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

ANNUAL REPORT
1972–73

10 Burlington Road, Dublin 4.

Prl.3779

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

Annual Report of the work of the Institute and its Constituent Schools presented by the Council to the Minister for Education in respect of the Financial Year 1972-73

Prl.3779

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

Summary of Annual Report
of the work of the Constituent Schools
for the year 1972-73

School of Celtic Studies

The School suffered a severe loss through the death of Professor Myles Dillon.

Mrs. Eileen Whitley, who was Visiting Professor during the Michaelmas term, held a seminar on the phonology of modern spoken Irish. Other seminars and classes were given by Professor Brian Ó Cuív and by Mr. Fergus Kelly. The Statutory Public Lecture, entitled 'A bibliographer's view of Irish studies', was delivered by Mr. Rolf Baumgarten.

The Summer School, held from 10-28 July 1973, was most successful, being attended by 53 students, 33 of them from overseas. Thirteen of the latter were awarded study grants from funds made available by the Department of Education.

The full report gives details of the work of research and editing carried out in their various fields by members of the School and by extern workers.

In the field of publications eleven books (including periodicals) were published, six of them by the Institute. Members of the School contributed thirteen papers or shorter items to books or periodicals published elsewhere.

School of Theoretical Physics

The new Senior Professor, Dr. J. T. Lewis, took up his appointment on 1 September 1972, and with his arrival a group has been formed in the new area of statistical mechanics. The School continued its research in the areas of general relativity, Lie groups and high energy physics, and three books and thirty-nine articles were published during the year. Members of the School attended ten international conferences and gave twenty-eight lectures in other institutions, among them a course of six lectures on Albert Einstein given by Professor Lanczos at Manchester University Twenty-three physicists from abroad visited the School.

Events which were continued from previous years were the Wednesday seminars, the Christmas and Easter symposia, and various weekly meetings held jointly with the universities. The joint UCD-TCD-Maynooth-DIAS postgraduate course was continued, and it was agreed to resume the international summer seminars (held in the forties and early fifties). The School participated in an international meeting on holomorphy organized by the Dublin Mathematical Group.

A Festschrift published by the Clarendon Press and edited by Professor Ó Raifeartaigh on behalf of the Royal Irish Academy was presented to Professor Synge on the occasion of his retirement, and the School was fortunate in obtaining as guest speaker for the occasion the celebrated astronomer Professor S. Chandrasekhar of Chicago University. A portrait of Professor Lanczos was presented to the School by the Irish-Israeli Society. The speaker for the statutory public lecture was the

President of the European Physical Society, Professor H. G. B. Casimir. Professor Casimir, who is an ex-director of the Philips Research Laboratories in Eindhoven, spoke on Physics and Industry.

School of Cosmic Physics

Astronomical Section:

Stellar and solar research continued as mentioned in last year's Report and much work was done on construction, renovation and maintenance of equipment.

Eleven seminars were held at Dunsink Observatory during the year and the Public Open Nights were arranged once more with large attendances.

Members of the staff of the Section attended and read papers at conferences and meetings abroad and submitted thirteen papers (nine of which were already published by the end of the period under review) to learned journals and periodicals.

During the year the Observatory was visited by several distinguished scientists.

Cosmic Ray Section:

Research on sub-nuclear particles continued and this year excellent results were obtained from plastics taken to high altitudes by balloons in three successful flights at Sioux Falls, S.D., U.S.A. A study of low energy cosmic ray nuclei on the lunar surface was greatly facilitated by the co-operation of the Apollo 16 Mission in taking, for the Section, a stack of cellulose triacetate sheets for exposure during the flight and on the moon's surface.

Members of the Section attended and read papers at conferences and meetings abroad. Two important papers were published.

Geophysical Section:

Work on magnetic and gravity surveys of Ireland progressed and in the latter field assistance was given to several prospecting companies who are using the information for general purposes and for the basis of detailed gravity work they are now undertaking. Gravity surveys in collaboration with these companies were carried out.

An interesting and unusual phenomenon was observed in the course of seismic work at Malin Head, Co. Donegal and previous seismic records for the area were checked.

The usual meteorological observations were continued. Classification of rock samples was completed and the data transferred to punch cards for subsequent analysis and cataloguing.

The statutory public lecture under the auspices of the School was delivered by Dr. T. F. Gaskell (British Petroleum, London) on the subject of North Sea Oil.

The Section participated in the Royal Dublin Society Science Exhibition, 6-10 February 1973.

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

Annual Report of the work of the Institute and its Constituent Schools presented by the Council for the Financial Year 1972-73

In accordance with the provisions of Section 29 of the Institute for Advanced Studies Act, 1940 (No.13 of 1940), the Council of the Institute has the honour to present to the Minister for Education for submission to the Government a report of the work and activities of the Institute and its Constituent Schools for the financial year ending 31st March, 1973.

The general purpose which it is hoped to accomplish is clearly stated in the Act establishing the Institute, namely, the Institute for Advanced Studies Act, (No.13 of 1940) and in the Establishment Orders establishing the three Constituent Schools, namely, the Institute for Advanced Studies (School of Celtic Studies) Establishment Order, 1940, the Institute for Advanced Studies (School of Theoretical Physics) Establishment Order, 1940, and the Institute for Advanced Studies (School of Cosmic Physics) Establishment Order, 1947, and need not be referred to here. It is deemed desirable, however, to include in the report for the purposes of record certain particulars about the constitution of the Council of the Institute and the membership of the Governing Boards of the three Constituent Schools on the 31st March 1973.

The report is presented under the following principal heads:-

I - Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31st March, 1973.

II - Report of the Governing Board of the School of Celtic Studies.

III - Report of the Governing Board of the School of Theoretical Physics.

IV - Report of the Governing Board of the School of Cosmic Physics.

I - Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31st March 1973.

1. THE COUNCIL OF THE INSTITUTE

Chairman:

Professor W. B. Stanford, M.A., Litt.D., F.T.C.D.

Ex-Officio Members:

Thomas Murphy, M.D., D.P.H., B.Sc.Pub.H., President, University College, Dublin; Albert J. McConnell, M.A., M.Sc., Sc.D., Provost, Trinity College, Dublin; David Greene, M.A., President, Royal Irish Academy.

Members appointed by the Governing Boards of Constituent Schools:

Professor Brian Ó Cuív, M.A., D.Litt.; T. K. Whitaker, D.Econ.Sc.; Professor L. Ó Raifeartaigh, M.Sc., Ph.D.; Professor P. Quinlan, B.E., D.Sc., Ph.D.; Professor C. Ó Ceallaigh, M.Sc., Ph.D.; Professor E. F. Fahy, M.Sc., Ph.D.

2. THE GOVERNING BOARD OF THE SCHOOL OF CELTIC STUDIES

Chairman:

Right Reverend Monsignor Patrick Boylan, D.D., M.A., D.Litt.

Senior Professors:

Daniel A. Binchy, M.A., Ph.D., B.L.; David Greene, M.A.; Brian Ó Cuív, M.A., D.Litt.

Appointed Members:

Tomás de Bhaldraithe, M.A., Ph.D., D.Litt.; James H. Delargy, M.A., D.Litt., Litt.D.; Proinsias Mac Cana, M.A., Ph.D.; Edward MacLysaght, M.A., D.Litt.; Ernest Gordon Quin, M.A., F.T.C.D.; Reverend John Ryan, S.J., M.A., D.Litt.; Thomas Kenneth M. Whitaker, D.Econ.Sc.

3. THE GOVERNING BOARD OF THE SCHOOL OF THEORETICAL PHYSICS

Chairman:

Albert J. McConnell, M.A., M.Sc., Sc.D., F.T.C.D.

Senior Professors:

Reverend James R. McConnell, M.A., D.Sc.; Lochlainn Ó Raifeartaigh, M.Sc., Ph.D.; John T. Lewis, B.Sc., Ph.D.

Appointed Members:

George R. Keating, M.Sc.; Reverend James J. McMahon, M.Sc., Ph.D.; Thomas Edwin Nevin, D.Sc.; Patrick Quinlan, B.E., D.Sc., Ph.D.; Seán Seosamh Tóibín, M.Sc., Ph.D.; Thomas David Spearman, M.A., Ph.D. (Cantab.).

4. THE GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS

Chairman:

Edward Francis Fahy, M.Sc., Ph.D.

Senior Professors:

Cormac Ó Ceallaigh, M.Sc., Ph.D.; Thomas Murphy, D.Sc.; Patrick Arthur Wayman, Ph.D.

Appointed Members:

Patrick M. A. Bourke, M.Sc.; Peter Kevin Carroll, M.Sc., Ph.D.; Cyril F. G. Delaney, M.A., Ph.D., F.T.C.D.; Eric M. Lindsay, M.A., M.Sc., Ph.D., F.R.A.S.; Reverend Thomas P. G. McGreevy, M.Sc., Ph.D.; Patrick J. Nolan, Ph.D., D.Sc.; Cilian Ó Brolcháin, M.Sc., Ph.D.; Neil A. Porter, Ph.D.; Ernest T. S. Walton, M.A., M.Sc., Ph.D., D.Sc., F.T.C.D.

5. ADMINISTRATIVE STAFF

Registrar:

Patricia O'Neill.

Senior Clerk:

Maura Devoy.

Accounts Clerk:

Mary A. O'Rourke.

Clerks:

Angela Stubbs; Noreen Madden; Desmond Pender.

II - Annual Report of the Governing Board of the School of Celtic Studies for the year 1972-73 adopted at its meeting on 3 July 1973.

1. STAFF, SCHOLARS AND EXTERN RESEARCH WORKERS

Senior Professors:

David Greene, Director of the School to 31 August 1972 and from 1 March 1973; Daniel A. Binchy; Myles Dillon (died 18 June 1972); Brian Ó Cuív, Director of the School from 1 September 1972 to 28 February 1973.

Professor:

James P. Carney.

Visiting Professor:

Mrs. Eileen Whitley (from 12 November 1972 to 21 December 1972).

Assistant Professors:

Rev. Pádraig Ó Súilleabháin, O.F.M.; Pádraig de Brún.

Junior Assistants:

Fergus Kelly; Tomás Ó Cathasaigh (on leave of absence from 1 October 1972, see below).

Assistants (Part-time):

Mrs. Nessa Doran; Mrs. Anne O'Sullivan.

Research Assistant:

Rolf Baumgarten.

Research Associates:

Proinsias Mac Cana; Heinrich Wagner.

Technical and Clerical Staff:

Máire Breatnach; Máire Bean Uí Chinnsealaigh.

Scholars:

Ronald Black; Máire Herbert; Luce Diez (to 31 August 1972); Damien Ó Muirí (to 30 September 1972); Pádraig Breatnach (to 30 September 1972); J. C. Douglas Marshall (to September 1972); Hildegard L. C. Tristram (from September 1972 to February 1973); Katharine Simms (appointed 1 October 1972); Alan Ward (appointed 1 October 1972).

Extern Research Workers:

Dr. Cecile O'Rahilly; Louis Paul Nemo (Roparz Hemon); Dr. Ludwig Bieler; Dr. I. P. Sheldon-Williams; Mr. Brynley Roberts; Rev. Fergal Mac Raghnaill, O.F.M.; Rev. Martin McNamara, M.S.C.; Dr. Gearóid Mac Niocaill.

The death of Professor Myles Dillon was a severe loss to the School; he had been a Senior Professor since 1949 and Director during the years 1960-68. Professor Binchy assumed responsibility for seeing Volume X

of Celtica through the press, and it was decided that Volume XI would be dedicated to the memory of Professor Dillon, and that it would be edited by Professors Greene and Ó Cuív. Mrs. Eileen Whitley was Visiting Professor during the Michaelmas term of 1972; her seminar attracted a small but devoted audience. (See also Section 4.) Tomás Ó Cathasaigh was granted a year's leave of absence to act as special lecturer in Early Irish in University College, Dublin.

The Department of Education approved the appointment of Mr. Donald MacAulay as Visiting Professor for the coming year, while indicating that such approval was conditional on no appointment being made to the Assistant Professorship left vacant by the resignation of Dr. Gearóid Mac Niocaill. Efforts to obtain a third member of the clerical staff were not successful; although the need for such an appointment was made less urgent by the death of Professor Dillon and the leave of absence of Tomás Ó Cathasaigh, this merely emphasises how unsatisfactory the staffing position is.

