

Pr. 4462

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
1956-57.

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Annual Report of the work of the Institute and
its Constituent Schools presented by the Council
for the Financial Year 1956-57

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, 1957.

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 1957.

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, 1957.
- 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 1957

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 Áine 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:

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 Tuathail, 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.; Herman 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 Doportó, D.Phys.Sc.

II - Report of the Governing Board of the School of Celtic Studies
adopted at its meeting on 10th July, 1957.

1. 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; Miss Cecile O'Rahilly (appointed as from 1 April
1956).

Assistant Professor:

Rev. Cuthbert McGrath, O.F.M.

Assistant (Part-time);

Mrs. Nessa Doran.

Technical and Clerical Staff:

Miss Maura Devoy; Miss Máire Breathnach.

Scholars:

Louis Paul Nemo (Roparz Hemon); Gearóid Mac Niocaill (to 31
October 1956); Terence McCaughey.

Extern Research Workers commissioned by the School:

Dr. R. I. Best; Mr. Seán Mac Airt; Mr. Liam Price; Mrs. Mary
Ellen Carney; Rev. Seán Ó Catháin, S.J.; 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. Breathnach;
Mr. Seán de Burca; Dr. R. L. Thomson; Professor Nils Holmer;
Mr. J. L. Campbell; Rev. Aubrey Gwynn, S.J.; Rev. G. S. M.
Walker; Rev. Professor D. Meehan; Dr. L. Bieler; Professor
Seamus Ó Néill.

2. GENERAL LINES OF RESEARCH WORK.

As before, the main work of the School during the year lay in
Irish studies, early and modern. In the latter field the compilation
of the material collected for the Linguistic Atlas was completed and
work continued in other branches of linguistics and in dialect

investigation. In other branches of Celtic Studies progress was made in work on etymology and comparative literature, works on Welsh and Breton were published and a work on Scottish Gaelic was still in the press. Proofs of all contributions to Celtica Vol.IV were revised.

In the Hiberno-Latin Texts Series, the second volume, The Writings of St. Columbanus was passed for press, the third volume was sent to press and work was in progress on the preparation of other volumes. The first volume in the series of Mediaeval and Modern Welsh texts was published and other volumes were in preparation. Final proofs of Vol.III of the Book of Leinster were at the press and Vols. IV and V were completely transcribed and are now being revised and checked with the manuscript.

At the end of the year under review three volumes had been published, twenty-one volumes edited or written by members of the staff or by extern research workers were in the press and approximately forty-three others were in preparation. Owing to reduction in the Estimate it was necessary to hold back certain important works, printing of which should have been commenced during the year, notably the first volume of Corpus Iuris Hibernici and the fourth volume of the Book of Leinster.

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

Senior Professors:

Michael O'Brien: Continued work on the indexes of Vol.I (in the press) of Corpus Genealogiarum Hibernicarum and on the texts of Vols. II and III. Completed revise of Vol.III of the Book of Leinster (now in final proof) and continued revision of MS. text of Vols.IV and V of the same MS. Work progressed on a new edition of the Old Irish Bethu Brigte. Contributed several articles to Celtica Vol.IV and to the Zeitschrift für slavische Philologie.

Daniel A. Binchy: Continued the copying of legal MSS. for Corpus Iuris Hibernici and also worked on an edition of Scéla Cano Meic Gartnáin

for the Mediaeval and Modern Irish Series. An expanded version of his Statutory Public Lecture on Tara and Cashel, together with another article on an allied subject, were prepared for publication in the forthcoming number of Ériu. Wrote detailed reviews of Jackson's Language and History in Early Britain and Murphy's Early Irish Lyrics for the forthcoming volume of Celtica.

Myles Dillon: An edition of The Book of Rights was revised for press. Two articles for Celtica Vol.IV were prepared and revised in print. Vol. XVII of the Mediaeval and Modern Irish Series was revised for press. In connection with the Linguistic Atlas two points in Donegal were visited for checking in collaboration with Dr. Wagner.

Professors:

James P. Carney: Continued work on a number of literary problems and on an edition of recently discovered Old Irish poems.

Miss Cecile O'Rahilly: Continued preparation of an edition of the Stowe Táin. Prepared Introduction with a Comparison of other recensions, LL. and Stowe and collated late MSS. of the Stowe version.

Assistant Professor:

Rev. Cuthbert McGrath, O.F.M.: Work progressed on Dán na mBráthar Mionúr. Corrected proofs of the poems of Brian Mac Giolla Phádraig returned to printers. Proofs of an article on Toirdhealbhach Ó Conchubhair to appear in the Wadding Memorial Volume were corrected. All the preliminary work for an edition of the poems of Sochaidh Ó hEodhusa has been completed while work proceeded on Plunket's Dictionary.

Assistant (Part-time):

Mrs. Nessa Doran: Work continued on a Catalogue of Irish MSS. in the National Library. Fasciculus I (MSS. nos.15-69) completed and part of Fasciculus II (vellam MSS.) is ready.

Scholars:

Roparz Hemon: Continued work on a Historical Grammar of Breton and a Historical Dictionary of Breton. The former is now almost completed and of the second the first 500 pages (letters A and B) have been typed.

Gearóid Mac Niocaill: Work continued on the edition of Duanaire Cloinne Suibhne and a beginning was made on collecting materials for a projected corpus of 15th to 17th century legal documents in Irish. Eight short articles were published in Éigse VIII and several prepared for the next volume of Celtica.

Terence McCaughey: Continued work on an edition of Aipgitir Crábad. This work has now been discontinued as Vernam Hull is bringing out an edition. Edited a short tract from H. 3. 17 which is to appear in Celtica and has completed the edition of an eighteenth century phrase-book in the National Library Gaelic MS.441.

Extern Research Workers:

Dr. R. I. Best: Final proofs of the Book of Leinster, Vol.III were revised. Completed transcript of Vols.IV and V. The transcript of the MS. is now complete except for the genealogies.

Seán Mac Airt: Commenced revision of proofs of Vol.I of the Annals of Ulster. Continued work on translation, notes and indexes and it is hoped to have these in the printers' hands during the coming year.

Liam Price: Material for Vol.V of the Place-Names of Co. Wicklow - The Barony of Rathdown - was sent to printers and first proofs were being revised at the end of the period under review.

Mrs. Mary Ellen Carney: Continued work on an edition of the Irish translation of the Aphorisms of Hippocrates.

Rev. Seán Ó Catháin, S.J.: Text of Betha Muire has been revised.

Rev. Anselm Faulkner, O.F.M.: Vocabulary and general notes for An Bheatha Dhiadha prepared and work was proceeding on the Introduction.

Editions of An Sgáthán Spioradálta and An Bheatha Chrábhaidh were in preparation.

Rev. Pádraig Ó Súilleabháin, O.F.M.: As well as the Introduction to Beatha San Frionsias has done some work on the Glossary to Lucerna Fidelium.

Rev. Bartholomew Egan, O.F.M.: Corrected the second galley proofs of two Franciscan grammatical texts (O'Hussey and O'Mulconry). The preparation of Preface, Notes etc. is continuing.

Heinrich Wagner: Continued work on The Linguistic Atlas and Survey of Irish Dialects. The MS. of the first volume was given to the printers in Zürich and it is hoped to have it published before the Summer of 1958.

R. B. Breathnach: Has completed the main part of his enquiry on (approx.) 13,000 excerpts from the notebooks of Dr. Sheehan. These have been checked with native speakers and the work is now being typed. Has also collected material for the study of the Morphology and Synthax of the Dialect.

Seán de Búrca: A phonemic study of the Irish of Tourmakeady was completed and sent to printers. Correction of first proofs was commenced.

R. L. Thomson: Completed revision of proofs of Pwyll Pendeuc Dyuet (Mediaeval and Modern Welsh Series, Vol.I) which was published in March 1957.

Nils Holmer: Revised proofs of the Gaelic of Arran.

J. L. Campbell: Continued revision of proofs and prepared indexes for Fr. Allan McDonald's Collection of Words from South Uist.

Rev. G. S. M. Walker: Completed revision of proofs of Sancti Columbani Opera (Hiberno-Latin Texts Series, Vol.II) which had been passed for press by the end of the period under review.

Rev. Denis Meehan: Completed preparation of Adamnan's De Locis Sanctis (Hiberno-Latin Texts Series, Vol.III) printing of which had commenced before the end of the period under review.

Séamus Ó Néill: Commenced work on a revised edition of Seanmóirí an Easpoig Uí Ghallchobhair.

3. LECTURES AND CONFERENCES.

Professor O'Brien gave the Rhys Memorial Lecture in London in March 1957 on Old Irish Personal Names.

Professor Dillon gave courses in Comparative Grammar and in Old Irish at the Linguistic Institute in the Summer School of the University of Michigan during July and August 1956. A course in Sanskrit was given during the academic year for graduate students.

