L. A. O'Donnell, S.J.

S.J.B.

A. M. D. G.

American Association of Jesuit Scientists

Eastern States Division

PROCEEDINGS

of the

TENTH ANNUAL MEETING

August 12, 13, 14, 1931

Holy Cross College, Worcester, Mass.

Published at

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CONTENTS

Bulletin of American Association of Jesuit Scientists

EASTERN STATES DIVISION

VOLUME IX | SEPTEMBER, 1931 | No. 1

BOARD OF EDITORS

PROGRAM OF GENERAL MEETINGS

Wednesday, August 12, 7:45 P. M. .... **Chemistry Amphitheatre**
O'Kane Building

Address of Welcome ....Rev. John M. Fox, S.J.

Reading of Minutes. Appointment of Committees.

Presidential Address ....Rev. C. E. Shaffrey, S.J.

Genes and Human Defects

New Business. Adjournment.

Friday, August 14, 1:00 P. M. .... **Chemistry Amphitheatre**

Report of Secretaries. Report of Committees.

Discussion. Resolutions.

Election of Officers. Adjournment.

PROGRAM OF SECTIONAL MEETINGS

BIOLOGY SECTION

Symposium on the Endocrine Glands

Thursday, August 13, 9:00 A. M.-3:30 P. M. ...... Biology Lecture Room
Bevan Hall

Friday, August 14, 9:00 A. M.

Chairman's Address ....Rev. John A. Frisch, S.J.

THE OVARIES

The Thyroid Gland ....Rev. Joseph F. Busam, S.J.

Glomus Caroticum, Glomus Coccygeum,
Rev. Clarence E. Shaffrey, S.J.

The Testes ....Mr. Arthur A. Coniff, S.J.

The Thymus Gland ....Mr. Austin Dowd, S.J.

Pineal and Pituitary Glands ....Mr. James Harley, S.J.

Islands of Langerhans ....Mr. Joseph G. Keegan, S.J.

Liver and Parathyroids ....Rev. George J. Kirchgessner, S.J.

The Adrenal Glands ....Mr. William G. Walter, S.J.

Endocrine Influence on Heredity .....Mr. Charles A. Berger, S.J.

Requirements for a Ph. D. in Biology Rev. Joseph Assmuth, S.J.

Courses Leading to M.S. for Our Scholastics,
Rev. Francis X. Reardon, S.J.

Path of Embryonic Inferior Vena Cava to the Heart,
Rev. Clarence E. Shaffrey, S.J.

MATHEMATICS SECTION

Meetings in Conjunction with the Physics Section.

Chairman's Address ....Rev. F. W. Sohon, S.J.

THE PERFECT SIXTY FOUR CELL MAGIC SQUARE

Elementary Discussion of Map Projections,
Mr. G. P. McGowan, S.J.

The Mercator Projection ....Mr. W. D. Sheehan, S.J.

The Stereographic Projection ....Rev. H. T. Quigley, S.J.

Albers Conical Equal Area Projection .....Rev. J. P. Smith, S.J.

Lambert Conformal Conic Projection ....Mr. T. D. Barry, S.J.

The Gnomonic Projection ....Mr. P. Fitzgerald, S.J.

Constructions with Ruler and Compass ...Rev. E. J. Nuttall, S.J.

CHEMISTRY SECTION

Chairman's Address ....Rev. George F. Strohaver, S.J.

THE WALDEN INVERSION

Gas Analysis ....Rev. Richard B. Schmitt, S.J.

The Hydrobromination of Propylene Rev. Joseph J. Sullivan, S.J.

Organic Mercurials Containing Fluorine,
Rev. George F. Strohaver, S.J.

PHYSICS SECTION

Symposium: X Rays

Thursday, August 13, 9:00 A. M.-3:30 P. M. ...... Physics Lecture Room Alumni Hall

Friday, August 14, 9:00 A. M.

Chairman's Address ....Rev. John A. Tobin, S.J.

"THE NATURE OF X RAYS"

Röentgen's Discovery of X Rays ....Mr. Lawrence M. Brock, S.J.

Photography of X Rays ....Mr. Leo F. Fey, S.J.

X Rays and the Quantum Theory ....Rev. Bernard Doucette, S.J.

The Compton Effect ....Mr. Francis B. Dutram, S.J.

X Ray Spectra and Mosely's Law....Mr. James D. Loeffler, S.J.

X Rays and Crystal Structure ....Rev. Henry M. Brock, S.J.

Industrial Applications of X Rays....Rev. John P. Delaney, S.J.

X Rays and Medicine ....Rev. Joseph P. Merrick, S.J.

Exhibition and demonstration of latest scientific apparatus by

Bausch and Lomb Optical Company, Rochester, N. Y.

Central Scientific Co., Chicago, Ill.

Laboratory No. 4 O'Kane Building.

PROCEEDINGS

FIRST GENERAL SESSION

The tenth annual meeting of the American Association of Jesuit Scientists, Eastern States Division was held at Holy Cross College, Worcester, Massachusetts, on August 12, 13 and 14, 1931. The general meeting was called to order by Rev. C. E. Shaffrey, at 7.45 P. M., in the Chemistry Lecture-Hall.

The minutes of the previous meeting and the treasurer's report were accepted as read. The Chairman then appointed the following committees:

Committee on Resolutions:

Rev. R. B. Schmitt
Rev. G. A. O'Donnell
Mr. J. J. Molloy

Committee on Nominations:

Rev. T. J. Love
Rev. T. P. Butler
Mr. J. L. Harley

PRESIDENTIAL ADDRESS

Genes and Human Defects

REV. C. E. SHAFFREY, S.J.

While human defects may be physical, mental or moral, all defects which are inherited are physical and these may give rise to mental defects with consequent moral defects. The underlying cause of mental and moral defects is some pathological condition in the body produced by the action of defective genes or to the absence of certain genes which are required for normal development.

We distinguish between hereditary defects strictly speaking, and those which are congenital but not hereditary in the true sense of the term. We rule out all those abnormalities, deformities, etc. in the foetus which are due to influences brought to bear on the foetus within the womb, and so have no causative factor in the gametes of the parents. The child may be born syphilitic, or with deformities due to adhesions of the membranes with consequent malformations or even absence of an arm or leg, but he has not inherited them from his parents in the sense in which the term is used in this paper. Only those characteristics are hereditary which are produced by some material factor borne on the chromosomes of the spermatozoon of the father or the ovum of the mother.

It is clearly demonstrated that inherited characteristics are represented by some agents which travel on the parental chromosomes and call these agents what we may, genes, factors, determiners, there is a material something passed from parents to offspring which accounts for the presence of those characteristics which we call inherited.

By experiments on plants and animals it has been determined that these agents which we shall call genes bear certain relations to one another, have certain characteristics of their own, and behave in certain ways in given circumstances with unbroken constancy, so that one experimenting with plants or animals can so cross parental strains as to produce desired effects which invariably follow.

A word is needed in regard to several fundamental facts and principles established by Mendel in his epoch-making work on the edible garden pea. These we can merely state, and accept as so well established by Mendel and the army of workers who have enlarged on his work and made the study of heredity a science in itself, that to reject them as unfounded would be stupid.

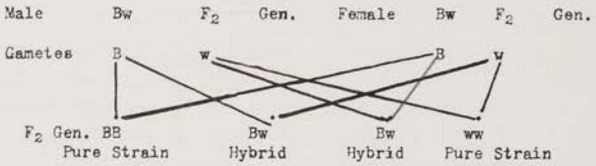
To state that characteristics are inherited we must find them appearing in the offspring according to regular Mendelian laws, or according to those of sex-linked inheritance.

For every character, as eye-color, condition of hair, i. e. curly or straight and the like, there is present a pair of genes or determiners in the body cells of the individual. If these two genes are alike the individual is homozygous in regard to that character, if one is for the character and the other for its contrasting character, as straight and curly in the case of hair, the individual is heterozygous for that condition.

When there are present genes for a pair of contrasting characters usually one of these characters appears and is said to be dominant while the other remains hidden and is said to be recessive. Dominance may be complete, as is black over white in the case of guinea pigs, or it may be incomplete as in the case of the Andalusian fowl, in which a black fowl crossed with a white fowl with black-splashed feathers produces offspring in the first filial generation which are all alike of a bluish color. Again, in the development of the germ cells, the ova and spermatozoa, the genes do not pass as a pair into a gamete but separate, one entering one gamete and the other another, the gametes being all alike if the individual is homozygous for the character, and an equal number for each of the pair of contrasting characters if the individual is heterozygous. This separation of the genes in the development of the germ cells is known as segregation. As a result of segregation we have the paternal element, the spermatozoon, in fertilization bringing one of the pair of genes while the maternal element, the ovum brings the other and the two genes for each character are to be found in the body cells or the somatic cells of the individual.

Hence we may represent the somatic cells of a black guinea pig which is a pure strain by BB, and its germ cells by B & B, and a white guinea pig by ww for somatic cells and w & w for the germ cells, capitals indicating the dominant characters and the small letters the recessive.

Where dominance is complete as in the case of black in guinea pigs, the members of the first filial generation will all be black. Now if the members of this generation are crossed the chances are that there will appear three blacks to one white, and of the blacks one will be a pure strain for black, two will be hybrids and one will be a pure strain for white as may be seen from the following diagram:



BB, Bw, Bw, Black; ww White Ratio 3 Blacks to 1 White

In the case of incomplete dominance as we find in the Andalusian fowl we would find all members of the F generation blue, and the members of the F_2 generation in the proportion of 1 Black to 2 Blue to one White.

Under the microscope the chromosomes appear to be made up of many chains of granules which probably contain the genes. Then too, the chromosomes are paired and the members of each pair carry corresponding sets of genes. In synapse the members of pairs are brought together. Since most defects are unit recessives the condition will appear only if both genes are defective, but if the defective condition is dominant it will appear even if only one gene bears the defect. So parents may have many defective genes and still produce normal children because the defective genes do not correspond, and too, defective genes may be present in the chromosomes of normal parents and coming together produce children with many defects.

.n .d .n .d .d .n .n .d .n .d .n.	.d .n .n .d .n .n .d .n .n .n .n.	Father
.n .d .n .d .d .n .n .d .n .d .n.	.n .n .n .n .n .n .n .n .d .d .n.	
.d .n .d .n .n .d .n .n .d .n .d.	.n .n .n .n .n .n .n .n .d .n .n.	Mother
.d .n .d .n .n .d .n .n .d .n .d.	.d .n .n .d .n .n .d .n .n .d .n.	
.n .d .n .d .d .n .n .d .n .d .n.	.d .n .n .d .n .n .d .n .n .n .n.	Child
.n .n .d .n .n .d .n .n .d .n .d.	.d .n .n .d .n .n .d .n .n .d .n.	

n=normal d=defective

Parents many defects, children none. Parents no defects, children many.

In order to gather data in the case of human characters we must use the statistical method. We cannot experiment on human beings, for we cannot cross the F_1 generation; brothers and sisters do not marry. By studying certain characters through a number of generations we are able to determine that certain ones do follow the Mendelian ratio. We find a number of deformities and diseases which are dominant. Polydactylism, a condition in which extra fingers have developed, is a dominant, hence the chances are that half of the descendants of a subject of the condition will be so affected if the parent has the determiner present in the simplex condition, and all of them if he has it in the duplex condition.

