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A. M. D. G.

BULLETIN

of the

American Association of Jesuit Scientists

(Eastern Section)

Published at

LOYOLA COLLEGE

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EASTERN STATES DIVISION

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SCIENCE AND PHILOSOPHY

SCIENTIFIC DEFINITIONS

Rev. Joseph P. Kelly, S.J.

Man is an interpreter of Nature. In the material creation he alone has an intellect and he alone can offer a rational analysis of the world in which he lives. In this sense, man is the measure of all things. In multitudinous ways Nature manifests its activities, its qualities and attributes; man gropes about trying to express adequately what he perceives. I say "gropes about" advisedly because the human mind has but a limited capacity for knowledge. Our modern scientists claim that they have learned humility in dealing with the universe. It is only another way of admitting the imperfection of the mind. Man is unable to find words by which he can distinguish those delicate shades of difference in natural phenomena. Our thoughts are the mental counterpart of the world. They are representations of reality. Words are the outward expression of our ideas. Language like life should be dynamic. A static language is dead and stagnant. It has neither fecundity nor growth. When new facts are discovered, new properties are found, we can say that Nature is growing, it is expanding and developing. A satisfactory understanding of this demands a corresponding evolution of thought and language. All three, evolving nature, thought and language grow apace. In a simple civilization, the elements which compose it are few. Hence a small number of concepts suffice for its comprehension; a limited vocabulary will permit a satisfactory exchange of thought. In a growing society the multiplicity of parts demand new factors, new ideas and a proportional fecundity of language. Otherwise the old "lingual-order" becomes too narrow and cramped to meet the increasing needs of the mind. The same principle holds true for any branch of knowledge in the process of development.

A problem of this sort exists today in the realm of Natural Sciences. For more than half a century new scientific discoveries have come to light with astonishing rapidity. They have constituted a veritable revolution in our outlook on the physical world. But concepts and terms, so useful and adequate for Classical Physics, have been found wanting in the realm of Atomic Physics. The laws of Newtonian Mechanics do not meet the needs of Quantum Mechanics.

The scientist is face to face with a multitude of previously unknown phenomena. He is burdened with the task of explaining them and reducing them to a system. The work is indeed gigantic and perhaps this is one reason why men of science have not found time to coin new words to describe their newly-found world. As a consequence, they have been compelled to use a terminology already consecrated by common use among men. When these current words are applied to the data of modern science, they do not quite fit the situation. They do not express exactly what has been found. For example, in the new physics we meet the term, "wave". Yet we are constantly warned not to try to identify this new concept with the material wave, e.g. water wave of Classical Physics. Thus the resourceful scientist must introduce a **new definition**, limited in its meaning, to an existing word. The process is not unwarranted. The term "New Deal" certainly has acquired a signification peculiar to our times. The situation in science has given birth to what might be called "double barrelled" words—words which have one definition in science and another in ordinary life or in Philosophy; again one meaning in one branch or period of science and a different signification in another, as we saw in the term "wave". We cannot justly deny the scientist the right to invent new concepts or new definitions, provided, of course, that the validity of these new creations be clearly understood and maintained in their proper spheres. The proviso is necessary since there is a tendency among a certain group to make science the ultimate criterion of all knowledge. That this position cannot be maintained is admitted even by many scientists like Planck, Eddington, etc. (1) Eddington "New Pathways of Science", p.65; Heisenberg, "The Physical Principles of the Quantum Theory", p.65.

These "double-barrelled" words are responsible for some of the apparent misunderstandings between the philosopher and the scientist. They are only apparent for, if we examine carefully the scientific definitions **from the scientific point of view**, and the definitions of the philosophers **in their philosophical aspects**, most of the problems disappear. This process is but the dictate of common sense. We all realize that if wordy disputants were to outline clearly their initial positions, many discussions would never take place and many quarrels would die aborning. But then, life might lose one of its joys. None the less, we would express a pious wish for the existence of a body of scientific coadjutors—"language creators"—whose office would be to coin new terms and definitions in keeping with fresh facts and theories of science. This might help to eliminate in some measure a perennial source of confusion.

Lest our thesis end in a purely abstract discussion, we will confirm the preceding by an example. The notion of causality is receiving much prominence today in both scientific and non-scientific circles. It is one of those "double-barrelled" words which the philosopher uses in one sense and the scientist in another. What I want to show is this: that if we perceive clearly the difference between these two definitions we will see that the admission, denial or change of the scientific notion will not radically affect the philosopher's concept. The problem is confined to efficient causality, in order to keep it on common ground. In the traditional, philosophical sense, a cause denotes a physical agent, which by its action brings into existence something that previously did not exist. Causality is that necessary connection between a cause and its effect. The typewriter which I am using could come into existence only through some physical agent which produced it. We here prescind from the question of miracles. Neither the typewriter nor any other material being is capable of producing itself. So that when any object begins to exist, some cause must be sought which will explain why this being began to be. Very few, if any scientists would deny this legitimate concept of the philosopher. Most will subscribe to this position, as expressed by Eddington: "the denial of determinism, or as it is often called, the "law of causality', does not mean that it is denied that effects may proceed from causes. The common regular association of cause and effects is a matter of experience."2)

When the scientist, speaking scientifically, talks of cause and causality he has something else in mind. "An event is causally conditioned if it can be predicted with accuracy."3) I do not mean to assert that the scientist identifies conceptually these two notions. But, for practical purposes he uses predictability for causality. Planck in the essay just cited affirms this. The philosopher admits an intimate connection between predictability and necessary causes. It logically follows, if the necessary, non-free cause is sufficiently known. Very little reflection is required to grasp the distinction between these two definitions.

