Pr. 5462

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 1958-59.

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Annual Report of the work of the Institute and its Constituent Schools presented by the Council for the Financial Year 1958-59

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, 1959.

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 1959.

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, 1959.

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

III - Report of the Governing Board of the School of Theoretical Physics.

IV - Report of the Governing Board of the School of Cosmic Physics.

I - Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31st March 1959.

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; Reverend Aubrey Gwynn, S.J., M.A., B.Litt. (Oxon.), 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 Cormac Ó Ceallaigh, M.Sc., 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 Tnúthail, 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.; Cormac Ó Ceallaigh, M.Sc., Ph.D.; Mervyn A. Ellison, D.Sc.

Appointed Members:

John J. Dowling, M.A., F.Inst.Phys.; Eric M. Lindsay, M.A., M.Sc., Ph.D.; Reverend Patrick J. I. McLaughlin, D.Sc.; Thomas Edwin Nevin, D.Sc.; Patrick J. Nolan, Ph.D., D.Sc.; John H. J. Poole, M.A., B.A.I., Sc.D.; Mariano Doporto, D.Phys.Sc.; John J. McHenry, M.A., (Cantab.), D.Sc., F.Inst.Phys.; Cilian Ó Brolcháin, M.Sc., Ph.D.

5. ADMINISTRATIVE STAFF

Registrar:

Patricia O'Neill.

Clerks:

Mary A. O'Rourke, B.A.; Mary J. Faul, B.A., D.P.A.

II - Report of the Governing Board of the School of Celtic Studies adopted at its meeting on 29th May 1959.

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.

Assistant Professor:

Rev. Cuthbert McGrath, O.F.M.

Assistant (Part-time):

Mrs. Nessa Doran.

Research Associate:

Heinrich Wagner.

Technical and Clerical Staff:

Miss Maura Devoy; Miss Máire Breathnach.

Scholars:

Louis Paul Nemo (Roparz Hemon); James Stewart (to 31 October 1958).

Extern Research Workers commissioned by the School:

Dr. R. I. Best; Mr. Seán Mac Airt; Mr. Liam Price; Mrs. Mary Ellen Carney; 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; Professor Nils Holmer; Mr. J. L. Campbell; Rev. Aubrey Gwynn, S.J.; Rev. Professor D. Meehan; Dr. L. Bieler; Professor Séamus Ó Néill; Mr. Derek Thomson; Signor Mario Esposito; Professor J. Vendryes; Professor Idris Foster.

2. GENERAL LINES OF RESEARCH WORK.

As usual, the main work of the School during the year lay in Irish studies, early and modern. In the latter field the Linguistic Atlas was published. Field work in the linguistic survey was continued under the direction of Professor Dillon; West Cork and Waterford were surveyed and valuable tape recordings were made. It

is proposed to publish a volume consisting of texts (orthographic and phonetic) of Munster Speech. These texts will be selected from tape recordings made in Irish-speaking districts throughout Munster.

Work continued in other branches of Celtic Studies. The first fasciculus of Professor Vendryes's Dictionnaire Etymologique de l'Irlandais was in the press. In Breton, a Historical Grammar of Breton by Roparz Hemon, submitted last year was still under consideration, and work progressed on the compilation of a Historical Dictionary of Breton of which Vols.II and III were in the press. One volume on Scottish Gaelic was published and a second, The Gaelic of Kintyre was being prepared for press. Celtica, Vol.IV was published and material for Vol.V was being prepared for press. A further volume in honour of R. I. Best is in preparation.

In the Hiberno-Latin Texts Series the third volume, Adamnán's De Locis Sanctis was published. The material for Vol.IV, Itinerarium Symonis Semeonis, edited by Mario Esposito was in the press and final proofs were being read. It is due to appear in 1959. Vol.V, a collection of the Hiberno-Latin Penitentials was almost ready for press at the end of the period under review. In the Mediaeval and Modern Irish Series one volume (Scéla Cano Meic Gartnáin) was in the press and several other volumes were in preparation. Vol.II in the Mediaeval and Modern Welsh Series, Branwen Uerch Lyr, was sent to press and Vol.III, Kulhwch ac Olwen was in preparation. In the Series of Franciscan Texts work on the preliminary matter and notes for Lucerna Fidelium was nearing completion. Proofs of Graiméir na mBráthar, edited by Bartholomew Egan, O.F.M. were revised and work progressed on the preparation for press of the second volume of Dán na mBráthar Mionúr (Cuthbert McGrath, O.F.M.). One volume, An Bheatha Dhiadha, was ready for press and four others were in preparation.

At the end of the period under review six volumes had been published, eighteen volumes edited or written by members of the staff or by extern research workers were in the press and approximately thirty-nine 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: Finished work on the indexes of Vol.I (in the press) of Corpus Genealogiarum Hibernicarum and continued work on the texts of Vols.II and III. Checked first proofs of Togáil Troí for Vol.IV of the Book of Leinster, continued revision of MS. text of Vol.V of the same MS. and commenced work on Vol.VI. Work progressed on a new edition of the Old Irish Bethu Brigte.

Daniel A. Binchy: Edited and saw through press Ériu, Vol.XVIII, and contributed three articles. Finished text, notes and vocabulary for edition of Scéla Cano Meic Gartnáin for the Mediaeval and Modern Irish Series. Completed revised translation (with notes) of two Old Irish Penitential tracts as appendix to Vol.V of Scriptores Latini Hiberniae. Continued transcription of Irish legal MSS.

Myles Dillon: Completed the revision of first proofs of the Book of Rights. Completed draft of the Irish volume in the Teach Yourself Series. Read for the press the second volume of the Mediaeval and Modern Welsh Series. Revised for the Mediaeval and Modern Irish Series an edition of Fled Dúin na nGed, by Ruth Lehmann. A volume of studies in honour of R. I. Best was in preparation and preliminary correspondence with contributors was carried out. Field work with tape-recorders was done in West Cork and in Kerry.

Professors:

James P. Carney: Work completed on the O'Reilly material which was sent to press. The first instalment of the Old Irish Poems was published in Ériu in January 1959 and the remainder is being prepared for publication

in the next volume. Work continued on the Patrician problem and the poems of Eochaidh Ó hEodhusa. Has been overseeing the work of Mrs. Doran and Dr. Eisner.

Miss Cecile O'Rahilly: Continued work on an edition of the Stowe Táin which was sent to press. Commenced work on a new edition of Cath Ficrntrágha for publication in the Mediaeval and Modern Irish Series.

Assistant Professor:

Rev. Cuthbert McGrath, O.F.M.: Continued preparation for press of the second volume of Dán na mBráthar Mionúr. Contributed an article (Seaán Mhág Colgan ect) to the Father John Colgan Memorial Volume, and prepared a further article (Fearghal Óg Mac an Bhaird) for publication in the Donegal Annual. Also did some work on B. Ó hEodhusa's Teagasg Críosdaidhe.

Assistant (Part-time):

Mrs. Nessa Doran: Work continued on a Catalogue of Irish Mss. in the National Library. One fasciculus has been prepared for printing.

Scholars:

Roparz Hemon: Work on a Historical Grammar of Breton was continued. Of the Historical Dictionary of Breton up to M was ready for printing and the texts of Vols.II and III were in the hands of the publishers.

James Stewart: Continued excerpting for the Dictionary of Classical Modern Irish.

Extern Research Workers:

Dr. R. I. Best: Corrected proofs of Vol.IV of the Book of Leinster which was sent to press during the period under review. Continued work on Vol.VII of the same MS.

Seán Mac Airt: Work continued on the Annals of Ulster.

Liam Price: Work continued on Vol.VI of the Place-Names of Co. Wicklow which was published in September 1958.

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

Rev. Canice Mooney, O.F.M.: Corrected second proofs of Searmónta Chúige Uladh.

Rev. Anselm Faulkner, O.F.M.: Work continued on An Sgáthán Spioradálta and An Bheatha Chrábhaidh. Revised the text of An Bheatha Dhiadha for press.

Rev. Pádraig Ó Súilleabháin, O.F.M.: Prepared preliminary matter and notes for Lucerna Fidelium, the text of which was in book-form. Commenced preparation of Buaidh na Naomhchroiche.

Rev. Bartholomew Egan, O.F.M.: Proofs of Graiméir na mBráthar were revised.