There is a condition known as congenital cataract in which the lens of the eye become opaque which is also a dominant. The opacity, however, does not develop until late in life, and so if often called prehensile cataract, and hence one could have raised a family before it was known that such a defect was being handed down. There is a disease known as Huntington's chorea in which the defective condition is dominant and does not appear until after middle life. The affected individual first experiences muscular twitchings which later become severe jerks, then impaired muscular movement followed by paralysis, dementia and death.

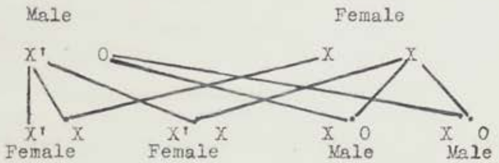
Fortunately most defective conditions are recessives and so do not occur very often since two of the determiners for the defect must meet, that is, the gene for the normal condition must be absent. In other words, the disease will appear only when we have the double recessive or duplex defective condition.

As a common example of a defective recessive we may mention deaf-mutism. If the father and mother are deaf mutes and they have inherited the condition, the children will certainly be deaf-mutes because neither father or mother has anything but defective genes to hand down. But if the malady has been acquired through accident or disease, then the children may be perfectly normal. Another instance of this kind is the nervous disease known as multiple sclerosis in which an abnormal proliferation of fibrous tissue together with a subsequent contraction of the fibres brings about a pressure atrophy of the cells and fibres of the nervous system, producing a gradually increasing paralysis, later dementia and finally death. Another is Meniere's disease which is called aural vertigo and is characterized by a great amount of dizziness and an inability to maintain equilibrium because of an affection of the cells in the semi-circular canals. It is thought too that a tendency toward, or a lack of resistence to certain diseases as tuberculosis, etc., have an underlying physical basis dependent upon genes transmitted, and it is possible that the same may be true of very great or very small intellectual capacity. The above are examples of defective conditions which statistics show to be transmitted from parent to offspring according to the Mendelian ratio. What can be said of human defects in connection with sex-linked inheritance? A few words of explanation of this type of inheritance may be needed. In the process of spermatogenesis, the development of the spermatozoon, cells in the lining epithelium of the seminiferous tubules known as spermatogonia give rise to what are known as primary spermatocytes. The division takes place by indirect cell-division. These cells contain the ordinary number of chromosomes or autosomes characteristic of the species, in the human it is forty-six, and in addition to that number an additional chromosome different from the rest and known as the X chromosome. These primary spermatocytes divide giving rise to two secondary spermatocytes, but in the division all of the autosomes undergo a longitudinal division so that each resulting cell contains the characteristic number, but the X chromosome fails to divide and passes toward one pole of the dividing cell and hence passes into the cell formed at that pole, so that when cell-division has been completed we have one secondary spermatocyte containing an X chromosome and the other lacking it. Each of these cells in turn divides, but the division is a peculiar one in that the chromatin of the nucleus breaks up into the number characteristic of the species but these merely separate into two equal groups which pass to opposite poles of the cell, so that when division is complete we have four spermatids each containing half the characteristic number. The division is peculiar also in that the X chromosome does divide, so that the two spermatids resulting from the division of the secondary spermatocyte which contained the X chromosome now have an X chromosome while those resulting from the division of the other secondary spermatocyte do not contain an X chromosome. Hence from the original primary spermatocyte we will have spermatozoa developed from the spermatids by a process of transformation, two of which will contain an X chromosome plus half the characteristic number of autosomes, and two which contain no X chromosomes but merely the reduced number of autosomes.

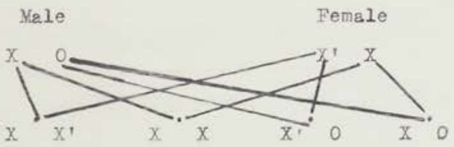
In the development and maturation of the ovum we have a similar reduction of the chromosome to half the characteristic number by the extrusion of the first and second polar bodies, the first having the full number while the second and the mature ovum have only half the number. In all of the divisions the X chromosomes divides and hence every ovum contains an X chromosome. When the sperm and ovum meet in the process of fertilization the chances are equal for the ovum being fertilized by a spermatozoon containing and X chromosome, and by one containing none. Should the former take place there would be two X chromosomes in the fertilized ovum and the individual would be a female; should the latter happen the fertilized ovum would contain only one X chromosome, and this would come from the ovum itself and hence from the mother and not from the father, and the individual would be a male.

The data concerning the transmission of certain diseases like color-blindness, haemophilia or bleeder's disease and many others have been noted clinically for many years, and the facts are such that if we were to assume that the genes which are the causative factors of the diseases travel on the X chromosome we would have a perfect explanation of all of them.

Taking color-blindness as an example, we find it more often in men than in women. This we would expect because the disease appears in males if the X chromosome is carrying the defect, for there is no other X chromosome in the male which could carry the gene for normality, but in the female there is. Hence if only one X chromosome of the female is carrying the defective gene, the individual will not suffer the disturbance of color-vision because the gene for the normal condition on the other X chromosome will be dominant, and hence the female will be capable of transmitting the condition to half of her sons but to none of her daughters so that they suffer the condition. It is well known too that if a father and mother are color blind, all of the children are as well. This is exactly as we would expect. A father cannot transmit color-blindness to his sons. This fact long known clinically finds an easy explanation in the fact that the son does not get his X chromosome from his father but from his mother. So a color-blind father and a normal mother will have only normal children, whether these be sons or daughters. The sons continue to have normal children, but the daughters though unaffected themselves transmit the disease to half of their sons. If such a woman were to marry a color-blind man, which could easily happen if she married a close relative, the chances are that not only half of the sons but half of the daughters as well would be color-blind. All the sons of color-blind women are color-blind. The explanation for these facts can be easily deduced from the following diagram in which the autosomes are disregarded as they play no part in the transmission, and the mark ' indicates color-blindness.



All daughters of normal vision but capable of transmitting the disease; all sons normal.



All daughters of normal vision, but half capable of tansmitting the disease; half of the sons color-blind and hence capable of transmitting the disease, the other half normal.

The inheritance of various other conditions in man follows practically the same course as color-blindness. Among these may be mentioned haemophilia which is a serious condition in which the blood will not clot properly rendering subjects of the disease liable to severe and very often to fatal hemorrhage. Nearsightedness, night-blindness, progressive atrophy of the optic nerve, Gower's muscular atrophy, ichthyosis, and syndactyly or webbed digits also seem to follow the lines of sex-linked inheritance.

What can we say about the inheritance of mental characteristics? We need to recall that whatever is passed from parent to child is something material, and consequently any effect produced is brought about by action on material, that is, on the body at some particular stage of development of the members, organs, tissues, glands, etc. Hence if we speak of mental characteristics as being inherited with consequent moral defects following from them, we can only mean that the causative factor must necessarily be found in a condition of development due to genes in their relation to the growth of certain parts of the body, especially the brain. Feeblemindedness. This in some types is certainly hereditary, and due to a single unit-recessive factor. Davenport states that there is not a case on record of two imbecile parents having produced a normal child. This is just what would be expected if the factor is a recessive behaving according to Mendelian laws.

There is known to be an inherited basic constitutional weakness predisposing to dementia precox in three fourths of the cases.

We spoke of Huntington's chorea and multiple sclerosis, and we may add ordinary muscular atrophy whose end-stage is one of insanity, all being certainly hereditary. Manic Depression Psychoses show a hereditary taint in eighty per cent of the cases.

That normal mentality and ability have an underlying physical basis which is hereditary would seem to be indicated by identical twins who necessarily have the same set of genes. Muller writes of a pair of twin sisters separated at the age of two weeks, living apart until they were eighteen years old. Thy were physically alike, both intellectually active, both quite capable, energetic, both popular in their communities, became leaders and prominent club women. One had a nervous breakdown and the other was close to a nervous collapse at about the same time. Both had attacks of tuberculosis at about the same time. Intellectual tests gave them very nearly the same rating. But environment can play a great part in these cases, and this is seen in the case of a pair of twins mentioned by Newman who were separated at the age of 18 months and lived apart until 17 years of age. Their environment was different, and they were unlike in as many instances as Miller's twins were alike, but they were temperamentally much the same, alike in their emotional traits.

What can we say about moral defects? It can be said that there is an intimate tendency to delinquency in a very large percentage of cases, but this tendency seems to flow from a condition of feeblemindedness. Guyer says that crime is in a considerable proportion of cases due to an innate inclination but just as much is acquired. For instance, in delinquent girls, figures from a house of detention in London shows feeblemindedness in 1/6 of the cases; New York statistics show the same in 25 to 50 per cent of cases; New Jersey shows about 33 per cent and Massachusetts about 25 per cent, while Chicago gives a proportion of only 10 per cent. In delinquents Johnstone finds feeblemindedness in 60 to 80 per cent and Goddard, Wilmarth, and Rogers each about 65 per cent. Of course there is no such thing as a crime factor or determiner, but there are defective genes transmitted and these have become so at some time or another in the ancestors through disease like syphilis or its sequelae, or they may have been impaired by infectious diseases of an acute type.

As an argument for the hereditary nature of degeneracy on the one hand and of exceptional ability on the other, the descendants of Max Juxes are compared to those of Jonathan Edwards, but while we can admit a hereditary influence we can see that environment has played as strong or even stronger part in determining the outcome.

Max Jukes was a shiftless, illiterate degenerate who lived in the wilderness of New York State in the early days. His descendants, 540 of them, were investigated up to the year 1877 by Dugdale who found that of the 540 one third had died in infancy, 310 were paupers who spent 2300 years in alms houses and cost the State of New York over a million and a quarter of dollars. More than half of the females were prostitutes, 130 convicted criminals, 7 murderers, not one educated, 20 learned a trade but 10 of these learned it in state's prison. Estabrook following 740 of the descendants between 1877 and 1915 was able to determine that though the environment had changed there were 323 typical degenerates among those who he had traced.

The descendants of Jonathan Edwards, the eminent clergyman, were traced, and of 1394 descendants there were found 295 college graduates, 13 presidents of colleges, 60 physicians, 100 lawyers, 75 officers in the army and navy, 30 judges, 80 who held public office, one Vice President of the United States, several governors of states, others members of congress, mayors of cities, ministers to foreign countries, etc.

Perhaps a more convincing case of the transmission of that innate tendency to delinquency proceeding from feeblemindedness is seen in a family to which the fictitious name of Kallikak has been given. In this case we have two lines of descent from the same father and two mothers. Martin Kallikak who was descended from a good family took advantage of a feebleminded girl and the result of their indulgence was a feebleminded son whose descendants were studied, 480 in all. Of these 143 were distinctly feebleminded, the rest mediocre of less, not one of exceptional ability. Some years later Kallikak married a Quaker woman who was normal and from this legal union there were 496 descendants. All of these but two were of normal mentality, and these two were not feebleminded.

The descendants of both the feebleminded woman and the normal woman were studied in every environment, and the respective strains have always been true to type, which tends to show that heredity has been a very strong determining factor in the formation of their respective characters, and that maternal inheritance seems to give dominant character to the descendants.

That these defects are intensified by inbreeding is seen in the account of the Nam family in which in one generation there were 55 per cent marriages between cousins, and as the strain was loaded with defects 90 per cent of the descendants are feebleminded, ¼ of the children born were illegitimate, and Davenport states that "infanticide, incest, murder and harlotry are written all over the chart." They have cost the community over a million and a half of dollars in care and in the damage they have done.

