

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  
1965-66

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

Summary of Annual Report  
of the work of the Constituent Schools  
for the year 1965-66

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School of Celtic Studies

Two important books were published during the year: Vol.IV of the Book of Leinster, edited by the late R. I. Best and M. A. O'Brien, and an edition of Táin Bó Cuailnge from a sixteenth-century manuscript in the Library of Maynooth College, by Rev. P. Ó Fiannachta.

Professor Carney was Visiting Professor at the University of California from September 1965.

Professor Dillon held a seminar on Acallamh na Senórach. Professor Binchy continued to transcribe the Irish legal manuscripts and dealt with his work in the Statutory Public Lecture entitled 'A thousand years of Irish - Corpus Iuris Hibernici'.

School of Theoretical Physics

Professor Lanczos continued research on boundary-value problems and on metrical substructure in general relativity. Professor Synge continued work on null networks in flat space-time; he also studied directivity of scalar radiation, helices in flat space-time and relative probabilities in Hilbert space. With Dr. Florides and Rev. J. McCrea, he studied gravitational waves. Professor Takahashi worked on non-linear field theory and he and Professor Lurié studied conservation laws and renormalization. Professor Ó Raifeartaigh continued his leave of absence at Syracuse University and studied the combination of Lorentz invariance and internal symmetry properties of elementary particles. Rev. Dr. Ryan studied higher symmetry groups and worked on a general review of weak interaction theory. For the work of Research Associates and Scholars, see the Report.

Weekly Seminars were held and two Symposia, attended by Professors, Lecturers and graduate Students from Irish Universities. The Statutory Public Lecture was delivered by Professor Lanczos in University College, Dublin. Members of the staff gave lectures or attended conferences in Ireland, Switzerland, U.S.A., Great Britain, Italy, India, Japan, Belgium and Germany.

The publications for the year consisted of one book, one translation of a book, one Communication and fifteen papers in journals.

School of Cosmic Physics

Astronomical Section:

Work with the Lyot Heliograph at the Cape was continued up to the end of 1965 and arrangements made for the continuation of the flare-patrol data by Dr. Reid after he left for Sacramento Peak in August 1965 and for subsequent transfer to the University of London Observatory. Miss McKenna made detailed study of particular regions of solar activity and some other

special studies were completed. Mr. Elliott completed many of the computer runs connected with the analysis of fine structure in the Balmer lines of solar spectra and made a cinematograph film to display the time-sequence of the chromospheric Doppler shifts.

Photographic material for several galactic fields and for Cepheid work in the Magellanic Clouds was obtained with the ADH telescope at the Boyden Observatory and Mr. Butler began photoelectric work there with an off-set photometer, mainly for obtaining 4-colour data on Cepheid variables in the Galaxy and the Magellanic Clouds.

Professor Wayman completed an account of the relationship between catalogue proper motion systems and the inertial frame of reference.

The Summer Meeting of the Royal Astronomical Society was held in Dublin in September and the necessary arrangements were jointly made by the Astronomical Section and the Royal Irish Academy.

#### Cosmic Ray Section:

The European K<sup>-</sup> Collaboration continued successfully throughout the year and meetings of the group were held at Geneva, London and Dublin. In collaboration with Drs. Peak and Woolcott of the University of Sydney an investigation of the backward emission of pions from cosmic ray jets was completed. Investigation of the emulsion chamber flown over India in the IQSY-BQEX Balloon Expedition of March 1965 commenced. The investigation of the ionization - velocity curve for photographic emulsion in the extreme relativistic region continued in collaboration with workers at the Max Planck Institute at Munich and the Naval Research Laboratory, Washington. Professor Ó Ceallaigh continued to act as member of the CERN Emulsions Committee and attended meetings held during the year.

Professor Ó Ceallaigh, on leave of absence, was visiting professor at the Tata Institute for Fundamental Research, Bombay, India from October 1965 to March 1966. During his visit to the Tata Institute he also lectured at the University of the Punjab and at the Osmania University, Hyderabad.

Four papers by members of the staff were published during the year as well as four papers published jointly by the collaborating groups.

#### Geophysical Section:

The south east Wexford area was investigated by gravity surveying and the results of the effect of the Carnsore granite is being prepared for publication in collaboration with J. W. Baker of University College, South Wales and Monmouthshire.

Geophysical investigations (gravity and magnetism) were carried out in Co. Mayo together with Dr. A. Phillips and students of Trinity College.

Assistance was given to members of Durham University carrying out geophysical work in the Irish Sea.

The work on rock magnetism in collaboration with Professor J. H. Poole and Dr. I. R. McAulay of Trinity College was continued.

The investigation of wind frequencies at Dublin City is progressing.

Seismic investigations in collaboration with Edinburgh and Birmingham Universities were undertaken.

Analysis of the long period seismic waves as recorded by the Meteorological Service at Valentia Observatory and a study of microseisms were commenced.

Professor Murphy attended the conference on Recent Crustal Movements at Aulanko, Finland, the International Gravity Commission at Paris and the Conference on Crustal Investigations North Sea and Adjoining Countries at Utrecht.

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

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Annual Report of the work of the Institute and  
its Constituent Schools presented by the Council  
for the Financial Year 1965-66

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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, 1966.

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 1966.

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, 1966.
- 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 1966.

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; Professor Myles Dillon, M.A., Ph.D., 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 Thomas Murphy, M.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.

Appointed Members:

Tomás de Bhaldraithe, M.A., Ph.D., D.Litt.; Éamonn Mac Giolla Iasachta, M.A., D.Litt.; Liam Price, M.A., B.L.; 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:

John Stephen Roy Chisholm, M.A., Ph.D.; 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 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.

I - Report of the Governing Board of the School of Celtic Studies  
adopted at its meeting on 7th June 1966.

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; Rev. Pádraig Ó Súilleabháin, O.F.M.; Gearóid Mac Niocaill (appointed 1 July 1965).

Assistant (Part-time):

Mrs. Nessa Doran.

Research Associates:

Heinrich Wagner; Liam Price; Proinsias Mac Cana.

Technical and Clerical Staff:

Máire Breatnach; Máire Bean Uí Chinnsealaigh.

Scholars:

Máire Próinséas Ní Chatháin (to 30 September 1965); Bruce Boling (to 30 September 1965); Winifred McEnery (to 31 January 1966); David Erlingsson (appointed 1 August 1965); Hans P. A. Oskamp (appointed 1 October 1965); James W. Gleasure (appointed 1 October 1965); Joseph Watson (appointed 1 October 1965).

Extern Research Workers:

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

2. RESEARCH

Professor Dillon completed his chapters of the book on The Celtic Peoples and it was sent to the publisher. A tract on 'The Rights of O'Neill was edited for the new Welsh journal Studia Celtica. Work on a Middle Irish Reader was resumed. Celtica VII is still at the press. In March 1966 Professor Dillon was elected President of the Royal Irish Academy.

Professor Binchy continued the transcription of Irish legal manuscripts for Corpus Iuris Hibernici. He saw the 20th volume of Ériu through the press. He wrote an article on Ancient Irish Law for the forthcoming first number of The Irish Jurist. On the invitation of the President of the third Indo-European Conference (to be held in Philadelphia in April 1966) he submitted a paper on 'Celtic Suretyship, a fossilized Indo-European institution?'. . . . .

Professor Carney accepted a visiting appointment at the University of California, Los Angeles from September 1965. Work continued on the Angus Matheson Memorial Volume with Professor David Greene as co-editor. Proofs were checked, indexes prepared and an Introduction contributed to Early Irish Literature which is to be published shortly by Routledge and Kegan Paul, London. During his stay at the University of California Professor Carney is engaged in lecturing on Modern Irish, Old Irish, Irish literature, folklore and mythology. He delivered a lecture at Dominican College, San Rafael, California on Old Irish Poetry in October 1965. On March 17, 1966 he lectured to the Ancient Order of Hibernians on St. Patrick. In May 1965 Professor Carney sent the text of a forthcoming publication on Medieval Irish Lyrics to the Dolmen Press.

M. Louis Paul Nemo continued to work on the Historical Dictionary of Breton, the 10th volume (Ganedigezh-Gouelan) of which was published in October 1965. The preparation of an edition of the fragments of the Middle Breton plays, La Destruction de Jérusalem and Les Amours du Vieillard is now complete except for the preface and index.