Heinrich Wagner: Saw the Linguistic Atlas and Survey of Irish Dialects, Vol.I through the press and commenced preparation of material for Vol.II. Completed revision of final proofs of Gaeilge Theilinn.

R. B. Breatnach: Prepared and sent to press material from the notebooks of the late Archbishop Sheehan which will be published under the title Seán-Chaint na nDéise, II.

Seán de Búrca: Completed revision of final proofs of The Irish of Tourmakeady which was published in August 1958.

Nils Holmer: The Gaelic of Kintyre was submitted for publication.

J. L. Campbell: Completed revision of final proofs of Gaelic Words and Expressions from South Uist and Eriskay from the collection of Fr. Allan McDonald. This work was published in December 1958.

Rev. Denis Meehan: Completed work on Adamnán's De Locis Sanctis (Hiberno-Latin Texts Series, Vol.III) which was published in March 1959.

David Greene: Proofs of the Maguire Poems were corrected and work commenced on a new edition of Macgnímartha Find for the Mediaeval and Modern Irish Series.

Séamus Ó Néill: Work continued on a revised edition of Seanmóirí an Easpoig Uí Ghallchobhair.

Derek Thomson: Completed preparation of material for Vol.II in the Mediaeval and Modern Welsh Series, Branwen Uerch Lyr, which was sent to press.

Mario Esposito: Corrected final proofs of Itinerarium Symonis Semeonis (Hiberno-Latin Texts Series, Vol.IV).

Joseph Vendryes: Continued work on an etymological dictionary of Irish - Dictionnaire Etymologique de l'Irlendais - the first fasciculus of which was in the press.

Idris Foster: Worked on the preparation of an edition of Kulhwch ac Olwen, for publication as Vol.III in the Mediaeval and Modern Welsh Series.

Dr. Ludwig Bieler with Dr. Binchy continued work on The Penitential Documents which is now ready for press.

3. 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 Friday, 6th March 1959. Professor Binchy's subject was The Origins of the so-called High-Kingship.

4. PUBLICATIONS

a. Books published by the Institute:

		Date of Publication
THE IRISH OF TOURMAKEADY. By Seán de Búrca.		
pp.x + 169.	Price 10/-	20/8/58

		Date of Publication
THE PLACENAMES OF CO. WICKLOW. By Liam Price Vol.VI - The Barony of Shillelagh.		
pp.iv + 42.	Price 2/-	13/9/58
CELTICA, Vol.IV. Edited by M. A. O'Brien.		
pp.iv + 297.	Price 30/-	13/9/58
GAELIC WORDS AND EXPRESSIONS FROM SOUTH UIST AND ERISKAY. (Collected by Fr. Allan McDonald) Edited by J. L. Campbell.		
pp.vi + 301 + Frontispiece.	Price 18/-	15/12/58
LINGUISTIC ATLAS AND SURVEY OF IRISH DIALECTS, Vol.I. By Heinrich Wagner.		
pp.xviii + 300 Maps.	Price 105/-	31/12/58
ADAMNÁN: DE LOCIS SANCTIS. Edited by Denis Meehan. (Scriptores Latini Hiberniae - Vol.III)		
pp.viii + 154 + Frontispiece.	Price 30/-	31/3/59

b. Contributions to Periodicals and other publications:

D. A. Binchy: The Date and Provenance of Uraicecht Becc. Ériu, XVIII, 1958.

The Fair of Tailtiu and the Feast of Tara. Ériu, XVIII, 1958.

Old-Irish Axal. Ériu, XVIII, 1958.

James Carney: Two Old Irish Poems. Ériu, XVIII, 1958.

Cuthbert McGrath, O.F.M.: Seaán Mhág Colgan cct. Father John Colgan Memorial Volume, 1958.

Roparz Hemon: Contribution à un Dictionnaire Historique du Breton, Vol.1: A. (Al Liamm, 1958, Brest).

III - Report of the Governing Board of the School of Theoretical Physics adopted at its meeting on 11th June, 1959.

1. STAFF AND SCHOLARS

Senior Professors:

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

Assistant Professor:

Yasushi Takahashi (appointed 1 April 1958).

Visiting Professors:

H. S. Green; I. A. Barnett; E. McLeod.

Technical Assistant:

Miss Evelyn Mills.

Scholars:

L. Bass; W. Israel (left September 1958); C. B. Rayner (left September 1958); C. B. Mast; J. Strathdee; H. Zorski (entered September 1958, left February 1959); A. Das (entered October 1958); D. Judge (entered October 1958); G. Papini (entered October 1958); Miss D. Roy (entered January 1959); W. Kantor (entered March 1959).

Student:

L. Ó Raifeartaigh, working with Professor W. Heitler at the University of Zürich.

2. STUDY AND RESEARCH

The work of Professor Synge was concerned mainly with the mathematical theory of measuring gravitational fields, which, according to the general theory of relativity, consist in the Riemann tensor of space-time, and are not to be confused with apparent (acceleration) fields due to the curvature of the world line of the observer. The techniques used were Fermi transport and a 2-point function (world-function), by means of which it is possible to carry out approximations in power series without losing the advantages of tensor notation. Astronomical aberration was investigated. Conservation equations were obtained in tensorial form. The results will be incorporated in a book on the general theory of relativity, now in preparation.

Mr. Israel investigated the speed of propagation of shock waves in a relativistic gas.

Dr. C. B. Rayner (holding a D.S.I.R. Fellowship) continued his work on the Rosen equations for rigid motion in conjunction with the field equations of general relativity. These equations, which are reducible to a parabolic system of three differential equations, were further simplified (a) by using a special first integral, and (b) by a special choice of initial surface. He made further investigations on parabolic spaces of odd dimension, associated with semi-definite tensors a^{ij}, and elucidated some special properties.

Dr. Mast continued his work on problems relating to clock retardation. He also worked on problems connected with general transport laws for vectors, and the physical interpretation of triads propagated along an observer's world line. In conjunction with Mr. Strathdee he worked on the relativistic interpretation of astronomical observations.

Dr. Zorski, who attended the School with the support of the Polish Academy of Sciences, investigated the possibility of applying the hypercircle method to Cauchy's problem. He also studied the geometry of large deformations, taking three different aspects of the problem. First, equations of compressibility and equilibrium were represented as the condition of vanishing of the curvature tensor of a more general (Weyl's, projective) space. Secondly, the projective and embedding formulation of the fundamental equation of the continuum was investigated; the affine connexion of the embedding space was constructed as the function of the deformation and stress tensor. Thirdly, certain theorems concerning the deformation of geodesics and the representation of the deformation by the affine connexion coefficients were proved.

Mr. Das worked chiefly at problems involving classical fields in general relativity. In particular, he generalised Birkhoff's

theorem from the pure gravitational case to the combined electromagnetic gravitational case.

Miss Roy studied the problem of the resistance of a circular cylinder due to a series of vortices moving symmetrically, and got a result for a double series in any approximate method.

Professor Lanczos continued his study of the conservation laws of general relativity. The pseudo-tensor of Einstein does not lead to a definite dynamic law, due to the lack of symmetry. The symmetrized form of this tensor allows a closer study of the motion law derivable from the Einsteinian field equations. Moreover, it is desirable to check the conclusions with the help of a model which is free of all singularities. He found a scalar model of a particle which is regular at all points and allows an accurate study of the dynamical problem of general relativity.

Following another line of research, he was concerned with the properties of linear operators and the vibration spectrum associated with such operators in the case of boundary conditions which are not of the customary kind. He found explicit solutions of the vibration problem of partly free, partly clamped elastic sheets which demonstrate the existence of a spectrum which is quite different from the usual type by showing that the frequency zero is a point of accumulation. This means that such a sheet can vibrate with frequencies which can be made as low as we wish, which is unexpected on the basis of the Rayleigh-Ritz method.

Professor Takahashi, working with Mr. Strathdee, showed that the self-stress of composite particles vanishes in relativistic quantum field theory. They also showed that various difficulties in quantum field theory, for example, diverging self-energy, the problem of unrenormalizable interaction, the finite size of elementary particles, and the parity violation in weak interaction, are related to one another, by a non-local field theory. Professor Takahashi also

analysed meson scattering in terms of the logarithmic derivative of the meson wave function at the nucleon surface, and showed that the S-wave is most sensitive to the inner structure of the nucleon.

