

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
1961-62

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for the Financial Year 1961-62

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, 1962.

The general purpose which it is hoped to accomplish is clearly stated in the Act establishing the Institute, namely, the Institute for Advanced Studies Act, 1940 (No.13 of 1940) and in the Establishment Orders establishing the three Constituent Schools, namely, the Institute for Advanced Studies (School of Celtic Studies) Establishment Order, 1940, the Institute for Advanced Studies (School of Theoretical Physics) Establishment Order, 1940, and the Institute for Advanced Studies (School of Cosmic Physics) Establishment Order, 1947, and need not be referred to here. It is deemed desirable, however, to include in the report for the purposes of record certain particulars about the constitution of the Council of the Institute and the membership of the Governing Boards of the three Constituent Schools on the 31st March 1962.

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, 1962.
- 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 1962.

1. THE COUNCIL OF THE INSTITUTE

Chairman:

Professor Edward J. Conway, M.D., D.Sc., F.R.S., F.R.C.P.I.

Ex-Officio Members:

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

Members appointed by the Governing Boards of the Constituent Schools:

Right Reverend Monsignor Patrick Boylan, D.D., M.A., D.Litt.; Professor
Myles Dillon, M.A., Ph.D.; Professor Felix E. W. Hackett, M.A., M.Sc.,
Ph.D.; Professor John L. Synge, M.A., Sc.D., F.R.S.C., F.R.S.; Professor
John H. J. Poole, M.A., B.A.I., Sc.D.; Professor M. A. Ellison, D.Sc.

2. THE GOVERNING BOARD OF THE SCHOOL OF CELTIC STUDIES

Chairman:

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

Senior Professors:

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.; Eamonn Mac Giolla Iasachta, M.A.,
D.Litt.; Ernest Gordon Quin, M.A., F.T.C.D.; Tomás de Bhaldraithe, M.A.,
Ph.D., D.Litt., M.R.I.A.

3. THE GOVERNING BOARD OF THE SCHOOL OF THEORETICAL PHYSICS

Chairman:

Felix E. W. Hackett, M.A., M.Sc., Ph.D.

Senior Professors:

John L. Synge, M.A., Sc.D., F.R.S.C., F.R.S.; Cornelius Lanczos, Ph.D.

Appointed Members:

Albert J. McConnell, M.A., M.Sc., Sc.D.; George R. Keating, M.Sc.;
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.;
David R. Bates, D.Sc., F.R.S.

4. THE GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS

Chairman:

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

Senior Professors:

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

Appointed Members:

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

5. ADMINISTRATIVE STAFF

Registrar:

Patricia O'Neill.

Senior Clerk:

Maura Devoy, B.A.

Clerks:

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

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

adopted at its meeting on 27th June, 1962.

1. STAFF, SCHOLARS AND EXTERN RESEARCH WORKERS

Senior Professors:

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

Professors:

James P. Carney; Miss Cecile O'Rahilly; Proinsias Mac Cana (appointed
1 October 1961).

Assistant Professor:

Rev. Cuthbert McGrath, O.F.M.

Visiting Professor:

Calvert Watkins.

Assistant:

Louis Paul Nemo (Roparz Hemon) (appointed 1 November 1960).

Assistant (Part-time):

Mrs. Nessa Doran.

Research Associates:

Heinrich Wagner; Liam Price.

Technical and Clerical Staff:

Miss Máire Breatnach; Máire Bean Uí Chinnsealaigh.

Scholars:

Richard A. Q. Skerrett; Rolf Baumgarten (appointed 1 June 1961).

Extern Research Workers commissioned by the School:

Rev. Anselm Faulkner, O.F.M.; Rev. Pádraig Ó Súilleabháin, O.F.M.;
Rev. Bartholomew Egan, O.F.M.; Dr. R. B. Breatnach; Professor Nils
Holmer; Dr. L. Bieler; Professor Idris Foster; Líl Nic Dhonnchadha;
Gordon Mac Lennan; Professor Simon Evans; Professor Brian Ó Cuív;
Derick Thomson; Professor Séamus O Néill; Mrs. Ruth Lehmann.

2. RESEARCH

Professor O'Brien completed his work on Volume V of the Book of Leinster, which has now gone to press. The first volume of Corpus Genealogiarum Hiberniae appeared during the year. He revised in typescript or in proof a number of articles for Celtica, and was always ready to advise and help the other members of the academic staff.

Professor Binchy continued the transcription of the legal manuscripts. The appearance of his edition of Scéla Cano Meic Gartnáin was held up owing to a misunderstanding by the printers which resulted in the alteration of most of the line numbers. Throughout the year he was engaged in a study of the Patrician sources for an article in Studia Hibernica, Vol.II.

Professor Dillon revised final proofs of the Book of Rights. Teach Yourself Irish (edited in collaboration with Professor Donnchadh Ó Cróinín) appeared during the year. Two articles were prepared for Celtica VI which is now in the press. A tract on 'The Inauguration of Ó Conchubhair' was edited for Mediaeval Studies Presented to the Rev. Aubrey Gwynn, S.J. A paper on 'Prose and Verse in Irish Tradition' was published in the Proceedings of the International Congress of Modern Languages and Literatures, Liège, 1960, (Paris, 1961). A lecture on 'Literary Activity in the Pre-Norman Period' was published in Seven Centuries of Irish Learning (ed. Ó Cuív).

Professor Carney completed work on his book The Problem of St. Patrick which was published during the year. Articles were published in Extension, an American monthly, and in The Homiletic and Pastoral Review. Professor Carney also reviewed several works for the Irish Press.

Professor O'Rahilly's edition of the Stowe Version of Táin Bó Cuailnge was published. The text, introduction, notes, appendices and glossary of Cath Finntrágha were in the press. Proofs of all this material except the glossary, were received and corrected by the author. Professor O'Rahilly commenced work on an edition of the LL Táin with translation. A lexicographical note on Copgha, Ga Cop, Ga Cró was published in Éigse IX. Professor O'Rahilly continued to supervise and check excerpts for the Dictionary of Classical Modern Irish.

Professor Mac Cana was engaged in preparing for publication a larger work on the Irish saga-lists and on the general background of early Irish literature. Some preparatory work was done on an edition of the poems of the twelfth century poet Prydydd y Moch.

Rev. Cuthbert McGrath, O.F.M. continued work on the second volume of Dán na mBráthar Mionúr. Eleven articles on Irish saints have been published in the first volume of the Enciclopedia Agiografica, proofs of twenty-two articles for the second volume were being corrected and approximately fifty articles for the third volume were in preparation. Proofs of an article on

The preterite passive plural in Bardic poetry for publication in Éigse were passed for press. While working at the University College of North Wales, Bangor, Fr. McGrath gave a course of lectures on Classical Irish and attended lectures on Old, Middle and Modern Welsh.

Professor Watkins took up his appointment as Visiting Professor on 15th September 1961. Proofs of his book on Indo-European Origins of the Celtic Verb, 1. The Sigmatic Aorist were received and corrected right through to the final stages. This book is to appear in the summer of 1962. He also prepared an article on the syntax of the Old Irish verb for publication in Celtica.

M. Hemon continued work on his Historical Dictionary of Breton. The fourth part (Chipotal-Derou) appeared in July 1961, the fifth (Derou-Dilezenn) in January 1962 and the sixth is to appear shortly. First proofs of his work on Trois Poèmes en Moyen-Breton (Vol. I, Mediaeval and Modern Breton Series) were received and corrected and these were being revised at the end of the period under review.

Mrs. Nessa Doran completed work on the second fasciculus of the Catalogue of Irish Manuscripts in the National Library which was published. This fasciculus contains MSS. Nos. 15-69. Of the fourteen vellum manuscripts (which will comprise Fasc. I) ten were catalogued. The remaining four (Nos. 8, 11, 12 and 13) are medical manuscripts. During the year Mrs. Doran worked on Nos. 8 and 11. The text and variant readings etc. of Fled Dún na nGedh (edited by Mrs. Ruth Lehman for the Mediaeval and Modern Irish Series) were checked. Two articles, The Rights of Mac Diarmada and Ó Conchobhair Chiarraighe were prepared for Celtica and sent to press.

Professor Heinrich Wagner prepared the material for the first part of the Linguistic Atlas and Survey of Irish Dialects, Vol. II.

Mr. Liam Price continued work on the archive of Irish place-names.

Mr. Richard Skerrett continued excerpting for the Dictionary of Classical Modern Irish. He also continued editing slips for the Royal Irish Academy Contributions. His edition of two fifteenth century translations of the Liber de Passione Christi, sometimes attributed to St. Bernard of Clairvaux, was prepared for publication in Celtica, and work was commenced on an edition of a similar text of the same period, a translation of the Dialogus de Passione of the pseudo Anselm.

