a television programme for the BBC in relation to possible earthquake events in the south Porcupine region off SW Ireland. It concerned the February 1980 event recorded in the region, which was measured as 4.5 Richter Local Magnitude Scale.

As a result of questions about earthquakes from listeners to The Ray Darcy Show, T. Blake gave a Radio interview about Irish Earthquakes and the Irish Earthquake Recording Network to the Show on Thursday 30th September 2004. Examples of what listeners had been interested to know included, whether we had in fact recorded any earthquakes in Ireland, if we had a network that in fact recorded continuously, and the July 19th, 1984 event in NW Wales and its likely reoccurrence, and seismic risk in Ireland.

11. Training undertaken

T. Blake

- Windows 2000 System Administration Course, 26-30 April.

C. Horan

- Basic CorelDRAW Course, 23-24 February.

M. Hamilton

- SAGE (Summer of Applied Geophysical Experience), New Mexico, USA, June-July.

A.G. Jones

- WinGLink training at Geosystem srl, Milan, 5-8 April

M. Moorkamp

- WinGLink at Geosystem srl, Milan, 5-8 April.
- SAGE (Summer of Applied Geophysical Experience), New Mexico, USA, June-July.

L. Collins

- Dreamweaver web design course, 26-29 April

C.K. Rao

- WinGLink at Geosystem srl, Milan 5-8 April.

G. Wallace

- LIMS training, Geological Survey of Canada, Ottawa, 31 March - 8 April.

12. Miscellanea

L. Collins

- Edits *Institute of Irish Surveyors News.*

A.G. Jones

- Editorial Board, *Earth, Planets & Space.*
- 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.
- Past Chair, Working Group I.2 on *Electromagnetic Induction in the Earth*, International Association of Geomagnetism and Aeronomy.
- Member, Program Committee, 18th Electromagnetic Induction Workshop, Spain, September, 2006.
- Member, Natural Sciences and Engineering Research Council of Canada (NSERC) Grant Selection Committee for the Earth Sciences.
- Member, Irish Geoscience Initiative Committee.
- Co-Convenor, Session on Imaging the Continental Upper Mantle, International Geological Congress, Florence, Italy, 20-28 August.
- Webmaster, MTNet (www.mtnet.info)

B.M. O'Reilly

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

P.W. Readman

- Member, Consultative Committee of the Geological Survey of Ireland.
- Secretary, National Committee for Geodesy and Geophysics of the Royal Irish Academy (to June).
- Titular Member for Ireland, European Seismological Commission.
- Member, Marine Institute Third Level Liaison Committee.
- Research Associate, University College, Dublin, Ireland.

U. Weckmann

- Convener at AGU Fall Meeting, Sessions GP11A, GP13A and GP14A: Electrical Conductivity of the Solid Earth, San Francisco, 13-17 December.

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. Pulé)

The collaboration with Prof. J. Pulé (UCD) on Anderson localisation in one-dimensional systems was continued. In previous work, the invariant measures in the limit of negligible disorder were computed for an Anderson model on a one-dimensional system consisting of two linked chains. This was meant to be a warming-up exercise for the problem of computing the Lyapunov exponents of a carbon nanotube, but it turned out to be a tour-de-force itself.

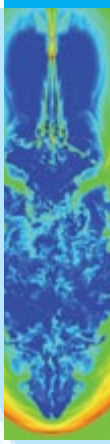
In 1998, White and Todorov advanced an argument based on Fermi's golden rule, to explain the high conductivity of single-walled carbon nanotubes. It is well known that even a small amount of disorder causes complete localisation in one-dimensional systems. This was first argued by Mott and Twose in 1972, and subsequently proved rigorously by Pastur, Molchanov and Goldsheid in 1978. Localised wavefunctions in principle imply zero conductivity. The conductivity of nanotubes must therefore be due to their finite extent. However, one would still expect the conductivity to be low, even for small disorder. White and Todorov argued, however, that the high conductivity is due to the particular dispersion relation of nanotubes, which has two branches which cross in the middle of the conduction band. Because the Fermi level is exactly in the middle of the band, they argue that the current is channelled through these two branches, which leads to an effective reduction in the disorder proportional to the circumference of the nanotube. This argument was essentially confirmed experimentally in 2000. However, theoretically, it is on rather shaky ground. The Fermi golden rule is equivalent to a simple secondorder expansion of the Lyapunov exponent, which is proportional to the conductivity, in powers of the disorder strength. In the case of a single chain, 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.

As a preparation for the analysis of the Lyapunov exponent of a nanotube, we started by setting up the problem, and computing the density of states and Green's functions for the nanotube. The work is to be continued into 2005.

1.1.2 Quantum Source Coding

(T.C. Dorlas & N. Datta)

After completing a collaboration with Dr. N. Datta (Cambridge) on random walks on a complete graph [4], a new project was started on an entirely different subject, at which the Cambridge group is expert. A review article was written about quantum source coding, outlining a few of the most important results in the area. As it is clearly impossible to cover the entire spectrum of this already extensive field in a limited number of pages, we chose to concentrate on two central results: the Schumacher Theorem about memoryless sources, which is a quantum generalisation of the famous Shannon Theorem, and a result by Petz and Mosonyi, which is a generalisation of the Shannon-McMillan Theorem for ergodic sources.



One can distinguish two kinds of source coding: noiseless coding and noisy coding. (There is also an entirely separate type of coding, namely secret coding or encryption, which we do not consider.) Noiseless coding concerns the efficient transmission of information by removal of redundancy. In a sense, noisy coding is the opposite: it concerns the addition of redundancy to an information stream in order to minimise the corruption of the information by noise in the channel. The techniques in these two areas are quite similar. We only considered noiseless coding in our review. Shannon's Theorem states that one can reduce the length of a signal consisting of independent randomly distributed elements to a limit which is the entropy (or information content) of the signal without loosing any information with high probability. Reducing it any further will always lead to loss of information. Schumacher's Theorem is the analogous statement for a memoryless quantum source, which consists of a product state on the tensor product Hilbert space. The analogue of the entropy in this case is the quantum or Von Neumann entropy.

McMillan generalised Shannon's Theorem to the case of ergodic sources. This was generalised to the quantum situation by Petz and Mosonyi. The definition of an ergodic quantum source is somewhat involved because it necessarily involves a quasi-local C*-algebra. Given a sequence of isomorphic 2-dimensional Hilbert spaces $\mathcal{H}_n \ \ (n = 1, 2, \dots)$ the observables for a finite sequence $n = 1, 2, \dots, N$ of qubits (say) are given by elements of the algebra $\mathcal{A}_N = \mathcal{B}(\mathcal{H}_1 \otimes \cdots \otimes \mathcal{H}_N)$ of $2^N \times 2^N$ matrices. The appropriate algebra for an infinite sequence is the norm-closure of the union:

$$\mathcal{A}_\infty = \overline{\cup_{N=1}^{\infty} \mathcal{A}_N}.$$

A quantum information stream is now characterised by a state ρ on this algebra. Such a state is said to be ergodic if it is extremal in the set of all translation-invariant states. The crucial element in the generalisation of the McMillan Theorem by Petz and Mosonyi is a theorem proved by Petz and Hiai which states that the quantum entropy can be characterised as the minimum of the logarithm of the dimension of subspaces whose projections have expectation close to 1. This is a kind of equivalence of ensembles for quantum spin systems. The proof given by Petz and Hiai is rather involved and refers back to earlier technical results about quantum entropy. In our review we give a short and self-contained proof of their theorem.

The review can be found in Preprint [04-10] and will appear in the Encyclopedia of Mathematical Physics.

1.1.3 Long-Range Order in Quantum Spin Models

(T.C. Dorlas & W. Skrypnik)

In collaboration with W. Skrypnik (Kiev), a number of quantum spin systems were studied which have the property that their ground state can be described as a Gibbs state of a classical spin system. This is a generalisation of an idea of T. Matsui. The simple structure of these ground states allowed us to conclude that these models have two independent order parameters with attendant long-range order. This work was published very quickly in [3].

1.1.4 The Asymmetric Exclusion Process

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

During a visit of the Joint Institute for Nuclear Research in Dubna (Russia) a new project was started in collaboration with V. B. Priezzhev concerning the exact solution of this model on a ring. 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. As a first step towards the calculation of more useful quantities, we started by analysing this normalisation of the total probability. We succeeded in solving this problem and in the process learnt useful techniques about the structure of the Bethe Ansatz equations for this model. The result was published in an electronic journal: see [6].

1.1.5 Integrable Perturbations of Conformal Field Theories

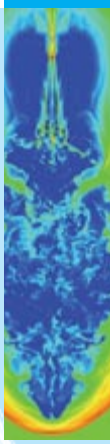
(W. Nahm)

In the previous year a new link between integrable quantum field theories in two dimensions and conformally invariant theories had been found. When such a theory is considered on a circle of circumference L, the limit $L \to 0$ yields a conformally invariant theory and the limit $L \to \infty$ a theory which can be described by an exactly known S-matrix. The Bethe ansatz was developed for the large L limit, but surprisingly it can be used to describe the small L limit, too. It was conjectured that it can be used for the whole range of L, but this idea was disproved. No analytic understanding of the intermediate behaviour has been obtained yet, but the states can be followed continuously over the whole range of L. Contributions from right- and left-movers factorise in the conformal limit, and the various sectors of the theory correspond to the occupation of zero momentum states. The relation is not one-to-one, however, and even in the Ising model with magnetic perturbation only a partial understanding has been reached. The link between the Bethe ansatz and quantum groups has been strengthened (W. Nahm and Sinéad Ní Chiagáin). So far the only explicit examples came from the A-series where the irreducible representations of Yangians can be understood as irreducible Lie algebra representation, but in the case of $SO(8)$ the Yangian description is essential and has been verified.

1.1.6 Vanishing Theorems in Algebraic Geometry

(W. Nahm & F. Laytimi)

To investigate the connectivity of the string theoretic version of the moduli space of Calabi-Yau varieties much stronger vanishing theorems are needed than what is available at the present stage of mathematical research. The proof of the strongest possible theorems is a long-term research programme. Two new results were obtained (F. Laytimi and W. Nahm). When one evaluates the cohomology of a vector bundle described by a Schur functor, Demailly had asked which power of the determinant of the vector bundle is needed as an extra factor to guarantee the vanishing of the cohomology group. He had made a conjecture, but only half of it had been proved. The group found a complete proof, as part of a more general investigation which concerned products over an arbitrary number of vector bundles. A second result concerns the cohomology of products of exterior powers of vector bundles. A result found in the previous year was generalised, with a simpler proof [15]. The new result seems to be optimal, since diverse examples show that one can have non-vanishing cohomology groups, if any of our assumptions is slightly violated.