Mr. Strathdee, in addition to his work with Professor Takahashi and with Dr. Mast, has been studying various aspects of quantum field theory, particularly the kinematical properties of the photon, and the role of the subsidiary condition in quantum electrodynamics.

Mr. Judge studied quantum field theory, with particular reference to invariance principles. With Professor Takahashi he is investigating the substitution law of Jauch and Rohrlich, and its possible relationship to these principles.

Dr. Papini made a general study of quantum electrodynamics and quantum field theory, and in particular studied problems of multiple meson production. He began a study of nucleon structure, and is now making some calculations in this field. He gave four informal talks in the seminar on infra-red divergence.

Dr. Bass studied the classical (macroscopic) limit of the quantum theoretical theory of measurement. He also continued his study of the consequences of the hypothesis, developed in earlier papers, of a finite photon rest-mass. He found that there are cosmological aspects of that hypothesis, and is preparing a paper on the subject.

Three major projects were undertaken by Professor Green, of which two were completed and the third was carried to the stage where a variety of new results were obtained. The first project was observation in quantum mechanics. Though quantum mechanics provides a self-consistent theory of the behaviour of microscopic systems (atoms, electrons, nuclei), this has not hitherto been applied to the processes by which such systems are observed, and some physicists have thought that the theory would prove inadequate in this respect. This project has been devoted to showing that quantum mechanics

also provides a correct account of the processes of observation, by examining the behaviour of a particular model. The second project concerned propagation of disturbances in fluids and plasmes. This is a subject which may lead to important applications to the controlled production of thermonuclear power. The difficulty in inducing nuclear fusion, except at very high temperatures, arises from the shielding of the nuclei by their electron shells, and though the electrons can be stripped, there is a tendency for the resulting plasma to 'relax'. This work investigates the relaxation processes in fluids and plasmas, and the possibility that if a disturbance can be produced with a frequency greater than a certain 'relaxation frequency', relaxation is eliminated, and together with it the difficulty mentioned above. The relaxation frequencies have been calculated for some simple systems. It turns out that a completely ionized system has no relaxation frequency (strictly, the relaxation frequency is zero). Professor Green's third project was in the ionic theory of magnetohydrodynamics. This subject also has an important bearing on the possibility of thermonuclear power. A variety of macroscopic equations have already been proposed for magnetohydrodynamics, but all are crudely approximate in some respects. For exact equations one has to consider the ionic theory of condensed systems, which has not hitherto been worked out in detail, owing to the difficulty raised by the long range of the Coulomb forces. Professor Green has overcome this difficulty, and made considerable progress in this work.

Professor Barnett extended to the case of n dependent variables the problem first considered in simplified form by Kasner (Trans. Amer. Math. Soc., 1925) of integrating the differential equations in the Einstein gravitation equations. He also investigated some problems associated with rational triangles.

Professor McLeod worked on a textbook on continuum mechanics.

Mr. Ó Raifeartaigh continued and completed to a first order non-relativistic approximation his calculations on the proton-neutron mass difference. With Dr. Sreeniswa he completed a note on the modification of the Feynmann formalism in the case of derivative couplings; he has also been working with Dr. Terreaux on a 'formal' proof of the gauge-invariance of mixed electromagnetic-mesonic theory; and with others at Zürich on relativistic form-factors in field theory.

3. SEMINARS AND LECTURES

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

The following seminar lectures were given (See also Section 6):

Professor M. A. Ellison (School of Cosmic Physics):
The structure of the Galaxy as revealed by 21 cm. radio emission (2 lectures).

Professor H. S. Green:
Relativistic wave mechanics (9 lectures).

Professor C. Lanczos:
Variational principles and the conservation laws of physics (5 lectures).

Rev. Professor J. McConnell (St. Patrick's College, Maynooth):
Recent theories of anti-nucleons (2 lectures).

Professor J. L. Synge:
Elasticity in general relativity (2 lectures).
Applications of Fermi propagation and Ruse's characteristic function to general relativity (5 lectures).
Aberration in general relativity (2 lectures).
Tensorial conservation equations.

4. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture, under the auspices of the School, was delivered in Trinity College, Dublin, on March 4, 1959, by Professor Lanczos. His subject was "Adventures in Space".

5. VISITING PROFESSORS

During the period under review, there were three visiting professors at the School as follows:

Professor H. S. Green (University of Adelaide), from April to September 1958;

Professor I. A. Barnett (University of Cincinnati), from October 1958 to January 1959;

Professor E. McLeod (Oregon State College), from January 1959.

6. VISITING LECTURERS

Professor W. Heitler (University of Zürich) visited the School from October 6 to 10, 1958, and lectured in the Seminar on electron nucleon scattering according to meson theory.

Dr. F. A. E. Pirani visited the School from April 14 to 18, 1958.

Dr. S. Kamefuchi (Imperial College, London) visited the School from February 16 to 23, 1959, and gave three lectures in the Seminar under the general title "Interaction between elementary particles".

7. SYMPOSIUM

A Symposium was held on Wednesday and Thursday, 17 and 18 December, 1958, at 64 Merrion Square. The attendance was 57. This included professors, lecturers and graduate students from the several Irish universities. The travelling expenses of those coming from Belfast, Cork and Galway were paid up to a total of approximately £50.

The programme included the following three lectures:

Mgr. P. de Brún: Non-Euclidean conic sections, treated as sections of the right circular cone.

Professor C. Lanczos: History of unified field theories in general relativity.

Professor P. B. Kennedy: The average rate of growth of certain regular functions.

Short talks (Previews) were given by the following:
E. P. Fahy, V. G. Hart, R. E. Ingram, D. Judge, D. Keefe, P. B. Kennedy, C. Lanczos, M. A. MacConaill, J. R. McConnell, J. J. McMahon.

The Symposium ended with a Business Meeting at which future plans were discussed. The members of the Symposium voted on the Previews to decide which should be presented in extenso at the next Symposium, to be held on Thursday and Friday, 2 and 3 April, 1959.

8. EXTERNAL ACTIVITIES

The International Congress of Mathematicians for 1958 (Edinburgh, August 14 - 21) was attended by Professors Synge, Lanczos and Green, and by Dr. Rayner. Professor Lanczos lectured on "Extended boundary value problems", and Professor Synge read a paper entitled "Elasticity in general relativity". Professors Synge and Green also attended the meeting of the International Mathematical Union at St. Andrews, prior to the Edinburgh Congress.

Professor Synge gave a course of eight lectures on General Relativity at the International Mathematical Summer Center at Sestriere, Italy, 20 - 30 July. On 14 November he gave the Larmor Lecture at Cambridge under the joint auspices of the Cambridge Philosophical Society and the Archimedeans, his subject being "From Riemann tensor to plumb line; physical interpretations of space-time geometry". On 9 March he lectured on "The idea of time in general relativity" to the Physical and Applied Mathematics Society of the Queen's University, Belfast.

Professor Lanczos attended the conference organized by Louis de Broglie on "Problèmes actuels en théorie de la relativité" at the Institut Henri Poincaré from 15 April to 20 May, and lectured there on "Electricité et relativité générale" on 13 May. On 6 June he gave two lectures at the University of Leeds on "Decomposition of linear operators", and "Quadratic action principle of general relativity". He lectured at Manchester

University on 6 November on "Matrices and function spaces", and on 7 November at the U.K. Atomic Energy Authority, Warrington (Lancs.) on "Decomposition of linear operators". On 11 November he lectured to the Dublin University Experimental Science Association on "The role of theory in contemporary physics". From 16 to 21 February Professor Lanczos visited the Faculté Polytechnique, Mons (Belgium), and lectured on "Stabilité elastique", "Matrices et espace fonctionnel", and on "Interpolation des données equidistantes". On 21 February he spoke at the University of Louvain on the last of these subjects. He spoke on 2 March at Queen's University, Belfast, Mathematical Union on "The algebra of the decimal system". On 9 March he lectured at the I.C.I. Research Division, Billingham (Co. Durham), on "Elastic vibrations of sheets", and on 10 March at King's College, Newcastle-on-Tyne on "Step by step integration of trajectory problems". He repeated this last lecture at the University of Leeds on 11 March, and at the Research and Armament Division, Ministry of Supply, Sevenoaks (Kent), on 13 March. On 12 March he lectured at the University of London Computing Centre on "Interpolation of equidistant data".

