

INSTITIÚID BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

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
1962-63

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for the Financial Year 1962-63

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, 1963.

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 1963.

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, 1963.
- 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 1963.

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:

Dr. Michael Tierney, M.A., D.Litt., President, University College, Dublin;
Dr. Albert J. McConnell, M.A., M.Sc., Sc.D., Provost, Trinity College,
Dublin; Professor John L. Synge, M.A., Sc.D., F.R.S.C., F.R.S., President,
Royal Irish Academy.

Members appointed by the Governing Boards of the 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 M. A. Ellison, 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.

Appointed Members:

Miss Áine de Paor, M.A., Ph.D.; Reverend John Ryan, S.J., M.A., D.Litt.;
Reverend Francis Shaw, S.J., M.A.; Eamonn Mac Giolla Iasachta, M.A.,
D.Litt.; Ernest Gordon Quin, M.A., F.T.C.D.; Tomás de Bhaldraithe, M.A.,
Ph.D., D.Litt., M.R.I.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:

Albert J. McConnell, M.A., M.Sc., Sc.D.; George R. Keating, M.Sc.;
Reverend James R. McConnell, D.Sc.; Máirtín Ó Tnúthail, D.Sc.;
Patrick Quinlan, B.E., M.Sc., Ph.D.; David R. Bates, D.Sc., F.R.S.

4. THE GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS

Chairman:

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

Senior Professors:

Leo W. Pollak, Ph.D.; Cormac Ó Ceallaigh, M.Sc., Ph.D.;
Mervyn A. Ellison, D.Sc.

Appointed Members:

Eric M. Lindsay, M.A., M.Sc., Ph.D.; Reverend Patrick J. I. McLaughlin,
D.Sc.; Thomas Edwin Nevin, D.Sc.; Patrick J. Nolan, Ph.D., D.Sc.;
Mariano Doporto, D.Phys.Sc.; John J. McHenry, M.A. (Cantab.), D.Sc.,
F.Inst.Phys.; Cilian Ó Brocháin, M.Sc.; Ernest T. S. Walton, M.A.,
M.Sc., Ph.D., F.T.C.D.; Cyril F. G. Delaney, M.A., Ph.D.

5. ADMINISTRATIVE STAFF

Registrar:

Patricia O'Neill.

Senior Clerk:

Maura Devoy, B.A.

Clerks:

Mary A. O'Rourke, B.A.; Janet Dowling, D.P.A.

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

adopted at its meeting on 24th September 1963.

1. STAFF, SCHOLARS AND EXTERN RESEARCH WORKERS

Senior Professors:

Myles Dillon, Director of the School; Michael A. O'Brien (decd. 25th December 1962); Daniel A. Binchy.

Professors:

James P. Carney; Miss Cecile O'Rahilly; Proinsias Mac Cana.

Assistant Professor:

Rev. Cuthbert McGrath, O.F.M.

Visiting Professor:

Calvert Watkins (to 30 September 1962).

Assistant:

Louis Paul Nemo (Roparz Hemon).

Assistant (Part-time):

Mrs. Nessa Doran.

Research Associates:

Heinrich Wagner; Liam Price.

Technical and Clerical Staff:

Miss Máire Breatnach; Máire Bean Uí Chinnsealaigh.

Scholars:

Richard A. Q. Skerrett; Rolf Baumgarten; Máire Ní Chatháin (appointed 1 October 1962); Alan J. Bruford (appointed 1 October 1962); Miss Meinir Lewis (from 1 February 1963).

Visiting Scholar:

Professor Johnston of the University of Melbourne (from 1 February 1963).

Extern Research Workers commissioned by the School:

Rev. Anselm Faulkner, O.F.M.; Rev. Pádraig Ó Súilleabháin, O.F.M.; Rev. Bartholomew Egan, O.F.M.; Rev. Canice Mooney, O.F.M.; Dr. R. B. Breatnach; Dr. L. Bieler; Professor Idris Foster; Líl Nic Dhonnchadha; Gordon Mac Lennan; Professor Simon Evans; Professor Séamus Ó Néill; Mrs. Ruth Lehmann; an tAth. Pádraig Ó Fiannachta; Dr. Wolfgang Meid.

2. RESEARCH

Professor O'Brien was incapacitated through illness during the year and died on December 25th 1962.

Professor Binchy continued transcription of legal manuscripts for Corpus Iuris Hibernici. He worked with Professor Watkins on archaic verse texts and edited and saw through the press Ériu, Vol.XIX. Professor Binchy was appointed Visiting Professor of Celtic at Harvard University from 1st September 1962. While at Harvard he held courses of lectures on Elementary Old Irish and Insular Celtic Institutions. Two seminars were also held there - Readings in Archaic Old Irish and Readings in early Irish historical documents. An article on Patrick and his Biographers, Ancient and Modern appeared in Studia Hibernica, Vol.II. Two articles were published in Ériu, Vol.XIX - The Old Irish Table of Penitential Commutations and A Misunderstood Marginal.

Professor Dillon revised proofs of two volumes for the Mediaeval and Modern Irish Series. The editing of Celtica, Vol.VI occupied most of his time. Work was continued on The Celtic Peoples, a volume of the History of Civilisation to be published by Weidenfeld and Nicholson. Field-work for the Linguistic Survey was done in Donegal in November and some very good tapes were made. A seminar was held during the year on the interpretation and editing of a Middle Irish text. A lecture on The Coming of the Celts was delivered at the University of Wales on the O'Donnell Foundation and two lectures on Indo-European Heritage of Celts and Hindus (Lewis Fry Memorial Lectures) at the University of Cardiff. Advance copies of the Book of Rights appeared in February.

Professor Carney continued work on his forthcoming edition of the poems of Bláthmac for the Irish Texts Society, and on the Lambeth Palace glosses. A series of lectures on Irish literature was delivered at The Queen's University Belfast during the year under review.

Professor O'Rahilly worked on the final proofs of Cath Finntrágha (Vol.XX of the Mediaeval and Modern Irish Series) which was published in December 1962. Preparation of the text of LL Táin Bó Cúailgne continued. Translation of the text is now complete.

Professor Mac Cana was occupied mainly with the Studies in early Irish literary tradition which are now nearing completion. He collaborated with Mr. Garfield Hughes of the University College of Wales, Aberystwyth, in editing and translating five poems by the Welsh poet Llywarch ap Llywelyn.

Prydydd y Moch (c. 1173-1220). The first draft of a lengthy article on an aspect of Welsh syntax was prepared and material was collected for an edition of Fled Bricrenn. An article entitled On the use of the term Retic was completed for Celtica Vol.VII together with A note on the derivation of Ir. ac-so and Notes on several Irish forms with Welsh cognates. Professor Mac Cana devoted some time to acquiring a reliable working knowledge of Middle and Modern Breton and also to the study of Sanskrit.

Rev. Cuthbert McGrath, O.F.M. prepared material for the second volume of Dán na mBráthar Mionúr. Work was suspended on fifty articles for the third volume of Enciclopedia Agiografica owing to the unsatisfactory work of the Italian translator. While at University College of North Wales, Bangor, Fr. Cuthbert delivered lectures on Classical Irish to the staff and students and attended the full course of lectures on Old, Middle and Modern Welsh. An article entitled the Preterite Passive Plural in Bardic Poetry was published in Éigse X.

Professor Watkins's book Indo-European Origins of the Celtic Verb, 1 - The Sigmatic Aorist was published in July 1962. He checked proofs of two important articles for Celtica Vol.VI - Preliminaries to a Historical and Comparative Analysis of the Syntax of the Old Irish Verb; Indo-European Metrics and Archaic Irish Verse.

M. Hemon continued work on his Historical Dictionary of Breton. The fifth volume (dilezer-divizoud) appeared in July 1962 and the sixth volume is due to appear shortly. M. Hemon's edition of Trois Poemes en Moyen-Breton (Vol.I of the Medieval and Modern Breton Series), was published in October 1962. He is now working on an edition of two Middle Breton prose texts for the same series.

Mrs. Nessa Doran worked on Fasciculus I of the Catalogue of Irish Manuscripts in the National Library. MSS. 11, 12, 13 are now catalogued and work is continuing on MS. 8 - the last MS. of the 14 vellums which will comprise this Fasciculus. Mrs. Doran checked proofs of her three articles for Celtica Vol.VI - An English-Irish Vocabulary; Ó Conchubhair Chiarraige; The Rights of Mac Diarmada. The checking of proofs of Aidedh Muirchertaigh Meic Erca was also undertaken. These were returned to the Printer for revise in book form.