Dr. G. S. Mac Eoin continued the revision of R.A.S. Macalister's edition of the Annals of Tigernach. He concluded the transcription of the texts of Imthechta na nÓinmheadh and commenced the collation of the texts. He worked on the 'Suretyship of the Elements' theme. Dr. Mac Eoin edited volumes V and VI of Studia Hibernica. During the year he gave instruction in Modern Irish to Mr. David Erlingsson.

Rev. Pádraig Ó Súilleabháin, O.F.M. prepared the text of Buaidh na Naomhchroíche which was sent to the printer in January 1966. Work on the vocabulary is proceeding. Final proofs of Seanmóna Chúige Uladh were checked and returned to the printer. Notes to Dán na mBráthar



Mionúr (part II) were revised and sent to the printer. A short article entitled 'An eighteenth century Kerry schoolmaster in Wexford' was accepted by the Irish Ecclesiastical Record.

Dr. Gearóid Mac Niocaill took over Vol.I of Seán Mac Airt's edition of the Annals of Ulster. He completed the collation of the galley proofs with T.C.D. ms. H.1.8 and began collation with the Rawlinson text. Revision of Mac Airt's draft translation was also begun. Dr. Mac Niocaill worked on an edition of seven legal documents in Irish from the Inchiquin archive for the Irish Manuscripts Commission, and on an edition of a late 13th century law tract. A review of Literary creation and Irish historical tradition by Brian Ó Cuív was written for Medium Aevum. Proofs of two articles for Celtica VII and one for Bibliotheca Sanctorum were checked.

Mrs. Nessa Doran prepared for press an edition of Tóraigheacht Dhiarmada agus Ghráinne (text, translation, variant readings, introduction and indexes) which is to be published by the Irish Texts Society. All material for Fasciculus I of the Catalogue of Irish MSS. in the National Library of Ireland was sent to the printer. MSS. G70-72 for Fasciculus III have been catalogued.

Professor Heinrich Wagner saw Vol.III of the Linguistic Atlas and Survey of Irish Dialects through the press. Investigation was carried out on the dialects of another few points in County Donegal and this material will be published in Volume IV of the Atlas. The material collected by Professor Wagner on Tory Island in 1949 has been taken over by N. Hamilton, M.A. (Assistant lecturer, Department of Celtic, The Queen's University, Belfast). This will be edited by Mr. Hamilton in conjunction with material collected by himself.

Dr. Liam Price continued to work on the archives of Irish place-names.

Professor Proinsias Mac Cana acted as General Editor of the Mediaeval and Modern Welsh Series. He checked the typescripts of two forthcoming publications in this Series - Owein edited by R. L. Thomson and The Poems of Taliesin edited by J. E. Caerwyn Williams.

Máire Próinséas Ní Chatháin completed the checking of proofs of the Latin text of Betha Muire and continued to work on the Irish text. Her work on Irish syntax, under the direction of Professor Jackson, continued. She attended lectures by Mr. E. G. Quin at Trinity College, Dublin on Vedic

Sanskrit and the seminar held by Mr. Bruce Boling on 'Comparative Indo-European Grammar'. In September 1965 Máire Ní Chatháin took up a post as lecturer at the University of Pennsylvania, Philadelphia.

Mr. Bruce Boling continued his research on noun-formation in Irish.

Miss Winifred McEnery excerpted from 'In Tenga Bithnua' and 'Smainte Beatha Chríost' for the Dictionary of Classical Modern Irish. She also worked on an edition of 'In Tenga Bithnua' from the Yellow Book of Lecan.

Mr. David Erlingsson was engaged in collecting notes on Irish-Icelandic connections in the fields of literature, language and history and has done some general reading on these matters in Celtic and Irish studies. Considerable time was spent in learning modern Irish and for this purpose Mr. Erlingsson spent some weeks at Indreabhán, Co. Galway. He attended Professor Dillon's Seminar on Acallam na Senórach.

Mr. Hans P. A. Oskamp prepared a diplomatic edition of Immram Curaig Maele Dúin from the Yellow Book of Lecan, together with the variant readings from Harleian 5280 and Egerton 1782. Work is progressing on the introduction to the text. This contains chapters about the text itself and its relations to the Navigatio Sancti Brendani Abbatis. Mr. Oskamp has prepared papers on the General Backgrounds of Dinnshenchus; The Structure of Lebor na hUidre; The Dutch Brandan-Legend. He attended Professor Dillon's Seminar on Acallam na Senórach.

Mr. J. W. Gleasure excerpted for the Dictionary of Classical Modern Irish and attended the weekly Seminar. A paper on the development of the forms of the present indicative of the Irish verb to be read at a forthcoming seminar was prepared. He studied in detail all the published material and works on Donegal Irish. Mr. Gleasure visited Na Cruacha in South Donegal for the purpose of becoming acquainted with the dialect and collecting material to be used for phonological analysis. Work has begun on the sifting and 'interpretation' of the material which has been recorded partly on tape and partly in a phonetic transcription. A review of Lochlann III was written for Studia Hibernica.

Mr. Joseph Watson is at present engaged in extending his knowledge of Indo-European studies with special regard to the Celtic languages, in addition to studying Old and Middle Irish material. With the help of the

lecturers and language laboratory at University College, Dublin he hopes to become competent in Modern Irish with a view to engaging in dialect studies. Mr. Watson is preparing a paper on Comparative Mythology under the guidance of the Director of the School whose weekly Seminar he attended.

Miss Cecile O'Rahilly prepared and sent to the printer replacements of the text and translation of Táin Bó Cualnge which had been lost in the fire at the printer's premises. She continued to work on the notes to text and corrected galley proofs of both the text and translation. Miss O'Rahilly continued to excerpt Bedell's Bible, Glenmasan MS., etc. for the Dictionary of Classical Modern Irish of which she is Co-Editor. She supervised Mr. Gleasure's work on the Dictionary.

Rev. Anselm Faulkner, O.F.M. has completed the preparation of the text, notes and introduction of An Bheatha Chrábhaidh. The text of An Sgáthán Spioradálta has been thoroughly compared with the original Italian and differences noted. The introduction, notes and vocabulary of An Bheatha Dhiadha have been with the printer for some time.

Rev. Cuthbert McGrath, O.F.M. prepared the notes and translation of Part II of Dán na mBráthar Mionúr and these were sent to the printer.

Rev. Fearghal Mac Raghnaill, O.F.M. made a comparative study of the Antwerp, Louvain and Rome editions of An Teagas Críosaíde. A final edited draft of the Antwerp text is being prepared. A critical draft of the text will be ready shortly.

Rev. Bartholomew Egan, O.F.M. checked proofs of the notes, introduction, and abbreviations of Graiméir Ghaeilge na mBráthar Mionúr and returned these to the printer.

Dr. Ludwig Bieler continued to act as Editor of the Hiberno-Latin Texts Series and read proofs of the two volumes at present going through the press.

Mr. Gordon Mac Lennan checked proofs of the notes, indexes and vocabulary of his forthcoming publication Gaidhlig Uidhist à Deas.

An tAthair Pádraig Ó Fiannachta checked final proofs of his edition of Táin Bó Cuailgne. The work was published in February 1966.

Dr. Wolfgang Meid checked proofs of his edition of Táin Bó Fraích which is to be published shortly in the Mediaeval and Modern Irish Series.

Éamonn Mhac an Fhailigh checked first proofs of the phonetic and

orthographic texts of his phonemic study The Irish of Erris, Co. Mayo. This work contains a grammatical supplement covering features of morphology.

Professor J. J. Tierney checked and returned book-proofs of his edition of Dicuil's De mensura orbis terrae.

Mr. I. P. Sheldon-Williams checked first proofs of his edition of Johannes Scottus (Eriugena), Periphyseon (De divisione naturae).

Professor David Greene checked page-proofs of the translation of Duanaire Mhéig Uidhir and is awaiting proofs of the notes and vocabulary before proceeding further with the work.

Dr. R. L. Thomson's edition of Owein, a forthcoming publication in the Mediaeval and Modern Welsh Series was prepared and sent to the printer in April 1965.

Professor J. E. Caerwyn Williams prepared for press the introduction, text and notes of The Poems of Talieson to be published in the Mediaeval and Modern Welsh Series.

Dictionary of Classical Modern Irish: Work on the Dictionary continued throughout the year with Miss O'Rahilly acting as Co-Editor. She supervised some excerpting done by Mr. Gleasure.