Mr. Rolf Baumgarten commenced preparation of a re-edition of the so called Mínigud Version of the Lebor Gabála from Rawlinson B 512 and other manuscripts, another old version of which exists in the beginning of the Book of Leinster and in the Book of Fermoy. He was also engaged on place-names research under the direction of Mr. Liam Price. In the autumn of 1961 he spent seven weeks in Cois Fhairrge studying the Connemara dialect.

Rev. Anselm Faulkner, O.F.M. worked on the revision of his edition of An Bheatha Dhiadha. Work progressed on editions of An Bheatha Chrábhaidh and An Sgathán Spioradálta.

Rev. Pádraig Ó Súilleabháin, O.F.M. checked and returned final proofs of the notes and glossary and first proofs of the preface of his edition of Lucerna Fidelium.

Rev. Bartholomew Egan, O.F.M. revised page-galley proofs of the text of Graiméir Ghaeilge na mBráthar Mionúr and worked on the preparation of the preface and notes.

Dr. R. B. Breatnach completed work on his edition of Seana-Chaint na nDéise II and the book was published at the beginning of the year.

Professor Nils Holmer checked revised proofs of the Gaelic of Kintyre which was passed for press at the end of the period under review.

Dr. L. Bieler continued checking the proofs of Volume V of the Scriptorés Latini Hiberniae series (The Irish Penitentials).

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

Lil Nic Dhonnchadha checked first proofs of the text of Aided Muir-chertaig Meic Erca to be published in the Mediaeval and Modern Irish Series and continued excerpting for the Dictionary of Classical Modern Irish.

Mr. Gordon MacLennan checked first proofs of Gaidhlig Uidhist a Deas which were returned to the printer for revision at the end of the year.

Professor Simon Evans checked revised proofs of the text and indexes of A Grammar of Middle Welsh for the Mediaeval and Modern Welsh Series. 'Copy' for the Prelims. and Introduction were sent to the printers.

Professor Evans also worked on the preparation of The Life of St. David and The Language of the Old Welsh Period for publication by the Institute.

Professor Brian Ó Cuív supervised and checked excerpts for the Dictionary of Classical Modern Irish.

Mr. Derick Thomson checked final proofs of Branwen Uerch Lyr (Vol. II - Mediaeval and Modern Welsh Series) which was published during the year.

Professor Séamus Ó Néill continued work on the preparation for publication of his edition of Bishop Gallagher's sermons.

The Dictionary of Modern Irish: Work on the Dictionary progressed during the year. Mr. Skerrett finished excerpting Irish Grammatical Tracts III and IV, Sgéalta Rómánsufochta (ed. Ní Mhuirgheasa and Ó Ceithearnaigh), and Agallamh na Senórach I, II and III (ed. Ní Shéaghda). He has commenced excerpting Smaointe Beatha Chríost (ed. Ó Maonaigh, O.F.M.). Lil Nic Dhonnchadha excerpted Trí Bruidhne (Leabh. Ó Láimh. II), Gallagher's Sermons (1752, 2nd edn.), Richardson's Sermons (1711). Her work on Cinnlae Amhlaoibh Uí Shúilleabháin is now in progress.

Place-Name Research: In the year 1961-62 the work has been continued in the manner described in the previous year's report. It has been principally concerned with the same four counties, Carlow, Kildare, Offaly (King's Co.) and Leix (Queen's Co.).

The cards containing the names taken from the documents of the 'Cromwellian' Settlement for Queen's Co. have been sorted into the county index (this was done last year for the other three counties). The Calendar of the Patent Rolls of James I and the Leinster Chancery Inquisitions, printed by the Record Commission, have been examined; these relate to the period from 1603 to 1641; the place-names for Co. Carlow and King's Co. have been extracted and the sorting into the county index has been completed for Carlow and partly done for King's Co. The place-names for Leix are being extracted. The names from a couple of sixteenth century maps have also been extracted.

Through the co-operation of Professor Delargy, Director of the Irish Folklore Commission, maps and notebooks have been completed and sent in by two of the Commission's collectors, Ciarán Bairéad and Micheál Mac Enrí. The place-names and notes, some in English and some in Irish, have been copied on to cards and inserted in the indexes; they are from Co. Galway and Co. Mayo. The scheme mentioned in last year's report for obtaining the help of students in St. Patrick's Training College in the collection of names, by supplying them with maps and notebooks, has been a failure; only a very

small number of maps and notebooks have been received, although those to whom they were issued have been asked more than once to return them.

Mr. Baumgarten has been helping with the work at times when he was not otherwise occupied and has shown a great deal of interest in it.

Hiberno-Latin Texts Series: Two further volumes in this series are in an advanced state of preparation: Dicuil, De mensura orbis terrae, edited by Professor J. J. Tierney, and the Liber ex Lege Moysi (with a tract De decimis et primogenitis as an appendix), edited by Rev. Dr. Raymund Kottje of Beuel-Vilich (Germany). Work is being continued on the editions of the Anonymus Salisburgensis (Liber de numeris, Liber de ortu et obitu patrum) by Rev. R. E. McNally, S.J. (Woodstock, Md.) and De rectoribus christianis by Sedulius Scottus, edited by Dr. Maurice Duggan. Mr. I. P. Sheldon-Williams has sent a revised (and final) typescript of Iohannes Scottus, Peri physeon Book I (with introduction), which will be in the next volume to be published.

3. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture was delivered by Professor D. A. Binchy at Trinity College, Dublin, on 13 March 1962. His subject was The Ritual Hunger Strike in Ancient Ireland.

4. LECTURES AND SEMINARS

Professor Binchy held a seminar on the early Irish law-tract Bretha Déin Checht.

Professor Watkins held a seminar on the Historical morphology and syntax of the Old Irish Verb. With the consent of the Governing Board he gave a course of lectures on Hittite in University College, Dublin.

A lecture entitled The Origins of Irish Literature was delivered by Professor J. Lohmann (University of Freiburg) on 21 April 1961.

5. EXTERNAL ACTIVITIES

Professor Dillon attended the International Congress of Phonetics at Helsinki in August 1961 and read a paper on 'Phonetic Analogy in Irish Dialects'.

Professor Carney lectured to the Classical Society, University College, Dublin, on Sedulius Scottus.

6. PUBLICATIONS

a. Books:

- Seana-Chaint na nDéise II. Edited by R. B. Breatnach. pp.xxvi + 449.
Price 21/- Published April 1961.
- Táin Bó Cuailnge. Edited by Cecile O'Rahilly. pp.lxi + 282.
Price 30/- Published April 1961.
- The Problem of St. Patrick. By James P. Carney. pp.xii + 193.
Price 15/- Published June 1961.
- Catalogue of Irish MSS. in the National Library of Ireland. Fasc.II,
MSS. G15 - G69. Compiled by Nessa Ní Shéaghda. pp.103.
Price 21/- Published August 1961.
- The Latin of St. Patrick. (Four Lectures). By Christine Mohrman. pp.54.
Price 7/6d. Published September 1961.
- Branwen Uerch Lyr. (Mediaeval and Modern Welsh Series - Vol.II).
Edited by Derick Thomson. pp.lii + 76. Price 8/6d.
Published November 1961.
- Dictionnaire historique du Breton. By Roparz Hemon.
Rann 3: Chipotal - Derou
Rann 4: Derou - Dilezenn
Chateaulin, Etienne, 1961.

b. Contributions to Periodicals:

- James Carney: St. Patrick and his Mission.
Extension, March 1962.
- St. Patrick and the Historians.
The Homiletic and Pastoral Review, March 1962.
- Proinsias Mac Cana: The Origin of Marbán.
Bulletin of the Board of Celtic Studies, XIX, 1-6.
- Textual Notes.
ibid. 113-117.
- Cecile O'Rahilly: Copgha, ga cop, ga cró.
Éigse, 9, 181, 1958-61.

III - Report of the Governing Board of the School of Theoretical Physics
adopted at its meeting on 10th May, 1962.

1. STAFF AND SCHOLARS

Senior Professors:

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

Professor:

Yasushi Takahashi.

Assistant Professor:

Lochlainn Ó Raifeartaigh.

Visiting Professor:

Alfred Schild.

Visiting Lecturer:

Susumu Kamefuchi.

Research Associates:

L. Bass; D. Judge.

Scholars:

A. Das (left August 1961); Rev. C. Ryan; Rev. J. Spelman (left August 1961); H. Shimodaira (appointed September 1961, left February 1962); P. Florides; E. Ortiz (appointed October 1961); Mrs. Y.-M. Chan (appointed October 1961, left January 1962); W. F. C. Purser (appointed October 1961); G. Rasche (appointed February 1962); C. B. Mast (temporary scholar from 25 June to 1 September 1961).

Technical Assistant:

Miss Evelyn Wills.

2. STUDY AND RESEARCH

Professor Synge completed the calculation of the numerical solution of a certain non-linear differential equation mentioned in the last Annual Report. He examined the convergence of certain integrals involved in the construction of gravitational waves. He studied the use of quaternions in connection with Lorentz transformations, in particular in relation to null rays invariant under such a transformation.

