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INSTITIÚID ÁRD-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

1966-67

INSTITIÚID ÁRD-LEINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

Summary of Annual Report
of the work of the Constituent Schools
for the year 1966-67

School of Celtic Studies

Seven books were published during the year, including Vol.III of Wagner's Linguistic Atlas and Survey of Irish Dialects.

Professor Binchy held a seminar on an early Irish homiletic text, and gave the Statutory Public Lecture. His subject was 'Tribe and Clan. The Celtic Evidence'.

Professor Carney was in California as Visiting Professor until December 1966.

Professor Dillon gave lessons in elementary Sanskrit, and finished work on The Celtic Realms which has since appeared.

Professor Binchy's Corpus Iuris Hibernici, the Dictionary of Classical Modern Irish, and the several series of publications of the School made important progress.

School of Theoretical Physics

Professor Synge completed his work on regular null networks in flat space-time and, with the scholars, carried out further study and research in general relativity. Professor Lanczos worked on a relativistic theory of submicroscopic world. Professor Takahashi proposed a new method of quantizing lattice vibrations and worked on a book on field quantization. Professor Ó Raifeartaigh continued his leave of absence at Syracuse University and worked on various topics of research including invariants of simple Lie groups and masses of elementary particles. Professor Lurié studied bound states in quantum theory and completed the manuscript of a text book on quantum field theory entitled "Particles and Fields". Professor Israel studied gravitational collapse and thin shells in general relativity. The Research Associates, Scholars and Student studied various topics in relativity, quantum physics and space physics.

Twenty-Seven Seminars were held and three Symposia, attended by Professors, Lecturers and graduate Students from Irish universities. The Statutory Public Lecture was delivered in Trinity College, Dublin, by Professor Werner Israel. His subject was "The Clock Paradox in Relativity". The staff gave over thirty invited lectures at other institutions, chiefly abroad. Professor Lanczos was on leave of absence for two months at Yale University.

During the year thirty papers were published in journals and twelve were in the press. Five books and one Communication were also in the press.

School of Cosmic Physics

Astronomical Section:

The transfer of responsibility for the Cape Lyot Heliograph work to University College, London, was completed during the year and the effort in

solar research was concentrated on time-analysis of chromospheric Doppler shifts, resulting in the production of many power spectra to characterise these shifts. Photoelectric and photographic observational work at Boyden was continued intensively, and several programmes on galactic and Magellanic Cloud fields were substantially completed, requiring over 100 nights' work with the Boyden 60-inch telescope. Other work included statistical analysis concerning extragalactic nebulae, various minor investigations using observational material obtained in previous years, or from other sources, and some experimental work with television techniques.

Cosmic Ray Section:

A new line of research using dielectric detectors was successfully initiated in collaboration with a research group headed by Dr. P. B. Price of the Research and Development Center of the General Electric Company, Schenectady, New York. Professor O'Ceallaigh, Drs. Thompson and O'Sullivan and Mr. J. Daly visited the Schenectady Center during November-December 1966 to set up the collaboration.

The European K⁻ Collaboration and other investigations using emulsion techniques were continued successfully throughout the year.

Four papers by members of the staff were published during the year, and seven others were in the press or in preparation.

Geophysical Section:

A gravity survey of north-west Mayo was undertaken, all gravity data from 1955 listed and measurements of rock densities continued.

A magnetic survey of north-west Mayo supplementing Dr. Phillips's work was carried out and an analysis of the magnetic diurnal variation is being prepared for publication.

The investigation of wind frequencies at Dublin City is nearing completion.

Microseismic observations were made at various sites between Clifden and Dublin and at Valentia Observatory.

A seismic station was set-up in East Anglia and later in Waterford to assist in the study of the earth's crust.

Professor Murphy and Mr. Jacob attended the meeting of the European Seismological Commission in Copenhagen.

The Statutory Public Lecture "Continents and Oceans - their Development" was given by Professor Bruckshaw of Imperial College, London.

INSTITIÚID ÁRD-LEINN 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 1966-67

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, 1967.

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, 1940 (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 1967.

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, 1967.
- 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 1967.

1. THE COUNCIL OF THE INSTITUTE

Chairman:

Professor Edward J. Conway, M.D., D.Sc., F.R.S., F.R.C.P.I.

Ex-Officio Members:

Mr. J. J. Hogan, M.A., B.Litt. (Oxon.), President, University College, Dublin; Dr. Albert J. McConnell, M.A., M.Sc., Sc.D., Provost, Trinity College, Dublin; Dr. Joseph Raftery, M.A., D.Phil., President, Royal Irish Academy.

Members appointed by the Governing Boards of Constituent Schools:

Right Reverend Monsignor Patrick Boylan, D.D., M.A., D.Litt.; Professor Myles Dillon, M.A., Ph.D.; Professor Felix E. W. Hackett, M.A., M.Sc., Ph.D.; Professor John L. Synge, M.A., Sc.D., F.R.S.C., F.R.S.; Professor John H. J. Poole, M.A., B.A.I., Sc.D.; Professor Cormac Ó Ceallaigh, 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.; Myles Dillon, M.A., Ph.D.

Appointed Members:

Tomás de Bhaldraithe, M.A., Ph.D., D.Litt.; Éamonn Mac Giolla Iasachta, M.A., D.Litt.; Ernest Gordon Quin, M.A., F.T.C.D.; Reverend John Ryan, S.J., M.A., D.Litt.; Reverend Francis Shaw, S.J., M.A.

3. THE GOVERNING BOARD OF THE SCHOOL OF THEORETICAL PHYSICS

Chairman:

Felix E. W. Hackett, M.A., M.Sc., Ph.D.

Senior Professors:

John L. Synge, M.A., Sc.D., F.R.S.C., F.R.S.; Cornelius Lanczos, Ph.D.

Appointed Members:

Alexander Dalgarno, B.Sc., Ph.D.; George R. Keating, M.Sc.; Albert J. McConnell, M.A., M.Sc., Sc.D.; Reverend James R. McConnell, D.Sc.; Thomas Edwin Nevin, D.Sc.; Patrick Quinlan, B.E., M.Sc., Ph.D.; Seán Seosamh Tóibín, M.Sc., Ph.D.

4. THE GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS

Chairman:

John H. J. Poole, M.A., B.A.I., Sc.D.

Senior Professors:

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

Appointed Members:

Patrick M. A. Bourke, M.Sc.; Cyril F. G. Delaney, M.A., Ph.D.; Eric M. Lindsay, M.A., M.Sc., Ph.D.; John J. McHenry, M.A. (Cantab.), D.Sc.; Right Reverend Monsignor Patrick J. I. McLaughlin, D.Sc.; Patrick J. Nolan, Ph.D., D.Sc.; Cilian Ó Brocháin, M.Sc.; Ernest T. S. Walton, M.A., M.Sc., Ph.D., F.T.C.D.

5. ADMINISTRATIVE STAFF

Registrar:

Patricia O'Neill.

Senior Clerk:

Maura Devoy.

Clerks:

Mary A. O'Rourke; Susan Reade; Desmond Pender.

II - Report of the Governing Board of the School of Celtic Studies
adopted at its meeting on 29th May, 1967.

1. STAFF, SCHOLARS AND EXTERN RESEARCH WORKERS

Senior Professors:

Myles Dillon, Director of the School; Daniel A. Binchy.

Professor:

James P. Carney.

Assistant Professors:

Louis Paul Nemo (Roparz Hemon); Gearóid S. Mac Eoin (to 15 October 1966); Rev. Pádraig Ó Súilleabháin, O.F.M.; Gearóid Mac Niocaill.

Assistants (Part-time):

Mrs. Nessa Doran; Mrs. Anne O'Sullivan (from 1 January 1967).

Research Associates:

Heinrich Wagner; Liam Price (deceased January 1967); Proinsias Mac Cana.

Technical and Clerical Staff:

Máire Breatnach; Máire Bean Uí Chinnsealaigh.

Scholars:

Hans P. A. Oskamp; David Erlingsson; James W. Gleasure (to 30 September 1966); Joseph Watson; Donncha Ó hAodha (appointed 1 October 1966); Pádraig de Brún (appointed 1 October 1966).

Extern Research Workers:

Miss Cecile O'Rahilly; Rev. Anselm Faulkner, O.F.M.; Rev. Cuthbert McGrath, O.F.M.; Rev. Bartholomew Egan, O.F.M.; Dr. Ludwig Bieler; Gordon Mac Lennan; Dr. Wolfgang Meid; Caitlín Ní Maol-Chróin; Éamonn Mhac an Fhailigh; Professor J. J. Tierney; Mr. I. P. Sheldon-Williams; Professor David Greene; Professor J. E. Caerwyn Williams; Dr. R. L. Thomson.