When, therefore, we read that science denies causality or that the New Physics has overthrown the principle of causality, our first question should be: does the denial fall on the definition of the scientist or that of the philosopher? May not the rejection of the **scientific causality** or predictability leave intact the philosophical concept? The philosopher would unhesitatingly answer in the affir-

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2) Eddington: "New Pathways of Science", p. 74. Cf. also p. 296.

3) Planck: "Causality in Nature", Cf. Crowther: "Science for a New World", p. 347. This point of view is confirmed by Eddington: "Determinism means predetermination." In the light of this predetermination of natural events Laplace imagined "an intelligence who from the present state of the universe could foresee the whole future progress down to the slightest atom." Eddington op cit, p. 76.

mative. I believe this would follow from the words of Eddington. (4) Of course the man-in-the-street may not realize the two-fold meaning of the term causality. From the too popular work of scientists or from the Sunday-supplement scientist, he might suppose that some new fact has been discovered which leads to the denial of causality, as he understands it. For, his notion is apt to be more like the philosophical idea than the scientific. Perhaps that is his misfortune. Scientific causality has not been promulgated sufficiently for common use. Hence in ordinary parlance, when one speaks of "cause," we are inclined to understand it in the sense of an "agent" or something that in some manner has an influence on the existence of the new being. I believe that the use of the term **cause**, with reference to the **predictability** notion, would would be rather rare. In this, we are not throwing blame on the scientist because he has retained the practical identity between causality and predictibility. That is an inheritance from his forebears who believed more in the absolute divorce between science and philosophy. The notion of cause as a productive agent belongs by prior rights to philosophy. In the interest of clear thinking, we might propose to an enterprising young mind, the task of inventing an appropriate word to express the scientific concept of cause in its relation to prediction. (5)

When the scientist undertakes to interpret natural phenomena through a process of measurement, the meaning of a physical quantity will be bound up with the method by which it is measured. It follows that scientific concepts and definitions will be couched in quantitative terms. This is the logical consequence of the scientific outlook. It is **one** point of view, legitimate in its sphere but by no means all-comprehensive. "We recognize that the type of knowledge after which Physics is striving is much too narrow and specialized to constitute a complete understanding of the environment of the human spirit. A great many aspects of our ordinary life take us outside the outlook of Physics. For the most part no controversy arises as to the advisability and importance of these aspects. We take their validity for granted and adapt our life to them without any deep self-questioning."6) Hence our discussion of scientific definitions and terms should be based on the recognition of the limitations and view-point of science. In other words, we should realize

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4) Though one reads in scientific literature that "causality has been overthrown" or "science denies causality," I believe that Eddington expresses it more correctly when he says that "physical science is no longer based on determinism."

5) A fuller development of the relation between scientific and philosophical causality may be found in: "Nature's Laws and the Principle of Causality." Jesuit Science Bulletin, Dec. 1935. March, 1938.

6) Eddington, op. cit. p. 316.

that a definition may be legitimate and satisfactory in the narrow confines of the Natural Sciences but not in the broad field of Philosophy. Among the various experimental sciences, a definition varies according to the object of the particular sciences. If applied to the field of Philosophy the difference may be very much greater, because of the more universal scope of the philosopher. Our criticism should take into account the purpose and scope of all fields. In other words, we may judge a definition in the light of the universal principles of metaphysics or accepting the assumption of a particular science, we man consider its consistency with the foundations of that science. Since we are dealing with a many sided nature, "we must be prepared to accept the fact that a complete elucidation of one and the same object may require diverse points of view which defy a unique description".7) Many centuries ago, St. Thomas Aquinas echoed the same thought when he asserted that "each of the sciences, according to its special consideration, deals with one aspect of being."8) Accipit enim unaquaeque scientiarum unam partem entis secundum specialem modum considerandi.

7) Bohr, "The Atomic Theory and the Description of Nature". p. 96.

8) St. Thomas de lib. Boetti de Trinitate, q. 5, art. 1, ad. 6.

BIOLOGY

TWO METHODS FOR SMEAR PREPARATIONS OF ROOT TIPS

JOSEPH E. SCHUH, S.J.

Warmke[1] and Heitz[2] have described methods for making smear preparations of root tips which we have tried at Woodstock and found very successful. The preparations are especially favorable for the study of chromosome numbers and mitosis. Warmke uses the ordinary aceto-carmine technique and Heitz the Feulgen reaction. While the results of both methods were highly satisfactory, the Heitz preparations were preferable due to the superior fixative and stain. There follows a brief summary of both procedures.

I

Warmke's Aceto-Carmine Smear Method

1. Kill and fix the root tips in glacial acetic acid and absolute alcohol (1:3). (12 hours or more)
2. Transfer to a solution of 95% alcohol and concentrated HCl. (1:1) (5 - 10 minutes)
   This mixture dissolves the pectic substances of the middle lamella, thereby allowing the individual cells to separate with the application of pressure.
3. Place in Carnoy's fluid (with chloroform). (5 minutes)
   This hardens the tissue which the HCl treatment has more or less softened.
4. Stain in a small drop of iron-aceto-carmine on a clean slide. (In this and all other smear preparations which are to be made into permanent slides, it is well to spread a drop of albumen fixative on the slide before making the smear.)
5. Cover with a cover slip. With a blunt instrument press gently on the cover slip to flatten the cells to a single layer.
6. Seal the cover slip with paraffin.
   The slides will keep in this condition for a week or ten days.

