

INSTITIÚID ÁRD-LEINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)
of the works of the Constituent Schools
for the year 1967-68

School of Celtic Studies

In the field of publications sixteen books appeared during the year, nine of which were published by the Institute. Twelve papers appeared at regular intervals.

Professor Sturdy's Course of Irish law-tracts now amounts to 1165 pages in total. He gave the first O'Connell memorial lecture in University College, Dublin, on 11th March 1968. Professor Murray published a paper in *Journal of the Royal Society of Medicine* and gave some 15 Irish papers presented at various places.

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

1967-68

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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 1967-68

School of Celtic Studies

In the field of publications sixteen books appeared during the year, nine of which were published by the Institute. Twelve papers appeared in learned journals.

Professor Binchy's Corpus of Irish law-tracts now amounts to 1165 pages in proof. He gave the first Osborn Bergin Memorial Lecture in University College, Dublin, on 15th March 1968. Professor Carney pursued research in Middle Irish poetry, and upon some Old Irish glosses preserved at Lambeth Palace. Professor Dillon worked at Celtica and revised proofs of his Stories from the Acallam. Professor Greene continued his work on bardic poetry and on linguistics. Professor Ó Cuív worked at Éigse and devoted some time to the Dictionary of Modern Irish and to two series of Thomas Davis Lectures. Professor Mac Niocaill continued his work on the Annals of Ulster, and wrote several articles. Professor Ó Súilleabháin revised proofs of his edition of Buaidh na Naomhchroiche and read other volumes of the Franciscan Series in proof and typescript. M. Nemo completed the second volume for the Mediaeval and Modern Breton Series and continued work on his Historical Dictionary of Breton. Mrs. Doran prepared the third fasciculus of the Catalogue of Irish Mss. in the National Library of Ireland. Mrs. O'Sullivan collated Professor Binchy's transcript of law-tracts with the Mss. The Scholars' work was mainly in the field of Old and Modern Irish under the direction of one or other of the Professors.

Progress was also made on a number of volumes to be published in the Hiberno-Latin Texts Series (Scriptores Latini Hiberniae), the Mediaeval and Modern Irish Series and the Mediaeval and Modern Welsh Series.

Seminars were held by Professor Greene and Professor Carney, and Professor Dillon continued his lectures on Sanskrit.

The Statutory Public Lecture, entitled The Lost Book of Glendalough - A Preliminary Investigation, was delivered by Professor James Carney in Trinity College, Dublin, on 20th March, 1968.

School of Theoretical Physics

Professor Lanczos, a Senior Professor in the School since 1954, retired in February 1968 and was made Professor Emeritus.

During the year Professor Synge developed a technique for using Einstein's field equations to obtain the metric tensor as a functional of the energy tensor. He worked on calculations in special relativity for the equations of motion. Professor Lanczos continued his researches concerning the modulations of a crystalline space-time lattice field. Rev. Professor McConnell carried out studies on Lie groups. Professor Takahashi formulated a theory of hyperquantization. His method has many advantages in dealing with fields with higher spin.

Professor Ó Raifeartaigh, still on leave of absence, worked in the three fields of mass-splitting theorems, broken symmetry, and infinite component wave equations. Professor Lurié investigated the correspondence between momentum-space Schroedinger equations and Bethe-Salpeter equations. Professor Balazs studied radiation from accelerated charge. Professor Israel worked on the dynamics of thin shells and gravitational collapse in general relativity; pulsars; and differential forms in general relativity. The Research Associates, Scholars and Student studied various topics in relativity and quantum theory.

Twenty-nine weekly seminar lectures were given but no Symposia were held on account of travel restrictions imposed by outbreak of Foot and Mouth disease in Britain.

The Statutory Public Lecture was delivered by Professor Balazs in University College, Dublin. The staff gave a number of invited lectures in Ireland and abroad and took part in meetings. Professor Lanczos continued his leave of absence in the U.S. up to June 1967.

During the year translations of two books by members of the staff were published and two volumes in the Communications of the Dublin Institute for Advanced Studies, Series A appeared. Eleven books were in the press. Thirty-four papers were published in learned journals and fifteen were in the press.

School of Cosmic Physics

Astronomical Section:

The main work of the Section consisted of formulating computer methods for handling the photoelectric and photographic observations of cepheid variable stars in the Magellanic Clouds. At the beginning of the year the photoelectric observations were still incompletely reduced to standard magnitude systems; by the end of the year, light curves of cepheid variables deduced from the photographic observations were being produced on the computer.

Solar research consisted of strengthening the results of previous years in defining the power spectra of vertical motion in the solar atmosphere and of obtaining new data in greater detail.

Various statistical analyses have been carried out, including the production of a catalogue of galaxy counts in a readily-used form and the application of Monte Carlo methods to double star statistics.

Cosmic Ray Section:

The work of collaboration with Dr. Price's group at the Research and Development Center of the General Electric Company at Schenectady, New York on the line of research using dielectric detectors, which was initiated last year, continued successfully during the current year. This research is concerned with the development of the technique of detection of primary cosmic rays in selected plastic materials. Dr. Price and Dr. Fleischer visited Dublin and lectured in the School and Dr. Thompson spent two months at the Research and Development Center of the General Electric Company. Mr. Daly continued his work in setting up the instrumentation of the new plastics laboratory in the School.

The European K⁻ Collaboration and other investigations using emulsion techniques were continued successfully by staff and scholars throughout the year, and various conferences and meetings were attended.

Eight papers by members of the staff - two of them in collaboration with Dr. Price's group - were published in learned periodicals; one paper was in the press and eight others in preparation.

Geophysical Section:

Gravity and magnetic surveying was carried out in various parts of the country mainly in the northwest and around Dublin.

Investigations of the diurnal magnetic variation over these islands and the adjacent part of the continent were started and showed up an anomalous behaviour.

The study of the long period seismic waves was continued and has yielded information regarding the crustal thickness in Ireland. The response of seismic detector arrays was also investigated in this regard.

The study of the sources of microseisms has necessitated the analysis of sea waves, their generation and build-up using a computer.

The magnetic polarisation of rock samples, in particular of a limestone formation, was measured and analysed.

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
for the Financial Year 1967-68

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, 1968.

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 Board of the three Constituent Schools on the 31st March 1968.

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, 1968.
- 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 1968.

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 T. Murphy, D.Sc.

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.; David Greene, M.A.; Brian Ó Cuív, M.A., D.Litt.

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.; Reverend James R. McConnell, M.A., D.Sc.

Appointed Members:

George R. Keating, M.Sc.; Albert J. McConnell, M.A., M.Sc., Sc.D.; Thomas Edwin Nevin, D.Sc.; Patrick Quinlan, B.E., M.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:

John H. J. Poole, M.A., B.A.I., Sc.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.; 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 Broilcháin, 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 27th June, 1968.

1. STAFF, SCHOLARS AND EXTERN RESEARCH WORKERS

Senior Professors:

Myles Dillon, Director of the School; Daniel A. Binchy; David Greene (from 1 October 1967); Brian Ó Cuív (from 1 October 1967).

Professor:

James P. Carney.

Assistant Professors:

Louis Paul Nemo (Roparz Hemon); Rev. Pádraig Ó Súilleabháin, O.F.M.; Gearóid Mac Niocaill.

Assistants (Part-time):

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

Research Associates:

Heinrich Wagner; Proinsias Mac Cana.

Technical and Clerical Staff:

Máire Breatnach; Máire Bean Uí Chinnsealaigh.

Scholars:

Hans P. A. Oskamp (to 31 August 1967); David Erlingsson (to 31 July 1967); Joseph Watson (to 30 June 1967); Donncha Ó hAodha; Pádraig de Brún; Donncha Ó Corráin (appointed 1 October 1967); Thomas Charles-Edwards (appointed 1 October 1967); Nicholas J. A. Williams (appointed 1 October 1967).

Extern Research Workers:

Dr. Cecile O'Rahilly; Rev. Anselm Faulkner, O.F.M.; Rev. Cuthbert McGrath, O.F.M.; Rev. Bartholomew Egan, O.F.M.; Dr. Ludwig Bieler; Mr. I. P. Sheldon-Williams; Eamonn Mhac an Fhailigh; Professor J. E. Caerwyn Williams; Dr. R. L. Thomson; Caitlín Ní Maol-Chróin; Máire Ní Chatháin; Mr. Brynley Roberts.

2. RESEARCH AND EDITING

Professor Myles Dillon revised the Notes in his Middle Irish Reader. Celtica VIII was seen through the press. Towards the end of the year he took part in editing the material collected for the Dictionary of Classical Modern Irish. (See also Sections 4, 5 and 6).

Professor Daniel A. Binchy continued to transcribe from Irish legal manuscripts for Corpus Iuris Hibernici of which 1,165 pages are now in first proof. He submitted a paper - 'St. Patrick's "First Synod"' which

was read by Professor Mac Niocaill to the Congress on Christianity in Roman and sub-Roman Britain in Nottingham in April 1967. An article on the subject-matter of the legal fragment recently discovered by Mr. and Mrs. O'Sullivan in a T.C.D. manuscript was written for Celtica VIII. Professor Binchy prepared for publication and edited an extract from the notebooks of Eoin Mac Néill for the Irish Jurist Vol.II. (See also Sections 5 and 6.)

Professor David Greene has checked page proofs of the text, translation, notes and glossary of Duanaire Mhéig Uidhir. A revised edition and notes of Cúirt an Mheán Oíche were prepared and sent to press at the request of the Merriman Society. First proofs were checked. Celtic Studies in memory of Angus Matheson was edited and seen through the press in collaboration with Professor Carney. A paper on the Consonant system of Proto-Celtic was prepared for presentation to a meeting of the British Linguistic Association. An article entitled Linguistic Evidence on Sub-Roman Britain was accepted for a volume edited by Professor Richard Hanson. A lecture on 'Irish as a Vernacular before the Norman Invasion' was accepted for publication in the Thomas Davis lecture series edited by Professor Ó Cuív. (See also Sections 4 and 6.)