2. RESEARCH

Professor Dillon continued work on a Middle Irish Reader. A text on the tributes paid to O'Neill was edited for Studia Celtica. Three articles were written for Celtica Vol.VIII. Proofs of The Celtic Realms were revised and returned to the publisher. Lessons in Sanscrit for students from University College were begun in the Hilary term. As President of the Royal Irish Academy Professor Dillon attended the Centenary Celebrations of the Roumanian Academy of Sciences in September 1966. (See also Sections 5 and 7.)

Professor Binchy continued to transcribe legal manuscripts for Corpus Iuris Hibernici. He checked book proofs of The Book of Leinster Vol.V. (See also Sections 3, 4, 5 and 7.)

Professor Carney continued his visiting appointment at the University of California, Los Angeles until December 1966. Final proofs of Medieval Irish Lyrics (to be published jointly by University of California Press and the Dolmen Press) and The Irish Bardic Poet (Dolmen Press) were checked. Since his return to Dublin, Professor Carney has been engaged on a number of articles of literary and philological interest.

M. Louis Paul Nemo continued to work on the Historical Dictionary of Breton. The eleventh volume (Gouelan-Gwallbedin) was published in July 1966. Publication of the twelfth volume (Gwallbezhe-Gwitibuntann) is due shortly. M. Nemo prepared an edition of two Middle Breton plays - La Destruction de Jérusalem and Les Amours du Vieillard - to be published as Volume III in the Mediaeval and Modern Breton Series. (See also Section 7.)

Dr. Gearóid S. Mac Eoin continued revision of Macalister's edition of the Annals of Tigernach and the edition of Imthechta na nCínmhídeadh. He took up an appointment as Professor of Old and Medieval Irish in University College, Galway from 1 October 1966. (See also Section 7.)

Rev. Pádraig Ó Súilleabháin, O.F.M. checked first proofs of his edition of Buaidh na Naomhchroíche to be published in the Series Scribhíní Gaeilge na mBráthar Mionúr. As General Editor of the Series he checked proofs of Dán na mBráthar, Graiméir Ghaeilge na mBráthar Mionúr and An Bheatha Dhiadha. (See also Section 7.)

Dr. Gearóid Mac Niocaill continued work on The Annals of Ulster. Collation of the Trinity text is completed and that of the Rawlinson text continued. Seán Mac Airt's annotations were revised and work continued on the remainder of the annotations in Part I. In collaboration with Michael Dolley of Queen's University, Belfast an article on 'Some coin-names in Ceart Uí Néill' was prepared for Studia Celtica II. An article on 'Bartholomaei Anglici de proprietatibus rerum liber VIII' was accepted for Celtica VIII and one entitled 'Sur l'identité de S. Mainchín' was prepared for Analecta Bollandiana LXXXV. (See also Sections 5 and 7.)

Mrs. Nessa Doran catalogued the mss. G73-80 for Fasciculus III of the Catalogue of Irish MSS. in the National Library of Ireland. Page proofs of Fasciculus I (volumes G1 - G14) were corrected and returned to the printer. She corrected final proofs of her edition of Tóraigheacht Dhiarmada agus Ghráinne which is to be published shortly by the Irish Texts Society.

Mrs. Anne O'Sullivan completed the collation of Professor Binchy's transcripts of law texts with the following MSS. in Trinity College Library: (i) MS. H.4.22, pp.1-86; (ii) MS. E.3.5 No.1, pp.1-20. (See also Section 7.)

Professor Heinrich Wagner read proofs of Vol.IV of the Linguistic Atlas and Survey of Irish Dialects. In collaboration with J. Hamilton, E. Evans, S. O'Kane and Seán Ó hEochaidh a fifth volume which will contain extensive vocabularies as well as phonetic texts from Tory, Fanaid, Gortahork and Teelin is being prepared.

Dr. Liam Price who died in January 1967 checked and passed for press the final proofs of Volume VII of the Place-Names of Co. Wicklow. This volume deals with the Baronies of Newcastle and Arklow and contains a general Introduction to the Series.

Professor Proinsias Mac Cana as General Editor of the Mediaeval and Modern Welsh Series checked proofs of the two volumes at present going through the press - The Poems of Talieson edited by J. E. Caerwyn Williams, and Owein edited by R. L. Thomson.

Mr. Hans P. A. Oskamp continued to work on his thesis 'Immram curaig Máele Dúin and the Legend of Saint Brendan'. Apart from a diplomatic edition of Immram curaig Máel Dúin from YBL and prolegomena for a critical edition the book will consist of an analysis of the Voyage of Máel Dúin and the several texts dealing with St. Brendan. Work is progressing on the relationship between Máel Dúin and the Legend in its various forms. Preparation was completed on a paper entitled 'Notes on the History of Lebor na hUidre' to be published by the Royal Irish Academy. Since January 1967 Mr. Oskamp has taken up a visiting appointment at the University of California, Los Angeles.

Mr. David Erlingsson continued collecting notes on Irish-Icelandic

connections in the fields of language and history with a view to a critical bibliographical survey. A study of the theme of the country as represented by a woman/queen/goddess in Irish and Icelandic tradition is in preparation. He continued to study Irish, concentrating on the older stages of the language, Early Modern Irish and Classical Old Irish and attended courses in University College given by Rev. Professor Shaw and Professor Con Ó Cléirigh. Mr. Erlingsson prepared an article on the folktale combination AsTh 511A + 300 (and 302) in Ireland and Iceland for publication in Béaloidess. He attended Dr. Binchy's seminar.

Mr. James W. Gleasure continued his research work on the dialect of Na Cruscha, Co. Donegal and began the preliminary work for an article on problems of palatalization etc. in Irish. In October 1966 Mr. Gleasure took up a post as lecturer in the Celtic Department of Glasgow University.

Mr. Joseph Watson was granted leave of absence to read for the newly instituted M.Litt. in Celtic Studies under the personal direction of Professor K. H. Jackson. He is working on a dissertation on 'The vowel system of a Gaelic dialect of East Ross-shire' for the Dialect Survey of Scotland and attending lectures in the General Linguistic Diploma course and reading for the 'Ordinary' Phonetics Certificate. For this course Mr. Watson has chosen to investigate the subject of 'The phonetic realization of the phenomenon of nasalization in initial dental plosives as found in the dialect of Ness, Lewis' (a palatographic and kymographic study).

Donncha Ó hAodha worked under the direction of Professor Binchy on the preparation of an edition of the Old Irish Life of St. Brigit. He read other Brigidine documents in both Latin and Irish and most of the research based on them. At Professor Binchy's suggestion he read many of the lives of Irish Saints and has studied the works of Fr. Delahaye. Under Miss O'Rahilly's supervision he excerpted from Seánmónta Chúige Uladh for the Dictionary of Classical Modern Irish. He attended Professor Binchy's Seminar on Aggítir Cráhaid.

Pádraig de Brún excerpted from Five Seventeenth-century Political Poems, Leorchaoineadh na hÉireann, and Comhairle Mhic Clamha for the Dictionary of Classical Modern Irish. Excerpting from Filíocht

Phédraigín Haicéad is in progress. He prepared for publication a Catalogue of Irish mss. in the Franciscan Library (M. Dillon and C. Mooney, O.F.M.) involving collation of typescript with manuscripts, description of eighteen additional mss. and supplying indices. Some preparatory work was done on an anthology of 17th-18th-19th century Irish poetry and on an edition of the poems of Piaras Feiritéar. An article entitled 'Dhá litir Ghaeilge' and one on 'Lámhscríbhinní Gaeilge i Luimneach' were accepted for publication in Éigse XII. He contributed 'Cnuasaigh de lámhscríbhinní Gaeilge: treoir-liosta' and a review of Lámhscríbhinní Gaeilge Choláiste Phádraig, Mú Nuad: Clár (Fasciculi iii and iv) for publication in Studia Hibernica VII.

Miss Cecile O'Rahilly saw final proofs of her edition of Táin Bó Cúalnge from the Book of Leinster through the press. She continued to work on the Dictionary of Classical Modern Irish, excerpting from Bedel's Translation of the Old Testament: Acallamh na Senórach² Vols. II and III; Life of S. Féchin of Fore (MS. dated 1329) and Gaelic Maundeville (MS. 1475). She supervised the work of scholars engaged on the project.

Rev. Cuthbert McGrath, O.F.M. checked book proofs of Part I of his edition of Dán na mBráthar, publication of which is expected shortly.

Rev. Anselm Faulkner, O.F.M. checked final proofs of his edition of An Bheatha Dhiacha. Preparation of the text, notes, vocabulary and sinneoir for an edition of An Bheatha Chrabhaigh was completed. He has compared An Spathán Spioradálta with the Italian original and general notes have been written in full.

Rev. Bartholomew Egan, O.F.M. corrected proofs of the introduction and notes of his edition of Graiméir Ghaeilge na mBráthar Mionúr and returned these to the printer for revision.