Place-Name Research: The work of excerpting the Calendars of the Fiants, mentioned in last year's report, has been completed and all the cards have now been sorted into the indexes. Many of the names on these cards are now obsolete, but it is practically always possible to locate the places within the limits of a parish; where the locality is doubtful, this has been indicated on the pink cards which have been made for these obsolete names. The same applies to the cards made last year by Mr. Nichols from early 14th century Carew documents; these have all now been placed in the indexes. They are interesting as supplementing the information to be found in the early ecclesiastical taxation documents about the extent of the old Irish tribal districts at the time of the Anglo-Norman settlement of Carlow. The Calendar of Ormond Deeds, edited in six volumes by Professor Curtis, has been examined, and cards are being made from these documents; the Butler properties covered large parts of Carlow, Kildare, Laois and Offaly, as well as Kilkenny, Tipperary and Dublin. The sorting

of these cards into the indexes will be put in hand when all the six volumes have been excerpted. Examination of the documents in the Calendar of the Papal Registers is also proceeding; this will take some time to complete.

It has been decided to concentrate on one county rather than to continue working on all four at the same time; the county of Carlow has been selected as the first to be completed, the purpose being to publish the results if the work can be carried out within a reasonable time.

The final section of the Place-Names of Co. Wicklow was finished during the year, with a review of the historical background, an index of elements, and a full index of names. This was sent to the printers in June 1965; galley proofs have been received and returned, and the complete page proof is now awaited. The first section of the Place-Names of Co. Wicklow was published by the Royal Irish Academy in 1938.

Dr. Price attended the Annual Conference of the Council for Name Studies which was held in the Institute on 26th March 1966.

Hiberno-Latin Texts Series: Professor Ludwig Bieler continued to act as General Editor of this Series. Proofs of Professor J. J. Tierney's edition of Dicuil's Liber de mensura orbis terrae to which Professor Bieler contributed were checked and returned. The setting-up of the first volume of Johannes Scottus (Eriugena), Periphyseon (De divisione naturae) edited by Mr. I. P. Sheldon-Williams has begun. First proofs have been read by Mr. Sheldon-Williams and Dr. Bieler. Preparation of Volume II of this work has been completed.

### 3. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture entitled A thousand years of Irish - Corpus Iuris Hibernici was delivered by Professor D. A. Binchy in Trinity College, Dublin, on 8th March 1966.

### 4. SEMINARS

Mr. Bruce Boling continued to hold a seminar on historical and comparative Indo-European grammar.

Professor Myles Dillon held a seminar on Acallam na Senórach.

5. EXTERNAL ACTIVITIES

Professor Dillon attended the Fifth International Colloquium on Gaulish, Celtic and Protoceltic Studies held at Amiens in August 1965. In February 1966 he attended an international conference at Kiel for the purpose of forming a European Linguistic Society. He was later a guest of the University of Berlin for several days. He was a guest of the University of Paris in March 1966 for the celebration of the centenary of the Société Linguistique.

Dr. Gearóid Mac Niocsaill delivered a lecture on Norman influence on Irish institutions in November 1965 to An Cumann Logainmneacha and in The Queen's University, Belfast.

6. PUBLICATIONS

a. Books:

The Book of Leinster, Volume IV. Edited by R. I. Best and M. A. O'Brien.  
Price 30s. pp.xviii + 761-1117. Published June 1965.

Táin Bó Cuailnge. Edited by Pádraig Ó Fiannachta.  
Price 21s. pp.xv + 97. Published February 1966.

b. Contributions to Periodicals:

Pádraig Ó Súilleabháin, O.F.M.: Nicholas Slevin, Maynooth professor (1823-29), in the McCormick papers 1815-16.  
Irish Ecclesiastical Record, fifth series, civ, 80-85.

Documents relating to Wexford Friary and parish 1739-98.  
Collectanea Hibernica, No.8, 110-28.

I - Report of the Governing Board of the School of Theoretical Physics

adopted at its meeting on 25th May, 1966.

1. STAFF AND SCHOLARS

Senior Professors:

John L. Synge, Director of the School, appointed for three years from 16 May 1962, and re-appointed for three years from 16 May 1965.  
Cornelius Lanczos.

Professors:

Yasushi Takahashi; Lochlainn Ó Raifeartaigh.

Visiting Professors:

David Lurié; Rev. Ciaran Ryan (appointed Visiting Assistant Professor 1 October 1965).

Research Associates:

D. Judge; P. S. Florides.

Scholars:

T. Yukawa (left 30 September 1965); H. Yeh (left 25 September 1965);  
Rev. J. McCrea; E. C. Callan (left 30 September 1965); M. Wong, S.J.  
(left 31 July 1965); E. Pechlaner (appointed 1 October 1965);  
J. Waddell (appointed 1 October 1965); K. Watanabe (appointed 1 October  
1965); K. S. Viswanathan (appointed 1 November 1965).

Technical Assistant:

Miss Evelyn Wills.

2. STUDY AND RESEARCH

Professor Lanczos continued his investigations in the field of boundary value problems, and considered the implications of expansions whose orthogonality extends over the boundary instead of the domain. Since the basic functions all satisfy the given homogeneous differential equation (or systems of such equations), and the prescribed boundary values can be satisfied with ever increasing accuracy, the difference between well-posed and ill-posed problems seems to disappear. He found, however, that in fact the characteristic difference comes in evidence in the convergence behaviour of the expansion thus obtained. In the "well-posed" problems the convergence throughout the domain is automatic, whereas in the "ill-posed" problems convergence to a definite limit at all points of the given domain occurs only if the boundary values are chosen from a properly restricted class of functions. He found some

explicit examples to illustrate this behaviour. Professor Lanczos also worked in the field of metrical substructure, studying the interaction between sub-structure and super-structure, which gives rise to additional terms in the metrical equations; these terms are not present in Einstein's gravitational equations, on account of their dimensional homogeneity. He found that the "free vector" in Einstein's equation for infinitesimal fields (corresponding to infinitesimal coordinate transformations) changes its character and reappears (in high approximation) as the "vector potential" of the Maxwell equations.

Professor Synge continued work on certain  $2 \times 2$  matrices involved in the construction of null networks in flat space-time. He investigated the directivity of scalar radiation from a set of point sources, and also studied the directivity of scalar radiation generated on the bounding plane of a half-space. He wrote a paper classifying helices in flat space-time, and showed that worldlines of charged particles in constant electromagnetic fields are helices of the several types, depending on the nature of the field and the initial conditions. In consultation with Dr. J. T. Lewis of Oxford he studied relative probabilities in Hilbert space, and also found a simple classification of all linear operators transforming Hilbert space into itself.

In collaboration with Dr. Florides and Rev. J. McCrea, he showed how to construct a model of a finite body generating gravitational waves with a residual energy tensor only of the order of the cube of the mass, and developed a system of radiation coordinates valid for any gravitational field. In collaboration with Rev. J. McCrea he wrote a paper on boundary-value problems with a strong vanishing on the boundary, this being a matter of importance in the radiative problem.

Professor Takahashi investigated the possibility of a dynamical rearrangement which might take place when the Nambu mass equation is imposed on a non-linear field theory. He proposed a formalism which yields generalized conservation laws without recourse to the Lagrangian formalism, and is at present investigating a possibility of expressing the time reversal transformation in terms of a unitary transformation. With Professor Lurié he extended further his method of normalization of wave functions to show



the relation between normalization of wave functions and the renormalization constants. They also investigated the question of generalized conservation laws using a technique based on a generalized Ward identity.

Apart from his work in collaboration with Professor Takahashi, described above, Professor Lurié worked on a text on quantum field theory.

Rev. Dr. Ryan continued work begun at the University of Rochester, U.S.A., on a number of topics, including the search for useful higher symmetry groups and the related question of current generated algebras; he also worked on a general review of weak interaction theory, as his contribution to a book on this subject in collaboration with Professor R. Marshak (University of Rochester), and Professor Riazuddin (University of Pennsylvania).

Dr. Judge continued his work on generalized eigenfunctions, and also considered some topics in Cerenkov radiation.

As well as his work in collaboration with Professor Synge, Dr. Florides worked on rotating shells in general relativity using the Florides-Synge method of successive approximations; he also worked on a solution of Einstein's field equations by the approximation method, in Fermi coordinates.

Dr. Wong and Dr. Yeh collaborated in some research on the application to particle physics of group theory, in particular the irreducible representation of  $SU_3$ .

Dr. Pechlaner studied the one-body problem in general relativity extending it to massless test-particles, and also studied the two-body problem.