Professor Carney delivered a lecture on December 5th 1956 to the Classical Society of University College, Dublin, on Christian and Classical Influence in Early Irish Literature. In March 1957 a lecture and seminar were given by him in the University of Uppsala.

4. STATUTORY PUBLIC LECTURE.

The Statutory Public Lecture under the auspices of the School was delivered by Professor Daniel A. Binchy in University College, Dublin, on Tuesday, 26th February 1957. Professor Binchy's subject was Tara and Cashel.

5. PUBLICATIONS.

a. Books

	Date of Publication
CHRISTMAS HYMNS IN THE VANNES DIALECT OF BRETON. Edited by Roparz Hemon. pp. lxxii + 115.	16/7/56
Price 12/6.	
COMPERT CON CULAINN. (Reprinted) Edited by A. G. van Hamel. pp. vii + 223	20/8/56
Price 5/-	

FWYLL PENDEUIC DYUET. Edited by R. L. Thomson.
(Mediaeval and Modern Welsh Series - Vol.I).

Date of
Publication

pp. xxxiv + 71.

Price 8/6

14/3/57

b. Contributions to Periodicals

Gearóid Mac Niocaill:

Uilliam Mac an Leagha Cecinit. *Éigse*, 8, 133, 1956.

Tionntó ar an "Adoro Devote". *Éigse*, 8, 135, 1956.

Carta Humani Generis. *Éigse*, 8, 204, 1956 (57).

Beatha Eoin Bruinne II. *Éigse*, 8, 222, 1956 (57)

Betha ocus Bás Chaitreach Fína. *Éigse*, 8, 231, 1956 (57).

Exempla. *Éigse*, 8, 237, 1956 (57).

Na Seacht Neamha. *Éigse*, 8, 239, 1956 (57).

III - Report of the Governing Board of the School of Theoretical Physics
adopted at its meeting on 12 June, 1957.

1. STAFF AND SCHOLARS.

Senior Professors:

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

Research Associates:

Stephen O'Brien; Mrs. Sheila Tinney.

Technical and Clerical Staff:

Miss Margaret Payne (resigned October 1956); Miss Evelyn Wills.

Scholars:

H. F. Sandham (left June 1956); B. Bertotti (left July 1956);
L. Bass; E. Bellomo (left October 1956); N. C. Sil; Rev. P. McHugh;
W. Israel (entered October 1956); L. O Raifeartaigh (entered October
1956); J. W. Herivel (entered October 1956, left December 1956 - on
leave of absence from Queen's University, Belfast).

2. STUDY AND RESEARCH.

Professor Lanczos continued his studies of canonical systems, particularly in relation to general relativity. The canonical method yields an adequate basis for the formulation of the field equations which can be deduced from a quadratic action principle. The earlier studies of the author between 1931 and 1944 came to a halt due to the absence of a proper mathematical method and could now be resumed under improved circumstances. New light is thrown also on Weyl's geometrical theory, which is shown to be included (up to quantities of second and higher order) in the quadratic action principle, without abandoning the Riemannian basis of geometry. The vector potential appears in the integrated form of the field equations and not as an added basic field quantity as in Weyl's theory. A certain discrepancy with earlier results of W. Pauli (Zürich) concerning Weyl's theory led to a correspondence with Professor Pauli who revised his calculations and corroborated Professor Lanczos' findings. The new formulation of

the theory of quadratic action leads to new perspectives concerning the theory of matter in general relativity, provided that the "cosmological constant", which is a basic element of the theory, is assumed to be of atomistic rather than cosmological magnitude. One can show that the field equations possess static eigensolutions which are regular everywhere. These solutions can be correlated to the material particles. These static eigensolutions are imposed, however, on a highly agitated metrical substructure since the very large value of the cosmological constant does not allow a quasi-Minkowskian universe but a universe which is Minkowskian only in the average. The actual construction of the eigensolutions has not been achieved up to now.

Father McHugh investigated the application possibilities of the so-called Debye Potentials. He digested the very extensive literature of the subject, which starts with Righi, Debye, Mie, and was further pursued by Whittaker and others. The theory shows that both the Maxwellian equations and the elastic equations for the case of homogeneity are solvable in terms of two scalar potential functions, if the question of boundary conditions is left aside. It seems difficult, however, to satisfy the proper boundary conditions in the elastic problem. Fr. McHugh also gave a number of talks on the application of the hypercircle method for the approximate solution of partial differential equations. Another field of research which led to frequent discussions, was the problem of finding the eigenfrequencies of an elastic cube, under free boundary conditions.

Mr. Sil continued his studies on the electron capture from hydrogen atoms by protons. Instead of solving the time-dependent Schrödinger equation directly, one introduces a proper trial function into the Lagrangian of the variation problem and obtains two coupled ordinary differential equations in time for the two unknown amplitudes which are left free in the trial function. These equations are then solved by neglecting terms which go to zero if the velocity of the

incident proton tends to zero. Finally an integration with respect to the impact parameter yields the total capture cross section. The validity of the calculations is restricted to small velocities of the incident proton.

In collaboration with Professor G. F. D. Duff of the University of Toronto, Professor Synge has applied the method of Fourier transforms to the Cauchy problem for elastic waves in an infinite anisotropic medium. The formulae, which express the disturbance at any time in terms of an arbitrary initial disturbance, generalize those given by Stokes for an isotropic medium. Professor Synge also investigated the flow of energy for plane waves in a layer of anisotropic material.

In the general theory of relativity, he obtained a positive-definite invariant density of gravitation, this density vanishing if, and only if, gravitation is absent. He also found the gravitational field due to a thin expanding shell of radiation.

Mr. Israel investigated the field of a star which is being transformed into radiation, and the field of a thin expanding shell of matter. He also studied axially symmetric gravitational fields and the general theory of thin material shells and shells of radiation.

Mr. Ó Raifeartaigh found a necessary and sufficient condition for the existence of Fermi coordinates connected with a subspace of a space possessing an affine connection; Fermi coordinates are of physical interest, since the energy pseudo-tensor of a gravitational field vanishes when they are used. He also obtained a generalization of the Einstein universe in the form of a statical model universe with spherical symmetry having two regions of different constant densities; such a universe, though statical, gives a spectral shift for light received from a distant star.

Dr. Bass studied Bohm's causal interpretation of quantum theory, on which he gave a series of informal lectures to the seminar in May 1956.

He also studied problems of emission of gravitational waves, particularly in connection with spherically symmetrical distributions of matter. He tried to find limitations of Birkhoff's theorem, but this work was inconclusive.

Dr. Bass further studied the stochastic equations containing energy loss of fast particles in matter; in particular he dealt with a new technique for solving the pertinent integro-differential equations. Lately he has been studying generalizations of stochastic equations arising from diffusion problems.

Following previous lines, Dr. Bellomo studied the case of an accelerated point-source in a general linear field. The four-dimensional self-force might cause a non-physical motion, or a change in its proper mass. This research, which is not yet complete, considers in particular fields causing attraction between two sources of equal sign.

Dr. Bertotti completed his work on gravitational motion, reported during the previous year as in progress. For the relativistic "perfect fluid" he developed a new approximation, which allows for any relative velocity of the bodies, in contrast to the usual "quasi-stationary" assumption. This approximation leads to more refined results.

Mr. Herivel investigated variational principles for dissipative systems, applications of thermodynamics to the motion of fluids, and in particular, the propagation of sound in viscous fluids conducting heat.

Mr. Sandham continued to work on products of hypergeometric functions and investigated the generalization of an interpolation formula due to Gauss.

3. SEMINARS AND LECTURES.

As in previous years the seminar lectures throughout the year were attended by members of staff and students from Trinity college, Dublin, University College, Dublin, and St. Patrick's College, Maynooth, as well

as by members of the two physics Schools of the Institute.

The following seminar lectures were given:

- Professor H. Brück (School of Cosmic Physics):
Recent investigations on the distance-scale of the universe.
- Dr. T. K. Carroll (U.C.D.):
Some electronic spectra of polyatomic molecules.
- Dr. M. Kennedy (U.C.D.):
Measure theory, and Schwartz' theory of distributions (10 lectures).
- Professor Lanczos:
An eigenvalue problem in the theory of interpolation.
Hamiltonian methods in solving linear differential equations.
The Green's function in the theory of elasticity (3 lectures).
Some interesting properties of Riemannian tensors.
Hamiltonian form of relativistic equations.
The quadratic action principle of relativity.
The theory of Weyl.
The problem of electricity in general relativity.
- Professor C. B. A. McCusker (School of Cosmic Physics):
Astrophysical aspects of cosmic radiation.
- Rev. J. McMahon (St. Patrick's College, Maynooth):
Rayleigh-Ritz estimates of eigenvalues.
- Professor T. E. Nevin (U.C.D.):
Fuel breeding in nuclear reactors.
- Mr. L. Ó Raifeartaigh:
Fermi coordinates.
- Professor Synge:
Elastic waves in anisotropic media (5 lectures).
Birkhoff's theorem (2 lectures).
An invariant density in empty space-time.

