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Pr. 3931

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  
to the Minister for Education in  
respect of the Financial Year

1955 - 56.

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

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its Constituent Schools presented by the Council  
for the Financial Year 1955-56

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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, 1956.

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 of the membership of the Governing Boards of the three Constituent Schools on the 31st March 1956.

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, 1956.
- 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.

1 - Constitution of the Council of the Institute and of the Governing Boards  
of the three Constituent Schools on the 31st March 1956.

1. THE COUNCIL OF THE INSTITUTE.

Chairman:

Right Reverend Monsignor Patrick Browne, M.A., D.Sc.,  
President, University College, Galway.

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;

Dr. James M. O'Connor, B.A., M.D.,  
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 Michael A. O'Brien, 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 Ernest T. S. Walton, M.A., M.Sc., Ph.D., F.T.C.D.;

Professor Hermann A. Brück, D. Phil, Ph.D.

2. THE GOVERNING BOARD OF THE SCHOOL OF CELTIC STUDIES.

Chairman:

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

Senior Professors:

Michael A. O'Brien, M.A., Ph.D.;

Daniel A. Binchy, M.A., Ph.D., B.L.;

Myles Dillon, M.A., Ph.D.

Appointed Members:

Miss Aine de Paor, M.A., Ph.D.;

Reverend John Ryan, S.J., M.A., D.Litt.;

Reverend Francis Shaw, S.J., M.A.;

Éamonn Mac Giolla Iasachta, M.A., D.Litt.;

Ernest Gordon Quin, M.A., F.T.C.D.;

Reverend Donnchadh Ó Floinn, 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:

Erwin Schroedinger, M.A., Ph.D., D.Sc., F.R.S.;

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.;

Thomas S. Wheeler, Ph.D., D.Sc., F.R.C.Sc.I.;

Reverend James R. McConnell, D.Sc.;

Máirtín Ó Thúthail, D.Sc.;

Patrick Quinlan, B.E., M.Sc., Ph.D.

4. THE GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS.

Chairman:

Ernest T. S. Walton, M.A., M.Sc., Ph.D., F.T.C.D.

Senior Professors:

Leo W. Pollak, Ph.D.;

Hermann A. Brück, D.Phil., Ph.D.;

Cormac Ó Ceallaigh, M.Sc.

Appointed Members:

John J. Dowling, M.A., F. Inst. Phys.;

Eric M. Lindsay, M.A., M.Sc., Ph.D.;

Rev. Patrick J. I. McLaughlin, D.Sc.;

Thomas Edwin Nevin, D.Sc.;

Patrick J. Nolan, Ph.D., D.Sc.;

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

Mariano Doporto, D.Phys.Sc.

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11 - Report of the Governing Board of the School of Celtic Studies adopted at its meeting on 6th June, 1956.

1. ACADEMIC STAFF, SCHOLARS AND EXTERN RESEARCH WORKERS.

Senior Professors:

Michael A. O'Brien, Director of the School;  
Daniel A. Binchy;  
Myles Dillon.

Professors:

James P. Carney;  
David Greene (resigned as from 30 September 1955 to take up the post of Professor of Irish in Trinity College, Dublin).

Assistant Professors:

Miss Cecile O'Rahilly;  
Rev. Cuthbert McGrath, O.F.M.

Assistant (Part-time):

Mrs. Nessa Doran.

Scholars:

Louis Paul Nemo (Roparz Hemon);  
Gearóid Mac Niocaill;  
Terence McCaughey (from 1 October 1955).

Extern Research Workers commissioned by the School:

Dr. R. I. Best;  
Mr. Seán MacAirt;  
Mr. Liam Price;  
Mrs. Mary Ellen Carney;  
Rev. Shan Ó Cuív;  
Mr. Brian Ó Cuív;  
Professor J. Vendryes;  
Rev. Seán Ó Catháin, S.J.;  
Dr. Tomás de Bhaldraithe;

Rev. Canice Mooney, O.F.M.;  
Rev. Anselm Faulkner, O.F.M.;  
Rev. Pádraig Ó Súilleabháin, O.F.M.;  
Rev. Bartholomew Egan, O.F.M.;  
Professor Heinrich Wagner;  
Dr. R. B. Breatnach;  
Mr. Seán de Búrca;  
Mme. Yves Marcel;  
Mrs. Celeste Davidson;  
Dr. R. L. Thomson;  
Professor Nils Holmer;  
Professor Robert T. Meyer;  
Mr. J. L. Campbell;  
Rev. Aubrey Gwynn, S.J.;  
Rev. G. S. M. Walker;  
Dr. L. Bieler.

2. GENERAL LINES OF RESEARCH WORK.

As usual, the main work of the School during the year lay in Irish studies, both early and modern; in the latter field the compilation of the material collected for the linguistic atlas progressed and work continued in other branches of linguistics and in dialect investigation. In other branches of Celtic Studies progress was reported in work on etymology and comparative literature and works on Welsh, Breton and Scottish Gaelic were in the press. The special Zeuss Memorial Volume edited by Professor Myles Dillon was published as Volume III of Celtica. Celtica Vol. IV was in proof by the end of the period under review. One volume in the Mediaeval and Modern Irish Series was published and another volume was sent to press. In the Hiberno-Latin Texts Series one volume was published, the second volume was in proof and progress was reported on the preparation of other volumes. The first volume in a series of Mediaeval and Modern Welsh texts was sent to press. The second volume

of the Book of Leinster was published, the third volume was in proof and the fourth volume was being prepared for press. At the end of the year under review six volumes were published, twenty volumes edited or written by members of the staff or by extern research workers were in the press and approximately forty others were in preparation.

A record of work in progress by individual members of the academic staff, scholars and research workers follows.

Senior Professors:

Michael O'Brien: Prepared material for Celtica IV (in the press); as co-editor with Dr. Best of the Book of Leinster edited Vol. II and revised Vols. III and IV and checked them with photostats and manuscript; continued work on Indexes of Vol. I (in the press) of Corpus Genealogiarum Hibernicarum and on the texts of Vols. II and III; work progressed on a new edition of the Old Irish Life of St. Brigid and on a new edition of the Feast of Bricriu; published a series of Grammatical and Etymological Notes in the Zeuss Memorial Volume of Celtica.

Daniel A. Binchy: Continued work on materials for the Corpus Iuris Hibernici, the first volume of which was ready for printing by the end of the period under review; commenced an edition of Scéla Cano Meic Gartnáin; contributed articles to the Zeuss Memorial Volume of Celtica and to Ériu Vol. XVII and edited the latter volume.

Myles Dillon: Post-graduate courses in Old and Middle Irish were given to individual students. The Zeuss Memorial Volume of Celtica was seen through the press. The draft translation of the Book of Rights was completed. Three volumes, now at the press, edited by extern research workers, were revised and read in proof.

Professors:

James P. Carney: Published Studies in Irish Literature and History; work continued on the preparation of a Catalogue of Irish Manuscripts in the National Library; progress made on an edition of the Old Irish poems on the Virgin Mary. Completed an article for the Festschrift to R<sup>o</sup>ke Campbell.

David Greene: Edition of Fingal Ronain and Other Stories published in the Medieval and Modern Irish Series; continued work on the proofs of Duanaire Mhéig Uidhir; published article on Geminatio in Celtica III - Zeuss Memorial Volume.

Assistant Professors:

Miss Cecile O'Rahilly: Commenced work on an edition of the Stowe version of the Táin Bó Cuailgne and carried out extensive collation of the text with other versions; work on the Dictionary of Classical Modern Irish continued; revised proofs of a Welsh text (Llyfr Marchwriaeth) to appear in Celtica IV.