Dr. Waddell's studies and research can roughly be described as belonging in the field of relativistic quantum statistical mechanics. He believes that one of the major unsolved problems in this field is a demonstration (or proof) that in an assembly of interacting matter and light particles the radiation will gradually redden with time. To the best of his knowledge no such proof exists, although this would seem to be a basic requirement in any theory about the interaction of matter and light. A conceptual modification in the present theory is therefore required, but it is not yet clear what this modification might be. Dr. Waddell would like this modification to predict the existence of zero energy photons, that is, particles which are carriers of a virtual entropy, which, as the radiant energy in a conservative system reddens or degrades, are converted into

carriers of finite energy, namely energetic photons. He believes there is ample observational evidence to indicate the existence of such particles. From this approach, as opposed to the astronomical research approach, Dr. Waddell has extended the early work of Lanczos in developing the quaternion algebra for quantum mechanics. This involves describing the non-homogeneous Maxwell's equations in quaternion form, and developing in a very natural way from there to the massless Dirac equation and finally the Dirac equation for the electron. This development, although it yields nothing new, provides a clear understanding of spinor polarization and negative energy solutions, and offers the Dirac development at an aesthetic level. He is at present engaged, with Professor Lanczos, in writing up this work.

Dr. Viswanathan's work can be divided into two parts: (i) Space and plasma physics and (ii) Solid state physics. In space and plasma physics, Dr. Viswanathan extended Störmer's theory to the study of the motion of a charged particle in a spherically confined magnetosphere, and showed that the trapping regions are determined by a cubic equation. The allowed region computed on this basis for proton energies ranging from 10 to 710 MeV is in close agreement with the radial distribution and latitude dependence of the inner zone. He also made a similar study for electrons in the energy range 10 to 900 KeV. In general the field arising from the currents flowing over the surface of the magnetosphere is a general spherical harmonic expansion in  $r$ ,  $\theta$  and  $\phi$ , though the dominant term of these is the first one, corresponding to a spherical magnetosphere model. In the first order perturbation calculation (which is quite adequate, since the perturbation terms are very small) the trapping region was shown still to be governed by a cubic equation. The longitude dependent terms occur in the coefficient of  $r$ . Dr. Viswanathan also derived an expression for the energy flux of a collision-free plasma in terms of the general pressure and heat conductivity tensors, and investigated the structure of a shock in a collision-free plasma; the density of the shock has the form of an elliptic integral of the third kind, and is proportional to both the Larmor ion radius as well as the square root of the ratio of the temperatures behind and in front of the shock.

In the field of solid state physics, Dr. Viswanathan, in collaboration

with Dr. Watanabe, found expressions for the inner displacements and level shifts of a general crystal in terms of the anharmonicity constants and the temperature of the crystal. They showed that the inner displacement of any atom is proportional to the mean thermal energy of the crystal, and derived expressions for the anharmonicity constants of a crystal lattice in terms of the third order elasticity constants.

Dr. Watanabe, apart from his work on solid state physics just described, investigated, using a simple example, the current algebra which has been introduced by Gell-Mann, and examined the connection with the bootstrap condition. In the field of nucleon-nucleon scattering, he analysed, in collaboration with Professor S. Furnichi (Rikkyo University, Tokyo) and Dr. H. Kanada (Nagoya University), the low energy scattering, using the partial wave dispersion relations; they also systematically investigated pion-pion, pion-nucleon and nucleon-nucleon interactions.

Mr. Yukawa continued his work on the gravitational field of a stream of dust particles in equilibrium, moving radially out, and falling back towards the central sphere. He obtained further differential equations and approximate integrations in this field.

Dr. Callan continued his study of elementary particle properties, and in particular of particle masses, continuing his comparisons between calculated and experimental masses, using an exponential formula described by two quantum numbers; and he continued his studies of Auger transitions and hypergeometric functions.

Professor Ó Raifeartaigh continued his leave of absence at Syracuse University, and during the Spring of 1965 he was engaged in a study of the question of combining Lorentz invariance and internal symmetry properties of elementary particles, and during the Summer he extended this work to a consideration of the H-atom as a prototype for elementary particle symmetries. He combined this with work on related symmetries, and also, in collaboration with Dr. A. J. MacFarlane, carried out some work on the representations of compact semi-simple groups. He completed some earlier work with Drs. Musto and Rao on the Smushkevich principle, and is at present working on current algebras and the question of making more rigorous the results obtained earlier concerning internal symmetries and Lorentz invariance.

### 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:

- Dr. R. G. Allcock (Liverpool University):  
The uncertainty relation between energy and time.
- Professor J. S. R. Chisholm (Trinity College, Dublin):  
Finite symmetries of elementary particles (4 lectures).
- Professor O. Frink (University College, Dublin and Pennsylvania State College);  
Generalisations of Cayley numbers.
- Professor W. Heitler (Zürich University):  
Is the equation 'Life = Physics + Chemistry' valid?
- Dr. D. Judge: Generalised functions and rigged Hilbert spaces (2 lectures).
- Dr. M. Kennedy (University College, Dublin):  
The spectral theorem (2 lectures).
- Professor C. Lanczos: Metrical lattice and the problem of electricity  
(2 lectures).  
Solution of the Einstein equations by successive approximations (3 lectures).
- Professor D. Lurié: Report on the Oxford Conference on Elementary Particles.
- Professor H. Lustig (City College of New York and University College, Dublin):  
Simple theory of the Mössbauer effect.
- Rev. Professor J. McConnell (Maynooth):  
Multiplicities in weight diagrams (2 lectures).
- Professor L. Rosenfeld (NORDITA):  
Epistemological aspects of quantum theory.
- Rev. Professor C. Ryan: Topics in weak interactions (5 lectures).
- Professor J. L. Synge: Some ideas about probability and Hilbert Space  
(2 lectures).  
Null networks in flat space-time (2 lectures).
- Professor Y. Takahashi: Conservation laws in non-Lagrangian theory  
(2 lectures).
- Professor P. A. Wayman (School of Cosmic Physics):  
Galactic motions (2 lectures).

#### 4. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture, under the auspices of the School, was delivered in University College, Dublin, on 9 December 1965, by Professor Lanczos. His subject was "Hamilton's quaternions".

#### 5. VISITING PROFESSORS

Dr. D. Lurić.

Rev. Dr. C. Ryan (University of Rochester) was appointed Visiting Assistant Professor for one year from 1 October 1965.

For lectures by Professors Lurić and Ryan, see Section 3.

#### 6. VISITORS TO THE SCHOOL

Dr. R. G. Allcock (University of Liverpool) from 21 to 23 April 1965.

Dr. D. Freedman (Imperial College, London) from 20 to 23 April 1965.

Professor L. Rosenfeld (NORDITA) from 28 to 30 April 1965.

Professor W. Heitler (Zürich University) from 20 to 24 September 1965.

For lectures by Visitors, see Section 3.

#### 7. SYMPOSIA

Mathematical Symposia were held on 12-13 April and 20-21 December 1965. The attendances were respectively 48 and 61; 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: Professor J. Dooge (University College, Cork):

Laguerre analysis of dynamic response.

Professor P. M. Quinlan (University College, Cork);

The  $\lambda$ -method for linear differential equations.

Professor D. Lurić: Elementarity and compositeness of bosons.

Dr. A. H. Klotz (University of Liverpool):

Relativity and uncertainty.

Professor J. N. Flavin (University College, Galway):

Elastic wave propagation in deformed media.

Rev. Professor J. MacMahon (Maynooth): Congruence.

December: Dr. D. J. Simms (Trinity College, Dublin):  
Vector fields on spheres.

Dr. J. T. Lewis (Brasenose College, Oxford);  
The Weyl mapping.

Professor J. L. Synge: Null networks in flat space-time.

Dr. R. Johnston (University of Liverpool):  
Integration in function-space.

Dr. D. Judge: What are conjugate variables?

Mr. J. P. J. McDermott (University College, Galway):  
Automorphism groups as permutation groups.

#### 8. EXTERNAL ACTIVITIES

The following attended an International Conference on Gravitation and General Relativity in London (1-10 July): Professors Lanczos and Synge, Dr. Florides, Mr. Yukawa, Dr. Yeh, Rev. J. McCrea.

Professor Synge lectured as follows: to the Irish Mathematics Teachers' Association on "Formal and visual aspects of mathematics", 20 May; to the Royal Astronomical Society on "Hamiltonian theory of rays and waves", 8 September; to the Mathematical Society, Queen's University, Belfast on "Regular figures in space-time", 1 February.