Dr. Florides and Professor Synge modified the Das-Florides-Synge method (see last Annual Report) in order to deal with the gravitational field of a rotating fluid mass having symmetry of revolution. The field was determined

up to and including terms of the fifth order in the angular velocity. This work was presented in a discussion in the Royal Society (see Section 8 below). Investigation of the more general fields is now in progress in order to clarify the question of the radiation of energy from a spinning rod or Jacobi ellipsoid, and also the equations of motion of a set of bodies. In the course of this work the Newtonian hydrodynamics of rotating fluid masses was investigated in general terms, that is, without the assumption of any equation of state.

Dr. Florides applied the above method to the case of a rotating spheroid of constant density, and obtained the second and third order components of the metric tensor in an integrated form, no matter how flat the spheroid may be. This involved new and compact formulae for certain Newtonian potentials.

Professor Synge used Fermat's principle to investigate the behaviour of ocean waves on beaches, obtaining an interesting result in the case of waves incident on a circular island: there exist one or more critical circles on which standing waves are formed.

Mr. Purser and Professor Synge worked on more general applications of Hamilton's optical method to water waves. It was found that many well-known results (such as the pattern of waves from a ship) can be established simply and elegantly in this way, and new problems can be treated. Investigations are in progress on the relations between the Hamiltonian method and Kelvin's stationary-phase method for approximating integrals arising in dispersive problems.

Dr. Das constructed models of the electron from a class of exact solutions of combined Maxwell-Einstein-Dirac equations.

Professor Lanczos, using a new formulation of the canonical Lagrangian, considered the exploitation of the special properties of a Riemannian space of specifically four dimensions, in view of the fact that both the Maxwell equations and Dirac's equation indicate that the structure of the Physical universe is closely tied to its four-dimensionality, while in Einstein's gravitational theory this property does not come into explicit appearance. The method of the Lagrangian multiplier brings the existence of a tensor of third order H_{LJK} in evidence which is anti-symmetric in i, j . It is reminiscent of the anti-symmetric part of the Γ_{LJ}^K quantities in Einstein's unified field theory, although here the classical framework of Riemannian

geometry has not been abandoned. The curvature tensor is now expressible in terms of H_{Ljk} , with the help of first order derivatives only. This has the advantage that the fundamental operator is no longer the Laplacian Δ but an operator which brings the Dirac matrices in evidence. A further property of the H_{Ljk} tensor is that it integrates the field equations of a quadratic action principle, by reducing them from the order four to the order two.

In the field of numerical analysis Professor Lanczos introduced a global method of integration in which the error of Simpson's formula can be reduced by a factor which is proportional to h^2 . The usual method of numerical integration is based on Simpson's formula which is applicable even to the evaluation of an indefinite integral. Although the integral from a to x does not involve the knowledge of the function beyond the point x , yet the fact that we cannot operate with the continuum but have to rely on a discrete set of values of the given function $f(x)$, indicates that we may fare better if we make use of all the given data of the entire interval $[a, b]$.

Dr. Ortiz worked on problems connected with the resolubility and uniqueness of solution of some differential operators arising in nuclear physics. Some numerical work has also been done with the aid of an electronic computer.

Professor Takahashi generalized the ordinary statistics of elementary particles (Bose-Einstein and Fermi-Dirac) in such a way that several identical particles can take one eigen-state. A field obeying such a generalized statistics can be quantized according to a new method, which he proposed. This method is an application of rotation and symplectic groups. He also examined the general properties of state-vectors constructed in terms of generalized creation operators, from the view-point of symmetry group.

Professor Ó Raifeartaigh completed a paper, in conjunction with Dr. Kamefuchi and Professor Abdus Salam of Imperial College, on the question of point transformations in quantum field theory, with particular reference to the gauge transformations which could be generated by such point transformations. He also examined the validity in quantum theory of the "Crossing Theorem", which forms a very important part of the basis of the theory of dispersion relations. For a certain class of elementary particle interactions he showed that the validity of the crossing theorem

is a consequence only of the charge conservation and of the micro-causality of the interaction. At the same time he carried out some further research on the problem of Fermi coordinates and Fermi subspaces, and obtained some results for the case in which the dimensions of the Fermi subspaces are one less than the dimensions of the enveloping Riemann space.

Dr. Rasche was principally engaged in studying with Professor Ó Raifeartaigh the mathematics underlying the more modern developments of quantum mechanics and quantum field theory; in the mathematical parts they were joined also by Dr. Ortiz. Dr. Rasche also had useful discussions with Professors Takahashi and Ó Raifeartaigh and Rev. C. Ryan on the principal aspects of elementary particle theory, in particular in connection with non-local models, especially that of Arnous-Heitler, and hopes to continue this work on his return to Zürich.

Dr. Kamefuchi worked with Professor Takahashi on a problem of a generalization of field quantization and of statistics of elementary particles. By means of a group theoretical method they have found that there exist commutation relations for creation and annihilation operators in field theory, which are more general than those of the ordinary Fermi-Dirac or Bose-Einstein statistics. They made a detailed investigation on the mathematical structure of such a theory and made clear its physical meaning. In particular, they studied in detail the problem of degeneracy of state vectors from the view-point of the theory of symmetry groups. This work will be published soon.

Dr. Shimodaira, using the modified Lee model, analysed the possibility of forming the extra one-particle states, which is usually called a superconductivity solution. He showed that these solutions can be identified with bound states, which behave like one-particle states, and gave a general proof of this.

Mr. Judge continued his study of abstract formulations of quantum field theory.

Rev. C. Ryan continued his investigations into strong coupling theory, with a view to applying it to the Hartree-type approximation for the nucleon core, and showed that this latter approximation was invalid. He undertook a study of generalised commutation relations, and with Professor Ó Raifeartaigh, he solved completely the problem of quantizing the linear harmonic oscillator by this general method. He developed a theory of lepton doublets within the framework of the two neutrino hypothesis.

Mrs. Chan studied a relativistic aspect of quantum field theory, that is, super-many-time theory by Dirac and Tomonaga. She investigated an integrability condition of the Tomonaga equation when the interaction Hamiltonian is bi-linear with respect to field operators but contains higher derivatives.

Rev. J. Spelman continued to work on electromagnetic form factors, and obtained some preliminary results, using Heitler's theory of radiation damping.

Dr. Bass studied the motion of non-relativistic test-charges in rapidly oscillating electromagnetic fields (such as exist in cavity resonators) which have a high frequency ω comparable with or greater than the local peak gyromagnetic frequency ω_c of the charges. Thus the currently used methods based upon the limit $\omega \ll \omega_c$ are supplemented. When the orbits are sufficiently localised by the action of the magnetic component of the field, rapidly converging expansions (involving integral order Bessel functions $J_\mu \left(\frac{\omega}{\omega_c} \right)$ as coefficients) are used to obtain asymptotic expressions for the kinetic energy limited by a simplified collision term in Lorentz's equations of motion. Kinetic energy resonances reminiscent of the action of the betatron arise, notably near the peaks of $\left\{ J_\mu \left(\frac{\omega}{\omega_c} \right) \right\}^2$. The work has been done in connection with the problem of electromagnetic heating of plasma.

Professor Schild completed work, begun with Dr. F. A. E. Pirani, King's College, London, on the geometrical interpretation of the conformal curvature tensor. He studied the problem of the motion of a system of interacting particles with charges, spins, and magnetic moments. He also studied the geometry of phase space in Hamiltonian mechanics; and worked on gravitational theories of the Whitehead type. He gave a number of informal lectures on relativity theory.

Dr. Mast continued his investigations in the possibilities of a transformation theory for general relativity. He also spent some time considering the use of special relativity and the principle of equivalence to explain the phenomenon of red shift. The results of this investigation were communicated to Professor L. I. Schiff of Stanford University, but were not otherwise considered publishable. Dr. Mast gave some lectures on group theory to the members of the School.

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. Every second seminar was devoted to Elementary Particle Physics, continuing the arrangement commenced during the previous year.