Rev. Cuthbert McGrath, O.F.M.: Revision of 'copy' and preparation of Vocabulary, Notes etc. for second volume of Dán na mBráthar Mionúr still in progress; corrected proofs of Brian Mac Giolla Phádraig for Celtica IV returned to printer; several articles prepared for Celtica V; other articles prepared for publication in Wadding Memorial Volume and Éigse.

Assistant (Part-time):

Mrs. Nessa Doran: Completed Nos. 46-69 of a descriptive Catalogue of Irish Manuscripts in the National Library under the supervision of Professor Carney.

Scholars:

Roparz Hemon: Continued work on a historical Grammar of Breton and on Contributions to a historical Dictionary of Breton; article for Celtica IV prepared; final revision of an edition of Christmas Hymns in the Vannes Dialect now passed for press.

Gearóid Mac Niocaill: Worked on an edition of the Duanaire Meic Shuibhne and prepared several articles for Celtica IV and Éigse.

Terence McCaughey: Attended courses in Celtic Studies at both Dublin Universities and received special instruction from Professor Dillon.



Extern Research Workers:

Dr. R. I. Best: Continued work on an edition of the Book of Leinster. Vol.II was published, Vol.III was in the press and Vols.IV and V were in preparation. A paper on the MS. Laud 610 appeared in the Zeuss Memorial Volume of Celtica.

Seán MacAirt: Work progressed on the indexes and translation of a new edition of the Annals of Ulster the text of which was in the press.

Liam Price: Work continued on the Place-names of Co. Wicklow.

Mrs. Mary Ellen Carney: Work continued on the Irish version of the Aphorisms of Hippocrates.

Brian Ó Cuív: Continued work on palatography and published an article in the Zeuss Memorial Volume of Celtica.

Joseph Vendryes: Work continued on an Etymological Dictionary of Irish; published an article on the Impersonal Use of the Verb in the Zeuss Memorial Volume of Celtica.

Rev. Seán Ó Catháin, S.J.: Edition of Betha Muire revised.

Tomás de Bhaldraithe: Article prepared for Celtica IV.

Rev. Canice Mooney, O.F.M.: Revised proofs of an edition of Seanmónta Chuige Uladh.

Rev. Anselm Faulkner, O.F.M.: Work progressed on a critical edition of An Bheatha Chrábhaidh.

Rev. Padráig Ó Súilleabháin, O.F.M.: Continued work on editions of three texts - Beatha San Froinsias; Lucerna Fidelium; and Buaidh na Croiche.

Rev. Bartholomew Egan, O.F.M.: Continued work on an edition of O'Hussey's and O'Mulconry's grammars.

Heinrich Wagner: Completed collection of material in various counties for the Irish Linguistic Atlas and commenced compilation of the first volume; commenced revision of proofs of Gaeilge Theilinn.

R. B. Breatnach: Continued preparation for the press of Déisi Irish materials left by the late Archbishop Michael Sheehan and carried out general investigation of Déisi Irish.

Mme. Yves Marcel: Revised proofs of text on the Life of Pope Gregory from MS. Rawl. B 477 for Celtica IV.

Mrs. Celeste Davidson: Completed the English translation of Thurneysen's Die irische Helden- und Königssage.

R. L. Thomson: Prepared and sent to press an edition of Pwyll Pendeluc Dyuet for the new series of Mediaeval and Modern Welsh texts.

Nils Holmer: Prepared a monograph on the Scottish Gaelic dialect of Arran which was in proof at the end of the period under review.

Robert T. Meyer: Prepared and sent to press an edition of Merugud Uilix Maic Leirtis for the Mediaeval and Modern Irish Series.

J. L. Campbell: Revised proofs of Fr. Allan McDonald's Collection of Words from South Uist.

### 3. LECTURES AND CONFERENCES.

Professor Dillon gave two lectures at the Royal Society of Antiquaries on the Sources for Early Irish History.

In January 1956 Professor Carney lectured on Beowulf to the Philological Society of Uppsala.

The following members of the staff contributed to the 1955 series of Thomas Davis Lectures broadcast from Radio Éireann:-

Professor Dillon: The Wooing of Étaín;

Professor Binchy:	<u>Sagas in the Law Tracts;</u>
Professor O'Brien:	<u>The Feast of Bricriu;</u>
Professor Carney:	<u>Cath Muighe Muccramha;</u>
Professor Greene:	<u>Táin Bó Cuailgne.</u>

Professor Carney represented the Institute at the International Conference on the Onomastic Sciences which was held at Salamanca from 12th to 16th April 1955.

4. STATUTORY PUBLIC LECTURE.

The Statutory Public Lecture under the auspices of the School was delivered by Professor Myles Dillon in Trinity College, Dublin on Tuesday, 6th March 1956. Professor Dillon's subject was The Book of Rights.

5. PUBLICATIONS.

a. Books		Date of Publication
SEAN-CHAINNT THEILINN. By Seán Ó hSochaidh. pp.viii + 146.	Price 7s.6d.	28/6/55
FINGAL RÓNÁIN. Edited by David Greene. (Mediaeval and Modern Irish Series, Vol.XVI). pp.vi + 88.	Price 5s.	21/7/55
THE LATIN WRITINGS OF BISHOP PATRICK. Edited by Aubrey Gwynn, S.J. (Scriptores Latini Hiberniae, Vol.I). pp.147.	Price 25s.	7/10/55
STUDIES IN IRISH LITERATURE AND HISTORY. By James P. Carney. pp.xi + 412.	Price 42s.	31/12/55
CELTICA - Vol.III, Zeus Memorial Volume. Edited by Myles Dillon. pp.344 + 5 plates.	Price 30s.	25/1/56
THE BOOK OF LEINSTER, Vol.II Edited by R. I. Best and M.A. O'Brien. pp.xi + 470 + 2 plates.	Price 30s.	28/3/56

b. Contributions to Periodicals

- M. A. O'Brien: A Middle-Irish Poem on the Christian Kings of  
Leinster. *Ériu*, XVII, 1955.
- D. A. Binchy: Bretha Nemed. *Ériu*, XVII, 1955.  
Irish Law Tracts Re-edited, I. *Ériu*, XVII, 1955.
- Nyles Dillon: The Syntax of the Irish Verb. Transactions of the  
Philological Society, 1955.  
Les Sources irlandaises du roman d'Arthur. *Études  
Romanes*.
- Gearóid Mac Niocaill: De dispositione corporis Mariae.  
*Éigse*, VIII, 1, 1955.  
Disiecta Membra. *Éigse*, VIII, 1, 1955.

111 - Report of the Governing Board of the School of Theoretical Physics adopted at its meeting on 16th May, 1956.

1. ACADEMIC STAFF AND SCHOLARS

Senior Professors

Erwin Schrödinger, Director of the School; retired 31 March 1956;  
John L. Synge;  
Cornelius Lanczos.

Assistant

Ernesto Corinaldesi; resigned 31 July 1955.

Research Associates:

Stephen O'Brien;  
Mrs. Sheila Tinney.

Scholars:

H. F. Sandham;  
J. R. Pounder; left August 1955;  
B. Bertotti;  
F. A. E. Pirani; left September 1955;  
L. Bass;  
E. Bellomo;  
B. K. P. Scaife; left October 1955;  
N. C. Sil; entered October 1955;  
Rev. P. McHugh; entered October 1955.

2. GENERAL LINES OF RESEARCH WORK

A series of lectures on Expanding Universes, which had been delivered at the seminar by Professor Schrödinger, was prepared for publication and is about to issue from the Cambridge University Press. He prepared for printing a collection of older essays to be published in the U.S.A. together with a reprint of "What is Life?" (printed five times since 1944

at the Cambridge University Press). He was also engaged in writing up his Turner Lectures (on "Mind and Matter") for Cambridge, but could not yet deliver them owing to ill-health.