Dr. Ludwig Bieler continued to act as General Editor of Scriptores Latini Hiberniae. He read final proofs of Professor J. J. Tierney's edition of Dicuili Liber de mensura orbis terrae which was published during the year. First proofs of I. P. Sheldon-Williams edition of Johannis Scotti Eriugeneae Periphyseon (de divisione naturae) Liber Primus on which Professor Bieler collaborated, were read and returned to the printer.

Dr. Wolfgang Meid's edition of Táin Bó Fraích (Mediaeval and Modern Irish Series, Vol. XXII) was published in February 1967.

Eamonn Mhac an Fhailigh read and returned to the printer page proofs of his phonemic study, The Irish of Erris, Co. Mayo. Preparation of the index has been completed and this section is now ready for setting.

Professor J. J. Tierney's edition of Dicuil's Liber de Mensura Orbis Terrae was published in February 1967.

Mr. I. P. Sheldon-Williams completed the correction of the first proofs of his edition of Johannis Scotti Eriugena's Periphyseon (de divisione naturae) Liber Primus and returned these to the printer for revision.

Dr. R. L. Thomson checked and returned for revision first proofs of his edition of Owein to be published in the Mediaeval and Modern Welsh Series.

Professor J. E. Caerwyn Williams checked first proofs of the introduction, text and notes of his edition of The Poems of Taliesin to be published in the Mediaeval and Modern Welsh Series. Material for the vocabulary and indexes was prepared and sent to the printer in March 1967.

Professor David Greene worked on the first proofs of the notes and vocabulary of his edition of Duanaire Mhéig Uidhir.

Mr. Gordon Mac Lennan's book Gaidhlig Uidhist a Deas was published in December 1966.

Dictionary of Classical Modern Irish: Work on the Dictionary continued throughout the year with Miss O'Reilly acting as Co-Editor. She supervised the work done by Pádraig de Brún and Donncha Ó hAodha.

Place-Name Research: Owing to the death of Dr. Liam Price in January 1967 no report on the Place-Names Archives is available.

Mediaeval and Modern Welsh Series: Two volumes in this series are at present going through the press - Owein edited by R. L. Thomson and The Poems of Taliesin edited by J. E. Caerwyn Williams. Mr. Brynley Roberts has compiled a selection of extracts from the Welsh version of Geoffrey of Monmouth's Historia Brittonum. This volume will be ready to go to press within the next few weeks. Several other volumes are in preparation.

3. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture entitled Tribe and Clan - The Celtic Evidence was delivered by Professor D. A. Binchy in University College, Dublin on 10th December 1966.

4. SEMINAR

Professor D. A. Binchy held a seminar on an archaic Old Irish homiletic text - Apigitir Crábaid from November 1966 to March 1967.

5. EXTERNAL ACTIVITIES

Professor Myles Dillon attended the International Congress on Onomastic Sciences held in London in July 1966.

Professor D. A. Binchy attended, by invitation, the second International Indo-European Congress at Philadelphia April 22-24, 1966, and read a paper entitled 'Celtic Suretyship, a Fossilized Indo-European Institution?' He lectured at Harvard University to post-graduate Linguistic Seminar on May 3, 1966. He delivered Gregynog Lectures (four) on 'Insular Celtic Institutions' at University College of Wales, Aberystwyth, in November 1966.

Dr. Gearóid Mac Niocaill attended the Congress of International Arthurian Society held at Caen in August 1966. In January 1967 he delivered a lecture at University College, Galway, on 'Work yet to be done in Early and Mediseval Irish History'.

6. LECTURE

A lecture on 'Problems of the Celtic Settlement of the British Isles' was delivered by Professor Stuart Piggott of the University of Edinburgh in the Lecture Room at No.5 Merrion Square on 3rd May 1966.

7. PUBLICATIONS

a. Books:

Linguistic Atlas and Survey of Irish Dialects, Vol.III. By Heinrich Wagner. (The Dialects of Connaught).
Price 75. pp.xvi + 378. Published April 1966.

- Historical Dictionary of Breton, Rann XI. By Roparz Hemon.
(Gouelan-Gwallbedin).
pp.1001-1100. Published Etienne, Paris, July 1966.
- Searmóna Chúige Uladh. Edited by Cainneach Ó Maonaigh, O.F.M.
(Scríbhinní Gaeilge na mBráthar Mionúr, ImI.VI).
Price 2ls. pp.xxii + 132. Published September 1966.
- Gaidhlig Uidhist 'a Deas. By Gordon Mac Gill-Phinnein.
Price 15s. pp.xxii + 139. Published December 1966.
- Togail Troí. Edited by M. A. O'Brien and R. I. Best.
(Offprint from The Book of Leinster, Vol.IV).
Price 10s. pp.1063-1117. Published February 1967.
- Dicuilí Liber de mensura orbis terrae. Edited by J. J. Tierney.
(Scriptores Latini Hiberniae, Vol.VI).
Price 30s. pp.viii + 135. Published February 1967.
- Táin Bó Fraích. Edited by Wolfgang Meid.
(Mediaeval and Modern Irish Series, Vol.XXII).
Price 8s.6d. pp.xxviii + 74. Published February 1967.

b. Contributions to Periodicals:

M. Dillon:

Ceart Uí Néill. Studia Celtica, I, 1-18.

D. A. Binchy:

Bratha Déin Checht. Ériu, XX, 1-66.

Varia III. ibid. 229-237.

Ancient Irish Law. The Irish Jurist, Vol.I, 84-92.

Gearóid Mac Niocaill:

Dhá leagan de scéal Phíoláit. Celtica, VII, 205-13.

Quatuor exempla. ibid. 214-7.

The origins of the betagh. The Irish Jurist, Vol.I, 292-8.

Registrum cantuarie S. Salvatoris Waterfordensis. Analecta Hibernica, XXIII, 135-222.

Various notices of Irish texts published in 1964-5. Bulletin Codicologique of Scriptorium, XX.

Brief notices of various Irish saints. Bibliotheca Sanctorum, L-M.

Pádraig Ó Súilleabháin, O.F.M.:

An eighteenth-century Kerry schoolmaster in Wexford. Irish Ecclesiastical Record, 5th Series CV, 124-6.

A celebrated eighteenth-century preacher in Dublin. ibid. CVI, 104-8.

An Dr. de Siún, Easpag Luimnigh (1796-1813), agus an Ghaeilge. Studia Hibernica, Vol.VI, 155-7.

Sidelights on the Irish Church, 1811-38. Collectanea Hibernica, No.9, 71-8.

Gearóid S. Mac Eoin:

A poem by Airbertach mac Cosse. Ériu, XX, 112-139.

Mrs. Anne O'Sullivan:

The Colophon of the Cotton Psalter (Vitellius F XI). Journal of the Royal Society of Antiquaries of Ireland, Vol. 96, Part 2, 79-80.

Miss Cecile O'Kahilly:

Marcach = 'messenger'. Celtica, VII, 32.

Gurab, Present Indicative of the Copula. ibid. 33-37.

Miscellaneous. ibid. 38-47.

The Preverb con- (co n-) in the LL Táin. Ériu, XX, 104-111.

Tecosc. Éigse, XI, 214-215.

III - Report of the Governing Board of the School of Theoretical Physics
adopted at its meeting on 6th July, 1967.

1. STAFF AND SCHOLARS

Senior Professors:

John L. Synge, Director of the School, re-appointed for three years
from 16 May 1965.
Cornelius Lanczos.

Professors:

Yasushi Takahashi; Lochlainn Ó Ráifeartaigh.

Visiting Professors:

David Lurié; Werner Israel (appointed for one year from 20 June 1966).

Visiting Assistant Professor:

Rev. Ciaran Ryan (to 30 September 1966).

Research Associates:

D. Judge; P. S. Florides; Rev. Ciaran Ryan.

Technical Assistant:

Miss Evelyn Wills.

Scholars:

Rev. J. McCrea (left 30 September 1966); E. Pechlaner; J. Waddell
(left 30 September 1966); K. Watanabe; K. S. Viswanathan (left
31 October 1966); H. H. Nickle (appointed 1 October 1966);
F. I. Cooperstock (appointed 1 October 1966); V. de la Cruz (appointed
1 October 1966); M. Murtagh (appointed 1 October 1966).

Student:

Rev. J. McCrea (appointed 1 October 1966).

2. STUDY AND RESEARCH

Professor Synge completed his work on regular null networks in flat space-time. He continued his investigations on the directivity of radiation, and found a type of source which yields a concentrated jet of radiation in any assigned direction; this applies to scalar radiation, electromagnetic radiation and gravitational radiation (linear theory). He found isomorphs of the four-colour problem in terms of the coding of edges of the dual map by imaginary elements or by the integers 1, 2, 3. With the assistance of Dr. Waddell, he studied the statistical distribution of photons in gravitational fields with spherical symmetry, in

particular the Schwarzschild field.