The following seminar lectures were given (Elementary Particle Seminars marked thus: *):

- * Dr. R. G. Allcock (Liverpool University):
Is₃-space, space-time, and space-inversion.
Meson-meson scattering (Discussion).
- Dr. A. C. Allen (Trinity College, Dublin):
A new approach to generalized function-spaces.
- * Mr. F. Anderson (University College, Dublin):
The role of bubble chambers in elementary particle physics.
- * Professor D. R. Bates, F.R.S. (Queen's University, Belfast):
Electronic recombination.
- * Dr. C. F. G. Delaney, F.T.C.D.:
Techniques in low-level counting.
- Professor M. A. Ellison (School of Cosmic Physics):
Solar differential rotation and the sun's magnetic field. (2 lectures).
- * Dr. D. ter Haar (Clarendon Lab., Oxford):
Tomonaga's treatment of collective behaviour.
The use of Green's functions in the many-body problem in statistical physics (Discussion).
- Professor V. Hlavaty (University of Indiana):
Einstein's unified field theory.
- * Mr. D. Judge:
Second quantization and commutation relations.
- * Dr. Anne Kernan (University College, Dublin):
The analysis of data from bubble chambers by digital computers at CERN.
- Professor C. Lanczos:
Boundary conditions in variational problems.
The splitting of the Riemann tensor. (2 lectures).
The conservation laws of field physics.
- * Professor S. Mandelstam (University of Birmingham):
Dispersion relations in strong-coupling physics. (3 lectures).
- * Professor P. T. Matthews (Imperial College, London):
Low energy pion physics.
- * Rev. Professor J. R. McConnell (St. Patrick's College, Maynooth):
Covariant statistical treatment of antiproton annihilation.
- Professor P. J. Nolan (University College, Dublin):
Combination coefficients of ions and nuclei. (2 lectures).
- * Dr. D. E. Page (School of Cosmic Physics):
Time variations in cosmic radiation.

Professor L. Ó Raifeartaigh:
Fermi coordinates.

* Dr. G. Rasche:
On solvable models in field theory. (2 lectures).

* Dr. B. K. P. Scaife (Trinity College, Dublin):
Fluctuation dispersion theorem.

Professor A. Schild:
Measurement of the vacuum Riemann tensor by light rays alone.
A conservation theory of gravitation of the Whitehead type.

Dr. R. G. Seeger (Deputy Assistant Director for Mathematical, Physical
and Engineering Science, National Science Foundation):
The work of the National Science Foundation.

* Dr. H. Shimodaira:
One particle states in quantum field theory.

Professor J. L. Synge:
Gravitational waves. (2 lectures).
On a certain non-linear differential equation arising in nucleon-core
theory. (2 lectures).

4. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture, under the auspices of the School, was delivered in University College, Dublin, on 29 March 1962, by Professor Synge. His subject was "Waves".

5. VISITING PROFESSOR

Professor Alfred Schild (University of Texas) was Visiting Professor at the School from 1 April to 5 June 1961. For lectures by Professor Schild, see Section 3.

6. VISITORS TO THE SCHOOL

Professor S. Mandelstam (University of Birmingham) from 18 to 21 April 1961.

Professor V. Hlavaty (University of Indiana) 30 June 1961.

Dr. D. ter Haar (Clarendon Lab., Oxford) from 11 to 13 October 1961.

Professor D. R. Bates, F.R.S. (Queen's University, Belfast) 25 October 1961.

Dr. R. G. Allcock (Liverpool University) from 8 to 10 November 1961.

Dr. R. G. Seeger (National Science Foundation, Washington) from 15 to 16 November 1961.

Professor P. T. Matthews (Imperial College, London) from 13 to 17 February 1962.

Dr. S. Kamefuchi, left June 1961. From 28 December 1961 to 5 January 1962.

Dr. H. Zorski (Polish Academy of Sciences) from 1 to 6 October 1961.

Mr. J. Strathdee (Imperial College, London) from 28 December 1961 to 5 January 1962.

For lectures delivered by Visiting Lecturers, see Section 3.

7. SYMPOSIUM

A Mathematical Symposium was held on 19-20 December 1961. The attendance was 69; this included Professors, Lecturers and Graduate Students from the several Irish universities.

In addition to the short communications (previews) the following lectures were delivered:

Professor P. B. Kennedy: Approximation to certain subharmonic functions.

Dr. M. Kennedy: Totally positive matrices and related problems.

Rev. P. McShane: Foundations of mathematics.

Dr. P. S. Florides: A solution of the "Cosmological Problem".

Professor E. F. Fahy: On the tight packing of spheres in flat N -dimensional space.

8. EXTERNAL ACTIVITIES

Professor Synge lectured on "Systematic approximation in the calculation of gravitational fields" at a discussion on the present state of relativity, held by the Royal Society on 22 February 1962. Dr. Florides attended the discussion.

Professor Lanczos lectured at Queen's University, Belfast, on 7 April 1961 on "Computing operations", and again on 15 January 1962 on "Unitary theories of physics". He lectured at Hull on 11 May 1961, to the Colloquium held by the combined universities of Hull, Leeds and Sheffield, on "On variational methods", and to the University of Hull on 12 May, on "Well-posed and ill-posed problems"; he lectured at the University of St. Andrew on 15 February 1962 on "Metrical geometry from Gauss to Einstein", and on 16 February at the University of Glasgow on "An integral approach to the calculus of variations". On 1 March 1962 he lectured to the University of Manchester on "Non-linearity in an infinite domain", and to the Manchester Branch of the

British Computer Society on "On global integration". On 1 March 1962 he commenced three months' leave of absence, as "Scientist in Residence" at the Institute of Science and Technology of the University of Michigan. He is giving a course of six lectures there on "The place of Albert Einstein in the History of Physics", of which four (8, 15, 22 and 29 March) have taken place in the period under review, and also conducting a graduate seminar on relativity, commencing on 26 March 1962.

Professor Takahashi visited Imperial College (London) from 5-10 February 1962, and lectured on "On the substitution law in quantum field theory", on 6 February. With Professor Ó Raifeartaigh, he attended the High Energy Conference held at Imperial College on 26-27 March 1962.

9. PUBLICATIONS

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

a. Books:

(i) Published:

* Linear differential operators. By C. Lanczos. Van Nostrand, London, 1961.

(ii) In the press:

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

* Mechanics. Analytical dynamics. By J. L. Synge. Two articles for Collier's Encyclopedia, New York.

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

No.14. Notes on the Schwarzschild line-element. By P. S. Florides and J. L. Synge. Price 7s. 6d. pp.29 + errata. Published 30 November 1961.

c. Contributions to Periodicals:

(i) Published:

J. L. Synge:

* Intuition, geometry and physics in relativity. Ann. di Mat. (Rome) 54, 275-284, 1961.

Gravitational waves in the second approximation. Proc. Roy. Irish Acad. 62A, 1-10, 1961.

On a certain non-linear differential equation. Proc. Roy. Irish Acad. 62A, 17-41, 1961.

A. J. Das, P.S. Florides and J. L. Synge:

Stationary weak gravitational fields to any order of approximation. Proc. Roy. Soc. A 262, 451-472, 1961.

P. S. Florides:

Applications of Møller's theory on energy and its localization in general relativity. Proc. Camb. Phil. Soc. 58, 102-109, 1961.

The electromagnetic energy and the gravitational mass of a charged particle in general relativity. Proc. Camb. Phil. Soc. 58, 110-118, 1961.

Y. Takahashi:

* The structure of the nucleon core by the Hartree approximation. Nuclear Phys. 26, 658-669, 1961.

L. Ó Raifeartaigh and Y. Takahashi:

* Further investigation on the non-local convergent field theory. Helvetica Phys. Acta 34, 554-586, 1961.

S. Kamefuchi, L. Ó Raifeartaigh and Abdus Salam:

Change of variables and equivalence theorems in quantum field theories. Nuclear Phys. 28, 529-549, 1961.

L. Ó Raifeartaigh:

The Dirac matrices and the signature of the metric tensor. Helvetica Phys. Acta 34, 545-553, 1961.

F. A. E. Pirani and A. Schild:

Geometrical and physical interpretation of the Weyl conformal curvature tensor. Bull. Polish Acad. Sci. 2, 543-547, 1961.

(ii) In the Press:

J. L. Synge:

* Relativity based on chronometry. Monographs on Gravitation, Volume dedicated to Professor Infeld, Inst. of Theoretical Physics, Warsaw.

* Tensorial integral conservation laws in general relativity. International Colloquium on Relativistic Theories of Gravitation, Royaumont, France, 1959.

Review: The Natural Philosophy of Time.
G. J. Whitrow. Edinburgh, Nelson, 1961.
Brit. J. Phil. Sci.

Review: Roger Joseph Boscovich, S.J., F.R.S., 1711-1787. Studies of his Life and Work on the 250th Anniversary of his Birth. Edited by L. L. Whyte. London, Allen & Unwin, 1961.
Brit. J. Phil. Sci.

Systematic approximation in the calculation of gravitational fields. Roy. Soc. Discussion.

J. L. Synge:

Action at a distance. Review: Forces and Fields.
The concept of action at a distance in the history
of physics. Dr. Mary B. Hesse. Edinburgh, Nelson,
1961. Nature.

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

Water waves and Hamilton's method. Nature.

A. Das:

A class of exact solutions of classical field equations
in general relativity. Proc. Roy. Soc. A.

C. Lanczos:

* Some properties of the Riemann-Christoffel curvature
tensor. Monographs on Gravitation, Volume dedicated
to Professor Infeld, Inst. of Theor. Phys., Warsaw.

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

The splitting of the Riemann tensor. Rev. Mod. Phys.