Professor Takahashi lectured at the University of Liverpool on 13 November 1958 on "A general treatment of expanding systems and its application to multiple meson processes". On November 17 he spoke at Imperial College (London) on the difficulties in quantum field theory, and the second kind of interactions.

Dr. Bass lectured to the Dublin University Mathematical Society in February 1959, on the correspondence between Berkeley's epistemology and the classical limit of the quantum theoretical theory of measurement.

Professor Green lectured at the University of Liverpool on July 25, 1958, and at the University of Edinburgh on August 22, on "Propagation of disturbances at high frequencies in fluids and plasmas".

9. PUBLICATIONS

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

a. Books:

(i) Published:

* Tensor calculus. By. C. Lanczos. Article for the Handbook of Physics. McGraw-Hill, New York, 1958. Part I, pp.111-22.

(ii) In the press:

* Variation principles of mechanics. By C. Lanczos. Article for the Handbook of Engineering Mechanics. McGraw-Hill, New York.

Linear differential operators. By. C. Lanczos. Van Nostrand, London.

* 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.13. The orthogonal and symplectic groups.
By F. D. Murnaghan.
Price 12/6. pp.146. Published 5 July 1958.

c. Contributions to periodicals:

(i) Published:

* J. L. Synge:
Stationary principles for forced vibrations in elasticity and electromagnetism. Proc. 8th Symposium Appl. Math., New York, McGraw-Hill, 1958, p.79.

* Whittaker's contribution to the theory of relativity. Proc. Edinburgh Math. Soc. 11, 39, 1958.

* An introduction to space-time. New Scientist, 3, 15, 1958.

On the behaviour, according to Newtonian theory, of a plumb line or pendulum attached to an artificial satellite. Proc. Roy. Irish Acad., 60 A, 1, 1959.

A plea for chronometry. New Scientist, 5, 410, 1959.

L. Ó Raifeartaigh and J. L. Synge:
A property of empty space-time. Proc. Roy. Soc. A, 246, 299, 1958.

* L. Ó Raifeartaigh:
A static generalization of the Einstein universe. Proc. Roy. Soc. A, 245, 202, 1958.

W. Israel:
Discontinuities in spherically gravitational fields and shells of radiation. Proc. Roy. Soc. A, 248, 404, 1958.

* C. Lanczos:
Linear systems in self-adjoint form. Amer. Math. Monthly, 65, 665, 1958.

" Iterative solution of large-scale linear systems. J. Soc. Indust. Appl. Math., 6, 91, 1958.

Electricité et relativité générale. Cahier de Physique, 12, 247, 1958.

Albert Einstein and the role of theory in contemporary physics. Amer. Scientist, 47, 41, 1959.

Y. Takahashi:
On the thermal expansion of solids. Physica, 24, 857, 1958.

J. Strathdee and Y. Takahashi:
On the self-stress of composite particles. Nuclear Phys., 8, 113, 1958.

Unrenormalizable interactions and the structure of elementary particles. Nuclear Phys., 9, 558, 1958.

H. S. Green:
Observation in quantum mechanics. Nuovo Cim., 9, 880, 1958.

Propagation of disturbances at high frequencies in fluids and plasmas. Phys. Fluids, 2, 31, 1959.

(ii) In the press, 31 March 1959:

J. L. Synge:
On some special coordinate systems in general space-time. Bull. Calcutta Math. Soc.

A theory of elasticity in general relativity. Math. Zeit.

C. B. Mast and J. Strathdee:
On the relativistic interpretation of astronomical observations. Proc. Roy. Soc. A.

A. J. Das:
Birkhoff's theorem for electromagnetic fields in general relativity. Phys. Rev.

H. S. Green:
Ionic theory of plasmas and magnetohydrodynamics. Phys. Fluids.

IV - Report of the Governing Board of the School of Cosmic Physics adopted at its meeting on 2nd November, 1959.

A. Astronomical Section.

1. STAFF AND SCHOLARS.

Senior Professor:

M. A. Ellison (appointed 1 November 1958).

Chief Assistant:

M. J. Smyth.

Assistant:

J. H. Reid (appointed 1 January 1959).

Technical and Clerical Staff:

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

Scholar:

Miss S. M. P. McKenna.

2. SOLAR RESEARCH

Solar Patrol:- Disk drawings of the sun in white light were made by Miss McKenna on 74 days. Observations in H_α light with the spectrohelioscope were made on 63 days for the detection of solar flares and other types of chromospheric activity.

The radio receiver for recording the integrated level of atmospherics on a frequency of 27 Kc/s was in continuous operation throughout the year. Some 103 sudden enhancements of atmospherics (S.E.A's) caused by solar flares were recorded.

Monthly lists of solar flares and S.E.A's were circulated to the World Data Centres of the International Geophysical Year and to interested observatories.

Lyot Hα Heliograph:- As from 1 November the Observatory assumed responsibility for the analysis of the Lyot Hα Heliograph films taken daily at the Royal Observatory, Cape of Good Hope. The Heliograph was built in the years 1956-57 by the firm S.E.C.A.S.I. of Bordeaux, the cost having been borne by a grant of £17,000 from the British National Committee for the I.G.Y. The Heliograph was erected and brought into use by Professor Ellison at the Cape in 1958 February and March. The instrument (see description in Nature, 182, 624, 1958) is fully automatic, being designed in accordance with the most advanced principles of electronic automation, and it photographs the sun's hydrogen atmosphere at 1-minute intervals for 7 hours each day. The band pass of the filter is 0.7A.

During the first nine months of operation, which included a phenomenally clear winter at the Cape, films were obtained on 230 days out of a possible 295, and 694 flares were recorded. By arrangement with the Royal Society and the British Admiralty (administratively responsible for the Cape Observatory) the Heliograph will be operated jointly by the Cape and Dunsink during the next five-year period.

With this instrument it is intended to carry out an extensive series of investigations on the light curves of solar flares, linking them with their simultaneous effects in the terrestrial ionosphere as recorded by radio and magnetic methods. In this connection the Eichner photoelectric photometer at Dunsink has been modified in order to be able to measure the photographic densities of the flare regions on the Hα films and for their conversion into light intensities.

Miscellaneous:- Preliminary adjustments were made of the photoelectric head on the concave-grating spectrograph, intended for the detection of approaching streams of magnetic-storm-generating particles. No systematic observations were possible in 1958 owing to poor weather.

In August N. J. Woolf and W. L. W. Sargent of the University of Manchester, used the concave-grating spectrograph for experiments designed to improve the resolving-power and light-efficiency of a large stellar spectrograph by means of a Fabry-Perot interferometer.

3. STELLAR RESEARCH

Two-colour photoelectric observations of the eclipsing variable star β Lyrae were made and forwarded to the Lick Observatory as part of a co-operative photometric programme.

A few photoelectric measurements were made of the recurrent nova RS Ophiuchi near light maximum, notification of the outburst having been received by I.A.U. Telegram.

The 1957 measures of Comet Arend-Roland, referring to a fixed region of the coma, were considered in conjunction with the other observations, in particular those of Thiessen at Hamburg, in order to obtain a more complete light-curve. The comparison stars were re-measured in order to derive appropriate colour corrections. The results are being prepared for publication.

A thorough re-calibration was carried out of the graduated interference filters made by Dr. Smyth at Manchester University in 1956. The filters are intended for photoelectric measurements of the interstellar 4430A absorption band in the spectra of distant early-type stars. Preliminary tests at the 28-inch telescope indicate that the loss of light, by comparison with ordinary colour filters, is about 3.5 magnitudes only. Thus photoelectric photometry will be possible for considerably fainter (and more distant) stars than those reached by the Edinburgh slit spectrophotometry programme.

An experimental integrating feedback amplifier, based on the low leakage of polystyrene film condensers, was constructed and tested on the 28-inch reflector, with encouraging results. By integration of

a period of the order of one minute, the effect of stellar scintillation is largely removed, without the complication of a photon-counting photometer.