2. RESEARCH AND EDITING

Professor David Greene continued his work on Saltair na Rann. It has been decided to publish the Adam and Eve section separately; Dr. Brian Murdoch, of Stirling University, will contribute a commentary on the sources and Mr. Fergus Kelly will collate the prose texts. Work is continuing on the historical study of the Irish language; an article on declensional developments in Early Irish will appear in Ériu XXV. A study of the semantic shift 'want' > 'wish' in the modern Celtic languages was given to the School's symposium (March 1973); an extended treatment will be published in the Zeitschrift fÜr Celtische Philologie. Work as editor of Ériu continued; Vol.XXIII appeared in December 1972, Vol.XXIV is in the press, and contributions are being collected for Vol.XXV. From Vol.XXIV onwards, Professor Proinsias Mac Cana is co-editor. See also Sections 5, 6, 10 and 11.

Professor D. A. Binchy continued the revision of first proofs of the Corpus Iuris Hibernici. Virtually half of the entire work (which will comprise 2303 pages in all) is now ready for second (and it is to be hoped, final) proof. He also prepared for press Volume X of Celtica, which was to have been edited by the late Professor Dillon and will appear under his name as editor. Proofs of three articles by Professor Dillon himself, with which the volume opens, have been received and corrected. The script of Dr. Dillon's Bergin Memorial Lecture (1972) has also been revised and handed over to the authorities of University College for Publication. Some proofs of Dr. Dillon's book Celt and Hindu, which is being published by the Indian Institute for Advanced Study in Simla, have been corrected. See also Section 10.

Professor Myles Dillon wrote three articles for inclusion in Celtica X and edited and prepared the volume for press. Professor Dillon died on 18 June 1972. See also Section 10.

Professor Brian Ó Cuív continued his work on Early Modern Irish bardic poetry devoting special attention to its transmission in manuscript form and to its relevance to the study of Irish history. He compiled for A New History of Ireland the first part of his contribution dealing with Irish language and literature in the period after 1534. He also prepared some articles for publication in periodicals. He edited two issues of Éigse and sent the copy for a third to the printer. See also Sections 4, 5, 6, 7, 9 and 11.

Professor James Carney worked on early Irish poetry and the ogam alphabet. He advised Mr. Nicholas Williams on editorial matters and supervised the work of Dr. Hildegard Tristram. See also Sections 10 and 11.

Rev. Pádraig Ó Súilleabháin indexed etymological notes, notes on grammar and syntax and linguistic dating. The following journals and books have been excerpted; ZCP, I-XXXII, Scottish Gaelic Studies I-VIII, Journal of Celtic Studies I-II, Middle Irish Declension, Grammar of Old Irish (for etymological notes only), Parrthas an Anma, Buaidh na Naomh-chroiche, Rialachas S. Froinsias, Lucerna Fidelium, An Bheatha Dhiadha, Beatha S. Froinsias, Stair Éamuinn Uí Chléire, an tAithríoch Ríoga, Trompa na bhFlaitheas, Seanmónta Chúige Uladh, Dhá Sgéal Artúraíochta (for dialect forms in the vocabulary), Cath Maighe Léna. For examples of dá with the present subjunctive, and má with the present indicative excerptions were made from the following: New Testament (1602 and 1681), Desiderius, Stapleton's Catechismus, Parrthas an Anma, Buaidh na Naomh-chroiche, Scáthán Shacramuinte na hAithridhe, Lucerna Fidelium, Old Testament (Genesis, Exodus, Leviticus, Numbers, Proverbs, Psalms), Richardson's Sermons. Preparatory work was done on an article entitled 'Father McDonnell's visit to Derrynane in 1833' for publication in Journal of Kerry Archaeological and Historical Society and proofs of the translation and notes of Rev. Cuthbert McGrath's edition of Dán na mBráthar Mionúr were read and corrected. See also Section 11.

Pádraig de Brún commenced work on a catalogue of Irish manuscripts in Cambridge University libraries (with Máire Herbert). From November 1972 to February 1973 he gave twice-weekly lessons in modern Irish to Dr. Hildegard Tristram. The following articles have been accepted for publication: 'Two Bréifne manuscripts' (Breifne 1973); 'A census of Ballyferriter parish, 1827', 'Diasa díolama ó Chloinn Mhuiris' and 'A monk of Rattoo' (Journal of Kerry Archaeological and Historical Society 7). See also Sections 9 and 11.

Mr. Fergus Kelly revised the typescript of his edition of Audacht Morainn and the work was sent to the printer in August 1972. First proofs were received in January 1973 and the correction of these is in progress. Proofs of a poem in praise of Columb Cille which is to be published in Ériu XXIV were checked. See also Sections 4 and 5.

Tomás Ó Cathasaigh completed the preparation of The Heroic Biography of Cormac mac Airt and the material was sent to press in July 1972. He worked on some early Irish texts, mainly 'The Expulsion of the Dési' and Cath Maige Tuired and did some preliminary work on the Leabhar Breac. The arranging and describing of certain papers of the late T. F. O'Rahilly continued. See also Section 10.

Mrs. Nessa Doran checked the typescript of Fasc.III of A Catalogue of Irish MSS. in the National Library of Ireland and this is now ready for press.

Mrs. Anne O'Sullivan checked first proofs of Professor Binchy's edition of Corpus Iuris Hibernici with the following manuscripts: Rawl. B 487; E 3. 5; H 2. 15; H 3. 18; H 2 15b. This completes the checking of the portion of the work set by the Richview Press (1138 pages). Some work has been done on a transcription of the Book of Leinster up to p.354^{b}.

Mr. Rolf Baumgarten continued to collect and arrange entries for the Bibliography of Irish Linguistics and Literature. Various contributions on Celtic subjects have been published in Brockhaus Enzyklopädie and on traditional Irish literature in Kindlers Literatur Lexikon. An article entitled 'Old Irish personal names: M. A. O'Brien's Rhys Lecture notes, 1957' has been accepted for publication in Celtica X and one entitled 'Alf Sommerfelt's proposals for an Irish Linguistic Survey, 1941' for publication in Studia Hibernica. See also Sections 3 and 11.

Professor Proinsias Mac Cana read and prepared for press the typescript of Brynley Robert's edition of Cyfranc Llud a Lleuelys which is to be published in the Medieval and Modern Welsh Series.

Mr. Ronald Black prepared a classified list of texts of Scottish authorship or provenance in Irish Ms. collections. Most of the texts classified as of Scottish authorship were excerpted for the Historical Dictionary of Scottish Gaelic. An edition of a 17th century bardic poem by Maol Domhnaigh Ó Muirgheasáin was accepted for publication in Scottish Gaelic Studies. See also Section 11.

Miss Máire Herbert worked on the preparation of a catalogue of Irish mss. in Cambridge (with Pádraig de Brún). In October 1972 Miss Herbert was awarded the Gardner Scholarship to Cambridge where she attended courses in Medieval Welsh, Early Irish and Northumbrian Church History, Anglo- Saxon history, language and literature. Work continued on the editing of the Columcille poems from the ms. Laud 615, with special emphasis on the poems

of historical interest, and the prophetic poetry. An article on 'The History of the manuscript Laud 615' (in association with Mrs. Anne O'Sullivan) was accepted for publication in Celtica X. See also Section 11.

Dr. Arndt Wigger carried out research on the phonology and morphology of Connacht Irish, in association with Mícheál Ó Siadhail of Trinity College, Dublin. The aim of the work is a comprehensive account of the sound pattern of that dialect in the generative framework, showing the overall system and its local differentiation. The work should be completed by the end of 1973. A preliminary survey of results was compiled in February 1973.

Miss Luce Diez continued her studies of Old and Modern Irish.

Damien Ó Muirí completely revised his work on the sentence patterns of the Irish of Gaoth Dobhair and added a comprehensive introduction. Copies of this work were submitted to Professors Greene and Ó Cuív. Tape recordings of the Sociolinguistics lectures of the Celtic Studies Summer School held in July 1973 were indexed and labelled. Work continued on the survey of dialect tapes in the School.

Pádraig Breatnach prepared an edition, with introduction and notes, of a poem of Fearghal Óg Mac an Bhaird on Aodh Ruadh Ó Domhnaill. The work has been accepted for publication in Éigse. In September Mr. Breatnach studied Scottish Gaelic on the island of South Uist.

Dr. J. C. Douglas Marshall was primarily interested in studying the relationship between Irish and medieval Latin vision literature. An article entitled 'Three Problems in the Vision of Tundal' was accepted for publicatior in Medium Aevum. He discussed with Professors Binchy, Greene and Bieler the possibility of preparing a critical edition of the Vision of Tundal to be included in the Hiberno-Latin Texts Series and began work on this project before leaving Ireland.

Miss Katharine Simms checked catalogues of Irish MSS. and relevant publications to collect as far as possible all contemporary material in the Irish language for her Ph.D. thesis on 'Gaelic lordships in Ulster in the Later Middle Ages' (14th and 15th centuries). She read unpublished poems addressed to medieval Ulster chiefs in the Book of O Conor Don, and 14th century genealogies in NLI MS. G 2-3. Under the supervision of Professor Ó Cuív she studied bardic poetry and classical Irish grammar. See also Section 10.

Dr. Hildegard Tristram studied the literary properties of the transmitted Old/Middle Irish texts. She attended Professor Ó Cuív's classes on palaeography and editing of Early Irish texts and Fergus Kelly's seminar on Fo réir Columcille. Under the supervision of Professor Carney she studied the earliest Irish literary texts and their metrical structure. She took lessons in Kerry Irish from Pádraig de Brún and attended Mrs. Whitley's seminar on the prosodic analysis of modern spoken Irish.

Mr. Alan Ward worked on an analysis of the morphology and syntax of Munster Irish dialects based on published sources. This theoretical analysis was undertaken as a preparation for field work to be done in the following year. Some work was done on a prosodic analysis of Manx, and a note on four TERH roots in Celtic was written. A short note on 'Testament' in Irish was accepted for publication in Ériu.

Dr. Cecile O'Rahilly continued preparation of an edition of Recension I of Táin Bó Cuailnge. She continued to excerpt for the Dictionary of Early Modern Irish and compared Plunkett's Dictionary with vocabulary of NT and OT already excerpted. A note on Techt tuidecht was accepted for publication in Éigse.

M. Louis Nemo continued to work on the Historical Dictionary of Breton. Preparation of the Historical Morphology and Syntax of Breton was completed and the Governing Board of the School has accepted it for publication. See also Section 11.

Dr. Ludwig Bieler continued to act as General Editor of Scriptores Latini Hiberniae and supervised the preparation of the following texts:- Iohannes Scottus Eriugena, Periphyseon Book III (ed. I. P. Sheldon-Williams); Augustinus Hibernicus, De mirabilibus sacrae scripturae (ed. G. MacGinty); Collectio Canonum Hibernensis (ed. M. P. Sheehy); Vitae Latinae S. Brigidae (ed. Seán Connolly and others). Preparation of Dr. Bieler's edition of Muirchú, Tirechán and other Patriciana in the Book of Armagh continued.

Dr. I. P. Sheldon-Williams read final proofs of his edition of Iohannis Scotti Erivgenae Periphyseon Liber II and the work was passed for press in September 1972. Preparation of Periphyseon Book III (in collaboration with Ludwig Bieler) continued.

Mr. Brynley Roberts' edition of Cyfranc Llud a Lleuelys was accepted for publication in the School's Medieval and Modern Welsh Series.

Rev. Feargal Mac Raghnaill's edition of Ó hEódhasa's Teagasg Críosduidhe was sent to press in April 1972.

Rev. Martin MacNamara, M.S.C. worked on The Apocrypha in the Irish Church which was sent to press in April 1972. First proofs were checked and returned to the printer for revise.

Dr. Gearóid Mac Niocaill completed work on the Translation and Notes of Seán Mac Airt's edition of the Annals of Ulster. The typescript of these sections was sent to the printer for setting together with the galleys of the Text for revise in September 1972.

3. STATUTORY PUBLIC LECTURE

A statutory public lecture entitled 'A bibliographer's view of Irish Studies' was delivered by Mr. Rolf Baumgarten in University College, Dublin, on 8 February 1973.

4. SEMINARS

Professor Brian Ó Cuív held a weekly class on manuscript reading and textual editing in the Trinity and Michaelmas terms 1972 and the Hilary term 1973.

Mr. Fergus Kelly held a weekly seminar during the Michaelmas term 1972 on a poem in praise of Columb Cille beginning Fo réir Choluimb céin ad-fías.