In addition to the above seminars, the Scholars spoke on the subjects of their study and research at informal colloquia throughout the year.

In October and November Professor Synge gave a course of six special lectures on the General Theory of Relativity. There was a good attendance of students and junior staff members from Dublin, Cork, and Galway. The railway fares of those coming from Cork and Galway were paid by the School.

4. STATUTORY PUBLIC LECTURE.

A Statutory Public Lecture, under the auspices of the School, was delivered in Trinity College, Dublin, on February 15, 1957, by Professor Synge. The subject was "The Concept of Time".

5. VISITING LECTURERS

During the year eight lectures were given in the School by visiting lecturers, as follows:

Professor Marcel Riesz, University of Lund:

A special characteristic surface - A new relativistic model for the electron? (2 lectures; 17 and 19 October 1956).

Professor H. S. Ruse, University of Leeds:

Metrisable Lie groups and algebras (2 lectures; 18 and 20 October 1956).

Professor H. Fröhlich, F.R.S. University of Liverpool:

Methods of field theory in solid state physics (2 lectures; 20 and 21 March 1957).

Dr. R. Furth, Birbeck College, University of London:

Some problems in the theory of crystal lattices (20 March 1957).
The Theory of fluctuations of macroscopic parameters (21 March 1957).

6. EXTERNAL ACTIVITIES

Dr. Bertotti gave a seminar at King's College (London) on June 28, 1956, on his recent work on gravitational motion. From July 15 to August 4, 1956, he attended an International School on Magnetic Properties of Matter, held at Varenna (Italy).

Dr. Bass attended a meeting of the Eddington Group in King's College, Cambridge, on 1 and 2 October 1956, and gave a talk there on the limitations of Birkhoff's theorem.

Professor Synge lectured on "Basic Ideas of Relativity" at the University of North Wales (Bangor), on December 6, 1956.

Professor Lanczos lectured on "The Formal Language of Algebra" to the Dublin University Mathematical Society, on February 11, 1957.

7. PUBLICATIONS

a. Books:

(i) Published:

Expanding Universes. By E. Schrödinger. University Press, Cambridge, 1956.

Applied Analysis. By Cornelius Lanczos. Prentice Hall, Inc., Englewood Cliffs, N.J., 1956.

(ii) In the press:

Variational Principles of Mechanics. By C. Lanczos. Article for the Handbook of Engineering Mechanics. McGraw-Hill, New York.

Tensor Calculus. By C. Lanczos. Article for the Handbook of Physics. McGraw-Hill, New York.

The Hypercircle in Mathematical Physics. By J. L. Synge. University Press, Cambridge.

The Relativistic Gas. By J. L. Synge. North-Holland Publishing Co., Amsterdam.

Classical Dynamics. By J. L. Synge. Article for Vol.3 of Encyclopedia of Physics. Springer, Berlin.

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

No. 12. Geometrical Optics in moving dispersive media. By J. L. Synge.

Price: 3/- pp.iii,63 Published 31 December 1956

c. Contributions to periodicals:

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

(i) Published:

* L. Bass:

Radiation with a finite rest-mass and the heat balance of the earth. Nuovo Cim. Ser. 10, 3, 1204, 1956.

On the stochastic equation for the energy of fast electrons in matter. Proc. Indican Acad. Sci., 44 A, 423, 1956.

B. Bertotti:

On gravitational motion. Nuovo Cim., Ser. 10, 4, 898, 1956.

E. Corinaldesi:

Remark on a previous note. Nuovo Cim. Ser. 10, 2, 168, 1955.

On the two-body problem of general relativity. Jubilee of theory of Relativity, Bern, July, 1955. Helv. Phys. Acta, Suppl. 4, Basel, Birkhauser, 1956.

* C. Lanczos:

Albert Einstein and the theory of relativity. Nuovo Cim., Suppl. Ser. 10, 2, 1193, 1955.

J. McConnell and J. Spelman:

Production of negative protons in the atmosphere. Nuovo Cim. Suppl., Ser. 10, 4, 836, 1956.

F. A. E. Pirani:

On the definition of inertial systems in general relativity. Jubilee of theory of Relativity, Bern, July, 1955. Helv. Phys. Acta, Suppl. 4, Basel, Birkhauser, 1956.

* H. F. Sandham:

A square and a product of hypergeometric functions. Quart. J. Math. (Oxford) Ser. 2, 7, 153, 1956.

J. L. Synge:
Flux of energy for elastic waves in anisotropic media.
Proc. Roy. Irish Acad. 58 A, 13, 1956.

(ii) In press 31 March 1957:

F. A. E. Pirani:
On the physical significance of the Riemann tensor. Acta Phys.
Polon.

* 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.).

J. L. Synge and W. F. Cahill:
The torsion of a hollow square. Quart. Appl. Math.

IV - Report of the Governing Board of the School of Cosmic Physics
adopted at its meeting on 8th July, 1957.

A. Astronomical Section.

1. STAFF AND SCHOLARS.

Senior Professor:

H. A. Brück.

Chief Assistant:

M. J. Smyth.

Junior Assistant:

G. I. Thompson (resigned September 30).

Research Associate:

Máire T. Brück.

Technical and Clerical Staff:

Mrs. M. Connolly; Mr. P. Murphy.

Scholar:

B. G. Tunmore (resigned June 30).

2. EQUIPMENT.

The performance of part of the solar installation has been improved in two ways: the mechanism of the oscillating slits in the spectrohelioscope has been redesigned, and the brightness of the image in the same instrument has been considerably enhanced and the intensity of scattered light reduced by the installation of a 3-inch blazed Bausch and Lomb grating. The spectrohelioscope performs now very satisfactorily.

In connection with the proposed flare patrol of the sun, an Atmospheric Receiver with an Evershed Recorder has been obtained and put into operation. It is being used for the registration of Sudden Enhancements of Atmospherics (SEAs).

A Cambridge Ratio Recorder, originally obtained on loan, has been purchased to serve in the projected programme of photoelectric photometry of the solar spectrum.

The aluminising equipment of the observatory has been installed in a new laboratory under the Meridian Room which has been fitted out by Mr. P. Murphy. The completion of this laboratory marks the end of the gradual conversion of the basement of the main building into working accommodation.

3. RESEARCH WORK.

Solar Spectroscopy:- Dr. Thompson's work on the ultra-violet spectrum of the sun has continued. Further plates have been secured with the grating in the third order, and the region down to 3200 Å is now sufficiently well covered by satisfactory spectrograms. Intensities have been recorded on the greater part of these plates. When Dr. Thompson left, the programme was taken over by Dr. M. T. Brück. Its extension to the ultra-violet limit and the final reduction of the plates is expected to be complete by the summer of 1957. In the meantime further intensity records have been sent to Professor Minnaert of Utrecht, for his proposed Table of Equivalent Widths of Fraunhofer Lines.

Solar Patrol:- Regular observations of the sun with the spectro-helioscope were begun by Dr. M. T. Brück in August 1956. The observations were discontinued during December and January and were resumed on February 1. Up till March 31, owing to poor weather conditions the sun could be observed on 48 days only. Twelve flares were recorded.

Solar observations are now being sent monthly to Observatoire de Meudon, France, the central office in western Europe for collecting data of transient phenomena on the sun. Arrangements have been made also to send data fortnightly to the Fraunhofer Institute, Freiburg, Germany, where daily maps of the sun are prepared for quick circulation.

All arrangements have been completed for the observatory's participation in the Solar Patrol during the International Geophysical Year. Solar flares and sudden disappearances of prominences will be observed. Monthly reports of these and also of any SEAs recorded by the Atmospheric Receiver will be sent to Meudon and to the IGY Committee in the Meteorological Office, Dublin. Phenomena of outstanding importance will be communicated by coded telegram to the Bureau Ionosphérique Français, Paris, and special messages or warnings will be received from the Centre National des Ursigrammes, Paris. In view of the great shortage of staff, Mrs. Connolly, Clerk, has been trained to assist in this type of solar work. She has already given considerable help with the Solar patrol. Every effort is to be made to observe the sun as regularly as possible during the IGY.

Stellar Work:- Lack of assistance has greatly handicapped stellar observations, and it has not been possible, in particular, to commence systematic work on the intensity of the interstellar 4430 Å absorption band, which was mentioned in last year's Report. On the other hand, when Dunsink was invited by the Utrecht Observatory to take part in an international co-operational programme on the star 12 Lacertae, an important variable of the Beta Canis Majoris type, Dr. Smyth was able to secure a good set of photoelectric observations for a total period of 24.5 hours. These observations are being made ready for publication.