Professor Synge directed the work of Rev. J. McCrea and Dr. Pechlaner on relativistic models of extended time-dependent distributions of matter.

Professor Lanczos continued his work on the exploration of a submicroscopic lattice structure of fourfold periodicity in a positive definite Riemannian world. Under the assumption that the perturbation frequency is very small compared with the lattice frequency, he investigated the small perturbation of the lattice, and showed that, under proper conditions, the lattice acts like a low pass filter, propagating only waves satisfying the Maxwellian equations. The appearance of the wave equation in the superposition field does not contradict the positive definite nature of the line element. The low frequency of the superposition field allows averaging over the lattice cell and has the effect that the signals transmitted are not arbitrary, but are submitted to a set of linear field equations, without invoking any action principle.

Professor Takahashi proposed a new method of quantizing lattice vibrations. He also showed a close relation between the Poincaré group and the vacuum subtraction in quantum field theory, and worked on a book on field quantization.

Professor Ó Raifeartaigh worked on various topics of research, which have been, or are being published, and are listed under publications, including a long review article on the construction of the invariants of the simple Lie groups. He also worked, in collaboration with Professor I. Segal, of M.I.T., on the problem of making some earlier results on the subject of mass-differences of the elementary particles mathematically rigorous. This work also is being written up for publication, in a number of articles by Professor Ó Raifeartaigh and/or Professor Segal.

Professor Lurié completed the manuscript of a textbook on quantum field theory, entitled "Particles and Fields", and undertook, in conjunction with this work, further study of the particular topic of bound states in quantum theory. In collaboration with Professor Takahashi, he studied the connection between the commutation relations for the generators of the inhomogeneous Lorentz group and the vanishing of the zero point energy in quantum field theory.

Professor Israel studied problems in gravitational collapse, analytic continuation of relativistic manifolds, dynamics of stationary null hypersurfaces and event horizons in asymmetric space-time, thin shells in general relativity, and energy localization in stationary vacuum space-times.

Rev. Dr. Ryan continued his work on current algebras and current algebra sum rules, and also collaborated with Dr. Watanabe in work on a dispersion theoretic and current algebra treatment of K_{l5} decay.

Dr. Watanabe is collaborating with Prof. Furnichi (Rikkyo University, Tokyo) and Prof. Kanada (Nagoya University) in a systematic study of the pion-pion, pion-nucleon, and nucleon-nucleon interactions, and the electromagnetic nucleon form factors.

Rev. J. McCrea was appointed a Student of the School of Theoretical Physics when his Scholarship ended in September 1966, and went to King's College (London) for a year. He continued the work of constructing a model radiative universe, showing how one may proceed to any order of approximation, and studied in detail the asymptotic behaviour of the Riemann tensor in first approximation for such a model. He also studied the use of spinors in general relativity and, in collaboration with Dr. F. A. E. Pirani, the question of conformal tensors involving derivatives of the Riemann tensor.

Dr. Pechlauer's work was devoted to the understanding and construction of time-dependent gravitational fields, with vanishing Einstein tensor in certain domains. He studied publications which prove the non-existence of gravitational fields time-dependent for all time, with a vacuum everywhere outside, and he found that the validity of these proofs is very restricted. He tried to construct time-dependent fields by an approximation method, by considering stress as the macroscopic manifestation of oscillations of dipoles in the microscopic domain, and concluded that such oscillations cannot contribute to the first order metric. He also attempted, without success, to calculate a first order metric, using already deformed light cones. He began work, in collaboration with Prof. Synge, on a method to calculate the gravitational field of an oscillating body, screened off by a second body.

Dr. Florides concluded his work of last year on rotating shells in general relativity, and on a solution of Einstein's field equations by the approximation method, in Fermi coordinates. He is now working on the gravitational field of a spherically symmetric system consisting of dust particles moving in circular paths, with a common centre, under the gravitational field produced by all of these. He is also completing work begun some time ago on a model of the Maclaurin spheroid in general relativity.

Dr. Judge continued his investigations of a sequence approach to generalised eigenvectors. In the case of operators with simple spectra, he obtained results equivalent to those of Hirschfeld; these results can be extended to the case of a complete commuting set of operators.

Dr. Waddell, in addition to his work with Prof. Synge (see above) continued his investigations into zero-energy photons. After returning to the U.S.A., Dr. Waddell was killed in a motor accident. His article in Nature (see publications) was published posthumously.

In the field of Space Physics, Dr. Viswanathan investigated the interaction of the solar wind with the geomagnetic field. Using the spherical harmonic expansion given by Mead for the magnetic field created by the currents on the surface of the geomagnetic cavity, he considered the nature of the trapping regions and showed that to a first order of approximation in the expansion coefficients the allowed regions are still determined by a cubic equation. He made numerical determinations for the structure of the allowed regions for particles of different energies both on the sunlit side and on the dark side of the earth. Dr. Viswanathan also carried out some investigations on the structure of shock waves in a collision-free plasma. The structure of the pressure tensor in a collision-free plasma is different from that in an ordinary conducting fluid, and Dr. Viswanathan utilised this fact to obtain the thickness of the shock front in a collisionless plasma, as for example the shock produced by the magnetosphere in the solar plasma. He obtained a closed expression for the thickness of the shock in a collision-free plasma, by using the expressions for the pressure and heat transport. The shock thickness depends on the ordinary as well as the magnetic Mach numbers, and is directly proportional to the ion Larmor radius.

Dr. Cooperstock calculated the energy absorption for an electromagnetic oscillator in the field of a plane gravitational wave. He studied the resonant and non-resonant energy and momentum transfer via gravitational radiation in the quasi-stellar radio sources, and the interaction between electromagnetic and gravitational waves-electromagnetic field and energy density perturbation; and he is currently studying momentum flux via gravitational radiation by the superposition of two periodic radiators.

Dr. Nickle carried out research on the following problems: (i) positron focusing in a linear accelerator, (ii) the Doppler frequency shift of a light wave which undergoes multiple reflections between two mirrors in relative motion, (iii) the solution of the Schrödinger equation for a non-relativistic electron in the presence of both a periodic crystal potential and monochromatic laser radiation, (iv) double-photon contributions to multiple-photon processes, and (v) multiple-phonon processes associated with the electron-phonon interaction in solids.

Mr. de la Cruz studied the possibility of inducing a flat-space-time in the interior of a rotating shell of arbitrary angular momentum.

Mr. Murtagh studied a formalism for the quantization of fields in which the Lagrangian is not explicitly used, and a corresponding derivation of conservation laws without recourse to the usual Lagrangian formalism. He also studied the irreducible representations of local compact Lie groups, and the application to particle physics of the representations of SU_2 and SU_3 .

3. SEMINARS AND LECTURES

As in previous years the seminar lectures throughout the year 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 seminar lectures were given:

Professor W. Israel: Gravitational bounce (2 lectures).

Dynamics of the Schwarzschild singularity.

Professor C. Lanczos: Noether's principle and the conservation laws
(2 lectures).

Einstein's equations and electromagnetism
(2 lectures).

Professor D. Lurié: The Schwinger quantum action principle
(2 lectures).

Field operators for composite particles
(2 lectures).

Professor A. Mercier (Bern): On time.

Rev. Professor J. McConnell (Maynooth):
Reduction of higher symmetries (2 lectures).

Rev. J. McCrea: Gravitational radiation.

Rev. Dr. C. Ryan: Report on the Glasgow Conference on nuclear and particle
physics.

Dr. D. J. Simms (Trinity College, Dublin):
A simple approach to the classical Lie algebras (3 lectures).

Professor T. D. Spearman (Trinity College, Dublin):
The two-pion interaction - a basic problem in strong interactions
(2 lectures).

Professor J. L. Synge: Thoughts about the four-colour conjecture.
Highly directed beams of radiation (elastic,
electromagnetic, gravitational (2 lectures).

Professor Y. Takahashi: Some aspects of linear field equations
(2 lectures).

Dr. K. S. Viswanathan: Adiabatic invariants and the van Allen
radiation belts.

4. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture, under the auspices of the School, was
delivered in Trinity College, Dublin, on 24 February 1967, by Prof. Israel.
His subject was "The clock paradox in relativity".

5. VISITING PROFESSORS

Dr. D. Lurié.

Professor W. Israel (University of Alberta) was appointed Visiting
Professor for one year from 20 June 1966.

Rev. Professor Ciaran Ryan was Visiting Assistant Professor until
30 September 1966.

For lectures by Professors Lurié, Israel and Ryan see Sections 3 and 4.

6. VISITORS TO THE SCHOOL

Professor A. Mercier (Bern) from 31 January to 1 February, 1967.

Professor F. Rohrlach (Syracuse) on 3 February, 1967.