These temporary preparations may be made permanent by the McClintock permanent method[3] or the one outlined below which was used at Woodstock by Rev. C. A. Berger, S.J. The latter method is simpler and equally efficient. It is as follows:

1. Scrape off as much of the paraffin as possible from the slide without removing the cover slip and place the slide in 45% acetic acid **vapor.** (Several hours)
2. Change to 95% alcohol **vapor.** (Several hours)
   The first step may be omitted and the slides placed directly in the 95% alcohol **vapor.**
3. Float-off the cover slip in a petri dish containing 95% alcohol.
4. Dehydrate in 95% and absolute alcohols and Xylol. (15 minutes—1 hour in each)
5. Mount in Balsam.

II

Heitz's Nucleal-Smear Method

(Nukleal-Quetschmethode)

1. Fix the root tips in chromo-osmic acid. (15 minutes)
   Heitz gives no definite formula for this fixative. We used Fleming's strong formula without acetic acid[4] and had favorable results. It consists of 15 parts of 1% chromic acid to 4 parts of 2% osmic acid.
2. Remove from the fixative; place on a piece of filter paper and transfer to N/HCl at 60° to hydrolyze. (10—20 minutes)
3. Change to water. (2—3 minutes)
4. Place in Feulgen stain[5]. (20—30 minutes)
5. Transfer to a large drop of 45% acetic acid and cut the root tip into small pieces.
6. Prepare sufficient clean slides with albumen fixative and a small drop of acetic acid (or water) and place a small piece of the root tip in each.
7. Cover with a cover slip and apply gentle pressure to spread the cells to a single layer.
8. Seal with paraffin and make permanent as in the first method.

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1. Stain Technology, **10**, 101-3. 1935
2. Ber. d. Deutsch. Bot. Gesellschaft, 53, 870-8. 1936
3. Stain Technology, 4, 53-6. 1929
4. Lee—**Microtomist's Vade-Mecum**, Ninth Edition, p.37. 1928
5. cf. Lee for formula.

THE ANTIRACHITIC VITAMIN

ALFRED J. KILP, S.J.

While civilization at large was recuperating from the devastating effects of the World War, there came forth from an English laboratory one of the first experimentations with the antirachitic factor. It was declared by the scientist Mellanby that cod liver oil and butter fat had successfully prevented the disorder in puppies reared on a diet of cereal and milk. He was firmly convinced that the disease was due to the lack of certain elements of nutrition—the absence of the antirachitic factor which was either fat soluble A, or something that has a similar distribution to fat soluble A. This led many to the conclusion that rickets could be prevented by Vitamin A. However, difficulties gradually arose which confused the conclusion.

During 1920 Hess and Unger experimented and learned that infants who have been fed with sufficient vitamin A and milk had developed rickets. Scientists then began to offer a Babel of solutions. This led the way for the search for Vitamin D.

The first real evidence for Vitamin D was offered byMcCollum in 1922. He showed that cod liver oil oxidized from 12-20 hours will not cure xeropthalmia (a dry and thickened condition of the conjunctiva leading to a lustreless appearance of the eyeball) in rats, which function was already attributed to Vitamin A. Nevertheless, calcium will be deposited in the bones in immature rats afflicted with rickets. This proved that oxidation can destroy fat soluble A without doing away with another factor which contributes much to the growth of bones. This and other similar experiments gave enough evidence to show whether particular fats, by possessing something distinct from Vitamin A, have the potency of curing rickets. Thus a fourth vitamin exists which man deposit calcium provided enough calcium and phosphorous are found in the diet. This vitamin was then called Vitamin D.

Vitamin D has been frequently called the "Sunshine Vitamin". It is so called because in nature it is probably produced in this manner. Chemically it has been found that cholesterol precedes Vitamin D. When irradiated with ultra-violet light, an isomere of cholesterol was produced. This isomere was Vitamin D. Experiment proved that, after all purifying processes had been tried, cholesterol was always found mixed with another sterol, ergosterol. This sterol was then considered the true pecursor of Vitamin D, because, when used in a pure state, very much antirachitic potency was available.

We find that in nature Vitamin D is prepared by irradiation. Thus when a case of rickets needs treatment, the patient is frequently exposed to the sun. The ergosterol of the tissues is activated by the solar rays to form Vitamin D.

As for the sources of Vitamin D in nature, the best are found in the fish liver oils. It is interesting to note that the only valuable fish oils are those of the Teleost or bony fishes. The Elasmobranch liver oil is useless for Vitamin D content. This is logical inasmuch as they have a cartilaginous skeleton, and consequently, no Vitamin D is required for the making of a hard bony framework.

Experimenters have proven that the fish liver oils usually contain an excess of Vitamin D. This comes from the food material of the fish which is composed of minute marine animals called Plankton. These small forms float on the surface because of their oily content. By a process of irradiation the Plankton tissues become very abundant in the antirachitic factor. When ingested by the fish, in excess amounts, the liver oil storage of Vitamin D then occurs.

Much research with the antirachitic factor has been carried on by the vitamin assay department of Loyola University of Los Angeles. All work is supervised by Professor Harold Harper, head of our biology department. Numerous experiments have been performed for some of the nationally famous vitamin food companies.

The method used for the Vitamin D test is known as the Line Test, with the white rat used as the experimental animal. Ossification of the long bones always takes place from certain centers. Since histological changes are more evident in the tibia, the metaphysis acts as this center. We find that the young rat fed on a rachitogenic diet will soon develop a decalcification of the metaphysis and clinical evidence of rickets is apparent. If at this time an effective antirachitic is administered, a line of calcification or bone healing will be established in the metaphyseal matrix.