An attempt was made to secure similar observations of the star Nu Eridani as part of an international programme sponsored by Professor Kukarkin of the Sternberg Institute, Moscow, but the low altitude of the star made it impossible to obtain results of the necessary precision.

Following early experiments by Dr. H. E. Butler, some tests were made in which two stars were observed simultaneously with two photoelectric photometers, the first of which was attached to the 28-inch reflector, the second to the 12-inch refractor, a hundred yards away from the reflector. No significant results have been obtained so far.

4. ADH TELESCOPE AND BOYDEN OBSERVATORY.

Professor Brück attended a meeting at the University Observatory, Bonn, of the Administrative Council of the Boyden Station at which it was decided to extend for another year the present scheme of operation of the Station. Lack of staff has made it impossible, unfortunately, to send an observer from Dunsink to South Africa during the year, or to make progress with the measurement of the existing ADH plates of open star clusters.

5. CONFERENCES AND VISITS.

Dr. Smyth and Dr. Thompson attended the Bristol meeting of the Royal Astronomical Society. Dr. Thompson also attended the Seventh International Symposium at Liège.

Professor and Mrs. Brück, following an invitation which they first received at the Dublin Assembly of the International Astronomical Union, visited the observatories in the Crimea and at Abastumani, Bjurakan, Pulkovo and Moscow as guests of the USSR Academy of Sciences.

Professor Brück lectured at the University of Kiel as guest of the University and also at the Physics Department of the University of Münster and at the University Observatory at Bonn.

6. VISITORS.

The Observatory has been open to the public as usual on the first Saturday of each month, and large numbers of visitors have attended the "open nights".

7. PERSONAL

Mr. B. G. Tunmore resigned his Scholarship at the end of June. Dr. G. I. Thompson resigned his post as Junior Assistant at the end of September to join the staff at the Cambridge Observatories.

In February Professor Brück received his Warrant of Appointment to the combined post of Astronomer Royal for Scotland and Regius Professor of Astronomy in the University of Edinburgh.

B. Cosmic Ray Section

1. STAFF AND SCHOLARS.

Senior Professor:

C. O'Ceallaigh.

Professor:

C. B. A. McCusker.

Student:

R. H. W. Johnston.

Technical and Clerical Staff:

Miss Eileen Smith; Mr. Jeremiah Daly; Mrs. Máirín Johnston (resigned 31 July 1956); Mrs. Joan Keefe (resigned 5 September 1956); Miss Philomena Leahy (resigned 27 October 1956); Miss Máire O'Brien (resigned 27 October 1956); Miss Carmel Inight (appointed 3 September 1956); Miss Norah Leahy (appointed 6 September 1956); Miss Nuala Ryan (appointed 29 October 1956); Miss Noeline Fellowes (appointed 12 November 1956).

Scholars:

R. J. Reid; G. Alexander; M. J. O'Connell (entered 12 November 1956).

2. RESEARCH WORK

The work using the photographic-plate and counter techniques was continued during the year 1956-57. The first technique is used to study the newly discovered short-lived heavy unstable particles first discovered in cosmic radiation, and more recently produced directly and in abundance at the Bevatron at Berkeley, California by the impact of 6 Gev protons on a copper target. These heavy mesons decay in accordance with one of six recognised modes and their relative frequencies have been estimated by experiment. Certain of these decay-modes result in the production of more than two secondary particles. Consequently, the energy of the charged particle is not unique. For this reason, a preliminary study has been made of the decay-spectra of the three-body modes. The second technique is used for the study of penetrating extensive air-showers. From observation of the variation of the intensity of such with time, coupled with a study of the apparent points of origin of these showers, it is expected that information of great value will be accumulated which will be of help in the elucidation of the origin of the cosmic radiation.

Photographic Emulsion:- The work described in the report for 1955-56 on the stack K_2 exposed to the K^+ meson beam at the Berkeley Bevatron has been continued. Some 3500 cases of K-decay have been analysed, and the relative abundance of the decay modes $K\mu_2, X, Y, T$ and T' have been estimated. These are given in the following table, and are compared with those obtained in a similar experiment at Berkeley by the Group of R. W. Birge.

Mode	Number	Class	% of all K-decay	
			Present Exp.	Berkeley Grp.
$K\mu_2$	202.5	A	56.9 ± 2.6	58.5 ± 3.0
$\chi (K\pi_2^0)$	82.5	A	23.2 ± 2.2	27.7 ± 2.7
$\chi (K\mu_3)$	21	A	5.90 ± 1.3	2.83 ± 0.95
$K\beta$	18	A	5.06 ± 1.3	3.23 ± 1.30
Total	324		91.06 ± 1.50	92.26 ± 1.50
T	(24.1)	A+B+C	6.77 ± 0.43	5.56 ± 0.41
T'	(7.6)	A+B	2.15 ± 0.42	2.15 ± 0.47
Total K	356		99.98	99.97

Preliminary results have been obtained on the form of the energy spectra of the rarer 3-body decay modes. These results which were free from selection bias must be regarded as being of a preliminary nature, as the number of cases obtained $K\mu_3$ (21), T' (20) and $K\beta$ (18) was not sufficient to enable statistically significant comparison with the spectra predicted by theory. One feature of interest was the observation of 5 cases out of 18 of emission of electrons of energy approximate to the maximum energy 250 MeV. This result might be taken to indicate the existence of a two-body decay-mode $K\beta_2 \rightarrow e + \gamma$ but such an inference must be regarded with caution as theory predicts for a vector meson with scalar coupling, a bimodal distribution of electron energy from the three-body mode $K\beta_3 \rightarrow e + \gamma + \pi_0$ with which the available experimental results are in agreement. It is hoped to continue work on this important problem. The correction for energy-loss by Bremsstrahlung of fast electrons which is of importance in the investigation, has been examined theoretically by Professor O'Ceallaigh and arrangements have been made through the courtesy of Professor W. K. F. Panofsky to have stack exposed to the monoenergetic beam of electrons from the linear accelerator at Stanford University, California, with a view to testing these ideas by experiment. During the year, 218 examples of T -decay were made available to the workers of the emulsion

group of the University of Göttingen. Dr. N. Varshneya of this group made measurements at Dublin during the months of November and December 1956, the results being a contribution to a collaborative study of the energy distribution of the π^- mesons from T^- decay, in order to determine the spin and parity of the T^- meson. He received a grant towards maintenance from the Institute during this period. Further work on this problem has been undertaken by Mr. M. J. O'Connell in collaboration with the University College Dublin Group and is at present in progress. A collaboration to study the interactions of negative K - mesons was initiated by the Bristol, University College London, Milan and Padua Groups. The emulsions group at the Dublin Institute for Advanced Studies was invited to join. The plates were made available gratis through the generosity of the Bristol Group, it being a condition that representatives of the collaborating groups should meet at various centres as often as was thought necessary, and that funds be made available by the interested groups to finance these meetings. The work is making satisfactory progress and, if successful, it is hoped to carry out collaborative work on other projects involving plates exposed to the particle beams at the high-energy machines.

Counter Work - Time Variation of Cosmic Ray Showers:- Early in April 1956, work was begun by Professor McCusker and his collaborators on a cloud chamber experiment to determine the apparent points of origin of penetrating extensive air showers. Two cloud chambers (one lent by Professor Nevin to whom we are greatly indebted) with their axes at 90° were used, triggered by either of the two penetrating shower sets recording extensive air showers. The experiment began on May 18, 1956 and continued to run throughout the year. The quality of the photographs has been maintained at a high standard throughout, and the experiment has proved successful. The results of the last two years run, show that a marked anisotropy of direction of high energy cosmic ray primaries can be detected. This experiment, in effect, opens up a new branch of Astronomy.

At the same time the apparatus has provided much information of the structure and nature of extensive air showers at sea level. Because of the acute shortage of staff, much of this has not yet been analysed.

Summaries of earlier results and suggestions for new experiments had been sent to the European Office of the U.S.A.F. Air Research and Development Command during the year 1955-56. Negotiations with the Command went on during the present year. Shortly before Xmas 1956, a contract was signed with A.R.D.C. The estimated cost of the experiments was \$ 18,846 for the first year Dec. 1, 1956 to Nov. 30, 1957. The contract called for the erection of a station in Jamaica. Dr. F. C. Bowen of the Physics Department, U.C.W.I. had already been approached and had signified his readiness to help in this project. Building of the equipment began at once. By the end of March 1957 the equipment (4 counter trays and associated cathode followers, 6 M-units, 3 addition circuits, one master unit, 12 hodoscope strips, one neon operating unit, 3 stabilized power packs for 350, 220, and - 105 volts, one stabilized E.H.T. power pack, one camera and camera box and auxiliary equipment) had been built, tested, packed and despatched by air to Jamaica. The total weight of this equipment was 1560 lbs.