The question presents itself, how can genes be to blame. They have a function in development at some period or other, early or late, but if through some influence or another the gene has become defective the structures whose initial growth or later development are governed by them will be inferior. Just how the genes exercise this influence on growth and development is a question. Some regard them as closely related to the enzymes. The development of structures and the production of diverse functions seems to result from the interaction of genes and cytoplasm aided or hindered by the environment of the cells in the early stages, and their adjustment to conditions up to certain stage when their constitution becomes fixed. After this time environment has little effect and adjustment to conditions no longer occurs, and so processes must then go on, following the course determined by the initial stimulus furnished by the genes defective or normal as the case may be.

And what can be done about it? Scientific knowledge makes it impossible to correct many types of mental defects, and by social work and education much can be done to make useful men and women of mental defectives, provided that the measures employed take into account man's soul as well as his body, recognizing that his spiritual activities can exercise a great influence over his bodily well-being. Constructive eugenics must rest upon a sound ethical basis, which is in small measure true of the means proposed today for solving the problem, for they are merely biological and interfere with the rights of man as man, composed of body and soul and given a destiny by God Who made him.

FINAL GENERAL SESSION

On Friday, August 14th, at 11:00 A. M., the first part of the final general session was held in the Chemistry Lecture-Hall.

The reports of the secretaries of the different sections showed that the following officers had been elected for the coming year:—

Biology:	Chairman, Rev. J. A. Frisch Secretary, Mr. J. L. Harley
Chemistry:	Chairman, Rev. T. J. Brown Secretary, Mr. J. J. Molloy
Mathematics:	Chairman, Rev. G. A. O'Donnell Secretary, Mr. P. J. McKone
Physics:	Chairman, Rev. J. J. Lynch Secretary, Mr. L. J. Walsh

Then followed the report of the Committee on Resolutions. Father R. B. Schmitt read the following resolutions:

The American Association of Jesuit Scientists, Eastern States Division, assembled at its Tenth Annual Meeting at Holy Cross College, presents the following resolutions:
Be it resolved:

1) That the Association expresses its gratitude to the Very Reverend Fathers Provincial for their kind encouragement and support of the work of the Association, shown especially by granting the members of the Association, at Weston and Woodstock permission to attend the meetings of the Association.

2) That we express our sincere thanks to Rev. Fr. Rector, in appreciation of the genuine hospitality extended by himself and his community to the Association; asking that he thank particularly Fr. Minister for his cooperation; and to the members of the various science departments for their generous time and service.

3) That a copy of these resolutions be presented to Rev. Fr. Rector by the secretary of the Association.

The meeting was then given over to a general discussion.

It was propsed that steps be taken to exchange publications with the Western Division of Jesuit Scientists. In the discussion which followed it was shown that no real publication existed in the Western Division.

Mr. William Sheehan then told of a letter that was received by a student from a graduate of one of our Jesuit colleges, who was refused admittance into the Medical School of a non-Catholic University, because the course he had received was entirely inadequate. Fr. Assmuth proposed that action be taken immediately to correct this opinion. The president, Fr. Shaffrey asked Mr. Sheehan to obtain the letter in question and send it to him so that he might be able to approach the proper authorities and effect a complete understanding.

A program committee, consisting of the Chairmen of the different sections was appointed to prepare a program for the next annual meeting.

At 1:00 P. M., the second part of the final session was held, which consisted of the election of officers:

Father C. E. Shaffrey was reelected President; and Mr. J. C. Moynihan was elected Secretary.

The meeting was adjourned on a motion made by Father Love and seconded by Father Coyle.

At a meeting of the Executive Committee, Father Richard B. Schmitt was reappointed Editor of the Bulletin.

The following members were admitted into the Association:

NEW MEMBERS

Peter J. McKone, S.J., Boston College
Walter J. Miller, S.J., Georgetown University
Francis B. Dutram, S.J., Holy Cross College
Daniel Linehan, S.J., Holy Cross College
Charles H. Rohleder, S.J., Woodstock College
Lincoln J. Walsh, S.J., Loyola College
Anthony D. Ecker, S.J., St. Peter's College
Albert F. McGuinn, S.J., Fordham University
F. Marshall Smith, S.J., Brooklyn Preparatory School
Edmund A. Anable, S.J., St. Joseph's High School
Harold A. Pfeiffer, S.J., Gonzaga High School
Francis J. Heyden, S.J., Ateneo de Manila

The following members of the Association were present:

Rev. J. Assmuth
Rev. J. P. Smtih
Rev. G. F. Strohaver
Rev. G. L. Coyle
Rev. J. S. O'Conor
Rev. W. G. Logue
Rev. G. O'Donnell
Rev. H. P. McNally
Rev. B. Doucette
Rev. J. A. Frisch
Rev. J. Blatchford
Rev. H. Freatman
Rev. E. Nuttall
Rev. T. J. Brown
Mr. L. J. Fey
Mr. G. McGowan
Mr. J. Loeffler
Mr. L. Brock
Mr. J. J. Molloy
Mr. M. Smith
Mr. A. J. Carroll
Mr. J. MacNicholas
Mr. P. McKone
Mr. J. Doherty
Mr. J. Harley
Mr. W. Miller
Rev. T. Butler
Rev. J. J. Lynch
Rev. R. B. Schmitt
Rev. C. E. Shaffrey
Rev. T. J. Love
Rev. J. P. Delaney
Rev. J. A. Tobin
Rev. J. P. Merrick
Rev. T. H. Quigley
Rev. H. Brock
Rev. F. A. Power
Rev. J. M. Kelly
Rev. A. J. Hohman
Rev. A. Langguth
Mr. J. G. Keegan
Mr. G. Denis
Mr. J. O'Callahan
Mr. B. Dutram
Mr. D. Linehan
Mr. A. D. Ecker
Mr. J. C. Moynihan
Mr. W. Sheehan
Mr. A. McGuinn
Mr. G. Landrey
Mr. E. S. Hauber
Mr. W. G. Walter

BIOLOGY

THE THYMUS GLAND

Austin V. Dowd, S.J.

(Abstract)

The weight of experimental knowledge seems to show that the Thymus is more than a lymph gland and that it should be classed with the endocrines, though its function has not as yet been definitely determined. Therapeutic experiments show, with some degree of probability, that there is an important relation between the Thymus and the Thyroid, since Thymoid extract has been given with beneficial results in the case of goiter. There seems to be some relation regarding the formation of the bones, as removal of the Thymus from young animals has resulted in malformation of the bones; this evidence is increased by the fact that the extract has been given successfully in cases of rickets. Removal of the glands is followed by the enlargement of the Thymus, and in castrates disintegration of the Thymus is slow to set in, while in normal animals, it commences about the age of puberty. This is not the way the ordinary lymph glands act. Therapeutic experiments, however, for want of more accurate data, have to be conducted on empirical lines. The gland seems to be essential during the first ten days of life, and apparently indispensable during the first two years of life, as experiments have shown. However, as yet, there is not much data about the gland and little can be said about it with much certainty. Contradictory reports from experiments have made scientists very wary of speaking about this gland with any degree of sureness. The data given above seems however to be very probably true. The gland offers itself as a problem to be solved by science, and it is hoped that within a few years, research will tell us with certainty what we now know only with probability.

THE GLOMERA CAROTICA

Rev. C. E. Shaffrey, S.J.

(Abstract)

The carotid gland is about the size of a grain of rice, one to be found in the bifurcation of the common carotid of each side. It was formerly thought to be developed from the 3rd pharyngeal pouch, but that idea has been abandoned. Chromaffin cells from the glossopharyngeal and vagus plexuses and from the superior cervical ganglion migrate between the external and internal carotids and come to lie in the mesoderm of the 3rd arch from which it derives its mesodermal constituents and the vascular network in which these cells lie. It contains both medullated and non-medullated nerves and a few multipolar ganglion cells.

There is some evidence that the gland furnishes an internal secretion which produces cardio-vascular depression. Mechanical stimulation by compression with the fingers or forceps, as well as electrical stimulation produce such an effect. That the depression is due to the effect on the gland and not on the blood vessels seems to be indicated by the fact that direct stimulation of the carotid sinus by faradic current before and after removal of the gland has no cardio-vascular effect at all.

Extirpation of the gland is usually followed by an increase in arterial pressure, hence removal might possibly relieve hypotension.

According to Bremer, extracts of the gland do not give the reaction of adrenalin. Smith in the Jour. of Anat. 1924, states that there is no evidence to warrant including the carotid body in the endocrine system. It is true that removal of both glomera is not followed by any marked systemic symptoms like in the case of the thyroid, suprarenal, etc., but this may be due to the fact the function could readily be taken up by the chromaffin group of glands which it resembles so much. However, tumors of the gland seem to produce symptoms merely by pressure due to enlargement and not by any over-production of an internal secretion.

We must conclude that if the glomera carotica have an internal secretion it is insignificant.

The Glomus Coccygeum

This gland, often called Luska's gland, lies in the space between the tendons of the levator and muscles at the tip of the coccyx. It lies in close relation with the middle sacral artery and, according to Arey, develops from the wall of that artery. It appears in the 3rd month of gestation and becomes encapsulated during the 4th month. Schumacher holds the cells to be transformed smooth muscle cells from the arterial vessels while others regard them as modified endothelial cells of these vessels.

It is a small gland about 2.5 mm. in diameter. In structure it resembles the carotid gland. It is surrounded by a capsule of fibrous tissue from which septa extend into the gland dividing it into lobules. Each lobule is composed of polyhedral cells which contain a large oval nucleus surrounded by clear protoplasm which does not stain with chromium salts.

Cords of these cells surround lumina of tortuous sinusoidal blood spaces from which capillaries ramify through the gland.

The gland was at one time regarded as one of the chromaffin group and thought to be developed from the sympathetic ganglia, but that is now held to be untrue. True, nerves from the sympathetic system enter it but the nature of their termination is unknown.

Stoerck states that the cells at no time give the chromaffin reaction, and Arey too says that it bears no resemblance to the chromaffin tissues. Hence it would seem that the balance of evidence is against an endocrine function of the gland.

The Paraganglia

In human embryos of about 14.5 mm. age about 45 days, there are found compact groups of cells which resemble those of the sympathetic ganglionated cord. They lie in front of the aorta, for the most part, but there are two groups which extend down along the sides of that vessel to a point below the origin of the inferior mesenteric artery. These give rise to the ganglia of the prevertebral sympathetic plexus and also to peculiar bodies which consist of small groups of chromaffin cells. The largest of these are found in close relation with the inferior messenteric artery, one on each side. These are known as the Organs of Zuckerkrandl.

Each body has a rich blood supply consisting of a network of blood spaces surrounded by irregular, interlacing cords of polyhedral cells which contain a spherical nucleus which is poor in chromatin while the cytoplasm contains the characteristic chromaffin granules.

The internal secretion of the paraganglia depends upon the adrenal content of the granules. The adrenalin which they secrete produces contraction of smooth muscle and influences blood pressure by maintaining the tonus of the blood vessels.

Other chromaffin cells migrate to the liver, kidney, uterus, etc., organs which receive a considerable sympathetic innervation. Paraganglia have been found in the human heart by Busachi and in the striped muscle of the human oesophagus by Thulin.

THE OVARY AS AN ENDOCRINE GLAND

Rev. J. A. Frisch, S.J.

(Abstract)

An explanation is sought for the following facts in the life of the female animal:

1) Prepubertal Development resulting in the physical characteristics and other sex-characters of the female.

2) The Oestrous Cycle, consisting a) in the ovary, of the maturation of the Graafian follicle, ovulation and corpus luteum formation, and b) in the accessory organs, of growth, congestion and sloughing of the uterine mucosa, the cornification of the cells of the vagina, and the enlargement of the mammary glands.