With carefully controlled experiments we are now able to produce animals that can be made rachitic 18 days after the commencement of rachitogenic diet. Then all of the animals are confined to individual cages in order that their food consumption and the antirachitic substance can be individually regulated. A standard test period of 11 days follows, during 8 days of which, the antirachitic substance is administered. There are various methods by which the degree of healing can be gauged. Unit healing, which is a narrow continuous line of calcification across the metaphysis, is termed three plus healing. A wider line which also tends to the diaphysis of the bone is four plus healing. Lower grades are designated as two and one plus healing, with complete rickets at zero.

While science has accomplished much during the past 20 years in vitamin study, many treasures of their complete understanding remain to be revealed. May interested workers soon be able to pronounce the magic words of "Open Sesame" and enter to explore thoroughly these all-important vitamins.

CHEMISTRY

RADIUM: THE EXTRAORDINARY ELEMENT

REV. RICHARD B. SCHMITT, S.J.

Do you know that:

Radium was not known forty years ago.

Radium is the most costly and most precious of all known substance.

Gold is thirty-five dollars an ounce; the same amount of radium would be worth one million and five hundred thousand dollars.

The price of radium to-day is seventy thousand dollars a gram.

Radium is the most difficult of the elements to wrest from nature.

Radium emits 250,000 times as much heat as an equal amount of coal.

Radium transmutes itself into another element—lead.

On January 4, 1896, William Conrad Roentgen announced to the Berlin Physical Society that he had discovered radio-activity. No word was available for this phenomenon, and so it was called: X-ray.

Antoine Henri Becquerel missed the opportunity to become the discoverer of radium. Unknowingly he placed a piece of uranium ore on a photographic plate. Two weeks later he wished to use the sensitized plate; when the plate was developed, he found it was **light struck** in the center portion and not on the edges. He realized that the **light struck** portion was approximately the size of the uranium ore. He concluded the uranium ore had given off invisible rays.

Becquerel found that pitchblende from Bohemia gave off radiations. He concluded it would take much time and labor to solve the problem of what metal was producing this effect. He was too busy with other researches; so he put the problem aside.

Manya Sklodovska, a Polish girl, at this time was seventeen years old. Her one ambition was science, so she willingly worked in her cousin's chemical laboratory in Warsaw.

At the age of twenty-four Manya Sklodvoska, because of political unrest in her native land, went to Paris to complete her education. At this time she decided to sign her name as Marie, instead of Manya.

Marie Sklodovska lived in a garret on frugal meals in order to persue her education at the Sorbonne.

In 1894, Marie Sklodovska met Pierre Curie at the home of a mutual friend. On July 26, 1895, Marie Skodlovska married Pierre Curie.

Becquerel selected Marie Curie to undertake the arduous research to discover the unknown element. Money was borrowed to buy a ton of pitchblende from Austria. In their poverty, they carried on their work of research in a shed; and this work continued for four years. Many difficulties beset their path, illness, poverty, lack of resources, but no discouragement.

In 1899 radium salts were prepared for the first time in the history of the world.

In 1902 Marie Curie prepared a decigram of pure radium and determined the atomic weight as 225.

From 1899 to 1904, Marie Curie published thirteen papers on the physical, chemical and physiological properties of radium.

The emanations of radium penetrate almost all substances, except lead. Radium emanations are two million times stronger than that of uranium.

Radium spontaneously gives off heat. Its temperature can go up ten degrees higher than the surrounding atmosphere.

Radium makes the atmosphere a conductor of electricity.

Radium colors the glass container in which it is kept. It corrodes the paper and cotton wool in which the tube is wrapped.

The luminescence of radium is very beautiful. It gives off sufficient light to read in a dark room.

The real diamond is made phosphorescent by the action of radium, and so distinguishes the true from the false diamond.

Radiations from radium are contagious. Any object, a plant, an animal or a person near a tube of radium acquires a notable activity, which a sensitive apparatus can detect. This interference was a daily obstacle to the precise experiments of Pierre and Marie Curie. This acquired activity may remain in an object for thirty or more years.

Marie Curie received the Nobel Prize for Physics in 1903. Again in 1911, she was honored with the Nobel Prize for Chemistry. She also received 129 medals, decorations and honorary titles from all parts of the world.

In 1903, Ramsay and Soddy demonstrated that radium disengaged a small quantity of helium. This was the first known example of the transmutation of the elements.

Because of radioactivity, generation of heat, production of helium, radium gradually destroys itself. These emanations give off three kinds of rays: alpha, beta and gamma rays. To diminish itself by one-half, uranium requires several thousand million years; radium about sixteen hundred years, and radium enanations about four days.

Radium is found with uranium. Uranium is widely distributed in minute quantities throughout the lithosphere in the mineral called pitchblende. Radium ores are found in samples taken from the floor of the ocean. Other ores of radium are: CARNOTITE, i. e., potassium uranyl vanadate, found in Utah and Colorado; also AUTUNITE, i. e., calcium uranium phosphate, found in Portugal and Australia.

Radium in ore is detected by the electroscope and spinthariscope.

In the research laboratory of the American Standard Chemical Company, six chemists died from the effects of radium emanations; all were less than forty years old.

In order to get a gram of radium (one twenty-eighth of an ounce) from 1000 pounds of radium chloride, it was necessary to treat 500 tons of ore with 300 tons of chemicals, the heat of 1000 tons of coal, 1000 tons of distilled water and the labor of 150 men for a period of six months.

The richest radium deposits of pitchblende are now found in the Belgian Congo. These deposits are owned by the **Union Miniere du Haut Katanga**, and each year more than 60 grams of radium have been extracted from the ore, for the past seven years.