Mrs. Eileen Whitley held a twice-weekly seminar during the Michaelmas term 1972 on a prosodic view of the phonology of modern spoken Irish.

5. SUMMER SCHOOL

The Celtic Studies Summer School held at St. Patrick's College, Drumcondra, Dublin, from 10 to 28 July was attended by 53 students, 33 of whom came from overseas universities:- Canada (1); Denmark (1); England (16); France (1); Germany (3); Italy (1); Scotland (5); U.S.A. (5).

Thirteen overseas students were awarded Study Grants from funds made available by the Department of Education. The awards ranged in value from £50 to £120.

The following courses were given: (1) West Glamorganshire Welsh (T. Arwyn Watkins); (2) Connemara Irish (Tomás de Bhaldraithe); (3) Lewis Gaelic (Donald MacAulay); (4) Early Modern Irish (Brian Ó Cuív); (5) Medieval Welsh (David Greene); (6) Old Irish (Fergus Kelly); (7) The historical development of Irish (David Greene and Brian Ó Cuiv); (8) The historical development of Welsh (Proinsias Mac Cana); (9) Sociolinguistics of Irish, Scottish Gaelic and Welsh (Máirtín Ó Murchú, Donald Mac Aulay, T. Arwyn Watkins).

6. SYMPOSIUM

On March 30 and 31 1973 a symposium was held for university and college staffs and research workers. The following papers were read:-

Gearóid Mac Eoin: SeanGhaeilge coí > NuaGhaeilge cuach

Breandán Ó Buachalla: An Aisling i bhFilíocht an Tuaiscirt

Proinsias Mac Cana: Word-order in the sentence in Irish and Welsh

Brian Ó Cuív: Téacsanna filíochta a chur in oiriúint do scoláirí aeanscoile

Tomás Ó Concheanainn: Roinnt lámhscríbhinní Connachtacha i nDún Éidin

Dáithí Ó hUaithne: 'Cad tá uait?

7. MANUSCRIPT CATALOGUING

Work on the indexing of the contents of the Irish manuscripts in the National Library of Ireland continued under the direction of Professor Brian Ó Cuív. Two of the School's scholars and one extern worker took part. Nearly three hundred manuscripts have now been indexed and the work of typing and arranging the reference cards is continuing.

8. LEXICOGRAPHICAL AND LINGUISTIC ARCHIVES

The work of excerpting for the Dictionary of Early Modern Irish was continued by Professor Pádraig Ó Súilleabháin, O.F.M. and Dr. Cecile O'Rahilly.

9. DUANAIRÍ NA SCOL

The texts for Duanaire na hArdteistiméireachta, referred to in last year's Report, were completed by Professor Brian Ó Cuív and Pádraig de Brún and were issued to members of the Irish Educational Publishers Association. Subsequently consultations took place between the representatives of the School, Seán Mac Phaidín of the Department of Education and a numbers of editors representing publishing firms. It is expected that the Leaving Certificate volume will be published in 1974. Work on the Intermediate Certificate poems is progressing.

10. EXTERNAL ACTIVITIES

Professor David Greene was Visiting Professor of Linguistics in Harvard University for the fall semester, 1 October 1972 to 31 January 1973. He delivered the Vernam Hull Lecture in Harvard University in November 1972 and also lectured to the Linguistic Departments of the Universities of Chicago, Philadelphia and Pittsburgh, and to the Yale Linguistic Circle. He read a paper on 'The Growth of Palatalisation in Irish' to the Philological Society in London in February 1973, and took part in a symposium on 'Myth and Poetry' in McGill University, Montreal, in March 1973.

Professor D. A. Binchy lectured on 'Pignoris Capio in early Irish law' to the Société Internationale Fernand de Visscher pour l'étude des droits de l'antiquité which held its Congress in Dublin in September 1972.

Professor Myles Dillon attended a meeting of the Irish Texts Society in London in June 1972 and while in London lectured to the Irish Literary Society on 'A New Ireland'.

Professor James Carney accepted an invitation of the German Government, extended through the Royal Irish Academy, to spend the months of April, May and June in Germany, and lectured on aspects of Irish literature at Bonn, Bochum, Munich and Innsbruck. At the Department of History of University College, Dublin he delivered a lecture entitled 'Conversion' and at Trinity College, under the auspices of An Cumann Gaelach and the Philosophical Society, he lectured on 'The Earliest Irish Poetry' in February 1973. On December 4 and 11 1972 lectures on Early Irish Literature were delivered to the School of Irish Studies.

Tomás Ó Cathasaigh lectured to the Dublin Summer School on Irish mythology in July 1972 and to groups of American college students in January 1973. A lecture on Togail Bruidne Da Derga was given, under the auspices of An Cumann Gaelach and the Philosophical Society of Trinity College, Dublin, on 12 February 1973 at Trinity College.

Mr. Ronald Black delivered a lecture on 'Colla Ciotach' to the Gaelic Society of Inverness at Inverness on 5 January 1973. This lecture will be published in its Transactions. On 26 February 1973 he lectured to the Philosophical Society and Cumann Gaelach of Trinity College, Dublin, on Bardic Poetry.

Miss Katharine Simms lectured to the Irish Historical Society on 'The O'Neills and the Archbishops of Armagh 1347-1471' on 13 February 1973 and on 14 March 1973 to the Dublin Medieval Society on 'The Role of Women in Gaelic Ireland'.

11. PUBLICATIONS

(a) Books published by the Institute:

Duanaire Mhéig Uidhir. Edited by David Greene. pp.xvi + 291. Price £2.40. Published April 1972.

Irish Dialects Past and Present. By T. F. O'Rahilly. (Revised edition). pp.xiii + 303. Price £2.10. Published April 1972.

Catalogue of Irish MSS. in King's Inns Library, Dublin. By Pádraig de Brún. pp.xviii + 105. Price £1.05. Published August 1972.

Armes Prydein. (Medieval and Modern Welsh Series, Vol.VI). Edited by Sir Ifor Williams. English translation by Rachel Bromwich. pp.lvi + 87. Price £1.50. Published August 1972.

Iohannis Scotti Erivgenae Periphyseon Liber II. Edited by I. P. Sheldon-Williams. pp.vi + 252. Price £4.50. Published January 1973.

Buaidh na Naomhchroiche. (Scríbhinní Gaeilge na mBráthar Mionúr, Iml.X). Edited by Pádraig Ó Súilleabháin, O.F.M. pp.xlviii + 552. Price £4.80. Published March 1973.

(b) Books published outside the Institute:

David Greene:

Ériu XXIII. Published by the Royal Irish Academy and edited by David Greene.

Writing in Irish To-day. Published by the Cultural Relations Committee, 1972.

Brian Ó Cuív:

Éigse XIV, Parts III and IV. Published by the National University of Ireland and edited by Brian Ó Cuív.

Roparz Hemon:

Historical Dictionary of Breton: Rann XVIV. (Korf - Iliz - Kriz) Published by Etienne, Paris, April 1972. pp.1801-1900.

Historical Dictionary of Breton: Rann XX. (Kriz - Lavarout) Published by Etienne, Paris, March 1973. pp.1901-2000.

(c) Contributions to periodicals and other publications:

David Greene:

A detail of syncope. Ériu XXIII, 232-4.

The founding of the Gaelic League. The Gaelic League Idea (Edited by Seán Ó Tuama) 1972, 9-19.

Brian Ó Cuív:

Fear an Éada. Éigse XIV, 240.

Modern Irish srúill. ibid. 241-4.

Reviews. ibid. 256-64, 341-6, 350-2.

James Carney:

The Lambeth Commentary. Ériu XXIII, 1-55.

Alt-irische Dictung - Der geschichtliche Hintergrund. Ensemble, 1973, 66-79.

Pádraig Ó Súilleabháin, O.F.M.:

A gul gion gur lamhadh lé. Éigse XIV, 297-99.

Pádraig de Brún:

Forógra de Ghaelaibh, 1824. Studia Hibernica 12 (1972), 142-66.

A song relative to a fight between the Kerry Militia and some Yeomen at Stewartstown, Co. of Tyrone, July 1797. Journal of Kerry Archaeological and Historical Society (1973), 101-130.

An early reference to the legend of Gleann na nGealt. ibid. 197-9.

Rolf Baumgarten:

A crux in Táin Bó Fraích. Ériu XXIII, 235-41.

Máire Herbert:

Some Irish Prognostications. Éigse XIV, 303-18.

III - Report of the Governing Board of the School of Theoretical Physics for the year 1972-73 adopted at its meeting on 25 July 1973.

1. STAFF AND SCHOLARS

Emeritus Professors:

Cornelius Lanczos; John L. Synge.

Senior Professors:

Rev. James R. McConnell; Lochlainn S. Ó Raifeartaigh, Director for three years from 10 January 1972; John T. Lewis, appointed 1 September 1972.

Visiting Professors:

Michael Carroll (October 1971 - September 1972); John A. Wheeler (June 1972); David Atkinson (27 November - 22 December 1972); Jorge A. A. G. Barroso (January - March 1973).

Assistant Professors:

Seán Dineen (to 30 September 1972); R. Acharya (appointed 1 October 1972).

Research Associates:

D. Judge, Rev. C. P. Ryan (deceased 14/1/73), Rev. D. McCrea (UCD); P. S. Florides, B. K. P. Scaife (TCD); P. D. McCormack (UCC); A. I. Solomon (Open University) - all re-appointed to 30 September 1975; S. Dineen (UCD), D. H. Tchrakian (Maynooth) - appointed 1 October 1972 to 30 September 1975.

Scholars:

P. Yodzis (to 30 September 1972); S. Banerji (to 30 September 1972); P. de Baenst (without stipend); T. Yoshimura (to 30 April 1972); J. Gomatam; S. Browne (without stipend); P. Hogan; D. Tchrakian (to 30 September 1972); B. Mainland (appointed 1 October 1972); E. Harper (appointed 1 October 1972); Z. Horváth (appointed 1 October 1972); A. O'Connor (appointed 1 October 1972); T. Garavaglia (without stipend - appointed October 1972).

Research Students without stipend:

R. Critchley, P. Sisson, J. Ziegler (appointed 1 October 1972); P. Berner (appointed January 1973).

Secretary and Assistant Librarian:

Evelyn R. Wills.

2. GENERAL

Dr. J. Lewis, who had been appointed Senior Professor, took up his appointment on 1 September 1972.

A Festschrift to celebrate Professor Synge's 75th birthday was prepared by Professor Ó Raifeartaigh and presented to Professor Synge by the Royal Irish Academy on 24 April 1972.

A decision was made to resume the summer seminars which were held in the nineteen forties (and 1952), and one will be held in the Summer of 1973 at St. Patrick's Training College, Drumcondra.

The School provided accommodation for four of the visitors attending the Conference on Infinite Dimensional Holomorphy held by the mathematicians of the two Dublin universities over the three months January-March 1973, and paid a partial salary of £450 for three months to one of them (Professor Barroso).

3. STUDY AND RESEARCH

Professor Lanczos continued his research concerning the quadratic action principle of relativity. He showed that for a certain value of the free parameter the quadratic action principle leads to a Minkowskian rather than a positive definite line element. Further research is in progress concerning the possibility of reconciling a genuine (positive definite) Riemannian metric with the indefinite metric of the macroscopic superposition field. Professor Lanczos also spent a great deal of time in a careful study of Einstein's original papers between the years 1905 and 1915, and prepared a book on the Einstein decade 1905-1915.

Professor Synge continued work on the elastic collision of identical massive particles; following an ingenious suggestion of Professor R. Penrose, he was able to show that, in relativistic theory, four particles can experience seven collisions, and so the formula $\frac{1}{2}n(n-1)$ is not a valid expression for the maximum number of collisions of n particles. He also investigated anti-Compton scattering arising in the elastic collision of a massive particle and a luxon (particle of zero proper mass) with negative energy.

Dr. Hogan worked in general relativity, and also in classical electrodynamics.

Dr. Yodzis continued his earlier work on Lorentz cobordism, showing that changes of topology are consistent with the following three demands, taken together, i) stable causality, ii) geodesic completeness, iii) positive energy. He devised a gedankenexperiment for simultaneously measuring the first and second fundamental forms of a space-like hypersurface in spacetime, and commenced work on the extension of the notion of tangent to topological spaces other than differentiable manifolds.

Dr. Banerji studied the operational determination of Schwarzschild co-ordinates, and also some general theorems in Brans-Dicke and Hoyle-Narlikar cosmologies.