3) The Post-ovulative and Pregnancy Changes, consisting of the sensitization of the uterus for the implantation of the egg, the decornification of the vagina, the interruption of the oestrous cycle, the maintenance of pregnancy to term, and the full development of the mammary glands as milk secreting structures.

4) The Periodicity of the Oestrous Cycle, occurring as it does every twenty-eight days.

Prepubertal Development—No definite hormone comparable to the testicular hormone of the interstitial cells of the testes has been isolated, but the presence of some basic secretion is a necessary assumption from the evidence at hand.

The Oestrous Cycle—A hormone, variously named, but preferably called oestrin, has been isolated from the ovary, placenta, the body fluids and other structures. Its injection produces all the extra-ovarian symptoms of oestrus, even in immature animals. It will not, however, induce or hasten ovulation. It seems that under certain conditions, if not normally, the stromal tissue of the ovary is the source of the hormone.

The Post-ovulative and Pregnancy Changes—The presence of the corpus luteum is necessary for all the post-ovulative and pregnancy changes. A hormone has been isolated from corpora lutea which produces the same effects, though interstital tissue and corpora lutea are claimed to be to some extent functionally interchangeable.

The Periodicity of the Oestrous Cycle—This periodicity is controlled by the anterior lobe of the pituitary body. Its hormone primarily affects the ovary causing the production of oestrin, which in turn causes the symptoms of oestrus. This implies a periodic action in the anterior pituitary, which periodicity is probably conditioned by events in the accessory organs.

ENDOCRINE INFLUENCE ON HEREDITY

CHARLES E. BERGER, S.J.

(Abstract)

Thirty years of intensive investigation building on Mendel's work have clarified many fundamental misconceptions about heredity. The particulate nature of heredity is well established as are the laws by which the distribution of the particles are governed. Johannsen's "pure-line" experiments and others of the same nature seem to rule out even the possibility of blending inheritance. The problems at present attracting attention, are—the nature of the hereditary particles; the relations between heredity and development, the method of action of hereditary units in determining adult characteristics, and the relative importance of heredity and environment.

In the solution of these problems several subsciences of biology other than genetics are playing an important part and noteworthy among these are experimental embryology and endocrinology. The idea prevalent among early Mendelian investigators that individual hereditary particles or genes were infallibly connected with certain well defined adult characteristics did not long survive the attack of adverse experimental results. Geneticists themselves soon found out that any one gene interacts with all the other genes, so that when treating of the relation between the totality of adult characteristics and hereditary determinants we must consider not only individual genes but also their reactions on one another—in other words the entire genetic complex. With this as a starting point we ask ourselves the question—what is the connection between the gene complex in the fertilized egg and the adult character. The tentative answer as at present put forth is as follows. Experimental Embryology seems to show that in the early development of the individual up to the time of well formed organs the reaction between the cytoplasm and the genes brings about a differentation of the cytoplasm and the formation of tissues and organs. This process of interaction between the genes and the internal environment of the embryo is constantly conditioned by the external environment to which the individual is subjected. Experimental Endocrinology seems to show that later development is governed largely by the action of hormones which differ quantitatively and qualitatively with the different sets of genes that produced them. Here too as in early development the external environment is an ever present and varying condition.

The determination of sex presents an illuminating example of the part hormones play in the formation of adult characters. In many organisms the sexes are distinct in the one cell stage in having a slightly different chromosome complex. This original difference brings about a different process of development which consists especially in the formation of either male or female sex glands. These glands elaborate a sex-hormone which,

circulating through the blood produces the secondary sexual characteristics. If the glands are removed shortly after their formation many of the secondary characters are not produced. If the male gland is transplanted into the female body or vice versa many of the secondary sexual characters of the opposite sex will be developed. In cattle when twins of opposite sexes are born the female called a Free-Martin is usually sterile and shows many male secondary sexual characters. This has been explained by F. R. Lillie as follows: the two embryos have an intra-chorionic vascular connection and the male germ gland which always develops first pours out its hormone which circulates through the female and causes the mixture of the sexual characters. In all these cases the transformation of sexes is never quite complete showing that the original sex-chromosome combination always exerts some influence.

Recent experiments have shown that the thyroid secretion is the active principle in bringing about the metamorphosis of amphibia. If the thyroid is removed from tadpoles they undergo no metamorphosis although they grow large and may become sexually mature. J. F. Gudernatsch by feeding pieces of thyroid to very young tadpoles caused them to metamorphose and thus secured frogs no larger than flies. It is now possible by injecting extract of the anterior lobe of the hypophysis or by transplantation of the gland substance to bring baby mice and monkeys to "maturity" in a few days time.

From these and many other examples of the effects of hormonic action on the adult characteristics it is evident that the hormones are a very important part of the internal environment of development and of great significance to the geneticist as intermediate steps between the genes and the adult characteristics.

INSULIN AND ITS ANTAGONISTS

JOSEPH G. KEEGAN, S.J.

(Abstract)

Introduction

Insulin and diabetes

Is diabetes caused by a failing sugar utilization? or,

Is diabetes caused by increased sugar production?

Discussion

A. The argument for Insulin

In the islands of Langerhans is formed a hormone quite necessary for the metabolism of carbohydrates and fats, because

a) removal of the pancreas is followed by diabetes,

b) transplantation of the pancreas or of a part of it averts diabetes until the transplant is later removed,

c) there are in the pancreas distinct areas of cells different from the acinar secreting cells.

d) extract of insular cells hastens carbohydrate metabolism, whereas extract of the acinar cells alone has no such effect.

B. The history of insulin

a) called insulin in 1916 when still hypothetical,

b) discovered in 1922

c) method of extraction and administration

d) probable chemical composition (polypeptid-like guanidin linkage)

C. Recent trends

Regulation of sugar metabolism involves the activities of several glands and there is a prospect of learning more of insulin by studying it in relation to its antagonists, especially adrenalin. For,

a) whereas adrenalin raises the blood sugar, insulin lowers it,

b) whereas adrenalin stimulates the glycogenic function of the liver, insulin retards it

c) whereas injection of adrenalin is followed by a rise in the fat content of the blood, insulin decreases the fat content

d) whereas adrenalin increases lactic acid content, insulin lowers it.

Conclusion

Comparative study of the effects of insulin and other hormones is leading investigators to think that insulin is only one cog in a very complicated machine. It is part of a balancing system, and its real nature can only be fathomed when studied in conjunction with its antagonists and counterbalancers. The key to this study is the regulation of carbohydrate metabolism.

There seems to be a renewed effort toward showing the possibility of changing the acinar tissue to insular tissue, an effort which deserves scrutiny.

FUNCTIONS OF THE PITUITARY GLAND

James L. Harley, S.J.

(Abstract)

I. ANTERIOR LOBE.

1) In General—

a) Overactivity causes—Gigantism and Acromegaly.

b) Underactivity causes—Dwarfism and Froehlich's Syndrome.

2) In Particular—

a) *Effects growth.* This Growth Hormone has been used experimentally in producing giant dogs, rats, frogs, etc.

b) *Effects Sex Development.* This hormone, called Prolan, stimulates the ovaries, thus indirectly causing Oestrus, etc.

c) *Affects other Glands.* When this lobe is removed, the other Endocrine Glands are affected; especially the Thyroid and the Adrenals.

II. POSTERIOR LOBE.

1) In General—

a) Overactivity causes—high blood pressure and decreased tolerance of starches and sugars.

b) Underactivity causes—low blood-pressure and increased tolerance of starches and sugars.

2) In Particular—

a) Effects Blood-pressure. The hormone, Pitressin, causes a rise in arterial blood-pressure.

b) Effects Smooth Muscle. The hormone, Pitocin, is used to stimulate the muscles of the uterus in childbirth.

c) Effects Secretion of Urine. This effect is anti-diuretic, but under some conditions it is diuretic.

TESTICULAR HORMONE

Arthur A. Coniff, S.J.

(Abstract)

The preparation of a highly purified testicular hormone is outlined in detail by T. F. Gallagher in the Journal of Biological Chemistry—1929, 84(2). By some authors the production of this hormone is ascribed to the interstitial cells; by others, on the contrary, the seminiferous epithelium itself is made responsible. Experimental data favoring the first hypothesis show that in all cases where an individual is rendered sterile and there is atrophy of the seminiferous tubules, the interstitial cells remain unharmed, or are slightly increased, and the individual retains all the masculine characteristics. Such cases are cryptorchid testes, complete X-ray sterilization, ligation of excretory ducts. Also in castrated animals testicular grafts showed atrophy of the tubules and proliferation of the interstitial cells, while masculine characters returned. Closer examination, however, has found that in almost every case of cryptorchid tests the tubules still retain Sertoli cells and spermatogonia, that in grafts the epithelium, although atrophic, survives a long time, and that the same is true for testes sterilized by X-raying. Recent investigations have shown, furthermore, that after ligation of the ducts atrophic changes need not develop, provided the blood vessels remain intact. Thus the possibility that the hormone is secreted by the seminiferous tubules has never been excluded. In cases in which the epithelium of the tubules undergoes complete degeneration, the interstitial cells usually also disappear, and there is absence of sexual activity. In seasonal breeding animals there is not regular relationship between the quantity of interstitial cells and the development of sexual characters. Therefore, according to the authors, Maximow and Bloom, it is far more probable that the source of the male hormone has to be located in the epithelium of the seminiferous tubules. Investigators who hold this opinion believe the interstitial cells to elaborate and to transmit to the epithelium the nutritive material needed by the spermatogenic cells. As the interstitial cells in many animals seem to hypertrophy exactly at the time when the sex cells undergo seasonal regressive changes and degeneration, they may, according to these authors, also be active in the absorption and utilization of the disintegrating cellular masses.

THE LIVER AND THE PARATHYROID GLANDS

George J. Kirchgessner, S.J.

(Abstract)

The liver has long been known to produce the nutritive substance glycogen in the form of an internal secretion. Several Japanese workers are conducting research on a detoxicating hormone of the liver called by them pakriton.

The parathyroid glands, on account of their variability in size, number and position, are difficult subjects of experimentation. It is known, however, that their complete removal causes a disease called tetany, which is quickly followed by death. The same disease appears independently of parathyroidectomy. But it is commonly believed to be caused always by deficiency in parathyroid activity. Tetany is characterized by extreme sensibility of the whole or part of the nervous system. The two principal theories concerning the function of the parathyroid glands are: first, that they control the lime content of the tissues; and secondly, that they counteract poisons in the system. Extracts made from parathyroid tissue have been found useful in alleviating the symptoms of tetany, but so have calcium—and other solutions, and even "bleeding". The only cure found for acute tetany has been the implantation of parathyroid tissue.

REQUIREMENTS FOR PH. D. IN BIOLOGY

Rev. J. Assmuth, S.J.

(Abstract)

Before a student can register for Graduate work in Biology he must be interviewed by the staff and passed upon by all the members of the staff, as to the general qualifications of the candidate.

Each candidate must have a reading knowledge in French or German or both, and must have obtained the degree of M. S.

Candidates in possession of the degree of Master are expected to complete at least 30 semester hours, extending over a period of 2 years.

The candidate must have taken a full course in General Philosophy and a special course in the Philosophy of Evolution. No credits are assigned for courses taken in these subjects.

(N.B. Philosophy courses as outlined above have meanwhile been ruled out for Fordham Univ.)

The chief work expected of the candidate for the degree of Ph. D. is that he disclose some new position in his chosen field of Biology and substantially contribute to present knowledge in that field.

Before the candidate starts his problem of original research, it must be approved by the Head of the Biology Department, and the latter will keep in touch with the progress of the work from time to time to give aid if necessary.