Professor Brian Ó Cuív devoted some time to editorial work on texts, some to the Dictionary of Classical Modern Irish and some to research on metrics and Early Modern Irish grammar. He continued to edit Éigse for the National University of Ireland. Part II of Volume XII was published in January 1968 and Part III was in proof in March 1968. Professor Ó Cuív has also been concerned as editor with two series of Thomas Davis lectures:- (1) Seven Centuries of Irish Learning 1000-1700, first published by the Stationery Office in 1961 and being republished now by the Mercier Press; (2) A View of the Irish Language which is to be published by the Stationery Office and to which he contributed two lectures - 'The Changing Form of the Irish Language' and 'Irish in the Modern World'. (See also Section 6.)

Professor James Carney worked on (i) certain Middle Irish poems from N. Lib. Ire. MSS. G 1 and G 2 with a view to publication, and (ii) Lambeth Glosses. He also carried out research work necessary for the Statutory

Public Lecture. He continued work as co-editor with Professor Greene of Celtic Studies in memory of Angus Matheson. (See also Sections 3, 4 and 6.)

M. Louis Paul Nemo continued to work on the Historical Dictionary of Breton. First proofs of La Destruction de Jérusalem and Les Amours du Vieillard, to be published in the Mediaeval and Modern Breton Series, were checked. Following the discovery of about 400 new fragments it was necessary to write an appendix to the volume. (See also Section 6.)

Rev. Pádraig Ó Súilleabháin, O.F.M. checked and returned for revise the Text and Latin version of Buaidh na Naomhchroiche. Work continues on the Notes and Vocabulary. He read the final proofs of Fr. Cuthbert's edition of Dán na mBráthar Mionúr, Cuid I and first proofs of the Notes and Translation for Cuid II. He read the typescript of Fr. Anselm's edition of An Bheatha Chrábhaidh. An article entitled 'Varia' has been accepted for publication in a forthcoming volume of Éigse.

Dr. Gearóid Mac Niocail completed the collation of the Rawlinson text of The Annals of Ulster. Annotation of the Translation continued. The following articles were prepared and accepted for publication:- 'The proportional method in dating Irish texts', Studia Celtica III; 'Blúire de chroinicí Fhinghin Mhic Cárthaigh', Galvia IX; 'Trí hórmarharg' (with M. Dolley), Éigse XII. (See also Section 6.)

Mrs. Nessa Doran checked and passed for press the final proofs of Fasc.I of the Catalogue of Irish Mss. in the National Library of Ireland. Mss. 81-88 for Fasc.III were catalogued. (See also Section 6.)

Mrs. Anne O'Sullivan collated Professor Binchy's transcripts of Irish law texts with the following manuscripts: T.C.D. E.3.5 pp.21-60, H.2.15 pp.1-67, H.3.17 cols.1-103; Brit. Mus. Harl. 432 pp.1-22, Eg. 90 ff.8-16; Bodleian Rawl. B 506 ff.16c-62c; B 487 ff.53a-67a; R.I.A. 23.P.12 ff.335a-348b. In collaboration with Wm. O'Sullivan she has done preliminary work on the inscriptions in the law mss. with a view to establishing the manuscript tradition of the texts. She has continued her study of the early 16th cent. Brit. Mus. Ms. Add. 33993: to assess its value as a literary collection reflecting local conditions in north Tipperary and to publish the unpublished elegies of some 15th cent. nobles which it contains and

which are interesting for the historical information they can provide. The following contributions have been accepted for publication:- Introduction to a reprinting of Edward Lhuyd's Archaeologia Britannica (with Wm. O'Sullivan); 'O'Moore Poems in the Book of Leinster' and 'A legal Fragment' (with Wm. O'Sullivan) for Celtica VIII. (See also Section 6.)

Professor Heinrich Wagner read proofs of Volume IV of the Linguistic Atlas and Survey of Irish Dialects which contains the Ulster, Manx and Scottish Gaelic materials. This work is completed (303 pages) and the Introduction is being prepared. Material for a fifth volume containing small monographs of the Irish of Fánaid, Glenvar, Tory Island as well as a 'Glossary of the Sea' from various parts of Co. Donegal has been prepared by Professor Wagner's collaborators.

Professor Proinsias Mac Cana as General Editor of the Mediaeval and Modern Welsh Series checked book proofs of Professor Caerwyn Williams's edition of The Poems of Taliesin and passed for press the final proofs of Cwein edited by R. L. Thomson. 'Copy' for an edition of Brut y Brenhinedd by Brynley Roberts was read and sent to the printer in June 1967.

Mr. Hans P. A. Cskamp has been occupied with more research into the earliest Irish and Latin voyage literature. The result of this research is to be published as a book. He held a visiting appointment at the University of California from January to June 1967.

Donncha Ó hAodha continued excerpting for the Dictionary of Classical Modern Irish under the supervision of Dr. O'Rahilly. Preparation of an edition of the Old Irish Life of St. Brigit was continued under the supervision of Professor Binchy.

Pádraig de Brún prepared for press a Catalogue of Irish Mss. in the Franciscan Library (M. Dillon and C. Mooney, O.F.M.). The body of the catalogue is in typescript, the indices are almost complete and the introduction is in preparation. He continued preparatory work on an anthology of 17th to 19th century Irish poetry and on an edition of poems of Piaras Feiritéar. He edited Journal of the Kerry Archaeological and Historical Society, No.1. An edition of Filíocht Sheáin í Bhraonáin is in preparation. The following articles were accepted for publication in Éigse XII:

'Epitaph Aogáin Í Rathaile'; 'Cnuasach d'fhillíocht Phádraigín Haicéad';
'Tuireamh Laidne ar Dháibhí Ó Bruadair'. (See also Section 6.)

Donncha Ó Corráin devoted most of his time to the study of early Munster history. He has transcribed from the Books of Lecan, Ballymote and Uí Maine the Munster genealogies not published by Professor O'Brien in Corpus Genealogiarum Hiberniae I. He has also transcribed the Frithfolaid text from the Book of Lecan and has begun work on a similar text in H.2.7. He has devoted considerable time to other Munster texts. An article entitled 'The Alltraige' has been accepted for publication in Journal of the Kerry Archaeological and Historical Society, No.2. An article on the revisions in the chronology of Mac Carthy's Book has been accepted for publication in the Journal of the Cork Historical and Archaeological Society.

Mr. Thomas Charles-Edwards worked on a thesis entitled 'A comparison between Old Irish and Mediaeval Welsh land-law'. To this end he has written the first draft of a chapter on Irish and Welsh clientship and is working on a chapter dealing with the legal procedure for establishing claims to land.

Mr. Nicholas J. A. Williams has tried to reconstruct as far as possible the Irish dialect(s) of North Louth and S. Armagh, (more specifically the four baronies of Upper Orior, Upper Fews, Upper and Lower Dundalk) and to relate the dialect(s) to the Irish of the surrounding sread - S. Louth, N. Meath, Farney, Co. Down, etc. Material for this work is still being collected. He has examined inter alia printed works by J. Lloyd, Rev. L. Murray, Éamonn Ó Tuathail, John Hannon, P. Mac Con Midhe; accounts of the Irish of native speakers by Wagner, Ó Searcaigh, Sommerfelt and records of the last native speaker of Louth; manuscripts in the Royal Irish Academy and on microfilm in the National Library. An article on first person pronouns has been accepted for Éigse.

Dr. Cecile O'Rahilly excerpted from Stair an Bhíobla, Vols. II and IV, In Cath Cathardha, An Bheatha Chrábhaidh and various short texts from periodicals for the Dictionary of Classical Modern Irish. 'Three Notes on Syntax' was accepted for publication in Celtica VIII and 'Mairg atá sa mbeathaidhsi' for a forthcoming number of Éigse.

Rev. Cuthbert McGrath, O.F.M. checked final proofs of Dán na mBráthar Mionúr Cuid I which was published during the year. He checked and returned for revise first proofs of the Notes and Translation of Cuid II. Work on the Introduction, Vocabulary and Appendices continues.

Rev. Anselm Faulkner, O.F.M. checked final proofs of An Bheatha Dhiadha which was published during the year. Preparation of the Text, Notes, Vocabulary and List of Proper Names of An Bheatha Chrábhaidh was completed. Micro-film copies of several manuscripts obtained from English libraries were compared with the basic text of An Sgáthán Spioradálta. Work is proceeding on this text.

Rev. Bartholomew Egan, O.F.M. checked final proofs of his edition of Graiméir Ghaeilge na mBráthar Mionúr which was published during the year.

Dr. Ludwig Bieler continued to act as General Editor of Scriptores Latini Hiberniae. He read final proofs of I. P. Sheldon-Williams's edition of Johannis Scotti Eriugenae - Periphyseon (de divisione naturae) on which he had collaborated. These proofs were passed for press. The typescript of Book II of this work was read and revised. Professor Bieler's edition of The Four Latin Lives of St. Patrick was prepared and sent to the printer in December 1967.

Mr. I. P. Sheldon-Williams saw through the press the final proofs of Johannis Scotti Eriugenae Periphyseon (de divisione naturae). Book II of this work was prepared for press. Work on the English translation of Book III is in progress. Manuscripts have been collated for Books IV and V.

Éamonn Mhac an Fhailigh checked and returned for revise book proofs of his phonemic study, The Irish of Erris, Co. Mayo.

Dr. R. L. Thomson saw the final proofs of his edition of Owein (Mediaeval and Modern Welsh Series, Vol.IV) through the press. The book was published in March 1968.