Professor Heinrich Wagner worked on proofs of Vol.II of the Linguistic Atlas and survey of Irish Dialects. The manuscript for Vol.III is now in preparation.

Mr. Liam Price continued work on the archive of Irish place-names. He prepared an article entitled Note on the use of the word baile in place names for Celtica Vol.VI

Mr. Richard Skerrett continued to work on the R.I.A. Contributions and to excerpt for the Dictionary of Classical Modern Irish. His work on the Irish version of Dialogus de Passione attributed to St. Anselm and known as Fiarfaidhi Sansalmuis progressed. Mr. Skerrett was granted leave of absence for six months from 1 October 1962 to take up an appointment as Assistant in the Department of Celtic at The Queen's University, Belfast. He also checked proofs of his article Two Irish Translations of the Liber de Passione Christi for Celtica Vol.VI.

Mr. Rolf Baumgarten continued work on an edition of the earliest text of the Book of Invasions and assisted Mr. Price in his work on Irish place-names.

Máire Ní Chatháin worked on the proofs of Betha Muire, an edition by Rev. S. Ó Catháin, S.J., and attended Professor Dillon's Seminar. Material for a study on the syntax of the verb in Irish was continued.

Mr. Alan J. Bruford worked on the text Eachtra Conaill Ghulban and attended Professor Dillon's Seminar. Much of his time was spent at the Irish Folklore Commission where his work was directed by Professor Delargy.

Miss Meinir Lewis studied the subject of 'The Orthography of Middle Welsh'. She attended Professor Dillon's Seminar. Miss Lewis also attended courses on Old, Middle and Modern Irish at University College, Dublin and on Modern Irish at Trinity College, Dublin. An article entitled Cyfnodan Orgraffyddol Hen Gymraeg was prepared for publication in The Bulletin of the Board of Celtic Studies.

Rev. Anselm Faulkner, O.F.M. corrected and returned first proofs of An Bheatha Dhiadha. The texts of An Bheatha Chrábhaidh and An Sgathán Spioradálta are in an advanced stage of preparation and the former will soon be ready for submitting to the Printer.

Rev. Pádraig Ó Súilleabháin, O.F.M. completed work on Lucerna Fidelium

which was published in February 1963. Two articles were contributed to Celtica Vol.VI - Scurry's Collection of Irish Words; Comhréir an Fhorainm Réamhthagraigh san Abairt Ionnis. Work on Buaidh na Naomhchroiche is in an advanced stage of preparation.

Rev. Bartholomew Egan, O.F.M. corrected final proofs of the text of Graméir Ghaeilge na mBráthar Mionúr. The preliminaries, notes and indexes were prepared for the Printer.

Rev. Canice Mooney, O.F.M. completed work on his edition of Seanmónta Chúige Uladh and submitted it for printing.

Dr. R. B. Breatnach continued his research and survey work on Déise morphology.

Lil Nic Dhonnchadha finished excerpting Cinn Lae Amhlaobh Uí Shúilleabháin for the Dictionary of Classical Modern Irish. She excerpted the poems of Aonghus Fionn Ó Dálaigh and Pilip Bocht Ó hUiginn and Díoghlaím Dána. Proofs of Aidedh Muirchertaigh Meic Erca - Vol.XIX of the Mediaeval and Modern Irish Series - were checked.

Dr. Ludwig Bieler checked the final proofs of his book The Irish Penitentials which will appear shortly as Vol.V in the Hiberno-Latin Texts Series.

Professor Idris Foster continued work on his edition of Kulhwch ac Olwen.

Mr. Gordon Mac Lennan checked proofs of his book Gàidhlig Uidhist a Deas and returned these to the Printer for revise.

Professor Simon Evans read the final proofs of A Grammar of Middle Welsh which will be published in the Mediaeval and Modern Welsh Series. Work progressed on The Life of Saint David, a further volume to be published in this Series.

An tAthair Pádraig Ó Fiannachta prepared and submitted 'copy' for Táin Bó Cuailnge from O'Curry Ms. 1.

Dr. Wolfgang Meid worked on an edition of Táin Bó Fraích for the Mediaeval and Modern Irish Series which was sent to the Printer in February 1963. The preparation of the Notes etc. is nearing completion.

Professor Séamus Ó Néill continued to work on the preparation of his edition of Bishop Gallagher's Sermons.

Mrs. Ruth Lehmann prepared an edition of Fled Dúin na nGéd, the text of

which was sent to the Printer in October 1962. First proofs were received and checked.

The Dictionary of Classical Modern Irish: Little progress was made during the year, but some excerpting was done.

Place-Name Research: During the year 1962-63 the examination of the place-names of the four counties Carlow, Kildare, Offaly (King's Co.) and Leix (Queen's Co.) has been continued. The making of cards for the names contained in the Calendar of Patent Rolls of James I and in the Leinster Chancery Inquisitions (1603 to 1641, and continued from Charles II's reign to the end of the century) has been completed for Carlow, King's Co. and Queen's Co., and the cards have been sorted into the indexes; work on these cards for Co. Kildare is proceeding. The names have also been extracted from the maps made about the year 1560 for use in the plantation of the territories of Leix and Offaly; most of them have been identified and are being added to the indexes; others will have to wait until the names contained in the sixteenth century Fiants have been dealt with. A manuscript copy of the description of the plantation of Leix and Offaly dated 1556 and 1557, made from the original in the Record Office, London, by Mr. Dean White, post-graduate student in Trinity College, Dublin, was kindly lent by him, and cards have been made for all the place-names contained in this document, and they are being compared with the names shown on the contemporary maps. Mr. Baumgarten has assisted in all these various stages of the work. Maps and notebooks have again been sent in by Ciarán Bairéad and Micheál Mac Enrí from Co. Galway and Co. Mayo and cards have been made for the place-names entered in them.

It will be necessary, as soon as a suitable worker or workers can be found, to go out into the country for the purpose of obtaining local pronunciation of names, finding out unrecorded names (probably there are a number of these in the Slieve Bloom mountain area), observing topographical details, collecting local stories about place-names, and so on.

Hiberno-Latin Texts Series: Work progressed on the preparation of two further volumes in this Series - Iohannes Scottus, Peri physeon (ed. Sheldon Williams) and Dicuil, De mensura orbis terrae (ed. Tierney). A prospectus

in connection with the Series was drawn up by Dr. Ludwig Bieler.

3. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture entitled Sedulius Scottus - A man of adequate piety was delivered by Professor James Carney at University College, Dublin, on 28th November, 1962.

4. SEMINAR

Professor Dillon held a seminar on the interpretation and editing of a Middle Irish text.

5. EXTERNAL ACTIVITIES

Professor Dillon delivered the O'Donnell Lecture at the four Colleges of the University of Wales on The Coming of the Celts, and the Lewis Fry Memorial Lecture at the University of Cardiff on the Indo-European Heritage of Celts and Hindus.

Two seminars were held by Professor Binchy while Visiting Professor at Harvard University. The subjects were Readings in Archaic Old Irish and Readings in early Irish historical documents. Two courses of lectures were also held by him, the subjects being Elementary Old Irish and Insular Celtic Institutions.

5. PUBLICATIONS

a. Books:

Corpus Genealogiarum Hiberniae, Vol.I. Edited by M. A. O'Brien.
pp.vii + 764. Price 63/- Published April 1962.

Proceedings of the International Congress of Celtic Studies, Dublin 1959.
Edited by Brian Ó Cuív. pp.xxvii + 132. Price 18/- Published
April 1962.

The Gaelic of Kintyre. By Nils Holmer. pp.160. Price 25/-
Published May 1962.

Indo-European Origins of the Celtic Verb. 1 - The Signific Aorist.
By Calvert Watkins. pp.203. Price 30/- Published July 1962.

Trois Poèmes en Moyen Breton. Edited by Roparz Hemon. pp.xxiv + 171.
(Mediaeval and Modern Breton Series, Vol.I). Price 15/-
Published October 1962.