1.1.7 Astrophysics and Maya Research

(W. Nahm)

Investigations of supernova remnants are much better constrained when the age of the remnant is known. Thus historical supernova observations are of great astrophysical interest. The observations at 1006, 1054 and 1181 AD are known from various regions, but for earlier supernovae only the Chinese report from 393 AD seemed trustworthy. Another Chinese report from 185 AD had been explained away as a confusion of a nova and a comet. The study of Maya inscriptions of Tikal yielded a strong link of the 393 AD supernova in Scorpio with the birth of a king. On Stela 1 this king is shown in an astronomical context, at the location of the supernova. The Hauberg Stela from 197 AD is the only one with a similar iconography and highlights the position of the 185 AD event. This confirms the Chinese report and fixes the age of the controversial remnant RCW86. In addition, the Hauberg stela emphasises Scorpio. This may well be due to the previous observation of a supernova very close to the 393 AD event. Indeed, the close neighbours G348.5+0.1 and G348.7+0.3 are both young remnants and strong candidates for historical supernovae.

1.1.8 Fuzzy Physics

(Denjoe O'Connor)

The principal focus of research in 2004 was the construction of suitable fuzzy supersymmetric field theory models for Monte-Carlo simulations.

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 to a finite number of degrees of freedom while retaining exact supersymmetry. Now, the ingredients are a graded matrix algebra, where the matrix entries contain both commuting and anticommuting (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 (Berlin). The research will be ground breaking in that it will be the first nonperturbative study (a Monte-Carlo study) of supersymmetric models using this approach.

1.1.9 The Universal Critical Equation of State

(Denjoe O'Connor & C.R. Stephens)

A new, physically motivated, parametrisation of the universal scaling equation of state for the $O(N)$ model was described and studied in detail at one and two loops. The consequent one-loop approximation is explicit in terms of elementary functions. The only ingredients needed for the parametrisation are appropriately defined Wilson functions γ_{λ}, γ_{φ} and γ_{φ^2}, which are associated with a crossover renormalisation group. The resulting universal scaling function $f(x)$ satisfies Griffiths analyticity throughout the phase diagram. In a two loop study excellent agreement with known results and with recent Schofield representations was found.

1.1.10 Fuzzy Physics and Monte Carlo Simulations

(Denjoe O'Connor, X. Martin & F.G. Flores)

Besides the theoretical study of these matrix spaces and the field theories on them, the group has implemented Monte-Carlo studies numerically. The simplest model is that of a real scalar field on the fuzzy sphere, and was successfully simulated for the model that exhibits UV-IR mixing.

UV-IR mixing is a common feature of all non-commutative field theories, but is difficult to study by regular perturbative methods. The numerical approach taken here offers non-perturbative insight to this problem.

The simulations show the existence of three phases, the two standard ones (disordered and uniform phases) and a new phase which can be called a non-uniformly ordered phase (or matrix phase). A detailed numerical and theoretical study of this phase was performed, including identifying the scaling properties of the phase transitions, and the properties of the phase itself.

It was found that the transition from the uniformly ordered to the non-uniformly ordered phase is that of a pure matrix model and agrees in detail with known results from random matrix theory. The second transition line caused much difficulty and required new techniques to obtain reliable Monte-Carlo results. The new techniques have now been successfully implemented and progress and results will be reported in the 2005 Annual Report.

1.1.11 Scalar Field Theory

(J. Medina, W. Biedenholtz & Denjoe O'Connor)

This group is interested in Matrix approximations in three dimensional Quantum Field Theory. In this context, investigations focused on Scalar Field Theory on $S^2 \times \mathrm{T}$, which is a 3-dimensional sphere. The group has already implemented numerical simulations for the $\lambda\phi^4$ model where S^2 is replaced by the fuzzy sphere and T by $\mathbb{Z}_N$ 1-dimensional periodic lattice of N points. The next step is to interpretate the data obtained, we have the phase diagram of the model. The group is currently studying the behaviour of the model under different limits.

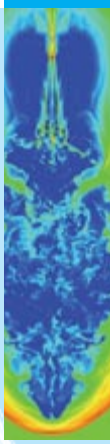
1.1.12 Quantum Random Walks

(X. Martin, Denjoe O'Connor & R.D. Sorkin)

Discrete random walks are Markov processes whereby a "walker" moves around on a discrete lattice. The short term goal of this research is to produce quantum analogues of the simplest classical discrete random walks. One can view quantum mechanics as a generalisation of classical probability theory that provides for pairwise interference among alternatives. Adopting this perspective, the classical random walk was "quantised" by finding, subject to a certain condition of "strong positivity", the most general Markovian, translationally invariant "decoherence functional" with nearest neighbour transitions. Such walks were called quantal random walks.

This now allows one to proceed and investigate similarly quantised dynamics for causal sets. Causal sets are discrete sets of causally ordered events and provide natural candidates for the "atoms" of quantum gravity.

A further research line being pursued, and which it is hoped to dedicate more time to in the future, is the causal set approach to quantum gravity. This is a discrete approach where the basic notion is the causal order. However, it does not sit naturally with unitary quantum mechanics and suggests that if this approach is correct one needs to find a more fundamental theory



which supersedes quantum mechanics. The study of discrete quantal random walks was a first step in this direction. The generalisation of quantum mechanics was to Markovian processes that generate positive generalised quantum measures. The notion of unitarity is replaced by positivity and to our surprise, in this context, the two notions turn out to be surprisingly close.

1.1.13 Non-Commutative Geometry

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

Our 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 group is currently further extending the analysis to supersymmetric matrix algebras, 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 been developed.

1.1.14 The Renormalisation Group in Genetic Dynamics

(C. Stephens, A. Wright & A. Zamora)

Perturbative methods, both with and without the renormalisation group, were used to approximate the dynamics of genetic systems evolving under the action of selection and mutation. This work has led to one publication with another one in preparation.

This work also offers a potential route to systematically calculate approxmations to the transfer matrix for two dimensional statistical systems.

1.1.15 Emergence of Algorithmic Language in Evolving Systems

(C. Stephens, C. Ryan & M. Nicolau)

A model evolutionary system was used to investigate how a non-trivial evolution may continue in a system that is "optimally" fit. This evolution is among degenerate genotypes allowing for the development of not only fit genotypes, but also robust ones. In the model system examined, based on a gene expression model developed previously by Prof. Stephens, and Grammatical Evolution, developed by Dr. Ryan, a simple algorithmic language was seen to emerge that was a direct result of the emergence of robustness in the evolution.

1.2 Independent Work by Research Scholars

1.2.1 Applications of Stochastic and Statistical Mechanics

(S. Adams)

In collaboration with some groups of electrical engineering, applications of stochastic and statistical mechanics to communication networks problems were examined. One part concerns here the optical transmission problems [24, 04-23], where the stochastic scheduling and queueing analysis plays an important role. The other area is wireless communication networks [25], where specified handover procedure and security checks were analysed. It is planned to establish contacts with the Dublin Institute of Technology, especially the former group who worked with John Lewis, about large deviations analysis for communication networks and related problems.

1.2.2 Kinetic Energy

(S. Adams & J. Lebowitz)

Collaboration continued with Joel Lebowitz from Rutgers University, New Jersey, USA, about fluctuations of the kinetic energy in the microcanonical ensemble.

1.2.3 Bose Condensation

(S. Adams)

Research related to the physics of dilute and non-dilute Bose systems, concentrating on Bose condensation, large deviations, equivalence of ensembles and superfluidity properties is ongoing.

More precisely, one project concerns an interacting Bose system on a complete graph. Here, the intention is to generalise the hard-core repulsion (exclusion process) to a repulsion potential which allows up to an arbitrary finite number of bosons occupying one lattice site.

1.2.4 Poisson Point Process

(S. Adams & M. Scheutzow)

Research, in collaboration with M. Scheutzow (Technical University Berlin and Siemens Research Group Berlin), is being carried out on a mathematical Poisson point process model for geographical addressing and routing in wireless communication networks.

1.2.5 A Model for Superfluidity

(S. Adams & J.-B. Bru)

The Angelescu-Verbeure-Zagrebnov (AVZ) Hamiltonian, also called the superstable Bogoliubov model [12], was solved for any temperature and any chemical potential. This model corresponds to a "minimal" stabilisation of the Bogoliubov Hamiltonian and was first developed in 1992. In fact, the analysis done in our paper [12] corresponds to the main technical step to deduce, in the canonical ensemble, a new microscopic theory of superfluidity at all temperatures as explained in [13] and [14].

1.2.6 Large Deviation Analysis

(S. Adams, J.-B. Bru & W. König)

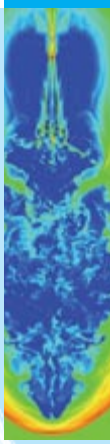
A new project was started in collaboration with Prof. W. König (Berlin) concerning a large deviation analysis of bosons in a trap. This is an important problem with direct relevance for recent experiments in atomic physics where Bose-Einstein condensates of dilute alkali gases in magnetic traps are now routinely produced and investigated. A considerable amount of theoretical work on such systems has been done by Lieb, Yngvason and Seiringer. These workers use entirely different techniques however. The Large Deviation approach is complementary to their operator theoretical techniques and should lead to new insights. The group's approach makes use of a Feynman-Kac representation of the Boson gas in terms of interacting Brownian partices in a trapping potential. Assuming a particular path interaction it was proved that the zero-temperature limit leads to a variational principle similar to the Gross-Pitaevski equation but with a modified interaction parameter.

1.2.7 Quantum Field Theory

(R. Delgadillo Blando)

As a follow up to the work on UV-IR mixing the group started to study the model implementing the RG program for matrix models. Some of the degrees of freedom are integrated and the rest is taken as the background. Notwithstanding this work is still in progress.

They also began a study of $U(n)$ gauge theory on $\mathrm{S}^2_{\mathrm{F}} \times \mathrm{S}^2_{\mathrm{F}}$. They are interested in studying the gauge theory



in a 4-dimensional space. For this purpose the gauge theory on the simplest 4-dimensional fuzzy space which is $S_F^2 \times S_F^2$ was studied. The main goal is to compute the effective action. This work is still under progress. They are also interested in looking for the phase transition in this model. For this reason studies of the effective potential were first carried out. The results are not conclusive yet.

The group studied the possibility of obtaining the $S^2 \times S^2$ model from a matrix model using the generators of $SU(4)$. Also is it possible to obtain it from 2-matrix models? This work is still under progress.

1.2.8 Thermodynamical Properties of Many-Body Systems

(F. García Flores)

As a part of our project, the Monte Carlo method to study the thermodynamic properties in non-perturbative sector of ϕ^4 model on a regularised fuzzy sphere was implemented. In this context, regularised means that the fields have been parametrised in terms of finite matrices, which is very natural on non-commutative spaces.

The simulation of matrix models present several technical difficulties. An example of such difficulties is that the matrix models are highly not local, namely, every entry or field in the matrix is strongly related to the rest of the fields. Therefore to obtain an equilibrium configuration with little correlation to the previous one in the Markov chain is very difficult, increasing the time of calculation in a considerable way.