During the course of the year, DeBenedetti et al. published the results of an analysis of a very high energy event in a photographic plate. A fortunate circumstance made it possible to analyse this event much more thoroughly than had previously been possible. It was possible to compare in some detail the results of this analysis and the predictions of the Tunnel theory of these high energy events put forward some years ago by Dr. F. C. Roesler and Professor McCusker. The agreement was excellent. At the same time, a comparison of all the known high energy events with the theory was made again with excellent results. The necessary computation was carried out on the I.C.I. electronic digital computer and we are indebted to the Company for this.

3. CONFERENCES.

Rochester Conference 1957: Professor O'Ceallaigh attended by invitation the 6th. Annual Rochester Conference on High Energy Nuclear Physics at

Rochester N.Y. from April 3rd. - 6th. 1956, and contributed an account of the Relative Frequencies of the Decay Modes of K -mesons. Results from the Dublin Institute for Advanced Studies on the decay -spectra of the three-body decay modes were communicated along with those from other laboratories by Dr. K. Gottstein (Göttingen) and Dr. J. Crussard (École Polytechnique Paris). Professor O'Ceallaigh also gave a talk on the above topics to the Emulsion Group at the Naval Research Laboratory, Washington D.C. and visited the Brookhaven National Laboratory, Upton, Long Island N.Y.

Oxford Cosmic Ray Conference 1957: Professor McCusker attended the Oxford Cosmic Ray Conference organized by the Atomic Energy Research Establishment, in April 1956, reading a paper (McCusker and Reid) on time variations produced at sea level by high energy cosmic ray primaries.

4. SEMINARS.

Dr. C. Franzinetti of the University of Rome, gave two lectures on "Automatic Scanning Devices" and "Recent Advances in the Study of Heavy Mesons". Dr. A. Engler gave a talk on "Cosmic Ray Events at Extreme High Energies", dealing mainly with the phenomenon of high energy jets in photographic plates. Dr. Z. Koba of the University of Kyoto, gave two lectures on high energy cosmic ray phenomena.

5. INSTRUMENTS AND WORKSHOP.

A further Reichert stand has been fitted on our workshop by Mr. J. Daly with the 'Special Bannister Kinematic Stage'. The general maintenance of the microscopes has been attended to throughout the year. In the case of the scanning microscopes which are subject to very hard wear, Mr. Daly has replaced the fine-focussing gear by a special movement of his own design. This new movement has been functioning in a very satisfactory manner.

6. PUBLICATIONS.

(i) Published:

- C. B. A. McCusker and B. G. Wilson:
The rate of extensive showers of high electron density at sea level. *Nuovo Cim. Ser. 10*, 3, 188, 1956.
- C. B. A. McCusker and R. J. Reid:
Variations in the rates of high energy cosmic ray primaries. *Proc. Oxford Conference*, April 1956, A.E.R.E. Report.
- C. B. A. McCusker and E. C. Roesler:
New experimental evidence and the tunnel theory of cosmic ray jets. *Nuovo Cim. Ser. 10*, 2, 1136, May, 1957.
- G. Alexander and R. H. W. Johnston:
On the Relation between Blob-Density and Velocity of a Singly Charged Particle in G.5.Emulsion. *Nuovo Cim. Ser. 10*, 2, 363, 1957.

(ii) In the press:

- G. Alexander, R. H. W. Johnston and C. O'Ceallaigh:
The Relative Frequencies of the Decay Modes of Positive K⁻-Mesons and the Decay Spectra of the Modes $K_{\mu 3}$, T and K_{β} . *Nuovo Cim.*

C. Geophysical Section.

1. STAFF AND SCHOLARS.

Senior Professor:

Leo W. Pollak.

Professor:

Thomas Murphy.

Senior Technical Assistant:

Thomas J. Morley.

Technical and Clerical Staff:

Miss Nessa Falconer; Miss Margaret Ryan; Mr. Kevin Bolster;
Mr. Martin Cotter.

Scholar:

Arvids Leons Metnieks.

2. INVESTIGATIONS, EXPERIMENTAL AND FIELD WORK.

a. Senior Professor L. W. Pollak and Co-workers:

- (i) Methods for determining the diffusion coefficient (size) of condensation nuclei. - The extensive comparison of the static and dynamic methods for determining the diffusion coefficient of condensation nuclei

has been concluded (Pollak - Metnieks) and a paper summarising the results published. The possible factors influencing both methods have been studied, and the experimental results theoretically interpreted by R. Fürth.

A further improvement of the photo-electric counter and an exact definition of the diameter of its air column was achieved by replacing the blotting-paper lining by a porous ceramic lining machined to an accuracy better than 0.05 cm which is required when the diffusion coefficient determined by the static method using the fog tube as decay vessel should be accurate to 5%.

(ii) Nucleus counter with stereo-photographic recording. -

Photograms obtained by the nucleus counter with stereo-photographic recording (Pollak assisted by J. Daly) proved the value of this method also in other condensation nuclei investigations and led to the development of a new type of droplet counter. A paper on this construction was read at the Second International Symposium on condensation nuclei held in Basel and Locarno in Autumn 1956.

(iii) Absolute and relative nucleus counters. - Considerable progress

has been made in the construction of a reliable and accurate absolute and relative instrument for measuring number per cm^3 and size of condensation nuclei in the region of 10^{-6} cm diameter (Pollak and Metnieks, Pollak and Daly).

(iv) Recording nucleus counter. - Verzár's automatic condensation

nucleus counter has been assembled and its records compared with our standards. A paper summarising the results was read at the Second International Symposium on condensation nuclei held in Basel and Locarno in Autumn 1956 (Metnieks).

(v) Large nuclei. - Equipment for measuring nuclei of size between

0.3 and 20 microns has been assembled and tested. Measurements in suitable weather situations at 5 Merrion Square have started (Metnieks).

(vi) Photo-electric nucleus counters for low and very low concentrations; resolution of polydisperse aerosols. - The last months were devoted to the comparison of two photo-electric counters with ceramic linings having direct and "broken" light beams respectively, the determination of the diffusion coefficient of heterogeneous aerosols by the dynamic method and the construction of a twin photo-electric condensation nucleus counter of high precision for measuring very low concentrations as occur with the resolution of polydisperse aerosols into their components using the dynamic method, in high altitude, maritime and arctic aerosols (Pollak and Metnieks).

b. Professor T. Murphy and Co-workers:

(i) Geodesy.- The publication concerning the coordinates of the Six-Inch sheet maps of Ireland was finally completed and has now been issued. For the first time in Ireland it is now possible to ascertain the latitude and longitude of a point with an accuracy of about one second of arc without a long calculation. These are the only figures of their kind, and now available just one hundred years after the surveys were completed. The lengthy investigation brought to light many obscure points which are not disclosed in the publication but which have been acknowledged by the Ordnance Survey as very important. The computations were carried out twice by Miss Ryan and Mr. Murphy on two different machines.

(ii) Gravity. - After the Worden gravimeter was received it was decided to establish base stations throughout the country linking up with the earlier work. The field work was done in 1954-5. The analysis and adjustment have now been accomplished and published as a Geophysical Bulletin of the School. The gravimeter has proved very accurate and reliable. The scale value has been compared with other similar ones in England so that the gravity values in Great Britain and Ireland are on the same basis. Messrs. Ferranti were of great assistance in this work by solving the 37 simultaneous equations on their electronic calculator "Pegasus" at a nominal charge and almost by return of post.

The general gravity survey is continuing but the field work has been suspended until some of the computations and analyses have been undertaken. The south eastern corner of Ireland has been worked up and with a station density of better than one per 9 sq.kms a detailed analysis (regional anomaly, second and fourth differentials of the vertical component) is almost complete. It is thought that work in this region will give important clues to the structure of the earth's crust.

(iii) Radioactivity. - Semi-routine measurements of the radioactivity of the air are being taken at the rear of No.5 Merrion Square. The sampling is accomplished by collecting the active particles on a paper filter and the beta activity measured with a counter and scalar. A few months' figures will be assembled before an attempt is made at analysis. The measurements are being carried out by Miss Ryan.

(iv) Photo-electric nucleus counter. - The formation of fog in the cylindrical cloud chamber of the photo-electric nucleus counter has been studied with a photographic recording multiflex galvanometer (period 2 sec) and a short period galvanometer (period 0.02 sec) in conjunction with the photo-kymograph belonging to Verzár's automat. The changes of temperature and humidity during the adiabatic expansion in the fog tube has been investigated with a Hartmann & Braun thermo-electric clinical psychrometer purchased for this purpose. The results were presented at the Second International Symposium on condensation nuclei held in Basel and Locarno in Autumn 1956.