- Cath Finntrágha. Edited by Cecile O'Rahilly. pp.xxxii + 123.
(Mediaeval and Modern Irish Series, Vol.XX). Price 8/6d.
Published December 1962.
- Twenty-Year Report of the School of Celtic Studies. pp.vii + 31.
Price 3/6d. Published January 1963.
- Lucerna Fidelium. Edited by Pádraig Ó Súilleabháin, O.F.M.
pp. xxii + 197. (Scribhinní Gaeilge na mBráthar Mionúr, Iml.V).
Price 21/- Published February 1963.
- Scéla Cano Meic Gartnáin. Edited by D. A. Binchy. pp.xxii + 123.
(Mediaeval and Modern Irish Series, Vol.XVIII). Price 7/6d.
Published February 1963.
- Dictionnaire historique de Breton. By Roparz Hemon.
Rann 5: Dilezer-divizoud
Rann 6: Divizour - E
Chataulin, Etienne, 1962/63.

b. Contributions to Periodicals:

- D. A. Binchy: Patrick and his Biographers, Ancient and Modern.
Studia Hibernica, Vol.II, 1-173.
- The Old Irish Table of Penitential Commutations.
Ériu, Vol.XIX, 47-72.
- A Misunderstood Marginal.
ibid., 121-2.
- The Old Name of Charleville, Co. Cork.
Éigse, Vol.X, 211-235.
- Myles Dillon: History of the Preverb to
Éigse, Vol.X, 120-126.
- Cuthbert McGrath, O.F.M.: The preterite passive plural in Bardic
Poetry.
Éigse, Vol.X, 144-148.

III - Report of the Governing Board of the School of Theoretical Physics
adopted at its meeting on 19th June, 1963.

1. STAFF AND SCHOLARS

Senior Professors:

John L. Synge, Director of the School; Cornelius Lanczos.

Professor:

Yasushi Takahashi.

Assistant Professor:

Lochlainn Ó Raifeartaigh.

Visiting Professor:

John C. Taylor.

Research Associates:

L. Bass; D. Judge; P. S. Florides (appointed May 1962).

Scholars:

Rev. C. Ryan (left September 1962); P. S. Florides (left April 1962); E. Ortiz; W. F. C. Purser (left November 1962); G. Rasche (left April 1962); A. I. Solomon (appointed April 1962); R. O'Connell (appointed June 1962); W. Henneberger (appointed October 1962); J. Gallivan (appointed October 1962); B. Gruber (appointed January 1963).

Student:

Rev. C. Ryan (appointed October 1962).

Technical Assistant:

Miss Evelyn Wills.

2. STUDY AND RESEARCH

In collaboration with Mr. Purser, Professor Synge continued work on the application of the Hamiltonian method to water waves. In collaboration with Dr. Florides, he investigated the (relativistic) gravitational field of a steadily rotating system, using a modification of the method previously used with success when the system has an axis of symmetry. The calculations involved in this work are intricate, and it has not been found possible so far to reduce the residual energy tensor outside the system beyond the third order in the density of the system. In the Newtonian theory of rotating systems, Professor Synge showed that the observed variation of the Sun's rotation with latitude establishes a theoretical relation between two small

quantities which lie outside the range of present observation - the deviation of the Sun's form from sphericity and the deviation of its gravitational field from that of a monopole.

The bulk of Professor Lanczos's research in relativity during the year was focused around the question of an undulatory Riemannian plateau of ultra-high frequencies. Einstein's hypothesis that the metric of the world is weakly Riemannian need not hold in sub-microscopic domains, since the possibility of high frequency oscillations around constant average values cannot be ruled out. This gives the picture of a four dimensional metrical lattice of four-fold periodicity which permeates the entire universe. Professor Lanczos showed that such a lattice of large amplitude variations can give rise to the macroscopic Minkowskian indefinite metric, although the true microscopic line element is of a positive definite character. He also found that the spectre of an "absolute reference system" generated by such a lattice (an objection raised by Einstein) in fact does not exist; the Lorentz transformations remain valid in macroscopic domains. Professor Lanczos also investigated the question of "noise", in relation to the Fourier series. If equidistant data are given which are subject to errors of a random nature ("noise"), the most effective method of smoothing the data is obtainable with the help of the Fourier series laid through the given data. Professor Lanczos analysed the Fourier coefficients and found the point at which the Fourier spectrum should be terminated, thus omitting the bulk of the noise. The resulting truncated series yields a smooth curve, which at the same time reduces the amplitude of the error by a gain factor which is proportional to the square root of the number of observations. The cooperation of Dr. J. G. Byrne, Trinity College, Dublin, in conducting the numerical experiments, using the IBM 1620 Electronic Computer, is gratefully acknowledged by Professor Lanczos. The investigation is continuing.

Dr. Ortiz investigated the convergence behaviour of the tau method for solving linear differential equations, and found a simple method of obtaining the "canonical polynomials" with the help of a simple recurrence scheme. He also made progress in his researches concerning the Hardy averaging operator, and obtained a well convergent numerical method for generating the upper bound of that operator in any given case.

Professor Takahashi worked on the following four subjects: i) relativistic quantization of fields; ii) bound-state problem; iii) strong-coupling theory; iv) the mass-difference of the muon and the electron. In the first of these he is trying to quantize fields without recourse to Lagrangian formalism, which is customarily employed. One great advantage of his formalism is that it can be applied to a covariant quantization of fields with higher spin. The logical consistency of the quantization is also manifest. In the second he proposes a formalism by which the difference between elementary and composite particles can be checked up experimentally. This is a generalization of Umezawa-Ezawa's theory of composite particles. In the third, by using a formalism proposed by him in Physics Letters, he has formulated a theory which can be applied to a system of strongly interacting particles. With Mr. Judge, he has treated rigorously Bogoljubov's transformation for polarons. In the fourth subject Professor Takahashi has interpreted the mass-difference of the muon and the electron in terms of gravitational interaction.

Professor Ó Raifeartaigh and Dr. Rasche completed their work on unitary and anti-unitary transformations in Hilbert spaces, and their application to physics, particularly to systems in which there are superselection rules. Professor Ó Raifeartaigh also studied the theory of dispersion relations, with particular interest in the possibility of using this theory to reformulate the theory of quantum electrodynamics in a convergent way.

Dr. O'Connell carried out research on the theory of weak interactions with particular emphasis on the decay modes of the Σ and K particles, and worked with Professor Ó Raifeartaigh on a generalisation of the Gell-Mann-Rosenfeld triangle for Σ decays. At the same time Dr. Ó Connell continued his investigations into the theory of internal conversion, and obtained exact analytical results for the K shell internal conversion coefficients for threshold values of the gamma-ray energy. An investigation of the possibility of extending these results to values of the gamma-ray energy away from threshold is now in progress. Dr. O'Connell also studied the dispersion relation method and the Regge pole hypothesis in elementary particle theory, as well as investigating the feasibility of obtaining a higher order term in the Sommerfeld-Laue expansion for the

relativistic Coulomb wave function.

Dr. Ryan was appointed a Student of the School of Theoretical Physics when his Scholarship ended in September 1962, and he went to Rochester University (N.Y.) for a year. He continued his investigations in the theory of weak interactions, explored certain consequences of the existence of the second neutrino, and suggested some new symmetry properties of weak interactions. He examined lepton production in high energy neutrino experiments with a view to determining whether the 1962 Brookhaven experiment provides unambiguous evidence in support of the two-neutrino hypothesis; calculations are still in progress, under the direction of Professor Marshak and Dr. Okubo. In collaboration with Professors Takahashi and Ó Raifeartaigh, Dr. Ryan studied certain aspects of the theory of generalised statistics, and obtained the representation of a certain generalised commutation relation. With Professor Sudarshan, Dr. Ryan has worked out all irreducible representations of a general parafermi ring of operators. Dr. Ryan has also been studying the theory of Regge poles.

Mr. Solomon's work during the year consisted of a continuation of previous investigations on the properties of the elementary particles, in particular their masses. The methods of quantum field theory are not yet sufficiently developed to permit more than a superficial treatment of what is undoubtedly a rather profound problem, and the calculations made were based on crude perturbation theory. The underlying hypothesis of this approach is that the masses of the particles, in part at any rate, may be deduced from their interaction self-energies. The results are not inconsistent with this hypothesis.

Dr. Henneberger worked with Rev. Professor J. McConnell on the statistical theory of pion production, and studied the many body problem. He also worked with Professor Ó Raifeartaigh on dispersion relations and Regge poles and commenced work on the application of Dyson's new Tamm-Dancoff method to the problem of an elastically bound electron interacting with the dipole part of the radiation field.