Currently:

1. The phase diagram of the fuzzy ϕ^4 model on a two dimensional space has already been obtained.
2. Some technical problems inherent in this type of model from the numerical point of view have been overcome. An efficient method to improve the sampling of the phase space has been implemented, and with this, tunnelling in some regions very difficult to access with conventional methods has been managed.
3. Due to the fact that good tunnelling has been achieved it has been possible to access some of the regions of interest to delimit them by means of a curve of coexistence. This curve has only been suggested in some articles but its existence has not been verified.

1.2.9 Time-Space Non-Commutativity and Waves

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

During this period, Dr. Kurkcuoglu 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), the general theory of waves in spacetimes where time and space coordinates do not commute has been investigated. Research on this topic was initially motivated by the recent developments, in the formulation of quantum physics in noncommutative spacetime.

It is well-known that waves on "commutative" spacetimes like $\mathbb{R}^d$ are elements of the commutative algebra $C^\infty(\mathbb{R}^d)$ of functions on $\mathbb{R}^d$. When $C^\infty(\mathbb{R}^d)$ is deformed to a noncommutative algebra $\mathcal{A}_\theta(\mathbb{R}^d)$ with deformation parameter θ ($\mathcal{A}_0(\mathbb{R}^d) = C^\infty(\mathbb{R}^d)$), waves being its elements, are no longer complex-valued functions on $\mathbb{R}^d$. Thus a generalised 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 noncommutativity. Novel phenomena are encountered. Thus when the time of observation T is so brief that $T \leq 2\theta w$, where w is the frequency of incident waves, no interference can be observed. For larger times, the interference pattern is deformed and depends on $\frac{\theta w}{T}$. It approaches the commutative pattern only when $\frac{\theta w}{T} \to 0$. Finally, effects of time-space noncommutativity on interference of stellar light due to cosmic strings is explored. Results of this research has been written up and a preprint will be released in February 2005, after completing a final proof-reading by the authors. It will be submitted for publication shortly afterwards.

1.2.10 Quantum Hall Effect

(M. Leitner)

When, in a two dimensional device, an electric field is turned on, a transversal current is induced. By the Ohm-Hall law, particle flow and electric force are coupled by e^{-2} times the conductivity matrix, $\vec{J}/e = \sigma/e^2(e\vec{E})$, and $\sigma_H := \sigma_{21}/e^2$. In experiments, one additionally applies a constant magnetic field perpendicularly to the plane, of strength F^{12}, in order to obtain a nonzero Hall conductivity σ_H. Actually, a time reversal breaking term in the Hamiltonian may suffice to produce a nonzero Hall conductivity (Zero Field Hall Effect [1]).

In solid state physics, provided the Fermi energy lies in a spectral gap and the temperature is zero, $2\pi\sigma_H$ is an integer (Integer Quantum Hall Effect). Classically, this quantisation can be traced back to topology. Namely, the contribution to $2\pi\sigma_{21}$ of the n-th energy band can be identified with the Chern number of the complex line bundle of the eigenspaces over the 2-torus of boundary conditions T^*.

In three-dimensional QED, the Euclidean Dirac operator $D = -i\not{D}^{\underline{A}} + m$ with covariant derivative $\underline{D}^{\underline{A}}$ and fermion mass $m \in \mathbb{R} \setminus \{0\}$ reveals an Ohm-Hall law for the ground state current in the background field $(F^{\mu\nu})^2_{\mu,\nu=0}$, $F^{\mu\nu} \equiv \partial^\mu A^\nu - \partial^\nu A^\mu$.

1.2.11 Bulk Physics

(M.Leitner)

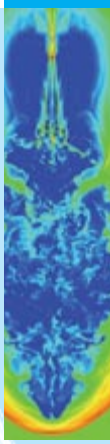
A Zero Field Hall Effect is investigated for the constant Dirac operator

$$D = -i\sum_{j=1}^{2} \sigma_j \frac{\partial}{\partial x^j} + \sigma_3 m, \quad m \in \mathbb{R} \setminus \{0\}. \quad (1.1)$$

Here, σ_H is easily computed in Fourier space by means of the Kubo formula. The contribution of the negative energies, for $\vec{k} \in T^* = \mathbb{R}^2/\mathbb{Z}^2$, is

$$\sigma_H^{(-)}(\vec{k}) = i\mathrm{Tr}\{\hat{P}_0[\partial_{k_1}\hat{P}_0, \partial_{k_2}\hat{P}_0]\}, \quad (1.2)$$

where $\hat{P}_0$ is the projector onto the multifermion ground state in $\wedge_{\vec{K}\in\mathbb{Z}^2}\mathbb{C}^2$. Formula (1.2) formally looks like the curvature of the adiabatic connection $\hat{P}_0 \circ \nabla_{\vec{k}}$. Surprisingly however, its average turns out to be a half integer. This deviation from integrality can be understood in two ways. From the point of view of one-particle states, since every energy band has degeneracies over T^*, there is no line bundle contribution and hence no need for $2\pi\sigma_H^{(-)}$ to be an integer. In the multi-particle description, i.e. in QED_3, non-degeneracy is assured by the Dirac principle. However, each energy crossing causes an interchange of wedge factors in the ground state, which occurs an infinite number of times, so that the transition function cannot be determined globally over T^*. Thus the geometrical object of smoothly varying everywhere one-dimensional vector spaces does not define a line bundle, in the sense that it cannot be embedded into a fixed Hilbert space.



At least, $2\pi\sigma_{21}$ can be described geometrically as a solid angle in $\mathbb{R}3$ [1], and quantisation is due to Lorentz invariance.

The result for $\sigma_H^{(-)}$ is consistent with the Ohm Hall law in $QED3$ when applied to vacuum fluctuations. Indeed, the latter is obtained by reformulating the Kubo formula in a relativistically invariant way.

1.2.12 Edge Physics

(M. Leitner)

Another interesting feature is the dependence of $\sigma_H^{(-)}$ on the mass sign which continues to hold for the edge conductivity σ^e for a rather general class of selfadjoint extensions, parametrised by some constant $c \in \mathbb{R}$, of the Dirac operator (1.1) on the half plane. In particular, an existence condition is related to sgn(mc), and the bulk conductivity equals the arithmetic mean of the two possible values for the edge conductivity, which are integral. Topologically, $2\pi\sigma^e$ is the spectral flow through the gap of the original bulk operator.

Compared to the bulk discussion, there is an even more striking zero field effect which doesn't need any external field. An observation of this phenomenon in a dedicated experiment would be of great interest.

1.2.13 Cosmic Strings

(X. Martin)

Current-carrying cosmic strings are topological defects which behave literally like wires, i.e. flexible one dimensional objects which can carry a current. The simplest cosmic strings formed at Grand Unification mass scales have now been constrained by the CMB observations to less than 10 per cent of the source of initial gravitational perturbations. However, this leaves plenty of room for lighter cosmic strings such as cosmic superstrings and current-carrying cosmic strings. The later model, in which a current may condense along the string, has been focused on. The object of this investigation is to ascertain the effect on the string dynamics of having more then one current condense in the string. Since in particle physics most particles are coupled to many other particles, this issue is quite relevant.

The quantum analysis of a toy model with two bosonic currents was performed and it was found that depending on the parameters, zero, one or two currents would condense in the string. A corresponding equation of state which describes the macroscopic properties of the cosmic string was also derived. The dynamical formalism appropriate to describe a string with several currents was also derived, and we are now investigating the dynamical stability of the currents in the string. Our expectation is that in general, dynamical evolution will render the currents unstable until we revert to the known case when there only remains one current along the string.

1.2.14 Lattice Gauge Theory

(M. Panero)

At present, Lattice Gauge Theory is a powerful and widely exploited tool to investigate non-perturbatively the Confinement phenomenon in Quantum ChromoDynamics. The work done in this field during the year has been focused on various topics. The study of the behaviour of the interaction between a quark and an anti-quark in the confined regime of compact $U(1)$ theory in four space-time dimensions has been addressed, by means of a powerful numerical algorithm which is based on the analytical duality properties of the theory; the results that have been obtained show a degree of precision which is comparable to the ones

obtained by other state-of-the-art algorithms. Similar techniques have been used in another work about $Z(2)$ Lattice Gauge Theory in three space-time dimensions, allowing subleading corrections to the results that are already known in the literature to be observed. Lattice techniques have also been used in a study focused on the presence of confining phenomena in a pure random percolation model, giving a new perspective into the highly non-trivial finite temperature deconfinement transition. Finally, numerical lattice techniques have been used to test the range of length scales where the predictions of an effective string picture for confinement is expected to hold. In all of these studies, the work done at the Institute has concerned both the analytical and the numerical aspects.

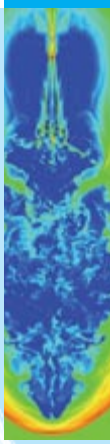
1.2.15 String Theory in Higher-Dimensional Space-Time

(T. Tsukioka & Y. Watabiki)

The group has been investigating the formulation for string theory in higher-dimensional spacetime. Since the extended spacetime involves two or more time coordinates, their research might be the clue for understanding the origin of time and spacetime itself. Gauge symmetries and supersymmetries are emphasised in much of their research on field theory and string theory. Sometimes the symmetry structures in physics suggest new physical concepts.

From the point of view of the string unification, the relations between string theories in various dimensions have been studied and it was also conjectured that all of these string theories were regarded as different phases of an underlying theory in higher-dimensional spacetime. Meanwhile, the idea of extra time dimensions, which might be hidden dimensions, was suggested and studied. It is the purpose of their research to cast some further light upon constructions of theories involving two or more time dimensions and to search for a fundamental theory with an underlying complex nature of spacetime which would be linked via dualities to M-theory, type II string theories and F-theory.

With Y. Watabiki, a superstring model which coupled with the generalised topological Chern-Simons action was proposed. The superstring model has additional gauge symmetries including nontrivial gauge symmetries $i.e.$ $U(1)_v \times U(1)_A$ gauge symmetries which come from the generalised Chern-Simons action as well as usual gauge symmetries on the string world-sheet. The interesting observation is that the introduced gauge symmetries lift up the dimension of background spacetime to a higher one. Actually, one time and one space dimensions are added to the background spacetime. In the covariant formulation of the superstring model, the generalised Chern-Simons action plays an important key role. The quantisation of the model was explicitly carried out by Lagrangian and Hamiltonian BRST formulations *à la* Batalin, Fradkin and Vilkovisky and noncovariant light-cone gauge formulation. Upon the quantisations the model turns out to be formulated consistently in 10+2-dimensional background spacetime involving two time coordinates instead of in 9+1-dimensional background spacetime in usual superstring theories. Conversely, the requirement of two negative signatures in the background metric is a natural one due to the "gauge" symmetry of the model, so that the existence of two time coordinates is not in conflict with the unitarity of the theory. The critical dimension was obtained from both the BRST Ward identity in the BRST formulation and the Ddimensional full quantum Poincaré algebra in the noncovariant light-cone gauge formulation. The quantum states were also considered from the mass-shell relations. Contributions toward the mass-shell



relation from zero-modes of additional scalar fields which originally arise from the generalised topological Chern-Simons action are completely cancelled, so that the superstring model possesses the same spectra as usual ones. Therefore, the model is naturally linked to usual superstring models. However, the two extra dimensions should be taken more seriously and their physical and topological meanings for these off-shell extensions should be also considered.