Rev. Dr. McCrea (UCD) continued his study of the equations of motion for several macroscopic bodies using the method of Synge (1970), in association with Dr. Hogan. They solved satisfactorily the problem of finding internal stresses consistent with the equations of motion and

which, at the same time, would not unduly complicate the subsequent calculations. The results of this work were written up for publication. Dr. McCrea also worked on the problem of trying to obtain explicit Robinson-Trautman solutions to Einstein's vacuum field equations. Such solutions, in the context of the Newman-Posadas approach to the equations of motion, would provide relatively simple models of gravitational radiation from an accelerated source.

Dr. Florides (TCD) completed work begun earlier on a new interior Schwarzschild solution, and is writing this up for publication. He also continued to work on a possible source of the Kerr metric.

Professor McConnell continued and extended his study of the properties of weight diagrams for the algebras of Lie groups. In collaboration with Dr. M. J. Newell (President of University College, Galway) he worked on the expansion of symmetric products in series of Schur functions.

Professor Ó Raifeartaigh's main project for the year was the completion of a paper with Dr. U. Niederer on covariant wave-equations. This work, which has been expanded over four years to a paper of almost one hundred highly condensed pages, is now almost finished. He worked also with Drs. Gomatam and Tchrakian on Wigner angles and with Dr. Mainland on the fixed point theorem for the Poincaré group and unified gauge theories. Professor Ó Raifeartaigh's teaching activities included the symmetry part of the M.Sc. course for the universities in the Dublin area, and the assistance of two M.Sc. students and one doctoral student in their theses.

Dr. Tchrakian worked in particles and radiation, in particular on the application of group theoretical techniques in the study of gravitational radiation, for instance in the study of null congruences and the application of twistors, as well as the study of conformal field theory.

Dr. Gomatam developed an exactly solvable model of interacting biological populations, and obtained conditions of stability of two- and three-species systems in a non-perturbative context. In collaboration with Mr. T. Garavaglia, he undertook a study of the quantum mechanical structure of the DNA molecule. Triple-orthonormal systems with helical geometry were constructed, and the Schrödinger equation describing the hydrogen bonding was derived. Dr. Gomatam also investigated the vanishing mass limit of massive quantum electrodynamics, using massive coherent states, and showed that it is possible to formulate the problem rigorously as a weak limit on the massive coherent states.

Dr. Garavaglia completed his Ph.D. thesis on scattering of light by light.

Dr. Mainland's research was primarily concerned with the quantization of field theories in the presence of constrains. In the spin 3/2 field in the presence of a minimal external electromagnetic interaction, he

found that the Heisenberg equations of motion are in agreement with the classical Lagrange equations of motion when the usual Schwinger quantization techniques are used. Dr. Mainland found, however, that this is not the case when the spin 3/2 field is allowed to interact with itself via a minimal electromagnetic coupling.

Since his arrival at DIAS Professor Lewis has continued his collaboration with Dr. D. B. Abraham (Oxford) on the equilibrium statistical mechanics of lattice systems. Mr. Sisson and Mr. Ziegler, who are registered as Ph.D. candidates at Trinity College, Dublin, have joined in this work. Professor Lewis has continued working on Bose condensation. Mr. R. Critchley, who is registered as a D.Phil. candidate at Oxford, has extended this work to Bose systems with spin and investigated the spontaneous magnetisation of the condensate. An instructional seminar has met regularly to learn about recent technical developments in equilibrium mechanics. Professor Lewis, in collaboration with Dr. L. C. Thomas (Swansea), has continued work on time-dependent problems in statistical mechanics, in particular, the Brownian motion simulated by a heat bath.

Dr. O'Connor wrote a paper on the decay properties of bound state wave functions; this paper has been accepted for publication. He then worked with Dr. J. L. Lebowitz (Yeshiva) on heat flow in disordered systems, and commenced to write this work up for publication. He also has attempted to use the Lee Yang circle theorem for ferromagnetic systems to obtain a new proof of the concavity of the magnetization of these systems, and has made some progress in this direction.

Dr. Harper has been using the unitary pole expansion of various realistic nucleon-nucleon potentials as a means of systematically investigating the effects of these potentials in the bound trinucleon system as well as in three-body bound state scattering and breakup reactions. He is also studying the effects of short range phase-equivalent unitary transformations of the two-body Hamiltonian on the three-body system. The Faddeev formalism is used to describe the three-body system of interacting nucleons and the resulting sets of coupled integral equations were solved numerically using the UCD IBM 360-50 digital computor.

The problem of constructing gauge models based on spontaneously broken symmetries, so as to include strong, electromagnetic and weak interactions, was considered at some length by Drs. Acharya and Horvath. They constructed an explicit model without strange particles, in order to study the various aspects pertaining to current algebra content, mass shift calculation, etc. The incorporation of tensor mesons into this framework is under consideration.

Dr. Dineen completed a number of projects started the previous year, and wrote the work up for publication, in papers on C^{∞}-functions on a

real Banach space, on sheaves of G-holomorphic functions, and on holomorphic functions on locally convex spaces (2 papers). He then commenced a study of convolution operators on spaces of G-holomorphic functions on an arbitrary vector space, in collaboration with P. Boland (UCD). Using weighted spaces of Taylor, Boland and Rubel, they showed that the convolution equations considered by them had solutions, and that a Malgrange approximation theorem existed for the solutions. In the latter half of the year Dr. Dineen studied surjective and projective limits in infinite dimensional holomorphy. He found that these limits could be used to classify locally convex spaces in a way which revealed properties of the holomorphic functions on such spaces. He is now preparing this work for publication.

Professor Carroll and Dr. McCormack (UCC) both worked on continuum mechanics, Professor Carroll taking advantage of his sabbatical leave from the University of California, Berkeley, to write up work which he had done there earlier. Dr. Scaife (TCD) carried out much of the work for the Lanczos Festschrift at the Institute, and Dr. Solomon (Open University) and his colleague, Dr. W. Montgomery, studied the application of Lie-algebraic methods to Hamiltonians, in particular to the Hamiltonian for the Ising model of ferro-magnetism. Finally Professor Barroso and Drs. Berner, Ström and Josefson worked on infinite dimensional holomorphy during the Spring Conference on that subject.

4. SEMINARS AND REVIEW LECTURES

Review and Seminar lectures were held throughout the year, and as in previous years they were attended by members of staff and students from Trinity College, Dublin, University College, Dublin, and St. Patrick's College, Maynooth, as well as by members of the School of Cosmic Physics.

The following Seminars were given:

Professor R. Acharya (DIAS): Goldstone bosons and Higgs mechanism.

Professor D. Atkinson (Gröningen): Construction of scattering amplitude from the cross-section and unitarity.

Professor B. Bertotti (Pavia & Oxford): Precision measurement of the sun's gravitational field.

Dr. M. Boon (Battelle): Unitary representations of non-type-I groups in solid state physics.

Professor H. B. G. Casimir (Philips Laboratories, Pres. EPS): Solid State Physics.

Professor S. Chandrasekhar (Chicago): Radiation reaction in general relativity.

Professor S. Dineen (DIAS): Survey of no-go theorems in mathematics (Trisecting 60°, etc.).

Dr. P. Florides (TCD & DIAS): A new interior Schwarzschild solution.

Dr. H. Fried (Brown): High energy eikonal applications.

Professor Y. Fujii (Tokyo): Dilation and possible non-Newtonian gravity.

Dr. J. Gomatam (DIAS): Theory of interacting populations.

Dr. P. Hogan (DIAS): Problem of interpretation of coordinates in general relativity: An example.

H-type renormalisation in classical relativistic dynamics.

Dr. F. Imbusch (UCG): Optics in the solid state.

Professor S. Kamefuchi (Tokyo Univ. of Ed.): Spin and parastatistics.

Professor G. L. Kane (Michigan & Rutherford Lab.): A biased review of the status of Regge and duality physics.

Dr. J. Kennedy (UCD): Report on Oxford Conference.

Professor V. P. Kenney (Notre Dame): Single and two-particle inclusive $\pi^{\pm}p$ reactions.

Dr. F. Klotz (TCD): Twistors and the conformal group.

Professor J. Lewis (DIAS): Recent developments in phase transitions.

Professor J. McConnell (DIAS): Symmetric function expansions.

Dr. M. J. Newell (UCG): Determinantal forms for Schur functions.

Dr. A. O'Connor (DIAS): Exponential decay in bound state wave functions.

Professor L. Ó Raifeartaigh (DIAS): The general wave-equation for definite spin.

Dr. S. Rao (Queen Mary Coll. London): Breaking of hadronic symmetry.

Dr. Riazzudin (Daresbury NPL): Light-cone approach to structure functions in unified theory of weak and electromagnetic interactions.

Dr. M. Rice (Bell Tel.): Exciton condensation or highly quantum gas-liquid transitions.

Dr. C. P. Ryan (UCD & DIAS): Light-cone expansions.

Professor D. Sciama (Oxford): A rigorous formulation of Mach's principle in general relativity.

Dr. S. Sen (TCD): Short-distance behaviour and eigenvalue calculation of e^2/hc.

Dr. H. Smith (UCD): Radio search for cataclysmic astrophysical events.

Professor J. A. Wheeler (Princeton): Black hole physics.

Beyond the end of time.

Dr. P. Yodzis (DIAS): Is the topology of space static, or is it dynamic?

Dr. P. Yodzis (Hamburg): Censorship and collapse or The occurrence of naked singularities in general relativity.

5. COURSES

The MSc. courses provided jointly by the Universities in the Dublin area and the Institute were resumed. The Institute's contribution was provided by Professor Ó Raifeartaigh who lectured during the Michaelmas and Hilary terms on "Symmetry Groups in Quantum Theory". An informal course on "Recent developments in statistical mechanics" was given by Professor Lewis, and a series of evening seminars on "Special functions

and the theory of group representations" for research workers was organized by Professor Lewis. The Wednesday public seminars were continued, and joint colloquia in mathematics, relativity and particle physics were held in collaboration with the universities.

6. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture, under the auspices of the School, was delivered in Trinity College, Dublin, on "Physics and Industry" by Professor H. B. G. Casimir, on 9 March 1973.

7. VISITORS

For lectures given by Visiting Professors and other Visitors see Sections 3, 4, 5 & 6.

Dr. D. B. Abraham (Oxford) 27-29 March 1973.
Professor D. Atkinson (Gröningen) 27 November - 22 December 1972.
Professor J. A. Barroso (Rio de Janeiro) 12 January - 30 March 1973.
Professor B. Bertotti (Pavia & Oxford) 7-8 November 1972.
Dr. M. Boon (Battelle) 14-17 November 1972.
Professor H. B. G. Casimir (Pres. European Physical Society, former Director, Philips Research Labs. Eindhoven) 8-9 March 1973.
Professor S. Chandrasekhar (Chicago & Oxford) 24-27 April 1972.
Dr. H. Fried (Brown) 17-18 April 1972.
Professor Y. Fujii (Tokyo) 24-25 October 1972.
Dr. F. Imbusch (UCG) 10 May 1972.
Dr. B. Josefson (Uppsala) March 1973.
Professor S. Kamefuchi (Tokyo Univ. of Ed.) 3-7 July 1972.
Professor G. L. Kane (Michigan & Rutherford Lab.) 24-25 May 1972.
Professor V. P. Kenney (Notre Dame) 17 July 1972.
Professor M. J. Newell (UCG) September 1972.
Dr. S. Rao (Queen Mary Coll. London) 10 April 1972.
Dr. Riazzudin (Daresbury NPL) 17 May 1972.
Dr. M. Rice (Bell Telephones) 7 June 1972.
Professor D. Sciama (Oxford) 14 February 1973.
Dr. Bo Ström (Uppsala) March 1973.
Dr. R. L. Warnock (Ill. Inst. Tech., Chicago) 1-7 December 1972.
Professor J. A. Wheeler (Princeton) 3-28 June 1972.
Dr. P. Yodzis (Hamburg) 12-15 March 1973.

8. SYMPOSIUM

A Mathematical Symposium was held on 18-19 December 1972. The

attendance was 47; this included Professors, Lecturers and Graduate Students from the several Irish universities.

In addition to the short communications (previews), the following lectures were delivered:

Dr. P. J. Boland (UCD): Theory of distributions.
Mr. C. Nash (Cambridge): Light cone current algebra and parastatistics.
Dr. P. Hogan (DIAS): Motion in relativity.
Dr. N. Buttimore (TCD): Rising cross-sections, ℓ-plane analyticity and unitarity in s and t channels.
Dr. S. Browne (UCD & DIAS): Conformal invariance of the spin 0 field.