Mr. Gallivan devoted his attention mainly to quantum theory, being interested in the mathematical foundations, as expounded in von Neumann's well-known book, and in the theory of Hilbert spaces. Mr. Gallivan was

also interested, to a lesser extent, in the theory of relativity.

Dr. Gruber studied dispersion relations.

Mr. Judge applied Professor Takahashi's method of pseudo-canonical variables to the wave mechanical description of N-body motion in the centre of mass frame, obtaining results equivalent to those of Skinner. Mr. Judge also studied the L_z , ϕ uncertainty relation.

Dr. Bass worked along four different lines during the year: i) on dynamical similarity of vibrating models; ii) on the motion of test charges in rapidly oscillating electromagnetic fields; iii) on the elasticity and strength of composites; and iv) (current work) on irreversible interactions between metals and polar electrolytes.

Professor Taylor undertook research on partial wave amplitudes for production processes, involving a new description of the angular momentum of 3-particle states using rigid-body wave-functions. This work will be submitted to Physical Review in a joint paper with D. Branson and P. V. Landshoff. Dr. Taylor also carried out some preparatory work for a review article on weak interaction theory, to be published in Reports on Progress in Physics.

1. 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. L. Bass:

The motion of test charges in rapidly oscillating electromagnetic fields.

Dr. H. C. Corben (Imperial College, London):

A new approach to the theory of elementary particles.

Dr. L. J. Crane (Trinity College, Dublin):

High-speed jets.

Dr. S. Deser (CERN):

Conditions for flatness of an Einstein space.

Uniqueness of commutation relations in field theory.

Dr. P. S. Florides and Professor J. L. Synge:

Gravitational fields of rotating fluid masses.

- Mr. J. Gallivan:
The Einstein-Rosen-Podolsky paradox.
- Dr. W. Henneberger:
A synopsis of the statistical theory.
- Dr. K. U. Imaeda (School of Cosmic Physics):
Jets in cosmic ray physics.
- Dr. S. Kamefuchi (Imperial College, London):
Commutation relations and super-selection rules.
- Dr. T. W. B. Kibble (Imperial College, London):
Theory of measurements in finite space-time regions.
- Professor C. Lanczos:
The symmetric conservation laws in general relativity.
- Professor F. D. Murnaghan (David Taylor Model Basin, Washington, D.C.):
The evaluation, to a high degree of accuracy, of the probability integral.
On the converging factor for the exponential integral.
- Dr. R. O'Connell:
Dispersion theory approach to the static meson model and Chew-Low equation.
- Professor L. Ó Raifeartaigh:
A survey of the position in weak interactions.
Dispersion relations and pion-pion scattering.
- Dr. E. Ortiz:
Potential-type operators.
- Mr. W. F. C. Purser:
Application of Hamiltonian methods to water waves.
- Dr. G. Rasche (University of Zürich):
The Zachariasan model.
- Rev. C. Ryan and Professor L. Ó Raifeartaigh:
On commutation relations in quantum mechanics.
- Mr. A. I. Solomon:
Elementary masses.
Non-linear theories and elementary masses.
- Professor J. L. Synge:
Hamiltonian treatment of rays and waves (3 lectures).
- Professor J. C. Taylor:
An unexpected singularity in partial wave amplitudes.

4. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture, under the auspices of the School, was delivered in Trinity College, Dublin, on 11 December 1962, by Professor Lanczos. His subject was "Science and Understanding".

VISITING PROFESSORS

Dr. J. C. Taylor (University of Cambridge) was Visiting Professor,
16-31 March 1963.

VISITORS TO THE SCHOOL

Professor H. S. Green (University of Adelaide, S. Australia) 5 April 1962.

Dr. T. W. B. Kibble (Imperial College, London) from 21 to 25 May 1962.

Dr. G. Rasche (University of Zürich) from 28 September to 16 October 1962.

Dr. S. Kamefuchi (Imperial College, London) from 4 to 11 February 1963.

Dr. S. Desser (CERN) from 13 to 14 March 1963.

Dr. H. C. Corben (Imperial College, London) from 26 to 27 March 1963.

For lectures delivered by Visiting Lecturers, see Section 3.

SYMPOSIA

Mathematical Symposia were held on 17 - 18 April and 19 - 20 December,
1962. The attendances were respectively 54 and 48; 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:

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

Mr. T. T. West (Cambridge): Geometry of normed linear space.

Miss S. O'Shea (University College, Cork): Divergent trigonometric series.

Mr. R. McFadden (Queen's University, Belfast): Partially ordered semi-
groups.

Dr. P. D. Barry (University College, Cork): The maximum principle as a
tool in function theory.

December:

Dr. A. M. Arthurs (Queen's College, Oxford): Model hamiltonians in
scattering theory.

Professor L. Ó Ráifeartaigh: Some Newtonian concepts.

Dr. E. Ortiz: On certain functional equations.

Mr. A. I. Solomon: Elementary masses.

Mr. R. E. Harte (Cambridge): A Hahn-Banach theorem for modules.

8. EXTERNAL ACTIVITIES

Professor Synge attended the Summer Institute of the American Mathematical Society on "Relativity and Differential Geometry" at Santa Barbara, California, from 18 - 30 June 1962. He gave lectures there on "The World-Function in General Relativity", and "Approximate Solutions of Einstein's Field Equations". With Professor Ó Raifeartaigh, he attended a conference on Relativistic Theories of Gravitation, in Warsaw 25 - 31 July 1962, where Professor Synge delivered a lecture entitled "Relativistic Interpretations and Modifications of Newtonian Models". Professor Synge and Dr. Bass attended an International Congress of Mathematicians in Stockholm, 15 - 22 August, Professor Synge reading a paper entitled "The Hamiltonian Method applied to Water Waves", and Dr. Bass a paper entitled "The Motion of Test Charges in Rapidly Oscillating Electromagnetic Fields". On 12 December 1962 Professor Synge lectured on "Space-Time" to the Institute of Chemistry of Ireland. Dr. Bass lectured at the Autumn Meeting of the Institute of Metals at Swansea on 24 September, on "Fibre-reinforced Composite", and on 1 March at King's College, Newcastle-on-Tyne (University of Durham) on "Irreversible Interactions between Metals and Electrolytes".

Professor Lanczos continued the three months' leave of absence which he had commenced on 1 March 1962, as "Scientist in Residence" at the Institute of Science and Technology, Ann Arbor, and at the University of Michigan, and completed the course of six lectures there on "The Place of Albert Einstein in the History of Physics", and the graduate seminar on relativity mentioned in the previous report as having already commenced. He also conducted graduate courses on Tensor Calculus, and lectured on Einstein in Dearborn College, Flint College, and at Wayne State University. He lectured on "The Splitting of the Riemann Tensor" at the University of Michigan, and at Wayne State and Notre Dame Universities. He lectured on "Global Integration" at the Oak Ridge National Laboratory. The Tercentenary of the death of Blaise Pascal was commemorated at the Université de Clermont by a Colloque de Mathématique from 6 - 8 June 1962. Professor Lanczos attended this Colloquium and gave a lecture on "Intégration Globale". He again lectured on this subject at the University of Grenoble, and at the University of Manchester on 26 June. He conducted a one-day Colloquium at Hatfield

College of Technology on "Applications of the Chebyshev Polynomials", and lectured at Queen's University, Belfast, on "Some Properties of the Gamma Function", and on "Convergence by Weighting".

Professor Takahashi went to Japan on a year's leave of absence from September 1962, and gave the following lectures there: "On the Statistics of Elementary Particles" (Rikkyo University, Tokyo, 8 October 1962); "On the Statistics and the Spin of Elementary Particles" (Waseda University, Tokyo, 25 October); "On the Generalized Statistics of Elementary Particles" (Nihon University, Tokyo, 14 November); "Can one generalize the Statistics of Elementary Particles?" (Tokyo University, 23 January 1963); "Heitler's Non-Local Field Theory" (Kyoto University, 1 February); "The Structure of the Nucleon" (Tokyo University, 28 February).

Mr. Solomon lectured to St. Columba's Scientific Society on 19 February 1963, on "Cybernetics".

Dr. Ryan lectured at the University of Rochester on "Introduction to the Theory of Regge Poles" on 8 March, and on "Review of the New York Meeting Results" on 6 February.