S. Kamefuchi and Y. Takahashi:

A generalized statistics and quantum field theory.
Nuclear Phys.

L. Ó Raifeartaigh:

On the validity of the crossing theorem. Nuclear
Phys.

Riemannian spaces of N dimensions, which contain
Fermi subspaces of N-1 dimensions. Proc. Roy.
Irish Acad. A.

A. Schild:

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

IV - Report of the Governing Board of the School of Cosmic Physics adopted at its meeting on 28th June 1962.

A. Astronomical Section.

1. STAFF AND SCHOLARS

Senior Professor:

M. A. Ellison.

Chief Assistant:

J. H. Reid.

Assistant:

Vacant.

Research Assistant (Royal Society I.G.Y. Bursary):

Miss S. M. P. McKenna.

Scholar:

Ian Elliott.

Clerical and Technical Staff:

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

2. LYOT HELIOGRAPH AT THE CAPE

The present functions of this instrument are twofold: (a) to provide a cinematographic patrol of activity occurring in the sun's hydrogen atmosphere, the records of which are distributed as quickly as possible to the various World Data Centres and others who require them; (b) to provide materials for basic researches upon solar flares and their terrestrial effects. These studies include the influence of flare X-rays upon the ionosphere (sudden ionospheric disturbances) and the acceleration by flares of high-energy protons which are recorded by cosmic ray monitors, or by polar cap absorption effects, on the earth.

During 1961 the heliograph was operated on 296 days with a total coverage of 1652 hours, as compared with 284 days and 1555 hours in 1960. The best months of the year were February, November and December when observations were obtained on 26, 29 and 29 days respectively.

The following table summarises the operation of the instrument and the number of flares recorded in each of the past three (calendar) years:

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

These figures illustrate the general decline of flare activity with the approach to solar minimum conditions which are expected to occur in 1964. In addition to the 294 flares which were counted, there were 11 examples of active prominence regions, 17 surges on the limb and disk, 8 eruptive prominences at the limb and 9 disparitions brusques.

Throughout the year the heliograph exposures were normally made at 1-minute intervals during the 7-hour (07^h00^m - 14^h00^m) daily schedule: the films were developed at the Cape and despatched weekly to Dunsink Observatory for analysis and distribution of the results. The work of analysis has been carried out by Mr. J. H. Reid and Miss S. M. P. McKenna.

A special study has been made (1) of the development and other characteristics of the ten cosmic ray flares, i.e. those which have accelerated high-energy (>1 Bev) protons into space, these having been recorded by cosmic ray detectors at ground level. Two of these cosmic ray flares were recorded with the heliograph and a third example was added on 1961 July 18 (2).

A new phenomenon - the flare nimbus - has been found in association with some Class 3 and 3+ flares recorded with the heliograph (3). This is a dark absorbing halo which begins to surround the flare some few minutes after the filaments have reached their maximum light intensity: its duration is some hours and its diameter is about 300,000 km. Seven cases have been studied, all of them associated with unusually strong outbursts of radio emission of Type IV (continuum radiation). It is believed that the halo is the optical counterpart of the cloud of relativistic electrons whose occurrence in the flare region has been postulated by Boischoit and Denisse in order to account for the synchrotron emission.

We are greatly indebted to Her Majesty's Astronomer at the Cape, and to his efficient staff (J. Churms in charge of the heliograph, assisted by Miss M. G. Pragnell, J. D. Laing, R. Lake and D. S. Malan) who have maintained the instrument in continuous operation during the year. This has rendered possible a valuable co-operative programme of solar research sponsored by the two observatories.

3. SOLAR SPECTROGRAPH

The reconstruction of the spectrograph was completed during the year. The dispersive element is a Bausch and Lomb "certified precision" plane grating having a ruled area 127 x 153 mm. with 1200 grooves/mm. Light from the slit is collimated and passed to the grating by means of a concave spherical mirror of $6\frac{1}{2}$ inches aperture and 23 feet focal length. A similar mirror, mounted vertically above the first, focuses the spectrum on the plate. Such an arrangement (as used by Hale in his spectrohelioscope) gives a point image of a point source (minimum astigmatism) and is therefore ideal for analysing the spectra of fine details in prominences. An image rotator of the reflecting (3-mirror) type has been incorporated and can be mounted on an optical bench in front of the entry slit. This allows one to form the spectral image of any prominence on the plate without the prejudicial entry into the spectrograph of direct photospheric light.

Profiles of lines from laboratory sources are highly symmetrical and the measured half-width in the second order for the krypton green line (λ 5570) is 0.03A.

An investigation of the profiles of the H and K lines of ionised calcium in quiescent prominences has been carried out with this instrument by Mr. Ian Elliott and the results have been submitted as a thesis for the Master's degree at Dublin University.

4. SOLAR FLARE EFFECTS

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

The direct recording H-magnetograph performed continuously throughout the year. One solar flare effect (crochet) and 17 sudden commencements of magnetic storms were recorded. Magnetically, the most interesting period was that associated with the flare active spot group which had its central meridian passage on July 14. The flares themselves and the various particle streams which issued from them have been made the subject of a paper to Monthly Notices (2).

5. ANNALS OF THE INTERNATIONAL GEOPHYSICAL YEAR

Volumes 21 and 22 of the Annals (4) were published during the year by Pergamon Press. These comprise the Solar Activity Maps D-1 and D-2, printed in four colours by the Institut Géographique National in Paris, Stonyhurst disk transparencies being provided for the reading off of coordinates. The D-1 Maps contain sunspot drawings (black) prepared at Zürich, the calcium plages (blue) prepared at Arcetri, the flares collected at Meudon and the active prominences on the disk and limb, as assembled at Boulder.

The D-2 Maps comprise the sunspots (black) with the Waldmeier type and number of spots for each group, prominences (red) on disk and limb, both prepared at Freiburg. In addition, there are the intensities of the λ 5303 coronal line (green) at 5° intervals round the limb, prepared by Boulder, and radio heliograms (blue) showing the 1420 Mc/s radiation (radio isophotes), as recorded at Sydney.

Drawings for the Catalogue of Sunspot Magnetic Fields for the IGY covering the second 9 months of the period were received from the Crimean Astrophysical Observatory. Material for the volume on Solar Radio-emission Data for the IGY was received from Sydney. Both these volumes are now with the printers.

6. CONFERENCES AND VISITS

Professor Ellison attended the XIth General Assembly of the International Astronomical Union at Berkeley, California, August 15-24, and presented two papers. He was present at the Symposium on the Solar Corona,

held at Cloudcroft, New Mexico, August 27-30, and attended the meeting of the Boyden Observatory Council at Berkeley, August 24-25. He attended the fourth meeting of the International Committee for Geophysics and the first IQSY meeting held in Paris, March 21-29.

Mr. J. H. Reid attended the conference on Cosmic Rays, Solar Particles and Space Research held at Varenna May 23 - June 3, and presented a short paper entitled "An Optical Phenomenon Associated with Type IV Radio Emission".

Miss S. M. P. McKenna was present at the Berkeley meeting of the I.A.U. and visited the Climax, Lockheed and McMath-Hulbert Observatories, the Stanford Radio Observatory and the California Institute of Technology.

7. STAFF AND VISITORS

There were no changes of staff during the year. The Observatory has been open to the public on the first Saturday of each month from September to April. The 12-inch South refractor was available to members of the Dublin Centre of the Irish Astronomical Society.

8. PUBLICATIONS

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

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

A description and discussion of the ten great solar flares which have generated cosmic rays recorded at ground level. Dunsink Observatory Publications, 1, 51, 1961.

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

Cosmic Ray Flares associated with the 1961 July event. Monthly Notices of the Royal Astronomical Society. (In the press).

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

Flares associated with the 1960 November event and the flare nimbus phenomenon. Monthly Notices of the Royal Astronomical Society, 122, 491, 1961.

- (4) M. A. Ellison (Editor):

IGY Solar Activity Maps, Vols. 21 and 22. Prepared by the Solar World Data Centres. (Pergamon Press, Oxford, 1962).

B. Cosmic Ray Section.

1. STAFF AND SCHOLARS

Senior Professor:

C. Ó Ceallaigh.

Professor:

Vacant.

Assistant Professor:

K. Imaeda.

Technical and Clerical Staff:

Miss C. Inight, Mr. J. Daly, Miss N. Leahy, Miss M. McGovern,
Miss P. Cully, Miss M. Longmore.

Scholars:

Miss M. Kazuno; K. Halpenny (to November 1961); A. Thompson;
J. Avidan; T. P. Shah (entered 6 November 1961); D. O'Sullivan
(entered 6 November 1961).