Some preliminary measurements were made on the galactic cluster plates obtained with the ADH-Telescope by Drs. Butler and Thompson. Photoelectric comparison sequences in some of these clusters are being observed with the 60-inch reflector at the Boyuen Observatory. It is intended that Dr. Smyth shall measure these plates with the Becker iris astrophotometer at the Royal Observatory, Edinburgh.

4. ARTIFICIAL SATELLITE OBSERVATIONS

Occasional photographic observations of the bright Russian artificial earth satellites continued, using a miniature 35mm camera and timing impulses derived from the Shortt clock. Results were communicated to the official Data Centres.

Dr. Smyth investigated the accuracy and limitations of the miniature camera technique and presented the results at the Rockets and Satellites Symposium during the CSAGI meetings in Moscow.

5. CONFERENCES AND MEETINGS

In August Dr. Smyth attended in Moscow the Fifth Assembly of the Special Committee for the International Geophysical Year (CSAGI), representing the Irish National Committee for the IGY. Dr. Smyth and Miss McKenna (by invitation of the President) attended the Tenth General Assembly of the International Astronomical Union in Moscow. Dr. Smyth represented Dunsink at the meeting in Bergdorf of the Administrative Council of the Boyden Observatory.

6. VISITORS

The Observatory has been open as usual to the public on the first Saturday of each month from September to April. So great

has been the popular interest in astronomy that on several occasions more than 150 visitors arrived and the problem of accommodating and entertaining them in our small buildings became acute. The 12-inch South refractor has continued to be available to members of the Dublin Centre of the Irish Astronomical Society.

7. LIBRARY

Arrears of binding have been accumulating for many years. A useful start has been made in binding up-to-date some 326 volumes of those periodicals which are most frequently consulted.

The Library continues to receive additions by purchase, and by exchange of publications with some 250 Academies and Observatories throughout the world. The housing of these books has become a major problem since all the suitable space for accommodating them has now been exhausted. A new room for the Library is urgently required.

8. ACCOMMODATION

A memorandum on the accommodation needs of the Institute has been prepared for submission to the Council of the Institute for its consideration.

9. PUBLICATIONS

a. Books:

The Sun and its Influence (second edition). By M. A. Ellison. Routledge and Kegan Paul, London, 1959.

Russian edition of the above. State Publishing House for Physical and Mathematical Literature, Moscow, 1958.

Spanish edition of the above. National University Press of Mexico, 1958.

b. Periodicals:

M. A. Ellison:
The Lyot He Heliograph at the Cape of Good Hope.
Nature, 182, 624, 1958.

M. A. Ellison:
The recording of sudden enhancements of atmospherics (S.E.A's.) for purposes of flare patrol. Jour. Brit. Astron. Assoc., 69, 127, 1959.

M. J. Smyth:
Photoelectric observations of 12 (DD) Lacertae. The Observatory, 78, 82, 1958.

M. J. Smyth et al.:
Combined Light and Velocity measurements of the variable star 12 Lacertae. Nature, 180, 1112, 1957.

M. J. Smyth:
Photographic observations of Artificial Earth Satellites. Spaceflight, 1, 247, 1958.

Photographic Satellite Tracking with 35mm cameras. National Research Council Publication C.4, Washington, 1959.

Impressions of the IGY and IAU Congresses in Moscow. Irish Astron. Jour., March, 1959.

S. M. P. McKenna and M. J. Smyth:
RS Ophiuchi. The Observatory, 78, 245, 1958.

10. PERSONAL

Dr. M. A. Ellison took up his appointment as Senior Professor and Director of Dunsink Observatory on 1 November 1958. He moved into residence in the Director's House on 1 December 1958.

Mr. J. H. Reid, of the Royal Observatory, Edinburgh, assumed his duties as Assistant on 1 January 1959.

B. Cosmic Ray Section.

1. STAFF AND SCHOLARS

Senior Professor:

C. Ó Ceallaigh.

Professor:

C. B. A. McCusker.

Assistant Professor:

R. H. W. Johnston

Technical and Clerical Staff:

Mr. J. Daly, Miss C. Inight, Miss E. Smith, Miss N. Leahy, Miss N. Ryan (resigned 31 October 1958), Miss H. Clarke (resigned 28 February 1959), Miss D. Kelly, Miss C. Duff (entered 23 February 1959), Miss P. Hayden (entered 1 March 1959), Mrs. F. Shaukat (entered 27 October 1958, resigned 1 December 1958).

Scholars:

R. J. Reid, D. E. Page, M. J. O'Connell, M. A. Shaukat (entered 13 October 1958), K. Imaeda (entered 17 November 1958).

2. RESEARCH WORK

Work using the photographic plate and counter techniques has been continued throughout the year 1958-59.

The study by the European Collaboration of the interactions of negative K-mesons was concluded, and the results, embodied in several papers, are in course of publication in Nuovo Cimento. The investigation has been continued by the Collaboration, but owing to demands on our resources by other current projects, it was decided that the School should decline an invitation to continue with this work using material which was kindly offered by the Collaboration.

Work on the problem of the relative frequencies and the three-body spectra of K^+ -meson decay was continued, a further 3000 samples of decay at rest having been studied. From this work, preliminary information concerning the form of rare three-body decay spectra has been obtained on the basis of the following number of examples

$$K\mu_3 = 65$$

$$K\beta_3 = 42$$

$$\tau' = 48$$

The information which flows from this work is valuable, in spite of the moderate statistical weight, since it has not yet been found feasible to arrange for counter experiments to be set up in conjunction with the existing large accelerators. In part, this situation has arisen because of major breakdowns and consequent pressure of demands on the working time of the machines.

The material resulting from the K^+-investigation has been used by K. Imaeda and M. A. Shaukat to study the direct decay of π_o-mesons emitted as a product of K-decay. In a fraction of such cases a so-called Dalitz pair is emitted, observation of which provides direct visual proof of emission of uncharged pions in the decay process. Some 30 examples have been found. In some 20 of these, the emitted charged particles have been insufficiently good geometry to permit of a useful dynamical analysis of the event.

3 examples of the decay	$K\mu_3$	
10 examples of	$K\pi_2$	
1 example of	$K\pi_3$	
2 examples of	$K\beta_3$	
4 examples of	$K\mu_3$	or $K\pi_2$

The last two cases are of great interest and importance, since they are the first examples in which it has been found possible that π_o-mesons are produced in the decay mode $K\beta_3$. The work of analysis of these events is being completed and a description of the first has been submitted for publication in Nuovo Cimento. An extension of the work of Alexander and Johnston on the relation between ionisation and energy as measured by grain and blob-counting has been in progress during the year. The object of the investigation has been to extend our knowledge of the shape of the curve beyond the minimum, as this is expected to be of importance in work involving exposure of photographic emulsions to the beams of particles produced in the 25 Gev machines at present under construction at C.E.R.N. and Brookhaven National Laboratory. A series of plates was exposed for us at the Berkeley Bevatron by Dr. D. Prowse through the kind offices of Professor E. J. Lofgren. Pions at momenta ranging from 400 Mev/c to 1 Gev/c were blob-counted, and the results were normalised to plateau ionisation found by measurement on electrons with a beam of which the plates were irradiated at the electron synchrotron at the California Institute of Technology. The results to date are in

definite disagreement with those found by certain workers using cosmic ray plates, but seem to have been confirmed by similar measurements carried out by a group at the Tata Institute at Bombay.

At the same time as the ionisation exposure, a small stack of plates was exposed to monoenergetic electrons at the C.I.T., and these have been used to continue the investigation of the best method of estimating by the scattering technique the initial energy of fast electrons which emit energy by Bremsstrahlung. This work has been referred to in the Report for 1957-58. Measurements have been continued, and a programme has been set up in order to solve the problem of the sampling distribution of the estimate of energy using electronic computing machines. This latter work has been done in collaboration with Mr. Donovan of Aer Lingus.

During the year an invitation was issued to Professor Ó Ceallaigh to attend a meeting organised by the authorities at C.E.R.N., Geneva, to study the problems involved in using photographic emulsions as particle detectors in conjunction with the 25 Gev proton-synchrotron at present being completed. In consequence of this meeting a number of sub-committees was established. It was arranged that the School would be represented on that dealing with the techniques of measurement by Dr. R. H. W. Johnston. As a result of these discussions, work has been started by Dr. Johnston assisted by Mr. Glass of Trinity College, Dublin on the construction of an engine for yielding automatically the value of the mean absolute value of second difference for a series of observations. This project, if it can be realised, will speed up considerably the processing of scattering observations.