3. PUBLICATIONS

a. Geophysical Bulletins of the School of Cosmic Physics:

No. 13. The Latitudes and Longitudes of the Six-Inch Sheet Maps of Ireland.
By Thomas Murphy assisted by Roisín Ryan.
Price: 15/- pp. 67 Published September, 1956.

No. 14. The Gravity Base Stations for Ireland. By Thomas Murphy.
Price: 7/6. pp. 14 Published April, 1957.

Summary: A grid of 82 gravity base stations has been set up in Ireland. 37 of these form a network of 69 connections and 45 are intermediate. The network has been adjusted and values for each station are given as a difference from the principal base, at Dublin, which in turn is connected to the pendulum station at Dunsink. The measurements were carried out in 1954-5 with a standard Worden gravimeter. This meter has been compared with four

other Worden gravimeters at Macclesfield, England, one of which has been compared with pendulum observations in Great Britain.

b. Contributions to periodicals:

L. W. Pollak, T. C. O'Connor & A. L. Metnieks with a contribution by R. Fürth:

On the determination of the diffusion coefficient of condensation nuclei using the static and dynamic methods. *Geofisica Pura e Applicata*, 34, 177-195, 1956.

L. W. Pollak:

Report on the determination of the diffusion coefficient of condensation nuclei using the static and dynamic methods. Proc. 2nd International Symposium on Condensation Nuclei in Basel and Locarno. *Geophysica Pura e Applicata*. 36, 70-75, 1957.

Summary: It was intended to carry out a detailed comparison between the values of the diffusion coefficient of condensation nuclei obtained by the static method and the corresponding values deduced from measurements by the dynamic method.

In order to increase the accuracy of the diffusion coefficient as determined by the static method, using as decay vessel the fog tube of a photo-electric counter, it was necessary to develop a new version with an air column diameter smaller than that previously employed. Calibration curves for counters with fog tubes of 1.1, 1.9 and 2.5 cm diameter together with that for the standard of 3.85 cm are given. Fürth's theory of the static method was experimentally verified and shown to be consistent in itself.

With regard to the dynamic method, the effect of varying the air-flow on the results obtained with the diffusion box was investigated and a marked influence on the value of the diffusion coefficient using Gormley's formula found. A regular and systematic increase of the diffusion coefficient with increase of air-flow, apparently overlooked up to now, was discovered. Within the range of 1 to 4 litres/min air-flow a change by 1 litre/min alters the diffusion coefficient by about 12%. Since for technical reasons during one experiment, adjustment of the air-flow by two litres/min was not uncommon hitherto, the diffusion coefficient determined in this way may be wrong by 25% of its value for this reason alone. The influence of humidity on the diffusion coefficient determined with the diffusion box was also studied. It was found that the reduction of the diffusion coefficient due to increase in relative humidity from 53% to 84% amounts in the average and over a very wide range of diffusion coefficients to about 10%.

The comparison of the diffusion coefficients determined by the static and dynamic methods gave the following results: The diffusion coefficient of large hot nichrome wire nuclei ($D \leq 10 \cdot 10^{-6}$ cm²/sec) determined by the static method is approximately one third of that obtained when the dynamic method with an air-flow of 1 litre/min is used. With decreasing size of nuclei the diffusion coefficients measured by the two methods approach each other.

It is suggested that the observed discrepancies are due to a thin boundary layer which at the start of the diffusion process is almost free of nuclei. The theory of the static method is accordingly modified and a new formula for the calculation of D is derived which leads to agreement between the static and the dynamic determinations of D when it is assumed that the boundary layer has a thickness of about 1.5 mm.

L. W. Pollak & J. Daly:

A condensation nucleus counter with stereo-photomicrographic recording. Proc. 2nd Internat. Symposium on Condensation Nuclei in Basel and Locarno. *Geofisica Pura e Applicata*, 36, 27-34, 1957.

Summary: In order to discriminate better in photograms of the graticule of an Aitken type nucleus counter between droplets formed around the nuclei and spurious condensation products or extraneous matter on both sides of the graticule, a nucleus counter with stereophotomicrographic recording has been constructed. Its description together with a sample stereogram is given. The advantages of stereophotographic recording are demonstrated.

Stereo-photographic recording makes it possible to dispense with the glass graticule altogether, and to follow the tracks of the droplets during their fall in the receiver. Their counting in any plane or volume is carried out by methods as used in stereo-photogrammetry. Simple stereometers are considered sufficient for this purpose. Stereograms of falling droplets formed on condensation nuclei when photographed after removing the glass graticule are reproduced. They make directly visible and record for the first time, the complicated paths which, due to turbulence, the falling droplets in the receiver of an Aitken counter describe and they demonstrate the difficulty in applying Aitken's theory under these conditions.

The experimental model of a condensation nucleus counter employing the principle of the slit ultra-microscope combined with stereo-photomicrographic recording is depicted.

L. W. Pollak:

Methods of measuring condensation nuclei. Principal lecture delivered at the 2nd Internat. Symposium on Condensation Nuclei in Basel and Locarno. Proc. 2nd Internat. Symposium on Condensation Nuclei in Basel and Locarno. *Geofisica Pura e Applicata*, 36, 21-26, 1957.

Summary: The lecture reviewed the instruments for measuring the concentration, diffusion coefficient (size), mass, density, decay (coagulation and sedimentation) and charge of condensation nuclei of about 10^{-6} cm diameter, their development especially in the last fifteen years, discussed their features good and bad, and concentrated on the question as to how far in the seventy-five years of condensation nuclei research we advanced in the construction of an absolute and relative condensation nucleus counter.

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

On the determination of the diffusion coefficient of heterogeneous aerosols by the dynamic method. *Geofisica Pura e Applicata*, 37, 1957. In course of publication.

Summary: It is shown that the marked influence of the air-flow on the value of the diffusion coefficient as determined by the dynamic method can be fully explained when heterogeneity of the condensation nuclei in the aerosol is assumed. A theory of the dynamic method for heterogeneous aerosols is given on the assumption that the diffusion loss of a mixture of condensation nuclei of different diffusion coefficients is the sum of the diffusion losses of its components. Procedures of resolving heterogeneous aerosols into their components using the dynamic method are developed. The accuracy attainable by one of the methods which requires no assumptions on the number of components in the aerosol under investigation is illustrated by a numerical example.

T. Murphy:

The formation and disappearance of fog in photo-electric nucleus counters. Proc. 2nd Internat. Symposium on Condensation Nuclei in Basel and Locarno. *Geofisica Pura e Applicata*, 36, 35-40, 1957.

Summary: In photo-electric nucleus counters, the fog begins to form on expansion and is complete in less than one second. Within a few seconds it begins to disperse by fall under gravity and by evaporation. Both the formation and the disappearance depend on the diameter of the fog tube. It is easier to construct an accurate counter when the diameter is less than 3.8 cm.

A. L. Metnieks:

On F. Verzár's photo-electric automatic nucleus counter. Proc. 2nd Internat. Symposium on Condensation Nuclei in Basel and Locarno. Geofisica Pura e Applicata. 36, 41-48. 1957.

Summary: A Verzár condensation nucleus counter with automatic recording was tested under constant and controlled conditions in the laboratory and compared with the standard photo-electric nucleus counter of high precision of the School of Cosmic Physics. The photographic records of the fog formation in the cylindrical cloud chamber of the Verzár automat made with galvanometers of 0.019 sec and 1.0 sec periods show that a galvanometer of 1 sec period cannot follow the rapid formation and disappearance of the fog, apparently due to the horizontal arrangement of the fog tube and the absence of an insulating wet lining.

The Verzár automat is an excellent apparatus for continuously recording concentration of condensation nuclei. Its calibration curve, however, would require adjustment if the photo-electric nucleus counter of the School of Cosmic Physics in Dublin were accepted as standard. A new calibration curve deduced from the Dublin comparisons made so far is given.

c. In the press:

Due to lack of funds the printing of Geophysical Bulletin No.15: L. W. Pollak and T. C. O'Connor, Tables and graphs for determining the diffusion coefficient, size, density and mass of condensation nuclei etc. had to be suspended. It is hoped, however, that the issue will be possible in the next financial year.

d. Manuscripts awaiting publication:

The manuscript of the second part of the Climatology of Dublin City, Geophysical Bulletin No.16 (Pollak-Morley) covering temperature and humidity, is ready for the printers but is being held over also because of lack of funds.

4. SCHOLAR.

Mr. Arvids L. Metnieks' application to be registered for the degree of Ph.D. has been accepted by Trinity College, Dublin. Professor J. H. J. Poole has kindly agreed to act as supervisor.

5. REQUEST FROM HEADQUARTERS, U.S. AIR FORCE CAMBRIDGE (Mass.) RESEARCH CENTER for the cooperation of the Meteorological and Geophysical Section, with expenses paid, in investigations into the origin, size and correlation of occurrence of natural ice nuclei.