Visiting Physicists:

Z. Osborne (to 14 August 1961); E. Page (to 9 October 1961).

2. RESEARCH WORK

Schein Stack: Work on the material of this stack, details of which have been given in the Report for the Year 1960-61 is now coming to a conclusion. Those engaged in the experiment, on behalf of the School, are Professor K. Imaeda, Miss M. Kazuno and Mr. J. Avidan, assisted by Miss P. Cully and Miss M. Longmore. Preparation of the publication of the results on behalf of the Collaboration is now in progress and, in addition, the material has been used by Professor Imaeda and Miss M. Kazuno for independent studies as listed under PUBLICATIONS.

Mr. J. Avidan has used material from the stack to study the anisotropy and asymmetry of emission in the C.M. system of the individual particles in the jets, and he, with Professor Ó Ceallaigh, has investigated the statistical problem of which tests are appropriate to establish the existence of anisotropy in emission, if it should exist. At the time of writing, evidence has been found for anisotropy of emission using jet particles from the outer core. Those belonging to the inner core are now

being examined in order to obtain, if possible, confirmation of the existence of the effect. Miss P. Cully has assisted in the work.

Cosmic Ray Time Variations Experiment: Professor C. B. A. McCusker having decided to discontinue the experimental work at Dublin, the apparatus has been dismantled and stored. He desires to thank the Board and School for the facilities made available to him since his departure. The cloud-chamber and ancillary gear has been loaned to Edgar Page who plans to continue experimental work on this problem at the Radio Research Station, Ditton Park, Slough, Bucks., where he now holds a position.

No definite decision has yet been taken in respect of the station at Jamaica.

Ionization-Velocity Relation in Photographic Emulsion: The work of Johnston, Prowse and Shaukat has been revised by Professor Ó Ceallaigh, and it was decided that a modified treatment of the experimental data due to the latter would constitute an improvement on the existing work and a modified presentation is in preparation. It was decided to obtain additional experimental material and a collaboration was set up with physicists from the University of Bristol with the aim of obtaining the necessary exposures at the Proton Synchrotron at CERN. The exposures and processing of the plates were successfully carried through, and the Dublin contribution is progressing satisfactorily. Those engaged are A. Thompson, T. P. Shah and D. O'Sullivan with Professor Ó Ceallaigh. They have been assisted by Miss N. Leahy and Miss M. McGovern. Mr. A. Thompson assisted CERN, Geneva, and the University of Bristol with the work of exposure and processing.

Relative Frequencies of K^+ Meson Decay-Modes and K_{μ} and $K_{\mu 3}$ Decay Spectra: Owing to the departure of Dr. R. H. W. Johnston and Dr. M. O'Connell, the work of writing up the results of this experiment has been delayed, but the manuscript now awaits final revision prior to submission for publication.

K^- Stack Collaboration: Discussions have taken place between representatives of University College Dublin, University College London, Université Libre de Bruxelles and the School of Cosmic Physics with the aim of seeking exposure facilities at CERN, Geneva for a stack of plates which it is proposed to use

to study hyperfragment production and excited states of the K meson. It is expected that the exposures will be obtained in April 1962, and that the Collaboration will be engaged on the work of scanning and measurement for at least one year.

π - Diffraction Scattering Experiment: A stack was exposed on behalf of University Colleges, Dublin and London and of the School at CERN, Geneva in order to study the diffraction scattering of π -mesons using the perpendicular exposure method originally used for protons by Chen Pu-in and his collaborators at Dublin. Dr. Z. Osborne with Mr. K. Halpenny attended at CERN to assist with the exposures, returning to Bristol where they spent about 2 weeks on the processing of the stack. Unfortunately, it was found on examination of the plates that the collimation of the incoming beam at the P.S. was not sufficient and after about two months' work it was decided that it would not be possible to obtain results of value for a reasonable expenditure of time and manpower. Consequently, it was decided to abandon the experiment.

'Emulsion Cloud-Chamber' Experiments and Flights: An experiment for the study of high energy interactions in particular of the π^0 components was proposed by Professor K. Imaeda and approved by the representatives in Europe of the Schein Stack Collaboration. Professor Imaeda, whose travelling and maintenance expenses were kindly paid by this organisation, was present for four weeks at Bari, Italy, but owing to bad weather it was impossible to fly the stack. Unfortunately, further efforts by Professor C. F. Powell, F.R.S. to have the stack flown in India have hitherto proved unsuccessful.

3. CONFERENCES

Professor Ó Ceallaigh attended by invitation, the Conference on High Energy Nuclear Physics at Aix-en-Provence, in September 1961. He acted as chairman of the Session on Technical Developments.

4. COMMITTEES

British Emulsion Committee N.I.R.N.S., Harwell: Professor Ó Ceallaigh

continued to act as a member of the above Committee and attended all meetings called during the year.

CERN, Geneva, Emulsions Experiments Committee: Professor Ó Ceallaigh was again co-opted a member of this body and attended all but one of its meetings. The constitution and purpose of both Committees was fully set out in the Report for the Year 1960-61.

5. SEMINARS AND VISITORS

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

Dr. C. Peyrou (CERN, Geneva) 25 and 26 April, 1961:

The Liquid Hydrogen Bubble Chambers of CERN.
The Production of Strange Particles by π^- -mesons of 16 Gev.

Professor R. D. Hill (University of Urbana, Ill., and CERN, Geneva)
16 May, 1961:

K^- -meson Scattering.

Dr. B. Feld (M.I.T., Boston, Mass., and CERN, Geneva) 29 May, 1961:

Nucleon Isobar Excitation in Diffraction Scattering of High Energy Protons.

6. LIBRARY

The removal from the rear hut of the apparatus connected with the time-variations experiment has made available space for housing the library of the Section hitherto accommodated piece-meal about the house. The structure was not interfered with, and the four columns or struts supporting the flat roof in the central region of the hut were used to support three double-sided sets of shelving. The space available will suffice for the needs of the Section for some years to come.

The shelving was erected very efficiently by a firm of contractors. The concrete floor was levelled and covered with plastic tiles. Shelves were fixed to the walls for purposes of reading and paper work, as a cheaper but equally efficient alternative to the purchase of tables.

7. WORKSHOP AND INSTRUMENTS

The routine servicing and repair of the microscopes and associated instruments has been carried out by Mr. J. Daly. The Leitz Ortholux

microscope with the Stodiek stage was delivered at the end of the year. During the month of January 1962, Mr. Daly worked at CERN, Geneva, on the design and construction of the control system for the dropping table used in the exposure of emulsion stacks of the European collaborations.

8. PERSONAL

Owing to the poor prospect of obtaining results of value with the π^- perpendicular exposure stack referred to earlier, and to which he had devoted several months of his year's Fellowship, Dr. Z. Osborne decided to continue his work at the Radiation Laboratory, Berkeley, California, and left in August 1961. Dr. E. Page, who was engaged for three years on the Time Variations Experiment, has taken up a research position at the Radio Research Station, Ditton Park. The cloud-chamber and equipment used in this experiment was transferred to the above establishment on temporary loan for the use of Dr. Page who aims to continue with the experiment.

Miss E. Smith, sometime Clerk in the Cosmic Ray Section, left in October 1961 to take up a position at Sydney.

9. PUBLICATIONS

M. Kazuno:

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

K. Imaeda:

An Investigation of Jets based on a Fireball Model.
(Submitted to Il Nuovo Cimento).

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

The Relation between Ionization and Momentum for Singly
Charged Particles in G.5 Emulsion.
(To be submitted for publication).

C. Geophysical Section.

1. STAFF AND SCHOLARS

Senior Professor:

Leo W. Pollak.

Professor:

Thomas Murphy.

Research Assistant:

Arvids Leons Metnieks

Research Associate:

Rev. G. McGreevy.

Senior Technical Assistant:

Thomas J. Morley.

Technical and Clerical Staff:

Miss Nessa Falconer; Miss Brenda Kennedy; Mr. Kevin Bolster;
Mr. Martin Cotter.

2. INVESTIGATIONS, EXPERIMENTAL AND FIELD WORK

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

The continued demand for the School of Cosmic Physics photo-electric nucleus counter Model 1957 with its 1960 calibration table and problems arising out of its application in pure research, in public health services (air pollution), by atomic energy commissions and in industry again determined to a great extent the course of our investigations.

The world-wide use of the photo-electric nucleus counter (School of Cosmic Physics Model 1957) often under conditions very different from those under which the instrument was calibrated in 1959 and 1960, made an investigation into the effect of temperature on the counting of condensation nuclei with this instrument imperative. Since the counter is now much used in polar regions, in the first place the dependence of extinction, as measured by the photo-electric counter, on low temperature was examined (ii)*. For this purpose a chamber was constructed in the workshop of the Section in which

* The numbers in brackets refer to the papers listed in Section 3, Publications.

a whole photo-electric counter could be cooled down to -7°C . A definite relationship between the extinction as measured with a photo-electric counter and temperature was found. The effect of a cooling and re-heating cycle on an aerosol and the elimination of the temperature effect on the counting of nuclei with a photo-electric counter is discussed.