In 1937, Canada produced about 50 grams of radium salts, i. e., radium bromide, which is about 90% radium.

The medical profession uses radium emanations in the treatment of cancer, fibroid tumors and tubercular glands of the neck.

Some factory workers using radium salts for painting luminous figures on dials acquire necrosis, which has caused some deaths.

When radium is used in medicine, only the emanations are used. They are in sealed tubes with very definite specifications clearly marked.

Our knowledge of radium is still infinitesimal and this curious and extraordinary element is of the greatest interest to the chemist, the physicist and the doctor of medicine.

MATHEMATICS

HILBERT SPACE

R. Eric O'Connor, S.J.

This article is an attempt to explain, in a manner intelligible to anyone acquainted with calculus and elementary differential equations, some of the concepts of the theory of Hilbert space and the manner in which this theory is useful in mathematical physics. These concepts are especially interesting as examples of recent generalizations in mathematical theory.

The similarity of the problem of solving for y and y , the system of equations

$$(1) \qquad a_{11} y_1 + a_{12} y_2 = x_1$$
$$a_{21} y_1 + a_{22} y_2 = x_2,$$

to the problem of solving for y(x), subject to stated conditions, the differential equation

$$(2) \qquad \frac{d^2y}{dx^2} + p_1(x)\frac{dy}{dx} + p_2(x)y = q(x),$$

will appear "thin" or "profound" according to one's point of vief. As a matter of fact two points of similarity can readily be seen. System (1) can be interpreted as defining a transformation in the plane from the point P, (y_1, y_2), to the point Q, (y_1, y_2); since, given the coordinates of P, we can, from the left side of (1) alone, calculate those of the point Q. Symbolically (1) may be written

$$T(P) = Q$$

and the problem connected with (1) is that of finding the inverse transformation, if it exist, namely the four numbers $\{b_{ij}\}$ such that

$$y_1 = b_{11} x_1 + b_{12} x_2$$
$$y_2 = b_{21} x_1 + b_{22} x_2$$

so that, given the coordinates of x_1 and x_2 of Q, we can calculate those of P. Symbolically we want to find the transformation T^{-1}.

Consider now (2). The operator

$$\frac{d^2}{dx^2} + p_1(x)\frac{d}{dx} + p_2(x)$$

can evidently be considered as defining a correspondence among functions of x. If we denote this operator by T and suppose it to operate on a function P (x) whose second derivative exists, it will yield a second function Q (x) according to the equation

$$T(P) = Q$$

The problem connected with (2) is ordinarily to find the function P (x) which, while satisfying the assigned conditions, satisfies also

$$T(P(x)) = q(x);$$

a more general problem—indeed the problem generally attacked—is to find the inverse operation T such that

$$\text{if } T(P) = Q, \quad \text{then} \quad T^{-1}(Q) = P,$$

provided of course, such an inverse operation has a meaning.

The first point of similarity of (1) to (2) is common to a great number of mathematical problems; the following is more particular. Both problems are "linear" problems. If we understand that a point $P(x_1, x_2)$ is a linear combination of two points,

$P_1(x_1', x_2')$ and $P_2(x''_1, x''_2)$, when

(3)
$$x_1 = a_1x_1' + a_2x_1''$$
$$x_2 = a_1x_2' + a_2x_2'',$$

a_1 and a_2 being any numbers, real or complex, then we can express this relationship by an equation

(4)
$$P = a_1P_1 + a_2P_2$$

to be interpreted, of course, by (3); while if we understand that a function $P(x)$ is a linear combination of two functions, $P_1(x)$ and $P_2(x)$, when

$$P(x) = a_1 \,.\, P_1(x) + a_2 \,.\, P_2(x)$$

with a_1 and a_2 any constants, equation (4) could stand for this idea as well. It is readily verified that, when T stands for either the transformation in (1) or the operator in (2), then

$$T(a_1P_1 + a_2P_2) = a_1 \,.\, TP_1 + a_2 \,.\, TP_2$$

The transformation can thus be considered as an operator and a linear operator. It is not so clear that any simplification will be gained by considering the differential operator as a linear transformation. The problem solved by the theory of Hilbert space is that of defining "space" such that the functions entering problem (2) can be considered as points. The problem of solving (2) is then the problem of finding, not an inverse operator, but an inverse **transformation** to T.

Below I shall indicate the line of thought followed in defining this space. Let us for the moment consider this done, with the result that we can speak of any function $f(x)$, known or unknown but subject to the natural restrictions of the problem, as a point of this space. The same will hold true of functions involved in far more difficult problems, for example, the problems connected with the general linear differential equation

(5)
$$\left(p_0(x) \,.\, \frac{d.^n}{d\,x^n} + p_1(x) \,.\, \frac{d.^{n-1}}{d\,x^{n-1}} + \ldots\ldots + p_n(x)\right) y = q(x),$$

and the integral equation — to be solved for $y(x)$ —

$$(6) \quad \int_a^b K(x, \xi)\, y(\xi)\, d\xi - 1 ,\, y(x) = q(x),$$

and will also hold true of the sequence $(y_1, y_2, y_3, \ldots\ldots)$, a solution of the system

$$\begin{aligned} a_{11}\, y_1 + a_{12}\, y_2 + \ldots\ldots &= x_1 \\ a_{21}\, y_1 + a_{22}\, y_2 + \ldots\ldots &= x_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & \end{aligned}$$

provided the coefficients satisfy certain conditions of boundedness. The value of the theory lies in its abstracting from the vast dissimilarity of these problems—due to the difference of definition of derivative, integral, matrix, etc.—and reducing them to a single problem which might be stated as follows:

If T is a linear transformation in Hilbert space; under what conditions will its inverse exist and what will be its general properties?