Professor J. E. Caerwyn Williams checked and returned for revise book proofs of his edition of The Poems of Taliesin (Mediaeval and Modern Welsh Series, Vol.III). Preparatory work has been done on The Poems of

Llywarch Hen and The Poems of Aneurin.

Mr. Brynley Roberts worked on an edition of Brut y Brenhinedd to be published in the Mediaeval and Modern Welsh Series. 'Copy' for the Introduction, Text, Notes, Appendix, Vocabulary and Indexes was submitted to the printer in June 1967.

Professor Caitlín Ní Maol-Chróin has done some preparatory work on the Introduction to her edition of Caithréim Cellaig, which is to be published in the Mediaeval and Modern Irish Series. The two Texts, Apparatus Criticus, Glossary and Index Nominum are already in proof.

Máire Ní Chatháin continued her editorial work on Betha Muire.

3. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture entitled The Lost Book of Glendalough - A Preliminary Investigation was delivered by Professor James Carney in Trinity College, Dublin, on 20th March 1968.

4. SEMINARS

Professor Myles Dillon continued to give lessons in Sanskrit to students from University College, Dublin.

Professor David Greene held a weekly Seminar on Críth Gablach from October 1967 to April 1968.

Professor James Carney held a weekly Seminar on Scéla Cano Meic Gartnáin from October 1967 to April 1968.

5. EXTERNAL ACTIVITIES

The third International Congress of Celtic Studies was held at Edinburgh from 23rd to 29th July 1967. The Congress was attended by members of the Institute which was officially represented by Professor Myles Dillon.

Professor Myles Dillon attended, and read papers at, the Tenth International Congress of Linguists at Bucharest from 28th August to 2nd September 1967 and the Sixth International Congress of Phonetic

Sciences at Prague from 7th to 13th September 1967.

Dr. Gearóid Mac Niocail read Professor Binchy's paper 'St. Patrick's "First Synod"' at the Congress on Christianity in Roman and sub-Roman Britain held at Nottingham in April 1967.

Professor D. A. Binchy delivered the first Osborn Bergin Memorial Lecture in University College Dublin on 15th March 1968.

6. PUBLICATIONS

a. Books published by the Institute:

Táin Bó Cúalnge from The Book of Leinster. Edited by Cecile O'Rahilly.
Price 50s. pp.lv + 356. Published April 1967.

Place-Names of Co. Wicklow - VII. By Liam Price.
Price 7s.6d. pp.xcvi + 383-532. Published May 1967.

An Bheatha Dhiadha. Edited by Anselm Ó Fachtna, O.F.M.
(Scríbhinní Gaeilge na mBráthar Mionúr, Iml.IX).
Price 42s. pp.xx + 262. Published November 1967.

The Book of Leinster, Vol.V. Edited by M. A. O'Brien and R. I. Best.
Price 45s. pp.xiv + 1119-1325. Published December 1967.

Catalogue of Irish Mss. in the National Library of Ireland - Fasc.I.
By Nessa Ní Shéaghda.
Price 21s. pp.103. Published December 1967.

Dán na mBráthar Mionúr (Cuid I). Edited by Cuthbert Mhág Craith, O.F.M.
(Scríbhinní Gaeilge na mBráthar Mionúr, Iml.VIII).
Price 50s. pp.xiv + 379. Published December 1967.

A Historical Phonology of Breton. By Kenneth H. Jackson.
Price 8gns. pp.xxviii + 904. Published December 1967.

Owein. Edited by R. L. Thomson.
(Mediaeval and Modern Welsh Series, Vol.IV).
Price 12s.6d. pp.cvi + 98. Published March 1968.

Graiméir Ghaeilge na mBráthar Mionúr. Edited by Parthalán Mac Aogáin,
O.F.M. (Scríbhinní Gaeilge na mBráthar Mionúr, Iml.VII).
Price 21s. pp.xxv + 158. Published March 1968.

b. Books published outside the Institute:

Myles Dillon (in collaboration with Mrs. Nora Chadwick):

The Celtic Realms. Published (in the series The History of
Civilization) by Weidenfeld, London, 1967.

James Carney:

The Irish Bardic Poet. Published by The Dolmen Press, Dublin, 1967.

Mediaeval Irish Lyrics. Published by The Dolmen Press, Dublin, 1967.

Roparz Hemon:

Historical Dictionary of Breton, Rann XII. (Gwallbezh-Gwitibuntamm). pp.1101-1200. Published Etienne, Paris, April 1967.

Historical Dictionary of Breton, Rann XIII. (Gwitod-Higolenn). pp.1201-1300. Published Etienne, Paris, October 1967.

Mrs. Nessa Doran:

Tóraigheacht Dhiarmada agus Ghráinne (Irish Texts Society, Vol.XLVIII). Published by The Educational Company of Ireland, Ltd., Dublin, 1967.

Pádraig de Brún:

Clár Lámhscríbhinní Gaeilge Choláiste Ollscoile Chorcaí: Cnuasach Thorna. Published by Cló Bhréanainn, 1967.

c. Contributions to Periodicals and other publications:

D. A. Binchy:

Prolegomena to a Study of the Ancient Laws of Ireland by Eoin Mac Neill, with an introduction and footnotes by D. A. Binchy. The Irish Jurist, Vol.II, 106-115.

David Greene:

Old Irish is ... dom 'I am'. Beiträge zur Indogermanistik und Keltologie Julius Pokorny zum 80. Geburtstag gewidmet, 171-3.

Provection and calediad. Studia Celtica, II, 101-4.

Brian Ó Cuív:

Reflexes of Old Irish neuter s-stem nouns in Early Modern Irish. Beiträge zur Indogermanistik und Keltologie Julius Pokorny zum 80. Geburtstag gewidmet, 243-9.

A Satirical Poem on Franciscan Friars. Éigse, XII, 139-40.

Gearóid Mac Niocaill:

Notes on litigation in late Irish law. Irish Jurist, II, 299-307.

Documents relating to the suppression of the Templars in Ireland. Analecta Hibernica, XXIV, 183-226.

Some coin-names in Ceart Uí Néill (with M. Dolley). Studia Celtica, II, 119-24.

Anne O'Sullivan:

Contributions to a Dictionary of the Irish Language letter A, Fasc.II. (With E. G. Quin.)

Pádraig de Brún:

Dhá litir Ghaeilge. Éigse, XII, 85-90.

Lámhscríbhinní Gaeilge i Luimneach. *ibid.* 91-108.

Cnuasaigh de lámhscríbhinní Gaeilge: treoirliosta. Studia Hibernica, VII.

III - Report of the Governing Board of the School of Theoretical Physics
adopted at its meeting on 18th September, 1968.

1. STAFF AND SCHOLARS

Senior Professors:

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

Cornelius Lanczos (retired 2 February 1968).

Rev. James R. McConnell (appointed 1 February 1968).

Professors:

Yasushi Takahashi; Lochlainn Ó Raifeartaigh.

Visiting Professors:

David Lurié (to 31 August 1967); Werner Israel (re-appointed for one year from 1 September 1967); Nandor Balazs (appointed for one year from 1 September 1967).

Research Associates:

D. Judge (re-appointed to 30 September 1969); P. S. Florides (re-appointed to 30 September 1969); Rev. C. Ryan (re-appointed to 30 September 1969).

Technical Assistant:

Miss Evelyn R. Wills.

Scholars:

E. Pechlaner (left 31 August 1967); K. Watanabe (left 31 August 1967); H. H. Nickle (left 30 June 1967); F. I. Cooperstock (left 30 June 1967); V. de la Cruz (left 5 June 1967); M. Murtagh (left 31 July 1967); H. Efinger (appointed 1 October 1967); M. Misra (appointed 1 October 1967); I. Khan (appointed 1 October 1967); F. Ando (appointed 1 September 1967); P. Boyle (appointed 1 January 1968); A. Singh (appointed 1 January 1968); E. Massa (15-26 January 1968).

Student:

Rev. J. McCrea (re-appointed 1 October 1967).

2. STUDY AND RESEARCH

Professor Synge developed a technique for using Einstein's field equations to obtain the metric tensor as a functional of the energy tensor. Equations of motion emerge in successive orders of approximation, and these are expressed in Eulerian form so that they may be compared with the Newtonian equations of celestial mechanics. He also made calculations in special relativity for the equations of

motion of a charge of finite size, rigid in the sense of Born. He collaborated with Dr. Pechlaner in obtaining a class of non-stationary massive systems without radiation of energy.

Professor Lanczos continued his researches concerning the modulations of a crystalline space-time lattice field, which show that a genuine positive-definite Riemannian geometry is not in conflict with the Minkowskian character of the superimposed macroscopic perturbation.

Rev. Professor McConnell carried out studies on Lie groups of rank two. In particular, he investigated some lower-dimensional representations of the exceptional group G_2 and constructed certain invariants for this group.

Professor Takahashi formulated a theory of hyperquantization. His method has many advantages in dealing with fields with higher spin. He also investigated the problem raised by Johnson and Sudarshan in connection with fields with spin $3/2$ interacting with an electromagnetic field.

Professor Ó Raifeartaigh's work fell roughly into three parts. (1) He completed work on mass-splitting theorems begun earlier, and his contribution to a book on Applications of Symmetry Principles to Physics, edited by Dr. E. Loeb. (2) He worked on infinite component wave equations and their possible application to particle physics, in particular the possibility of using them to saturate current algebra with 1-particle states at infinite momentum. (3) With Dr. S.-J. Chang he has been carrying out a systematic investigation of a general condition derived by Gell-Mann and Dashen in order that the hadron current algebra be saturated with 1-particle states at infinite momentum. This work is not yet complete.