Extract from letter of Air Research and Development Command, Bedford, Mass. (CRZP P-7641, T-76412) addressed to Professor Pollak dated 3 January 1957:

The "Geophysics Research Directorate would appreciate very much the cooperation of your Institute in the investigation which Dr. H.-W. Georgii, University of Frankfurt, is doing for us on Contract AF 61(514)-927.....This program involves careful laboratory studies of the freezing spectra as well as field measurements at geographically selected sites. The most favorable place in Europe to investigate the freezing nuclei under pure maritime conditions is certainly the west coast of Ireland. We, therefore, suggested a trip of Dr. Georgii to Ireland and it would, of course, be of considerable help for Dr. Georgii if we could obtain the support of your Institute. We are sure that your Institute, so well equipped for the research in this field and your own considerable experience in the field of atmospheric condensation nuclei, would be of great help to us.

Since the planning of this trip has to start soon, I would suggest that you discuss all technical details with Dr. Georgii on your visit to Frankfurt on 20 February. It might be useful to make an estimate of the costs involved so far as your Institute is involved and to get in contact with our office in Brussels on your way back to Ireland. We would appreciate being kept informed directly about the results of these discussions.

I have another independent question. Since I became interested quite recently in methods of nuclei counting at low concentrations, I would appreciate your information about the new ultra-microscope counter with stereo-microphotographic recording. Do you have a publication on this instrument available, and can this instrument be obtained commercially?"

Signed: C. E. Junge, Project Scientist
Aerosol Physics Laboratory
Geophysics Research Directorate
(Cambridge, Mass.)

In the Meteorological and Geophysical Institute of the University in Frankfurt a.M. Professor Pollak inspected on 19th February 1957 the rather bulky, but not heavy (200 kg) equipment which Dr. H. -W. Georgii constructed and assembled for his investigation on natural ice nuclei carried out for the U.S. Geophysics Research Directorate. It was decided that the equipment should be flown to Dublin for the six to eight weeks' combined work on the west coast of Ireland.

Our cooperation which the Headquarters of the U.S. Air Force Cambridge Research Center, Air Research and Development Command requested on 3 January 1957, will consist in supplying our mobile laboratory, all necessary equipment and personnel for measuring concentration, size and charge of large and Aitken condensation nuclei. Our team will consist of Professors Pollak and Murphy, Metnieks (Scholar) and Cotter (Mechanic). A caravan as trailer to our van will be rented, the costly three phase generator

required for Dr. Georgii's freezing cloud chamber would be supplied by the U.S. Air Force.

The estimated budget as far as our cooperation is concerned amounts to \$ 1877.00 which expense will be borne by the U.S. Geophysical Directorate. Professor Pollak wishes to state that no salary or wages for any member of the team provided by the School have been claimed.

On the suggestion of the Headquarters of the U.S. Air Force Cambridge Research Center Professor Pollak visited the European Office of the Air Research and Development Command in Brussels on 26 February 1957. Professor Pollak had a long and very satisfying discussion there with Lt. Colonel, U.S.A.F., A. C. Trakowski, chief, Physical Sciences, Technical Operations Division. At the outset of the meeting Lt. Colonel Trakowski expressed the hope that our cooperation would not be confined to Dr. Georgii's project but that Professor Pollak would continue working for their Directorate under special contract. Professor Pollak pointed out that he was not and still is not keen to work under contract, but since the conditions offered were so good and advantages, particularly for his Section, so great he agreed to work out a scheme for further collaboration.

Lt.Col. Trakowski is particularly interested in the absolute nucleus counter with stereo-microphotographic recording, the new photo-electric counter for very low concentration and the methods of resolving polydisperse aerosols into their components. Professor Pollak has been asked to work out the programme which he outlined during the discussion and to include amounts as follows: (i) Salary of a Research Associate or Assistant for which he suggested Mr. A. L. Metnieks, Scholar of the Section, (ii) Travelling expenses, (iii) Overhead expenses, (iv) Services of a mechanic, (v) Expendable supplies etc.

In accordance with this request Professor Pollak transmitted a Research Proposal to the European Office of the Air Research and Development Command in Brussels on 15th March 1957 which suggests a 2-year project commencing 1st March 1958 with an estimated annual budget of \$ 3380.00. No salary or any fee is proposed for the Principal Investigator, Professor L. W. Pollak.

It may be useful to mention that the project suggested was for a long time on the programme of the Section, but could not be undertaken since two persons of equal skill and familiarity with the problems and equipment are required which were not available until recently.

6. CONFERENCES.

Meeting of the International Commission on Gravity in Paris (3rd to 8th September, 1956): Professor Pollak (member) and Professor Murphy (guest) attended this conference which dealt with questions to be submitted for decision to the Toronto meeting of the I.U.G.G. in 1957. Twenty-seven nations with forty-five delegates were represented, among them those from U.S.S.R., Yugoslavia and C.S.R. It was gratifying to see Ireland on the world map of gravity, exhibited during the conference and much referred to during the discussions, completely covered by Professor Murphy's measurements, whereas countries such as Great Britain with a most important network of absolute and relative measurements were blank, the reason being that their results are not yet published in extenso or at all.

Second International Symposium on Condensation Nuclei in Basel and Locarno (1st to 4th October, 1956): Forty-nine delegates representing twelve nations attended. On the invitation of the organising Swiss National Committee Professor Pollak delivered one of the four principal lectures. In addition the Geophysical Section contributed four papers. Professor Murphy also attended this Symposium. Professor Pollak was elected Chairman of the opening meeting on 1st October, 1956, which took place in the presence of the Rector of the Basel University, and he was invited to address and close the Symposium in Locarno on the 4th October, 1956. He was elected a member of the Standing Committee entrusted with the preparation of the next symposium scheduled for 1958. The Committee consists of Pollak (Ireland), Thams and Verzár (Switzerland).

7. LECTURES ABROAD

(1) Professor Pollak on invitation delivered a lecture "Ten years geo-

physics in the Dublin School of Cosmic Physics" in the Physical Society of the Frankfurt University on February 20, 1957 and showed after his talk - for the first time on the Continent - the new 30 min. colour-sound film "Dublin's Fair City" which Aer Lingus made available.

The Irish Legation in Bonn was represented by its Secretary Aedan O'Beirne and the Irish-German Society in Bonn by its Chairman, o.ö. Professor Dr. Rudolf Hertz, occupant of the Chair for Celtology in the University of Bonn.

The Chairman of the Physical Society Dr., Dr.h.c.Ph. Siedler who presided, expressed in his closing speech the hope that Germany would have in the not too distant future a similar research institute of equal freedom and facilities as Ireland.

(ii) Professor Pollak spoke on February 21, 1957 in a combined session of the German Meteorological Society and the Colloquium of the Meteorological and Geophysical Department of the University in Frankfurt a.M. on "Absolute and relative condensation nucleus counters, their recent developments and applications". In the chair was the Dean of the Faculty, o.ö. Professor Dr. R. Mügge who had invited Professor Pollak to report on this subject. In this lecture a diagram of the new photo-electric nucleus counter for low concentrations was included and a method of resolving polydisperse aerosols into their components was described.

The large audience comprised professors, lecturers and staff of the Universities of Frankfurt and Mainz, the Director of the Institute for Cloud Physics, Prof. Dr. M. Diem (Karlsruhe), members of the Max Planck-Institute, the U.S. Weather Service, the Institute for Radiation Research, etc.

8. INVITATIONS

(i) Professor Pollak was invited by the Chairman of the Irish-German Society in Bonn, Professor Hertz to repeat his talk on "Ten years geophysics in the Dublin School of Cosmic Physics" in the University of Bonn in Autumn 1957. Travelling expenses and subsistence allowance will be paid by the Bonn Society.

Professor Pollak has been invited by the Chief of the Aerosol Physics Laboratory, Geophysics Research Directorate, Headquarters, U.S. Air Force Cambridge Research Center, Air Research and Development Command to attend the 2nd Conference on Atmospheric Electricity to be held at Wentworth-By-The-Sea, near Portsmouth, New Hampshire, during May 20-23, 1958. Travelling expenses and subsistence allowance during the Conference are provided by the U.S. authorities.