9. EXTERNAL ACTIVITIES

Professor Lanczos lectured on "Nature of a matrix" at UCD on 20 April 1972; on "Emmy Noether and the calculus of variations" on 26 April, and on "Decomposition of a matrix" on 27 April at Manchester; on "Science as a form of art" on 3 May at St. Patrick's College, Maynooth; on "The importance of geometry teaching in secondary schools" on 18 May to the Irish Mathematics Teachers' Association; on "Survey of my research" at Frankfurt on 28 June, on the occasion of receiving the degree h.c. of Doctor philosophiae naturalis; on "Legendre versus Chebyshev polynomials" on 25 August at the Numerical Analysis Symposium in Dublin, sponsored by the Royal Irish Academy. From 10 to 26 October 1972 he gave a course of six lectures at Manchester on the life and work of Albert Einstein, and a lecture on 20 October on "Babylonian mathematics"; he lectured on "Einstein's early papers" on 18 January 1973 and on "Morals not molecules are the true measure of man" on 26 January (as an invited speaker to a Debate) at UCD; on "Creativity: Science as a form of art" at a Symposium on Creativity at Our Lady's School, Dublin on 6 February; and on "The early papers of Einstein" at UCC on 15 February.

On 24 April 1972 Professor Synge was presented with a Festschrift by the Royal Irish Academy to mark his 75th birthday. He lectured as follows: on "The hypercircle method" on 14 August to the Numerical Analysis Conference in Dublin; on 29 November on "The general theory of relativity" at UCD; and on 5 January 1973 on "What is a geodesic?" to the Irish Physics Students' Association at TCD.

Professor McConnell attended the Drexel University SIAM Conference on Lie algebras, in Philadelphia 15-16 July 1972, and presented an invited paper on "Reduction of representations of the general linear group using Lie algebras". He visited the physics departments of Duke University and North Carolina State University in the second half of July.

Professor Ó Raifeartaigh attended the Frascati Conference on Symmetries at High Energy, in May 1972; and the Marseilles Colloquium on Group Theoretical Methods in June, giving an Invited Talk on "General covariant wave-functions for massive fields"; and he attended the Trieste Conference on "Physicists' Conception of Nature" in September. He visited the University of ZÜrich twice in connection with his work with Dr. Niederer, and gave a seminar at Manchester on this work.

Professor Carroll gave a seminar at the Heriot-Watt University, Edinburgh, on 26 May 1972 on "Controllable states of deformation and stress".

Drs. Tchrakian and Hogan attended the N.A.T.O. Institute for Advanced Study Conference on Group Theory in Nonlinear Problems, in Istanbul from 7-18 August 1972, and Dr. Tchrakian gave an informal seminar there on "Higher rank spinors in general relativity". Dr. Tchrakian visited CERN in April 1972.

Dr. O'Connor visited the Institut des Hautes Études Scientifiques, Bures-sur-Yvette, for the month of December 1972. He gave a talk there on the decay of wave functions, and studied the spectral properties of quantum systems.

Dr. Horvath attended the Rutherford High Energy Conference in January 1973.

Dr. Gomatam gave a seminar on "Mathematical models of interacting biological populations" at Kevin St. Technical College, on 9 January 1973 and at Sussex University on 2 March 1973.

Dr. Dineen attended the International Colloquium on Several Complex Variables at Paris, 14-20 June 1972, and read a paper there. He acted as coordinator for the Infinite Dimensional Holomorphy Year sponsored by the Dublin Mathematical Group during the academic year 1972-73. During the colloquium he gave a graduate course on Infinite Dimensional Holomorphy, which was attended by students from UCD, TCD and he also helped organize an international conference on Infinite Dimensional Holomorphy at UCD, 26-30 March 1973. This Conference was attended by research workers from France, Germany, Sweden, Brazil and the USA. The year-long project was very successful due to great cooperation between TCD, UCD and DIAS, and the National Science Council. A full report is being prepared by the Dublin Mathematical Group.

Dr. C. Ryan was awarded a scholarship to enable him to visit CERN where he worked on weak interactions from 1 October 1972 until his untimely death in a mountain-climbing accident on 14 January 1973.

10. PUBLICATIONS

Items marked with an asterisk were recorded as in press in previous reports.

(1) Books:

Published:

*General Relativity. Papers in honour of J. L. Synge. Edited by L. Ó Raifeartaigh. Clarendon Press, Oxford, 1972.

In the press:

The Einstein decade: 1905-1915. By C. Lanczos. Paul Elok Scientific Books, London.

Festschrift for Professor Lanczos' 80th birthday. Edited by B. K. P. Scaife. Academic Press.

(2) Communications of the Dublin Institute for Advanced Studies, Ser.A. (Theoretical Physics):

Published:

*No.21. Quaternions, Lorentz transformations, and the Conway-Dirac-Eddington matrices. By J. L. Synge. Price £1.50. pp.i + 67. Published 15 August 1972. Dedicated to the memory of A. W. Conway.

(3) Contributions to periodicals and other publications:

Published:

C. Lanczos:

*Einstein's path from special to general relativity. General Relativity.

Papers in honour of J. L. Synge. Edited by L. Ó Raifeartaigh. Clarendon Press, Oxford, 1972. pp.1-19.

*Vector potential and quadratic action. Foundations Phys. 2 1972, 271-85.

The Poisson bracket. Aspects of quantum theory. Papers in honour of P. A. M. Dirac, edited by A. Salem and E. Wigner. Cambridge University Press, 1972. pp.169-78.

J. L. Synge:

*Newtonian gravitational field theory. Nuovo Cim. 8B (1972), 373-90.

*The electrodynamic double helix. Magic without magic. Wheeler Festschrift. Edited by J. R. Klauder. Freeman, San Francisco, 1972. pp.117-33.

*Review of K. T. Hopper, The common scientist in the 17th century - A study of the Dublin Philosophical Society, 1683-1708. Routledge & Kegan Paul, 1970. Hermathena 111 (1971), 103-4.

*Geometry of dynamical null lines. Tensor 24 (1972), 69-74.

Aetherial problems. Review of Lloyd S. Swenson, Jr., The Etherial problem. Univ. of Texas 1972. Nature 240 (1972), 273.

Geometry and physics (Boyle Medal Lecture). Sci. Proc. Roy. Dublin Soc., A, 4 (1972), 253-273.

Maximum number of collisions of elastic particles. Proc. Roy. Soc. 231A (1972, 1-18.

J. L. Synge and P. Yodzis:

*Kinematics, angular momentum and Eulerian dynamics in Hilbert space. Proc. R.I.A. 72A (1972), 121-147.

P. A. Hogan and J. L. Synge:

*Model of a gravitating sphere set in motion by internal stress. General rel. and Grav. 3 (1972), 269-80.

P. Yodzis:

*Lorentz cobordism. Commun. math. Phys. 26 (1972), 39-52.

*t^{-2} law for electromagnetic form factors. Phys. Rev. 6D (1972), 929-31.

P. Florides:

*Rotating bodies in general relativity. General Relativity. Papers in honour of J. L. Synge. Edited by L. Ó Raifeartaigh. Clarendon Press, Oxford, 1972. pp.167-81.

A rotating sphere as a possible source of the Kerr metric. Nuovo Cim. 13B (1972), 1-18.

D. McCrea:

*Gravitational field of a uniformly rotating sphere in third approximation. Proc. R.I.A. 73A (1973), 25-45.

E. Massa:

Spinor equivalents of irreducible tensors under the special Lorentz group. Il Nuovo Cim. 9B (1972), 41-52.

S. Banerji:

Operational determination of Schwarzschild coordinates. Nature - Phys. Sci. 239 (1972), 140-42.

S. Banerji and R. Chanda:

Pulsar glitches and the metastability of the superfluid core. Nature - Phys. Sci. 239 (1972), 139-40.

J. McConnell:

*Weight diagrams for the general linear group in five dimensions. Hungar. Phys. Acta 32 (1972), 61-74.

*Critical notice of "Space through the ages", by C. Lanczos, Academic Press, 1970. Phil. Studies 20 (1972), 272-4.

A. P. Balachandran, J. Nilsson and L. Ó Raifeartaigh:

Scattering of particles with spin; Mackey-state formulation. Nuclear Phys. 49B (1972), 221-41.

U. H. Niederer and L. Ó Raifeartaigh:

General covariant wave-functions for massive fields. Colloquium on Group theoretical methods in physics, Marseilles, June 1972. C.N.R.S., Marseilles, 1972, pp.II-1-6.

J. T. Lewis:

The free boson gas. Proc. L.M.S. Sympos. "Mathematics of Contemporary Physics". Edited by R. Streater. Academic Press, 1972. pp.209-26.

D. B. Abraham and J. T. Lewis:

High temperature correlation function for the planar ising model. Phys. Lett. 42A (1973), 535-6.

M. M. Carroll:

Plane waves of constant amplitude in non-linear dielectrics. Phys. Rev. 6A (1972), 1977-80.

M. M. Carroll and P. M. Naghdi:

*On the influence of the reference geometry on the response of elastic shells. Arch. Rat. Mech. Anal. 48 (1972), 302-18.

R. Acharya and Z. Horváth:

Determination of mixing angle in Weinberg's SU(2) x U(1) model. Il Nuovo Cim. Lett. 6 (1973), 464-66.

T. P. Coleman and J. Gomatam:

Application of a new model of species competition to Drosophila. Nature - New Biol. 239 (1972), 251-3.

S. Dineen:

Holomorphic functions on (c_o, X_b)-modules. Math. Ann. 196 (1972), 106-116.

Sheaves of holomorphic functions on infinite dimensional vector spaces. Math. Ann. 202 (1973), 337-45.

Holomorphic functions on locally convex topological vector spaces, I. Locally convex topologies on $\mathcal{H}(U)$. Ann. Inst. Fourier Univ. Grenoble 23 (1973), 19-54.

S. Dineen and L. Nachbin:

Entire functions of exponential type bounded on the real axis and Fourier transforms of distributions with bounded support. Israel J. Math. 13 (1972), 321-326.

D. Tchrakian:

Form factors for any spin and charge coupling. J. Math. Phys. 13 (1972), 1476-84.

M. Conneely and S. Ormonde:

*Continuum processes in atomic nitrogen. Phys. Rev. A. 4 (1971), 1432-45.

B. Scaife:

*The theory of the macroscopic properties of isotropic dielectrics. Dielectrics and Related Molecular Processes. Edited by Mansel Davies, Vol.1. Chem. Soc., London, 1972. pp.1-20.

B. Scaife and T. Ambrose:

*On the long-range and short-range interactions of the London-Van der Waals type. Proc. R.I.A. 72A (1972), 155-73.

11. PAPERS ACCEPTED FOR PUBLICATION (in press)

C. Lanczos:

Emmy Noether and the calculus of variations. Bull. Inst. Math. and Appl.

Legendre versus Chebyshev Polynomials. Proc. Numerical Analysis Sympos., Dublin 1972.

J. L. Synge:

*The hypercircle method. Lanczos Festschrift - "Studies in numerical analysis".

Linked harmonic oscillators. SIAM Journal Appl. Math. Dedicated to Prof. W. Prager on his 70th birthday.

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S. Banerji:

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P. Yodzis:

*On the expansion of closed universes. Proc. R.I.A.

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J. McConnell:

*On the reduction of representations of the general linear group using Lie algebras. SIAM Sympos. Ser.

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J. McConnell and M. J. Newell:

Expansion of symmetric products in series of Schur functions. Proc. R.I.A.

L. Ó Raifeartaigh and W. Montgomery:

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J. Gomatam, D. Tchrakian and L. Ó Raifeartaigh:

Simple calculation of Wigner angles. Math. and Theor. Phys. (USSR).

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G. B. Mainland and L. Ó Raifeartaigh:

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G. B. Mainland and E. C. G. Sudarshan:

Heisenberg equations of motion for the charged spin 3/2 field. Phys. Rev.

R. Acharya and P. A. Hogan:

Equivalence of massive Brans-Dicke and Einstein theories of gravitation. Il Nuovo Cim. Lett.

D. Tchrakian:

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A. O'Connor:

Exponential decay of bound state wave functions. Commun. Math. Phys.

M. Conneely, L. Lipsky and M. Ahmed:

*Configuration mixings in two-electron systems. Proc. Seventh Intern. Conf. on Physics of electronic and atomic collisions. North-Holland.