The work must be done in the University Laboratories unless the Head of the Biology Department gives explicit permission to perform it in whole or in part at some outside institution.

The candidate must present the results of his investigation in the form of a thesis which is to be read by the staff of the Biology Department.

A favorable report must be given on his thesis before the candidate can take the following examinations:

a) a written examination of 2 hours in whatever special field of Biology he has elected (Botany, Zoology, Histology, etc.);

b) an oral examination of 2 hours conducted by the staff, in any or all the branches of Biology, or any subject taken in preparation for the above degree.

In addition, the candidate must be capable of lecturing to a group on his work.

Every course and every examination or test must be passed with a grade of 75%. A candidate rejected from one graduation will not, under any circumstances, be granted a re-examination for the same graduation.

There will be monthly seminar meetings for all candidates for Graduate degrees.

CHEMISTRY

QUANTITATIVE METHODS OF GAS ANALYSIS

Rev. R. B. Schmitt, S.J.

(Abstract)

This paper presented an outline of the various methods used for the quantitative determinations in gas analysis. A description of the various types of apparatus was given, including the different methods employed from the Hemple tube to the latest type of apparatus issued by the Bureau of Mines. The fundamental principles of gas analysis were explained and their application made to fourteen important gases.

APPARATUS FOR GAS ANALYSIS. Gas burette. Absorption pipettes. Confining liquid: water—mercury. Measurements of 100 cc. Compensator for variable pressure. Constant temperature. Hemple, Orsat and Bureau of Mines.

FACTORS AFFECTING ACCURACY OF ANALYSIS. Specific absorption of the reagents.—Changes of temperature and pressure.—Changes in the water-vapor content.—Solubility of gases in the confining liquid.—Solubility of the gases in different absorbents.—Graduation of burettes.—Calibration.—Capillary error of the apparatus.—Running-down of the confining liquid.

METHODS OF GAS ANALYSIS. ABSORPTION: Proper reagent. Specific absorption.—Solubility of gases in reagents and confining liquid. Measurement of the volume.—SLOW COMBUSTION: Glowing platinum spiral.—Sample about 100 cc.—Control of rheostat.—Oxygen supplied.—Calculations.—EXPLOSION: Explosion pipette.—Spark with platinum wire electrodes.—Mercury for confining liquid.—Rubber tubing safety valve.—Gas volumnes proportional.

OXYGEN. Slow combustion.—Copper eudiometer.—Absorption: Alkaline pyrogallol. Phosphorus. Copper in solution of ammonium carbonate and ammonium hydroxide. Iron wire and sodium hyposulphite.

OZONE. Solution of potassium iodide and titrating the iodine set free.

HYDROGEN. Absorption: Palladium black in U tube at 100° C. One per cent solution palladious chloride, warm. Explosion: Mix with pure oxygen and measure contraction after explosion. Slow combustion: Burned with equal parts of oxygen and air. Sample about 100 cc. Dull red platinum spiral. Residual gas measured.

NITROGEN. Absorption: one part powdered magnesium; five parts ignited lime; and 0.25 part metallic sodium. (Calcium nitride.)

NITRIC OXIDE. Absorption: Solution of ferrous sulphate. Many other methods.

NITROGEN PEROXIDE. Absorption: Concentrated sulphuric acid.

AMMONIA. Nessler's reagent: alkaline solution of potassium mercuric iodide. Gas mixture passed through dilute acid (known value) neutralized by ammonia and titrated.

ACETYLENE. In ammoniacal cuprous chloride solution—a reddish brown precipitate. This precipitate filtered off and washed with dilute ammonia water. The moist copper acetylide collected in Gooch crucible and dried over calcium chloride in a current of carbon dioxide and weighed as copper acetylide.—Electrolytically: by the determination of copper.—Volumetric method: O.1N potassium permanganate.

HYDROGEN SULPHIDE. A measured quantity of gas in solution of iodine in potassium iodide and starch. Stopped when solution becomes colorless. Calculated.—Standard solution of iodine and excess titrated with sodium thiosulphate.

SULPHUR DIOXIDE. Absorption: Sodium hydroxide.—If carbon dioxide is present, by titration.—Measured volumne in bromine water and precipitating the sulphuric acid formed by barium chloride.

CARBON DIOXIDE. Absorption: Concentrated potassium hydroxide.—Standard solution of barium hydroxide.

CARBON MONOXIDE. Absorption: Ammoniacal solution of cuprous chloride.—Iodine pentoxide.

METHANE. Explosion: with oxygen and air and determining the carbon dioxide formed.—Combustion: with copper oxide.

ETHYLENE, PROPYLENE and BUTYLENE. Absorption: Fuming sulphuric acid.

Illustrated with lantern slides

HYDROBROMINATION OF PROPYLENE

Rev. J. J. Sullivan, S.J.

(Abstract)

Some very interesting experiments on the reactivity of propylene with hydrobromic acid in the vapor phase were carried on in the Laboratory at Boston College during the past six months. The work is still incomplete, but the following are some of the results obtained.

When carefully dried the two substances do not react in the gaseous phase at temperatures below a hundred degrees centigrade. Neither do they react in a vessel with clean glass (pyrex) walls, even in the presence of perceptible moisture. However, when the walls of the reacting vessel were coated with a thin film of stearic acid, the hydrobromic acid and the propylene combined at a measurable speed. This reactivity held for temperatures up to 45° C., about fifteen degrees below the melting point of the stearic acid wall coating. At this latter temperature, the reactivity ceased, thus indicating that some change was occuring in the stearic acid which nullified its catalytic activity. Equations set up for the rate of reaction indicate that the reaction is bi-molecular.

MATHEMATICS

IMPOSSIBILITY OF SQUARING THE CIRCLE

REV. EDMUND J. NUTTALL, S.J.

(Abstract)

THE PROBLEM:-- With a ruler and compass to construct a square the area of which is equal to the area of a given circle; or in other words required the side of a square whose area is equal to the area of the circle Πr^2

If k is the side of the square, then
$k^2 = \Pi r^2 \therefore k = r\sqrt{\Pi}$

SOLUTION:-- Every particular geometric (with rule and compass) is effected by the intersection of two str. lines; two circles or a str. line and a circle; and is equivalent to a rational operation or the extracting of a square root.

HENCE:-- a geometric construction is impossible unless it can be constructed by rational operations or by the aid of a finite number of square roots.

An algebraic number is a number which is the root of an algebraic equation.

A rational number is one which can be written in the form of a fraction p/q where p and q are integers and where p can be zero while q can not.

A number which is not algebraic, i. e., which satisfies no equation is called transcendent.

HENCE:-- If Π satisfies no algebraic equation with rational coefficients, it cannot be found by means of ordinary algebraic operations and therefore cannot be constructed geometrically with rule and compass; in other words, if Π is transcendent it can not be found geometrically.

To prove that Π is transcendent.

From Maclaurin's formula:

$$f(x) = f(o) + f'(o)\,x + f''(o)\,\frac{x^2}{L\,2} + f'''(o)\,\frac{x^3}{L\,3} + \ldots\ldots$$

We have:

$$e^x = 1 + \frac{x}{1} + \frac{x^2}{L\,2} + \frac{x^3}{L\,3} + \ldots\ldots$$

$$\cos x = 1 - \frac{x^2}{L\,2} + \frac{x^4}{L\,4} - \frac{x^6}{L\,6} + \frac{x^8}{L\,8} - \ldots\ldots$$

$$\sin x = x - \frac{x^3}{L\,3} + \frac{x^5}{L\,5} - \frac{x^7}{L\,7} + \frac{x^9}{L\,9} - \ldots\ldots$$

From which it follows:

$$e^{ix} = 1 + \frac{i\,x}{1} - \frac{x^2}{L\,2} - \frac{i\,x^3}{L\,3} + \frac{x^4}{L\,4} + \frac{i\,x^5}{L\,5} - \ldots\ldots$$

$$i \sin x = i\,x - \frac{i\,x^3}{L\,3} + \frac{i\,x^5}{L\,5} - \frac{i\,x^7}{L\,7} + \ldots\ldots$$

$\therefore e^{ix} = \cos x + i \sin x$

If $x = \Pi$

$\therefore e^{i\Pi} = -1$

or $1 + e^{i\Pi} = 0$

It can be proven that in an equation of the type:

$$a_0 + a_1 e^p + a_2 e^q + a_3 e^r + \ldots\ldots = 0$$

the exponents and coefficients cannot all be algebraic numbers.

Hence in the equation $1 + e^{i\Pi} = 0$ where the cofficients are algebraic, the exponents cannot be algebraic and hence Π is transcendent.

THE MERCATOR PROJECTION

William D. Sheehan, S.J.

(Abstract)

The Mercator projection is a cylindrical projection. Hence the nature of the cylindrical projection was first discussed and its four types were briefly explained. Thus we led up to the Mercator projection which is a conformal projection in which the sketching in latitude is limited to an equality with the sketching in longitude. This is the only projection on which a straight line is able to represent a rhumb line, i. e. a line that crosses the successive meridians at a constant angle. It is therefore the only one that meets the requirements of navigation and has a world-wide use, due to the fact that the ship's track on the surface of the sea under a constant bearing is a straight line on the projection. We then discussed briefly the choice that a navigator must make between the rhumb line which is longer but of constant direction and the arc of a great circle which is shorter but of constantly changing direction.

ELEMENTARY DISCUSSION OF MAP PROJECTIONS

George P. McGowan, S. J.

(Abstract)

This was the introductory paper in the Symposium of Map Projections. The definiticn of a map was given as a small-scale, flat-surface representation of some portion of the earth or of the entire earth. The difficulty of reproducing on a plane surface, areas of a spherical surface was brought out in the treatment of distortion. It was shown that any position of the earth must be determined by the co-ordinates of Latitude and Longitude on the map, and the method of finding these latter values was explained. The fundamental types of map projections, including the special ones treated at length in the succeeding papers, were briefly touched upon, aided by a suitable selection of slides, in the production of which the members of the Mathematics Section wish to express their appreciation to Father John Blatchford. The paper concluded with an explanation of developable, both cylindrical and conical surfaces, and their limits in overcoming distortion.

PHYSICS

THE NATURE OF X-RAYS

Rev. J. A. Tobin, S.J.

(Abstract)

What is the nature of X-rays? There are so many questions connected with the answer to this question, that it is impossible to do justice to a subject of such comprehensive nature in the little time given to us. To answer the question we must explain the nature of all electromagnetic waves as radio waves, heat waves, light waves, ultra violet waves, gamma rays, etc. All these waves seem to have the same nature and differ only in wave length. Again we must reconcile the phenomena of Photoelectric Effects and Common Effects, where these effects seem to demand particles, with the phenomenon of reflection, refraction, and interference that need the wave theory for an explanation. These two theories have been united in the theoris of wave mechanics and quantum mechanics, but as Fr. Wulf points out in his final pages, they have not been developed far enough to say that the goal has been reached. To reach that goal we must break down the dividing wall between atoms and waves. To give a complete answer to the question "What is the nature of X-rays" we would have to know the secrets of the universe and explain how a wave can have the properties of a particle, and how a particle can have the properties of a wave.