7. SYMPOSIA

Mathematical Symposia were held on 4-5 April, 19-20 December 1966 and 30-31 March 1967. The attendances were respectively 45, 60 and 49; this included Professors, Lecturers and Graduate Students from the several Irish Universities.

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

April: Mr. C. Thompson (Cambridge):

Some results for subharmonic functions.

Dr. M. F. McCarthy (University College, Galway):

The growth of acceleration waves in magnetoelastic solids.

Dr. V. G. Hart (University College, Cork):

Mahoney's method for singular perturbations.

Professor J. Flavin (University College, Galway):

Bounds for torsional rigidity of orthotropic cylinders.

Dr. R. H. Boyer (Liverpool):

Rotating fluids in general relativity.

Dr. Siobhán Ó Snea (University College, Cork):

Power series with non-negative coefficients.

December: Dr. J. T. Lewis (Brasenose College, Oxford):

The gradient vector.

Rev. Dr. C. Ryan (University College, Dublin and D.I.A.S.):

The problem of merging space-time symmetries and internal symmetries.

Rev. R. E. Ingram, S.J. (University College, Dublin):

Normed algebras with some account of four- and eight-square problems.

Rev. J. McGee, O.F.M. (King's College, London):

Spinors in general relativity.

Professor B. H. Murdoch (Trinity College, Dublin):

Wiener's test for Markov chains.

Mr. T. Donnellan (Preston, Lancs.):

Finite partition lattices and Boolean algebras.

- March: Dr. A. M. Arthurs (York):
Complementary variational principles.
- Mr. R. Johnston (Liverpool):
Quaternion quantum mechanics.
- Professor T. Kiang (D.I.A.S.):
Random fragmentation in two and three dimensions.
- Professor S. Tobin (University College, Galway):
Wreath products of groups.
- Professor D. L. McQuillan (Cambridge):
A remark on function-fields.
- Dr. R. Harte (Swansea):
Varopoulos algebras.

8. EXTERNAL ACTIVITIES

Professor Synge visited the University of Kentucky as Distinguished Visiting Lecturer, 13-15 April, and gave three lectures under the sponsorship of the Institute for Theoretical and Applied Mechanics. On 28 April he lectured to the Science Society of University College, Dublin, on "Is Einstein's general theory of relativity really physics?" On 23 June he spoke to the Irish Mathematics Teachers' Association on "Functions". As invited speaker to the meeting of the Society of Natural Philosophy in Chicago, 21-22 October, he lectured on "The chronometric foundations of relativity".

On 1 July Professor Synge received the degree of LL.D (honoris causa) from the University of St. Andrews. He was appointed to the Editorial Board of *Il Nuovo Cimento*.

Professor Lanczos, as Invited Speaker, spoke at St. Salvator's College, University of St. Andrews on 9, 10, 12 and 13 May 1966 on "A modified eigenvalue problem and its application to boundary value problems". On 11 May he spoke to the Joint Math.-Phys. Colloquium on "Unified field theories", and on 21 and 23 June to the U.C.D. Teachers' Summer Course on "Arithmetic as a precursor of algebra". He attended, by invitation, the Colloquium on Numerical Analysis in Besancon, from 7-14 September, giving the Introductory Talk, "On the philosophy of error analysis" and a lecture on 9 September on "Boundary value problems and the algebraic

method". As an Invited Lecturer of the Institute of Mathematics and its Applications, he spoke at Leeds on 18 September on "Analysis of noisy data", at Glasgow on 1 November on "Boundary value problems", and at Queen's College, Dundee (University of St. Andrews) on 2 November on "Smoothing by Fourier series", on 3 November on "Boundary value problems and orthogonal expansions", and on 4 November on "Analytical continuation". On 31 October he spoke as an Invited Speaker at the Annual Meeting of the Irish Mathematics Teachers' Association on "Why mathematics?", and on 16 January to the Mathematics Association of University College, Galway, on "The nature of mathematical proofs". Professor Lanczos was on leave of absence for February and March. He was appointed Visiting Professor to the Astronomy Department of Yale University for the Spring Semester (Feb. - June) 1967, and commenced a biweekly series of talks there on "Advanced dynamics", and a weekly discourse on relativity.

Professor Takahashi lectured at the University of Liverpool on 29 November on "The vacuum subtraction and the Poincaré group", and on 30 November on "Quantization of fields with higher spin".

Professor Ó Raifeartaigh was on leave of absence during the whole year, holding the position of Professor in the Department of Physics, Syracuse University. He attended a colloquium at the State University of New York at Stony Brook in June, and colloquia at M.I.T. in June and November. He gave an invited talk at the Milwaukee Conference on Non-compact Groups in Elementary Particle Physics in May 1966, and a short talk at the 13th International Conference on High Energy Physics at Berkeley in September. He also attended the Eastern Theoretical Physics Conference at Brown University in November, the 4th Coral Gables Conference on Symmetry Principles in High Energy Physics at Miami in January 1967 and the New York Meeting of the American Physical Society in January 1967, giving at the last-named a joint paper with O. Fleischmann, R. Musto and P. S. Rao.

Dr. Lurié lectured on 26 April at Durham University on "Compositeness criteria in quantum field theory", and on 25 May at Cambridge University on "Normalization of Bethe-Salpeter amplitudes". He also gave a series of lectures at the American university of Beirut in March 1967.

Rev. Dr. Ryan lectured on "Aspects of current algebras" in Trinity College, Dublin, on 22 April, and at the Universities of Glasgow, Edinburgh and Durham in May 1966. Dr. Watson and Rev. Dr. Ryan attended the Institute of Physics and Physical Society Conference on Elementary Particles at Glasgow, 21-23 September, where Dr. Watson reported the preliminary calculation in his work with Professors Furnichi and Kanada on nucleon-nucleon scattering, and Dr. Ryan spoke on "Aspects of current algebra sum-rules". Dr. Watson also attended the International School of Physics "Ettore Majorana", held at Trice, Sicily, from 21 June to 2 July 1966.

Dr. Israel lectured at King's College, London, on 23 March, on "Gravitational bounce".

Dr. Florides lectured to the Scientific Society, University College, Dublin, on 5 May 1966, on "The Greeks, the stars and all that".

9. PUBLICATIONS

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

a. Books:

In the press:

Numbers without end. By T. Lencz. Oliver & Boyd.

An introduction to field quantization. By Y. Takahashi. Pergamon Press.

Particles and fields. By David Lurié. John Wiley & Sons.

Topics in bound state theory. By David Lurié (article for "Lectures in High Energy Physics", ed. H. H. Aly. John Wiley & Sons.

Broken symmetry. By L. O. Raifeartaigh. Contribution to "Group Theory and its Applications", ed. E. Lohr. Academic Press.

b. Communications of the Dublin Institute for Advanced Studies, Series A (Physics):

In the press:

No. 17. Aspects of the current algebra approach. By C. Ryan.

c. Contributions to periodicals and other publications:

Published:

J. L. Synge:

* Directivity for scalar radiation. Q. Appl. Math. 24 (1966), 90-92.

J. L. Synge:

* George Boole and the calculus of finite differences. George Boole - A Miscellany, Cork Univ. Press, 1966, 16 pp. (R.I.A. Meeting at Cork, 1964).

* What is Einstein's theory of gravitation? Perspectives in Geometry and Relativity (Essays in Honor of V. Hlavaty), Indiana Univ. Press, 1966, 15 pp.

Timelike helices in flat space-time. Proc. Roy. Irish Acad. 65 A (1967), 27-42.

Thin shells and relative probabilities in Hilbert space. Proc. Roy. Irish Acad. 65 A (1967), 77-91.

Kilmister on Eddington, Review of "Men of Physics. Sir Arthur Eddington", by C. W. Kilmister, Pergamon Press, 1966. Nature, 213 (1967), 866.

P. S. Florides, J. McCrea & J. L. Synge:

* Radiation coordinates in general relativity. Proc. Roy. Soc. 292 A (1966), 1-13.

J. McCrea & J. L. Synge:

On certain boundary-value problems with strong vanishing on the boundary. Quart. Appl. Math. 24 (1967), 355-64.

C. Lenczós:

* Boundary value problems and orthogonal expansions. J. SIAM, Appl. Math. 14 (1966), 831-63.

D. Lurić, A. J. MacFarlane & J. G. Kuriyan:

* Algebraic tabulation of the Clebsch-Gordan coefficients of SU_n from the product $(\lambda, \mu) \otimes (1, 1)$ of representations of SU_n . J. Mathl. Phys. 6 (1965), 722-33.

D. Lurić, Y. Takahashi & H. Umezawa:

* Generalized Ward identity and unified treatment of conservation laws. J. Mathl. Phys. 7 (1966), 1478-83.

S. Kamefuchi & Y. Takahashi:

* A Lagrange formalism and the relativistic quantization of the Bargmann-Wigner fields. Nuovo Cim. 44 A (1966), 1-16.