The experiments of Professor McCusker and his collaborators on the time variations of cosmic-ray showers have been continued throughout the year at the Dublin and Jamaican Stations and, in addition, a further station has been set up at Sydney where Professor McCusker has been on leave of absence since June 1st 1958 as Visiting Professor at the University. This work is sponsored by the Office of Scientific

Research of the Air Research and Development Command, United States Air Force Contract No. A.F. 61(514)-1164.

The aim of the investigation has been to investigate local and penetrating extensive cosmic-ray showers and also showers of high electron density in order to elicit information concerning the following fundamental topics

(a) Nuclear Interactions at very high energy

(b) The Origin of Cosmic Radiation

(c) The Movements of the Upper Atmosphere

Observations from the Dublin and Jamaican Stations have been used in combination to study (a) and (b) by examining the variation with siderial time of penetrating extensive shower events as recorded by two Wilson Cloud Chambers.

The mean rate of events per hour of R.A. for the belt of declination 40° - 50°N was found to be 14.6, but the rate for the interval 0 - 1 hr. R.A. was 6 while that for the interval 8 - 9 hrs. R.A. was 27. This observation would seem to indicate that the hypothesis of equal intensity from all directions is invalid but the statistical weight of the experiment, as it stands at present, is insufficient to establish the existence of regions associated with definite maximum and minimum arrival rates.

During the period covered by this report, observations giving information concerning (c) have yielded very interesting results. It has been found that the semi-diurnal atmospheric pressure wave is more regular and larger in amplitude at Jamaica (Lat.18°N) than in the temperate latitude of the Dublin Station (Lat.53°N).

It has already been demonstrated at Dublin that the intensity of showers of high electron density (> 700 particles/m.^{2}) varied in phase with atmospheric pressure showing maximum rates at 10 hrs. and 22 hrs. local solar time, at both stations, hours which correspond to diurnal

maxima in the value of atmospheric pressure. This behaviour is unexpected since normally the rate of such cosmic-ray events decreases with increase of pressure. It seems clear that this effect is correlated with oscillations of the upper atmosphere. A possible explanation might be that the height at which the initial interaction of the primary particle occurs varies periodically, producing in consequence a variation in the structure at sea level of the resultant showers. It is assumed to be unlikely that the primary flux varies with solar time.

No essential changes have been made in the experimental arrangements at Dublin, while those in the British West Indies have been improved. In scope they are now about equal to that in Dublin, but are considerably more elegant in design. It is hoped to continue along the present lines the experiments at both stations for a further period.

Personnel of Dublin Station (April 1958 - March 1959):

April - June 1958	Professor C. B. A. McCusker
April - August 1958	D. E. Page
April - March 1959	Miss B. Smith
September 1958 - March 1959	R. J. Reid

Personnel of Jamaica Station (April 1958 - March 1959):

April - September 1958	R. J. Reid
August 1958 - March 1959	D. E. Page
November 1958 - December 1958	Mrs. I. Greenleaves

3. CONFERENCES

Rochester Conference 1958 C.E.R.N. Geneva: Professor Ó Ceallaigh attended by invitation the 8th Annual International Conference on High Energy Physics held at C.E.R.N. Geneva from June 30th - July 5th 1958.

A new departure was taken at this Conference in that the various topics discussed were described by selected rapporteurs, the work from the School being incorporated in certain of these reports.

Professor Ó Ceallaigh also attended by invitation the 2nd Conference held at the Université de Montréal, August 25th - September 3rd 1958, to which he contributed three communications, besides acting as Chairman of one of the Sessions. Later he visited the Atomic Energy Establishment at Chalk River Ontario, the Naval Research Laboratory at Washington D.C., at which he gave talks on the Electron Bremsstrahlung Loss-Correction and the Ionisation Calibration work in progress in the School. He also visited the Physics Department, University of Rochester and the Brookhaven National Laboratory, where he saw the 25 Gev proton-synchrotron at present under construction.

During the year Professor McCusker visited the Laboratories at the following Institutions:- Imperial College, London, Atomic Energy Research Establishment, Harwell, M.I.T. Boston, Mass., the Universities of Cornell and Maryland, Naval Research Laboratory, Washington D.C. and the California Institute of Technology, Pasadena.

4. SCANNERS AND CLERICAL STAFF

The following persons resigned during the year from the position of Scanner: Miss Helen Clarke (28th February, 1959), and Miss Nuala Ryan (31st October, 1958). The vacancies were filled by the appointment of Miss Clare Duff (23rd February, 1959) and Miss Pauline Haydon (1st March, 1959).

5. INSTRUMENTS AND WORKSHOP

Mr. Daly has continued the work of servicing and replacement of the fine-focussing gear by a mechanism of his own design on the scanning microscopes. These instruments require constant attention owing to the fact that they are in continuous use. It is thus inevitable that parts wear out rapidly, a fact for which the manufacturers can scarcely be held to blame. He has also adapted another Bannister type scattering stage to a Reichert Stand. He has continued to give the technical help necessary to maintain in running order the apparatus of the time-variations experiment.

6. PUBLICATIONS

(i) Published:

C. B. A. McCusker, D. E. Page and R. J. Reid:
Further Evidence for a Variation in the Rate of Dense Extensive Air Showers with Solar Time.
Phys. Rev. 113, 712, 1959.

G. Alexander, P. Anderson, R. H. W. Johnston, D. Keefe, A. Kernan, J. Losty, A. Montwill, C. O'Ceallaigh and M. O'Connell:
Investigation of the Strong and Weak Interactions of Positive Heavy Mesons.
Report of the 2nd U.N. Geneva Conference 1958, p.215.

(ii) In the Press:

C. B. A. McCusker:
The Measurement of Primary Directions in Extensive Air Showers.
Phys. Rev.

C. B. A. McCusker, D. E. Page and R. J. Reid:
The Directional Properties of an Extensive Air-Shower Array.
Phys. Rev.

R. H. W. Johnston, D. Prowse and M. A. Shaukat:
An Ionisation Calibration Experiment in Photographic Emulsion.
Proc. Montreal Conf. 1958. (In preparation).

European K^- - Collaboration.

D. Bhowmik, D. Evans, D. Falla, F. Hassan, A. A. Kamal, K. K. Nagpaul and D. J. Prowse (Bristol); M. René (Brussels); G. Alexander, R. H. W. Johnston and C. O Ceallaigh (Institute for Advanced Studies, Dublin); D. Keefe (University College, Dublin); E. H. S. Burhop, D. H. Davies, R. C. Kumar, W. B. Lasich, M. A. Shaukat and P. R. Stannard (University College, London); M. Bacchella, A. Bonetti, C. Dilworth, G. Occhialini and L. Scarsi (Milano); M. Crilli, L. Guerriero, L. von Lindern, M. Merlin and A. Salandin (Padova):

The Interaction and Decay of K^- - Mesons in Photographic Emulsion.

The Interaction of K^- - Mesons with Photographic Emulsion Nuclei.

Part II. The Emission of Hyperons from K^- interactions at rest.

C. Geophysical Section.

1. STAFF AND SCHOLARS

Senior Professor:

Leo W. Pollak.

Professor:

Thomas Murphy.

Research Assistant:

Arvids Leons Metnieks (under U. S. Air Force Contract).

Research Associate:

Rev. G. McGreevy (from 21 February 1959).

Senior Technical Assistant:

Thomas J. Morley.

Technical and Clerical Staff:

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

2. INVESTIGATIONS, EXPERIMENTAL AND FIELD WORK

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

The main object of the research during the period covered by this report was a new calibration of the photo-electric nucleus counter. The world-wide use of our counter under conditions very different from those under which the instrument in its rather primitive early form was calibrated some fifteen years ago, made a re-calibration particularly urgent. Before starting the calibration of the photo-electric nucleus counter, Model 1957 with our absolute stereo-photomicrographic counter their agreement was tested (Pollak-Metnieks).

The processes in the cloud of the fog-tube of the counter after the adiabatic expansion and their effect on the extinction measurements which form the basis for the application of the photo-electric counter were studied in greater detail by Professor Pollak and Mr. Metnieks.