Professor Lanczos lectured as follows: to the Mathematical Society, Queen's University, Belfast on "Periodic space-time structure", 27 April; at the IBM Research Laboratories, Zürich on "Orthogonal expansions in linear boundary value problems", 3 May; as an Invited Speaker to the Courant Symposium held at New York University on "Boundary value problems and orthogonal expansions", 9 June; to the Mathematics Teachers' Association (Dublin) on "Rigour through the ages", 16 September; as an Invited Speaker at the Einstein Symposium of the Berlin Academy of Sciences on "Tetrad formalism and space-time structure", 2 November; to the Science Society, University College, Dublin on "Rationalism and the physical world", 11 November; to the Pax Romana Society (Dublin) on "Science and religion" 14 November; to the University College, Dublin Science Society (during the Trinity College Mathematical Congress) on "Crystalline structure of the space-time world", 18 February. He also acted as Visiting Professor at North Carolina State University from 18-22 October, giving a lecture

and consultations on relativity, and lectures on "The inspired guess in the history of physics", and on "Mathematics for engineers", as well as a television broadcast on Einstein; and as Visiting Professor at the University of Nottingham from 19-22 November, where he lectured on "Data analysis by Fourier analysis", and on "Orthogonal expansions in boundary value problems".

Professor Takahashi visited the Istituto di Fisica Teorica, University of Naples, from 1 June to 31 July, and gave one lecture there on "Hamiltonian formalism with a supplementary condition" (24 July); he visited the Matscience Institute of Mathematical Sciences, Madras, from 13 December to 17 February, where he attended a symposium, gave two lectures, "Normalization of the Bethe-Salpeter wave functions" and "Generalized conservation laws", and gave a course of eight lectures on "Introduction to field quantization". He visited the Indian Institute for the Cultivation of Science, Calcutta, from 17-20 February, giving two lectures, "Non-Lagrangian theories and generalized conservation laws", and "Crossing symmetry in quantum field theory"; he visited Tokyo University and Tokyo University of Education from 21 February to 20 March; and he attended a Symposium on Symmetries at the Institute for Fundamental Physics, Kyoto University, from 13-15 March, and gave a lecture there on "Non-Lagrange theories and conservation laws".

Professors Takahashi and Lurié and Dr. Callan attended a Conference on High Energy Physics at Birmingham University from 5-7 April.

Professor Lurié also visited the University of Brussels from 1 May to 1 June, and gave a series of five seminars there; he visited CERN from 1-7 June, and the International Centre for Theoretical Physics, Trieste, from 7-14 June, giving a seminar at each; he attended a Seminar on Unified theories of Elementary Particles at München in July and the Oxford Conference on Elementary Particles in September; he gave a seminar at the University of Durham while visiting there from 20-25 March.

Dr. Florides lectured to the Irish-Hellenic Society in Dublin on 29 November on "The Greeks, the stars, and all that".

Dr. Judge attended the British Mathematical Colloquium, held in Dundee from 6-9 April.

Professor Ó Raifeartaigh, continuing his leave of absence from the School at Syracuse University, spoke at Colloquia as follows: Louisiana State

University (2 April); Argonne National Laboratory (August); Princeton University (October); Institute for Advanced Study, Princeton (October); University of Pennsylvania (October); Yale University (November); Rockefeller Institute (December); Massachusetts Institute of Technology (March); Rensselaer Institute (March). He presented a paper at a meeting of the American Physical Society in Washington (May); and also a paper at each of the following conferences: Athens (Ohio) Conference on Elementary Particles, Toronto Conference on Elementary Particle Symmetries (October), and the Milwaukee Conference on the Use of Non-Compact Groups in Physics (May). He also attended the International Conference on Weak Interactions, Argonne National Laboratory (October) and the Eastern Theoretical Physics Conference, Stonybrook, New York (November).

## 9. PUBLICATIONS

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

### a. Books:

Published:

- \* Discourse on Fourier series. By C. Lanczos. Oliver & Boyd, 1966.

Principios de mecánica. By J. L. Synge and B. A. Griffith (Principles of mechanics, 3rd edn., translated to Spanish by J. Bescós & J. Olivé) McGraw-Hill, 1965.

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

Published:

- \* No.16. Introduction to the Group Theory of Elementary Particles. By J. McConnell. Price 12s.6d. pp.111. Published 27 October 1965.

### c. Contributions to periodicals and other publications:

Published:

J. L. Synge:

Review: Einstein-Räume. By A. S. Petrow, Berlin, Akademie-Verlag, 1964. Nature 207 (1965), 673.

- \* Application of the Laplace transform to the inhomogeneous Klein-Gordon equation. J. Lond. Math. Soc. 40 (1965), 667-70.

- \* The escape of photons from gravitationally intense stars. Mon. Nots. Roy. Astron. Soc. 131 (1966), 463-66.



P. S. Florides:

The foundations of the theory of relativity. I. Special relativity. Kosmos No.3 [Feb. 1966], 11-17.

F. Oktem:

\* On affine field laws. Proc. R.I.A. 64 A (1966), 107-13.

C. Lanczos:

Metrical lattice and the problem of electricity. J. Mathl. Phys. 7 (1966), 316-24.

D. Lurié, A. J. MacFarlane and Y. Takahashi:

Normalization of Bethe-Salpeter wave-functions. Phys. Rev. 140 B (1965), 1091-9.

D. Lurié and Y. Takahashi:

\* Intrinsic parity of mesons as quark-antiquark composites. Phys. Rev. Lett. 14 (1965), 653-4.

Normalization of wave function and wave-function renormalization constants. Il Nuovo Cim. 40 A (1966), 295-8.

S. Furnichi and K. Watanabe:

Pion-pion correlation effect in two-pion exchange contribution for nucleon-nucleon scattering. Progr. Th. Phys. 35 (1966), 408-15.

M. Wong:

\* On the Mössbauer effect. Proc. Phys. Soc. 85 (1965), 723-34.

J. C. Guillot, W. Jaus and L. Ó Raifeartaigh:

\* A survey of the Heitler-Arnous non-local field theory. Proc. R.I.A. 64 A (1965), 93-105.

L. Ó Raifeartaigh:

\* Mass differences and Lie algebras of finite order. Phys. Rev. Lett. 14 (1965), 575-7.

Lorentz invariance and internal symmetry. Phys. Rev. 139 B (1965), 1052-62.

A. J. MacFarlane, L. Ó Raifeartaigh and E. C. G. Sudarshan:

\* Nucleon magnetic moments in covariant version of Wigner's super-multiplet theory. Phys. Rev. Lett. 14 (1965), 755-57.

E. C. G. Sudarshan, N. Mukunda and L. Ó Raifeartaigh:

Group theory of the Kepler problem. Phys. Lett. 19 (1965), 322-26.

N. Mukunda, L. Ó Raifeartaigh and E. C. G. Sudarshan:

Characteristic non-invariance groups of dynamical systems. Phys. Rev. Lett. 15 (1965), 1041-44.

In the press:

J. L. Synge:

\* What is Einstein's theory of gravitation? Hlavaty Festschrift,  
Univ. of Indiana Press.

Directivity for scalar radiation. Q. Appl. Math.

George Boole and the calculus of finite differences. Cork Univ.  
Press.

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

Radiation coordinates in general relativity. Proc. Roy. Soc. A.

C. Lanczos:

Boundary value problems and orthogonal expansions. SIAM J.

S. Kamefuchi and Y. Takahashi:

A Lagrange formalism and the relativistic quantization of the  
Bargmann-Wigner fields. Il Nuovo Cim.

D. Lurié, Y. Takahashi and H. Umezawa:

Generalized Ward identity and unified treatment of conservation  
laws. J. Mathl. Phys.

D. Lurié, A. J. MacFarlane and J. G. Kuriyan:

\* Algebraic tabulation of the Clebsch-Gordan coefficients of  $SU_3$   
for the product  $(\lambda, \mu) \otimes (1, 1)$  of representations of  $SU_3$ .  
J. Mathl. Phys.

C. Ryan:

Implications of current algebra approach to higher symmetries.  
Annals of Phys.

On getting an  $SU(6)$  result from chiral  $SU(3) \times SU(3)$ . Phys. Rev.

C. Ryan, S. Okubo, R. E. Marshak and H. Goldberg:

The maximal chiral group with the quark model. Physics.

K. Watanabe:

Shmushkevich principle and current algebra. Il Nuovo Cim.

K. S. Viswanathan:

The geomagnetic cavity and the van Allen radiation belts.  
Planetary and Space Science, Pergamon Press.

D. J. Judge:

Square roots of the nu and delta functions as generalized  
eigenfunctions of momentum and position. J. Math. Mech.