Dr. Bass investigated in more detail the interaction of possible longitudinal light waves with matter. Though their influence (if any) can, according to experimental and theoretical evidence, be but extremely small, with regard to microscopic systems, the astonishing result was obtained that they might remove an ostensible difficulty in accounting for the heat economy of our planet, whose measured heat flow through the surface is many times too small for carrying away the heat produced by radioactive decay, unless a rather strained hypothesis on the distribution of radioactive material is made, more or less ad hoc. It is this hypothesis of an unlikely distribution of radioactivity, which is rendered unnecessary if the existence of longitudinal photons is admitted.

Dr. Bertotti completed his work on the motion of charged particles in general relativity, in which the equations of motion of two such bodies are derived up to the first relativistic corrections. Then continuing on these lines he found an interesting direct connection between the Lagrangian for the field equations and the geodesic principle. In the search for a rigorous approach to the problem he is now studying some properties of the relativistic "perfect fluid"; as far as the actual approximation is concerned, he is also examining the possibility of a new method in which no restriction is demanded on the velocities of the bodies (the usual procedure being valid for "quasi-stationary" conditions only).

Dr. Bellomo completed and published his work on the structure of the classical electron. He studied the structure and stability of compound nuclei, and the theory of continuous Lie groups and their application to nuclear physics.

Dr. Scaife continued his work on the theory of dielectrics, and after an extended correspondence with Professor H. Fröhlich (Liverpool) submitted a paper on dielectric polarization in polar substances for

publication. Discussions with the referees regarding this paper are still in progress. Dr. Scaife also studied electrostriction, the effect of a transverse electric field on the viscosity of a fluid, ferroelectricity, and the value of the dielectric constant of water; and he extended a theorem due to Fröhlich.

During the period April-December Professor Synge had little time for research, being occupied with the publication of his book on Relativity (Dr. Pirani collaborated in the proof correction), and also with the writing of an article on Classical Dynamics for the new edition of the Handbuch der Physik. In the period January-March, when he was on leave of absence in the U.S.A., he carried out research in the theory of elasticity, directing calculations of torsional rigidity on SEAC (the electron computer at the National Bureau of Standards), and also developing a new approach to the general theory of elastic waves in anisotropic media, a subject of interest to geophysicists.

Dr. Pirani, supported by a Rutherford Memorial Fellowship of the Royal Society of Canada, completed his work on the theory of the expanding universe and prepared a further paper for publication. He continued his work on the theory of the Foucault pendulum and investigated the theory of the gyroscope in general relativity, using Papapetrou's spinning test-particle as a model. This work is being prepared for publication.

Mr. O'Brien continued his work on the statistics of collisions of relativistic particles with intrinsic angular momentum.

Mr. Pounder worked at the theory of rigid motions in general relativity, studying the equations recently given by Salzman and Taub.

Professor Lanczos continued his investigations on the rôle of the adjoint operator in the eigenvalue problem of linear differential equations. He found a general method of constructing the Green's

function with the help of the double system of orthogonal functions associated with any non-Hermitian problem. This gives a new basis for the discussion of arbitrary under-determined or over-determined linear systems. He also investigated a method for obtaining upper and lower bounds for the energy levels of excited states which does not depend on a knowledge of the lower energy levels. Another line of research was the motion problem of a particle in general relativity. The Einsteinian conservation laws do not lead to the establishment of a dynamical principle since they lack symmetry. A modified procedure shows that the symmetric conservation laws exist. On the basis of these conservation laws a dynamical law can be established which corresponds to Newton's law of motion with a correction term caused by the reaction of the field on itself.

Father McHugh started an investigation of the elastic vibrations of a cube, and the possibility of using the Debye potentials for the solution.

Mr. Sil devoted much of his time to an investigation of the capture of electrons by protons passing through hydrogen, employing a new mathematical technique. Although the Schrödinger equation is not directly solvable in this case, the approximation obtained promises to be satisfactory for the case of sufficiently small velocities.

Dr. Corinaldesi derived the equations of the two-body problem of general relativity by a Hamiltonian method based on an expansion of the general co-variant Lagrangian in powers of the gravitational constant and using the techniques and the viewpoint of the quantum theory. He found that, within the approximation in which they have so far been calculated, the equations could have been obtained identically from a linear theory of gravitation.

Mr. Sandham studies generalisations of the quadratic transformations of hypergeometric functions and of the known theorems on the products of pairs of hypergeometric functions. He is also writing a Ph.D. thesis, entitled "The products of hypergeometric functions".



3. SEMINAR AND LECTURES

Throughout the year, as in previous years, the seminar lectures 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 two physics Schools of the Institute.

During the summer term a series of single lectures and short courses was given. Dr. Bass spoke on "Must the photon mass be zero?"; Professor Lanczos on "Adjoint differential operators and Green's function"; Mr. Pounder on "The initial-value problem for the wave equation in  $N$  dimensions"; Dr. Pirani on "Relativistic cosmology and the steady state theory".

In the first winter term Professor Schrödinger gave a course of lectures on objections to the probability interpretation, and this was followed by courses by Professor Lanczos on the conservation laws of general relativity, and on the action principle of general relativity. Dr. Bass spoke on the clock paradox, and on non-vanishing rest-mass; Dr. Bertotti spoke on gravitational motion and Hamilton's principle.

In the second winter term Rev. Professor J. R. McConnell (Maynooth) lectured on the theory of the negative proton. This course was followed by a series of three lectures by Professor McCusker, (i) on the origin of cosmic radiation, (ii) cosmic radiation and the upper atmosphere, and (iii) experiments in cosmic rays. Professor Lanczos lectured on the symmetrization of linear operators, and on Green's function and the bilinear expansion; and Professor Nevin (University College, Dublin) spoke on nuclear reactors for research. During this term private colloquia were held twice a week among the Scholars, at which they informally presented reviews of topics connected with their research. Dr. Bellomo spoke on nuclear forces; Dr. Bertotti spoke on the basic principles of group theory and its application to quantum mechanics, and also on the mathematical theory of the Earth's magnetism.

4. STATUTORY PUBLIC LECTURES

The Statutory Public Lectures were delivered, under the auspices of the School, in University College, Dublin, on December 6 and 13, 1955, by Professor Lanczos. His subject was: Albert Einstein - His life and his work. Mimeographed copies of these lectures were distributed to interested individuals and organisations.

5. VISITING LECTURERS

While on a private visit to Dublin Dr. W. Heitler visited the School, and lectured to the seminar on the self-stress problem, on March 16, 1956.

6. EXTERNAL ACTIVITIES

Professor Schrodinger attended and lectured at the International Conference on elementary particles which took place at Pisa from June 11 to 17, 1955, under the auspices of the Italian Physical Society; he also took part in the meeting of the Austrian College at Alpbach, from August 19 to September 8. In July he was awarded the degree of LL.D. (h.c.) in the University of Edinburgh. On November 10, 1955, he lectured on "The physical basis of consciousness" at Trinity College, Dublin.