One of the remarkable features of the higher-dimensional formulation is that the model is allowed to have pairs of the extra time and space coordinates. Therefore, by applying the mechanism, a succession of supersymmetric models can be formulated in background spacetimes, involving some time coordinates, where Majorana-Weyl fermions can live consistently. In this framework, a new "family" of F-theories can be also constructed. It would be interesting to discuss duality relations of these theories.

1.2.16 UV-IR Mixing in Gauge Theories

(P. Castro Villarreal, R. Delgadillo Blando & B. Ydri)

From a string theory point of view the most natural gauge action on the fuzzy sphere $\mathbf{S}_L^2$ is the Alekseev-Recknagel-Schomerus action which is a particular combination of the Yang-Mills action and a Chern-Simons-like term. The differential calculus on the fuzzy sphere is 3-dimensional and thus the field content of this model consists of a 2-dimensional gauge field together with a scalar fluctuation normal to the sphere. For $U(1)$ gauge theory we computed the quadratic effective action and showed explicitly that the tadpole diagrams and the vacuum polarisation tensor contain a gauge-invariant UV-IR mixing in the continuum limit $L\rightarrow\infty$ where L is the matrix size of the fuzzy sphere. In other words the quantum $U(1)$ effective action does not vanish in the commutative limit and a noncommutative anomaly survives. We also computed the scalar effective potential and proved the gauge-fixing-independence of the limiting model $L=\infty$ and then showed explicitly that the one-loop result predicts a first order phase transition which was observed recently in simulation. The one-loop result for the $U(1)$ theory is exact in this limit. It is also argued that if we add a large mass term for the scalar mode the UV-IR mixing will be completely removed. It is found in this case to be confined to the scalar sector only. This is in accordance with the large L analysis of the model. Finally we showed that the phase transition becomes harder to reach starting from small couplings when we increase M.

1.2.17 Phase Structure of 2-Dimensional NC Fuzzy Yang-Mills Theory

(B. Ydri)

The most general U(n) gauge theory on $\mathbf{S}_L^2$ is a 3-matrix model with three parameters g (the gauge coupling constant), M (the mass of the normal scalar field) and α (the linear coupling of this scalar field). There is evidence from numerical simulations for the existence of a first order phase transition for the $U(1)$ model with $M=\alpha=0$. The first theoretical result is that this transition can be captured in one-loop perturbation theory (the fuzzy model is exactly solvable). The second (also obtained in large L analysis) is that in the limit $M\rightarrow\infty$, $L\rightarrow\infty$ the phase transition disappears (the gauge invariant UV-IR mixing of the model is removed). We have already established the first result in our Monte Carlo simulations. For example we have computed the specific heat, the action, the operators D_a^2 and F_{ab}^2 as well as the probability distribution $P(\phi)$ and all data indicate the existence of the expected first order phase transition.

1.2.18 The NC Fuzzy Schwinger model: Towards Fuzzy QCD

(B. Ydri)

Here we want also to determine explicitly the phase structure of this model and in particular verify rigorously the above second statement related to the mass operator. This will shed new lights on the origin of the UV-IR mixing in 2-d noncommutative gauge theories. As a consequence we will learn how to approximate ordinary YM_2 using fuzzy sphere without any noncommutativity residues. We can also compare with the exact solution of YM_2 in commutative two dimensions and test explicitly this regulator.

1.2.19 Exact Solution of NC $U(1)$ Gauge Theory in 4-dimensions.

(B. Ydri)

Noncommutative $U(1)$ gauge theory on the Moyal-Weyl space $\mathbf{R}^2\times\mathbf{R}^2_\theta$ is regularised by approximating the noncommutative spatial slice $\mathbf{R}^2_\theta$ by a fuzzy sphere of matrix size L and radius R. Classically we observe that the field theory on the fuzzy space $\mathbf{R}^2\times\mathbf{S}^2_L$ reduces to the field theory on the Moyal-Weyl plane $\mathbf{R}^2\times\mathbf{R}^2_\theta$ in the flattening continuum planar limits $R,L\rightarrow\infty$ where the ratio $\theta^2=R^2/|L|^{2q}$ is kept fixed with $q>\frac{3}{2}$. The effective noncommutativity parameter is found to be given by $\theta^2_{eff}\sim 2\theta^2(\frac{L}{2})^{2q-1}$ and thus it corresponds to a strongly non-commuting space. In the quantum theory it turns out that this prescription is also equivalent to a dimensional reduction of the model where the noncommutative $U(1)$ gauge theory in 4 dimensions is shown to be equivalent in the large L limit to an ordinary $O(M)$ non-linear sigma model in 2 dimensions where $M\sim 3L^2$. The Moyal-Weyl model defined this way is also seen to be an ordinary renormalisable theory which can be solved exactly using the method of steepest descents . More precisely we find for a fixed renormalisation scale μ and a fixed renormalised coupling constant g^2_r an $O(M)$–symmetric mass, for the different components of the sigma field, which is non-zero for all values of g^2_r and hence the $O(M)$ symmetry is never broken in this solution. We obtain also an exact representation of the beta function of the theory which agrees with the known one-loop perturbative result.

1.2.20 Noncommutative $U(1)$ Gauge Theory

(B. Ydri)

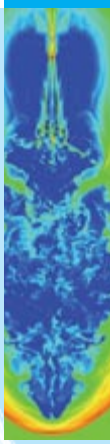
Noncommutative $U(1)$ gauge theory in 4-dimensions is shown to be equivalent in some scaling limit to an ordinary non-linear sigma model in 2-dimensions. The model in this regime is solvable and the corresponding exact beta function is found. We also show that classical $U(n)$ gauge theory on $\mathbf{R}^{d-2}\times\mathbf{R}^2_\theta$ can be approximated by a sequence of ordinary $(d-2)-$dimensional Georgi-Glashow models with gauge groups $U(n(L+1))$ where $L+1$ is the matrix size of the regularised noncommutative plane $\mathbf{R}^2_\theta$.

1.2.21 The Fuzzy Supersphere

(S. Murray)

S. Murray joined Denjoe O'Connor's group in September as a pre-doctoral scholar under the supervision of Dr. Dolan. Time was spent becoming familiar with the topic and the activities of the group, i.e. constructing an action on the fuzzy supersphere that corresponds to the continuum action under an appropriate limit.

After a suggestion by Dr. Dolan, a relation giving the commutator of a general bosonic field with an Osp(2,2) fermionic generator in terms of the field and the Osp(2,1) generators was constructed and proved analytically for any element of the bosonic enveloping



algebra. This relation corresponds to a known relation on the supersphere and may be useful in removing Osp(2,2) generators from the action.

1.2.22 Lie Algebras

(S. Ni Chiagain)

In quantum field theory certain integrable models are described in terms of pairs of Dynkin diagrams of simple Lie algebras. The algebraic equations for these models are of the form $U = AV$, where $A = C(\mathrm{X})\otimes C(\mathrm{Y})^{(-1)}$, C denotes Cartan matrices, and X and Y are the Dynkin diagrams of simple Lie algebras of ranks r and s respectively. Moreover $U = (u_{r1}, u_{r2}, \ldots, u_{rs})$, $V = (v_{r1}, v_{r2}, \ldots, v_{rs})$, and $e^{uij} + e^{vij} = 1$ for all i, j. These equations have been studied for the case where both X and Y are the Dynkin diagrams of simple Lie algebras of type A. In this case it is possible to solve the equations using the representation theory of Lie algebras.

Different cases of these equations can be studied, where X and Y need not be restricted to the A-series. For example one could allow X and Y to be simple Lie algebras of types D or E. On studying these equations it should again be possible to find all solutions in explicit form. It is expected that this can be done using the representation theory of Lie algebras and related quantum groups. Of most interest to my PhD is the case where X is of type A and Y is of type D, but to get an insight into the structure of the system the simpler case of B_2 was considered first.

Let g be a simple Lie algebra of type B_2, and let $Y(g)$ be the corresponding Yangian. Let W_l^m be irreducible representations of $Y(g)$, where $m = 1, \ldots, l = 1, 2, \ldots r$, and $r = rank(g)$. In particular W_l^1 and W_2^l are the fundamental representations of $Y(g)$. Using the Weyl character formula the characters of these fundamental representations can be calculated. They turn out to be:

$$\chi_{\omega_1} = e^{\alpha_1+\alpha_2} + e^{\alpha_2} + 1 + e^{-\alpha_2} + e^{-\alpha_1-\alpha_2}$$

and

$$\chi_{\omega_2} = e^{\frac{1}{2}\alpha_1+\alpha_2} + e^{\frac{1}{2}\alpha_2} + 1 + e^{-\frac{1}{2}\alpha_2} + e^{-\frac{1}{2}\alpha_1-\alpha_2}$$

respectively, where α_1 and α_2 are the simple roots of the Lie algebra g.

In a paper by Kirillov and Reshetikhin, Q_m^l are defined as the characters of the representations $W_l^m|_g$. Using equations for these that are given in the same paper, the characters can be calculated explicitly. It is then possible to write the Yangian representations in terms of irreducible representations of the Lie algebra g. It is conjectured that the following recurrence relations hold for the irreducible Yangian representations:

$$W_1^{(k)} = V(k\alpha_1 + k\alpha_2)$$

$$W_2^{(k)} = V\left(\frac{k\alpha_1}{2} + k\alpha_2\right) + W_l^{(k-2)}$$

where $V(x)$ denotes the representation of g of highest weight x. It has been proved that the above equations satisfy the equations in the Kirillov-Reshetikhin paper. At present the same thing is being done for D_4.

Over the next year it is hoped to find a tensor product formula for the Yangians, generalise the Weyl character formula to the Yangians, find out which characters vanish for $U = AV$ and give an inductive proof, study the numerators of the generalised character formula to find all solutions, and consider the corresponding dilogarithm values and the corresponding conformal dimensions in conformally invariant quantum field theories.

1.3 Work by Research Associates

1.3.1 The Quantum Hall Effect

(B. Dolan & Cliff Burgess)

The collaboration with Cliff Burgess of McGill University, Montreal, Canada on duality and the modular group in the quantum Hall effect is ongoing. The role of the modular group in quantum Hall bi-layer systems is currently being developed.