9. METEOROLOGICAL AND GEOPHYSICAL SEMINAR

- 12th April 1956. Professor P. A. Sheppard, Director, Department of Meteorology, Imperial College, London: An investigation of the lower atmosphere in the Trades.
- 26th April 1956. Mr. J. M. Craddock, Meteorological Office, Air Ministry, Dunstable: Investigations into the possibility of extended range forecasting for periods of up to about one month.
- 10th May 1956. Dr. E. J. Öpik, The Observatory, Armagh: Terrestrial accretion from meteoric sources.
- 7th June 1956. Mrs. N. Carruthers-Goldie, Stirling, Scotland: Frequencies and correlation in upper-air data.
- 25th October 1956. Dr. R. C. Sutcliffe, O.B.E., President of the Royal Meteorological Society, London: The water balance in the general circulation of the atmosphere.
- 22nd November 1956. Dr. David M. Gates, Deputy Scientific Director, Office of Naval Research, U.S. Embassy, London: Infrared solar and atmospheric spectroscopy from balloons in the stratosphere (with slides and cine-film in colour).
- 6th December 1956. Mr. J. S. Sawyer, British Meteorological Office, Dunstable; Numerical weather prediction.
- 6th, 7th and 8th February 1957. Professor M. G. Kendall, School of Economics, University of London: (i) Sampling rare events, (ii) The introduction of the graphical method in statistics, (iii) Ranks as substitutes for variate values, (iv) Symmetric functions in Statistics.
- 19th March 1957. Dr. R. Fürth, Birkbeck College, London: On the theory of diffusion of polydisperse aerosols.
Professor L. W. Pollak and Mr. A. L. Metnieks, School of Cosmic Physics, Dublin: On the determination of the diffusion coefficient of heterogeneous aerosols by the dynamic method.
- 28th March 1957. Mr. C. M. Wilson, Messrs. Ferranti Ltd., London: Electronic computers (with slides and sound film on 'Pegasus').

10. EQUIPMENT

A photo-electric Tracing Recorder for visibly recording the deviations of a light-pointer was purchased from Messrs. Dr. B. Lange, Berlin. It

is being used in conjunction with one of our Multiflex Galvanometers of the same firm.

11. MISCELLANEOUS

(i) The Director of the Geofysisk Institutt of the University in Bergen, Norway, Professor C. L. Godske sent Mr. K. Utaaker of Bergen University to the Section for two weeks in order to acquaint himself with experimental and theoretical problems on which we have published in the last few years. Mr. Utaaker remained in the Section from 18th June 1956.

(ii) Mrs. Rita C. Sagalyn, Project Scientist, Atmospheric Physics Laboratory, Geophysics Research Directorate, U.S. Air Force Cambridge (Mass.) Research Center, visited the Section on 14th and 15th May for a discussion. The main subject dealt with was the absolute calibration of a photo-electric condensation nucleus recorder now being built by the G.E.C. for the U.S. Research Center. Mrs. Sagalyn was shown our new experimental set-up for investigations into the size of nuclei.

(iii) The Health Physics Division of the U.K. Atomic Energy Authority, Atomic Energy Research Establishment, Harwell in a letter dated 3rd May 1956 asked for permission to check in Dublin the calibration of their replica of our photo-electric nucleus counter of high precision against our standard. Mr. W. J. Megaw and his Assistant, Mr. R. D. Wiffen, carried out this comparison on 5th and 6th June assisted by Professor Pollak, Messrs. O'Connor, Metnieks and Cotter. Mr. Megaw was introduced into all methods used here and acquainted with equipment not yet described in publications and he was given access to unpublished results in order to speed up the important investigations contemplated at Harwell.

From the letter (dated 8th June 1956) received it is evident that the visitors were very pleased with the success of their visit. Professor Pollak was offered the loan of equipment and we have received in the meantime bakelite resin, millipore filter discs and Porton asbestos filter paper for our experiments.

(iv) On 1st June 1956 Professor Pollak attended the Open Day of the

Atomic Energy Research Establishment at Harwell to which he was invited. At the request of their Health Physics Division he inspected on this occasion the photo-electric Nucleus counter of high precision which has been built by that Division according to our specification and with our assistance, and he took part in a discussion on the problems for which our counter will be used. As a result of his visit important last-minute changes in their replica were carried out which made its standardisation in Dublin three days later possible.

It may be worthwhile mentioning that the static method for determining the diffusion coefficient has been successfully employed at Harwell for their problems.

(v) On the occasion of Professor Pollak's private visit in London from 30th May to 2nd June he had useful discussions with Dr. R. Furth on our results obtained by the static method for determining the diffusion coefficient; with Messrs. C. F. Casella, re instruments for the Section, and with the London Computer Centre of Messrs. Ferranti, Ltd. Messrs. Ferranti agreed to solve the 37 normal equations required by Professor Murphy for adjustment of the fundamental gravity network with their electronic computer "Pegasus" which took only 40 minutes since the programme for a system of 86 equations is available at the firm.

(vi) Re item 8 of the Annual Report in respect of the Financial Year 1955/56: Manufacture of the direct-beam photo-electric nucleus counter of high precision. As reported orally in the Meeting of the Governing Board on 30th April 1956, Messrs. Joyce Scientific Instruments Ltd., Newcastle upon Tyne expressed their interest in the manufacture of the counter in an unsolicited letter dated 28 July 1955 (Ref.HL/BY/G.S.). Just as in all cases of Professor Pollak's constructions and patents which have been manufactured in series he does not receive any payment whatsoever. On the contrary, he has visited the works at his own expense on 22nd and 23rd April 1956 in order to acquaint himself with the range and quality of the instruments manufactured by the firm and to discuss details of the serial production

of the counter. The connection with this electronic, optical and precision instrument company, however, will be of value for our future experimental work, particularly important now with our considerably diminished funds. Professor Pollak was promised that instrument parts required will be put at his disposal free of charge and he received already for a certain experiment a heat-flow plate with 300 thermo-elements per square inch.

(vii) The Director of the British Caribbean Meteorological Service (Mr. W. A. Grinstead), Port of Spain, Trinidad enquired in his letter of 15th June 1956 (Ref.8.7) whether their copy of the nucleus counter of high precision constructed according to our design and working drawing might be standardized in our laboratory.

(viii) On 10th September 1956 Professor Pollak discussed with the experts of the Zeiss-Aerotopograph Works in München the evaluation of sample stereomicrograms obtained by the condensation nucleus counter with stereophotomicrographic recording, after they had advised him in their letter of July 25, 1956 "that any such experiments would be entirely free of charge". Messrs. Zeiss-Aerotopograph have agreed that their Engineering Department undertakes experiments for evaluating the stereo-micrograms with their new instruments designed for small-scale plotting.

(ix) The Health Physics Division of the Atomic Energy Research Establishment, Harwell has kindly supplied free of charge eleven large aluminised glass plates for the construction of a new diffusion apparatus.

(x) Major General J. C. T. Willis, C.B., C.B.E., Director of the British Ordnance Survey, Chessington visited the Section and was shown over the Laboratory. He offered the loan of any equipment at his disposal and the use of their electronic computer for our work.

(xi) Mr. S. Ohta, Chief, Section of Surface Observations, the Meteorological Agency, Tokyo has according to his letter of August 11, 1956 constructed a photo-electric nucleus counter to our design described in 1953. He was supplied with details of our recent improvements, method of calibration and extensive calibration tables.

The Shell Petroleum Company has urgently ordered parts for a photo-

electric nucleus counter.

(xii) Messrs. Joyce Scientific Instruments, Newcastle-upon-Tyne, who have taken over the serial manufacture of our photo-electric nucleus counter of high precision, showed one instrument of their series at the Physical Society Exhibition in London in March 1957 (see Handbook of Scientific Instruments and Apparatus, 1957 Exhibition, page 132).

(xiii) The Physics Laboratory of King's College, Newcastle-upon-Tyne (letter of 23 January 1957, signed K. D. Brown) has built a simplified photo-electric condensation nucleus counter according to our design (Model 1956) and was on request supplied with calibration tables and advised regarding accuracy and performance of the most recent models.

(xiv) Professor Pollak has received from Dr. H. Weickmann, another project scientist of the U.S. Air Force Cambridge (Mass.) Research Center (letter of 14 February 1957) information that two photo-electric nucleus counters have been ordered from Messrs. Joyce, Newcastle-upon-Tyne for their "arctic programme".

(xv) The Physics Department, Faculty of Science, Cairo University, Giza, Egypt asked for literature on our photo-electric nucleus counter.

(xvi) Extract from letter of Headquarters, U.S. Air Force Cambridge (Mass.) Research Center (CRZP P-7641, T-76412) dated 28 January 1957 and signed by C. E. Junge:

"I would like to thank you also for the page proof on the stereo-nuclei counter. To photograph the volume within the counter by avoiding the graticule is definitely a decisive step and eliminates a lot of trouble....We can then make arrangements to have your technicians make another copy for us in the meantime".

(xvii) On the invitation of the English participants in the recent Symposium at Basel and Locarno the 3rd International Symposium on Condensation Nuclei will take place in the Cavendish Laboratory at Cambridge (England) in mid-July 1958.

Pádraig de Brún

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CATHAOIRLEACH

13th February, 1958.