Professor Synge gave five lectures on "Hamilton's method in the relativistic theory of waves, particles and photons" at a Mathematical Colloquium at St. Andrew's, Scotland (14 - 22 July). He visited University College, Galway (14 - 15 November), giving a popular lecture on "The concept of time", and two lectures to students on the theory of elasticity. During January, February and March he was on leave of absence in the United States and Canada. For most of this period he was Consultant at the National Bureau of Standards, Washington, D.C.; for one week he was Consultant at the University of California at Los Angeles. He visited a number of universities, and gave lectures as follows: "Classical dynamics and de Broglie waves", at New York University, Princeton University,

Brown University, Ballistics Research Laboratories (Aberdeen, Maryland), Carnegie Institute of Technology, University of California at Los Angeles, National Bureau of Standards, University of Maryland, and the University of Toronto; "Geometrical optics in moving media" at Harvard University and the University of California; "Elastic waves in anisotropic media" at the Massachusetts Institute of Technology, National Bureau of Standards, University of California, Iowa State College, and the University of Toronto; "The concept of time" at the National Bureau of Standards; "Stationary principles for forced vibrations in elasticity and electromagnetism" at the Symposium on Applied Mathematics of the American Mathematical Society in Chicago.

An invitation was extended to Professor Lanczos by the Université de Louvain, to visit the university from May 8 to 15, 1955, and to report on his investigations concerning the eigenvalues of large matrices, particularly in connection with the new electronic computers. He had extended discussions with the directors of the Mathematical Centre of Belgium, Professor C. Manneback and Canon G. Lemaitre, on various problems of numerical analysis. He gave a public lecture in Louvain on "Eigenvalue analysis by minimized iterations". Later he visited the new electronic calculator of the Mathematical Centre at Antwerp, and while there gave a further lecture on the same topic. A lecture tour to England from February 5 to 11, 1956, was organized by Dr. C. V. L. Smith of the Office of Naval Research. On February 7 Dr. Lanczos addressed the Physics Seminar of Professor R. Furth, Birkbeck College (University of London), on the subject "The motion problem of general relativity"; on February 8 he addressed the Mathematical Seminar of Professor A. C. Offord, Birkbeck College on "Green's function and the bilinear expansion". He spoke to the University Mathematical Laboratory at Cambridge (director: Professor M. V. Wilkes) on February 9 on "Spectroscopic eigenvalue analysis"; and on February 10 he visited the Mathematics Division of the National Physics Laboratory in Teddington, Middlesex, and had detailed discussions with Dr. E. T. Goodwin and other members of the staff. At a meeting of the Dublin University Mathematical Society on February 27, 1956, Dr. Lanczos spoke on "Quadrature methods".

Dr. Corinaldesi and Dr. Pirani attended the Berne Conference on relativity, from July 10 to 16, 1955, where Dr. Pirani delivered a paper entitled "On the definition of inertial frames in general relativity", which is now in course of publication. Dr. Pirani also assisted Dr. Brück in the organisation of the International Astronomical Union Conference, which was held in Dublin from August 29 to September 5, 1955.

On March 8, 1956, Dr. Bass lectured at Imperial College (University of London) on "Radiation with finite rest-mass and the heat balance of the Earth".

## 7. PUBLICATIONS

### (1) Books:

#### (i) Published:

Relativity. The Special Theory. By J. L. Synge. North-Holland, Amsterdam; 1956.

#### (ii) In the press:

Expanding Universes. By E. Schrödinger. University Press, Cambridge.

Collection of older essays, together with a reprint of "What is Life?". By E. Schrödinger. Doubleday Doran, New York.

### (2) Contributions to periodicals:

#### (i) Contributions recorded as in the press in previous reports:

E. Schrödinger: The wave equation for spin I in Hamiltonian form. Proc. Roy. Soc. A, 229, 39, 1955.

L. Bass and E. Schrödinger: Must the photon mass be zero? Proc. Roy. Soc. A, 232, I, 1955.

B. K. P. Scaife: The high temperature susceptibility of a lattice of permanent dipoles. Phil. Mag. Ser. 7, 46, 903, 1955.

J. L. Synge: The motion of a viscous fluid conducting heat. Q. Appl. Math. 13, 271, 1955.

- C. B. Rayner: The effects of rotation of the central body on its planetary orbits, after the Whitehead theory of gravitation. Proc. Roy. Soc. A, 232, 135, 1955.
- F. A. E. Pirani: On the perihelion motion according to Littlewood's equations. Proc. Camb. Phil. Soc. 51, 535, 1955.
- (ii) New contributions:
- E. Schrodinger: The wave equation for spin 1 in Hamiltonian form. II. Proc. Roy. Soc. A, 232, 435, 1955.
- E. Bellomo: Sul moto di un elettrone finito e la corrispondenza con l'elettrone puntiforme nella meccanica classica relativistica. Il Nuovo Cim. Ser. 10, 2, 456, 1955.
- B. Bertotti: On the motion of charged particles in general relativity. Il Nuovo Cim. Ser. 10, 2, 231, 1955.  
Gravitational motion and Hamilton's principle. Il Nuovo Cim. Ser. 10, 3, 655, 1956.
- B. K. P. Scaife: On the molecular theory of electrostriction. Proc. Phys. Soc. B, 69, 153, 1956.
- J. L. Synge: A technique for the solution of the biharmonic equation. Atti del Convegno internazionale sulle equazioni alle derivate parziali, Trieste, 1954, p. 39. Rome, Cremonese, 1955.  
Review of N. I. Muskhelishvili: Some basic problems of the mathematical theory of elasticity (trans. Radok. Groningen, Noordhoff, 1953, 3rd edn.). Bull. Amer. Math. Soc. 61, 445, 1955.
- L. Infeld and J. L. Synge: Gap problem in antenna theory. J. Appl. Phys. 27, 310, 1956.
- J. R. Founder and J. L. Synge: Note on the initial-value problem for the wave equation in N dimensions. Proc. R. I. A., 57 A, 151, 1955.
- L. Bass and F. A. E. Pirani: On the gravitational effects of distant rotating masses. Phil. Mag. Ser. 7, 46, 850, 1955.
- C. B. Rayner: Whitehead's law of gravitation in a space-time of constant curvature. Proc. Phys. Soc. B, 68, 944, 1955.

- C. Lanczos: Spectroscopic eigenvalue analysis. J. Wash. Acad. Sciences, 45, 315, 1955.  
Science and society. Icarus, 5, 31, 1955.
- E. Corinaldesi: Quantum field theory and the two-body problem of general relativity. Il Nuovo Cim. Ser. 10, 1, 1289, '55. The two-body problem in the theory of the quantized gravitational field. Proc. Phys. Soc. A, 69, 189, 1956.

(iii) The following contributions were in the press at the end of the period under review:

- L. Bass: Radiation with finite rest-mass and the heat balance of the Earth. Il Nuovo Cim.
- J. L. Synge: Elastic waves in anisotropic media. J. Math. Phys. Stationary principles for forced vibrations in elasticity and electromagnetism. Proc. Symposium Appl. Math. (Amer. Math. Soc.)
- C. Lanczos: Albert Einstein and the theory of relativity. Supplement to Il Nuovo Cim.
- H. F. Sandham: Rogers' function and Thebault triangles. Amer. Math. Monthly Mag.  
A square and product of hypergeometric functions. Q. J. Math.  
Generalisations of Gauss's quadratic transformation of the hypergeometric function. J. Lond. Math. Soc.

IV - Report of the Governing Board of the School of Cosmic Physics adopted at its meetings on 30 April and 6 November 1956.

A. Astronomical Section.

1. ACADEMIC STAFF AND SCHOLARS.

Senior Professor: H. A. Brück.

Chief Assistant: M. J. Smyth

Assistant: G. I. Thompson.

Research Associate: Máire T. Brück.

Scholar: B. G. Tunmore (from 1 July 1955).

2. EQUIPMENT.

The construction of the new 28-inch reflector has been completed and the telescope has been mounted in the dome on the roof of the main building.