They considered isothermal distillation, coagulation and differential settling and computed the theoretical amount of the additional extinction produced by these processes in the cloud. The decisive influence of the heat-flow from the walls was proved using a counter specially fitted for this investigation with a fog-tube of 8cm air-column diameter. Apart from their importance for the calibration of the counters the results are of general interest in cloud physics.

The extinction in monochromatic and standard white light was measured next and the experimental results were compared with those computed by using MIE's scattering functions for spherical particles (Pollak and Metnieks). Investigations of this kind are possible only now on account of the high precision and stability of our counters, Model 1957.

An attempt was made to determine the size spectrum of the cloud droplets by measuring the extinction in two monochromatic wave-lengths and collecting the fog droplets on coated slides (Pollak-Metnieks). The experiments, the first of their kind, were successful.

The research into the diffusion coefficient of polydisperse aerosols was carried a step further by Professor Pollak and Mr. Metnieks. The diffusion coefficient of large ions was measured and what was called by them a "Universal Diffusion Battery" for measuring the size of nuclei using the dynamic method, has been constructed, tested and compared with a "diffusion box" of the old type employed since its introduction in 1935. The new construction removes one of the main objections to the whole method i.e. unequal flow through the channels. Even with equal flow through the channels a strong influence of the air-flow on the diffusion coefficient with polydisperse aerosols has been found, as expected from theoretical considerations.

The new absolute counter which records by stereo-photomicrography the droplets on the graticule or without graticule during their fall in space and which incorporates several new and important features,

has been completed and thoroughly tested (Pollak and Daly). The instrument exceeds all expectations and the records are of great clarity and beauty since the misting of the graticule occurring in all Aitken-type counters hitherto constructed has been eliminated by accommodating a dark-field illumination of special construction in the movable piston and the necessary strong electric bulb outside the cloud chamber. It has reduced turbulence in the cloud chamber during expansion and possesses two separate microscopes with photographic attachments and a third microscope as view-finder. Requests for replicas of this counter had to be turned down on account of our own constructional work.

In order to meet the great demand for advice in constructing and handling the photo-electric counter (received from the universities of Heidelberg, Genoa and Milano, Mainz, Karlsruhe etc. recently) preparatory to the re-calibration of the counter a detailed instruction for use of photo-electric condensation nucleus counters, their care and maintenance together with calibration and auxiliary tables, incorporating all our experience extending over ten years, has been drawn up and is in course of printing (Metnieks and Pollak). In addition to the calibration tables for every tenth of extinction percentage this instruction is accompanied by extensive tables for the application of the photo-electric counter to problems other then measuring the concentration of nuclei, a list of special parts used in the construction and accessories, and a workshop drawing (Scale 1 : 1) to facilitate the construction of the instrument by mechanics in research and university laboratories.

The new calibration of the relative photo-electric nucleus counter by means of the absolute stereo-photographic method has been completed (Pollak and Metnieks). The measurements have been analysed and a publication describing the method employed for the calibration and giving the results is ready for dispatch.

The results of the investigations mentioned above were published in papers quoted in Section 3 and reported by Professor Pollak to

Conferences at Wentworth-by-the-Sea, New Hampshire (USA) on 20th May 1958, in Dublin on 26th June 1958 and in the Cavendish Laboratory at Cambridge (England) on 17th July 1958.

b. Professor T. Murphy:

The gravity survey of Ireland has been continued and the fieldwork extended to cover twelve counties and part of two others. The area surveyed at a density of one station per 9 sq. km measures 12,000 sq. miles. The computation of this is now catching up with the fieldwork and will be completed soon.

Already it is apparent that the results will be important in our study of the crust of the earth and the large role played by granite in tectonics.

The papers "Gravitational evidence for a granitic layer under Ireland" and "The Caledonide structure of Ireland from geophysical measurements" are being prepared as well as the various regional studies of the gravitational field.

The Worden gravimeter has been tested in the laboratory regarding its behaviour to thermal changes. Although each meter has individual characteristics the results of the investigation are considered to have general application and are being published under the title "The changes of sensitivity and drift rate of a Worden gravimeter with time and temperature".

A conclusion of importance to the accuracy of the readings is the effect of rapid changes of temperature heretofore unappreciated. Very recently a new model of the Worden has been announced which incorporates a "temperature-stabilizing feature" so that the makers are aware of, but have not admitted, certain drawbacks of the design of the meter.

Another result concerns the effect of temperature on the sensitivity. This has been a controversial point in recent months but in the case of our meter the effect is negligible.

In February a communication from the Geological Survey of Great Britain gave news of a very intensive geophysical survey to be undertaken for the Government of Northern Ireland. We were asked to help in connecting the gravity survey to our network and Professor Murphy paid a visit to London to work out the details along with Mr. O'Brien, Director of the Irish Geological Survey.

Discussions have taken place with the Ordnance Survey and arrangements are being made to have the results of the gravity survey printed by them in a series of maps on the 1/4" scale. The basic maps are a new series and by making advance provisions while these are being drawn and printed the cost to us of publishing the gravity data will be reduced very considerably.

c. Dr. A. L. Metnieks (Research Assistant):

The cooperative fieldwork of the Meteorological and Geophysical Section (Pollak and Metnieks) Contract No. AF 61(052)-26 and of the University of Frankfurt a.M. (Georgii), Contract No. AF 61(514)-927 was carried out from July 17 to August 20, 1958. The synchronous measurements of Aitken, salt and ice nuclei took place on Valentia Island at the Cable Station and on the west coast of the island directly at the open Atlantic. In addition to the measurements of the Aitken nuclei made with a Scholz counter on the island, observations with a photo-electric counter at Valentia Observatory, Cahirciveen were kindly supplied by the Irish Meteorological Service.

The expedition to the island yielded the important result of a striking correlation between salt and ice nuclei.

A paper on this cooperative work has been published by Drs. Georgii and Metnieks (see Section 3, Publications, iii).

Mr. Metnieks' extensive researches on salt nuclei at sea on the Atlantic west of Galway and on the Aran Islands published under the title "The size spectrum of large and giant sea-salt nuclei under maritime conditions" have been accepted by the Board of Trinity

College, Dublin as thesis for the degree of Ph.D. of the University of Dublin. The degree was conferred on him on 3rd July 1958.

3. PUBLICATIONS

L. W. Pollak and A. L. Metnieks:
Further investigations of the fog in the photo-electric condensation nucleus counter.
Proc. 3rd Internat. Symposium on Condensation Nuclei in Cambridge, England, July 1958. Geofisica Pura e Applicata, Milano; Vol.42 (1959/I), pp.89-107. Serial No. of Reprint: 29.

L. W. Pollak:
A simple integrating lightmeter.
Ibidem; Vol.40 (1958/II), pp.200-202. Ser. No.30.

H. W. Georgii and A. L. Metnieks:
An investigation into the properties of atmospheric freezing nuclei and sea-salt nuclei under maritime conditions at the west coast of Ireland.
Ibidem; Vol.41 (1958/III), pp.159-176. Ser. No.31.

L. W. Pollak and A. L. Metnieks:
A universal diffusion battery.
Ibidem; Vol.41 (1958/III), pp.201-210. Ser. No.33.

L. W. Pollak and J. Daly:
An improved model of the condensation nucleus counter with stereo-photomicrographic recording.
Ibidem; Vol.41 (1958/III), pp.211-216. Ser. No.34.

T. Murphy:
The precision nucleus counter (Pollak type) with automatic recording.
Ibidem; Vol.41 (1958/III), pp.194-200. Ser. No.35.

A. L. Metnieks:
The size spectrum of large and giant sea-salt nuclei under maritime conditions.
Geophysical Bull. No.15 of the Meteorological and Geophysical Section, School of Cosmic Physics, July 1958.

In Course of Printing:

L. W. Pollak:
Counting of condensation nuclei and applications of the counting results.
International Journal of Air Pollution, Pergamon Press.
Ser. No.32.

A. L. Metnieks and L. W. Pollak:
Instruction for use of photo-electric condensation nucleus counters, their care and maintenance together with calibration and auxiliary tables.
Geophysical Bull. No.16 of the Meteorological and Geophysical Section, School of Cosmic Physics, March 1959.