M. M. Carroll:

Controllable states of stress for incompressible elastic solids. J. Elast.

M. M. Carroll and S. C. Chow:

Motions of proportional extension. Q. J. Mech. Appl. Math.

M. M. Carroll and A. C. Holt:

Steady waves in ductile porous solids. J. Appl. Phys.

S. Dineen:

Holomorphic functions on locally convex topological vector spaces. II. Pseudo convex domains. Ann. Inst. Fourier.

S. Dineen and P. Boland:

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B. K. P. Scaife:

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IV - Annual Report of the Governing Board of the School of Cosmic Physics adopted at its meeting on 14th June 1973.

A. Astronomical Section

1. STAFF AND SCHOLARS

Senior Professor:

P. A. Wayman.

Professor:

T. Kiang.

Research Assistants:

I. Elliott; C. J. Butler.

Experimental Officer:

B. D. Jordan.

Research Associates:

Professor N. A. Porter, UCD; Dr. M. Hoey, UCD; Dr. A. D. Andrews, Armagh Observatory (to 1972 November).

Technical and Clerical Staff:

Miss A. M. Callanan; Mr. R. P. Murphy; Mrs. A. Norris (to 1972 December 31); M. O'Sullivan (1973 January 1 - March 31).

Scholars:

M. V. Norris (to 1972 September 30); P. B. Byrne; S. H. Plagemann (to 1972 October 31).

The National Science Council supported the appointment of Dr. C. J. Butler as Research Assistant throughout the year. Dr. Elliott became Secretary of the Irish National Committee for Astronomy in January 1973.

2. RESEARCH WORK

Photometry of Stars: P. A. Wayman, C. J. Butler, P. B. Byrne.

The total of 91 plates available for the Cepheid region LMC I was measured using 'Galaxy' measuring machine at the Royal Greenwich Observatory in December and January. 490 possible variables and 159 standard stars were scheduled for measurement on each plate. The use of an automatic measuring machine makes possible a complete sample of variable stars, between five and six times the number measured by hand in each of the regions LMC II and SMC I. The observations for LMC I are in U,B,V, and R, and represent what is probably the most thoroughly

measured star field for cepheid variables yet established. Existing computer programs are being adapted to handle this material and tests have been made which indicate that "Galaxy measure" is a remarkably accurate measure of star brightness on these plates.

As part of the search for the optical counterpart of the X-ray source SMC X-1, UBV photometry of 114 field stars in the vicinity of the X-ray error box was carried out. The stellar population of the region is predominantly early Population I similar to the LMC cluster complexes and HII regions. There may be above-normal reddening in the region studied.

The suspected optical counterpart of SMC X-1, designated Sk 160, and identified by Liller in October 1972, was the subject of a special investigation designed to verify the identification by independent data. Photographic photometry was carried out from 60 ADH plates in the UBV system, including plates made available by Dr. E. M. Lindsay, Armagh Observatory. The B plates showed evidence of periodicity near 3.89 days, confirming Liller's identification. A lengthening of the period from 3.85 to 3.89 days between 1966 and 1971 (the latter epoch being that of the "X-ray period", 3.8927 $\pm$ .0010 days) was suspected but could not be definitely established. Rapid erratic changes were found to be superposed on any underlying regular variation in optical brightness; regular variations in V-light and U-light were difficult to establish from the limited data. The observations generally favoured interpretation in terms of an ellipsoidally distorted BOIb primary star, a member of the Small Magellanic Cloud, and a compact eclipsed companion object, connected with X-ray emission.

Cepheid Variables: C.J. Butler; M.V. Norris.

The accumulated data on Magellanic Cloud stars of the cepheid variable type have been particularly analysed with respect to selection of stars for intercomparison of different stellar regions. Amplitude of variation must enter as the chief criterion as to whether a star is regarded as a variable star or not and the amplitude of cepheid pulsation varies substantially within the "instability strip" of the Hertzsprung-Russell diagram. The role played by scatter about a mean light curve is being investigated from our data, using digital representation of the observations and of the hand-drawn light curves.

It has been found that periods derived from earlier data by Gaposchkin are, in the main, accurately maintained in our samples, contrary to a suggestion by Arp that 30% of short-period SMC cepheids had decreasing periods. On average about 10% of the periods show some discrepancy with earlier values but some of these differences are due to misidentification and other gross errors.

Comparison of the photometric results on cepheids continues to show excellent agreement with the results of Gascoigne, fair agreement with P. J. Andrews, but relatively poor agreement with the results by Gaposchkin and by Arp.

Observations of the short-period cepheids in NGC 1466 near the Large Magellanic Cloud have been interpreted in terms of the theoretical models by van Albada and Baker and by Iben and Huchra. Values reported by M. Norris in a paper presented to I.A.U. Colloquium No.21 at Toronto in August show, for the short period cepheids in NGC 1466, log M/L = -1.93 ± .09; M_{bol} = + 0.46; corrected distance modulus 18.70 ± 0.15; and helium abundance Y = 0.29.

Solar System: T. Kiang.

In connection with work reported in a previous year (1970-71) on Halley's Comet, much interest has arisen on the question of the possible existence of a trans-plutonian planet. Such an object was postulated in April 1972 by J. L. Brady of the University of California in order to account for a 600-year period remaining in the perihelion time of Halley's Comet after the effects of all known planets were allowed for. Direct search at various observatories failed to reveal this "Planet X" and its existence in any case was improbable for other reasons. Nevertheless, the 600-year period had to be explained. Consideration of the 3-body configuration Sun-Jupiter-Halley showed that this period is the main period in the solution of the differential equation which governs the behaviour of any residual between a theoretical and observed orbit. That such a long-term periodicity should be induced by Jupiter (period 11 years) in a comet is a new and unexpected result. The physical cause of the residuals arises from the non-gravitational forces, whose existence and order of magnitude were, in the case of Halley's Comet, demonstrated in the previous work.

Statistical Astronomy: T. Kiang; S. H. Plagemann.

In preparation for further research on the statistics of asteroids and the distribution of stellar luminosities ("luminosity-function"), three substantial catalogues have been transcribed to machine-readable form - the 1972 Catalogue of Orbital Elements of Asteroids, the Palomar-Leiden Survey of Faint Asteroids, and the Lowell Proper Motion Survey. Preliminary work on correction for selection effects in the Palomar-Leiden Survey has been made.

The problem of whether the positions of quasi-stellar radio sources exhibit a significant departure from a random distribution over the sky was investigated. Particular attention was paid to the question of completeness in possible samples. Association of faint QSR's with

brighter galaxies could not be confirmed. There was evidence of anisotropy in the distribution of 3C radio sources not optically identified. Also, the bright compact QSR's with flat radiospectral index are anisotropically distributed along the axis of the Local Supercluster at high galactic latitudes. The effect on interpretation of log N - log S curves has been considered.

Light-Pulse Experiments: P. B. Byrne.

The records of light flashes from the direction of the galactic centre made in 1971 were further analysed by lowering the threshold of detection of an "event". The tendency of the light pulses to cluster into pairs with inter-arrival times < 1 minute persists for the galactic centre region, while in the control region a Poisson distribution is followed. There is a possible correlation between pairing of light pulses of unusually short duration, but this correlation is still uncertain, pending construction of apparatus for automatic extraction of pulse data from the magnetic tape records.

A search for possible periodicities in detected flashes, most of which originate from meteors, gave no positive result.

Miscellaneous Work

P. B. Byrne and C. J. Butler:

Comparison of radio and optical observations of the region containing the X-ray source LMC X-1 led to the suggestion that the source of X-rays is associated with the pair of radio sources MC 76/77 and coincident H II regions. These sources are one of six pairs previously noted as comprising one thermal and one non-thermal source. MC 76 has a spectral index typical of supernova remnants.

J. Patrick (Bolton St. College of Technology) and C. J. Butler:

Analysis of data on configurations of neolithic standing stones, particularly the Carnac Menhirs considered by A. S. Thom, has been carried out with a view to establishing the statistical evidence for the existence of a "megalithic yard" as a spacing unit used in placing such stones. At present the results do not favour the incorporation of such a unit of length in the spacings.

A. D. Andrews and P. A. Wayman:

A method for measuring positions of spectral lines using the Joyce-Loebl autodensidater and paper-tape input to the IBM 1620 computer was developed using image-tube spectra of stars borrowed from Professor D. E. Blackwell. It was intended to use measurements of this kind in a scheme of spectral classification but only preliminary consideration of the problem has yet been carried out.

3. INSTRUMENTS, ETC.

Mechanical Workshop: B. D. Jordan; R. P. Murphy.

The video comparator has been completed in its initial form. This machine provides means for superimposing two photographs on a video monitor, using a flying-spot scanner. Either a "blink" technique or a difference signal may be used. Adjustment of the scale and the adjustment of the independent gain and black level controls present some problems.

The 28-inch mirror and some smaller mirrors were aluminized at Kevin Street College of Technology with the co-operation of the College staff. Coatings obtained with the large vacuum tank have not been entirely satisfactory.

The 12-inch South telescope with its 1832 Cauchoix objective has been dismantled and cleaned and is being restored as far as possible to its original form. The Grubb dome is still, after 105 years, in very good working order. Some repairs on the shutters were carried out in August but extensive renovation was not found to be necessary.

Electronics Laboratory: B. D. Jordan; P. B. Byrne.

An electronic slave system for Shortt Clock No.86 was constructed. A photoelectric device on the pendulum-case controls the impulses sent to the seconds dial and the pendulum re-set impulse is actuated once per 100 seconds. Reliability and accuracy is increased, fluctuations in rate being of the order of .005 s/day or less.

Installation arrangements, maintenance and minor repairs of the Nova 1220 data-handling system, including magnetic tape casette storage, were undertaken from August 1972. Development work on the control unit and punch drivers for a high speed punch is nearing completion.

Electronic Computers: I. Elliott.

The IBM 1620 computer continued in use throughout the year, including use by other Sections, but at a reduced level due partly to availability of other facilities. Typewriter repairs were frequently necessary. A Data-General Nova 1220 system suitable for real-time operation and for general computing was installed in August. The system consists of a central processor with a core memory of 8K 16-bit words, a teletype and a fast paper-tape reader. A Tri-Data Cartrifile magnetic tape cartridge unit permits rapid transfer of data to and from the core memory, the transfer time for 8K words being 12 seconds. The programming languages available at present are BASIC and FORTRAN IV. Initial difficulties in use of the Cartrifile system are gradually being overcome but a considerable amount of software manipulation remains to be done.

Assembler language programs to handle Galaxy tapes have been developed.

4. MISCELLANEOUS

I. Elliott:

A list of eclipses of the moon visible in Ireland between A.D. 674 and 921 was prepared for the History Department, University College, Galway, in connection with Dr. Mac Niochaill's work on the Annals of Ulster.

T. Kiang:

Research carried out over the last 3 years on the orbit of Halley's Comet was the subject of a section of the Institute's display at the 1973 Science Exhibition of the Royal Dublin Society in February.

C. J. Butler:

The photoelectric sequence data of Dunsink Observatory Publications, Vol.1, No.6, 1972, were arranged and indexed for the January 1973 publication "A Catalogue of Photometric Sequences", by A. N. Argue, B. J. Bok and E. W. Miller, the Steward Observatory, University of Arizona.

5. LECTURES, VISITS, ETC.

Eleven informal seminars took place in the Observatory during the year, using the lecture room in Dunsink House.

Professor Wayman visited St. Andrews University Observatory in May, speaking on "Photometry of Cepheid Variables".

Professor Kiang read three papers at I.A.U. Colloquium No.22 on "Asteroids, Comets and Meteoric Matter", in Nice, France in April:

1. Observational Selection and Statistics of Asteroids.
2. The Distribution of the Argument of Perihelion in Asteroids.
3. The Past Orbit of Halley's Comet.

Professor Kiang presented a paper entitled "The Cause of Residuals in the Motion of Halley's Comet" at the Royal Astronomical Society, London, in December.

Professor Wayman and Dr. Butler attended the Summer Colloquium on Astrophysics in Cambridge, England, in June.

Dr. Butler attended the 1st European Meeting of the International Astronomical Union in Athens in September and the meeting on Astronomy in Prehistory at the Royal Society, London, in December.

Dr. Elliott and Mr. Jordan attended courses held by Data General Ltd. in London in June and Dr. Elliott attended the Institute of Physics Meeting on "On-line computers for laboratory experiments" at Imperial College, London, in January.