Part of the solar installation has been changed and the coelostat arrangement, in particular, has been rebuilt. It consists now of a twin set of mirrors of 16 inch and 8 inch apertures which feed respectively the solar telescope and the spectrohelioscope, and whose secondary mirrors are mounted together on a polar axis.

Suitable vacuum equipment has been installed and it is now possible to aluminise all mirrors of the observatory with the only exception of the 28-inch for which a larger vacuum tank than the existing one is to be set up.

3. RESEARCH WORK.

Solar Work:- Dr. Thompson has continued his photometric programme on the ultra-violet spectrum of the Sun. He has been able to secure further sets of plates with the reconstructed solar installation. He has been engaged chiefly on the difficult analysis of the region between

3400 and 3600 A. Intensity records and results on equivalent widths of spectrum lines have been communicated to Professor Minnaert of Utrecht as a contribution to the proposed Table of Equivalent Widths of Fraunhofer Lines.

Dr. Thompson has worked also on the theoretical interpretation of equivalent widths which is difficult in the ultra-violet region of the solar spectrum, since no detailed theory of the continuous absorption coefficient exists yet for this part of the spectrum where severe blending of lines provides additional problems. Dr. Thompson has developed a theory which is to be tested by spectrograms to be taken in the visible region.

Dr. M. T. Brück has started work on the NH-band at 3360 A in the solar spectrum.

Stellar Work at Dunsink:- Some first tests have been made of the performance of the new 28-inch reflector and the attached photoelectric photometer. This photometer which has been constructed by Dr. Smyth with the assistance of Mr. Tunmore is of the pulse-counting type. Intensities are recorded in terms of the number of pulses which are registered by sets of decatron valves. Three such registers make it possible to "interlace" observations on three objects and thus to reduce effects of atmospheric variations. The photometer can effectively resolve pulses more than 3 microseconds apart. Its lower limit of sensitivity depends on the duration of the counts and on the accuracy required. A standard counting time of one minute and an accuracy of one per cent correspond (at the 28-inch reflector) to a star of the 13th magnitude. Fainter stars can be measured by counting for a longer period.

The new installation is to be used chiefly for spectrophotometric observations and in particular for measurements of total intensities of the interstellar absorption band at 4430 A whose origin is still unknown, but whose strength appears to be correlated with interstellar reddening and polarisation.



Spectral separation is to be carried out by means of interference filters with narrow band widths and high transmission. Dr. Smyth has been able to produce such an all-dielectric interference filter with 17 layers in the Physical Laboratories at Manchester where he spent a fortnight in May. The filter has a band width of only 20 Å and a transmission of over 50 per cent. Its peak transmission varies over a range of 400 Å between 4250 and 4650 Å along a distance of 10 cm.

The observatory has agreed also to take part in a combined photometric programme in which 16 observatories, fairly equally spaced in longitude over the earth, are to make photometric and spectroscopic observations during a specified period of the important variable star  $\iota$  Lacertae.

Stellar Work with the ADH-Telescope:- Dr. G. I. Thompson spent the period from April to July at the Boyden Station, Blomfontein, South Africa, to work on open star clusters with the ADH-telescope. Though hampered by instrumental trouble and poor weather conditions, Dr. Thompson was able to collect some 60 plates of 6 clusters in red, yellow and ultra-violet.

#### 4. CONFERENCE ON THE BOYDEN STATION.

The functioning of the Hamburg-Agreement on the future operation of the Boyden Station was reviewed at a meeting of five members of the new Administrative Council which took place at the Royal Belgian Observatory at Uccle, Bruxelles, and which Professor Brück attended. General agreement was reached on the division of programmes and on the general administration.

Harvard's part-ownership of the ADH-telescope has now been transferred officially by the authorities of the Harvard Corporation to the observatories at Armagh and Dunsink.

#### 5. ASSEMBLY OF INTERNATIONAL ASTRONOMICAL UNION.

Some time was spent preparing for the 9th General Assembly of the International Astronomical Union which took place in Dublin between

August 29 and September 5. Some 600 astronomers and 200 guests came to the meeting, representing 38 countries in all five continents. The meeting has in this way been the best attended and most representative meeting which the Union has held so far. An account of the meeting for Irish readers has appeared in the March 1956 issue of the Irish Astronomical Journal.

#### 6. VISITORS.

The observatory has been visited by nearly all delegates to the meeting of the International Astronomical Union and their guests. Other visitors included the Taoiseach and Mr. Éamon de Valéra.

The observatory has been open to the public as usual on the First Saturday of each month and these "open nights" have been as popular as ever.

#### 7. STATUTORY PUBLIC LECTURES.

Two Statutory Public Lectures delivered under the auspices of the School of Cosmic Physics were given by Professor H. A. Brück in the Physical Laboratory, Trinity College, Dublin on 6th and 13th March 1956. Professor Brück's subject was Radio Astronomy.

#### 8. PUBLICATIONS.

Contributions from the Dunsink Observatory Nos. 8 and 9 have now been published.

No.8 H. E. Butler: An Indirect Method of Starcounting ("Vistas in Astronomy" London, 1955);

No.9 H. A. Brück and Máire T. Brück: The Solar Installation of Dunsink Observatory ("Vistas in Astronomy" London, 1955).

Among non-technical articles is an account of the 9th Assembly of the International Astronomical Union by Professor Brück in the Irish Astronomical Journal, Vol.4, 2, 1956.

B. Cosmic Ray Section

1. ACADEMIC STAFF AND SCHOLARS.

Senior Professor: C. O'Ceallaigh.

Professor: C. B. A. McCusker.

Scholars: R. H. W. Johnston (entered 1 October, 1953; appointed to Studentship 1 October, 1955).

L. J. Crane (entered 1 October, 1954; resigned 1 October, 1955).

J. G. Dardis (entered 1 January, 1955; resigned 1 June, 1955).

R. J. Reid (entered 1 January, 1956).

Gideon Alexander (entered 1 January, 1956).

2. RESEARCH WORK.

The year 1955-56 was one of great activity in the Section. Work using photographic plate and counter techniques was continued, and again very satisfactory progress may be reported.

The G-Stack plates were delivered on 31 January, 1955. During the session the work was continued and successfully completed. This stack was the largest ever flown and the examination and measurements were carried out through a close collaboration between the nuclear plate groups of the Universities of Bristol, Copenhagen, Dublin Institute for Advanced Studies, University College, Dublin and the Universities of Genoa, Milan and Padua. Some 300 K-decay events were found in all; of those the Dublin Institute for Advanced Studies contributed 50. The aims of this research project have been set out in the Report for the Financial Year 1954-55 and it is not thought necessary to repeat them. A preliminary report of the results was published in an unsigned article in Nature and in the Proceedings of the Pisa Conference, and the final paper appeared in Il Nuovo Cimento 11, pp. 1063-1103, November 1955. For the final discussion and collation of the results and the composition of the final draft of this paper, Professor O'Ceallaigh returned to Italy in September 1955.

He also took part in the flying of new stacks at Mirandola near Modena and visited the Laboratory of the École Polytechnique on his return through Paris.

Pisa Conference: - The International Conference on High Energy Nuclear Physics was held at Pisa, 12 - 18 June, 1955. Professor O'Ceallaigh, Professor McCusker and Dr. Johnston attended the Conference. All contributed papers and took part in the discussions. The Senior Professor was invited to act as Chairman of one of the sessions. He also reported, on behalf of the G-Stack Collaboration, the results of the work on the  $\chi$ -decay mode of K-mesons. In addition, an extension of experimental work originally carried out by him to support his theory of gap-formation between the developed grains of photographic emulsion was reported by Winzeler (Berne) and by Fowler and Perkins (Bristol). Professor O'Ceallaigh received an invitation to attend the Sixth Annual Conference on High Energy Nuclear Physics to be held at the University of Rochester, N.Y. 3-7 April, 1956.