Naturally the properties of the "space" are employed in solving the problem. The "geometric" results have analogues in plane geometry and hence appear somewhat natural and are easily recalled. For example, a condition necessary and sufficient that the inverse of T exist is that the correspondence, between all points T(P) resulting, be one-to-one. But this condition is equivalent to the condition that

$$T(P_1) = T(P_2) \quad \text{must imply} \quad P_1 = P_2$$

and hence to the condition that

$$T(P) = 0 \quad \text{must imply} \quad P = 0.$$

It is noteworthy how completely this little bit of reasoning is completely independent of the type of operators represented. Only their property of being linear is employed.

Using more abstruse properties of the "space" we soon come upon a type of transformation that always possesses an inverse and whose inverse satisfies a simple "equation"; this type is seen to correspond to operators with a definite kind of symmetry—the self adjoint differential operators and the integral operators with symmetric kernels are examples. An easy consequence is that, if T stand for either of the operators connected with (5) or (6) subject to these conditions of symmetry and to certain conditions of boundedness, then the equation

$$(7) \quad T.y - \lambda, y = q,$$

where λ is a constant, real or complex, and q a given function (not zero) of x, has a unique solution for all values of λ save at a most denumerable infinity, and such a solution (and indeed any function satisfying the boundary conditions of the problem) can be expanded in a series of the functions obtained as solutions of

$$T.y = \lambda.y$$

for those exceptional values of λ for which (7) ceases to have a unique solution.

This is probably sufficient to show the type and generality of the results obtained; a few words have been promised on the concept of "space" here involved. That the functions pertinent to the problems could conveniently thought of as "points" of a "space" is suggested by the following. According to the theory of Fourier series, any moderately well behaved function, defined for a finite interval of values of a single variable x, can be represented by a convenient series of the form

$f(x) = a_1 + a_2 \cos ax + a_3 \sin ax + a_4 \cos 2ax + a_5 \sin 2ax + \ldots$, the sequence of constants

$$(8) \qquad a_1, a_2, a_3, \ldots\ldots$$

being characteristic of the function f. Having in mind that all number pairs a_1, a_2 correspond to the points of a plane; all number triples a_1, a_2, a_3, to the point of natural space; that all number n-triples $a_1, a_2, \ldots\ldots, a_n$ constitute, by definition, the points of an n-dimensional space; what is more natural than to enquire whether unending sequences like (8) could not be conveniently defined to constitute the points of a space dimension number ∞ ? This is what actually is done; it is found however that the definitions are not useful unless the sequence satisfies the condition that

$$|a_1|^2 + |a_2|^2 + |a_3|^2 + \ldots\ldots$$

is a convergent series; and one could, in a rough way, say that a Hilbert space is simply the set of all sequences of constants which are convergent in the above sense.

Approaching the matter in a less concrete manner, any set of elements P, Q. R . . . .—not necessarily numbers or functions—is said to constitute a metric space provided a real number [P,Q] can be made to correspond to each pair P, Q—distinct or not—of elements, and provided further these real numbers satisfy the following relations:

$$[P,Q] = [Q,P];$$
$$[P,Q] > 0 \text{ unless } P = Q; \qquad \text{if } P = Q \text{ then } [P,Q] = 0;$$
$$[P,Q] + [Q,R] \geqq [P,R];$$

the equality sign between elements denoting merely identity. The last inequality is called the "Triangle inequality" and its analogue in ordinary space is obvious. The number P,A so defined is called the distance from P to Q. In the particular metric space that we are considering, Hilbert space, the "distance" between two elements f(x) and g(x) is defined to be the positive square root of the integral of

$$(f(x) - g(x)) \qquad (\bar{f}(x) - \bar{g}(x))$$

over the interval on which the functions are all to be defined. Here $\bar{f}$ denotes the complex conjugate of f. It can easily be verified that the distance so defined is real, positive,* and satisfys the triangle

*Actually it can be zero without f and g being identical functions; but when this occurs they are considered as being "identical in the space".

inequality. It can also be seen without difficulty that if the Fourier representations of f and g are

$$f(x) = a_1 + a_2 \cos ax + a_3 \sin ax + a_4 \cos 2ax + \ldots\ldots$$

$$g(x) = b_1 + b_2 \cos ax + b_3 \sin ax + b_4 \cos 2ax + \ldots\ldots$$

then the "distance" from f to g becomes the positive square root of

$$|a_1 - b_1|^2 + |a_2 - b_2|^2 + |a_3 - b_3|^2 + \ldots\ldots$$

which is highly suggestive of the formula for distance in the Euclidean plane.

Once distance has been defined in a metric space, the notion of limit can be introduced. In plane geometry a sequence of points P_1, P_2, P_3, ... is said to converge to the limit point P if every circle, no matter how small, with P as centre contains all the points of sequence except perhaps a finite number of them. Thus convergence to a limit is defined in terms of distance, and the definition can be phrased so as to be equally applicable to the Euclidean plane or to any metric space. Thus, the sequence P_1, P_2, P_3, ... converges to the limit point P. if and only if sequence of positive numbers $[P_1, P]$, $[P_2, P]$, $[P_3, P]$, ... has limit zero.