1.3.2 Monopole-Antimonopole (MAP) Solutions

(D.H. Tchrakian, E. Radu & V. Paturyan)

Monopole-antimonopole (MAP) solutions were constructed in two distinct 3 dimensional $SU(2)$ Yang-Mills-Higgs (YMH) models.

The first incorporates a higher order term which results in the mutual attraction of like-monopoles.

The second one incorporates instead a negative cosmological constant. In this case both multimonopole (MM) and MAP solutions were constructed.

MAP solutions for the usual YMH model are known in the literature. These axially symmetric solutions feature the zeros of the monopole and the antimonopolesseparated on the z-axis. The separation depends on the detailed values of the parameters in the model. The same qualitative features were confirmed in our model, e.g. the separation distance decreasing (to a limit) with increasing Skyrme-coupling and (the magnitude of) cosmological constant, respectively.

1.3.3 Einstein-Yang-Mills System

(D.H. Tchrakian, D. Maison, P. Breiteunlohner, Y. Brihaye & E. Radu)

The group extended the study of the systems consisting of the first two members of the Einstein-Hilbert and the Yang-Mills hierarchies in dimensions $d = 6, 7, 8$ to the case of all members of the YM hierarchy and in principle in all dimensions. The results, which differ appreciably from those of the usual Einstein-Yang-Mills system in $3 + 1$ dimensions, were completely classified. The special critical behaviour in $d = 5$ discovered previously was shown to repeat in every $d = 4p + 1$. Multinode solutions, and the non Abelian version of the Reissner-Nordstrom solutions were also found.

1.3.4 Fermionic Models

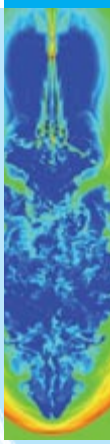
(D.H. Tchrakian & W. Nahm)

The study of fermionic models, where the fermion is localised to the brane was continued. These generalise the case of 1 extra dimension to that of d extra dimensions. Two classes of models were proposed. In the first class, the Dirac operator in the extra d dimensions featured a partial derivative, while in the second, it featured a covariant derivative. It was found that none of the first class of models, except that with $d = 1$, localise the fermion, while models of the second class exhibit this mechanism of localisation successfully.

1.3.5 Solitons in Higher Dimensional Yang-Mills Systems

(D.H. Tchrakian, Y. Brihaye & E. Radu)

The stability, and instability, properties of the `solitons' in higher dimensional Yang-Mills systems were studied. In even spacetime dimensions these turn out to be (unstable) *sphalerons*, while in odd dimensions they can



be stabilised by the Pontryagin (topological) charge. In the unstable cases, both the noncontractible loops in the configuration space of the fields were constructed, and, the negative modes of the corresponding fluctuation equation was constructed.

2 Publications

2.1 Books

1. M. Leitner: Zero Field Hall Effect für Teilchen mit Spin 1=2. *Logos Verlag Berlin*, 2004.

2.2 Papers in Refereed Journals

2. T. C. Dorlas & J. V. Pulé: The invariant measures at weak disorder for the two-line Anderson model. *Rev. Math. Phys.* **16**, (2004) 1-34.

3. T. C. Dorlas & W. Skrypnik: Two order parameters in quantum XZ spin models with Gibbsian ground states. *J. Phys. A: Math. & Gen.* **37** (2004) 6623-6632.

4. N. Datta & T. C. Dorlas: Random walks on a complete graph: a model for infection. *J. Appl. Prob.* **41** (2004) 1008-1021.

5. T. C. Dorlas & W. M. B. Dukes: Fluctuations of the local magnetic field in frustrated mean-field Ising models. *Markov Proc. and Rel. Fields* **10(4)** (2004) 585-606.

6. T.C. Dorlas & V.B. Priezzhev: A normalisation identity for the asymmetric exclusion process on a ring. *Journal of Statistical Mechanics: Theory and Experiment* P11002 (2004).

7. Denjoe O'Connor: Field theory on low dimensional fuzzy spaces. *Mod. Phys. Lett.* **A 18** (2003) 2423-2430.

8. B. Dolan, Denjoe O'Connor & P. Presnajder: Fuzzy complex quadrics and spheres. *JHEP* **02** (2004) 055.

9. X. Martin: A matrix phase for the ϕ^4 scalar field on the fuzzy sphere. *JHEP* **04** (2004) 077.

10. J. Guven: Second variation of the Helfrich-Canham Hamiltonian and reparametrisation invariance. *J. Phys.* **A 37** (2004) 5983.

11. J. Guven: Membrane geometry with auxiliary variables and quadratic constraints. *J. Phys.* **A 37** (2004) L313.

12. S. Adams & J.-B. Bru: Exact solution of the AVZ-Hamiltonian in the grandcanonical ensemble. *Ann. Henri Poincaré* **5** (2004) 1-31.

13. S. Adams & J.-B. Bru: Critical analysis of the Bogoliubov theory of super-fluidity. *Physica* **A 332** (2004) 60-78.

14. S. Adams & J. -B. Bru: A new microscopic theory of superfluidity at all temperatures. *Annales Henri Poincaré* **5** (2004) 435.

15. F. Laytimi & W. Nahm: A generalisation of Le Potier's vanishing theorem. *Manuscripta Math.* **113** (2004) 165-189.

16. M. Caselle, M. Hasenbusch & M. Panero: Short distance behaviour of the effective string. *JHEP* **05** (2004) 032.

17. W. Nahm & D.H. Tchrakian: Localisation of fermions to branes: codimension equal to or greater than 2. *JHEP* **04** (2004) 075.

18. S. Kurkcuoglu: Non-linear sigma models on the fuzzy supersphere. *JHEP* **04** (2004) 062.

19. B. Ydri: Noncommutative $U(1)$ Gauge Theory As a Non-Linear Sigma Model. *Mod. Phys. Lett.* **A 19** (2004) 2205-2213.

20. B. Ydri: Exact Solution of Noncommutative $U(1)$ Gauge Theory in 4-dimensions. *Nucl.Phys.* **B 690** (2004) 230-248.

2.3 Papers in Conference Proceedings

21. T. Tsukioka: String Models in 26+2 and 10+2-dimensional Spacetime. *Proceedings YITP Workshop on Fundamental Problems and Applications of Quantum Field Theory, Yukawa Institute for Theoretical Physics, Kyoto, Japan, 26th December 2003*. Soryushiron Kenkyu (Kyoto) **109-6** (2004) F45.

22. W. Nahm: Modular forms and torsion elements in an extended Bloch group. *Proceedings of the Third Spring Conference on Modular Forms and Related Topics, Hamamatsu*. Printed by Ryushi-do. (2004) 20.

23. W. Nahm: (T)BA. *Proceedings 11th Regional Conference on Mathematical Physics, Tehran,(2004).*

24. C. Fan, M. Reisslein & S.Adams: The $FT^{N} - FR^{A}$ AWG Network: A practical and efficient single-hop Metro WDM Network for uni- and multicasting. *IEEE Infocom-Proceedings, Hongkong (2004).*

25. T. Chen, G. Schäfer, G. Fan, S. Adams & A. Wolisz: Denial of service protection for optimised and QoS-aware handover based on localised cookies. *Proceedings 5th European Wireless Conference, Barcelona, (2004) 155-161.*

2.4 Preprints

DIAS-STP-

[04-01] M. Caselle, M. Hasenbusch & M. Panero: Short distance behaviour of the effective string.

[04-02] T.C. Dorlas & W. Skrypnik: Two order parameters in quantum XZ spin models with Gibbsian ground states.

[04-03] X. Martin: A matrix phase for the ϕ^4 scalar field on the fuzzy sphere.

[04-04] X. Martin, Denjoe O'Connor & R.D. Sorkin: Random walk in generalised quantum theory.

[04-05] B. Ydri: Exact solution of noncommutative $U(1)$ gauge theory in 4 dimensions.

[04-06] P. Castro-Villareal, R. Delgadillo-Blando & B. Ydri: A gauge invariant UV-IR mixing and the corresponging phase transition for $U(1)$ fields on the fuzzy sphere.

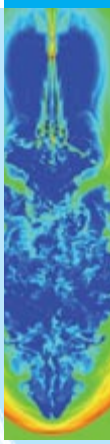
[04-07] B. Ydri: Noncommutative $U(1)$ gauge theory as a non-linear sigma model.

[04-08] J. Guven: Second variation of the Helfrich-Canham Hamiltonian and reparametrisation invariance.

[04-09] J. Guven: Membrane geometry with auxiliary variables and quadratic constraints.

[04-10] N. Datta & T.C. Dorlas: Source coding in quantum information theory.

[04-11] M. Panero: A numerical study of a confined Q anti-Q system in compact $U(1)$ lattice gauge theory in 4D.



[04-12] B.P. Dolan: Quantum black holes: the event horizon as a fuzzy sphere.

[04-13] J-B. Bru: Large deviations for local particle densities.

[04-14] C.R. Stephens, A. Zamora, A. Wright, R. Poli & W.B. Langdon: Perturbation theory and the renormalisation group in genetic dynamics.

[04-15] K. Duffy, D. Malone, E.A. Pechersky, Y.N. Suhov & N.D. Vvedenskaya: Large deviations provide good approximation to queueing system with dynamic routing.

[04-16] S. Adams, J-B. Bru & W. Koenig: Large deviations for trapped interacting Brownian particles and paths.

[04-17] M. Rimaldi & Paul Watts: Pre-Big Bang Scenarios on Self-T-Dual Bouncing Branes.

[04-18] T. Tsukioka & Y. Watabiki: Quantisation of Neveu-Schwarz-Ramond Superstring Model in 10+2-dimensional Spacetime

[04-19] M. Nicolau, C. Ryan & C. Stephens: Zero is not a Four-Letter Word: Studies in the Evolution of Language.

[04-20] M. Gruber & M. Leitner: Zero field Hall effect for Dirac fermions in an edge device.

[04-21] T.C. Dorlas & V.B. Priezzhev: A normalisation identity for the asymmetric exclusion process on a ring.

[04-22] M. Christandl, N. Datta, T. C. Dorlas, A. Ekert, A. Kay & A. J. Landahl: Perfect Transfer of Arbitrary States in Quantum Spin Networks.

[04-23] M. Herzog, S. Adams & M. Maier: Ringostar: A Performance Upgrade for Metro Packet Rings.