Dr. R. H. W. Johnston made two journeys to the H. H. Wills Physical Laboratories, University of Bristol to help with processing the stacks and with the cutting of the plates, after their division among the collaborating laboratories.

Machine Exposures in U.S.A.: - At the Pisa Conference the first results of study of the properties of K-mesons produced by the 6 Bev Bevatron at Berkeley, California were described. In so far as they were comparable, these were in agreement with those already described in the preliminary report of the G-Stack Collaboration. In addition, the machine results furnished for the first time accurate mass-values of primary K-particles which underwent decay according to the various established modes. No statistically significant difference in mass could be established. A further point of interest in comparing the machine with the cosmic ray results was that owing to the longer path lengths those particles of which the decay was observed had lived for times of  $\sim 10^{-8}$  secs compared with times  $\sim 10^{-10}$  sec in cosmic ray exposures. If the particles decaying by

the various established modes were in fact distinct, one might expect differences in the relative abundance of the particles due to possible difference in life-time. At the time of the Conference, comparison between machine and cosmic-ray results failed to show any significant difference in the relative frequency of the various decay modes, but it should be observed that the weight of available statistics was small.

Thanks to the generous and far-seeing policy of those responsible for the organization and construction of the Bevatron, the individual laboratories composing the G-Stack Collaboration have been granted facilities for exposing stacks of plates at the machine. To date, two stacks of plates have been exposed to the  $K^+$  'beam' at the Bevatron. The first allocation to this laboratory was 10 plates from the stack  $K_1$ . This was afterwards sold to Copenhagen in exchange for a much larger share (50 plates) from the second exposure.

Stack  $K_2$ :- Since starting work on these plates in July 1955, our scanners have found some 2000 examples of K-decay compared with 50 examples in 6 months scanning of the G-stack plates.

The problems at present being studied in these plates are: -

- (a) The relative frequencies of the K-decay modes  $K_\mu, \chi, K, \tau, \tau'$ , and  $K_\rho$ .
- (b) The nature of the spectra of the three-body decay modes  $K, \tau$  and  $K_\rho$ .

Among 1500 cases of K-decay some 150 examples in good geometry have been studied to date, yielding the following preliminary estimates of relative frequency: -

	Number	%
$K_\mu$	78	51 $\pm$ 5.7
$\chi$	42	27.5 $\pm$ 4.2
$\tau$	10	6.5 $\pm$ 0.6
$K$	11	7.2 $\pm$ 2.1
$\tau'$	6	3.9 $\pm$ 1.6
$K_\rho$	6	3.9 $\pm$ 1.6
Total	153	100

This includes 10 cases contributed by Dr. E. F. Fahy, University College, Cork. Work on these problems is being continued.

Counter Work - Time Variation of Cosmic Ray Showers: - An analysis of the results of one complete year's run with a penetrating shower set under 20 cms of lead showed a variation with sidereal time of extensive penetrating showers. A year's run with the six M units set up in March 1955 showed a variation of extensive air showers of high electron density with solar time. This variation is  $180^{\circ}$  out of phase with the previously observed solar variation of local penetrating showers.

A second penetrating shower set was brought into operation in November, 1955 and the older set was rebuilt and brought into operation again early in 1956. At the same time, 6 additional M-units were added to the, by now, large array. In addition 3 large shielded trays, separated by about 4 metres from each other, were arrayed to study extensive penetrating showers.

In order the better to study the sidereal effect, work has been begun with two cloud chambers. By using these with their axis at right angles, it was expected that the direction of extensive showers might be determined to within  $\pm 2^{\circ}$  in contrast with the estimated  $\pm 20^{\circ}$  of the penetrating shower sets above. In fact preliminary work with the magnet cloud chamber suggests than an even better accuracy, of the order of  $\pm \frac{1}{2}^{\circ}$  may be attained.

The results of the work at Dublin have made it very desirable to erect similar stations at different latitudes - both for the study of solar and sidereal effects. For the former a station within the tropics would be best. Accordingly, the Air Research and Development Command of the United States Air Force was approached. In February 1956, Captain Berge and Dr. Otting of this Command came to Dublin to discuss the project and see the apparatus. As a result of this visit, Professor McCusker has submitted a formal proposal to the Command. The estimated cost of the experiment is about \$ 40,000.

3. INSTRUMENTS AND WORKSHOP.

During the year 1955-56 a further Cooke M.4000 scattering and measuring microscope has been purchased. Two Reichert stands have been fitted in our workshop by Mr. J. Daly with the special Bannister kinematic stage. The new lathe referred to in the report for 1954-55 has been delivered. Some difficulty was experienced with the head which had to be returned to the manufacturers for adjustment. Mr. Daly has improved the precision of this machine and of the older South Bend 9" lathe by painstaking scraping of the ways.

4. SEMINARS.

During the year lectures were delivered to the Seminar by Dr. M. G. K. Menon (Bristol) who described some current work seen by him during his stay in the U.S.A. and Dr. M.W. Friedlander (Bristol) on recent work on K-mesons and Hyperons. A lecture on the latter topic was also given to the Geophysical Seminar by Professor O'Ceallaigh. Dr. D. Keefe, (University College, Dublin) spoke about current theoretical ideas about isotopic spin and associated production. Dr. W. Gibson (Queen's University, Belfast) described experimental work done at Belfast by him and his collaborators on proton-proton scattering in photographic emulsions. Professor C. B. A. McCusker gave two talks to the Theoretical Physics Seminar on theories of the origin of cosmic rays and on the time variations of local penetrating showers and of extensive penetrating showers which he and his collaborators in the Cosmic Ray Section have recently shown to exist. Professor McCusker has also lectured on these results by invitation to the Cosmic Ray Group at the Atomic Energy Research Establishment, Harwell, at the International Conference at Pisa and at the Oxford Conference on Cosmic Radiation and Astrophysics.

5. PERSONAL.

L. Crane did not seek re-election to his scholarship owing to difficulty in being accepted as a higher degree student. Since then,

it has been possible in individual instances to arrange for students who satisfied the necessary requirements of academic standing to be registered in the University of Dublin as candidates for higher degrees. Mr. R. J. Reid of Queen's University, Belfast was awarded a research Scholarship on 1 January, 1956, and Mr. Gideon Alexander of the University of Jerusalem was appointed to the remaining vacant scholarship on 1 January, 1956. Both have been accepted as Ph.D. students by the University of Dublin.

Miss Norah Leahy resigned her position as scanner on 1 February, 1956 and was replaced by Mrs. Joan Keefe B.A.

#### 6. PUBLICATIONS.

R. H. W. Johnston: A Scattering Calibration Experiment.  
Pisa Conference Report, p. 287, 1955.

C. O'Ceallaigh: G-Stack Collaboration Report on  $\chi$ -Decay.  
Pisa Conference Report, 218, 1955.

R. H. W. Johnston and C. O'Ceallaigh: Some K-decay Results observed in the Sardinian Stack .  
S.30.  
Pisa Conference Report, 343, 1955.

Davies et al. (University of Bristol), Bjggild et al. (Institut för Teoretisk Fysik, Köbenhavn), L. Crane, R. H. W. Johnston and C. O'Ceallaigh, (Dublin Institute for Advanced Studies), Anderson et al. (University College, Dublin), Alvial et al. (Istituto di Fisica, Padova).  
On the Masses and Modes of Decay of Heavy Mesons Produced by Cosmic Radiation.  
Nuovo Cimento 2, 1340, 1955.