9. PUBLICATIONS

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

a. Books:

Published:

Relativity: the General Theory. By J. L. Synge. Translated into Russian by B. T. Vavilov, edited by A. Z. Petrov, Moscow, 1963.

Variational Principles of Mechanics. By C. Lanczos. 2nd edn., University of Toronto Press, 1962.

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

None published.

c. Contributions to periodicals and other publications:

(1) Published:

J. L. Synge:

- * Review: Forces and fields. The concept of action at a distance in the history of physics. Mary B. Hesse. Edinburgh, Nelson, 1961. Nature 194 (1962), 47.

J. L. Synge (contd.):

- * Dynamics, Analytical. New York, Collier's Encyclopedia, 1963.
- * Relativity based on chronometry. Recent Developments in General Relativity (Volume dedicated to Prof. Infeld). Pergamon Press/Warsaw, PWN: 1962, pp.441-8.
- * Tensorial integral conservation laws in general relativity. International Colloquium on Relativistic Theories of Gravitation, Royaumont, France, 1959. Paris, Centre Nat. Rech. Sci., 1962, pp.75-83.
- * Review: The Natural Philosophy of Time. G. J. Whitrow. Edinburgh, Nelson, 1961. Brit. J. Phil. Sci. 13 (1962), 177-80.
- * Review: Roger Joseph Boscovich, S.J., F.R.S., 1711-1787. Studies of his Life and Work on the 250th Anniversary of his Birth. Edited by L. L. Whyte. London, Allen & Unwin, 1961. Brit. J. Phil. Sci. 13 (1962), 248-50.
- * Systematic approximations in the calculation of gravitational fields. Proc. Roy. Soc. A 270 (1962), 315-26.

Dynamical consequences of the fact that the Sun's rotation varies with latitude. Mon. Nots. Roy. Astron. Soc. 124 (1962), 275-8.

Water waves and hydrons. Science 138 (1962), 13-15.

Review: The Concept and the Role of the Model in Mathematics and Natural and Social Sciences. Edited by Hans Freudenthal, Dordrecht-Holland: D. Reidel Publishing Co., 1961. Philosophical Studies 12 (1963), 257-60.

W. F. C. Purser and J. L. Synge:

- * Water waves and Hamilton's method. Nature 194 (1962), 268.

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

The gravitational field of a rotating fluid mass in general relativity. Proc. Roy. Soc. A 270 (1962), 467-92.

A. J. Das:

- * A class of exact solutions of certain classical field equations in general relativity. Proc. Roy. Soc. A 267 (1962), 1-10.

C. Lanczos:

- * Variational principles of mechanics. Handbook of Engineering Mechanics, New York, McGraw-Hill, 1962. Part 2, ch.24 (23 pp.).

An integral approach to the calculus of variations. Studies in Mathematics and Related Topics (Essays in Honor of George Polya), edited by Gilbarg et al. Stanford Univ. Press, 1962. pp.191-8.

- * The splitting of the Riemann tensor. Rev. Mod. Phys. 34 (1962), 379-89.
- * Some properties of the Riemann-Christoffel curvature tensor. Recent Developments in General Relativity (Volume dedicated to Prof. Infeld). Pergamon Press / Warsaw, PWN, 1962, pp.313-21.

Y. Takahashi:

A canonical formalism with a linear supplementary condition.
I & II. Phys. Letts. 1 (1962), 278-9, 279-80.

S. Kamefuchi and Y. Takahashi:

* A generalization of field quantization and statistics.
Nuclear Phys. 36 (1962), 177-206.

Generalized commutation relations and statistics. Proc.
Internat. Conf. on High-Energy Physics at CERN 1962. Geneva,
CERN, 1962, pp.703-6.

L. Ó Raifeartaigh:

* On the validity of the crossing theorem. Nuclear Phys. 35
(1962), 571-81.

* Riemannian spaces of N dimensions, which contain Fermi subspaces
of N-1 dimensions. Proc. R.I.A. 62 A (1962), 63-72.

L. Ó Raifeartaigh and C. Ryan:

On a generalized commutation relation. Proc. R.I.A. 62 A
(1963), 93-115.

R. F. O'Connell and L. Ó Raifeartaigh:

On a generalization of the Gell-Mann-Rosenfeld triangle for
 Σ -decays. Phys. Letts. 3 (1963), 197-8.

C. Ryan:

A note on muon parity. Phys. Letts. 1 (1962), 135.

A doublet scheme for the leptons. Nuclear Phys. 36 (1962),
464-70.

A. I. Solomon:

Motion of a particle with spin in a non-homogeneous electromag-
netic field. Nuovo Cim. 26 (1962), 1320-24.

The nucleon electromagnetic mass difference. Nuovo Cim. 27
(1963), 748-50.

L. Bass:

The motion of test charges in rapidly oscillating electro-
magnetic fields. Proc. Phys. Soc. 80 (1962), 634-49.

Fibre-reinforced composite: Elastic moduli and strength of a
composite isotropic and homogeneous material. Aircraft
Production 25 (1963), 38-44.

Dynamical similarity of vibrating models. Machine Tools
Res. 1 (1962), 103.

(ii) In the Press:

J. L. Synge:

The Hamiltonian method and its application to water waves.
Proc. R.I.A.

J. L. Synge:

Review: Les Théories Relativistes de la Gravitation.
Editions du Centre National de la Recherche Scientifique,
Paris, 1962. Contemporary Physics.

C. Lanczos:

* Methodes locales et globales pour l'intégration des problèmes
de trajectoires. Comptes Rendus du Colloque sur l'Analyse
Numérique, Mons, 1961.

Undulatory Riemannian spaces. J. Mathematical Phys.

Intégration Globale. Blaise Pascal Memorial Volume,
Université de Clermont-Ferrand.

A. Schild:

* Gravitational theories of the Whitehead type. Proc.
International School of Physics "Enrico Fermi", Course 20,
1961.

Y. Takahashi and H. Umezawa:

Relativistic quantization. Nuclear Phys.

R. C'Connell:

K-shell internal conversion coefficients at threshold.
Nuclear Phys.

IV - Report of the Governing Board of the School of Cosmic Physics adopted at its meeting on 26th June 1963.

A. Astronomical Section.

1. STAFF AND SCHOLARS

Senior Professor:

M. A. Ellison.

Chief Assistant:

J. H. Reid.

Assistant:

Miss S. M. P. McKenna.

Scholar:

F. N. Byrne (appointed 1 February 1963).

Clerical and Technical Staff:

Mrs. M. Connolly (resigned 31 December 1962); Miss M. Callanan (appointed 11 March 1963); Mr. P. Murphy.

2. LYOT HELIOGRAPH AT THE CAPE

This instrument has now been in operation for four years. As mentioned in previous reports, its functions are to provide: (a) a cinematographic patrol of activity occurring in the sun's hydrogen atmosphere. The reports, based upon the 35 mm film pictures taken at 1-minute intervals, are distributed as quickly as possible to the various World Data Centres and others who require them; (b) materials for basic researches upon solar flares and their terrestrial effects. These studies include the influence of flare X-rays upon the ionosphere (sudden ionospheric disturbances) and the acceleration by flares of high-energy protons which are recorded by cosmic ray monitors, or by polar cap absorption effects, on the earth.

During 1962 the heliograph was operated on 276 days with a total coverage of 1567 hours, as compared with 296 days and 1652 hours in 1961. The best months of the year were January (30 days) and May (28 days).

The following table summarises the operation of the instrument and the number of flares recorded in each of the past four years:

Number of days of observation	Possible number of days	Class	FLARES					Total
			1-	1	2	3	3+	
1959: 258 (71% of possible)	365		475	307	61	6	0	849
1960: 284 (78% of possible)	366		399	249	22	4	2	676
1961: 296 (81% of possible)	365		170	112	10	0	2	294
1962: 276 (76% of possible)	365		63	67	7	0	0	137

These figures illustrate the continued decline of flare activity with the approach to solar minimum conditions which are expected in 1964.

The following publications, which include results obtained with the heliograph, have been printed during the year:

1. Monthly Notices of the Royal Astronomical Society 124, 263, 1962.
Cosmic ray flares associated with the 1961 July event. By M. A. Ellison, Susan M. P. McKenna and J. H. Reid.
2. Proc. Royal Institution, 38, 619, 1961.
Cosmic rays from the sun. By M. A. Ellison.