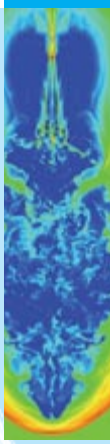
3 Programme of Scholarly Events

3.1 Lectures Organised by The School

- S. Bal (Theoretical Physics Laboratory RIKEN, Japan) *Dynamical generation of space-time and gauge group in matrix models.* 8 December
- I.M. Benn (School of Mathematical and Physical Sciences, Newcastle University NSW, Australia) *Generalised killing tensors and symmetry operators.* 20 September
- M. Deserno (MPI für Polymerforschung, Mainz, Germany) *Toroidal DNA condensates – with a new twist.* 18 May (held in TCD)
- D. Kochan (Comenius University, Bratislava) *Differential gorms and worms.* 7 December
- W. König (Technical University, Berlin) *Random matrix theory I*. 7 July
- W. König (Technical University, Berlin) *Random matrix theory II*. 8 July
- W. König (Technical University, Berlin) *Random growth models*. 11 August
- W. König (Technical University, Berlin) *Non-colliding random processes*. 18 August
- A. Stern (University of Alabama, Tuscaloosa) *Use of singular maps in non-commutative physics.* 10 December
- K. Takenaga (Osaka University, Japan) *Supersymmetry in quantum mechanics with point interactions.* 17 May

3.1.1 Seminars Organised by The Theoretical Particle Physics Group

- E. Corrigan (University of York) *Boundaries and defects in integrable field theories*. 29 April
- P.H. Damgaard (Niels Bohr Institute) *Low-energy QCD and random matrix theory*. 22 April
- B.P. Dolan (NUI Maynooth) *The event horizon as a fuzzy sphere*. 7 October
- P.A. Grassi (YITP, Stony Brook) *Recent developments in pure spinor string theory.* 20 May
- B. Guilfoyle (Institute of Technology, Tralee) *Computing the Casimir effect by geometric optics.* 2 December
- J. Guven (ICN-UNAM, Mexico) *Surface deformations, conservation laws, and the geometry of cell membranes.* 11 March
- T. Hadfield (Queen Mary College, University of London) *Quantum groups and noncommutative geometry*. 15 January
- I. Jack (Liverpool University) *Yukawa textures and anomaly mediated supersymmetry breaking.* 12 February
- N. Kawamoto (Hokkaido University, Japan) *Twisted superspace for N=2, 4 SUSY with Dirac-Kaehler fermion mechanism on the lattice.* 4 March
- W. Koenig (Technische Universität Berlin) *Parabolic Anderson model with bounded potential.* 22 January
- M. Leitner (Inst. für Theoretische Physik II, Universität Augsburg, Germany) *Zero field effect for particles with spin* 1/2. 13 May
- R. Manvelyan (Technische Universität Kaiserslautern, Germany) *Higher spin theories in AdS space and generalised Weyl invariance.* 25 November
- R. Minasian (CPHT, France) *On mirror symmetry with fluxes.* 17 February
- H. Nicolai (Max-Planck-Institut für Gravitationsphysik, Potsdam) *Cosmological billiards and Lorentzian Kac Moody algebras*. 9 December
- B. Noyvert (The Weizmann Institute of Science, Israel) *Quantum Hamiltonian reduction of affine superalgebras.* 1 April
- P. O'Hara (Northeastern Illinois University) *Rotational invariance and the spin-statistics theorem*. 26 February
- P. Peter (Institute of Astrophysics of Paris, France) *Properties of cosmological perturbations through a bouncing phase.* 25 March
- J. Slingerland (Heriot Watt University) *Topological interactions, symmetry breaking and confinement in discrete gauge theory*. 2 April
- S. Stepin (Moscow State University) *Scattering and spectral singularities for Schrödinger-type operators.* 13 February
- C.R. Stephens (DIAS & Instituto de Ciencias Nucleares, UNAM, Mexico City) *The equation of state: some new twists to an old story*. 4 November
- P.C. Villareal *The UV-IR mixing problem and the phase diagram for gauge fields on the fuzzy sphere*. 15 April
- K. Wendland (University of Warwick) *From geometry to CFT's and back to geometry.* 18 March



3.1.2 Lectures Given by DIAS Members Elsewhere in Ireland

- W. Nahm *HMI Lunchtime talk "The nature of time"*. TCD, 10 November.
- M. Panero *Cluster confinement mechanism in lattice gauge theories.* TCD, 7 April
- C. Stephens *Effective fitness, evolutionary robustness and language.* 3 seminars, University of Limerick, September & October

3.2 Symposia, Conferences, Workshops Organised

The fourth meeting on **Mathematical Analysis of Quantum Systems** was organised and took place on 29 & 30 September and 1 October. The following talks were given.

- B. Nachtergaele (Davis, CA) *Ferromagnetic ordering of energy levels and applications.*
- P. Exner (Prague) *On the meaning of quantum graph models.*
- Y. Kozitsky (Lublin, Poland) *Irreducible dynamics of quantum systems associated with Levy processes.*
- D. Petritis (Rennes) *Quantum grammars and their applications to genomics.*
- J. Yngvason (Vienna) *Bose gases in thin traps: from 3D to 2D.*
- Ch. Dobrovolny (Marseille) *The semi-infinite Potts model in the lowtemperature regime.*
- R. Olkiewicz (Wroclaw) *Quantum stochastic dynamics of CCR algebras.*
- J.V. Pulé (UCD) *A Dicke-type model for BEC superradiance.*
- J.-B. Bru *A new superfluidity theory for non-dilute Bose gas.*
- A. Suto (Budapest) *Bose-Einstein condensation and symmetry breaking.*
- A. Aftalion (Paris) *Vortex patterns of rotating Bose-Einstein condensates.*
- S. Adams *Stochastic interface models and large deviations for their random field of gradients.*
- W. Cegla (Wroclaw) *Orthomodularity condition and quantum logic*.
- W. Skrypnik (Kiev) *Two order parameters in quantum XZ spin models with Gibbsian ground states.*
- D. Yarotsky (UCD & DIAS) *Ground states and quasi-particles in weakly interacting lattice models.*
- V.B. Priezzhev (Dubna, Russia) *The asymmetric exclusion process.*

The Quantum Spaces – Noncommutative Geometry Network was held in the Institute from 15-19 November.

The following talks were delivered.

Monday 15th November

- S. Echterhoff (Universität Münster, Germany) *Topological K-theory and the Baum-Connes conjecture.*
- A. Thom (Universität Müunster, Germany) *Algebraic K-theory of locally convex algebras.*

- S. Damaville (Universität Münster, Germany) *Regular operators on C*- modules and signature operator on Lipschitz manifolds with group action.*
- D. Guido (University of Rome) *Ultraproducts and matricial quantum Gromov Hausdorff completeness for C*- algebras.*
- R. Vergnioux (Wilhelius Universität, Münster) *The property of rapid decay for discrete quantum groups.*
- T. Hadfield (Queen Mary, University of London) *Twisted homology of quantum groups.*
- G. Ruzzi (University of Rome) *Homotopy and net-cohomology of posets.*

Wednesday 17th November

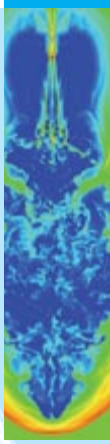
- K. Henning (Universität Göttingen) *Local QFT on a halfspace from nonlocal QFT on the boundary.*
- X. Martin (Université de Tours) *Simulating the scalar field on the fuzzy sphere.*
- A. Agostini (University of Cardiff) *Action functional for κ-minowski spacetime.*
- L. Hirshberg (University of Southern Denmark) *Representations of C*- correspondences.*
- D.G. Evans (University of Cardiff) *Computing the K-theory of k-graph C*- algebras.*
- E. Christensen (University of Copenhagen) *Totally disconnected non commutative compact spaces.*

Thursday 18th November

- S. Wasserman (University of Glasgow) *Continuous bundles of C*-algebras with discontinuous tensor products.*
- B. Burgstaller (Universität Münster, Germany) *Higher rank Cuntz-Krieger algebras.*
- S. Thorbjornsen (University of Southern Denmark) *Applications of random matrices to C*-algebras.*
- W. Werner (Universität Münster, Germany) *Causal structure on infinite dimensional symmetric spaces.*
- I. Androulidakis (Paris 6) *Realising foliations by Lie groupoids.*
- M. Talbi (University of Rome) *Property of rapid decay and group acting on some spaces.*
- C. Voigt (Universität Münster, Germany) *Baaj-Skandalis duality in cyclic homology.*
- S. Doplicher (University of Rome) *Quantum field theory and quantum spacetime.*

Friday 19th November

- M.J. Gabriel (University of Rome) *Implementation of Bogoliubov endomorphisms, q-commutation relations and EO-semigroups.*
- T.M. Carlsen (NTNU, Trondheim, Norway) *On C*-algebras of actions of inverse semigroups.*
- P. Pinto (Lisbon, Portugal) *Subfactors and modular invariants: examples*
- R. Fischer (Université Blaise-Pascal, Clermont-Fd.) *Coactions of quantum groups.*
- B. Ydri *Phase structure of noncommutative gauge theory on the fuzzy sphere.*
- E. Vasselli (University of Rome) *A geometrical look to tensor C*-categories and duality.*



- G. Piacitelli (Trieste) *Perturbative QFT on DFR quantum spacetime.*
- E. Stormer (University of Oslo) *On the definition of noncommutative dynamical entropy.*

A **Workshop on Causal Sets** was held in the Institute from 13-17 December.

The following discussion sessions were held.

- F. Dowker (Imperial College London) *Overview of causal sets.*
- J. Henson (University of California, San Diego) *Propagation on causal sets.*
- S. Marr (Imperial College London) *Black hole entropy.*
- G. Brightwell (London School of Economics) *Covariants in models of sequential growth.*
- S. Surya (Raman Research Institute, Bangalore, India) *Rogue forested turtles.*
- D. Rideout (Hamilton College, Clinton, NY) *Thickened anti-chains and cactus.*
- I. Herbauts (Queen Mary, University of London) *A causal collapse model on a lattice.*
- R.S. Garcia Carrillo (Imperial College, London) *From histories to Hilbert space.*
- R. Salgado (Dillard University, New Orleans) *The D'Alembertian and the adjacency matrix of a causal set.*
- N. Georgiou (London School of Economics) *Random binary orders.*
- Denjoe O'Connor *Quantum random walks.*

The **Winter Symposium** was held on 15th and 16th December. Lectures were given as follows:

- G. Brightwell (London School of Economics) *Hard constraint models and graph colouring.*
- M. Huxley (Cardiff University) *Remarks on the Riemann Zeta function and lattice points.*
- S. Adams *Large deviations for interacting Brownian particles and paths in trap potentials.*
- G. Crowley (Science Foundation Ireland) *Address*
- M. Klimek (Uppsala) *Mathematics of decision making.*
- Y. Suhov (Cambridge University) *On Anderson's N-particle model of localisation.*
- W. Kager (University of Amsterdam) *The area explored by a class of random walkers.*
- A. Diatta (University of Liverpool) *An application of geometry and singularity theory to computer vision: symmetry sets and medial axes of plane curves.*

4 Presentations at Conferences or Seminars

4.1 Talks and Papers Presented

T.C. Dorlas

- Talk "Bosons on graphs" at "Aspects of Large Quantum Systems Related to Bose-Einstein Condensation" Conference, Aarhus, 14-18 April.
- Colloquium talk "Random walks on a complete graph", Marseille, 19 May.