Manuscripts ready for Publication:

L. W. Pollak and A. L. Metnieks:
New calibration of photo-electric nucleus counters.
Ser. No.36.

T. Murphy:
The changes of sensitivity and drift rate of a Worden gravimeter with time and temperature.
Ser. No.37.

4. U.S. AIR FORCE CONTRACT AF 61(052)-26

The aims of this Contract have been successfully fulfilled.

The Contract has been extended for a further 15 months from March 1, 1959.

As a result of Professor Pollak's discussions with Dr. C. Junge in the Aerosol Physics Laboratory of the U.S. Air Force Cambridge Research Center, Bedford, Mass. on May 23, 1958 and on the occasion of the Third International Symposium on Condensation Nuclei in the Cavendish Laboratory, Cambridge (England) on July 16, 1958 Professor Pollak has proposed as problem for the continuation of the Contract the calibration of absolute and relative condensation nucleus counters for other than laboratory conditions which constitutes a logical extension of the work done under the Contract during the first year. Preliminary experiments carried out with our flexible equipment proved the necessity for such an extension of the calibration.

5. U.S. ARMY CONTRACT

Professor Pollak, at the request of the Electronics Branch of the European Research Office, U.S. Army, submitted a Research Proposal: "Construction of a continuously sensitive recording diffusion cloud chamber of greater accuracy and resolving power than the present known cloud chambers of this type for studying ice nuclei and its application in a subtropical climate."

Col. M. E. Freeman, Ph.D., Chief, European Research Office of the U.S. Department of the Army, Frankfurt a.M. in his letter of

11th March 1959 has informed Professor Pollak that the European Research Office has been given technical approval for contracting to Professor Pollak's proposal.

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

Professor Pollak has been invited to go to Schenectady for about six months to advise and help in setting-up certain experiments and in interpreting the results. The invitation is a direct consequence of recent constructions and development of new methods in the laboratory of the Section.

The collaboration with the Research Laboratory of one of the greatest firms in the world, with more than a quarter of a million employees, will provide the laboratory of the Meteorological and Geophysical Section of the School with equipment not procurable otherwise.

7. VISIT TO U.S.A.

1. Professor Pollak presented a paper "The diffusion coefficient of large ions" by L. W. Pollak and A. L. Metnieks at the Second Conference on Atmospheric Electricity, Wentworth-by-the-Sea, Portsmouth, New Hampshire on May 20, 1958.

2. On the 26th May Professor Pollak was shown around Mr. T. A. Rich's laboratory in the G.E. Works at Schenectady. Mr. Rich uses in his laboratory three photo-electric nucleus counters of our design, two of them with elaborate, secret electronic attachments recording every fifteen seconds by pen and ink the nucleus concentration on a wide continuous roll. Here Professor Pollak learned for the first time some of the applications of the photo-electric nucleus counter to industry.

3. On the afternoon of June 2nd, 1958 Professor Pollak delivered a lecture on the "Present state of the development of the photo-electric nucleus counter and its application" in the Meteorological Branch of the U.S. Army Laboratories at Fort Monmouth, New Jersey. The Head of the Physical Science Division (Teisinger), the Head of the Aerosol Laboratory (Kampe), the Head of one of its Sections (Weickmann) and about 25 experts were present.

4. After the lecture Mr. Panak of the U.S. Army Laboratories at Fort Monmouth asked Professor Pollak again to consider collaboration with their Laboratory. Since he assured Professor Pollak that he is permitted to be Chief Investigator in more than one U.S. Government contract, Professor Pollak accepted this offer provisionally for submission to the Governing Board. The offer includes provision for a scientific research assistant and assistance in personnel and material. Professor Pollak was advised to visit the U.S. Army Research and Development Liaison Group in Frankfurt a.M. for further discussions; the Meteorological Branch of Fort Monmouth would notify Frankfurt regarding arrangements for Professor Pollak's visit.

5. No expenditure whatsoever has been incurred by the Institute in connection with Professor Pollak's visits to and discussion in the United States, Frankfurt a.M. and Milan.

8. ROYAL METEOROLOGICAL SOCIETY, LONDON, MEETING IN DUBLIN

The 1958 two-day Summer Meeting was held in Dublin from 25th to 27th June. It was the first two-day annual meeting held outside the United Kingdom since the foundation of the Royal Meteorological Society in 1850. Professor Pollak was elected Chairman of the local organising Committee. The scientific sessions took place in Trinity College Dublin. The first day (26th June) was devoted to "Atmospheric Aerosols". On the Society's request the introductory lecture of the first session was delivered by Professor Pollak on "The photo-electric nucleus counter and its application" incorporating unpublished results of recent investigations

in the laboratory of the Section. In the session on 27th June on "Aeronautical Meteorology" Professor Pollak acted as Chairman on designation by the Royal Meteorological Society.

The meeting was attended by 60 weather experts from Great Britain and Ireland.

9. THIRD INTERNATIONAL SYMPOSIUM ON CONDENSATION NUCLEI

A paper "Further investigations of the fog in the photo-electric condensation nucleus counter" giving the results of our investigations in extenso was presented by Professor Pollak and Dr. Metnieks at the Third International Symposium on Condensation Nuclei held in the Cavendish Laboratory at Cambridge (England) on 17th July 1958.

At the request of the Chairman of the British Organising Committee Professor Pollak acted as Chairman of the first session of the Symposium on 16th July, 1958.

The three-day conference was attended by Professor Pollak, Dr. Metnieks and Professor Murphy.

10. RESEARCH ASSOCIATE

Rev. G. McGreevy, Professor of Experimental Physics in St. Patrick's College, Maynooth requested permission to take up research work in the Meteorological and Geophysical Section. No payment whatsoever is involved. The Governing Board of the School at its meeting on 20th February 1959 approved that Rev. Father McGreevy joins the Section as an unpaid research associate.

Professor McGreevy started work in our laboratory on 21st February, 1959.

11. STATUTORY PUBLIC LECTURE

The Statutory Public Lecture of the School was given on February 19th,

1959 by Dr. R. S. Scorer, Imperial College, London under the title "Some aspects of the dynamics of clouds and fallout" in the Physics Theatre, University College, Dublin.

12. METEOROLOGICAL AND GEOPHYSICAL SEMINAR

24th & 25th November 1958: Dr. C. E. Junge, Geophysics Research Directorate, U.S. Air Force, Cambridge Research Center, Bedford-Boston, Mass.: (i) A general survey about air chemistry, (ii) The sulfur cycle in the atmosphere, (iii) Some new investigations of stratospheric aerosols.

11th & 12th December 1958: Mr. W. J. Megaw, Health Physics Division, Atomic Energy Research Establishment, Harwell: (i) The environmental aspects of the Windscale incident, (ii) Health physics in the nuclear power industry.

29th January 1959: Dr. J. H. Hodgson, Dominion Observatory, Ottawa, Canada: Tectonics and earthquake mechanisms.

19th February 1959: Dr. R. S. Scorer, Imperial College, London: Aircraft condensation trails.

13. MISCELLANEOUS

(i) Professor Pollak has been asked by the British Editor of the "International Journal of Air Pollution" the first number of which has just been issued, to contribute one or two articles giving a comprehensive survey of the work on aerosol physics done in the laboratory of the Meteorological and Geophysical Section of the School.

(ii) At the request of the Health Physics Division, Atomic Energy Research Establishment, Harwell one of their copies of our photo-electric nucleus counters was rechecked in our laboratory on 11th December 1958.

(iii) Professor Pollak has been invited by Dr. Jan Bouska, State Geophysical Institute of the Czechoslovak Academy of Science, to visit Prague as the guest of the Academy.

Professor Pollak has not accepted the Czech invitation.

(iv) Dipl. Physicist W. Hoppe of the II. Physikalisches Institut der Universität Heidelberg has prepared, partly with our help, a note on his very interesting theoretical investigation of the "scintillation

effect" which we have discovered, described and explained in Geofisica Pura e Applicata, Vol.38 (1957). Dr. Hoppe shows that the explanation of the scintillation effect as given by Professor Pollak and Dr. Metnieks is correct and that its amount, as observed, can be theoretically deduced with surprising accuracy. Dr. Hoppe's paper is being published in Geofisica Pura e Applicata, Milano.

PÁDRAIG de BRÚN

CATHAOIRLEACH

25 Márta 1960