During the year the Continuous Movie* of solar activity for the period 1959 July 6 - 20 was completed by Dr. H. J. Smith at the Sacramento Peak Observatory on behalf of the International Astronomical Union. Of the eleven heliographs which contributed films for this production the Cape came second with a coverage of 53½ hours. The high coverage and the consistently uniform seeing throughout the day continue to be the most valuable features provided by the climate of the Cape.

Throughout the year the films have been developed at the Cape and despatched weekly to Dunsink for analysis and distribution of the results to Data Centres and other institutions. The work of analysis has been carried out by Dr. J. H. Reid and Miss Susan M. P. McKenna.

* Copies available from World Data Centre: Solar Activity, HAO Boulder, Colorado, U.S.A.

Dr. Reid has also carried out an extensive photometric survey of the plage regions on the films where important flares have occurred in order to study the changes which are induced by the flares: a preliminary account of these results and his studies of the nimbus phenomenon (first discovered on the Cape films) have been published in The Observatory (3).

The cost of films, electronic spares and replacements during the year amounted to £171. This sum was provided by the Dublin Institute for Advanced Studies. A considerable amount of maintenance was successfully carried out in the Cape workshops: this included the construction of a new shutter vane of stainless steel to replace the original one of aluminium, new bronze gear wheels for the shutter mechanism and the declination motor gear box, all of which showed serious signs of wear after four years of continuous use.

In conclusion, our thanks and appreciation are due to Her Majesty's Astronomer at the Cape, Professor R. H. Stoy, and to his staff who have maintained the heliograph in operation at a high level of efficiency throughout the year. This effort has provided a large body of material for present and future researches in solar physics.

3. SOLAR FLARE EFFECTS

The radio receivers which record the integrated level of atmospheric ionospheric layers on frequencies of 24 and 30 Kc/s were in operation throughout the year: 6 sudden enhancements of atmospheric ionospheric layers (S.E.A.s) indicative of D-layer ionization by solar flare X-rays, were recorded.

The direct recording Askania H-magnetograph performed continuously throughout the year. One solar flare effect (crochet) and 23 minor magnetic storms were recorded. Of the latter, 5 only began with a sudden commencement.

4. ANNALS OF THE INTERNATIONAL GEOPHYSICAL YEAR

Volume 23 of the Annals (4) was published during the year by Pergamon Press. This comprises the catalogue of Sunspot Magnetic Fields for the IGY together with an analysis and daily maps, as prepared at the Crimean Astrophysical Observatory under the direction of Professor A. B. Severny. Six solar observatories have contributed to this work. Material for the last

of the volumes of selected polar data, entitled Solar Radio-emission Data for the IGY is now complete and with the printers.

5. CONFERENCES AND VISITS

Professor Ellison attended the meeting of the Boyden Observatory Council, held at the Royal Observatory, Brussels, 16 - 17 May 1962. He also attended the Second Assembly of the CIG-IQSY Committee, held in Rome 18 - 23 March 1963, and acted as Chairman of the Solar Activity Working Group. Final plans were drawn up for the conduct of the observations to be made during the IQSY.

Dr. J. H. Reid attended the Summer School in Radio Astronomy held at Jodrell Bank, 26 June to 7 July 1962. Professor Ellison, Dr. Reid and Miss McKenna were present at the meetings of the Royal Astronomical Society held in Belfast 5 - 8 September 1962.

6. STAFF AND VISITORS

Miss S. M. P. McKenna was appointed to the vacant post of Assistant from 1 September 1962, having previously held the post of Royal Society IGY Research Assistant for three years.

Mr. Ian Elliott resigned his Scholarship at Dunsink on 31 March 1962. He was later awarded his M.Sc. Degree by Trinity College, Dublin and left in April to take up work at the Sacramento Peak Observatory, New Mexico. Dr. F. N. Byrne was appointed to the vacant Scholarship from 1 February 1963.

Mrs. Connolly resigned her post as Clerk on 31 December 1962, having acted as Secretary and Librarian since 1957. She was succeeded on 11 March 1963 by Miss M. Callanan.

7. PUBLICATIONS

The numbering corresponds with the references in the various sections of the Report.

- (1) M. A. Ellison, Susan M. P. McKenna and J. H. Reid:

Cosmic Ray flares associated with the 1961 July event.
Monthly Notices of the Royal Astronomical Society, 124,
263, 1962.

- (2) M. A. Ellison:
Cosmic Rays from the Sun. Proc. Royal Institution, 38, 619, 1961.
- (3) J. H. Reid:
Hydrogen Plage Regions and Great Solar Flares. The Observatory, 83, 40, 1963.
- (4) M. A. Ellison (editor):
Sunspot Magnetic Fields for the IGY. Annals of the International Geophysical Year, Vol.23 (Pergamon Press, London, 1962).
- (5) M. A. Ellison:
Energy Release in Solar Flares. Quarterly Journal of the Royal Astronomical Society, 4, 62, 1963.
- (6) Susan M. P. McKenna:
Solar Particle Emission. Astronomical Society of the Pacific, Leaflet 395, 1962.
- (7) Susan M. P. McKenna:
Wave Radiation from Solar Flares. Astron. Soc. Pacific, Leaflet 401, 1962.
- (8) Susan M. P. McKenna:
Solar Radio Interference as a function of frequency and time associated ionospheric disturbances. Institute of Electrical and Electronic Engineers, Communications Systems, D-5272, pp.65-74, 1963.

The Irish Astronomical Journal began publication again in March 1963.

It will be published quarterly under the auspices of the Observatories of Armagh and Dunsink.

B. Cosmic Ray Section.

1. STAFF AND SCHOLARS

Senior Professor:

C. Ó Ceallaigh.

Professor:

Vacant.

Assistant Professor:

K. Imaeda.

Assistant:

Miss M. Kazuno (appointed 1 January 1963).

Technical and Clerical Staff:

Miss C. Inight; Mr. J. Daly; Miss N. Leahy; Miss M. McGovern;
Miss M. Longmore; Miss P. Cully (resigned 28 September 1962);
Miss E. Cullen (appointed 17 September 1962).

Scholars:

Miss M. Kazuno (to 31 December 1962); A. Thompson; J. Avidan;
T. P. Shah; D. O'Sullivan.

2. RESEARCH WORK

The work of Mr. J. Avidan on the existence of anisotropy and asymmetry of emission in the Central Mass system of individual particles in high energy jets has been completed and is to be submitted for publication.

European K^- Collaboration: D. O'Sullivan, T. P. Shah and A. Thompson, assisted by Misses N. Leahy, M. McGovern and E. Cullen.

This Collaboration involving the Universities of Bristol, Warsaw and Brussels, together with University College and Westfield College, London and this Institute, has continued most successfully during the year. A stack exposed to a beam of K^- mesons of energy 1.3 and 1.5 Gev/c has been used to study the production and properties of hyperfragments and the results have been published during the year. It is planned to continue the investigation using stacks exposed to K^- beams of energy 3.0, 6.0 and 12 Gev/c. Mr. A. Thompson has assisted at CERN, Geneva with the exposures at the machine, and has gained much valuable experience.

A successful exposure to a beam of stopping K^- mesons was carried through

in March 1963, and the stack has been shared out among the participating laboratories in order to study the elastic scattering process of K^- mesons on protons at very low energies.

A number of meetings of the Collaboration has been held during the year at Dublin, Brussels and St. Cerque. They have been attended by representatives of the Cosmic Ray Group. Several papers dealing with this work have been accepted for publication, and one which has already appeared is listed under PUBLICATIONS.

Ionization-Velocity Relation in Photographic Emulsion: Professor Ó Ceallaigh, D. O'Sullivan, T. P. Shah and A. Thompson, assisted by Misses N. Leahy and M. McGovern.

Measurements on the plates exposed at the CERN P.S. on behalf of the Dublin-Bristol Collaboration have been carried out during the year, and they have been compared with the results of earlier work of Johnston, Ó Ceallaigh Shaukat and Prowse. The agreement appears to be satisfactory. On the other hand, our results are in definite disagreement with those recently announced by Zdanov and his co-workers at the Lebedew Institute, Moscow. Since the problem of the variation of ionization with velocity in the extreme relativistic region is of considerable interest, and must be regarded as unsolved, steps have been taken to obtain exposures to electrons of energy of the order of 1 Gev, in order to obtain material for further study.