- Talk "Quantum source coding" at Warwick EPSRC Symposium on "The Mathematics of Quantum Systems." Workshop on "Large Many-Body Systems", 23-27 August.
- Invited talk "Quantum source coding", at "Nonlinear Systems, Ergodic Theory and Renormalisation" Workshop, University of Leiden, The Netherlands, 19-26 September.

W. Nahm

- Seminar talk on "Bethe ansatz modular forms and algebraic K-theory for conformal field theories with integrable perturbation" TCD, 13 January.
- Colloquium talk on "Hidden dimensions" UCC Cork, 22 January.
- Talk on "Modular forms and torsion elements in an extended Bloch group" at Third Spring Conference on Modular Forms and Related Topics, Hamamatsu, 16-20 February.
- Talk on "Monopoles and Olive-Montonen Duality" at Conference on Strings, Gauge Fields and Duality to mark the retirement of Professor David Olive, CBE, FRS, Swansea, 24-27 March.
- Talk on "(T)BA" at Regional Conference on Mathematical Physics, Tehran, 3-6 May.
- Seminar talk on "Field theory, S-matrices and Rogers-Ramanujan type identities" Hongkong University, 30 June.
- Talk on "The Bethe ansatz for integrable QFTs in 1 + 1 dimensions" at the ICMS Conference on Complex Geometry and Physics, Edinburgh, 6-10 September.
- Talk on "TBA" at the ninth ABCKLM network meeting, Gregynog, Wales, 28-31 October.
- Seminar talk on "The Bethe ansatz and conformal field theory" at Kings College London, 3 November.

Denjoe O'Connor

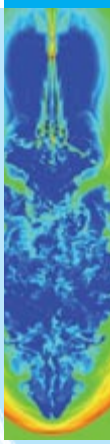
- Talk "A matrix model approach to nonperturbative field theory" at Nichtkommutative Geometrie, Oberwolfach, Germany, 12-18 September.

R. Delgadillo Blando

- IOPI-ASGI Post Graduate poster session "$U(1)$ Gauge Theory on the Fuzzy Sphere" Armagh, 1-4 April.
- Talk "Teoria de norma $U(1)$ sobre la esfera fuzzy y su limite continuo" ("$U(1)$ Gauge Theory on the Fuzzy Sphere and its continuum limit"), CINVESTAV, 21 June.

J.-B. Bru

- Talk on "A new microscopic theory of superfluidity at all temperatures", FB Mathematik und Informatik, Mainz, Germany, 24 May.
- Talk on "A new microscopic theory of superfluidity at all temperatures", Laboratoire Kastler Brossel, Departement de Physique de l'Ecole Normale Superieure, France, 26 May.
- Talk on "A superfluidity theory for the non-dilute Bose gas", Workshops on Phasenübergänge, Oberwolfach, Germany, 23 June.
- Talk on "A new superfluidity theory for the non-dilute Bose gas", Erwin Schrödinger Institute, Vienna, Austria, 20 September.



- Talk on "A new microscopic theory of superfluidity at non-zero temperatures", LPTMS, Université Paris-Sud, Orsay, France, 12 October.

M. Leitner

- "Geometry of the Quantum Hall Effect in QED in 2 + 1 dimensions", talk delivered at the String Theorie und Geometrie Workshop, Oberwolfach, 8-17 August.
- "Zero Field Hall Effect in 2 + 1 dimensional QED", talk presented at the Dublin Theoretical Physics Colloquium, TCD, 6 December.

S. Panero

- "A numerical study of a confined Q1Q system in compact $U(1)$ Lattice Gauge Theory in 4D", parallel talk presented at the 22nd International Symposium on Lattice Field Theory (Lattice 2004), Batavia, Illinois, USA, 21-26 June.
- "Effective string scenario for confinement and high precision lattice results", invited talk given at Universidad Nacional Autonoma de Mexico, Mexico City, Mexico, 17 June 2004.
- "Duality and the $U(1)$ LGT", invited talk given at Turin University, Turin, Italy, 11 December.

B. Ydri

- "Some Quantum Aspects of Noncommutative Fuzzy Gauge Fields", talk at 11th Irish QFT Conference, National University of Ireland, Maynooth, 14 May.

F. Garcia Flores

- Poster: "New phase transition in the $\lambda\phi^4$ model on the fuzzy sphere", Spring Weekend Meeting of the IOPI and the Spring 2004 Meeting of the ASGI, 3 April.
- Talk on "The phase diagram of the fuzzy ϕ^4 model from Monte Carlo simulation", 11th Irish Quantum Field Theory Meeting 2004, National University of Ireland, Maynooth. 15 May.

J. Medina

- "Simulaciones del modelo $\lambda\phi^4$ en el espacio S^2-fuzzy con tiempo" (Simulations on the $\lambda\phi^4$-model on S^2_L) Departamento de Física del Centro de Investigación y de Estudios Avanzados del IPN., México, D.F. 18 June.

S. Ní Chiagain

- Poster on "Algebraic K-theory and partition functions in conformal field theory", IRCSET symposium, Croke Park, Dublin, 2 November.

5 Collaboration with the Wider Research Community

5.1 National

Lecture Courses and Workshops

T.C. Dorlas

- Course for undergraduates on "Quantum Computing"(TCD Course #471, UCD Course #MAPH4151) (Academic year 2003-2004)
- An international workshop on "Mathematical Analysis of Quantum Systems" was organised and took place from 29 September - 1 October.
- The Winter Symposium was organised on 15-16 December.

W. Nahm

- Postgraduate lecture series on "Integrable Systems". (October to December)

S. Adams

- Course for undergraduates on "Mathematical Statistical Physics"(UCD Course #MAPH4151) (January to May)

Staff Acting as External Examiners

- W. Nahm: External examiner for a Ph.D. thesis in NUI, Cork, 22 January.
- D. O'Connor: External examiner for a Ph.D. defence of Vivien de Beauce in TCD, November 2004.
- C. Stephens: External examiner for a Master's thesis, University of Limerick.

Speakers Sponsored at Outside Conferences/ Meetings

- P. Candelas (Oxford) The 11th Irish Quantum Field Theory Meeting, NUI Maynooth, 14-15 May
- G.F. Giudice (Geneva) The 11th Irish Quantum Field Theory Meeting, NUI Maynooth, 14-15 May
- J. Kuti (La Jolla, CA) The 11th Irish Quantum Field Theory Meeting, NUI Maynooth, 14-15 May

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-Maximilians-Universität 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. Shatashvilli, 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

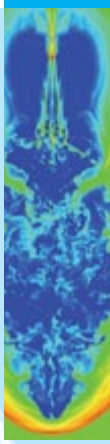
Lecture Courses and Workshops

W. Nahm

- Organised Conference "String-Theorie und Geometrie" with Nigel Hitchin, Oxford and Anton Kapustin, Pasadena in Oberwolfach, Germany, 8-14 August.

Staff Supervising External Students

- D. O'Connor: Ph.D. supervisor for P. Castro, R. Delgadillo, J. Medina, F. Garcia and I. Huet. (Cinvestav, Mexico)



- X. Martin: Ph.D. supervisor for A.C. Cordero (Mexico) who successfully completed 2 July.

Visiting Researchers

Short visits (up to one week):

- I. Benn (Newcastle, Australia and University of Aberdeen) 19-22 September
- W. Bietenholz (Berlin) 28 November - 2 December
- E. Corrigan (University of York) 29-30 April
- P.H. Damgaard (Niels Bohr Institute, Copenhagen) 22-25 April
- M. Deserno (Mainz) 18-23 May
- H. Eberle (University of Bonn) 16-22 May
- P.A. Grassi (State University of New York and Paris) 17-22 May
- B. Guilfoyle (IT, Tralee) 2 December
- T. Hadfield (University of London) 14-15 January
- G. Immirzi (Univ. di Perugia, Italy) 19-25 January, 9-14 March
- I. Jack (University of Liverpool) 12-13 February
- N. Kawamoto (Hokkaido University, Japan) 2-6 March
- M. Leitner (University og Augsburg, Germany) 11-17 May
- X. Martin (University Tours, France) 13-20 November
- M. Mueller (MPG, Mainz) 18-23 May
- H. Nicolai (MPI, Potsdam, Germany) 8-11 December
- B. Noyvert (Israel) 29 March - 4 April
- P. O'Hara (Northeastern Illinois University, Chicago) 26 February
- J. Pawlowski (University of Heidelberg, Germany) 3-9 October
- P. Peter (Paris) 23-26 March
- J. Polchinski (U.C. Santa Barbara) 23 July
- D. Roggenkamp (ETHZ, Switzerland) 19-22 July
- V.V. Sreedhar (Indian Institute of Technology and University of Uppsala) 27-30 July
- P. Teotonio-Sobrinho (Sao Paulo, Brazil) 6-13 March
- J. Volkholz (Berlin) 28 November - 5 December
- Y. Watabiki (Tokyo Institute of Technology) 4-11 March
- K.Wendland (Warwick University) 15-22 March

Long visits:

- S. Bal (RIKEN, Japan) 2-11 December
- A.P. Balachandran (Syracuse, USA) 6-14 March
- C. Chryssomalakos (Mexico) 21 March - 3 April, 5-18 December
- C. Dobroovolny (Marseille) 14 June - 17 July
- D. Dou (Algeria) 1-11 October
- H. Eberle (University Bonn, Germany) 27 November - 10 December
- D. Evans (Cardiff) 4-12 March
- G.W. Ford (Michigan University, Ann Arbor) 31 May - 7 July
- J. Guven (Cinvestav, Mexico) 1 January - 8 July

- D. Kochan (Bratislava, Slovakia) 14 November - 12 December
- W. Koenig (TU-Berlin) 14-24 January, 6-19 July, 10-21 August
- F. Laytimi (Lille University, France) 21 August - 4 September
- D. Maison (Munich) 4-16 July
- R. Manvelyan (Kaiserlautern, Germany) 16-26 November
- R.F. O'Connell (Louisiana State University, USA) 28 May - 11 August
- E. Pechersky (Moscow) 1-15 September
- P. Presnajder (Bratislava, Slovakia) 12-24 November
- V.B. Priezzhev (Moscow) 28 September - 28 October
- J. Santiago (Mexico) 13-25 July
- W. Skrypnik (Kiev, Ukraine) 26 September - 8 October
- S. Stepin (Moscow State University) 30 January - 15 February
- C. Stephens (UNAM, Mexico) 4 July - 31 December
- A. Stern (Alabama, USA) 1-22 December
- Y. Suhov (Cambridge) 30 August - 9 September, 15-23 December
- K. Takenaga (Osaka University, Japan) 10-23 May, 28 May - 3 June
- S. Vaidya (Indian Institute of Science, Bangalore, India) 9-31 July
- N. Vvedenskaya (Moscow) 1-15 September

Research Visits by School Staff

T.C. Dorlas

- Visited University of Bologna, Italy, 1-4 February.
- Visited Joint Institute for Nuclear Research (JINR), Dubna, 16-26 March.
- Visited University of Cambridge, 26-29 April, 12-21 July, 11-16 October.
- Visited CPT, Marseille, 14-22 May.