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

Origin of symmetry and self-coupling of vector mesons.

V - Report of the Governing Board of the School of Cosmic Physics  
adopted at its meeting on 15th June, 1966.

A. Astronomical Section.

1. STAFF AND SCHOLARS

Senior Professor:

P. A. Wayman.

Chief Assistant:

J. H. Reid (to 31 July 1965).

Research Assistants:

I. Elliott (appointed 1 November 1965); Miss S. M. P. McKenna (returned from McMath-Hulbert Observatory 1 January 1966).

Experimental Officer:

B. D. Jordan (appointed 1 February 1966).

Scholars:

I. Elliott (to 31 October 1965); C. J. Butler.

Clerical and Technical Staff:

Miss M. Callanan; Mr. P. Murphy.

Mr. C. J. Butler worked at the Boyden Observatory from 20 September 1965.

2. LYOT HELIOGRAPH AT THE CAPE

This instrument, operated by the staff of the Royal Observatory, Cape Town, continued to operate up to 1965 December 31. It was subsequently withdrawn from service for overhaul and adjustment to be carried out by the Royal Observatory workshop and it is intended to be ready for resumption by 1966 July 1. Negotiations have been entered with Professor C. W. Allen of the University of London Observatory for the transfer to him of future responsibility for the use of the heliograph material.

Films in hydrogen-alpha light were received for the period 1965 April-June and for the remainder of 1965 were sent direct to Dr. J. H. Reid at the Sacramento Peak Observatory, New Mexico.

During 1965 heliograph records were available for 296 days with a total of 1815 hours, and with the increase of solar activity following

the minimum in 1964, 89 flares were recorded. Results have been distributed to the World Data Centres for International Quiet Sun Years.

Dunsink-Cape flare-data for the period 1958-1965 are being entered on to punched cards at Sacramento Peak and seven series of films covering the occurrence of flares showing the nimbus phenomenon have been taken to Sacramento Peak. A series coincident with times when rocket photographs of the sun using X-rays are available has been loaned to the Astronomy Department, University of Leicester (Dr. A. J. Meadows).

Some series of disc photographs in the centre of  $H\alpha$  and in the wings of the line at 15-sec. intervals during periods of clear skies were taken during January 1966, without the interposition of long exposures for recording prominences. These series are intended to give information on travelling waves in the chromospheric network (see Section 4 below).

For the operation of this instrument and for the special series we are indebted, as in previous years from 1958, to H.M. Astronomer at the Cape and his staff.

### 3. SOLAR-TERRESTRIAL RELATIONSHIPS

Miss McKenna has carried out a thorough study of the first part of the disk-passage of an active solar region in 1959 July and has shown that more definite association between radio-wave bursts and flare activity can be established if high-quality patrol heliograms are available and are studied in extreme detail. Association to within  $\pm 1$  minute with optical features are possible for 47 out of 49 radio events occurring during the period completed so far and this represents a much closer association than is possible when published lists of flare activity are consulted, both with regard to tolerance of time-interval and in percentage of identified associations. Extension to the remainder of the disk-passage, using heliograph material on loan from Michigan is continuing. Wavelength-swept spectroheliograms in  $H\alpha$  and in the K-lines are also available and this material is being used to assist in differentiation between the small brightenings that are identical on the routine patrol heliograms but show varied properties in other respects (radio noise, corpuscular streams).

Miss McKenna has also studied the positions of the flares occurring in the same region relative to the nearby sunspots and to the features of the "calcium" network.

#### 4. SOLAR ABSORPTION LINES

Analysis of the digitized records of chromospheric Doppler-shifts at different parts of corresponding Balmer lines in the solar spectrum, using material obtained at Sacramento Peak and by use of the IBM 1620 computer at University College, Cork, has been carried out by Mr. Elliott. The amplitude of the velocity field is found to increase markedly from the wings of each line towards the line centre indicating a random macroturbulence increasing with height in the solar atmosphere. This amplitude can be used to give an indication of corresponding effective heights of absorption-line formation in different parts of two Balmer absorption lines and an explanation of the correspondence will give values of parameters related to temperature, Stark broadening and turbulence at different atmospheric heights.

The use of correlation analysis of the shifts has also been thoroughly explored but here the results are less capable of quantitative explanation. High correlations exist for Doppler shifts within one line but when the shifts from separate lines are considered, the correlations are not so high. Explanation, allowing for the influence of random errors, in terms of overlapping contributions from different heights towards the Doppler shifts, has been sought, but no entirely satisfactory interpretation has so far been possible.

A time-sequence for  $H\alpha$  Doppler shifts was measured at a fixed line-breadth and large amplitudes have been found to be systematically associated with steady downward motion. The relation with the chromospheric network on spectroheliograms in calcium and hydrogen-light is being investigated. A cinematographic film of the sequence shows clearly the oscillatory nature of the shifts, confirmed by autocorrelation analysis, and a horizontally-travelling disturbance moving with a velocity of about 100 km/sec. has also been detected.

## 5. GALACTIC RESEARCH

A total of 60 direct and 28 objective prism plates of galactic fields were taken in 1965 April-June with the ADH telescope mostly by the permanent staff at the Boyden Observatory. The field of NGC 3532 has been first selected for analysis and calibration by photoelectric photometry using the off-set guiding method with the 60-inch reflector.

The problem of definition of an inertial frame in the co-ordinate-systems implied by the proper-motion systems of the standard catalogues has been considered by Professor Wayman. It has been possible to demonstrate that corrections to precession and a value of Oort's constant B are available from 34 distant OB stars appearing in the FK4 catalogue alone, if physical information on the stars is fully utilised. The question of the relation between precession corrections and the relativistic advance of perihelia of the inner planets has been investigated and in particular the situation that results from the application of revised planetary masses, suggested by Marsden as required for resolving the discrepancy between values of the astronomical unit given by celestial mechanics and by radar methods.

## 6. MAGELLANIC CLOUDS

A programme to determine whether some of the differences in the period-luminosity relationships derived for cepheids in the two Magellanic Clouds are due to differential absorption effects has been started by Mr. C. J. Butler. Three regions, two in the Large Cloud and one in the Small Cloud, are being considered, and series of ADH plates in the UV system covering, in principle, some hundreds of identified cepheids have been taken, 126 plates in all. These plates are intended to be suitable for obtaining periods, light curves and colour curves. Calibration by faint photoelectric sequences will be necessary and so far this has only been partially carried out on the 60-inch telescope, on twenty-eight nights in 1966, and that only as far as stars bright enough to be seen in the telescope. The off-set photometer using a refrigerated photomultiplier and an integrating circuit has been tested and is being put into use as soon as possible in order to reach fainter stars.

The problem of distinguishing foreground stars from bright Magellanic Cloud stars can, in principle, be tackled by objective-prism radial-velocity methods. A neodymium chloride filter has been used in an attempt to effect this separation with the ADH telescope but the plates so far taken do not show the absorption lines sufficiently clearly for easy measurement. A thicker filter is being considered.

Ten objective-prism plates of Magellanic Cloud fields have been taken with the ADH telescope close to the 30 Doradus nebula and sent to the Royal Observatory, Edinburgh (Dr. K. Nandy). Their purpose is to indicate whether the Edinburgh reddening measurements can be extended to this region usefully.

#### 7. INSTRUMENTS

The off-set photometer head for use with the 60-inch telescope was completed during the year at Dunsink and at Boyden. The 9558Q EMI Photo-multiplier has provision for cooling by dry ice and the apparatus includes integrating condensers whose voltage is measured with a General Radio voltmeter. Tests on the telescope have indicated that the system is suitable for measurement of stars too faint to be seen visually in the telescope.

Tests have been made with Grundig 625-line closed circuit television equipment on loan from a Dublin agency with a view to establishing the utility of such equipment in viewing astronomical plates; particularly the superposition of fields from more than one plate is being considered.

A two-coordinate screw-motion holder for viewing plates in a binocular microscope has been partially constructed. Other instruments delivered at Dunsink include a Recordak film reader and a Joyce-Loebl microdensitometer.

Photoelectric equipment at Dunsink has been re-built by Mr. Jordan in a form suitable for registering the occultation of stars by the moon, and Mr. Butler has constructed a neodymium filter for use with the ADH telescope.