Professor Lurié investigated, in collaboration with Professor H. H. Aly of the American University of Beirut, the correspondence between the momentum-space Schrödinger equations and Bethe-Salpeter equations in order to exhibit the relation between various classes of singular potentials on the one hand and various types of relativistic field theoretical models on the other. He also gave a series of four lectures to a study group on the partially conserved axial vector current hypothesis.

Professor Balazs worked on the radiation of a charge under the influence of a constant force.

Professor Israel worked on the following topics: (1) sources of the Kerr metric; (2) dynamics of thin shells in general relativity; (3) differential forms, complex vectorial formalism in general relativity; (4) gravitational collapse; (5) pulsars; (6) (working with Mr. de la Cruz) event horizons in very intense gravitational fields, including the problem of existence of regular event horizons in static electrovac space-time.

Dr. Watanabe worked mainly on the application of the dynamical model for weak interactions.

Dr. Nickle revised his article "Comment on Cohan and Hamka's theorem on double-photon contributions to multiple-photon processes". He worked also on intrinsic multiple-phonon processes associated with the basic electron-phonon interaction in solids.

Dr. Cooperstock worked on the flux of momentum from gravitational radiation due to two spinning rods for different relative orientations and spin alignments. The momentum flux can occur to lower order in c^{-1} than that predicted by W. B. Bonnor for a more complicated system. Dr. Cooperstock considered the potential relevance of this for astrophysics: binary stars are possible emitters of gravitational radiation; two such systems could serve as a source of momentum flux and the composite system might recoil if their interaction is sufficiently strong.

Mr. Murtagh continued his work on the quantum theory of fields, under Professor Takahashi. He also studied applications of the Lie groups $SU(2)$ and $SU(3)$ in particle physics and the theory of the representations of the Poincaré group.

Dr. Efinger's research has been in the field of relativistic quantum theory, including the theory of gravitation. His preliminary results concern the possibility of linking Schrödinger's wave mechanics with Einstein's theory of gravitation, and the gravitational coupling constant of elementary particles (non-relativistic limit). He has generalised the theory observing Einstein's principle of general covariance, and is presently working on an approach to gravitation and quantum theory based on

a covariant model theory of gravitation, following closely the pattern of well understood electrodynamics.

Dr. Misra has been mainly concerned with the study of the Schild-Kerr metric, with a view to obtaining a non-static generalization of the Kerr solution. In this work he has been collaborating with Professor Synge. Some interesting results have been obtained, but the work is not yet complete.

Dr. Khan has been working on the theory of Regge poles in elementary particle physics, studying in particular the problem of pion photo-production off nucleons and also the general problem of the domain of validity of the so-called superconvergence relations. He has also been studying a picture of space-time consistent with the reciprocity of monads; he considered the astrophysical data on the quasi-stellar sources and the data on low intensity radio counts compiled at Cambridge and elsewhere, and concluded that the quasi stellar sources are not as far or as bright (intrinsically) as is commonly believed from the conventional picture of space-time.

Dr. Ando explored possibilities of new fields of endeavour. It has been realized that even a study of low-energy strong interactions requires a basic understanding of very high energy phenomena. Thus the elastic scattering at very high energy with large momentum transfer was first attacked by means of various phenomenological models; Dr. Ando's conclusions, which are quite model-dependent, and their interrelations, are still being pursued. Dr. Ando realised that Regge pole theory must play a very important role in this research, in the basic understanding of high energy collisions, through the theoretical rather than the phenomenological structure. He has been working on a simple formalism, in which the analyticity structure is clearer, it is hoped, through unitarity, than in the usual approach.

Dr. A. Singh has been studying "Schwinger terms" in field theory commutators and the problem of inconsistencies in quantum field theory.

Mr. Boyle has been working on his doctoral thesis, on stationary fields to any order of approximation in Fermi coordinates, with Dr. Florides. They aim to set up an approximation method for the solution of Einstein

field equations in general relativity, using Fermi coordinates.

Dr. Florides worked also with Mr. R. Wingate on rotating shells in general relativity, and with Mr. R. Jones on rotating fluid masses in general relativity, attempting to calculate the gravitational field of a spheroid consisting of a perfect fluid in steady rotation about its axis of symmetry; the calculations, based on the Florides-Synge method of successive approximations, are now almost completed up to the fifth order of approximation. Dr. Florides and Mr. Jones also collaborated in work on stationary systems with spherical symmetry consisting of many gravitating masses.

Rev. Dr. C. Ryan has been mainly occupied with writing a book on weak interactions of elementary particles, in collaboration with Dr. R. E. Marshak (Univ. of Rochester) and Professor Riazuddin (Univ. of Islamabad, Pakistan).

Rev. J. McCrea completed the final revision of his doctoral thesis, and is now doing research on the focussing of null geodesics in axially symmetric space-times. The purpose of this work is to determine under what conditions such focussing occurs, and consequently the validity of various types of "radiation coordinates" breaks down.

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 N. L. Balazs: Lasers (2 lectures).
- Dr. G. Barton (Sussex): Electromagnetic masses.
- Dr. F. Bloore (Liverpool): Inelastic meson-nucleus scattering by direct interaction.
- Dr. A. Böhm (Syracuse): Algebraic models and the meson spectrum.
- Dr. F. Cooperstock: Gravitational waves.
- Dr. D. A. Dubin (Imperial College, London): Certain aspects of two-dimensional quantum field theory.

Dr. P. S. Florides: On stationary systems with spherical symmetry consisting of many gravitating masses.

Rotating shells in general relativity.

Professor W. Israel: A simple model for understanding gravitational instability and collapse.

Spinning shells and Newton's bucket.

Dr. D. Judge: Operators with simple spectra.

Professor Y. Katayama (Kyoto): Space-time picture of elementary particles.

Dr. J. Kennedy (U.C.D.): Some problems related to π - π dynamics.

Professor C. Lanczos: Particle problem in general relativity.

Dr. A. J. MacFarlane (Cambridge): Comments on symmetry-breaking effects in particle physics.

Dr. M. Misra: A unified treatment of the Kerr and Vaidya solutions in general relativity.

Rev. Prof. J. R. McConnell: The exceptional G_2 -Lie group.

Dr. H. Nickle: Frequency shift of light waves being reflected between two mirrors in relative motion.

Dr. E. Pechlaner: A relativistic oscillator without gravitational radiation.

Professor L. Pičman (Nukl. Inst. J. Stefan, Yugoslavia): Some identities following from conservation laws, and their application.

Dr. F. A. E. Pirani (King's College, London): Some concepts from gravitational radiation theory.

Professor N. Porter (U.C.D.): New technique in high energy cosmic ray physics.

Rev. Dr. C. Ryan: Radiative correction in weak interaction.

Professor J. L. Synge: Field equations, equations of motion and integral conservation laws in general relativity.

Can an isolated massive body be set spinning by internal stress?

Professor Y. Takahashi: Infinite component wave equations.

Hyperquantization (2 lectures).

4. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture, under the auspices of the School, was delivered in University College, Dublin, on 22 February 1968, by Professor Balazs. His subject was "The Five Hall-Marks of Science".

5. VISITING PROFESSORS

Dr. D. Lurié (left August 1967).

Professor W. Israel (University of Alberta).

Professor N. Balazs (New York University, Stony Brook) was appointed Visiting Professor for one year from 1 September 1967.

6. VISITORS TO THE SCHOOL

Professor H. Goheen (Oregon State College) and Professor A. Wirshup (California State Polytechnic College) visited the School for the three months April-June, 1967.

Professor C. Misner (Maryland University) on 6 April, 1967.

Dr. F. A. E. Pirani (King's College, London) from 17 to 21 April, 1967.

Dr. A. J. MacFarlane (University of Cambridge) from 16 to 18 May, 1967.

Dr. A. Böhm (University of Syracuse) from 24 to 26 May, 1967.

Professor L. Pičman (Nuklearni Inšt. J. Stefan, Ljubljana, Yugoslavia) from 16 to 30 June 1967.

Professor Y. Katayama (Kyoto University) from 15 to 20 September, 1967.

Dr. D. A. Dubin (Imperial College, London) from 17 to 19 October, 1967.

Dr. F. Bloore (Liverpool University) from 13 to 14 March, 1968.

Dr. G. Barton (University of Sussex) from 27 to 29 March, 1968.

For lectures given by Visiting Professors and other Visitors to the School see Sections 3 and 4.

7. SYMPOSIA

No Symposia were held by the School during the period under review; a Symposium arranged for 18-19 December 1967 was cancelled because of governmental restrictions on travel due to the Foot and Mouth Disease in Britain.

8. EXTERNAL ACTIVITIES

Dr. Watanabe attended the Summer School of the Niels Bohr Institute at Copenhagen from 24-29 July 1967.

Dr. Nickle lectured at Queen's University, Belfast, on "Non-relativ-

istic quantum theory of an electron in an arbitrary theory of an electron in an arbitrary intense laser field", on May 30, 1967.

A two-day seminar on Relativity and Related Topics held at the University of London on 28-29 March 1968 was attended by Professors Balazs and Israel, Rev. J. McCrea, Drs. Efinger and Florides, and Mr. Boyle; the latter two gave short talks on their work. Dr. Israel lectured also at Queen Elizabeth College, London on 8 November on "Surface layers in general relativity". Dr. Florides lectured on 18 April on "The theory of relativity, fantasy or physics?" at Trinity College, Dublin, and on 4 January on "The evolution of the theory of relativity" at Queen's University, Belfast.