C. B. A. McCusker: A Variation of the Rate of Penetrating Extensive Showers with Sidereal Time.  
Nuovo Cimento 2, 1340, 1955.

C. B. A. McCusker and B. G. Wilson: The Rate of Extensive Showers of High Electron Density at Sea Level.  
Nuovo Cimento 3, 188, 1956.



C. Geophysical Section.

1. ACADEMIC STAFF AND SCHOLARS.

Senior Professor: Leo W. Pollak, Director of the School.

Professor: Thomas Murphy.

Senior Technical Assistant: Thomas J. Morley.

Scholars: Thomas C. O'Connor (to 31st January 1956).

Arvijs L. Metnieks (from 13th March 1956).

2. INVESTIGATIONS, EXPERIMENTAL AND FIELD WORK.

(i) Static method for determining the diffusion coefficient of condensation nuclei. - Professor Pollak and Mr. T. C. O'Connor continued their tests of a new method for measuring the size, density and mass of condensation nuclei which had been devised by Professor Pollak for investigating the quickly changing atmospheric aerosol, particularly during aeroplane flights. A report on preliminary results obtained was presented at the Dublin Symposium on atmospheric condensation nuclei and is published in its Proceedings (See Section 3/1, Publications).

Since then an extensive comparison of the static and dynamic methods has been undertaken. Decay experiments in cylindrical containers of various diameters and the results obtained with one and the same decay vessel for different decay periods made it possible to verify experimentally R. Furth's theory of the static method and to show that it is in itself consistent.

A paper on our investigation has been announced for the Second International Symposium on condensation nuclei to be held in Basel and Locarno in Autumn 1956.

(ii) Photo-electric nucleus counter of high precision.- During the tests of the static method mentioned above Professor Pollak and Mr. O'Connor came to the conclusion that for a more accurate measurement of the difference in nuclei concentration during the decay experiment re-

quired by the method, a photo-electric counter with a narrower fog-tube is needed. Professor Pollak arranged for the construction of a counter, the fog-tube of which could be easily exchanged for any other of different diameter. This experimental counter was designed by Professor T. Murphy and very ably constructed by Mr. M. Cotter, mechanic of the Section.

The very first tests of this counter with narrower fog-tubes showed that the uncertainties ascribed to the formation of the fog in the cloud chamber have disappeared. It can be stated, after more than 10,000 measurements, that these uncertainties which limited the accuracy of photo-electric counters up to now, have never reappeared.

As has been shown in the publication listed under (ii) in Section 3, the photo-electric counter models previously constructed, provided they are of rigid construction and equipped with electrically heated sealing glasses and a good collimator, can be converted into counters of high precision simply by inserting e.g. a wooden lining of appropriate thickness in the cylindrical cloud chamber.

(iii) A nucleus counter with stereo-photographic recording. - In order to facilitate the identification of the droplets in the photograms, the previously constructed counter with photographic recording was provided with stereo-photographic recording. The optics required for taking with one microscope stereo-photograms of the droplets on the graticule at a distance of 1 cm from the microscope objective was, according to suggestions by Professor Pollak, made by Messrs. R. & J. Beck, London.

The new construction is being tested and will be used for recalibrating the photo-electric nucleus counter of high precision.

(iv) Professor Pollak and Mr. T. J. Morley are preparing the second part of the Climatology of Dublin City, covering temperature and humidity, for the printers. The climatology which will comprise six parts is undertaken with a view to providing material for the study of climatic changes.

(v) Professor Murphy:

(a) Nucleus counter: - The fog formation in the photo-electric nucleus counters was studied with a Lange galvanometer and photographic recording. The results were communicated to the International Symposium on Condensation Nuclei 1955 (See Section 3/vi, Publications).

(b) Gravity: - A network of gravity bases has been set up in Ireland and precision measurements have been taken between them. There are 82 stations situated in or close to most of the principal towns and the network is comprised of 33 loops.

The gravimeter was brought to Macclesfield, England and there, together with four other Worden gravimeters, a calibration base line was set up to enable all gravity readings in these islands to be made coherent and eventually it is hoped that this base line will be compared with similar ones throughout the world.

The regional gravity survey of the south of Ireland was begun and measurements have been taken at 923 new stations. County Wexford has been fairly well covered; Counties Kilkenny and Waterford about a half; County Clare about a third; Counties Waterford and Wicklow about a quarter and several exploratory lines made through Tipperary and neighbouring counties.

The computational work for the adjustment of the gravity base station network has been commenced and the recording, cataloguing and computation of the regional gravity survey is also under way.

(c) Geodesy. - The latitudes and longitudes of the corners of the six inch sheet maps of Ireland have been computed, listed and made ready for publication.

### 3. PUBLICATIONS

(i) L. W. POLLAK and T. C. O'CONNOR, Decay of aerosols in small and very small vessels and a static method for determining the size of condensation nuclei. Proceedings First International Symposium on Condensation Nuclei

at Dublin, April 1955. Geofisica Pura e Applicata, Milano, Vol.31 (1955/II), pp. 66 - 79.

Extract of Summary: Recently in meteorology the tendency becomes apparent to seek information on the size of the condensation nuclei and their nature as well as their concentration. A new procedure, called static method for determining the size and mass of condensation nuclei, was developed. It permits determining the size of the nuclei from their changing concentration when stored in a closed vessel.

As an additional result during the present investigation it came to light that the coefficient of the linear term of the ordinary differential equation of first order and first degree which describes the disappearance of stored nuclei, is not a constant but depends on time.

The advantages of the static method for investigating the atmospheric aerosol, particularly during aeroplane ascents and flights are as follows: Utilising standard equipment it is possible to determine: (i) from two measurements of concentration the size of the nuclei, (ii) from three measurements of concentration the size, density and mass of the nuclei, (iii) a sequence of instantaneous values of size, density and mass of nuclei in contradistinction to the dynamic method which gives only averages covering periods of ten up to thirty minutes.

(ii) L. W. POLLAK and T. C. O'CONNOR, A photo-electric condensation nucleus counter of high precision. Geofisica Pura e Applicata, Milano, Vol.32(1955), pp. 139 - 146.

Summary: A new model of the direct beam photo-electric condensation nucleus counter and its properties are described. The main feature of the construction is the reduction of the fog-tube diameter which resulted in the complete elimination of all uncertainties in the measurement of the light intensity after the fog is formed by adiabatic expansion. - Individual measurements with two identical counters of this design which incorporate all previous improvements, agree to better than 5% in 70 of all cases, their average absolute difference being 2%. Deviations of more than one division of meter readings (or 10% of concentration) were not observed. This agreement is maintained over long periods. - A calibration curve of the latest model of the photo-electric nucleus counter is given.

(iii) L. W. POLLAK and T. J. MORLEY, The Climate of Dublin City, I - Rainfall at Trinity College; Geophysical Bulletin No.12 of the School of Cosmic Physics, Dublin, January 1956.

From the Introduction: The completion of fifty years of meteorological observations at the same site in Trinity College, Dublin and our own requirements suggested compiling this Bulletin which may be considered as a first contribution to the Climatology of Dublin City.

A second part covering temperature and humidity is already far advanced. In a further contribution a statistical analysis of the material will be given.

The rainfall values given in the tables of the Bulletin have been tested for homogeneity numerically and graphically in the accepted manner and found to be in very good agreement with the records of Phoenix Park.

The frequency and correlation tables were deduced from punched cards with statistical machines.

(iv) L. W. POLLAK, Condensation nuclei symposium in Dublin. Nature, London, Vol.175(1955), p.1072.