Besides the notion of "convergence to a limit", there is in elementary analysis the notion of "convergence" (sine addito). Thus a sequence of real numbers a_1, a_2, a_3, ... "converges" or "is regular", provided that, to any assignable, positive e there corresponds an integer n such that

$$| a_m - a_r | < \epsilon \quad \text{for every } m_1\ r > n$$

The properties of the real number system insures that every such sequence possesses a unique limit—in fact the real number system was defined so as to secure this—and thus "convergence" and "convergence to a limit" are equivalent ideas when applied to real numbers. The same is true with complex numbers and with the points of Euclidean geometry for, in each case, the calculation is based solely on real numbers; but in the present case a difference arises. Convergence (sine addito) in the general metric space implies that the sequence P_1, P_2, P_3, . . . of points under consideration is such that for any positive e, there exists an integer n such that

$$[P_m, P_r] < \epsilon \quad \text{for every } m_1\ r > n$$

For this to imply convergence to a limit P, it is necessary that there be a suitable P among the elements of the space. In defining Hilbert space in the abstract this property is postulated of its elements; thus a set of elements cannot be considered a Hilbert space unless they satisfy this postulate.

Consider now a sequence of functions that are to be elements of the space. Because of the definition of distance it is necessary that only integrable functions be admitted. But it can well happen that a sequence, even of bounded functions

$$f_1(x)\ ,\ f_2(x)\ ,\ f_3(x)\ ,\ \ldots .$$

converges to a limiting function f(x) and that every function of the sequence posses a Riemann integral, while the limiting function f (x) is not itself integrable. Thus f(x) would have to be left out in the cold and the property of closure (just explained) could not be had for the space of functions. For this reason the Riemann integral is supplanted in the definitions of distance, etc., by the far more satisfactory integral of Lebesgue. This has been a familiar tool of mathematicians for some twenty years and possesses precisely the property that if

$$f_1(x)\ ,\ f_2(x)\ ,\ f_3(x)\ ,\ \ldots.$$

is a sequence of functions (bounded, let us say, for simplicity, and by common bounds) which possess a Lebesgue integral on a given interval and which converge to a function f(x) on this interval, then f(x) also possesses a Lebesgue integral on the same interval and the integral of f is the limit of the integrals of $f_1, f_2, f_3, \ldots.$

To remain short, this article had better finish here. Only some of the concepts of Hilbert space have been touched upon. It may be well to remark that the complete theory is sufficiently complicated to be uneconomical for the experimental physicist. It would however be extremely useful for any one in theoretical physics since it makes possible an immediate qualitative judgement of the effect—on results—of changes in the form of a differential equation or in its boundary conditions, an ability of great value in the study of modern physical thories. Also, in so far as it puts order into a vast array of facts concerning integral equations and linear differential equation, ordinary and partial, it would grealy assist anyone who is teaching these subjects. A very satisfactory treatment is had in M. H. Stone's book, "Linear Transformations in Hilbert Space", published by the American Mathematical Society.

BOOK REVIEW

"INTRODUCTION TO PROJECTIVE GEOMETRY."

C. W. O'HARA, S.J., and D. R. WARD, S.J.

Published by Oxford Press

An excellent "Introduction to Projective Geometry" by two English Jesuits, Fathers C. W. O'Hara of Heythrop and D. R. Ward, of Stonyhurst, has been published recently by the Oxford Press. The authors follow a rigorous, postulational development but make it simple and satisfying by indicating the ideas that suggest each step as well as the possible alternate steps, and by calling attention to various sets of things that satisfy the postulates. General two-dimensional projective geometry is quite comprehensively studied up to and including conics. Mesh gauges and metric gauges are then introduced and the treatment is specialized to hyperbolic, elliptic and euclidean geometries. Nevertheless the simplicity and clarity of treatment makes it accessible to anyone who has studied Euclid. Throughout are numerous interesting problems; and generalizations to higher dimensional projective geometry, and applications in mathematical physics are suggestively indicated. Fathers O'Hara and Ward are to be congratulated on producing so stimulating a treat.

R. Eric O'Connor, S.J.

PHOTOGRAPHY

PHOTOGRAPHIC NOTES

Rev. John A. Brosnan, S.J.

Part I

These photographic notes made their first appearance, some years ago, in mimeograph dress, during the childhood days of the Science Bulletin when the energy and efficiency of Fr. Henry Brock did so much to help the youthful publication to grow to its present scientific stature.

The present Editor of the Bulletin very kindly suggested that the notes should reappear in real print and he offered them a place among the more pretentious scientific papers.

These notes are intended to give practical help to our teachers of Astronomy, Physics, Geology and Biology in the making of lantern slides for class work. History and Literature classes and even Chemistry and Mathematics may also be aided by screen illustrations. The writer is quite aware that all the following suggestions either have presented themselves or will present themselves to our science-teaching slide makers. They are offered here to remind those who may have forgotten them and to save others the waste of time waiting for them to appear.

In the old days of the albumen and collodion processes, a poor slide was a rarity. Nowadays, helped by the ready made lantern plates, commercial quantity-production has pushed quality from the first place; and good slides, that is, clean clear and sharp, with detail showing in the shadows, slides decent looking and well dressed are being hopelessly outnumbered by the mob of mediocre individuals let loose by many commercial firms. Excellent slides can be made by our teachers themselves and they will cost no more in money than poor slides. If screen illustrations are worth while making at all they are worth while making well. The prospective slide maker must understand the "festina lente", he must have patience and a memory of past errors together with their causes, a firm purpose of amendment and must be willing to give each slide individual attention in order to insure the best results. Since these notes are to be practical, fullness of detail will not be out of place.