Comparisons were made (i) of the extinctions as measured with a photo-electric counter when the 'over-pressure method' and the 'under-pressure method' with equal pressure expansion ratio were used for producing the adiabatic cooling of the sample in the fog-tube of the counter. The extinction measured by the second method is smaller than that by the first. Tables and graphs for converting the extinction obtained by one method into that by the other are given. The greatest advantage of the under-pressure method lies in the reduction of the diffusion losses after enclosing the sample in the fog-tube, when the concentration of nuclei with radii smaller than $1 \cdot 10^{-6}$ cm is to be determined.

In order to facilitate the application of condensation nucleus size spectrometers, extensive tables have been computed (iii) which give values of mobility versus radius and vice versa for small steps of the argument and for temperatures likely to occur in the laboratory.

It has been shown (Rich and Pollak & Metnieks, 1959) that for normal laboratory conditions the recently introduced equivalent radius represents a very good estimate of the average size of submicron particles in poly-disperse aerosols. Since the comparative simplicity of measuring with a photo-electric counter the uncharged fraction of an aerosol recommends this new size parameter particularly for field work, tables have been computed (iv) which give for temperatures 0° , 15° , 20° and 25°C and in small steps the percentage fraction of the uncharged particles as a function of the equivalent radius and vice versa.

Natural aerosols over the ocean are usually in electrical equilibrium, aerosols in cities hardly ever. Aerosols over land are frequently not in equilibrium even though distant from any obvious source of contamination. Calculations are given (v) of the time required to reach equilibrium.

The approach during natural ageing to charge equilibrium of an aerosol produced and stored in a polyester 'Mylar' balloon gasometer with metallized

internal surface and 4200 litres content was studied (vi). It was shown that a stored aerosol consisting of small nuclei of moderate concentration is in electrical equilibrium not later than 15 minutes after their birth. With increasing size and concentration of the nuclei it takes longer and longer until the stored aerosol attains charge equilibrium. Stored large nuclei do not appear to reach exact charge equilibrium even after several days.

The results of 91 resolutions of polydisperse aerosols produced and stored in a large gasometer using the Pollak-Metnieks Exhaustion Method are given and discussed in (vii). The interpretation of the results obtained is illustrated by numerical and actual examples.

The investigation into the applicability of Boltzmann's distribution law to the concentrations of charged and uncharged nuclei with radii in the region of $1 \cdot 10^{-6}$ cm has been continued (viii). Considerable experimental difficulties had to be overcome before the crucial experiments now under way could be undertaken.

The study of the ionization equilibrium in air had to be postponed until the problem just mentioned had been clarified.

Experiments with the bigger model of the cloud chamber for studying ice nuclei, constructed in the workshop of the Section, were continued (ix). It was found that the statements in the publications available regarding the solutions used for recording ice nuclei are too vague. A thorough investigation of this essential part of any ice nucleus chamber is being carried out.

The construction of a small, portable photo-electric counter for field work has been started.

The research reported above has been supported in part by the Geophysics Research Directorate of the United States Air Force, the U.S. Army Research and Development Liaison Group and the General Electric Co., Schenectady, New York.

b. Professor T. Murphy:

The occasional readings of low Bouguer anomaly first encountered in Meath and Westmeath have now been investigated in greater detail. They are connected with certain structural trends and appear to be widespread within definite belts

a few kilometres wide. In attempts to ascertain if they are caused by "pot-holes", areas in Galway and Waterford, where these are common, were surveyed, but no similar phenomena were encountered. The latter district was brought to our attention by R. Northridge of the Land Commission who sought our help in the siting of houses away from the danger of pot-hole slumping. Another possibility, raised by Dr. J. Jackson of the museum, after his discovery of an unusual fault breccia was investigated but so far with no positive result. Seismic prospecting results given to us by the Ambassador Oil Company, in return for help we are giving them, are being investigated before further gravity work is carried out. It is intended to give an account of these anomalies in a paper to the meeting of the European Association of Exploration Geophysicists in London.

Rock samples from the south of Ireland were collected for density measurements and some determinations made. This latter work has proved so time-consuming that only a sufficient number have been taken to justify the figures quoted in the papers being prepared. To accelerate matters an automatic balance has been obtained and the method of water impregnation is being improved. The density results so far show that our earlier estimates were quite good. The collecting of good, unweathered, representative samples is the most difficult part and has to be left to chance. Samples from borings put down by the Geological Survey and by the South-East Ireland Syndicate have been given to us and these are most useful. Samples from other borings have had to be declined because they were not representative of the country rock.

The meeting on Palaeomagnetism sponsored by the Physical Society and held in King's College, Newcastle-on-Tyne in April was attended by Professor Murphy who acted as Chairman for one of the sessions. He also attended the Hague meeting of the European Association of Exploration Geophysicists in May.

3. PUBLICATIONS

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

Extinction in a photo-electric nucleus counter using adiabatic expansion of 1.21 pressure ratio achieved by increasing or decreasing the original pressure.
Geofisica Pura e Applicata, Milano, Vol.49, 1961/II, pp.208-216.

- ii L. W. Pollak and A. L. Metnieks:
The influence of pressure and temperature on the counting of condensation nuclei; Part II: Influence of low temperature. Geofisica Pura e Applicata, Milano, Vol.50, 1961/III.
- iii A. L. Metnieks and L. W. Pollak:
Tables and Graphs for Use in Aerosol Physics; Part I: Mobility versus Radius and vice versa. Geophys. Bull. No.19 of the School of Cosmic Physics, Dublin. June 1961.
- iv A. L. Metnieks and L. W. Pollak:
Tables and Graphs for Use in Aerosol Physics; Part II: Number of uncharged particles in per cent of total number of particles versus Radius and vice versa. Ibidem, No.20, December 1961.

In Course of Printing:

- v T. A. Rich and L. W. Pollak & A. L. Metnieks:
On the time required for aerosols to reach electrical equilibrium. Geofisica Pura e Applicata, Milano, Vol.51 (accepted for publication 13th January 1962).
- vi L. W. Pollak and A. L. Metnieks:
The approach to charge equilibrium in a stored aerosol during ageing. Ibidem, Vol.51 (accepted for publication on 24th January 1962).
- vii A. L. Metnieks and L. W. Pollak:
On the particle size analysis of polydisperse aerosols using a diffusion battery and the Exhaustion Method. Geophys. Bull. No.21 of the School of Cosmic Physics, Dublin.

In Preparation:

- viii L. W. Pollak and A. L. Metnieks:
On the validity of Boltzmann's law for small nuclei.
- ix L. W. Pollak and A. L. Metnieks:
A multicompartiment mixing cloud chamber for synchronous determination of ice-nucleus concentration at various temperatures.
- x T. Murphy:
The structure of the Earth's crust under southern Ireland as deduced from gravity data.
- xi T. Murphy:
Some unusual low Bouguer anomalies of small extent in central Ireland and their connection with geological structure.

4. U.S. AIR FORCE CONTRACT AF 61(052)-26 and Supplemental Agreements 1 to 3.

The contract terminated on 31st October 1961.

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

The contract has been extended until 30th June 1962. The project scientist in charge of the contract informed Professor Pollak (letter of 30th December 1961) that the U.S. Army European Research Office is anxious to renew the contract for a further period.

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

On the invitation of the U.S. General Electric Company, Professor Pollak had consultations in the Research Laboratory (General Engineering Laboratory) of the firm in Schenectady, New York, during his visit from 13th to 27th September 1961.

During this period Professor Pollak had extensive discussions on subjects of common interest, the opportunity to acquaint himself with the mobile laboratory built since his last visit in September 1960 and to observe the very impressive performance of its equipment during a run in the neighbourhood of Schenectady.

On request, Professor Pollak attended an internal conference consisting of eight experts from two universities and members of the GE staff and he was authorised to report to the Governing Board of the School that the experience in Ireland was considered of great value in the interpretation of the results obtained with the GE mobile laboratory and in the planning of future work. The publications of the Meteorological and Geophysical Section of the School were placed at the disposal of the members of the conference and they were consulted during the discussion to which Professor Pollak frequently contributed.

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

7. FOURTH INTERNATIONAL SYMPOSIUM ON CONDENSATION NUCLEI (Frankfurt a.M. and Heidelberg, 24th to 27th May 1961).

(i) Professor L. W. Pollak and Dr. A. L. Metnieks attended the meetings; Professor Pollak reported on their investigation "The influence of low temperature on the counting of condensation nuclei" in the morning session on

May 24, 1961.

Professor Pollak acted as Chairman in the afternoon session on the same day.

In his opening address, o.ö. Professor Dr. R. Mügge, Director of the Universitätsinstitut für Meteorologie und Geophysik, Frankfurt am Main mentioned that the first Symposium was organised in Dublin in 1955 by the School of Cosmic Physics and has now become firmly established. On the invitation of France the next meeting is scheduled for 1963.