I.C.E.F. Collaboration: Professor K. Imaeda, Miss M. Kazuno, assisted by Misses M. Longmore, P. Cully and E. Cullen.

The study of the material made available from this large international collaboration has been completed. It is intended to publish the results of the work in a special issue of the Supplemento to the Nuovo Cimento which is expected to appear towards the end of 1963.

The members of the Section taking part, in addition to contributing to the general work of the Collaboration, have carried out various studies of a theoretical nature bearing on the general problem of high-energy interactions some of which, already published, are listed under PUBLICATIONS.

3. CONFERENCES

The following International Conferences were attended by members of the Cosmic Ray Group:

The 1962 International Conference on High-Energy Physics at CERN, Geneva, 4 - 11 July 1962. (Professor Ó Ceallaigh).

The Bristol Conference on Extreme High Energy Physics, 7 January 1963. This was attended by all members of the Group. Professor Ó Ceallaigh acted as Chairman of the 3rd Session.

The Royal Society Conference on High Energy Nuclear Physics, Burlington House, London, 21 - 22 February 1963. (Professor Ó Ceallaigh).

The Emulsion Experiment Committee 'Jamboree', the CERN Easter School, and the International Conference on Hyperfragments held at St. Cerque, Vaud, Switzerland, 17 - 31 March 1963 were attended by Professor Ó Ceallaigh and Mr. A. Thompson.

4. COMMITTEES

British Emulsion Committee at N.I.R.N.S., Harwell: Professor Ó Ceallaigh attended two meetings of this Committee held at N.I.R.N.S., Harwell.

Emulsion Experiments Committee, CERN, Geneva: Professor Ó Ceallaigh was again coopted a member of the above committee, and attended all meetings.

5. SEMINARS AND VISITORS

During the year the following lectures were given by visitors to the School:

Dr. G. Alexander (Berkeley, Cal., U.S.A.) 5 and 6 November 1962:

Strange Particle Production in the Reaction $\pi^- + p$ at 1.7 to 2.2. GeV/c.

Recent Experiments in Strange Particle Properties done in Berkeley.

Dr. F. Farley (CERN, Geneva) 23 and 25 May 1962:

The Strange World of Sub-Atomic Particles (Statutory Public Lecture under the auspices of the School, at University College, Dublin).

The Anomalous Magnetic Moment of the μ -Meson.

6. WORKSHOP AND INSTRUMENTS

Mr. Daly has continued to maintain the microscopic equipment, and has constructed a number of instrumental devices for increasing the scope and accuracy of measurement of the equipment. Two Friden desk calculators

which had reached the end of their useful life, have been replaced by Sumlock 'Anita' electronic desk-calculators. So far, the performance of these machines which is quite silent and rapid has proved to be very satisfactory.

7. PERSONAL

Miss P. Cully resigned her position as scanner on 28 September 1962 and Miss E. Cullen has been appointed in her place. Miss M. Kazuno has been appointed to the Academic Staff as Assistant for a period of three years from 1 January 1963.

8. PUBLICATIONS

J. Avidan, K. Imaeda and M. Kazuno:

Preliminary Report on I.C.E.F. Collaboration Results.
Jour. Phys. Soc. Japan, A, III, 1962.

M. Kazuno:

An Investigation of a High-Energy Nuclear Interaction.
Nuovo Cimento, XXIV, 1013, 1962.

K. Imaeda:

An Investigation of Jets based on a Fireball Model.
Nuovo Cimento, XXVI, 417, 1962.

K. Imaeda and M. Kazuno:

Impact Parameter Approach to the Experimental Study of High Energy Jets.
Nuovo Cimento, XXVII, 119, 1963.

D. O'Sullivan, T. P. Shah and A. Thompson (Institute for Advanced Studies); with E. R. Fletcher (Bristol), J. Lemonne, P. Renard and J. Sacton (Brussels), P. Allen, Sr. M. Heeran and A. Montwill (U.C.D.), J. E. Allen, M. J. Beniston and D. A. Garbutt (U.C.L.), R. C. Kumar and P. V. March (U.C.L.) and T. Priewski and J. Zakrzewski (Warsaw):

Production of Hyperfragments from the Interactions of 1.3 Gev/c and 1.5 Gev/c K^- Mesons with Emulsion Nuclei.
Physics Letters, III, 280, 1963.

In the press:

R. H. W. Johnston:

A Special-Purpose Computer for the Analysis of Measurements of Multiple Scattering in Photographic Emulsion.
Electronic Engineering.

To be Published:

R. H. W. Johnston, C. Ó Ceallaigh, M. Shaukat and D. J. Prowse:

The Relation between Ionization and Momentum for Singly Charged Particles in G.5 Emulsion.

C. Ó Ceallaigh:

Tables for Reduction of Estimates of Ionization by Blob-Counting in Nuclear Emulsion.

(Already distributed in mimeographed form.)

In this connection it might be useful to quote from a letter dated Paris, 25 February 1963, received by Professor Pollak from Professor J. Bricard, Institut d'Optique, Faculté des Sciences de Paris as follows:

"I send you herewith a computation which I published recently on the attachment of small atmospheric ions on ultra-fine aerosols. This computation which makes it possible to evaluate your relation N_0/Z as a function of the radius of the aerosol particle leads to conclusions which verify perfectly your experimental results: (a) agreement with Boltzmann's law for high values of the radius; (b) for weak values, I find as exactly as possible your experimental values etc. - I propose to mention this in my report to the Conference on Atmospheric Electricity, as well as your papers on the state of ionic equilibrium of the air, published in *Geofisica Pura e Applicata* of 1961, of which I was unaware."

The experiments with a cloud chamber for investigating the ice-forming properties of natural and artificial aerosols consisting of three adjacent compartments have been concluded. The description of the cloud chamber and its properties, an outline of the measuring procedure, and examples of counts of freezing nuclei in Dublin are given in publication (v).

The composition of the sugar solution in which the ice crystals forming in the compartments are recorded, is detailed. The connection between the temperature of the sugar solution for melting and growing of ice crystals and for self-crystallisation of the sugar solution and the concentration of the sugar solution is discussed.

A small portable direct-beam photo-electric condensation nucleus counter has been constructed in the workshop of the Section and calibrated in our laboratory (viii). Its height is less than one third of that of the photo-electric nucleus counter, School of Cosmic Physics, Model 1957 with a corresponding reduction in weight but of approximately the same accuracy as the standard model.

The test of an approximation formula (suggested by T. A. Rich) for the rate of production of small ions is being continued. A rather elaborate set-up consisting of a large metal gasometer (contents 5000 m^3), two large rubber balloons, large and small ion counters, denuder and diffusion battery without end-pieces etc. has been built.

Due to the small size of the main laboratory of the Section the equipment of the set-up had to be accommodated in the two non-adjacent rooms calling for difficult connections between the two parts of the set-up.

The research reported above has been supported in part by the U.S. Army Research and Development Liaison Group and the General Electric Co., Schenectady, New York.

b. Professor T. Murphy:

The occurrence of the small Bouguer anomalies mentioned in last year's report was recorded in a paper and presented to the London meeting of the European Association of Exploration Geophysicists, May 22-24, 1962. The paper was accepted and printed in their Journal. Later it was reprinted by request in the "Oil and Gas International."

More work on this phenomenon was carried out to accumulate any further evidence to support the suggested explanation. The selected districts were a) Near Edenderry, b) North of Tralee and c) In the valley which runs from Cahir to Carrick-on-Suir. It appears from these that the cause does not lie in simple solutioning of the limestone but a fundamental geological process may also occur. Considerable assistance in this study is being obtained from some of the prospecting companies working throughout the country.

The regional gravity survey was continued in part of the counties of Longford, Roscommon and Galway in order to obtain the information necessary to complete sheet 4 of the gravity map. The latter was published as Geophysical Bulletin No.22 in December 1962. The final drawings and printing were carried out by the Ordnance Survey.

A preliminary set of gravity readings was taken in a selected area northwest of Roscommon to obtain any possible information concerning the existence of the continuation of the Southern Uplands Fault of Scotland. These readings show that there is a positive gravity anomaly coinciding with the known magnetic anomaly there (Memoir II) and that very steep gradients are to be expected. The area seems thus to be a fertile field for further study. By chance, this work coincided with a renewed interest by English Geologists in the establishment or the contradiction of the position of this fault as given by Bailey and Høltedahl.