Professor Lanczos completed his series of biweekly talks on "Advanced dynamics", and weekly public lectures on relativity, at Yale University, Department of Astronomy, during his appointment as Visiting Professor to that Department from February to June 1967, as reported in the previous Annual Report. During May and June 1967 he gave 5 lectures per week in the Summer School of the North Carolina State University (Raleigh), on "Fourier series". He also lectured as follows: 14 April, Dartmouth College, Hanover, N.H. on "Well-posed and ill-posed problems"; 11 May, University of Maryland on "Einstein's cosmic philosophy"; 18 May, University of Texas, Houston on "Well-posed and ill-posed problems"; 1 June, Ford Motor Co. Scientific Laboratory, Dearborn, Mich. on "Agitated space-time"; 19 July, Georgia Institute of Technology, Atlanta, Georgia on "Well-posed and ill-posed problems". From 31 July to 10 August Professor Lanczos was Invited Lecturer at the Summer School of the Scottish Universities, on Solid State Physics, held at St. Andrew's, and lectured on "Variational methods". He gave a course of four lectures on Applied Analysis at the University of Manchester, viz. 3 October, "Tau method", 10 October, "Legendre versus Chebyshev polynomials", 17 October, "Analysis of noise by Fourier series", and 24 October, "Input-output relation of linear networks". He also lectured at Trinity College, Dublin on 3 November on "The art of smoothing"; at University College, Cork on 21 November on "Input-output relation of linear networks"; to the Mathematics Teachers' Association on 18 January on "History of numbers",

and at Rugby College of Engineering, Coventry on 22 January on "Fourier analysis of linear networks".

Professor Synge attended an International Colloquium on Fluids and Gravitational Fields in General Relativity in Paris, 19-23 June, and lectured on "Einstein's field equations, equations of motion, and integral conservation laws". On 31 October he spoke to the Irish Mathematics Teachers' Association on "How to make models of three-dimensional figures".

Dr. Ando attended the Informal Theoretical Physics Gathering at the Rutherford High Energy Laboratory on 18-19 December.

Professor Ó Raifeartaigh continued his leave of absence in the U.S.A. as Professor in the Department of Physics, Syracuse University, until August, and after that at the Institute for Advanced Study, Princeton. He gave invited talks at the Summer Institute of the University of Colorado, at Boulder in August, at the Eastern Theoretical Physics Conference, Nashville, Tenn., in December and at the Fifth Coral Gables Conference on Symmetry Principles at High Energy, in January. He also attended the International Conference on Particles and Fields, at Rochester in September. He gave talks at the Institute for Advanced Study, Princeton, at Notre Dame University, at St. Louis University, and at the University of Wisconsin, Milwaukee, in February, at Rutgers University in October, and at Stevens Institute of Technology in March.

Professor McConnell lectured to the Third Annual Congress of the Irish Association of University Mathematical Societies, at U.C.D. on 14 March. He was re-elected Secretary of the Royal Irish Academy, and elected its Science Secretary on 16 March.

Dr. Singh attended the Seventh Internationale Universitätswochen für Kernphysik, at Schladming (Austria) from 26 February to 9 March.

Rev. Dr. C. Ryan attended the International Conference on Particles and Fields, at Rochester in September, and the Informal Theoretical Physics Gathering at the Rutherford High Energy Laboratory on 18-19 December. He gave a seminar on K_3 decay at Cambridge University on 4 March, and was Summer Visitor at Rochester University from June to September and Visitor at Louvain University from 20 March to 9 April, 1968.

Professor Takahashi attended the Summer Institute of the University

of Colorado, at Boulder, from 4 July to 4 August and gave nine lectures there on "Quantization of higher spin fields"; and the International Conference on Particles and Fields at Rochester from 28 August to 1 September. He lectured at Yeshiva University, New York on 30 June; at University of Wisconsin-Milwaukee, Milwaukee on 24 August on "Hyperquantization"; and at the University of Chicago on 17 August on "Method of hyperquantization". He visited the University of Alberta, Edmonton from 4 to 8 September and lectured there on "Relativistic quantization of fields" and on "Hyperquantization".

9. PUBLICATIONS

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

a. Books:

Published:

Quantum particle dynamics. By J. McConnell. North-Holland, 1960. Translated into Russian.

Albert Einstein and the Cosmic World. By C. Lanczos. Wiley, 1965. Translated into Italian, Polish and Russian.

In the press:

* Numbers without end. By C. Lanczos. Oliver & Boyd, Edinburgh.

Variational methods. By C. Lanczos. Proceedings Summer Course in Solid State Physics, St. Andrews, 1967.

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

Normalization of the Bethe-Salpeter wave function. By Y. Takahashi. Matscience Symposia in Theor. Phys., Vol.6.

Non-Lagrange theories and generalized conservation laws. By Y. Takahashi. Matscience Symposia in Theor. Phys., Vol.6.

Quantization of higher spin fields. By Y. Takahashi. Boulder Summer Inst., Univ. of Colorado, 1967.

* Particles and fields. By David Lurié. Wiley.

Field operators for composite particles. By David Lurié. High Energy Physics, Lectures at American Univ. of Beirut, 1967.

* Broken symmetry. By L. Ó Raifeartaigh. Contribution to Group Theory and its applications, Ed. E. Loeb, Academic Press.

Analyses of the Gell-Mann-Dashen angular momentum condition for the isospin-factored case. By L. Ó Raifeartaigh. Proceedings 7th Nobel Symposium (Relativistic symmetries and analyticity), Stockholm, 1967.

Review of recent developments in internal and space-time symmetries. By L. Ó Raifeartaigh. Proceedings Fifth Coral Gables Conference on Symmetry Principles at High Energy. Benjamin.

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

Published:

No.17. Aspects of the current algebra approach. By C. Ryan. Price 10s. pp.66. Published 1 September, 1967.

No.18. Gravitational radiation. By J. McCrea. Price 12s.6d. pp.106. Published 22 March 1968.

c. Contributions to periodicals and other publications:

Published:

* J. L. Synge:

* Statistical distributions of photons emitted by a star. Mon. Nots. R. Astr. Soc. 136 (1967), 195-205.

A new pseudo-tensor with vanishing divergence. Nature 215 (1967), 102.

Two isomorphs of the four-colour problem. Canad. J. Math. 19 (1967), 1084-91.

* Directivity for one-dimensional scalar radiation. Quart. Appl. Math. 25 (1967), 317-8.

Regular null networks in flat space-time. Proc. RIA 66A (1968), 41-68.

E. Pechlaner & J. L. Synge:

Model of a spinning body without gravitational radiation. Proc. RIA 66A (1968), 93-103.

F. I. Cooperstock:

* Energy transfer via gravitational radiation in the quasi-stellar sources. Phys. Rev. 163 (1967), 1368-73.

Momentum flux by gravitational waves. Phys. Rev. 165 (1968), 1424-26.

W. Israel:

Possible instability in the self-closure phenomenon in gravitational collapse. Nature 216 (1967), 148-9.

Event horizons in static vacuum space-times. Phys. Rev. 164 (1967), 1776-9.

V. de la Cruz & W. Israel:

Gravitational bounce. *Nuovo Cim.* 51A (1967), 744-60.

H. J. Efinger:

On the gravitational constant of elementary particles. *Nuovo Cim.* 55A (1968), 199-202.

C. Lanczos:

* William Rowan Hamilton, an appreciation. *Amer. Scientist* 55 (1967), 129-43.

* Einstein equations and electromagnetism. *J. Mathl. Phys.* 8 (1967), 829-36.

Why mathematics? *Irish Math. Teachers' Assoc. Newsletter*, No.9, Nov. 1967, 7-11.

Rationalism and the physical world. *Boston Studies in the Philosophy of Science, III.* *Proc. Boston Coll. Phil. Sci.* 1964-66. Ed. Cohen and Wartofsky. Reidel, Dordrecht (Netherlands), 1967, Vol.3, 181-198.

Entstehung, Entwicklung und Perspektiven der Einsteinschen Gravitationstheorie. *Einstein-Symp., Deutsche Akad. Wiss.* 1965. *Akad.-Verlag* (1966), 38-56.

Y. Takahashi:

* Quantization of lattice vibrations. *Ann. Phys.* 45 (1967), 132-54.

A method of hyperquantization. *I. Phys. Rev.* 166 (1968), 1645-50.

K. Watanabe:

Dynamical model for the hyperon nonleptonic decay. *Phys. Rev.* 159 (1967), 1369-73.

Effect of electromagnetic interaction for $K^+ \rightarrow \pi^+ \pi^0$ decay. *Nuovo Cim.* 52A (1967), 519-28.

Superconvergence condition and scalar nonet. *Nuovo Cim.* 51A (1967), 551-3.

S. Furnichi & K. Watanabe:

* Effect of higher πN resonances to subtraction constant in $\pi\pi \leftrightarrow NN$ dispersion relation. *Progr. Th. Phys.* 37 (1967), 465-7.

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

* Remarks on S-wave pion-pion scattering. *Progr. Th. Phys.* 37 (1967), 1045-6.

Exact treatment of $(\pi + \pi \leftrightarrow N + \bar{N})$ amplitude and electromagnetic structure of the nucleon. *Progr. Th. Phys.* 38 (1967), 636-52.

J. McConnell:

Properties of the exceptional G_2 -Lie group. *Proc. RIA* 66A (1968), 79-92.

H. H. Nickle:

- * Comment on "Positron focusing in an accelerating field".
J. Appl. Phys. 38 (1967), 3212-14.

Comment on the solution of the Schrödinger equation for a non-relativistic electron in the presence of both a periodic crystal potential and monochromatic laser radiation. Phys. Rev. 160 (1967), 538-41.

Exact expression for the Doppler frequency shift of a light wave which undergoes multiple reflections between two mirrors in relative motion. J. Appl. Phys. 39 (1968), 353-55.

L. Ó Raifeartaigh:

Mass-splitting theorem for non-unitary group representations. Phys. Rev. 161 (1967), 1571-75.

A mass-splitting theorem for translationally invariant non-integrable Lie algebras. Phys. Rev. 164 (1967), 2000-2.

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

- * Current algebra and $\eta \rightarrow 3\pi$ decays. Nuovo Cim. 48A (1967), 830-3.