Since action at a distance is repugnant Newton thought that light traveled in straight lines composed of corpuscles. Huyghens on the other hand supposed light to be a wave motion. But a wave motion in what? Since light passed through a vacuum Huyghens postulated the elastic ether for what he thought were longitudinal waves. Young and Fresnell then proved that the waves were transverse. Then Foucault measured the velocity of light in water, and found that it traveled more slowly than in air and struck the finishing blow to Newton's Theory. But then the problem of energy transfer again demande d the particle theory. We have the same problem in X-rays. The marvelous explanation of the phenomena of interference, diffraction and polarization given by Young and Fresnel by their spreading wave theory gave strong grounds for the wave theory. The great fact that these electromagnetic waves were not deflected by a magnetic field seemed to prove that they were not particles and different from the beta rays and electrons. But in

1927 Davisson and Germer found that electrons produced diffraction patterns in passing through thin sheets of gold. Then the photoelectric effect could not be explained by the wave theory. And so in 1931 we have been forced to unite both theories to explain the effects.

In the symposium we will discuss the classical proof for each theory. First the proof that X-rays are waves. Roentgen thought that these rays were longitudinal vibrations of the elastic ether. Bragg thought that they were small particles like electrons. Faraday had suggested that the ether was connected somehow or other with the magnet, and the magnet had affected this ether. He made his lines of force to explain the phenomena. Maxwell, who was a great admirer of Faraday, took up this suggestion and worked out the electromagnetic theory for waves. Up to this time only the elastic ether was known and it only seemed to work on Mondays and Wednesdays and was thrown out the other days. But Hertz verified the mathematics of Maxwell by his experiments with the short radio waves. In 1873 Maxwell startled the world with his table of electromagnetic waves, since there were so many that he could not see. Now we have a table of sixty octaves of these waves. As the velocity of light is constant we can take for each octave one half the wave length of the wave before it on the table. This is the same as doubling the frequency as we do in sound waves for octaves. The ear has a range of eleven octaves. The eye only sees one octave. In this table we have 28 octaves of radio waves, 8 octaves of infra red waves, 1 octave of invisible waves, 8 of ultra violet waves, 8 of X rays, and 9 of gamma and cosmic rays. In this paper we will study these 8 octaves of X-rays. We find that they have all the properties of light waves.

The phenomenon of interference and diffraction was a great aid to prove that light was wave motion. In the same way we have this same phenomenon for X-rays. To measure the wave length of sodium light we use a diffraction grating and measure the distances between the slits and the angle theta. But with gratings it is difficult to get a slit distance less than five thousandths of a cm. But the wave length of X-rays are about ten millionths of a cm. Laue used crystal as a grating and had fine results in working out the equations.

Then they studied the spectra from these crystals as gratings. They found two different waves came from the same cathode. One gives a continuous spectrum like that of a heat wave. Plank's quantum theory, as will be explained in the symposium, was used to compute the wave lengths. Let h be Plank's universal constant ($6.54x10^{27}$), let V be the potential through which the cathode ray passes, and e the value of the charge on the electron as given by Millikan, then from the equation (h n=Ve) n can be found and from n (the frequency) the wave length can be found as the velocity is constant. This equation held both for electrons falling on matter and producing X-rays and for X-rays causing electrons to be emitted.

Superimposed on the continuous spectrum was the line spectrum. In 1913 Mosely worked out the table of elements, as we will hear in a paper. These lines depended on the material used as the anticathode. In 1905 Barkla found that the scattered X-rays from a plate bombarded by primary X-rays do not distribute themselves uniformly in a plane at right angles to the line of flight of the primary rays but tend to congregate in one particular plane, or the phenomena of polarization strengthened the proof that X-rays were wave motion. The wave theory was very helpful in explaining the phenomena of interference, diffraction and polarization, so it was natural to say that X-rays were waves.

But then new facts came to our knowledge that could not be explained by the wave theory. In the second part of the symposium we will discuss these phenomena that prove X-rays are particles. The first fact was the photoelectric effect. Electrons are driven out of a metal when light of a suitable wave length incident upon it contains the whole energy of the light quantum. The photon or light quantum explained the difficulty of how light filling the whole space gives its energy to a small atom. Then in 1923 Compton worked at the mutual action between an X-ray and an electron. In this Compton effect the X-ray acted like a particle, and seemed to have inertia and momentum.

According to the old classical theories it would be impossible for waves and particles to have all these properties in common. How bridge the gulf between the wave and the particle. Starting with the proof from diffraction and polarization that X-rays are electro magnetic waves we added Plank's suggestion that radiation is emitted in discrete units proportional to the frequency, and then added Einstein's photon. Goaded on by facts De Broglie seized both horns of the dilemma and made the theory of wave mechanics. We think of X-rays, when propagated, as electro magnetic waves, yet the energy of the X-ray is concentrated in the particles associated with the waves, and when the X-ray does something it does it as a particle.

Bibliography of Principal Sources for X-Ray Information

X-rays and Crystal Structure .... W. H. Bragg
Bell, '23

X-rays and Electrons .... A. H. Compton
Van Nostrand, '26

The Spectroscopy of X-rays .... M. Siegbahn, '25

Atomic Structure and Spectral Lines .... A. Sommerfeld
Dutton, '22

Atoms, Molecules and Quanta .... Ruark and Urey
McGraw-Hill, '30

The Structure of Line Spectra .... Pauling and Goudsmit
McGraw-Hill, '30

Modern Physics .... Theo. Wulf, S. J.
Dutton, '29

Ions, Electrons and Ionizing Radiations .... J. A. Crowther
Arnold, '24

X-rays .... G. W. C. Kaye, '23

Series Spectra .... N. R. Campbell, '23

The Structure of the Atom .... N. R. Campbell, '23

The Theory of Spectra and Atomic
Constitution .... Niehls Bohr, '23

On the Application of the Quantum Theory
to Atomic Structure .... Bohr, '25

Quantum Theory of Line Spectra .... Bohr, '18

Applied X-rays .... Geo. L. Clark
McGraw-Hill, '27

Introduction to Modern Physics .... Richtmyer
McGraw-Hill, '28

Philosophy and the New Physics .... L. Rougier
P. Blakiston Sons Co. Phila., '21

Origin of Spectra .... Foote and Mohler

Quantum Principles and Line Spectra .... J. H. Van Vleck

Treatise on Physical Chemistry .... Vol. 2, Taylor, '31

X-RAYS AND MEDICINE

REV. J. P. MERRICK, S.J.

(Abstract)

X-rays have a double function in medicine. First they are used to discover disease and abnormalities by radiography of the parts of the body. Second they are used as a therapeutic agent. The first has attained to a state of high perfection; the second is advancing slowly. The technique of the first was given, some radiographs were thrown on the screen and the resulting diagnosis outlined. The technique of localization of foreign bodies, of the opaque meal, and silver iodide catheter were explained. The so-called laws of X-ray therapeutics were enuntiated and analysed. After that therapeutic practice and conclusions were discussed and evaluated. Problems for future solution were proposed.

ROENTGEN'S DISCOVERY OF THE X-RAY

LAWRENCE M. BROCK, S.J.

(Abstract)

In the prime of life at the age of fifty-one Professor William Conrad Röentgen already had attained fame among physicists for his work in electricity and optics before his discovery of the X-Ray. Since so many erroneous accounts have appeared, chiefly in photographic journals about Röentgen's discovery, it seems worthwhile to repeat in Röentgen's own words how he discovered the X-Ray.

Professor Röentgen was asked in an interview that took place in his laboratory at Wurzburg the history of his famous discovery. "There is no history," he replied. "I had been interested for a long time in the problems of the cathode ray from a vacuum tube as studied by Hearzt and Lenard. I had followed theirs and other researches with great interest, and determined as soon as I had time to make some researches of my own."

"It was on the 8th of November in the year 1895 after working for some days that I discovered something new. There happened to be some barium-platino-cyanide on a bench near by, as I passed a current through a tube. I noticed a peculiar black line across the paper, an effect that could only be produced by the passage of light. However, no light could come from the tube since the shield that covered it was impervious to any light known, even that of the electric arc. I investigated still further. Assuming that the effect must come from the tube, since its character indicated that it could come from nowhere else, I tested this hypothesis. In a few minutes there was no doubt about it, for the rays were coming from the tube that had an aluminescent effect upon the paper. I tried it at greater and greater distances even at two metres. It seemed at first a new kind of light; it was clearly something new, something unrecorded." Is it light? "No," (for it could be neither reflected nor refracted). However, we shall see that later discoveries disproved this statement. Is it electricity? "Not in any known form." What is it? ''I do not know,'' said Professor Röentgen. ''Having discovered the existence of a new kind of ray, I, of course, began to investigate what it could do. It soon appeared from the tests that the rays had penetrative power to a degree hitherto unknown. They penetrated paper, wood, and cloth, with ease, and the thickness of the substance made no appreciative difference with reasonable limits. The rays passed through all metals, tested, with a facility, roughly speaking, (inversely) with the density of the metal."

"These phenomena I have discussed in my report to the Wurzburg Society, and you will find all the technical results therein stated." Such was Röentgen's account, given by word of mouth to his famous discovery.

It is a striking fact that in this narrative that Röentgen does not mention photography. Photography played no part in his original observations. Röentgen now perceived the possibility of photographs with his new ray and so experimented. He obtained a photograph of a set of metal weights that were shut up in a wooden box. Next of a compass, showing the needle and dial through the brass case. Then, placing the tube under the table, while he rested his hand on the table-top, he photographed it, obtaining for the first time a photograph of a living hand. It was the photography of the invisible.

As you were told in Röentgen's own words, his research began with the deliberate aim of re-investigating the problem of the emission of the cathode ray from the vacuum tube as studied by Heartz and Lenard. So as Lenard had done, he also employed an aluminescent screen to explore the rays and used a Crooke's tube similar to that employed by Lenard.

The vacuum tube with which Röentgen made his famous discovery in 1895 was pear-shaped, with a flat disc for the cathode, mounted in the body of the tube at its narrow end; the anode was in a small side tube. The cathode ray impinged on the large end of the tube and produced vivid fluorescence. Thus prepared, Röentgen found these mysterious rays which he called X-rays, but which will be best known as Röentgen Rays.

Röentgen now demonstrated that X-rays were only generated when the cathods ray struck matter. It was clearly seen that when cathode rays collided with matter that a great deal of heat was given off, while the remainder manifested itself as a disturbance in the ether, which we know as X-Rays. One important fact in Röentgen's discovery is often omitted, namely, that He obtained X-rays only after he had highly evacuated Crooke's tube.

Though Professor Röentgen admitted that he was at a loss to explain just what the X-Rays were, he strongly suspected that they were a form of light—but by his own experiments and those of others, this surmise seemed to be refuted. X-Rays could neither be polarized, refracted nor reflected. If they were light waves they should possess these characteristics. However, it has been recently shown that X-Rays have all of these characteristics. But even today the true nature of the X-Rays, whether they are light waves or quanta, is still in doubt.

PHOTOGRAPHY OF X-RAYS

Leo F. Fey, S.J.

(Abstract)

In the symposium on X-Rays, three practical applications of X-Rays were developed: Industrial Applications, X-Rays and Medicine and Photography of X-Rays. This paper dealt with the third application, the Photography of X-rays, or as it is better known, Radiography. The purpose of the paper was to answer the question "How do you make a good Radiograph?" It was stated that this question could be answered by telling how could be effected the four elements of a good radiograph, namely the minimum of distortion, sharp contrast, good detail and the proper radiographic density.

There are two kind of distortion, true and magnified distortion. The minimum of either distortion is obtained by the proper alignment of the film, the object and the focal spot of the X-Ray tube and also by the observance of the proper distances from the film, of the object and the focal spot.