Mr. M. V. Norris presented a paper on "Short-period variables in NGC 1466" at I.A.U. Colloquium No.21, "Variable Stars in Globular Clusters", held in Toronto, Canada, in August.

Mr. P. B. Byrne attended the Enrico Fermi Summer School on "Experimental Gravitation" at Varenna, Italy, in July.

6. VISITORS

Public Nights and special visits by groups were arranged during the period September to April, as in previous years.

Other visitors included Professor and Mrs. S. Chandrasekhar, Dr. C. Hazard, Professor J. A. Wheeler, Professor and Mrs. W. H. McCrea, Dr. T. L. Hankins, Dr. G. T. Wrixon, Rev. Professor D. J. K. O'Connell, S.J., Professor M. Shapiro, Dr. G. K. Miley and Dr. T. F. Gaskell.

7. PUBLICATIONS

C. J. Butler:

"Reduction of Iris-Diaphragm Measurements to Magnitude", Irish Astronomical Journal, 10, , 1972.

E. M. Lindsay and P. A. Wayman:

"Further Observation of HV 13055", Irish Astronomical Journal, 10, 141, 1971.

P. A. Wayman:

"The Phenomenon of the Ice Ages", Irish Astronomical Journal, 10, 63, 1971.

"The Visitation Book of Dunsink Observatory, 1791 to 1924". Irish Astronomical Journal, 10, 135, 1971.

"Classical Cepheids in the Magellanic Clouds". Quarterly Journal of the Royal Astronomical Society, 13, 219, 1972.

"Symposium on the New Astronomy", Monthly Notes of the Astronomical Society of Southern Africa, 31, 45, 1972.

"The Use of Schmidt Telescopes in the Southern Hemisphere", ESO-SRC Conference, Hamburg, p.101, 1972.

M. V. Norris:

"Short-Period Variables in the Magellanic Cloud Cluster NGC 1466", IAU Colloquium No.21 (in press).

T. Kiang and P. A. Wayman:

"The Orbit of Halley's Comet", Nature, 241, 520, 1973.

T. Kiang:

"The Cause of the Residuals in the Motion of Halley's Comet", Monthly Notices of the Royal Astronomical Society (in press).

S. H. Plagemann:

"On the Angular Distribution of Complete Samples of Bright Quasi-Stellar and Unidentifiable Radiosources", Monthly Notices of the Royal Astronomical Society (in press).

C. J. Butler and P. B. Byrne:

"Photoelectric Photometry of the Proposed Optical Candidate for SMC X-1", Nature Physical Science (in press).

P. B. Byrne and C. J. Butler:

"A Possible Candidate for LMC X-1", Nature Physical Science (in press).

B. Cosmic Ray Section

1. STAFF AND SCHOLARS

Senior Professor:

C. Ó Ceallaigh.

Professor:

K. Imaeda.

Assistant Professors:

D. O'Sullivan and A. Thompson (appointed 1 April 1972).

Research Assistant:

Dr. Y. V. Rao.

Visiting Scientist:

Professor A. G. Agnese, Istituto di Scienze Fisiche dell Universita, Genova.

Experimental Officer:

Mr. J. Daly.

Technical and Clerical Staff:

Miss M. Dalton (to 16 November 1972); Miss E. Kee, Miss D. Molloy, Miss H. O'Donnell, Miss E. Rankin (from 2 October 1972), Mrs. D. Ronaldson (née Byrue), Miss R. Ward (from 16 October 1972).

2. RESEARCH WORK

Study of Very Heavy and Ultra Heavy Cosmic Ray Nuclei in Collaboration with Bristol University:

C. Ó Ceallaigh, A. Thompson, D. F. O'Sullivan and Y. V. Rao assisted by J. Daly, Miss D. Molloy, Miss E. Rankin, Mrs. D. Ronaldson, Miss E. Kee, Miss H. O'Donnell and Miss R. M. Ward.

During May 1972 three very successful balloon flights were launched from Sioux Falls, South Dakota, U.S.A. The arrangements for launching and recovery were carried out in collaboration with Raven Industries Inc., Sioux Falls, South Dakota, U.S.A.

(a) The first flight was aloft for 86½ hours (a record duration) and the average altitude was 3.7 gm/cm^2, considerably higher than that for the May 1971 flights. The payload, which was recovered at Wilmont, Minnesota, consisted of seven double modules, each double module having a collecting area of 32" x 24". Three of the double modules were composite stacks consisting of Lexan polycarbonate and nuclear photographic emulsions interleaved with two linear distributions of iron degrader.

The total thickness of these modules was 9.6 gms/cm^2 copper equivalent at 300 Mev/N. The remaining four double modules consisted of Lexan (two hundred 250 μm sheets in each) with one sheet of nuclear emulsion and had a thickness of 8.7 gms/cm^2. The payload was assembled during March 1972 (see previous Report).

(b) The second flight had a duration of 69 hours and the average ceiling was 3.4 gms/cm^2. The payload consisted of ten composite modules each of size 32" x 12" with a total thickness of 6.9 gms/cm^2. The configuration of the modules was very similar to that employed in the May 1971 flights, namely an exponential distribution of brass degrader in Lexan polycarbonate and nuclear emulsion. The gondola was recovered in Colorado.

(c) The payload of the third flight was exactly the same as that of the second. Duration and average ceiling were 84 hours and 3.2 gms/cm^2 respectively. In this case, the gondola landed at Lucky Boy Pass in the Sierra Nevada mountains, Nevada, and was recovered by helicopter.

In contrast to the May 1971 flights, the three payloads made excellent landings and were recovered completely undamaged. All three flights employed eleven million cubic feet balloons. The balloons for flights (b) and (c) were supplied under guarantee by Raven Industries Inc., when the prototype thirty-three million cubic feet balloon, originally used to carry payloads (b) and (c) together, failed to reach full altitude. The overall performance of the prototype balloon was consistent with a flaw of about 2 cms diameter in the fabric near the top of the balloon. The modules for flights (b) and (c) had been assembled in July and August 1971.

All the nuclear emulsion from the three flights has been scanned and rescanned. About 45 very heavy and ultra heavy cosmic ray events have been found. The processing of the Lexan containing those events and the measurement and analysis of the resulting tracks are continuing. The pure Lexan modules from the Minnesota flight have been etched and scanned, using the semi-automatic ammonia technique in a search for stopping trans-iron nuclei. About 50 nuclei with $28 \leq Z \leq 34$ were found enabling estimates of the abundances of elements in this charge region to be made.

It may be noted that an accumulated exposure of 45 m^2 days at ceiling has now been obtained as a result of the flights in May 1971 and May 1972. A total of 80 very heavy and ultra heavy nuclei have been found of which $\simeq 50$ have $Z \geq 50$. Several of these nuclei have $Z \simeq 90$, some stopping and some relativistic. However, no tracks have yet been found which could be unambiguously interpreted as being due to trans-uranic nuclei.

Study of the Production of Heavy Nuclear Fragments in High Energy Proton Interactions in collaboration with European Centre for Nuclear Research (CERN)

C. O Ceallaigh, D. O'Sullivan, A. Thompson, A. J. Herz and P. Zielinsky.

During the Spring and Summer of 1972 a scattering chamber, one metre in diameter and 50 cms. deep, was built and installed to operate in the e6 proton beam (24 GeV/c) at CERN, Geneva. The chamber incorporated eight stack holders designed to expose stacks of Lexan polycarbonate sheets having a collecting area of 10 cms. x 10 cms. The disposition of the stacks was such that they collected fragments produced by interactions of 24 Gev/c protons with a gold target set up at the upstream side of the chamber.

Three exposures were made in September 1972. The numbers of protons involved were 5×10^{15}, 2×10^{16} and 10^{17} respectively. The exposures were successful in that the performance of the gold target and the magnitude of the signal to noise ratio in the Lexan detector exceeded expectations.

Approximately 10% of the total collecting area of Lexan has been etched and scanned for very energetic ($E > 15$ Mev/N) heavy fragments. No such fragments have been found so far. However, a large number of fragments in the charge and energy regions $6 \leq Z \leq 15$ and $1 < E < 5$ Mev/N respectively have been observed. It is intended to study in detail the charge and energy spectra of these fragments.

Study of Low Energy Cosmic Ray Nuclei on the Lunar Surface in Collaboration with P. B. Price, University of California, Berkeley.

D. O'Sullivan and A. Thompson.

A stack of 40 cellulose triacetate sheets having a collecting area of 16.5 cms x 11.5 cms was exposed during the Apollo 16 mission in April 1972. The stack was mounted on the lunar module before launch and was exposed to space just after translunar injection. It was deployed on the lunar surface for the duration of the mission and was returned to Earth inside the command module. Thermal protection on the lunar surface was ensured by means of a 50 μm silvered Teflon sheet covering the stack.

A section of the stack equivalent to 40 cm^2 of collecting area was etched and a sample of 360 stopping nuclei was measured in the energy interval 20 to 200 MeV/N. The relative fluxes and energy spectra of these nuclei were determined. These measurements were the first ever made at energies below 150 MeV/N on cosmic ray nuclei as heavy as Fe. They are particularly interesting in that the charge distribution at energies < 100 MeV/N obtained by us is remarkably similar to charge distributions obtained by others at energies between $\simeq 250$ MeV/N and

$\simeq$ 1 GeV/N. In particular, the observed proportion, relative to Fe and Ni, of nuclei with $17 \leq Z \leq 25$ is 1.51 ± 0.3. These nuclei are predominantly spallation products and are extremely rare in the sun and in solar particles. The above proportion is consistent with values at $E > 250$ MeV/N but is far higher than the value $\simeq 0.2$ obtained for solar flare particles. A strong case can thus be made that the majority of interplanetary particles with $E \geq 30$ MeV/N are of galactic rather than of solar origin.

Study of Ultra High Energy Nuclear Interactions in Photographic Emulsions.

K. Imaeda and A. G. Agnese (University of Genoa).

The theory of the 'liquid state' of hadron matter has been developed and used to predict the multiplicity and inelasticity distributions and the isobar and fireball production in very energetic interactions with primary energy greater than 10^{12}eV. Recent accelerator experiments at energies exceeding 500 GeV have confirmed one of our predictions, namely, that the interaction radius should increase logarithmically with primary energy. This observation provided a stimulus for further development and elaboration of the theory.

Professor Agnese has carried out an investigation of two-particle correlations in jets produced in high-energy collisions with energy ranging from 50 to 10^5 GeV. Strong positive correlations have been observed in our sample of jets, in contrast to the negative correlations reported for jets of energy less than 30 GeV.

3. WORKSHOP AND TECHNICAL DEVELOPMENT - J. Daly.

During the year a second 150 litre Lexan processing plant has been completed. Like the first plant, this equipment features temperature control to better than $\pm 0.02^{\circ}$C with continuous automatic monitoring and recording.

A semi-automatic Lexan scanning system has been installed. The basic operating principle of the system is the utilisation of ammonia gas and dye-line paper for the location of completely penetrating tracks in sheets of polymer plastic. By use of this technique, the rare trans-iron cosmic ray nuclei may be distinguished from a background of iron-group nuclei. The ratio of trans-iron nuclei to background is about 1 to 10^4.

A fifth measuring station has been set up. This consists of a Leitz Ortholux microscope with Leitz KS objectives coupled to a Rank-Taylor displacement transducer with associated electronics and digital display equipment. The system was calibrated by means of optical fringes in the standard manner.

4. NATIONAL SCIENCE COUNCIL RESEARCH GRANT

The National Science Council Research Grant was continued for a third year. Application has been made for the continuance of the grant for a further period of two years.

5. CONFERENCES, MEETINGS, ETC.

The following meetings, international conferences and discussion periods of scientific activity abroad involved members of the Section:

Preparation of equipment and payloads, launching and recovery of the 1972 Spring expedition at Sioux Falls, S.D., U.S.A. (C. Ó Ceallaigh, A. Thompson, J. Daly and Miss D. R. Molloy).

Apollo 16 Exposure. (D. O'Sullivan and A. Thompson). D. O'Sullivan spent a period of 6 weeks in the Department of Physics, Berkeley, California, for the purposes of processing the plastic detecting material exposed on the lunar surface during the Apollo 16 Mission and also for discussions with Professor P. B. Price concerning the programme of collaboration and to help with initial work on the material. Following his stay at Sioux Falls, A. Thompson joined the Berkeley group for a period of two weeks. A portion of the material was brought back by him to Dublin.