#### 8. LECTURES, CONFERENCES, etc.

Professor Wayman attended meetings of the Boyden Observatory Council in

Röttach-Egern, Bavaria, in August 1965, and, as Meeting Secretary, in Bloemfontein in March 1966. The University of the Orange Free State has been invited to share in the operation of the Boyden Observatory. Definite steps to improve the facilities offered by the 60-inch telescope have now been taken; a Pyrex mirror to replace the original Common mirror and a new Zeiss (Jena) spectrograph with all-mirror optics have been ordered.

Mr. Elliott gave a course of lectures on general astronomy to Junior Sophister students in General Studies in Trinity College, Dublin in the Hilary Term, 1966.

Professor Wayman contributed to the Physics Students' Seminar held in University College, Dublin in January 1966.

Dr. Reid and Mr. Elliott attended, in April 1965, the NATO Advanced Study Institute Course on Planetary and Stellar Magnetism at Newcastle-upon-Tyne, and Dr. Reid contributed a paper.

Miss McKenna attended and contributed to the Summer Meeting of the American Astronomical Society in August 1965.

Professor Wayman attended the Second Colloquium on Variable Stars in Bamberg, Bavaria in August 1965.

Mr. Elliott attended in September 1965 the NATO Summer School in Solar Physics in Lagonissi, Greece.

Saturday open nights, often with more than two hundred visitors, were held eight times and some ten lectures by the staff to the Irish Astronomical Society in Dublin, Belfast and Armagh and to University and other groups were given.

Professor Wayman was elected a Member of the Royal Irish Academy in March 1966.

## 9. PUBLICATIONS

The following scientific articles by the staff or based on the work of the Section appeared or were accepted for publication during the year:

P. A. Wayman, L. S. T. Symms and K. C. Blackwell:

Proper Motions and Radial Velocities of Hyades Stars.  
Royal Observatory Bulletins, No.98, 1965.



S. M. P. McKenna:

The International Years of the Quiet Sun. Irish Astronomical Journal, 7, 4, 1965.

Flare Emission over a Strong Magnetic Field. The Observatory, 85, 121, 1965.

Positions of recurrent flares, July 1959, relative to the Calcium Network. Astronomical Journal, 70, 684, 1965 (Summary).

In the press:

P. A. Wayman:

Inertial Frames of Reference. Quarterly Journal.

Quasi-Stellar Radio Sources and Quasi-Stellar Galaxies. Irish Astronomical Journal.

I. Elliott and J. H. Reid:

Two Class 2 flares on 1963 September 16. The Observatory.

J. H. Reid:

Solar Flares and Magnetic Fields. Proceedings of NATO Advanced Study Institute, Newcastle-upon-Tyne, May 1965.

#### O. SUMMER MEETING OF THE ROYAL ASTRONOMICAL SOCIETY AT DUBLIN

The Royal Astronomical Society, invited by the Royal Irish Academy, held a Summer Meeting in Dublin in September 1965 in connection with the Centenary of the death of Sir William Rowan Hamilton, Andrews Professor of Astronomy in Trinity College and Director of the Dunsink Observatory from 1827 to 1865. An astronomical Colloquium on "High-energy particles in Astronomy" and a visit of Fellows to Dunsink were arranged as part of the programme, which also included a Joint Symposium with the Royal Irish Academy on the influence of Hamilton's work, an Ordinary meeting of the Society, a Geophysical Discussion on "Ice Ages", and a social programme. At the ordinary meeting Mr. Elliott showed a cinematographic film of Doppler-shifts in the H $\alpha$  line of the sun's spectrum.

Articles relevant to the Hamilton Centenary appeared as follows:

J. H. Reid: Sir William Rowan Hamilton (1805-1865). Irish Astronomical Journal, 7, 1, 1965.

P. A. Wayman: Summer Meeting and Hamilton Centenary, Dublin 1965. Irish Astronomical Journal, 7, 49, 1965.

The Summer Meeting of the Royal Astronomical Society at Dublin, 1965 September 6-9. The Observatory, 85, 221-240, 1965. (By the Editors).

P. A. Wayman: The Descendants of Sir William Rowan Hamilton. Irish Astronomical Journal (in the press).

The Presidential address delivered to the Royal Irish Academy on Sir William Rowan Hamilton at the time of his death was reprinted from the Proceedings of the Royal Irish Academy, Vol. IX, Part III, and circulated at the Centenary meetings.

B. Cosmic Ray Section.

1. STAFF AND SCHOLARS

Senior Professor:

C. Ó Ceallaigh.

Professor:

K. Imaeda.

Assistant Professor:

Vacant.

Research Assistant:

Miss M. Kazuno.

Technical and Clerical Staff:

Mrs. C. Halpenny (to 30 June 1965); Mr. J. Daly; Miss N. Leahy;  
Mrs. M. Collins; Miss M. Longmore; Miss E. Magee; Miss A. Smyth.

Scholars:

A. Thompson; T. P. Shah (to 20 January 1966); D. O'Sullivan.

2. RESEARCH WORK

Cosmic Ray Balloon Flights - Interactions at extreme high energy:

Professor Imaeda has completed his analysis of the distribution of transverse momentum of the secondaries of high energy interactions. The results were compared with the predictions of the statistical theory of multiple meson production. He has commenced an investigation of the utility of the isobar-fireball model to predict observable features of cosmic ray jets such as inelasticity four-momentum transfer and asymmetry.

Miss Kazuno has carried out direct evaluations of four-momentum transfer and collision inelasticity for cosmic ray jets using the physical properties of target particles. Interesting results were obtained and are being prepared for publication. The masses of the target isobars for final states of the interaction were calculated.

In collaboration with Drs. Peak and Woolcott of the University of Sydney, Professor Imaeda and Miss Kazuno have completed an investigation of the backward emission of pions from cosmic ray jets. The results of the investigation have been published (see Publications).

Professor Ó Ceallaigh has investigated the problem of testing for isotropy and anisotropy the azimuthal distribution of the secondaries of high energy interactions as represented by target diagrams (see Publications). With Dr. J. Avidan, formerly a scholar, he has examined a convenient statistical parameter which may be applied to target diagrams in order to test for the presence or absence of isotropy in azimuthal distribution. This work has been completed and is being prepared for publication.

IQSY-EQEX Balloon Expedition: Professor Imaeda and Miss Kazuno, assisted by Misses Longmore and Magee.

The scanning of jets and following cascades back to their origin was commenced using the emulsion chamber flown over India in the IQSY-EQEX Balloon Expedition of March 1965. A few jets were successfully followed back to origin, and these provide the most detailed information on jets so far obtained from this type of emulsion chamber.

European  $K^-$  Collaboration: Messrs. O'Sullivan, Shah and Thompson, assisted by Misses Leahy, Magee and Smyth and Mrs. Collins.

The collaboration continued throughout the year and was mainly concerned with the decay of hypernuclei which originate from the interaction of  $K^-$  mesons, at rest, with emulsion nuclei. This work provided the largest sample to date of mesonically decaying hypernuclei. The binding energies of many species of hypernucleus were determined with much greater precision than had been achieved hitherto. The accuracy of the binding energy values thus obtained, has afforded a means of detecting the existence of an isomeric state of the lambda helium seven hypernucleus, a possible violation of charge symmetry in the lambda-nucleon interaction and a number of other nuclear phenomena. Furthermore, the ratio of positive to negative pion decay in the case of the lambda helium four hypernucleus was estimated.

Collaboration meetings were held at the following centres and were attended by members of the Section named in brackets: CERN, Geneva, June 1965 (C. Ó Ceallaigh, D. O'Sullivan); London, August 1965 (A. Thompson); Dublin, January 1966 (D. O'Sullivan, T. P. Shah and A. Thompson).

Mr. A. Thompson carried out some initial work in the field of solid-state nuclear track registration with a view to assessing the practicability

of future work in that field in the Cosmic Ray Section. The results of his reading and experimental work have been embodied in a memorandum which will be circulated among members of the Board of the School. At the same time, Professor Ó Ceallaigh had useful discussions with Dr. P. B. Price of the General Electric Laboratories, Schenectady, New York, a pioneer in the field, who was on the visiting staff at the Tata Institute for Fundamental Research, Bombay. Dr. Price has expressed himself willing to receive members of the group at Schenectady and it is proposed to accept his invitation in the autumn of 1966.

During Professor Ó Ceallaigh's absence in India, the Section was visited at monthly intervals by Dr. P. V. March of Westfield College, University of London, in order to supervise the progress of work on the  $K^-$  Collaboration project.

Ionization-Velocity Curve for Photographic Emulsion in the Extreme Relativistic Region: Professor Ó Ceallaigh, Mr. O'Sullivan and Mr. Thompson assisted by Miss N. Leahy.