By close attention to the timing of an exposure and the careful elimination of fog, comes sharp contrast. By timing is meant the combination of the actual time given an exposure, the amount of voltage supplied the X-Ray tube and the milliamperage used during the time of exposure. By carefully observing the rules for all three, good contrast can be effected. Fog is eliminated from the film, by stopping as much scattered radiation as possible. This is done, by enclosing the tube in a lead box, through which the rays cannot pass, and by the introduction of the Bucky Diaphragm.

The same factors that control distortion, distance of the object from the film, distance of the focal spot from the film and the alignment of the film, object and focal spot, are important in detail. In addition to these, the following have their effect on detail: the size of the focal spot, the non movement of the object film and tube, during the time of exposure and the use of intensifying screens.

Radiographic density is arbitrary, but it has to be controlable because of the necessity of duplicating films and of stereoscopic radiography. Density is effected by distance, time and voltage. The voltage or penetrating factor of the rays is most frequently used for the control of density, because of the very correct instruments available for the control and measurement of voltage and the duplication of any desired voltage. Radiographic density varies directly with the voltage.

X-RAY SPECTRA AND MOSELY'S LAW

James D. Loeffler, S.J.

The X-ray spectrum, in general, consists of a characteristic, or line, spectrum superimposed on a continuous spectrum. The wave-length of the lines is dependent solely on the material of the target, or anticathode, whence the rays proceed; their intensity is determined, for a given target material and tube current, by the voltage applied to the tube.

On the contrary, the wave-length characteristics of the continuous radiation, are quite independent of the material, and depend solely upon the voltage applied to the tube while the intensity of this radiation is dependent upon: a) the target material; b) the thickness of the target; and c) also on the voltage applied.

These facts were first demonstrated by Bragg, using crystals to diffract the rays. He used the fundamental equation described in the paper on crystal structure, and "d", the distance between the atom nuclei in the crystal of rock-salt, was first calculated from the known density of the substance, and has since been verified in other ways. From the diffraction obtained with such a grating-space, the wave-lengths of X-rays could be calculated, and, these known, the distances of the space-gratings of other crystals could be calculated with the same formula, by comparison of the rays diffracted with the latter.

Continuous Spectrum:— When moving electrons are stopped or retarded, energy is emitted. The more energy given up by the electrons, the higher the frequency of the radiation emitted. When an electron moving under a potential of, say, 20,000 volts, strikes the nucleus of an atom, it gives up all its energy at once, and the resultant emission of radiation is of the highest possible frequency for that voltage. We thus obtain a well-defined limit at the upper end of the continuous spectrum. Electrons retarded gradually, emit their radiation by discreet stages, the energy of the emitted radiation being proportional to the energy lost at successive stages. Hence the notion of discreet energy quanta is borne out, and the best determination of the value of the quantum is obtained from this phenomenon. For the energy of the moving electron, $\frac{1}{2}mv^2$, equals $hv=Ve$, by the quantum theory; the charge, e, on the electron has been accurately determined by Millikan; the applied voltage, V, is known; and the frequency, v, the maximum of the resulting radiation is readily obtained. This has been found to always be equal to $2.43x10^{14}$ multiplied by the voltage. Hence for any voltage applied we obtain the same accurate value for h, Planck's Constant.

Characteristic Spectrum:— For each element used as an anticathode there are a few well-defined lines of relatively great intensity in the spectrum. Barkla noticed that, while the spectra of different elements were similar, the frequencies of these lines increased as the atomic weight of the elements used became greater. Bohr sought the explanation of this in the atomic structure; he employed for his purpose Rutherford's Dynamic Atom Model, wherein electrons constantly rotated around a central nucleous, and applied the quantum theory to this. A remarkable fact was known which helped to strengthen the conviction that this was the proper method to follow, viz.: Before any substance would emit its characteristic rays the incident electrons must reach a precise critical velocity; below this there would be no effect whatever; above this critical value there would be no change until a certain higher critical velocity was attained, and then another line of slightly higher frequency would be added to the spectrum.

Bohr assumed a) The electrons revolving around the nucleus of the dynamic atom were not free to revolve in any orbits whatever, but only in a limited number, having definite paths and position with respect to the nucleus. b) If the atom receives energy from an outside source, it is taken up by these orbital electrons in definite quanta (only) which would be sufficient to send them revolving in one of the outer possible orbits. Unless the inner orbits are fully occupied the atom is in an unstable state. Hence when an electron has been ejected from one of these orbits another immediately falls in to occupy its place. This is accompanied by a corresponding loss of energy on the part of the incoming electron. If it falls from the L orbit to the K, or innermost orbit, its energy loss is L — K, where L and K signify the energy content of the two states. This energy, when emitted, causes the Kd line, as it is called, in the spectrum. A fall from M to K causes the emission of the Kb line; from M to L, the Ld line etc.

Bohr calculated the energy changes involved. The velocity of the orbital electron must balance the attractive forces between it and the nucleus. The formula for work done in moving a body from one stationary state to another, in ordinary laws of potential, is

$$W = q\left(\frac{1}{r'} - \frac{1}{r''}\right).$$

where q is the charge on a stationary body. In moving an electron from one energy level to another in an atom, the q of the above formula becomes Qe, the product of the charge on the nucleus with that on the electron. Since the atom is electrically neutral, the charge on the nucleus must be equal to an integral multiple of the charge on the electron. Hence Q may be represented by Ze where Z is an integer, and $Qe = Ze^2$. Also, the electron is not transferred from one stationary state to another, but to another orbit of motion. The potential energy lost in this change is only half of the kinetic energy emitted in the form of radiation, the other half going to increase the speed of the revolving electron in its new orbit. Hence the value Ze^2 must be divided by two in the formula. The resulting formula for emitted radiation, on the quantum hypothesis, should be

$$hv = \tfrac{1}{2}Ze^2\left(\frac{1}{a'} - \frac{1}{a''}\right), \text{ or } v = \frac{Ze^2}{2h}\left(\frac{1}{a'} - \frac{1}{a''}\right).$$

The number of possible orbits on the quantum theory were limited in such a way that, calling the first orbit a^1, the second orbit would equal 2_2a_1; the third, 3_2a_1, etc. Substituting in our formula, to represent a definite change from the third to the second orbit, of an electron, we get

$$v = \frac{Ze^2}{2h}\left(\frac{1}{2^2a'} - \frac{1}{3^2a'}\right), \quad \text{or} \quad v = \frac{Ze^2}{2ha'}\left(\frac{1}{2^2} - \frac{1}{3^2}\right).$$

Clearly, if we could find a value for the innermost orbit, we should be able to predict the frequency of emitted radiation. Bohr calculated this in many ways, always with the same result. One of these was the "Correspondence Principle", according to which the frequency of emitted radiation corresponds to the number of revolutions of the electron in its orbit. The radius of this orbit, a^1, could be worked out by Kepler's laws, since the attraction and mass of the particles were known.

Hence it was found that

$$a' = \frac{h^2}{4\Pi^2Ze^2m},$$

where m was the mass of the electron.

Substituting this in the above quotation, and letting R be the value of the known constants, we get

$$v = Rz^2\left(\frac{1}{n^2} - \frac{1}{m^2}\right); \qquad R = \frac{2\Pi^2e^4m}{H^3}.$$

In this formula m and n are integers, with mn.

Moseley's Law:—It was Moseley's endeavor to determine whether it was not nuclear charge instead of atomic weight that decided the nature of the characteristic Röentgen radiation. Employing a successively as anti-cathodes the elements from aluminium, No. 13, up to gold, No. 79, he measured the resulting X-rays by the then recently discovered method of crystal reflection. The rays measured covered a range of from .4 to 8 Angstrom units, and included the K and L series of lines for these elements.

The most striking thing in these photographs was the great regularity of the spectra. Each element had a spectrum for these lines identical with that of the preceeding element, except that the wave-lengths were changed. As he proceeded from the lighter to the heavier elements, the wave-lengths of the corresponding lines were shortened by a constant decrement.

In the two formulas,

$$\text{for the K series, } v = Rz^2\left(\frac{1}{1^2} - \frac{1}{m^2}\right)$$

$$\text{and for the L series, } v = Rz^2\left(\frac{1}{2^2} - \frac{1}{m^2}\right),$$

the only change was in the integer z, as he went from one element to the next, and this increased regularly by one unit, allowing a few gaps for elements as yet undiscovered. The atomic weights of the elements did not vary in this regular manner and Moseley showed that the only variable to explain this regularity, was the net positive charge on the nucleus of the atom. This therefore was what z, which he called the atomic Number, represented. Beginning with No. 1 for hydrogen, and continuing with No. 2 for Helium etc., he declared that the correct line for any element could be found by inserting the Atomic Number, always integral, in the proper formula for that line.

The law has been borne out by experiment, and has proved very useful in interpreting X-ray spectra (on the quantum theory), the structure of atoms, the fundamental relationships between the atoms, in the identification of elements in unknown solids (compounds or mixtures), and in the discovery of the missing elements such as Hafnium, Masurium, Rhenium and Illinium, which were first identified in this way. One much-discussed conclusion was that all elements are constructed of the same building units in definitely progressing complexity.

Bibliography

Modern Physics .... Tho. Wulf, S. J.
X-rays and Spectral Lines .... A. H. Compton
Atomic Structure and Spectral Lines .... A. Sommerfeld
Introduction to Modern Physics .... Richtmyer
Ions, Electrons and Ionizing Radiations .... Crowther
The Structure of the Atom .... Andrade
Outline of Physical Chemistry, vol. II .... Taylor

X-RAYS AND THE QUANTUM THEORY

BERNARD F. DOUCETTE, S.J.

(Abstract)

This paper will be only a brief outline of the part X-rays have taken in giving evidence in favor of the quantum theory. We know that the quantum theory originated as an explanation of the peculiar spectra of black-body radiation and of the specific heat phenomena of matter at low temperatures. Since then the theory has been confirmed by further evidence and part of this is due to phenomena connected with X-rays.

One question regarding quanta concerned their propagation. According to the theory they were like particles sent off into space and proceeding in straight lines. Very fine particles of bismuth were placed in the path of very weak X-rays and it was found that they would eject electrons known by an increase of charge. These particles were between $1x10^{6}$ and $5x10^{5}$cm in diameter, and were placed between the plates of a Millikan condenser, the lower plate of which was the anticathode of the small X-ray tube. These experiments only tell us that if quanta exist, they are as small as these particles, and not larger. They tell us nothing about the manner of collecting energy on the part of the receiving particle.

Another series of experiments give us an idea of the length of quanta in the direction of propagation. The method consists in a very rapid interruption of a beam of light. Two crossed Nicol prisms have two Kerr cells placed between them. Kerr cells consist of condenser with a suitable organic liquid between them. An electric field across these condenser plates will change plain polarized light to elliptically polarized light. When the fields of the two cells are equal, no light can pass through, but when the fields differ, then the elliptically polarized light from the first cell is not compensated by the second and there is a component which can be transmitted by the second Nicol prism. By means of light frequency alternating current, these cells form an electro-magnetic shutter which was operated as fast as 10^{9} times per second. With this apparatus, and utilizing light "waves" instead of X-rays, it seems that the so called quanta are not over a few centimeters in length, if even that long.

One of the important confirmations of the quantum theory is the excellent explanation it gives of the photo-electric effect. Briefly, this phenomenon is the release of energy from a metal when it is illuminated. Ultra-violet and X-rays are the ordinary means of illumination. There is no necessity of describing the photo-electric effect in detail yet there is one aspect that should be considered. Whether weak or strong X-rays fall upon the metal, the electrons escape at the same velocity. Strong X-rays may cause more electrons to be ejected, but the velocity of emission does not depend upon the intensity of the illumination. The quantum theory does not explain this aspect of photo-electric phenomena. To

do so would mean explaining, in an analogous sense, how a plank dropped 100 feet upon the smooth surface of a lake caused waves to travel a considerable distance and then strike another plank with enough force to rise above the water. But, the positive results of explaining the photo-electric effect are important, and due to such explanations, a method of measuring Planck's constant was derived. The value obtained is in close agreement with other determinations.