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

- * Relationship of the internal and external multiplicity structure of compact simple Lie groups. J. Mathl. Phys. 8 (1967), 536-46.

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

Self-consistent equations and self-coupling of vector mesons. Phys. Rev. 158 (1967), 1589-94.

In the press:

J. L. Synge:

Review of "The logic of special relativity", by Prokhovnik, Cambridge Univ. Press, 1967. Proc. Phys. Soc.

Jets of radiation. Quart. Appl. Math.

F. Cooperstock:

The interaction between electromagnetic and gravitational waves. Ann. Phys.

W. Israel:

Event horizons in static electrovac space-times. Comm. math. Phys.

W. Israel & V. de la Cruz:

Spinning shell as a source of the Kerr metric. Phys. Rev.

M. Misra:

Type null vacuum solutions in general relativity. J. Mathl. Phys.

Y. Takahashi:

Method of hyperquantization. II. Phys. Rev.

H. Nickle:

Comment of Cohan and Hamka's theorem on double-photon contributions to multiple-photon processes. Phys. Rev.

I. Khan:

The principle of reciprocity and equivalence of monads and their implications. Nuovo Cim.

J. Waddell:

An empirical determination of the continuum source function in the solar atmosphere. Astrophys. J.

L. Ó Raifeartaigh & A. Böhm:

A mass-splitting theorem for general definition of mass. Phys. Rev.

L. Ó Raifeartaigh & S. J. Chang:

Coupling of space-like and time-like wave-functions at infinite momentum. Phys. Rev.

On space-like solutions to infinite component wave equations. Phys. Rev.

L. Ó Raifeartaigh, S. J. Chang & J. Kuriyan:

SL(2,C) in an E(2) basis and calculation of form factors. Phys. Rev.

L. Ó Raifeartaigh & S. Komy:

On some properties of ladder operators. J. Mathl. Phys.

IV - Report of the Governing Board of the School of Cosmic Physics
adopted at its meeting on 15th November, 1968.

A. Astronomical Section.

1. STAFF AND SCHOLARS

Senior Professor:

P. A. Wayman.

Professor:

T. Kiang.

Research Assistant:

I. Elliott (on unpaid leave of absence from 1 July 1967).

Experimental Officer:

B. D. Jordan.

Clerical and Technical Staff:

Miss M. Callanan; Mr. P. Murphy.

Scholars:

C. J. Butler; A. D. Andrews (from 1 June 1967).

Dr. Elliott received an appointment as a Visiting Research Assistant at the Sacramento Peak Observatory for a period of twelve months from July 1967, and was granted unpaid leave of absence for twelve months.

Mr. M. Norris (U.C.D.), Mr. J. Tomkin (T.C.D.), and Mr. Paul O'Neill (U.C.D.) worked as Vacation Students in the Section in June, July and August 1967, for a total period of eight weeks.

Fr. F. Cullen (St. Mary's, Tallaght) studied astronomical work in the Section from September 1967 to March 1968.

Mr. A. D. Andrews of Armagh Observatory was appointed a Scholar without stipend in the Section in June 1967 under the supervision of Dr. Kiang to enable him to make use of facilities of the Section in carrying out work of mutual interest.

Professor Wayman served on the Council of the Royal Astronomical Society throughout the year and as External Examiner in Astronomy at Queen's University, Belfast.

2. RESEARCH WORK

Solar Research: I. Elliott. The analysis of Doppler shifts dispersion spectra of the solar Balmer lines was the subject for a thesis for the Ph.D. degree awarded by the University of Dublin in May 1967. The same material was subsequently analysed by means of a more powerful computer programme than had previously been feasible, using the I.C.T. 1909 computer at H.M. Nautical Almanac Office, by courtesy of the Astronomer Royal. Considerable improvement in the sharpness of the peaks in the power spectra was obtained and the characteristic frequencies of oscillation of the rising and falling currents in the upper chromosphere were thereby identified more accurately than had previously been known to be possible. The fluctuating component was largest at those places where the motion was directed downwards; that is, above the boundaries of the photospheric supergranulation cells. During the summer of 1967 new observations were obtained at Sacramento Peak, the chief aim being to obtain time series of groups of chromospheric lines simultaneously. Eight such time series have been obtained. Remeasurement in greater detail of the 1963 series of exposures has also been carried out and the measurements recorded on magnetic tape for future analysis.

Stellar Research: P. A. Wayman. Measurements of about 500 star images on each of twelve ADH plates of NGC 3532 were carried out with the iris diaphragm photometer and the reductions performed graphically. H γ line widths in the spectra of early-type stars in NGC 3293 (Radcliffe Observatory plates) were measured and calibrated with the use of the Joyce-Loebl densitometer. Some discrepancies for the absolute magnitudes of the cluster stars resulted from these measures and these have not yet been resolved.

A. D. Andrews. Sequences of photoelectric observations (UBVR) in the Orion I Association have been used to study the mean colours of Orion flare stars, T Tauri variables and H-alpha emission-line stars. Photographically determined magnitudes are derived from iris diaphragm measurements made at Armagh Observatory reduced

with the IBM 1620 computer at Dunsink. The B, V and R sequences are being extended using objective-grating ADH plates. Provisional results show that the scatter in the $(v-r)/v$ Colour-Magnitude diagram is virtually absent, the flare stars lying in a particular band of the main sequence of this diagram.

Magellanic Clouds: P. A. Wayman; C. J. Butler. Photometric work on the Cepheid variables has continued including the final reduction of the photo-electric observations made with the 60-inch Boyden reflecting telescope in 1966. The transformation of the instrumental system to the Johnson-Morgan system was good in B, V and R and satisfactory in U. Further comparison with independent photoelectric photometry at the Radcliffe Observatory shows good agreement between Small Magellanic Cloud standards in common, confirming a systematic divergence from earlier photometry by Arp. In the Large Magellanic Cloud comparison with Sandage and Eggen's photometry has not yet proved definitive but fair agreement has been reached with Hodge's unpublished work using observations in Australia. Further comparison will be made possible from the photographic measurements.

For reducing the iris-diaphragm measurements of the large number of photographic plates of the Cepheid fields (nine series for three colours in three Magellanic Cloud regions) an elaborate procedure using the IBM 1620 computer at Dunsink Observatory has been partially effected. The principal step involved is to permit the solution to make allowance for varying "zero-point" over the plate, thus enabling each plate to be reduced with an individual error pattern which takes up the effects of vignetting, focus, tilt, guiding error, etc. The effects of star colour and density of background are also allowed for in a least squares solution performed on the computer in fitting the photoelectric standard measurements to the iris-diaphragm readings. The procedure has been thoroughly tested on the "V" plates of the SMC region and the further stage of using the computer to extract optimum periods for the individual stars has been reached. Subsequent to recording the iris diaphragm readings on paper all the steps up to plotting light curves are handled solely on the computer.

New variable stars in each of the two LMC regions were detected by using the blink comparator at Bamberg Observatory, Germany. About 250 previously uncatalogued variable stars were detected and a catalogue has been partly prepared for publication prior to the investigation of the large majority of these stars by the procedures used for the 80 SMC variables.

Statistical Astronomy: T. Kiang. The application of multivariate analysis to classical cepheids has been explored, including the preliminary work of plotting data in two colours for 130 variable stars. Re-determination of periods is also necessary in some cases.

The statistical significance of the distribution on the celestial sphere of the poles of double-star orbits, as given by Batten, has been considered, using Monte Carlo methods on the IBM 1620 computer. The effectiveness of this approach has been demonstrated and it has been possible to pinpoint those features of the distribution which should be and those which should not be regarded as "remarkable".

The Lick Observatory counts of galaxies are being rearranged in terms of galactic co-ordinates so as to be more readily available for statistical analysis.

Some work on a new determination of the average density of visible material in space involved measurement of angular diameters of galaxies using the Palomar Sky Survey prints. In the course of this work it was found that at least one third of a species of "violet galaxies", listed by Haro, showed one or more jets or filamentary structure. A note giving illustrations has been published.

T. Kiang and W. C. Saslaw (Cambridge). The distribution in space of Abell's clusters of galaxies has been studied, based on the auto-correlation of counts. In general the numbers are small and the interpretation in terms of distance are uncertain but by means of a suitable statistical technique, using the 1620 computer, which evaluates the error to be associated with mean values of auto-correlation in three co-ordinates, some evidence of large scale structure seems to emerge.

Electronics Laboratory: B. D. Jordan. Work on flying-spot techniques for comparison of two photographic plates has continued to the point where the general design of the electronic circuits is complete. Some units are to be purchased, but the major work of the design and construction of a synchronising pulse generator has been carried out in the laboratory. The electrical and mechanical design of a focus power supply for the flying spot cathode ray tube has also been completed.

Occultations: Six observations of occultations made in 1967 gave corrections to the moon's place, as reported by H. M. Nautical Almanac Office, which seemed to indicate a r.m.s. error of timing, when corrected by Watts limb corrections, of around $0^s.1$. This emphasizes the great increase in accuracy necessary for the timing of occultations, now that the limb corrections can be employed. Some exploratory work on digital recording of the limb charts using the D-mac pencil follower was carried out in conjunction with H. M. Nautical Almanac Office.

3. INSTRUMENTS AND EQUIPMENT

Instruments purchased for the electronics laboratory include a Tektronix Oscilloscope, a Hewlett Packard Frequency Counter and Time Interval Unit, a Claude Lyons Pulse Generator, a Farnell power supply and, for the Askania Iris-diaphragm photometer, a Heathkit oscilloscope.

An IBM 1620 Computer, Model 1, previously at Trinity College, Dublin which uses paper-tape input and output was installed in the basement of Dunsink Observatory in December. A maintenance agreement with IBM (Ireland) Ltd. has proved very satisfactory and the computer has been used by all three Sections of the School, but mainly by the Astronomical Section, to the total extent of 75 hours per week on average between 1 January and 31 March.