The investigation of the variation of ionization with velocity for nuclear photographic emulsion in the extreme relativistic region was continued in collaboration with workers from the Max Planck Institute für Physik, Munich, and the Naval Research Laboratory, Washington D.C., U.S.A. The source of ionizing particles was the new electron synchrotron at D.E.S.Y., Hamburg which produces electrons of energies of the order of  $\gamma = 10^5$ . Through the kindness of the Director and his senior colleagues, it has been possible to obtain two exposures, one in February 1965, in which Professor Ó Ceallaigh took part, and another in the summer of that year. Plates from both exposures have been examined in the Cosmic Ray Section. The short-term aim of the investigation is to search for the existence of the so-called Tsytovitich Effect, claimed to have been found experimentally by Zhdanov and his collaborators at the Lebedev Institute, Moscow. Evidence obtained to date appears to be inconclusive, and further exposures are planned.

A review incorporating earlier work in the School of Cosmic Physics was given by Professor Ó Ceallaigh at the CERN Easter School held at Bad Kreuznach in April 1965, and has been published in the second volume of the School (see Publications).

### 3. CONFERENCES AND COMMITTEES

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

The 1965 CERN Easter School of Physicists, Bad Kreuznach, Germany, April 1965 (C. Ó Ceallaigh, D. O'Sullivan).

The International Conference on Cosmic Rays, London, September 1965 (K. Imaeda, M. Kazuno).

The Third International Conference on Nuclear Structure, Brussels, September 1965 (D. O'Sullivan).

The Oxford International Conference on Elementary Particles, Oxford, September 1965 (A. Thompson).

Professor Ó Ceallaigh attended the various meetings of the Emulsion Experiments Committee at CERN, Geneva which took place before his departure for India, and also visited CERN, en route from India, for consultations with Dr. A. J. Herz concerning future exposures in connection with the Ionization Experiment (15-16 March, 1966).

The meetings of the European  $K^-$  Collaboration have been mentioned already (see Research).

### 4. PERSONAL

Professor Ó Ceallaigh was granted leave of absence by the Board of the School to accept an invitation to act as Visiting Professor at the Tata Institute of Fundamental Research, Colaba, Bombay (October 1965 - March 1966). During his stay there, he delivered a course of 40 lectures on the Theory of Probability and Statistical Analysis to a class of postgraduate students. He also lectured, by invitation, at the University of the Panjab, Chandigarh, and at the Osmania University, Hyderabad (Deccan).

Mrs. Halpenny relinquished her position as Acting Clerk to the Cosmic Ray Section on 30 June 1965. Mr. T. P. Shah, having submitted his dissertation to the University of Dublin, resigned his scholarship and returned to India on 20 January 1966. He has since been adjudged successful in his candidature for the degree of Ph.D. at that University.

5. SEMINARS

Two Seminars were held in the Section during the year:

- Dr. W. G. Galbraith (N.I.R.N.S.):  
Neutral K Mesons and the Fifth Force (23 April, 1965).
- Dr. D. H. Perkins (University of Bristol);  
Neutrino Physics (16 June, 1965).

6. WORKSHOP AND LIBRARY

Mr. Daly continued to maintain the scanning and measuring microscopes and other instruments. Work on the decoration and conversion of the 'Assembly Room' of the Cosmic Ray Section was initiated by the Office of Public Works. When completed, it is intended to instal the joint library of the Cosmic Ray and Geophysical Sections in this room which opens off the front office, and is convenient to the two Clerks of the Sections, part of whose duties will be to look after the library.

7. STATUTORY PUBLIC LECTURE

The Statutory Public Lecture was delivered by Dr. P. V. March (Westfield College, University of London) in Trinity College, Dublin, on 16 February, 1966. His subject was "Hyperfragment Studies".

8. PUBLICATIONS

K. Imaeda and T. P. Shah:

Primary Energy of "Jets" based on the Momentum and Angular Distributions of the Secondaries. Nuovo Cimento, 41, 405, 1966.

K. Imaeda, M. Kazuno, L. S. Peak and R. S. Woolcott:

Emission of  $\pi$  Mesons in the Backward Hemisphere in the l.s. of Cosmic Ray Jets. Nuovo Cimento, 43, 206, 1966.

D. O'Sullivan, T. P. Shah, A. Thompson (with others):

The Interactions of low energy  $K^-$  mesons with protons. Physics Letters, 16, 89, 1965.

D. O'Sullivan, T. P. Shah, A. Thompson (with others);

Production of Hyperfragments from the interactions of 3.0 and 5.0 GeV/c  $K^-$  mesons with emulsion nuclei. Nuovo Cimento, 41, 235, 1966.

D. O'Sullivan (with others):

The  $\pi^+$  mesonic decays of hypernuclei. Bulletin de l'Institut de Physique de l'Université de Bruxelles, No.25, 1966.

C. Ó Ceallaigh:

The Frequency Function of the Gaps Defined by Points Placed at Random on the Circumference of a Circle. Comm. Dublin Inst. Adv. Studies, Series B, No.2, Dec. 1965.

C. Ó Ceallaigh:

Variation of Ionization with Velocity. Proc. CERN Easter Sch. for Physicists, Bad Kreuznach, Vol.II, 89, 1965.

C. Ó Ceallaigh:

The Frequency Function of Arc-Length defined by Points Distributed Independently on the Circumference of a Circle following a Prescribed Law. Comm. Dublin Inst. Adv. Studies, Series B, No.3, Jan. 1966.

In preparation:

K. Imaeda:

$P_t$  distribution of the Secondaries from high energy nuclear interactions.



1. Geophysical Section.

1. STAFF AND SCHOLARS

Senior Professor:

Thomas Murphy.

Professor:

Vacant.

Research Assistant:

Vacant.

Senior Technical Assistant:

Thomas J. Morley.

Scholars:

I. Dixon (from 1 December 1965); B. Jacob (from 1 October 1965).

Research Associate:

Rev. G. McGreevy (Maynooth College).

Technical and Clerical Staff:

Miss Brenda Kennedy; Miss Ann Nolan; Mr. Kevin Bolster; Mr. John Fay (from 1 November 1965).

Extern Research Workers:

I. R. McAulay (Trinity College); A. Phillips (Trinity College).

2. EXPERIMENTAL AND FIELD WORK

a. Gravity:

The area in South East Wexford covering the Carnsore granite and Carboniferous Limestone was investigated and the results are being prepared for publication in collaboration with J. W. Baker (University College, South Wales and Monmouthshire).

Measurements were continued in Co. Mayo.

The collaboration with Dr. A. Lees of Reading University on the structure of the Central Plain was continued but difficulties in the geological analysis of the gravity field have held up the work.

Assistance was given to members of Durham University carrying out geophysical work in the Irish Sea.

The complete gravity data, 1955 to date, is being transferred to punched cards.

b. Magnetism:

The work on rock magnetism in collaboration with Professor J. H. Poole and Dr. I. R. McAulay was continued. Samples of Carboniferous volcanic rocks from Scotland collected by the Geological Survey of Great Britain have been measured.

In the magnetic survey of Ireland being carried out by the Meteorological Service the School's precession magnetometer is being used as an independent check on their results.

A magnetic survey by Dr. A. Phillips, assisted by students of Trinity College, was undertaken in Co. Mayo using the precession magnetometers. The results are being 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 progressing.

d. Seismology:

In a collaboration with Edinburgh University, one of their portable seismic stations was set up at Tullamore and operated from the beginning of July until the end of September. Recordings of explosions set off in the Irish Sea, a joint project with the British Navy and Birmingham and Edinburgh Universities, were taken. Records of "local events" have not yet been analysed by us.

Analysis of the long period seismic waves recorded at Valentia and neighbouring observatories was commenced and has yielded results regarding the earth's crust in these parts.

A study of the nearby origins of microseisms from the Valentia and other records has been undertaken and the preliminary investigations into "local events" commenced.

3. PUBLICATIONS

T. Murphy:

Deep alteration of Carboniferous strata in the Middleton, Co. Cork district as detected by gravity surveying. Proc. R.I.A. 64, B, 323-334.

4. CONFERENCES

Professor Murphy attended the conference on Recent Crustal Movements at Aulanko, Finland, in August 1965, the International Gravity Commission at Paris in September 1965, and the Conference on Crustal Investigations North Sea and Adjoining Countries at Utrecht in February 1966.

EDWARD J. CONWAY  
CHAIRMAN

21st December 1966