The density measurements of the rock samples already collected was continued. Although the process has been speeded up by the introduction of better techniques it is still very time consuming. The present method enables samples up to 800 grams to be used which has proved convenient in measuring core samples, such as from the Oil Company's borings. The latter very readily gives us samples and any other scientific information if asked for.

During the year lectures were given by Professor Murphy to (a) The Geologists Society in Dublin, December 13, 1962; (b) The Mining and Quarrying Society in Birr, January 11, 1963; (c) The Geological Society of Liverpool University in Liverpool, February 28, 1963; and (d) The Scientific Society of University College, Dublin (Inaugural Meeting), March 8, 1963.

Professor Murphy attended the meeting of the Gravity Commission of the International Union of Geodesy and Geophysics in Paris, September 10-15, 1962.

3. PUBLICATIONS

- i T. A. Rich and L. W. Pollak & A. L. Metnieks:
On the time required for aerosols to reach electrical equilibrium.
Geofisica Pura e Applicata, Milano, Vol.51 (1962/1), pp.217-224.
- ii L. W. Pollak and A. L. Metnieks:
The approach to charge equilibrium in a stored aerosol during aging.
Ibidem, Vol.51 (1962/1), pp.225-236.
- iii A. L. Metnieks and L. W. Pollak:
On the particle size analysis of polydisperse aerosols using a diffusion battery and the Exhaustion Method.
Geophysical Bulletin, No.21 of the School of Cosmic Physics, Dublin, April 1962.
- iv L. W. Pollak and A. L. Metnieks:
On the validity of Boltzmann's distribution law for the charges of aerosol particles in electrical equilibrium.
Geofisica Pura e Applicata, Milano, Vol.53 (1962/III), pp.111-133.
- v L. W. Pollak and A. L. Metnieks:
A multi-compartment mixing-type cloud chamber for simultaneous determination of ice-nucleus concentration at various temperatures.
Ibidem, Vol.53 (1962/III), pp.133-142.
- vi T. Murphy:
Gravity Anomaly Map of Ireland: Sheet 4 - South East.
Geophysical Bulletin, No.22 of the School of Cosmic Physics, Dublin, December 1962.

vii T. Murphy:

Some unusual low Bouguer anomalies of small extent in central Ireland and their connection with geological structure. Geophysical Prospecting, The Hague (Netherlands), X (1962), pp.258-270.

Submitted for Publication:

viii L. W. Pollak and A. L. Metnieks:

A small portable photo-electric condensation nucleus counter.

4. U.S. ARMY CONTRACT DA-91-591-EUC-1282 and 1657

The contract terminated on 30 June 1962.

Quotation from a letter dated 19 July 1962, received by Professor Pollak from Colonel Charles D. Y. Ostrom, Jr., Chief of European Research Office, United States Department of the Army: "We are glad to have had the opportunity to support your research during the past two years. If, at any time in the future, you might care to submit a research proposal to this office for evaluation, please feel free to do so."

5. COLLABORATION WITH RESEARCH LABORATORY OF GENERAL ELECTRIC COMPANY IN SCHENECTADY, NEW YORK.

On the invitation of the General Engineering Laboratory, Professor Pollak stayed in the G. E. Company, Schenectady, N.Y. from the 13th to the 24th October 1962. During this period Professor Pollak had extensive discussions on subjects of common interest (Boltzmann's distribution law for the charges of aerosol particles in electrical equilibrium, small portable photo-electric nucleus counter just constructed in the workshop of the School, ionisation balance in a large closed vessel, conversion of trace gases into large ions).

Professor Pollak received and brought with him valuable material for the investigations now in progress in the laboratory of the Section.

No expenditure whatsoever has been incurred by the Institute in connection with this visit.

6. SYMPOSIUM ON SITE-TESTING OF THE INTERNATIONAL ASTRONOMICAL UNION IN ROME FROM 1st to 6th OCTOBER 1962.

On the suggestion of the U.S. Weather Bureau, Professor Pollak was

invited to act as expert for meteorological statistics at the Symposium No.19 of the International Astronomical Union in Rome from 1st to 6th October 1962.

No expenditure whatsoever has been incurred by the Institute in connection with his attendance.

7. METEOROLOGICAL AND GEOPHYSICAL SEMINAR

28th November 1962: Mr. W. J. Megaw, Health Physics Division U.K. Atomic Energy Research Establishment, Harwell: The nature of condensation Nuclei produced in Laboratory.

15th March 1963: Professor R. S. Scorer, Department of Mathematics, Imperial College of Science and Technology, London: The origins of Clear Air Turbulence; and Water and Ice Clouds - some common and some rare phenomena.

8. PERSONNEL

(a) On February 27, 1963, the Senate of the University of Dublin passed a grace for the conferring of the degree of Sc.D. honoris causa on Professor Dr. phil. L. W. Pollak.

(b) Extract from letter to Professor Pollak, dated July 3, 1962, signed by Dr. K. Spurny, Chairman of the organisation committee of the First National Conference on Aerosols with international participation, Prague, October 1962: "On the recommendation of Dr. Josef Podzimek from Geophysical Institute of C A S, the organisation committee of the Conference has elected you - as a person of great authority in the field of meteorology - into the International Advisory Council."

Professor Pollak did not attend the Conference.

(c) On the invitation of the Minister for Transport and Power (Mr. Childers), Professor Pollak attended the formal inauguration of the seismological observations at Valentia Observatory, Cahirciveen on 5th November 1962.

(d) Dr. A. L. Metnieks was elected Member of the Royal Irish Academy on March 16, 1962.

(e) Professor T. Murphy was elected Member of the Royal Irish Academy on March 16, 1963.

9. VISITORS

(a) Lt. Colonel William Jones, USAF, Chief, Physics Division, visited the laboratory of the Section on 21 May 1962.

(b) Mr. S. C. Coroniti, Section Chief, Geophysics, AVCO Corporation, Wilmington, Mass., U.S.A. visited Professor Pollak on May 14, 1962 in order to discuss the plans for the Third International Conference on Atmospheric Electricity which will take place in Montreux (Switzerland) from 6 to 10 May 1963.

(c) Mr. G. Severynse of the Physical Science Laboratory of the U.S. Weather Bureau stayed in our Laboratory from 31 July to 11 August 1962, during which time two of the four photo-electric counters made according to our specification in the workshop of the Weather Bureau were calibrated against our standard.

Quotation from Dr. F. W. Reichelderfer's (Chief of Bureau) letter to Professor Pollak dated July 6, 1962: "Our Physical Science Laboratory informs me that for some time now they have been operating the counters which they had manufactured from your specifications, and are exceedingly pleased and gratified with their performance. These instruments, of course, are still uncalibrated etc. Accordingly the Weather Bureau is now asking whether you would agree to Mr. Severynse of the Physical Science Laboratory, visiting you for this purpose."

In compensation for the calibration in our laboratory which took ten days, the Weather Bureau offered to carry out, free of charge, any computation we would require, on their large electronic computer, the monthly rent of which is \$60000.

(d) Mr. Elmar Robinson, Senior Meteorologist, Dept. of Atmospheric Chemical Physics, Stanford Research Institute, Menlo Park, California, U.S.A. on 14 and 15 February 1963. The Stanford Research Institute at present is carrying out an atmospheric research project, one part of which is concerned with condensation nuclei.

10. MISCELLANEOUS

(i) Standard Telephones and Cables Ltd. Information Processing Division, Newport, Mon. have - free of charge - computed for us extensive tables of F vs. radius accurate to 8 sign. figures (Geophys. Bull. No.20). The computation in question was estimated by the firm to cost £100.

(ii) Micro Methods Ltd., Wakefield, Yorks. have asked for permission to reproduce Dr. A. L. Metnieks's thesis (Geophys. Bull. No.15 of the School of Cosmic Physics) in micro recording.

(iii) Photo-electric Nucleus Counter. The following institutions and individuals who intend to make or have made for their own purposes copies of our photo-electric nucleus counter Model 1957, were supplied, on request, with our workshop drawing and our relevant publications or photograph of the instrument:

- (a) United Kingdom Atomic Energy Authority, Central Library, Atomic Energy Establishment, Winfrith, Dorchester, Dorset.
- (b) National Center for Atmospheric Research, Boulder, Colorado, U.S.A.

EDWARD J. CONWAY
CHAIRMAN

27th February 1964