S. Kamefuchi & Y. Takahashi:

On a possibility of a further generalization of field quantization. Progr. Theor. Phys. Suppl. 37 and 38 (1966), 244-54.

Y. Takahashi:

Relativistic quantization of fields. II. Nuclear Phys. 87 (1966), 481-94.

G. Ryan:

* Getting an $SU(6)$ result from chiral $SU(3) \times SU(3)$. Phys. Rev. 147 (1966), 1139-41.

* Implications of the algebra of currents approach to higher symmetries. Ann. Phys. 38 (1966), 1-27.

- S. Okubo, R. E. Marshak, H. Goldberg & C. Ryan:
 * The maximal chiral group with the quark model. *Physics* 2 (1966), 273-89.
- K. Katanabe:
 * Shmushkevich principle and current algebra. *Nuovo Cim.* 42 (1966), 707-10.
 S-matrix method for calculation of radiative correction for $\pi^+\pi^-\pi^0$. *Phys. Rev.* 149 (1966), 1188-90.
- K. S. Viswanathan & K. Katanabe:
 Anharmonicity of vibrations and the inner displacements in crystals. *Phys. Rev.* 149 (1966), 614-6.
- K. S. Viswanathan & P. Venkatarangan:
 * The geomagnetic cavity and the van Allen radiation belts. *Planet. Space Sci.* 14 (1966), 641-7.
- N. Rajappa, P. Venkatarangan & K. S. Viswanathan:
 The geomagnetic cavity and the van Allen radiation belts. II. *Planet. Space Sci.* 15 (1967), 495-502.
- D. Judge:
 * Square roots of the mu and delta functions as generalized eigenfunctions of momentum and position. *J. Math. Mech.* 15 (1966), 561-76.
- J. Waddell:
 Symmetry of the time axis and solar observations. *Nature* 213 (1967), 57-58.
- M. Goldberg, J. Leitner, R. Musto & L. Ó Raifeartaigh:
 Strong decay rates and SU(3). *Nuovo Cim.* 45A (1966), 169-78.
- L. Ó Raifeartaigh:
 Construction of the invariants of the simple Lie groups. *Symposia on Theor. Phys.* 2 (1966), Plenum Press, New York.
 Corollary to mass-splitting theorem. *Proc. Milwaukee Conf. on Noncompact Groups and Particle Physics.* Benjamin, New York, 1966.
- W. Israel:
 Gravitational collapse and causality. *Phys. Rev.* 153 (1967), 1388-94.
 Gravitational collapse of a radiating star. *Phys. Lett.* 21 A (1967), 184-66.
- P. S. Florides:
 Foundation of the theory of relativity: the general theory (Part 2). *Kosmos No.5* (1967), 8-12.

In the press:

J. L. Synge:

Statistical distribution of photons emitted by a star. Mon. Not. Roy. Astron. Soc.

Directivity for one-dimensional scalar radiation. Q. Appl. Math.

F. I. Cooperstock:

Energy and momentum transfer via gravitational radiation in quasi-stellar sources. Phys. Rev.

C. Lanczos:

Einstein equations and electromagnetism. J. Mathl. Phys.

William Rowan Hamilton - an appreciation. Amer. Scientist.

Y. Takahashi:

Quantization of lattice vibrations. Ann. Phys.

S. Furnichi & K. Watanabe:

Effect of higher πN resonances to subtraction constant in $\pi\pi \leftrightarrow NN$ dispersion relation. Progr. Theor. Phys.

S. Furnichi, H. Kanada & K. Watanabe:

Remarks on S-wave pion-pion scattering. Progr. Theor. Phys.

A. J. MacFarlane, P. S. Rao & L. Ó Raifeartaigh:

Connection between internal and external multiplicity. Structure of simple compact Lie groups. J. Mathl. Phys.

O. Fleischmann, R. Musto, L. Ó Raifeartaigh & P. S. Rao:

Self-consistency equations and self-coupling of vector mesons. Phys. Rev.

R. Graham, S. Pakuasa & L. Ó Raifeartaigh:

Current algebra and the decay $\eta \rightarrow 3\pi$. Nuovo Cim. Lett.

H. Nickle:

Comment on "Position focusing in an accelerating field" by G. W. Hong (J. Appl. Phys., 36 (1965), 2306). J. Appl. Phys.

IV - Report of the Governing Board of the School of Cosmic Physics
adopted at its meeting on 19th October, 1967.

A. Astronomical Section.

1. STAFF AND SCHOLARS

Senior Professor:

P. A. Wayman.

Professor:

T. Kiang (appointed 1 August 1966).

Research Assistants:

I. Elliott; Miss S. M. P. McKenna (to 31 August 1966).

Experimental Officer:

B. D. Jordan.

Clerical and Technical Staff:

Miss M. Callanan; Mr. P. Murphy.

Scholar:

C. J. Butler.

Mr. C. J. Butler worked at the Boyden Observatory, Bloemfontein, until 12 December 1966.

Mr. J. Brady (U.C.D.) worked as a Vacation Student in the Section in July and August, 1966.

2. LYOT HELIOGRAPH AT THE CAPE

Arrangements for the transfer to the University of London Observatory, of the work with the SECASI heliograph at the Royal Observatory, Cape Town, were completed. The backlog of solar flare record films, covering the years 1958-65, and comprising some 700,000 images, was sent to Professor C. W. Allen in January 1967. This transfer concludes the work on Solar Flare Patrol carried out under Professor M. A. Ellison from 1958 to 1963. The Cape films provided one of the strongest series of the international coverage of solar activity in the I.G.Y. and the I.Q.S.Y. For it being possible to carry out this work the Section is greatly indebted to the British National Committee for Geophysics and H.M. Astronomer at the Cape.

3. SOLAR-TERRESTRIAL RELATIONSHIPS

Miss S. McKenna: Work on the active solar region of 1959 July was continued at Dunsink during the period January-August 1966. Detailed comparison between optical and radio records was established and a brief description of some of the results was published.

4. SOLAR ABSORPTION LINES

I. Elliott: The results of the analysis of chromospheric Doppler shifts using spectra of the solar Balmer lines obtained at Sacramento Peak Observatory, New Mexico, have been incorporated in Mr. Elliott's Ph.D. thesis submitted to the University of Dublin. Work carried out during the year was mainly concerned with a one-hour sequence of H α spectrograms giving the local Doppler shifts as a function of position and time. A power-spectrum analysis of the sequence, using the Trinity College IBM 1620 computer, shows three prevalent periods. The largest peak, for a period of 280 seconds, corresponds to the principal peak in the underlying photospheric oscillations and this is found at all disk positions. The high-frequency peak may be found in a range of periods (140-200s) and its presence is tentatively ascribed to a period of natural oscillation. The low-frequency peak (1400s) is associated with steady downward motion and, by inference, with the presence of a magnetic field. Improved frequency-resolution at the low-frequency end of the power spectra is being sought.

5. GALACTIC RESEARCH

P. A. Wayman; C. J. Butler: Some twelve ADH plates of NGC 3532 with UVB filter-emulsion combinations were obtained, and the off-set photometer was used on the 60-inch reflector at Boyden Observatory for obtaining photo-electric measurements of about thirty stars down to 17.5 magnitude. This cluster has been studied mainly in order to test the photometric system, both at the telescope and in the reductions. Measurements of the plates have been provisionally reduced to the UVB system with satisfactory accuracy and an analysis of the population of the cluster is being undertaken.

A reconsideration of the Hyades Cluster parallax derived from proper motion and radial velocity data has shown that an error of greater than 0.3 magnitudes in the accepted distance-modulus, as has been suggested on other grounds, is most unlikely.

Densitometer records of the spectra of 315 late-type S. hemisphere stars (Royal Greenwich Observatory material) have been obtained for interpretation of line-strengths for stellar classification by numerical procedures. Preliminary results show that evaluation of criteria that are independent of density of exposure is difficult to achieve.

Discovery of an unusual flare-type star was secured in September 1966 by Mr. Butler, and the variation was confirmed on a subsequent night by A. D. Andrews of Armagh Observatory, also at Boyden Observatory at the time. This star is a flare star with a spectral type of around K0, most flare stars being much redder.

Some spectra of early-type stars in NGC 3293 have been received from Dr. M. W. Feast of the Radcliffe Observatory, Pretoria, for measurement of H α line-widths and comparison with standard calibrations of this quantity against absolute magnitude.

6. GLOBULAR CLUSTERS AND THE MAGELLANIC CLOUDS

P. A. Wayman; C. J. Butler: Registration of the outer-most contours of brightness of three globular clusters was achieved, using, on the Joyce-Loebl densitometer, positive copies of plates loaned by Dr. E. M. Lindsay of Armagh Observatory. For these three clusters, M13, ω Cen and 47 Tuc, it was possible to show a variation in the ellipticity of the contours (derived impersonally) out to a region where the integrated brightness represented of the order of 0.1% of the sky-background, much further than has been reached in photoelectric scans of globular clusters.