4. LECTURES, CONFERENCES, etc.

Professor Kiang gave a course of eight lectures on Statistical Astronomy at No.5 Merrion Square in April and May.

Dr. Elliott gave a seminar on Time Analysis of Chromospheric Motions at No.5 Merrion Square, on 18 May.

Professor Wayman attended the Herstmonceux Conference in April and with Professor Kiang and Mr. Butler visited Prague in August to attend the 13th International Astronomical Union General Assembly.

The Boyden Observatory Council met in London on 3 May, and in Prague at the I.A.U. Meetings and Professor Wayman attended each meeting.

Dr. Elliott visited the Royal Greenwich Observatory in May to use the I.C.T. 1909 computer and Mr. Butler visited the Remeis Observatory, Bamberg, in August to use the blink comparator.

Professor Wayman gave the opening address at the Physical Society conference on Astronomical Optics in London in July and addressed the Nicholas Callan Society at St. Patrick's College, Maynooth, in June.

Mr. Butler attended the Manchester Study Week on "Non-equilibrium processes in astrophysics" in July.

An afternoon colloquium at Dunsink Observatory on 15 June was the occasion for talks on various items of the work of the Section by Professor Wayman, Professor Kiang and Mr. Butler.

Professor Wayman attended the opening ceremony of the Isaac Newton Telescope at Herstmonceux on 1 December.

Dr. Kiang gave the Statutory Public Lecture of the School for the year 1967-68 on the postponed date of 21 May 1968, in Trinity College, Dublin, with the title "Astrostatistics".

5. PUBLICATIONS

T. Kiang:

On the Clustering of Rich Clusters of Galaxies. Monthly Notices of the R.A.S. 135, 1, 1967.

Jets and Filaments in Haro's Violet Galaxies. Astrophysical Journal Letters, 150, L31, 1967.

P. A. Wayman:

A Newtonian Order of Magnitude Argument. Irish Astr. Jour. 8, 13, 1967.

Optical Requirements of the Astronomer. Ibid. 117, 1967.

S. M. P. McKenna:

East Limb Passage of an Active Solar Region, Jul 7-10, 1959.
Astrophys. Jour. 150, 1087, 1967.

In the Press:

I. Elliott:

Power Spectra of H α Doppler Shifts. Solar Physics.

B. Cosmic Ray Section.

1. STAFF AND SCHOLARS

Senior Professor:

C. Ó Ceallaigh.

Professor:

K. Imaeda.

Assistant Professor:

Miss M. Kazuno (appointed 1 January 1968).

Research Assistants:

Dr. A. Thompson; Dr. D. O'Sullivan.

Technical and Clerical Staff:

Miss A. Madden; Mr. J. Daly; Miss N. Leahy; Miss M. Longmore (to 28 June, 1967); Miss A. Smyth; Miss E. Cullen (to 9 June, 1967); Miss D. Molloy; Miss E. Byrne (from 26 June, 1967); Miss G. Doyle (from 14 August, 1967); Miss L. Rogers (from 9 October, 1967).

Scholars:

T. Cantwell; P. Fleming.

2. RESEARCH WORK

Schenectady-Dublin Collaboration on the Application of Dielectric Detectors to the Study of Primary Cosmic Radiation: C. Ó Ceallaigh, A. Thompson and D. O'Sullivan. The work of this Collaboration has continued successfully during the year. A calibration experiment was carried out using plastic materials of widely different sensitivities which were exposed at the Yale

Heavy Ion Accelerator and irradiated with various ionic beams at initial speed corresponding to 10.3 MeV/nucleon. The ultimate aim of these experiments was to discover which plastics were most suitable for identifying ionizing particles in cosmic radiation. The plastic cellulose nitrate was found to hold out great promise in the study of the relative abundance in the primary cosmic radiation of isotopes such as B^{11} and B^{10} , quantities which are relevant to current astrophysical theories concerning the origin of cosmic radiation. Some difficulty was experienced because of an apparent lack of homogeneity in the sheets of cellulose nitrate used in the experiment, but it is hoped to obtain material which is satisfactory in that respect.

During the summer of 1967, balloon flights at 120,000 feet were used to expose stacks of lexan polycarbonate sheets at high geomagnetic latitude in order to study the very heavy component of the primary cosmic radiation at velocities corresponding to 100 MeV/nucleon and less. Work has begun on the material and the experiment promises to be very successful. In connection with the Collaboration, visits to Dublin were paid by Dr. R. Fleischer and Dr. P. B. Price and lectures were delivered by each. During August and September 1967, Dr. Thompson worked at the Research and Development Center of the General Electric Company, on the development of processing methods and the techniques of measurement in the Fort Churchill lexan stacks. The work of the Collaboration has led to two publications during the year. (See Section 5.)

Nuclear Interactions at Extreme High Energy: The analysis of nuclear interactions produced by cosmic rays of very high energy detected in nuclear photographic emulsions has been continued.

P. Fleming and K. Imaeda. An elaborate analysis of the nuclear interactions produced by heavy cosmic-ray primary particles is in progress. Principal features of the investigation are: (1) an expression has been derived involving the experimental $\log \tan \theta$ distribution of the fragmentation products which yields an estimate of the primary energy. The results have been compared with those obtained by use of the expression proposed by Kaplon and his Collaborators; (2) a study has been made of

the characteristic features of the high-energy nucleus-nucleus collisions and the contribution to multiple particle production of the following processes, fireball, isobar and fragmentation, has been studied in detail; (3) the asymmetrical distribution in angle of the secondary particles in cosmic ray jets has been analysed using the auto-correlation function method. An expression has been derived connecting azimuthal asymmetry with the transverse velocity of a fireball or isobar. The estimates of transverse velocity so obtained are in agreement with those found by other independent methods.

K. Imaeda. The current fireball model fails to predict the mass and velocity of fireballs and isobars in a jet. In view of this, an empirical expression has been suggested for the distribution of multiplicity and angle of the secondaries. Using this expression in conjunction with the fireball-isobar model, it is possible to predict some of the characteristic features of very high energy jets. A report was communicated at the 10th International Conference held in Calgary, Alberta.

K. Imaeda, M. Kazuno and P. Fleming. A study has been made of a nucleon-nucleon interaction of 10^{15} eV characterised by an unusually small value of inelasticity. Several different methods of evaluating the inelasticity have been used and are in good agreement among themselves and with that involving the Mirror System which is independent of the primary energy.

M. Kazuno. Approximately 1000 nucleon interactions of 10^{11} eV - 10^{14} eV have been examined in order to establish the nature of the primary interaction. 83 Nucleon-Nucleon and 142 Pion-Nucleon interactions have been identified. Differences in characteristics between N-N and π -N interactions would seem to be small but it would appear that multiplicity and angular dispersion of N-N are 10% - 15% larger than those of π -N interactions at any given primary energy. It is possible to interpret this difference in terms of the decay modes of Baryon and Boson isobars. The material has been used to provide information on the formation of intermediate states of multiple meson-production and there are indications that the dynamics of the fireball and isobar systems cannot be independent.

European K⁻ Collaboration: A. Thompson (with others). The production of hypernuclei from the interactions of Σ^- hyperons at rest with emulsion nuclei has been studied with larger statistics than hitherto and compared in detail with the corresponding production of hypernuclei by K⁻ mesons. The frequency of cryptofragment formation in heavy emulsion nuclei was estimated to be $(15 \pm 3)\%$ while the hyperfragment production rate was found to be $(3.21 \pm 0.19)\%$. The emission frequency of heavy spallation hypernuclei was seen to be significantly smaller in the case of rest Σ^- hyperon absorption than for rest K⁻ meson absorption. This was attributed to the smaller excitation energy of the parent nuclei in the former case. The mesonic decay rate of hypernuclei from rest Σ^- absorptions appeared to be higher than that of hypernuclei from rest K⁻ absorptions even when the contributions from heavy spallation hypernuclei were excluded. This effect could be explained by a larger neutron excess in hypernuclei produced by rest Σ^- absorptions which would arise from the different primary processes involved.

A. Thompson. A sample of 30,000 interactions of K⁻ mesons at rest with emulsion nuclei was examined in order to isolate $\Sigma^\pm \pi^\mp$ events resulting from K⁻ interactions with protons and $\Sigma^0 \pi^-$ events resulting from K⁻ interactions with neutrons. It was established that a K⁻ interaction with a neutron is a much more likely process in a heavy nucleus than in a light one. The results were taken to imply a large neutron excess in the extreme periphery of Ag and Br nuclei as suggested by the model of Johnson and Teller.

A. Thompson and T. Cantwell (with others). The production of hypernuclei from the interactions of 10.1 GeV/c momentum K⁻ mesons with emulsion nuclei was investigated and compared in detail with the corresponding production at lower K⁻ momenta. Most of the short range ($R \leq 10\mu\text{m}$) hyper-nuclei were found to be heavy residual spallation products of Ag and Br nuclei whose mass numbers differed on average from those of their parent nuclei. It was found that the fission process did not make a significant contribution to hypernucleus production, but that the fragmentation mechanism played an important role at intermediate hypernucleus ranges ($10\mu\text{m} - 50\mu\text{m}$). Apart from the expected decrease in

the Λ^0 hyperon trapping probability and a broadening of the range distribution peak, the general production features at 10.1 GeV/c were found to be very similar to those at 5.0 GeV/c.