W. Nahm

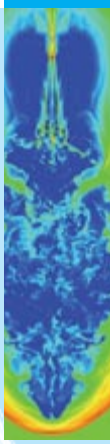
- Visited Research Institute of Mathematical Sciences, Kyoto University, Japan 14-26 February.
- Visited University of Bonn, 3-6 April.
- Visited Tehran, 2-9 May.
- Visited Heidelberg University, Germany, 26 May - 2 June.
- Visited Berlin University, Germany, 31 August - 2 September.
- Visited University of Bonn as a referee for a German Research Society Project, 20-23 October.
- Visited King's College, London, 3 November.

Denjoe O'Connor

- Visited Perimeter Institute, Waterloo, Canada, 9-20 February.
- Visited CINVESTAV, Mexico 20 Feb - 4 March.

S. Adams

- Visited Arizona State University, 3-11 January.



- Visited Institut für Mathematik, Technische Universität Berlin (Germany), 26 January - 18 February.
- Visited University of Bochum, Germany, 21-23 February.
- Visited the Institut für Mathematik, Technische Universität Berlin (Germany), 6-22 March.
- Visited the Institut für Mathematik, Technische Universität Berlin (Germany), 30 March - 1 April.
- Visited Center for Mathematical Sciences Research, Rutgers – The State University of New Jersey, 12-25 May.
- Visited University of Gottingen, Germany, 26 May - 15 June.
- Visited Max-Planck-Institut, Leipzig, 12-21 July.
- Visited University of Munich, Germany, 23-30 August.
- Visited Academy of Science, Prague, 9-28 September.
- Visited Max-Planck-Institut, Leipzig, 1 October - 30 November.

J.-B. Bru

- Visited Ecole Nationale des Arts et Metiers, Lille (France), 1-2 February.
- Visited the Institut für Mathematik, Technische Universität Berlin (Germany), 8-19 March.
- Visited FB Mathematik und Informatik, Mainz, 23-25 May.
- Visited Ecole Normale Superieure, Paris, 26-27 May.
- Visited University of Berlin, Germany, 1-3 September.
- Visited The Erwin Schrödinger Institute, Vienna (Austria), 3-29 September.
- Visited Laboratoire de Physique, Universite Paris-Sud, France, 11-15 October.

X. Martin

- Visited Institut d'Astrophysique de Paris, (IAP), Paris 1-9 April.
- Visited University of Tours, France 9-12 May.
- Visited University of Tours, France 5-12 July.

J. Medina

- Visited Institut für Physik, Humboldt-Universität zu Berlin. for research collaboration, 15 March - 5 April

T. Tsukioka

- Visited Department of Physics, Tokyo Institute of Technology, Japan, 3-10 January.

6 Participation in Outside Committees

T.C. Dorlas

Served on the National Committee on Mathematics, Royal Irish Academy, 4 March.

W. Nahm

Referee of Deutsche Forschungsgemeinschaft for the Collaborative Research Centre 647 Space-Time-Matter, Analytic and Geometric Structures, Berlin, 1-2 September.

Referee of Deutsche Forschungsgemeinschaft for the Special Research Project 2043 Particles, Strings and Early Universe: Structure of Matter and Spacetime, Hamburg, 21 October

7 Attendance at External Conferences, Meetings and Courses

7.1 Conferences Attended

T. C. Dorlas

- Conference on "Aspects of Large Quantum Systems Related to Bose-Einstein Condensation", University of Aarhus, Denmark, 14-18 April.
- Workshop on "Large Many-Body Systems", University of Warwick, 23-27 August.
- "Nonlinear Systems, Ergodic Theory and Renormalisation" Workshop, University of Leiden, The Netherlands, 20-24 September.

W. Nahm

- "Third Annual Spring Conference on Modular Forms and Related Topics", Kyoto University, 14-26 February.
- Conference "Strings, Gauge Fields and Duality", University of Swansea to mark the retirement of Prof. David Olive, 23-27 March.
- Regional Conference on Mathematical Physics, Tehran, 3-6 May
- "Algebraic Geometry and Complex Manifolds 2004", Hongkong University, 12-20 June.
- "String Theorie und Geometrie" Workshop, Oberwolfach 8-17 August.
- "Complex Geometry in Physics" Workshop, University of Edinburgh, Scotland, 6-10 September.

Denjoe O'Connor

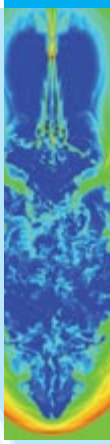
- "Noncommutative Geometry" Conference, Oberwolfach, Germany, 12-18 September.

S. Adams

- "Problems in Statistical Mechanics", University of Potsdam, Germany, 1-16 March.
- "Aspects of Large Quantum Systems Related to Bose-Einstein Condensation" Workshop, University of Aarhus, Denmark, 14-18 April.
- "Statistical Mechanics Conference", Rutgers University, New Jersey, 13-25 May.
- "The Mathematics of the Bose Gas and its Condensation" Workshop, Oberwolfach, 30 May - 5 June.
- "Phasenübergange" Workshop, Oberwolfach, 18-29 June.
- Workshop "Stochastic Aspects of Combinatorial Networks Planning" Technical University, Berlin and Humboldt University Berlin, 9-28 September.
- "Marie Curie Network Conference" 1 October - 30 November.

J.-B. Bru

- Workshop on "Aspects of Large Quantum Systems Related to Bose-Einstein Condensation," Department of Mathematical Sciences University of Aarhus, Denmark, 14-18 April.
- "The Mathematics of the Bose Gas and its Condensation" Workshop, Oberwolfach, 30 May - 5 June.



- "Phasenübergange" Workshop, Oberwolfach, 20-26 June.
- New Mathematical Problems in Quantum Many-Body Theory, Workshop, Erwin Schrödinger Institute, Vienna, Austria, 6-10 September.

M. Leitner

- "17th International Conference on General Relativity and Gravitation (GR17)" Dublin, 19-23 July 19-23.
- "String Theorie und Geometrie"Workshop, Oberwolfach 8-17 August.

S. Ní Chiagain

- "String Theorie und Geometrie"Workshop, Oberwolfach 8-17 August.

M. Panero

- Lattice 2004, XXII International Symposium on Lattice Field Theory, Fermi National Accelerator Laboratory, Batavia, Illinois, USA, 20-28 June.

T. Tsukioka

- 17th International Conference on General Relativity and Gravitation, Royal Dublin Society, 18-23 July.
- International Conference "Strings 04", Collège de France, Paris, France, 25 June - 4 July.

7.2 Lectures and Meetings Attended

T.C. Dorlas

- Series of lectures by W. König (Berlin) on "Random Matrix Theory", 7 July, 8 July and 11 August.

W. Nahm

- ABC-KLM Meeting, Gregynog, 28-31 October.

Denjoe O'Connor

- CONACyT-NSF workshop "Quantum and Fluctuating Geometries" Mexico City, 22 May - 30 June.

P. Castro

- Institute of Physics 33rd. Spring Weekend, Armagh, 1-4 April.
- "11th Irish Quantum Field Theory Meeting", NUI Maynooth, 14-15 May.
- Mexico City Fuzzy Physics group annual meeting, Cinvestav, and Physics Courses, 19 May - 31 July.
- Annual Theory Meeting, Grey College, Durham University, 16-18 December.

R. Delgadillo-Blando

- Institute of Physics 33rd. Spring Weekend, Armagh, 1-4 April.
- Mexico City Fuzzy Physics group annual meeting, Cinvestav, and Physics Courses on String Theory and Solid State Physics, 19 May - 20 August.
- Annual Theory Meeting, Grey College, Durham University, 16-18 December.

F. Garcia Flores

- Seminar "Facultad de Fisica de la Universidad Autónoma de Zacatecas", Mexico, 11 December 2003 - 16 January.
- Institute of Physics 33rd Spring Weekend, Armagh, 1-4 April.

- "11th Irish Quantum Field Theory Meeting", NUI Maynooth, 14-15 May.
- Mexico City Fuzzy Physics group annual meeting, Cinvestav, and Physics Courses, 31 May - 25 July.
- Annual Theory Meeting, Grey College, Durham University, 16-18 December.

X. Martin

- Weekly Dublin Theoretical Physics Colloquia, TCD.
- 11th Irish Quantum Field Theory Meeting, NUI Maynooth 14-15 May.
- Mexico City Fuzzy Physics group annual meeting, Cinvestav, and Physics Courses, 31 May - 29 June.
- GR17, RDS, 18-23 July.

J. Medina

- XI Irish Quantum Field Theory Meeting 2004, 14-15 May 2004, National University of Ireland, Maynooth.
- Mexico City Fuzzy Physics group annual meeting, Cinvestav, and Physics Courses, 19 May - 20 August.

M. Panero

- 11th Irish Quantum Field Theory Meeting 2004, National University of Ireland, Maynooth, 14-15 May.
- Fuzzy Physics Group Annual Meeting, CINVESTAV, Mexico City, Mexico, 13-20 June.
- Turin LGT meeting, Turin University, Turin, Italy, 4-12 December.

S. Murray:

- Dublin Theoretical Physics Colloquium: Weekly seminars hosted by the School of Mathematics, Trinity College Dublin.

B. Ydri

- 11th Irish Quantum Field Theory Meeting 2004, National University of Ireland, Maynooth, 14-15 May.

8 Research Grants

Denjoe O'Connor

Ongoing:

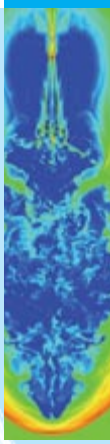
- 2002: NSF-CONACyT Grant Int-0203760: €27,500 (22,500 USD + 50,000 pesos).
- 2003: Basic Research Grant from Enterprise Ireland for €189,000.

New:

- 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.

C. Stephens

- €1,500 from Royal Irish Academy.



9 Honours/Awards/Special Achievements Received

T. Tsukioka

- Hamilton Scholars medal, Dublin Institute for Advanced Studies, 29 October.

B. Ydri

- Hamilton Scholars medal, Dublin Institute for Advanced Studies, 29 October.

10 Public Awareness Activities

10.1 Contribution to the Media

Denjoe O'Connor

- An article entitled *You can hear the shape of a Bodhrán* about the work of the School was published in the Irish Scientist Year Book 2004.