Corresponding to the photo-electric effect is the inverse photo-electric effect. If radiation falling upon a metal allows electrons to escape, then electrons should cause radiation when they bombard a metal. We have this phenomenon in all X-ray tubes.

We have very interesting results of the study of X-ray scattering. This happens when X-rays fall upon matter and part of the energy is absorbed and the rest is scattered. Absorption occurs in the phenomena of fluorescence where the matter is so changed that it can emit radiation at a frequency different from the incident X-rays. The scattering of X-rays however, is not easily explained without the help of the quantum theory. The Compton effect requires unidirectional quanta for its explanation. When X-rays fall upon a metal or other suitable substance and the so-called "reflected" beam is then examined by an X-ray spectrometer, a radiation of a new sort is found and is due to the encounters between the original radiation and the free electrons, as Compton explained it. With the help of this phenomenon, another method for determining the value of Planck's constant was developed, which, when measured, closely agreed with other determinations.

X-ray spectra of various metals are very interesting and are explained easily by the assumptions of the quantum theory. The spectra show the existence of different "energy levels" as they are called, and these give strong evidence of the existence of quanta. Also, on the photographic plates used for X-ray spectra, there is further evidence of the existence of quanta, namely the peculiar action of the silver bromide in the emulsion on the plates. There were found, in all exposed silver bromid plates, two definite changes in the darkening of the plates, always at the same frequency. These changes were explained as the absorption limits of silver and bromide, that is, the frequencies where the quanta can eject electrons in the silver or the bromide of the emulsion. Other light-sensitive substances were used and similar changes in density were found, peculiar to each substance. The quantum theory explained these phenomena very easily.

In this paper, a detailed explanation of all phenomena involving the quantum theory cannot be given. All that can be done is to indicate the various phenomena which confirm the quantum theory, and in these, X-rays have had an important part. This is evidence that X-rays are made up of quanta, but the final undeniable proof that they are so constituted has not been presented yet. Whether or not it will be presented is a question to be answered in the future.

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Brown, Rev. Thomas J., 1922, St. Joseph's College, Philadelphia, Pa.
Butler, Rev. T. J., 1922, Weston College, Weston, Mass.
Carroll, Anthony G., 1929, Holy Cross College, Worcester, Mass.
Coyle, Rev. George L., 1922, Georgetown University, Washington, D. C.
Gisel, Rev. E. A., 1925, San Andra, Levanttal, Karnten, Austria.
Doino, F. D., 1930, Woodstock College, Woodstock, Md.
Ecker, Anthony D., 1931, St. Peter's College, Jersey City, N. J.
Gorman, L. G., 1926, Woodstock College, Woodstock, Md.
Hauber, Edward S., 1929, Loyola College, Baltimore, Md.
Hohman, Rev. Arthur J., 1922, St. Peter's College, Jersey City, N. J.
Landrey, G. M., 1930, Holy Cross College, Worcester, Mass.
Langguth, Rev. A. B., 1924, Holy Cross College, Worcester, Mass.
MacLeod, Rev. H. C., 1924, Winchester Park, Kingston, Jamaica, B. W. I.

McCullough, Rev. H. B., 1923, Ateneo de Manila, Manila, P. I.
McGuinn, A. F., 1931, Fordham University, New York, N. Y.
Molloy, J. J., 1929, Georgetown University, Washington, D. C.
Moynihan, J. J., 1930, Holy Cross College, Worcester, Mass.
Muenzen, Rev. J. B., 1923, Fordham University, New York, N. Y.
Power, Rev. F. W., 1924, St. Andrew-on-Hudson, Poughkeepsie, N. Y.
Schmitt, Rev. R. B., 1923, Loyola College, Baltimore, Md.
Smith, F. M., 1931, Brooklyn Preparatory, Brooklyn, N. Y.
Strohaver, Rev. Geo. F., 1922, Holy Cross College, Worcester, Mass.
Sullivan, Rev. Joseph J., 1923, Boston College, Boston, Mass.
Tivnan, Rev. E. P., 1923, Boston College, Boston, Mass.
Wolff, Edmund J., 1926, Weston College, Weston, Mass.

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Chairman, Rev. George A. O'Donnell, St. Louis University, St. Louis, Mo.
Secretary and Sub-Editor of the Bulletin, Peter J. McKone, Boston College, Boston, Mass.

Members

Barry, Rev. T. D., 1926, Weston College, Weston, Mass.
Berry, Rev. E. B., 1922, Georgetown Prep. School, Garrett Park, Md.
Carasig, Rev. P. M., 1923, Manila Observatory, Manila, P. I.
Cusick, W. H., 1928, Weston College, Weston, Mass.
Dawson, Rev. J. F., 1922, St. Joseph's College, Philadelphia, Pa.
Depperman, Rev. C. E., 1923, Manila Observatory, Manila, P. I.
Doucette, Rev. B. F., 1925, St. Andrew-on-Hudson, Poughkeepsie, N. Y.
Dutram, F. B., 1931, Holy Cross College, Worcester, Mass.
Fey, Leo F., 1926, Woodstock College, Woodstock, Md.
Fitzgerald, Paul, 1930, Canisius High School, Buffalo, N. Y.
Gipprich, Rev. J. L., 1922, Georgetown University, Washington, D. C.
Kelly, Rev. Joseph M., 1922, Loyola High School, Baltimore, Md.
Kennedy, Rev. W. W., 1923, Boston College, Boston, Mass.
Logue, Rev. L. R., 1923, Holy Cross College, Worcester, Mass.
Long, Rev. J. J., 1924, St. Andrew-on-Hudson, Poughkeepsie, New York.
McCormack, Rev. J. T., 1923, Weston College, Weston, Mass.
McGowan, G. P., 1928, Woodstock College, Woodstock, Md.
McLaughlin, Rev. T. L., 1923, Winchester Park, Kingston, Jamaica, B. W. I.
McNally, Rev. P. A., 1923, Georgetown University, Washington, D. C.
Murray, J. L., 1928, Weston College, Weston, Mass.
Nuttall, Rev. E. J., 1925, Woodstock College, Woodstock, Md.
O'Callahan, J. T., 1929, Weston College, Weston, Mass.
O'Donnell, Rev. George A., 1924, St. Louis University, St. Louis, Mo.
O'Laughlin, Rev. F. D., 1923, Fordham University, Fordham, N. Y.

Phillips, Very Rev. E. C., 1922, 501 East Fordham Road, N. Y.
Quigley, Rev. T. H., 1925, Weston College, Weston, Mass.
Repetti, Rev. W. C., 1922, Manila Observatory, Manila, P. I.
Roth, Rev. A. C., 1923, St. Andrew-on-Hudson, Poughkeepsie, New York.
Roth, Rev. C. A., 1923, St. Andrew-on-Hudson, Poughkeepsie, New York
Smith, Rev. J. P., 1923, St. Peter's College, Jersey City, N. J.
Sheehan, W. D., 1928, Weston College, Weston, Mass.
Sohon, Rev. F. W., 1924, St. Andrew-on-Hudson, Poughkeepsie, N. Y.
Sweeney, J. J., 1930, Boston College High School, Boston, Mass.
Wessling, Rev. H. J., 1923, Boston College High School, Boston, Mass.

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Members

Berry, Rev. E. B., 1922, Georgetown Prep. School, Garrett Park, Md.
Brock, Rev. H. M., 1922, Weston College, Weston, Mass.
Brock, L. M., 1930, Holy Cross College, Worcester, Mass.
Crawford, Rev. W. R., 1924, Boston College High School, Boston, Mass.
Daley, Rev. J. J., 1930, Boston College High School, Boston, Mass.
Dawson, Rev. J. F., 1923, St. Joseph's College, Philadelphia, Pa.
Delaney, Rev. E. P., 1923, Canisius College, Buffalo, N. Y.
Depperman, Rev. C. E., 1923, Manila Observatory, Manila, P. I.
Doherty, J. G., 1930, Weston College, Weston, Mass.
Doucette, Rev. B. F., 1925, St. Andrew-on-Hudson, Poughkeepsie, N. Y.
Dowd, A. V., 1930, Woodstock College, Woodstock, Md.
Dutram, F. B., 1931, Holy Cross College, Worcester, Mass.
Fey, Leo F., 1926, Woodstock College, Woodstock, Md.
Frohnhoefer, Rev. F. R., 1926, St. Francis Xavier High School, New York, N. Y.
Gipprich, Rev. J. L., 1922, Georgetown University, Washington, D. C.
Hearn, Rev. J. R., 1925, Woodstock College, Woodstock, Md.
Heyden, F. J., 1931, Ateneo de Manila, Manila, P. I.
Kolkmeyer, Rev. E. J., 1922, Georgetown University, Washington, D. C.
Linehan, Daniel, 1931, Holy Cross College, Worcester, Mass.
Loeffler, J. D., 1929, Boston College High School, Boston, M,ass.
Logue, Rev. W. G., 1923, Woodstock College, Woodstock, Md.
Love, Rev. T. J., 1923, Loyola College, Baltimore, Md.
Lynch, Rev. J. J., 1925, Fordham University, New York, N. Y.
Mahoney, Rev. J. B., 1925, Manila Observatory, Manila, P. I.
McGowan, G. P., 1928, Woodstock College, Woodstock, Md.
McKone, P. J., 1931, Boston College, Boston, Mass.

McNally, Rev. H. P., 1922, Canisius High School, Buffalo, N. Y.
Merrick, Rev. J. P., 1923, Holy Cross College, Worcester, Mass.
Miley, Rev. T. H., 1923, St. Joseph's College, Philadelphia, Pa.
Miller, W. J., 1931, Georgetown University, Washington, D. C.
Moore, Rev. T. H., 1923, St. Joseph's College, Philadelphia, Pa.
Murray, J. L., 1928, Weston College, Weston, Mass.
Nuttall, Rev. E. J., 1925, Woodstock College, Woodstock, Md.
O'Callahan, J. T., 1929, Weston College, Weston, Mass.
O'Conor, Rev. J. S., 1928, Georgetown University, Washington, D. C.
O'Loughlin, Rev. F. D., 1923, Fordham University, New York, N. Y.
Phillips, Very Rev. E. C., 1922, 501 E. Fordham Road, New York, N. Y.
Quigley, Rev. T. H., 1925, Weston College, Weston, Mass.
Rafferty, Rev. P., 1923, Fordham University, New York, N. Y.
Rohleder, C. H. J., 1931, Woodstock College, Woodstock, Md.
Roth, Rev. A. C., 1923, St. Andrew-on-Hudson, Poughkeepsie, N. Y.
Roth, Rev. C. A., 1923, St. Andrew-on-Hudson, Poughkeepsie, N. Y.
Sheehan, W. D., 1928, Weston College, Weston, Mass.
Smith, Rev. J. P., 1923, St. Peter's College, Jersey City, N. J.
Sullivan, Rev. D. H., 1923, Boston College, Boston, Mass.
Tobin, Rev. J. A., 1923, Boston College, Boston, Mass.
Tynan, J. A., 1926, Woodstock College, Woodstock, Md.
Walsh, L. J., 1931, Loyola College, Baltimore, Md.