A major undertaking at the Boyden Observatory has been the completion of a series of ADH plates in the UBV system on Cepheid variable fields in the Small and Large Magellanic Clouds, comprising over 300 16 x 16-cm plates in all. This work is intended for an investigation of reddening and intrinsic colours of Cepheids. Photoelectric work on several

sequences down to the 18th magnitude has been carried out with the 60-inch telescope at Boyden Observatory. It is intended that these sequences shall provide for calibration against changes in zero point, colour equation over the full range of magnitudes, field errors and background variation. Preliminary reductions of the photoelectric measurements show good agreement with recent work at the Radcliffe Observatory, Pretoria, although there are systematic differences in comparisons with some earlier results. Included in this work are observations of galactic cepheids and other F - K type supergiants in four colours (U, B, V, R) which show that it may well be possible to determine the interstellar reddening from such measurements, and the red band measurements have been extended to some of the Cepheids in the Magellanic Clouds.

7. EXTRAGALACTIC STUDIES

T. Kiang: The spatial density of matter in the form of galaxies has been studied, making a better allowance for absorption effects in our own galaxy and in other galaxies. The amount of the absorption is being obtained from a statistical analysis of material in the Reference Catalogue of Bright Galaxies in book-form and on magnetic tape. Kiang's empirical distribution of luminosity will be utilized.

Work on random fragmentation has led to an interest in the size and shape of random cells in 2 and 3 dimensions. Formulae connecting the average properties throughout a region and some boundary elements have been derived. The 14-faced solid, Lord Kelvin's tetrakaidekahedron, is important in the 3-dimensional problem and an interesting relation seems to exist between types of polyhedra and the Fibonacci Series of numbers. An explanation in terms of n-dimensional geometry is being sought, and the relationship between this subject and theoretical spectroscopy (theory of angular momentum) is being explored.

8. INSTRUMENTS

A Joyce-Loebl Microdensitometer has been installed, provided with (effectively) rotatable slits, to deal with sloping lines in objective

prism spectra. This instrument is extremely versatile and has been used on several different problems and by several users elsewhere in Dublin.

An Askania Iris-diaphragm photometer has replaced the older Eichner instrument. The new instrument shows a vast improvement on the old machine and it gives a satisfactorily stable performance. With the help of a tape-recorder it is possible to register iris-diaphragm readings at the rate of over 120 per hour.

Two sets of closed-circuit television systems were made available to the Observatory for tests on the possibility of electronic superposition of the signals from two cameras viewing two photographic plates. It was found that the camera distortions were inherently too great and therefore a new start with flying-spot techniques is being investigated.

A D-Mac Pencil Follower for recording graphical material in digital form has been installed in joint ownership with other Sections of the School.

The possibility of using a narrow-band interference-filter and direct images to distinguish, by a radial velocity criterion, between foreground stars and Magellanic Cloud stars has been considered and a specification drawn up.

The Shortt Clock has been accurately adjusted throughout the year and has been used for timing occultations, observed with the 12-inch refractor.

9. LECTURES, CONFERENCES, etc.

As in previous years, Mr. Elliott gave a series of astronomy lectures at Trinity College during the Hilary term. Professor Wayman gave a series of ten lectures on stellar constitution to 4th year Physics students in University College, Dublin, in February and March 1967.

Professor Wayman contributed to the annual Herstmonceux Conference (April, 1966) with an invited paper "A determination of Cort's Constant B".

An afternoon colloquium on Quasi-Stellar Objects was held in June 1966 with contributions by J. L. Synge, P. S. Florides, E. M. Lindsay, N. A. Porter and P. A. Wayman.

Professor Wayman attended the Radial Velocity Colloquium (I.A.U. Commission 30) in Toronto in June and contributed a paper. Visits were also made to Cleveland, Washington and Boston.

Mr. Elliott attended the Exeter meeting of the Royal Astronomical Society in September; Mr. Jordan spent three weeks at the Royal Observatory, Edinburgh, in November; Professor Wayman attended the Symposium on Relativistic Astrophysics in New York in January 1967.

Professor Kiang contributed to the Mathematical Seminars in the School of Theoretical Physics in December and in March speaking on "Random Fragmentation in two and three dimensions."

Visitors to Dunsink Observatory included Professor H. A. Brück and Mr. J. W. H. O'Regan, great grandson of Sir W. R. Hamilton.

10. PUBLICATIONS

The following scientific articles by the staff appeared or were accepted for publication during the year:

P. A. Wayman:

Determination of the Inertial Frame of Reference.
Quarterly Journal of the Royal Astronomical Society, 7, 138, 1966.

Quasi-Stellar Radio Sources and Quasi-Stellar Galaxies.
Irish Astronomical Journal, 2, 175, 1966.

T. Kiang:

Mass Distribution of Asteroids, Stars and Galaxies.
Zs. für Astrophysik, 64, 426, 1966.

Random Fragmentation in two and three dimensions.
Zs. für Astrophysik, 64, 433, 1966.

I. Elliott and J. H. Reid:

Two Class 2 flares on 1963 September 16.
The Observatory, 86, 63, 1966.

S. M. P. McKenna:

Comparison of Solar Activity in Optical and Radio Wavelengths.
The Observatory, 86, 207, 1966.

A. D. Andrews, C. J. Butler and J. P. Eckstein:

Further Flare Activity in Butler's Star.
I.A.U. Information Bulletin on Variable Stars, No.157,
September 1966.

In the press:

P. A. Wayman:

The Outer Regions of Three Globular Clusters. The Observatory.

The Hyades Cluster Parallax. Publications of the Astronomical Society of the Pacific.

A Method of Distinguishing Magellanic Cloud membership. Transactions of I.A.U. Symposium No.30.

I. Elliott:

Measurement by Correlation. Irish Astronomical Journal.

B. Cosmic Ray Section.

1. STAFF AND SCHOLARS

Senior Professor:

C. Ó Ceallaigh.

Professor:

K. Inada.

Assistant Professor:

Vacant.

Research Assistants:

Miss M. Kazuno; Dr. A. Thompson; Dr. D. O'Sullivan.

Technical and Clerical Staff:

Miss A. Madden (appointed 1 July 1966); Mr. J. Daly; Miss N. Leahy; Miss M. Longmore; Miss A. Smyth; Miss E. Cullen; Mrs. M. Collins (to 15 April 1966); Miss E. Magee (to 10 March 1967); Miss D. Molloy (appointed 5 July 1966).

Scholars:

T. Cantwell (appointed 1 January 1967); P. Fleming (appointed 1 January 1967).

2. RESEARCH WORK

C. Ó Ceallaigh, A. Thompson and D. O'Sullivan. Collaboration on the Application of Dielectric Detectors to Cosmic Ray and Particle Physics.

As foreshadowed in last year's report, a fruitful collaboration has been established with the Group led by Drs. P. B. Price and R. L. Fleischer at the Research and Development Center of the General Electric Company, Schenectady, New York. In November 1966, Professor Ó Ceallaigh, accompanied by Drs. O'Sullivan and Thompson and Mr. J. Daly, spent approximately one month at those laboratories. They became acquainted with the technique of etching and measurement and contributed to certain fundamental calibration programmes. Professor Ó Ceallaigh returned to the U.S. in January and February 1967 where he joined in the research programme dealing with the characteristics of the plastic 'lexan'. Further collaborative work is contemplated and it is proposed that Drs. Fleischer and Price will visit the School for brief periods in the late Spring of 1967 in order to advise on the problems of setting up a continuing collaboration.

Dr. D. O'Sullivan: A study of the binding energy values of light hypernuclei was undertaken in conjunction with the European K^- Collaboration. Approximately 600,000 K^- meson interactions were investigated and 6,000 mesonic hypernuclei found. This large sample made it possible to determine the B_A values very accurately. Numerous other problems such as final state interactions between the decay products of hypernuclei are at present being studied using the information obtained in this work.

Further examples of the very rare π^+ decay mode of hypernuclei have been found and analysed and this mechanism has been studied in the light of various theoretical models.

Dr. A. Thompson: A study was made of the capture of K^- mesons in heavy nuclei. Approximately 20,000 K^- stars were investigated and it was shown that K^- interactions with neutrons are, relative to interactions with protons, about 6 times more probable.

Drs. A. Thompson and D. O'Sullivan: A search has been made for double hypernuclei in nuclear emulsions exposed at Brookhaven in December 1966 to K^- mesons of momentum 1.5 GeV/c. Only two such hypernuclei have been found hitherto. It is hoped that the present work will increase the statistics and throw some light on the almost unknown properties of the Λ - Λ interaction.