(v) L. W. POLLAK, Editor: Proceedings of the first international symposium on condensation nuclei at Dublin, April 1955. Geofisica Pura e Applicata, Milano, Vol.31(1955/II), 202 pages.

(vi) T. MURPHY, On the fog formation in the photo-electric counter. Proceedings First International Symposium on Condensation Nuclei at Dublin, April 1955. Geofisica Pura e Applicata, Milano, Vol.31(1955/II), pp.26-29.

Summary: The operation of a photo-electric nucleus counter has been examined in detail to investigate the causes of uncertainties in the readings with a photographically recording galvanometer. Various peculiarities are pointed out and it is suggested that these are the result of deposition of fog droplets on the glass closing plates and limit the accuracy of a counter to about 5%. Unsuccessful attempts to eliminate this deposition are given and the possibility of solution is offered by reverting to a different form of fog chamber.

(vii) T. C. O'CONNOR, Some characteristics of condensation nuclei stored in a large vessel. Proceedings First International Symposium on Condensation Nuclei at Dublin, April 1955. Geofisica Pura e Applicata, Milano, Vol.31(1955/II) pp. 107-113.

Summary: The coagulation coefficient, size and charge distribution of condensation nuclei from room air when stored in a 4.00 litre rubber balloon gasometer were studied. The results indicate that the acquisition of water vapour contributes to the growth of stored nuclei. A preliminary trial was made to see if JUNGE's approximate rule that the number of particles in an aerosol varies inversely as the third power of their radius, also holds for Aitken nuclei. Further confirmation of the relationship between the percentage of stored nuclei electrically charged and their average radius was obtained.

#### In Course of Publication

L. W. POLLAK and T. C. O'CONNOR, Tables and graphs for determining the diffusion coefficient, size, density and mass of condensation nuclei and calibration tables for photo-electric nucleus counters of different fog-tube diameter.

#### 4. OBSERVATORY

(1) An integrating luxmeter Type III (Dr. B. Lange, Berlin) has been installed on the roof of 5, Merrion Square. It consists of two special barrier photo-cells with opal platinum reduction filters and compensating filters in waterproof mounting, a d.c. amplifier and two d.c. counters. Range up to 100 and 100000 lux respectively, with automatic switching.

Equipment for checking the calibration is provided. After a trial period regular records will start on 1 April, 1956.

(ii) The VERZAR automatic condensation nucleus counter which uses the photo-electric principle, has been received from the Physiological Laboratory of the University of Basel. We are greatly obliged to Professor Dr. F. Verzár, Director of the Physiological Institute in whose workshop this elaborate equipment was built, for supplying it at cost price. Records of nucleus concentration can be made fully automatic every four minutes. Each cycle comprises 34 single switchings.

(iii) Equipment for regular measurements of radioactivity of air and precipitation is being assembled.

#### 5. GEOPHYSICAL EQUIPMENT

In order to facilitate the determination of elevation in the gravity survey of Ireland a GRAP-Askania, Berlin micro-barometer was purchased. The accuracy is 0.01 Torr. The instrument using a tubular Bourdon spring does not require a thermostat, whereas previous instruments of the same accuracy required a double thermostat of 10 Kg weight (without the accumulator battery). It is not sensitive to tilt, is magnetically damped and its readings are made optically after the autocollimation principle.

#### 6. METEOROLOGICAL AND GEOPHYSICAL SEMINAR

19th May 1955: Professor M. G. Kendall, School of Economics, University of London; Extreme and record values.

24th June 1955: Sir Edward Appleton, F.R.S., Principal, The Old College, Edinburgh; The Sun and the ionosphere.

17th November 1955: Professor C. O'Ceallaigh, School of Cosmic Physics; The New fundamental particles.

13th & 14th December 1955: Dr. J. A. Chalmers, University of Durham; (i) The Electric charges in clouds, (ii) Theories of charge separation in clouds.

19th January 1956: Professor L. W. Pollak, School of Cosmic Physics; Application of industrial television to meteorology and geophysics (with demonstration of a complete equipment for close-circuit television and its application).

- 26th & 27th January 1956: Professor M. G. Kendall, School of Economics, University of London; (i) The Birth of the calculus of probabilities, (ii) Some Problems in paired comparisons.
- 16th February 1956: Professor W. D. Gill, Department of Geology, Trinity College, Dublin; Current practice and problems in oil prospecting.
- 1st & 2nd March 1956: Dr. B. J. Mason, Department of Meteorology, Imperial College of Science and Technology, London; (i) Radar and other experimental studies of precipitating clouds, (ii) Experimental studies of nucleation and ice crystal growth.

7. THE FIRST INTERNATIONAL SYMPOSIUM ON CONDENSATION NUCLEI AT DUBLIN, 26th to 28th APRIL 1955.

Thirty-five delegates from eight countries participated; from France 1, Federal Republic of (West) Germany 5, Great Britain 10, Ireland 10, Italy 1, Sweden 2, Switzerland 3, United States of America 3. In all 26 papers were presented.

The Proceedings of the symposium have been published as a separate volume of the International Review *GEOPHYSICA PURA E APPLICATA* (See Section 3/v, Publications).

In the geophysical laboratory of the School of Cosmic Physics, equipment for determining concentration, size, mass and density of condensation nuclei and for measuring their vertical gradient near the ground were demonstrated during the symposium. A small exhibition showed the development of the photo-electric counter.

9. MISCELLANEOUS

(i) Mr. G. J. Day of the Meteorological Research Flight, Royal Aircraft Establishment, Farnborough, Hants., brought to Dublin their copy of our photo-electric nucleus counter for standardisation. The comparisons with two of our counters were carried out on 29th and 30th April. The agreement of all counters was very satisfactory.

(ii) Mr. T. A. Rich of the Instrument and Nuclear Radiation Department, General Electric Company, Schenectady, N.Y., left after the Dublin symposium his version of the photo-electric nucleus counter in our laboratory with the

request for calibration and comments.

(iii) The photo-electric nucleus counter which has been developed completely in Ireland and extensively used here, is now employed at various institutions in the U.S.A. (e.g. Pennsylvania State College and Oak Ridge National Laboratory, Tenn.); replicas according to our specification and with our assistance were made in Trinidad (University College of West Indies) and in Great Britain (Meteorological Research Flight, Royal Aircraft Establishment, Farnborough, and Health Physics Division, Atomic Energy Research Establishment, Harwell). Variations of our design are in use at the British Admiralty Research Laboratory, Teddington and at the General Electric Company, General Engineering Laboratory, Schenectady, N.Y. Our Instrument forms the principal part in the automatic recording nucleus counters built in Switzerland (Physiological Institute of the University, Basel) and Sweden (Institute for High Tension, Uppsala).

Requests for replicas of our photo-electric counter, to be used as standard, have been received from W.-Germany (State Institute for Hygiene, Hamburg) and Norway (Geophysical Institute of the University, Bergen).

(iv) Professor C. L. Godske, Director, Geofysisk Institutt, Universitetet i Bergen (Norway) and Dr. W. Johannesen of the State Meteorological Service in Oslo visited the Section during 30th August to 5th September, 1955. Their main object, according to Professor Godske's letter of 28th June 1955, was to discuss problems of climatological methods, since punch-card methods are being introduced in the Norwegian routine climatology. They wished further to get some contact with problems connected with time series and condensation nuclei.

(v) Professor Pollak has been invited to give a fortnight's lectures at the University in Bergen (Norway) and to the Geophysical Society in Oslo. Professor Godske, Director of the Geofysisk Institutt, suggested that one course of lectures should deal with machine methods in geophysics.