CERN-DIAS Collaboration: A Thompson spent a period of one week at CERN, Geneva in July 1972 for discussions with Dr. A. J. Herz and to carry out work in furtherance of the nuclear fragmentation experiment. In September 1972 he, with D. O'Sullivan and J. Daly spent three weeks at CERN in order to carry through three exposures to the high-energy proton beams at the Proton-Synchrotron.

Dublin-Bristol Collaboration: In January 1973 C. Ó Ceallaigh and A. Thompson met Professor P. H. Fowler and his colleagues to discuss the progress of the collaboration and to plan for future flights.

Conferences: Y. V. Rao represented the Bristol-Dublin Collaboration at the 8th International Conference on Nuclear Photography and Solid State Track Detectors in Bucharest, in July 1972, and read a paper embodying the results of the work of the joint groups.

K. Imadea attended the 4th International Conference on High Energy Collisions at Oxford, 5-7 April 1972, where he presented a paper entitled "Liquid State" of Hadron Matter and Particle Production in Very High Energy Collisions.

K. Imaeda and C. Ó Ceallaigh attended the Symposium on Cosmic Ray Physics, Paris, September 1972. K. Imaeda read a paper on Liquid State Model of Fireballs and Multiple Particle Production by Cosmic Rays.

During the year C. Ó Ceallaigh attended three meetings of the Physics III Committee at CERN, Geneva.

6. PUBLICATIONS

(a) Published:

C. Ó Ceallaigh, D. O'Sullivan, Y. V. Rao and A. Thompson with the Bristol Group:

Preliminary Study of the charge spectrum of Ultra Heavy Cosmic Ray Primaries. (Presented by Y. V. Rao at the 8th International Conference on Nuclear Photography and Solid State Track Detectors, Bucharest, July 1972.)

D. O'Sullivan with P. B. Price, D. Brady and J. Sullivan:

Composition of Interplanetary Particles at Energies from 0.1 to 150 MeV/Nucleon. Apollo 16, Science Report N.A.S.A. Publication S.P/315.

(b) In the press:

K. Imaeda and A. G. Agnese:

Two-Particle Correlations in the Inclusive Interactions from 50 to 10^3 GeV. Nuovo Cimento.

(c) In preparation:

D. O'Sullivan, A. Thompson and P. B. Price:

Composition of Galactic Cosmic Rays in the range 30 to 150 MeV/Nucleon.

C. Ó Ceallaigh, D. O'Sullivan, Y. V. Rao and A. Thompson with the Bristol Group:

Ultra Heavy Cosmic Ray Primaries. To be presented at the 13th International Cosmic Ray Conference, Denver, Colorado, U.S.A.

K. Imaeda and P. Fleming:

Nuclear Interactions produced by High-Energy Cosmic Ray Nuclei in Photographic Emulsion.

7. LECTURES, COLLOQUIA, ETC.

Professor Ó Ceallaigh attempted to deliver the Statutory Public Lecture which was to have been given by Professor P. H. Fowler of Bristol University. He was unable to do so, however, owing to a power cut consequent upon industrial action. He intends to give the lecture at a later date.

8. PERSONAL

Miss M. Dalton resigned her post as Clerk to the Section on 16th November 1972. Miss E. Byrne was married on 15th December 1972 but continued to serve as Junior Technical Assistant.

C. Geophysical Section

1. STAFF AND SCHOLARS

Senior Professor:

T. Murphy.

Professor:

Vacant

Assistant Professor:

D. G. G. Young (appointed 1 July 1972).

Research Assistants:

D. G. G. Young (to 30 June 1972); P. Morris (from 1 November 1972).

Senior Technical Assistant:

T. J. Morley.

Research Associates:

Rev. G. McGreevy (Maynooth College); P. Morris (Trinity College up to 31 October 1972); K. W. Robinson (Geological Survey); R. P. Riddihough (Geological Survey from 1 December 1972).

Technical and Clerical Staff:

Miss A. Byrne; Miss E. Ryan; K. Bolster; A. Keogh (from 25 July 1972); Mrs. W. Huddart (from 3 January 1973); Mrs. P. Bruck (part-time to 30 April 1972); Mrs. S. Leonard (part-time to 6 February 1973); G. Reynolds (vacation student, July-July 1972).

Scholars:

D. Howard; G. Reynolds (from 1 August 1972).

2. RESEARCH WORK

(a) Gravity:

For a considerable time this Section has been engaged in attempts to discover the underlying cause or causes of the small gravity anomalies which occur throughout the region covered by Carboniferous strata. It is thought that the main cause lies in the decalcification of limestones and one such gravity anomaly was investigated by G. Reynolds, a recent Scholar in the Section. It was known that a deposit of silica occurred at the site and gravity and resistivity surveys were made, the latter utilising a variety of techniques over an area of 6 sq. km. with more detailed work over one sq. km.

Because of the variety of techniques used the choice of models for computational purposes could be restricted and analysis of the data resulted in the following. The siliceous deposit occupies an elliptical

basin 1.5 km x 1 km with a maximum depth of 145 m, the bottom being at 42 m below mean sea level. Resistivity measurements indicate an homogeneous composition and this, together with some laboratory analyses, suggest that the material results from a selective chemical alteration of a Carboniferous sediment with subsequent reworking in a solution hollow environment. The larger scale gravity survey indicates structural control.

This phenomenon of alteration of limestone strata is widespread and it appears from enquiries from mineral prospecting companies that it is of economic importance. Thus it has caused a serious delay in the compilation of the half inch to one mile maps started last year because of the necessity of investigating numerous small discrepancies to ensure that they are not the result of simple reading errors. There is also the problem of deciding how much to omit from the maps without additional measurements.

The economic importance of the gravity survey has been brought out by the numerous enquiries from prospecting companies who are using the information for general purposes and also for the basis of detailed gravity work they are now beginning to undertake. We gave assistance to some of these companies and the service was repaid by giving us copies of the work carried out together with additional geological and geochemical information. In some cases we undertook gravity readings for companies where they had encountered the phenomenon mentioned earlier when investigating the occurrence of geochemical anomalies. These results have been most interesting and a theory is being evolved to explain the phenomenon. One of these areas was at Fairy Gate near Tralee, Co. Kerry.

Further work has been carried out in the Kingscourt area and it appears the structure is much more complicated than was originally thought. The trough structure is quite large and considerable thicknesses of light Carboniferous sediments occur which is surprising geologically. The work continues.

Dr. Young completed his analysis of the Donegal granites and the results were submitted for publication.

A gravity survey of Co. Waterford was carried out as interest both academic and economic has been shown in these areas and requests for our help in elucidating structures was called for (see later).

A short gravity investigation was carried out northwest of Carlow over a recently discovered deposit of probably Pliocene age. The anomaly measured was quite small, similar in size to others known to occur and quite different to the larger effects such as Mr. Reynolds has investigated near Dunshaughlin.

(b) Magnetics:

A limited magnetic survey was carried out by Mr. Howard on the Dingle peninsula and Great Blasket Island and showed a magnetic anomaly similar to the ones he encountered further east near Castleisland. As no readings were taken at sea the survey is not complete.

The results of the magnetic survey west of Ireland carried out by the Department of Physical Oceanography, University of Wales, have been drawn up by Dr. Young and prepared for publication. The analysis reveals that the sea bottom out to the limits of the Porcupine bank has magnetic characteristics similar to those found on continents and there is no evidence that the Porcupine Sea Bight has oceanic characteristics.

(c) Meteorology:

Routine observations of the meteorological elements were continued throughout the year, the autographic records tabulated and the results published. There is a steady demand for these publications especially from semi-state bodies and throughout the year numerous requests for particular information were received.

Meteorological observations have been made at Leinster Lawn and 5 Merrion Square since 1948 when the School was founded. The data have now been summarised and prepared for publication in Series D.

(d) Seismology:

The seismic station near Malin Head, Co. Donegal, was reoccupied during the period of the North Atlantic Seismic Project organised by the University of Durham. During this recording session which occurred in July the background seismic noise was exceptionally low and enabled high gains to be used in recording and on play back and 150 kilogram charges were recorded from distances as far as 500 km. When searching for the events the complete recordings were scrutinised and an unusual phenomenon was observed. This consisted of periods of microseismic activity lasting from one to two minutes with a frequency of about 12 Hz occurring sporadically at about half hour intervals throughout the day. Experiments carried out show that the activity is genuine ground motion and probably consists of Rayleigh waves.

Later a search was made of previous seismic records taken at Malin during the Scottish Offshore Explosion Programme in November 1970 by playing back several complete days recording at high gain which had not been done previously for two reasons. The principal one was because the shots were quite close and gave strong records and secondly, because the necessary band pass filters were not available. This revealed that very many events had been recorded but not during the hours from 10 p.m to 8 a.m. This suggests they are connected with cultural activity.

Enquiries abroad revealed a possibility of only one similar occurrence and that at Wolverton near Reading in England. Through the courtesy and interest of Dr. Thirlaway of the Seismological Unit of the U.K. Atomic Energy Authority records taken at Wolverton were inspected and it was obvious that extraordinarily similar happenings occur there. Arrangements have been made to have special recordings taken for investigation by us.

It is thought that this phenomenon is connected with the effect mentioned in last year's report, namely, the unexpected presence of high frequencies in recordings of shocks occurring over a few hundred kilometers away and which we now have found has been noticed extensively elsewhere but usually dismissed as due to "instrument noise". This research continues.

The results of the south-west Britain continental margin experiment in which we collaborated (Annual Report 1969-70) have been published and some of the findings are now the subject of a discussion between the principle author and this Section. Explosion seismology consists of a continuing series of experiments where each set of results depends on the findings of the earlier ones and thus it is of importance that each step be thoroughly assessed before proceeding. Future planned experiments may clear up some of the uncertainties.

(e) Palaeomagnetism:

Mr. Howard made a collection of samples from known Carboniferous igneous rocks and measured their magnetic parameters. In general the computed palaeopole positions are in agreement with the internationally accepted ones. One set of samples disagreed and the age was questioned. It is thought that this outcrop belongs to the Devonian system not the Carboniferous.

A more extensive collection was started of the Devonian rocks both igneous and sedimentary with the primary aim of relative age determinations.

(f) Rock Sample Data:

Mrs. Leonard completed classifying the rock specimens and the data has been transferred to punch cards for subsequent analysis and cataloguing.

3. COLLABORATION

At the request of the University of Leeds Geological Department advice and assistance was given to a party of undergraduates under Dr. Fairhead to carry out geophysical surveys in the Connemara area. The results will be given to us later.

A gravity survey was carried out at Fairy Gate, Co. Kerry, over a

areas. The results have been referred to earlier.

A gravity survey in the Oldcastle Co. Meath area was carried out in conjunction with Rio Tinto Exploration.

Gravity surveys were initiated under our guidance and some supervision by Barymin Explorations. The results will be given to us to fill our detail on our maps.

The collaboration with the University of Wales was extended to explosion seismic work and meetings to draw up plans for the Western Approaches Seismic Refraction Experiment took place.

Following the gravity work at Ballysodare of some years back, Dr. Synge of the Geological Survey explored the site with us and attempted to investigate by drilling. Unfortunately, owing to weather conditions the optimum position for drilling could not be reached and the alternative site encountered solid rock at a shallow depth. Further trials will be made.

4. STATUTORY PUBLIC LECTURE

The Statutory Public Lecture, under the auspices of the School, was delivered in University College, Dublin, on "North Sea Oil" by Dr. T. F. Gaskell (British Petroleum, London), on 9 January 1973.

5. CONFERENCES, MEETINGS AND EXHIBITIONS

The following have been attended by members of the Section:

NATA Advanced Study Meeting, Newcastle-upon-Tyne, April 10-14 1972 - Murphy.

European Association of Exploration Geophysicists, Paris, May 30 to June 2 1972 - Murphy.

At the RDS Science Exhibition, held 6-10 February 1973, as part of the joint display of the Institute the Section exhibited an illuminated demonstration of the techniques employed in crustal structure seismic investigations together with the apparatus used in collecting the data. A simultaneous aural and visual playback from recorded tapes was also given.

6. PERSONNEL

K. W. Robinson was awarded the degree of Ph.D. of the University of Dublin in May 1972.

D. Howard was awarded the degree of M.Sc. of the University of Dublin in July 1972.

7. PUBLICATIONS

D. G. C. Young: 'The Donegal granite - a gravity analysis' (Submitted for publication in Proc. R.I.A.).

27th September, 1973.

W. B. Stanford
CHAIRMAN.