(ii) It was brought out by the lectures at this Symposium that the photo-electric counter has been used for numerous purposes not visualised when originally constructed. For example, the counter is already in use for detecting minute leakages of dangerous materials from containers in the holds of ships, by a method which was first suggested by Professor Pollak in 1958 for use in a brewery.

The counter is expected to replace difficult detectors in Trace Chemistry in the future.

8. STATUTORY PUBLIC LECTURE

The Statutory Public Lecture was given on 29th November 1961 in the Physical Laboratory of Trinity College, Dublin under the title "Radioactive Iodine in medicine and nuclear energy" by Mr. W. J. Megaw of the U.K. Atomic Energy Research Establishment, Harwell.

9. METEOROLOGICAL AND GEOPHYSICAL SEMINAR

11th April 1961: Professor Dr. Tor Bergeron, Director of the Meteorological Institute, University of Uppsala: (a) Methods of scientific weather analysis and forecasting; present possibilities of improving Weather Service. (b) Possible future man-made climatic changes.

14th November 1961: Dr. M. Doporto, Director, Irish Meteorological Service: Meteorological aspects of radioactive fall-out.

28th November 1961: Mr. W. J. Megaw, Health Physics Division, U.K. Atomic Energy Research Establishment, Harwell: Diffusion coefficients of homogeneous nuclei.

10. EXTENSION OF LABORATORIES OF SECTION

In connection with the suggestion to purchase the stores situated at

6A Merrion Square adjacent to the present laboratories of the Section, the Chairman of the Council of the Institute, Professor E. J. Conway, the Director of the School, Professor M. A. Ellison and Professor Pollak had an audience with the Minister for Education, Dr. Hillary, on 16th November 1961. The premises were purchased by the Office of Public Works in the auction on 21st February 1962.

11. PERSONNEL

Dr. A. L. Metnieks who until 31st August 1961 was paid wholly from the American Contracts, was appointed Research Assistant as from 1st September 1961 to be paid partly from the funds of the Institute and partly from U.S. Contracts.

12. MISCELLANEOUS

(i) U.S. Department of Public Health: The School of Public Health, Department of Industrial Hygiene of Harvard University which built several photo-electric nucleus counters according to the School's specification, has drawn the attention of the U.S. Department of Health, Education and Welfare, Public Health Service, Cincinnati 28, Ohio, to the work carried out in our laboratory. Professor Pollak was contacted by an official of this Service during his stay in Schenectady and a meeting was arranged in New York for the 28th September 1961. It was attended by Mr. Heber J. R. Stevenson, Senior Health Services Officer, Air Pollution Engineering Research Section, and Mr. John S. Nader, Chief of Instrumentation Laboratory of Engineering and Physical Sciences, Robert A. Taft, Sanitary Engineering Center, Cincinnati. This center investigates the smog in California which causes serious damage to health (heavy irritation of lungs and eyes), vegetation, buildings, etc. The Cincinnati Service is interested in our methods and equipment for measuring the concentration and size distribution (Exhaustion Method) of condensation nuclei in exhaust gases of automobiles, etc. In a two-hour discussion the application of our work to their problems was discussed and it was decided that the contact initiated would be extended.

(ii) Philip Morris Research Center, Richmond, Va.: Professor Pollak

was invited by the Philip Morris Research Center, Richmond 6, Va. on August 29, 1961 to visit this Center and to present a Seminar to its Research Staff during his stay in the States. Since his time-table did not permit his travelling to Richmond, Mr. Lawrence M. Baxt, Ph.D. Senior Chemist of this Research Center, came to New York and extensive discussions took place on the 28th September, afternoon and on the 29th morning. The research center is also interested in the School's methods and equipment and asked for the workshop drawings of the School of Cosmic Physics Model 1957 photo-electric nucleus counter, the diffusion battery and denuder without endpieces, etc. It was decided that Professor Pollak should deliver a series of lectures on his work in their Center on the occasion of his next visit to the General Electric which is scheduled for September 1962.

(iii) The Atomic Energy Commission, Research Establishment Risø, Roskilde, Denmark, Chemistry Department, wishes to introduce the photo-electric counter, School of Cosmic Physics Model 1957 and our methods for determining the size spectrum of aerosols into Denmark (Letter of May 6, 1961, Ref.HF/kb) in order to study the absorption of radio-iodine on condensation nuclei.

Dr. Hans Flyger of the Chemistry Department applied for permission to acquaint himself with our equipment and to study our methods in the Laboratory of the Section, with a view to copying them. Dr. Flyger stayed in our laboratory from the 11th to the 23rd September 1961.

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

- (a) Professor F. Verzar, Institut für Experimentelle Gerontologie, Basel, Switzerland.
- (b) Physical Science Laboratory, U.S. Weather Bureau, Washington D.C. (Letter of April 6, 1961, Ref.R2: "We are now in the process of having four counters manufactured so as to be duplicates of your 1957 model instrument.")
- (c) Harvard University, School of Public Health, Boston 15, Mass. From letter dated April 20, 1961: "The construction of two copies of your counter has been completed, including a light source and lamp house of similar design, which duplicates the proper dimensions of the light

- pencil." Extract from Harvard School of Public Health Semi-annual Report (issued Jan.15, 1962) in American Iron and Steel Institute, Air Pollution Control Project: "It was decided to temporarily set aside the Harvard design and construct two exact duplicates of Professor Pollak's reportedly successful design. These are handoperated counters, of very precise and detailed construction with good reproducibility and accuracy. It is our current plan that these Pollak counters be calibrated (in Dublin) and set up for hand operation in the laboratory as standards."
- (d) Dr. A. P. van den Heuvel, Department of Meteorology, Imperial College, London.
 - (e) Health Physics Division, U.K. Atomic Energy Research Establishment, Harwell has five copies of our counter in permanent use.
 - (f) Meteorologisches Observatorium des Deutschen Wetterdienstes (Professor Dr. H. Israel), Aachen, West-Germany.
 - (g) Division of Occupational Health, Michigan Department of Health (Mr. Bernard D. Bloomfield, Assistant Director), Lansing 4, Michigan.
 - (h) School of Geophysics in the University of Santiago de Chile (Mr. V. H. Guerrini): one of several counters to be built is under construction (11th Oct. 1961).
 - (i) Gardner Associates, Inc., Makers of Measuring Instruments, 408 Charles Street, Scotia 2, New York, have built one counter as standard and intend to manufacture our model 1957 at a later date.
 - (j) Department of Physics, Cavendish Laboratory, University of Cambridge, England (Dr. T. W. Wormell): one counter under construction.
 - (k) Centrale Meteorologica Svizzera, Osservatorio Ticinese, Locarno-Monti, Switzerland (Dr. J. C. Thams).
 - (l) Zentralanstalt für Meteorologie u. Geodynamik, Wien, Austria.
Quotation from p.vi of Publ. Nr. 178, Jahrbücher, 97. Bd. (1960), Wien 1961: "Als instrumentelle Neuerwerbung ist der Bau eines Kondensations-Kernzählers nach L. W. Pollak zu verzeichnen."
 - (m) The Superintendent, the Lancaster and Morecambe College of Further Education, Lancashire Education Committee, Morecambe, Lancs.
 - (n) Atomic Energy of Canada, Ltd., Chalk River, Ontario (Dr. P. J. Barry).

- (o) Philip Morris Inc. Research Center, Richmond 6, Va., U.S.A.
- (p) Chemistry Department, Atomic Energy Commission Research Establishment Risø, Roskilde, Denmark. One counter under construction.
- (q) The American University, Washington 16, D.C. Ross Gunn, Ph.D., Research Professor of Physics (letter of December 11, 1961): "We have just had delivered a more or less faithful reproduction of one of your nuclei counters and hope to get it in operation shortly. ... Please accept this (new) cell as a minor symbol of my appreciation for the valuable work you have done in this field and for your splendid cooperation in making available information on the operation of the instrument" (Geophys. Bull. No.16).
- (r) A photograph of our counter was supplied for an article entitled "The cloud chamber as a tool in cloud physics" by Professor B. J. Mason, D.Sc., Imperial College of Science and Technology, London to be published in the journal 'Contemporary Physics'.

(v) Visitors: The following scientists have visited our laboratory in order to familiarise themselves with our work in aerosol physics or to standardise their copies of our counter.

(a) Mr. Alan G. Mencher, Deputy to the Scientific Attache of the American Embassy in London on 16th May 1961.

(b) Messrs. W. J. Megaw and R. D. Wiffen of the U.K. Atomic Energy Research Establishment on 28th and 29th November 1961 to check two copies of our photo-electric nucleus counter, built at Harwell, against our standard.

(vi) One of our photo-electric nucleus counters Model 1957 was taken to St. Moritz, Switzerland in summer 1961 by Dr. T. C. O'Connor, University College, Galway, and Rev. G. McGreevy, Research Associate of the School, for their work in collaboration with Professor F. Verzar, Basle.

EDWARD J. CONWAY
CHAIRMAN

28th November 1962