Professor K. Imaeda: Professor Imaeda has studied the transverse-momentum distribution of the secondary particles from high-energy nuclear interactions and the results have been published. (See Section 6.) A study has been made of the frequency distribution of the multiplicity of particles secondary to cosmic ray jets and also for events arising from interactions of high energy accelerator particles. A general study of the features of cosmic ray jets is in progress. In particular, the validity of the 'isobar fireball model' for nuclear interactions at extreme high energy and the utility of alternative models is under examination.

Miss K. Kazuno: An investigation has been carried out into the mechanism and interpretation of the so called catastrophic phenomenon in the ultra high energy nuclear interaction. The phenomenon (i.e. production of

extremely energetic secondary pions) cannot be interpreted on the basis of current theoretical models of multiple particle productions. That fact constitutes a grave defect in our understanding of the mechanism of ultra high energy nuclear interactions.

Measurement of the physical properties of such energetic pions has been made using ICEF cosmic ray jets of energy 10^{11} eV - 10^{15} eV.

On the basis of the Isobar theory, the production probability, energy transfer, angular distributions and charge ratios of the isobar decay pions have been calculated and compared with the experimental results.

Furthermore, by application of the Landau theory, the properties of energetic pions expected from the progressive wave (i.e. shock wave at the moment of nuclear impact) have been calculated and compared with the experimental result.

At primary energies 10^{12} - 10^{13} eV, the expected properties of energetic pions produced through the Isobar process and the Landau process do not differ significantly and agree well with the present experimental result. However, it should be possible to observe significant differences in the charge ratios of pions produced in the alternative mechanisms. The present result appears to favour the Isobar mechanism. The trend of the change in the energy transfer to pions as a function of primary energy is different for each process. It will be necessary to obtain more material to clarify the mechanism of the catastrophic phenomenon.

3. CONFERENCES AND COMMITTEES

The following international conferences and symposia were attended by members of the Section:

The Sixth International Conference on Nuclear Photography, Florence, 18-25 July, 1966 (C. Ó Ceallaigh, A. Thompson, D. O'Sullivan).

Cern, Physics III Committee, Geneva, 24 May and 11 October 1966 (C. Ó Ceallaigh).

Royal Society Conference, London, 3 November 1966 (C. Ó Ceallaigh, K. Imaeda).

European K⁻ Collaboration, London, 6 February 1967 (A. Thompson, D. O'Sullivan).

Rehovoth International Conference on Nuclear Structure, 26 February to 4 March 1967 (A. Thompson).

Professor K. Imaeda visited the University of Durham for discussion with Dr. A. W. Wolfendale, 13-14 March 1967.

Professor Ó Ceallaigh, Drs. Thompson and O'Sullivan visited the Research and Development Center of the General Electric Company, Schenectady, New York for a period of six weeks and Mr. J. Daly for four weeks during November and December 1966. Professor Ó Ceallaigh returned for a further four week period during January and February 1967.

4. PERSONAL

Miss A. Madden was appointed to the position of Clerk to the Section and took up her duties on 1 July 1966. Mrs. M. Collins relinquished her position as Scanner on 15 April 1966 and was replaced by Miss E. Cullen who had hitherto been working on a contract basis. Miss E. Magee relinquished her contract on 29 April 1966 and renewed it 9 October 1966 to 10 March 1967. Miss D. Molloy was appointed to the post of Scanner on 5 July 1966. Messrs. Patrick Fleming, B.Sc. and Thomas Cantwell, B.Sc., formerly of University College, Galway, were appointed Scholars on 1 January 1967. During the year, Drs. Thompson and O'Sullivan were awarded the degree of Ph.D. of the University of Dublin. They were appointed to the post of Research Assistant for a three-year period commencing 1 July 1966.

5. WORKSHOP AND LIBRARY

Mr. Daly continued to maintain the various instruments in use in the Section. In addition, he took a leading part in setting up the laboratory for implementing the newly-established programme of research on plastic particle detectors in collaboration with the group headed by Drs. P. B. Price and R. L. Fleischer at the Research and Development Laboratory of the General Electric Company, Schenectady, New York, U.S.A. The essential apparatus for etching and measurement of particle tracks has been installed. Research work on the examination of the characteristics of various

commercially-available plastics is now being carried out in the School.

The joint library of the Cosmic Ray and Geophysical Sections has now been set up in the newly-decorated 'Assembly Laboratory' of the Cosmic Ray Section and the cataloguing of the books is being carried out by Misses Nolan and Madden, Clerks to the Sections concerned.

6. PUBLICATIONS

K. Imaeda:

Transverse-Momentum Distribution of Secondaries from High-Energy Nuclear Interactions and Interpretation by means of a Statistical Model. *Nuovo Cim.* 48, 482, 1967.

D. O'Sullivan:

The π^+ Mesonic Decay of Hypernuclei. *Nuovo Cim.* 44, 688, 1966.

A. Thompson:

The Neutron Distribution on the Surface of Heavy Nuclei. *Proceedings of the Rehovoth Conference*, 1967.

M. Kazuno:

Evaluations of Mass of Target Isobar and Four-Momentum Transfer in Cosmic Ray Jets. *Nuovo Cim.* 47, 73, 1967.

In the press:

K. Imaeda:

An Interpretation of Cosmic Ray Jets. *Canadian J. of Physics*.

C. Ó Ceallaigh, D. O'Sullivan, A. Thompson:

Plastic Track Detectors for Identifying Light Isotopes in Cosmic Radiation. *Proceedings of the International Conference on Cosmic Rays, Calgary, Canada*, 1967.

C. Ó Ceallaigh, D. O'Sullivan, A. Thompson:

Identification of Energetic Particles with Dielectric Track Detectors. *Physical Review Letters*.

In preparation:

K. Imaeda:

Multiplicity Frequency Distribution of Secondaries in High Energy Interactions.

M. Kazuno:

Landau Process and Isobar Process in Cosmic Ray Jets.

D. O'Sullivan:

Accurate Determination of the Binding Energies of Light Hypernuclei.

The π^+ Decay of Hypernuclei.

C. Geophysical Section.

1. STAFF, SCHOLARS AND EXTERN RESEARCH WORKERS

Senior Professor:

Thomas Murphy.

Professor:

Vacant.

Research Assistants:

R. P. Riddihough (appointed 1 September 1966);
D. G. G. Young (appointed 1 March 1967).

Senior Technical Assistant:

Thomas J. Morley.

Technical and Clerical Staff:

Miss B. Kennedy (to 22 June 1966); Miss E. Byrne (appointed 18 July 1966); Miss A. Nolan; Mr. K. Bolster; Mr. J. Fay.

Scholars:

I. Dixon; B. Jacob; C. English (appointed 1 October 1966).

Research Associate:

Rev. G. McGreevy (Maynooth College).

Extern Research Workers:

I. R. McAulay (T.C.D.); A. Phillips (T.C.D.).

2. EXPERIMENTAL AND FIELD WORK

a. Gravity:

A gravity survey was made in North-West Mayo and additional readings were taken in South-East Wexford.

The complete gravity data (1955 to date) has been listed, typed and sent to international organisations.

Measurements of rock densities have been carried out on the samples collected over the last few years.

b. Magnetism:

A magnetic survey (total field) was carried out in North-West Mayo, linking up with the earlier work done by Dr. Phillips.

An analysis of the magnetic diurnal variation has been commenced and a preliminary account prepared for publication.

c. Meteorology:

Routine observations of the meteorological elements were continued throughout the year and the autographic records tabulated.

The investigation of wind frequencies at Dublin City is nearing completion.

The solar radiation records from the solarimeter on the roof of No.5 Merrion Square are now being evaluated.

d. Seismology:

The analysis of the long period seismic waves and the study of microseisms, as recorded at Valentia and nearby European seismic stations, were continued.

A microseismic survey was carried out at Valentia Observatory and various sites between Clifden and Dublin, using a portable seismic station.

e. International Collaboration:

A portable seismic station was set up in East Anglia and later in Waterford to record planned explosions at sea, in the first case by the Dutch Navy and in the second by the British Navy. These were studies into the structure of the earth's crust.

A member of the staff assisted in the scientific work during two weeks of the 14th cruise of the "R.R.S. Discovery" with members of the Universities of Bristol and Durham. Gravity, magnetic, seismic and depth studies were carried out together with geological sampling of the sea-bottom in the North Atlantic. The area covered part of the continental margin on the South-West of Ireland.

3. CONFERENCES

Professor Murphy and Mr. Jacob attended the meeting of the European Seismological Commission held in Copenhagen from August 1-7, 1966.

4. STATUTORY PUBLIC LECTURE

The Statutory Public Lecture, entitled "Continents and Oceans - Their Development", was delivered on March 10, 1967, at University College, Earlsfort Terrace, Dublin, by Professor J. M. Bruckshaw of Imperial College, London.

F. E. HACKETT.
ACTING CHAIRMAN.

5th March, 1968.