D. O'Sullivan (with others). Since the world sample of reliably identified p-shell hypernuclei is very small, the study of the binding energy of Λ^0 hyperons in light hypernuclei was extended in order to increase statistical weight. Using more stringent selection criteria, a sample of 2008 uniquely identified mesonic decays of hypernuclei was obtained. Various aspects of the Λ -N interaction were reviewed in the light of the new results. In addition, by employing the new data, the following lines of investigation were pursued: the lifetimes of light hypernuclei, the non-mesonic decay of light hypernuclei, the mass of the Λ^0 hyperon, the decay of heavy mesonic hypernuclei and final state interactions between the decay products of hypernuclei.

3. CONFERENCES AND COMMITTEES

The following international Conferences and Collaboration meetings have been attended by members of the Section:

The 10th International Conference on Cosmic Rays, Calgary, Canada, 19-30 June, 1967 (K. Imaeda).

International Conference on Elementary Particles, Heidelberg, W. Germany, 20-27 September, 1967 (D. O'Sullivan).

Meetings of the European K^- Collaboration, Zeuthen, E. Germany (D. O'Sullivan), Brussels (D. O'Sullivan), Warsaw (D. O'Sullivan and A. Thompson).

Mr. Daly visited the E. Leitz works at Wetzlar, W. Germany for discussions with Dr. Claussen, Chief Optical Designer, concerning the optical equipment most suitable for measurement of the tracks of ionizing particles in plastic materials.

Professor Ó Ceallaigh attended 3 meetings of the Physics III Committee at CERN, Geneva and also visited the Max Planck Institut für Physik, Munich for discussions concerning experiments in progress or ionization of electrons at extreme relativistic velocities in photographic emulsions.

Dr. Thompson spent a period of two months (August-September, 1967) at the Research and Development Center of the General Electric Company, Schenectady, N.Y. working with the Group of Dr. P. B. Price on the development of the technique of detection of primary cosmic rays in selected plastic materials.

4. WORKSHOP

Mr. Daly continued his work in setting up the instrumentation of the new plastics laboratory. Three Leitz ortholux microscopes have been installed. These have been fitted with precision dial gauges in order to measure the z-coordinates (position in depth in the plastics). He constructed an interferometer by means of which the readings of the dial gauge have been calibrated in terms of sodium fringes over the normal working range of the instruments. Routine maintenance of the scanning and measuring microscopes was continued.

5. PUBLICATIONS

P. B. Price, R. L. Fleischer & D. D. Peterson, G.E. Research and Development Center, Schenectady, N.Y., and C. Ó Ceallaigh, D. O'Sullivan and A. Thompson, D.I.A.S.:

Identification of Isotopes of Energetic Particles with Dielectric Track Detectors. Phys. Rev. 164, 1618 (1967).

P. B. Price, D. D. Peterson and R. L. Fleischer, G. E. R and D Center, Schenectady, N.Y., and C. Ó Ceallaigh, D. O'Sullivan and A. Thompson, D.I.A.S.:

Plastic Track Detectors for Identifying Cosmic Rays. G. E. Report, August, 1967. Also in publication, Can. Jour. of Physics.

K. Imaeda:

Multiplicity and Angular Distribution of Secondaries in High-Energy Jets. Nuovo Cimento 55A, 100 (1968).

K. Imaeda:

An Interpretation of Cosmic-Ray Jets. Proc. 10th Internat. Conf. on Cosmic Rays, Calgary, Canada, 1967 (in publication).

K. Imaeda, M. Kazuno and P. Fleming:

Inelasticity of Cosmic-Ray Jets of 10^{15} eV. Nuovo Cim. 55B, 288 (1968).

D. O'Sullivan:

A Determination of the Binding-Energy Values of Light Hyper-nuclei. Nuclear Physics, B4, 511 (1968).

A. Thompson:

Evidence for a Neutron Excess in the Periphery of Heavy Nuclei. Proc. 2nd Rehovoth Internat. Conf. on High Energy Physics and Nuclear Structure, 199 (1967).

M. Kazuno:

Isobar Process and Landau Process in Cosmic-Ray Jets. Nuovo Cim. 56A, 1 (1968).

In the Press:

A. Thompson, T. Cantwell (and others):

The Production of Hypernuclei from the Interactions of $10 \cdot 1$ GeV/c K⁻ Mesons with Emulsion Nuclei. Nuovo Cimento.

In Preparation:

A. Thompson (and others):

The Production of Hypernuclei by Σ^- Hyperon Absorption at Rest in Emulsion Nuclei.

D. O'Sullivan (and others):

The Non-Mesonic Decay of Hypernuclei.

D. O'Sullivan (and others):

The Mass of the Λ Hyperon.

D. O'Sullivan (and others):

New Results on the π^+ Mesonic Decay of Hypernuclei.

K. Imaeda:

Multiplicity Frequency Distribution of High-Energy Jets.

K. Imaeda and P. Fleming:

Azimuthal Angular Distribution of Secondaries of High-Energy Jets.

K. Imaeda and P. Fleming:

High-Energy Nuclear Interactions by Heavy Primary Cosmic-Rays.

M. Kazuno:

Characteristic Difference between Jets induced by Pions and Nucleons.

C. Geophysical Section.

1. STAFF AND SCHOLARS

Senior Professor:

T. Murphy.

Professor:

Vacant.

Research Assistants:

R. P. Riddihough; D. G. G. Young.

Senior Technical Assistant:

T. J. Morley.

Technical and Clerical Staff:

Miss E. Byrne; Miss A. Nolan (to 30 September, 1967); Miss A. Byrne (appointed 23 October 1967); Mr. K. Bolster; Mr. J. Fay.

Scholars:

I. Dixon; C. P. English; A. W. B. Jacob; P. Morris (appointed 1 November 1967); K. W. Robinson (appointed 1 October 1967).

2. RESEARCH WORK

Gravity and magnetic fieldwork: Drs. Riddihough and Young commenced a gravity and magnetic survey of Co. Donegal with several objects of study in mind. The main purpose was to elucidate the large scale structure and to correlate this with the corresponding regions in Scotland. A secondary one was to investigate in some detail the magnetic effects associated with the aureole of the diapiric granite at Ardara. The latter information is required for investigations of air and sea magnetic data.

Mr. English: The gravity survey of North Mayo was completed and analysed and the results incorporated in an M.Sc. thesis to be submitted to the University of Dublin. The gravity field is a very complicated one and could not be investigated fully because of the scarcity of roads and tracks in the area. The range of densities of the rock masses involved is large and the difficulty in analysis lies in assessing

the amounts involved. The Magnetic measurements also taken by him in this area were used to assist in the gravity analysis.

Mr. Robinson measured gravity and magnetics in the South Mayo area filling a gap in the areas surveyed to date.

Drs. Murphy and Young measured the gravity and magnetic fields near Dublin intermittently whenever instruments were available. Some years ago similar measurements in the Irish Sea showed up a great difference between an area centred on the Kish Bank and the adjacent coast indicating a major discontinuity between the two. So far the additional readings on land have not shown that this discontinuity can be traced into Ireland.

Magnetism: Dr. Riddihough after his preliminary investigation of the magnetic diurnal variations, which he published, expanded his area of analysis to cover Holland and Belgium with results in agreement with the earlier work. He also began to compare the diurnal variations on single days as measured at different sites. Instrumental difficulties severely curtailed this programme.

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

Seismology: Mr. Jacob has continued the analysis of the long period seismic waves and as a preliminary result the thickness of the earth's crust in Ireland has been determined as between 25 and 30 km. He has ascertained that much more information can be obtained from this study thanks to the facilities of the new, larger computer at Dublin University.

He also commenced an investigation of the response of the Eskdalemuir Array to various seismic events which gives some very surprising results regarding the velocities and dip of the "layers" beneath the array. This work is carried out with the co-operation and encouragement of the United Kingdom Atomic Energy Authority who permit Mr. Jacob to use their records, playback equipment and time on the Stretch computer.

Mr. Dixon, studying the generation of microseisms in the Atlantic, investigated the production, build-up and progress of sea waves in the Atlantic. This entailed the analysis of isobaric charts and Weather ship data using the computer at Dublin University. Already he has been able to eliminate "the cold front" and "storm centre" theories of origin of microseisms as causes of microseismic storms recorded at Valentia.

The records of the portable seismic station set up near Waterford for the collaboration seismic experiment off Lands End have been read by Mr. Jacob and combined with similar ones from a station at Lands End. Some very unusual results came to light. A velocity of 8.2 K./sec. for the upper mantle was indicated which is significantly higher than any recorded in these islands. Furthermore it would seem that the Mohorovičić discontinuity dips at an angle of approximately $2\frac{1}{2}^{\circ}$ from Lands End to Waterford. As this work was part collaboration, the results await publication.

Shallow refraction seismic experiments were carried out at various locations, their object being to ascertain the depth to bed rock and the seismic velocities in the rock. So far the results have shown the difficulties in analysing such records and have been a valuable help in assessing the value of published refraction data.

Palaeomagnetism: Mr. Morris took up the study of the magnetic polarisation of carboniferous limestones. He worked with Dr. MacAulay of Trinity College, made improvements to the Spinner magnetometer and re-measured the previously collected samples. A portable drilling rig has been obtained and with it he was able to obtain more accurately oriented specimens. His results indicate that the lower beds of the limestone series are polarised in the so-called reversed direction. The identification of the magnetic material was also investigated.

3. CONFERENCES

Professor Murphy and Dr. Riddihough attended the International

Meeting of the Union of Geodesy and Geophysics held in Switzerland in
September/October, 1967.

4. PUBLICATIONS

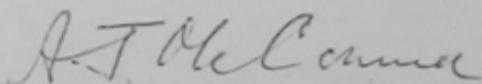
R. P. Riddihough:

Daily variation of total magnetic field over the British Isles.
Nature 215, 720-722, 1967.

In the press:

R. P. Riddihough:

Magnetic surveys off the north coast of Ireland.
Proc. R.I.A.



A. J. McConnell

P.P. CHAIRMAN