DARK ROOM: The dark room must, of course, be near the exposure room, and the position of this latter should, in our opinion, be determined by the class of the work to be copied. Besides diagrams and prints of various kinds (all flat work), our camera subjects may include "natural objects" both lifeless, and living. Flat work can be taken satisfactorily in artificial light, but reliefs, for simple strong, natural appearance with proper shadows, require daylight (diffuse) illumination. So do not put your dark room in a cellar.

Among the fittings of the dark room, sink, shelves, trays, graduates, etc., a few should have special mention. The developing table should be covered with a large piece of ribbed "skylight" glass, about 3 ft. long and 2 ft. wide, framed on three sides by a raised wooden moulding, one of the short sides being left free as an aid in cleaning. The developing light should be a flexible "goose neck" desk lamp with a clam shell reflector, carrying a 25 watt red light, ruby glass not "dipped", with a lamp of this kind the proper amount of red light, as much or as little as is necessary, can be turned on the plate tray with no glare in the eyes to interfere with the detection of slight changes in the developing plate.

A third special mention is an ordinary old-fashioned kerosene oil lamp; glass bowl (showing supply of oil), flat wick and glass chimney. This mysterious fitting is a real Aladdin lamp for good slide making. For contact printing of slides, have a flat printing frame, not smaller than 4"x 5", fitted with a snug piece of flat flawless glass. This extra size frame, larger than lantern size, will give plenty of margin to set properly a badly centered negative.

Among the chemicals in the dark room, one should have a 4 oz. bottle of ammonium persulphate, an ounce of methyl orange or tropaeolin orange (coal for colors), a cake of Gibon's Opaque and a few ordinary wood-handled camels-hair brushes, medium size. The use of these articles will be discussed later. It would be well to have a glass cutter of some sort, diamond, steel wheel, or even a Tungsten Carbide pencil (supplied by the Fisher Scientific Co., Pittsburgh, Pa.)

EXPOSURE ROOM: Let us now look at the exposure room. Many professionals exclude daylight, using only steady artificial sources, thereby eliminating one variable in the negative making. For our general work, including photo reproduction of natural objects, daylight with the sky as a reflector (even through windows) is preferable to smaller sources of light; since day-light shadows, so necessary to good relief, are more natural.

The furnishing of the room includes a stand, camera and lenses, a generous focusing cloth, a focusing glass and several sheets of white cardboard to serve as reflectors.

The stand, with camera-guides on a horizontal bed, should carry an exposure board, movable in a plane, vertically and horizontally, at right angles with the guides, stand and board being painted deep (flat) black. The board (30"x24") should have fittings to support the objects to be photographed, as well as the proper backgrounds. Good jewels are frequently spoiled by a bad setting, and a poorly selected background will sometimes kill an otherwise effective slide. These backgrounds are large sheets of paper,—white, black, and several shades of gray, all dull-surfaced, not glossy. For some objects the best backgrounds would be black velvet or a piece of black cloth without a pronounced pattern. Shelves for small objects, insects, etc., may easily be made by properly folding the correct background paper (or cloth) so as to have the front-drop, shelf and background in one continuous piece. The movement of the exposure board with its burden should be controlled from the back of the camera.

The camera, not smaller than 5"x7", with its ground glass and front board both parallel to the exposure board, should have a bellows-draw equal to at least twice the focal length of the lens employed, otherwise it will be impossible without inconvenient appliances to make a negative the same size as the object. The camera may be fitted with swing backs, rarely needed in the exposure room; but in every case if either the horizontal or vertical swing-back be used, it should be reset as soon as possible at the neutral point. The ground glass should be velvet grained, ground side in, (with rare exceptions), and bisected both ways—horizontally and vertically—on the ground side by two perpendicular india-ink lines and then marked off in three, four, and five inch squares concentric with the intersection of the perpendiculars.

A focusing glass (3X, at least) should be employed, no matter how good the eyesight of the operator may be. The focusing cloth ought to be light proof and large enough to cover completely the fully-extended camera bellows (which may leak) as well as the ground glass. Two lenses, long and short focus, both rectilinear and not necessarily fast, will make a good optical equipment, though excellent results may be had by using only one lens of medium focus for all classes of work. The shorter focus lenses will give better definition with natural objects whose parts are in planes at appreciably different distances from the lens, e.g., the skeleton of a snake's head, a cluster of flowers, etc.

The use of the tool is more important than its perfection. Professor Newcomb once said that the great Bessel could do more with a cart wheel and a spy glass than many astronomers with exquisite instruments. In photographing natural objects, in relief, for screen work the most agreeable results are obtained by having a slightly one-sided lighting, but for flat work the objects should be uniformly illuminated. Proper use of the cardboard reflectors will help to balance the lighting.

If artificial illumination be preferred for flat work, make sure to have two lamps of equal wattage, one on each side of the camera, back of the lens, far enough from the "copy" to have uniform lighting and far enough from the camera to aviod excessive reflection into the lense from the object to be photographed.

A few words about the plates or films. The plates we are going to suggest for both negatives and positives (slides, not paper) may not be the best, but they are certainly the plates with which one may obtain good results, and after getting first-class negatives and positives with these, one may wander into experimental fields. We shall take up only the ordinary plates, though we may state here that a black and white reproduction nearly proportional to the color values of any natural object may be had by using a good fast plate and by some "doctoring" of the negative. For outside biological or scenic work, use the Eastman 40, a rather fast plate. For inside work (exposure room), diagrams, maps, text and all purely black and white objects, including half-tone prints use the Hammer Slow plate—For black and white prints, with continuous shading (not dots or lines) in fair contrast, and even for many strong color prints, use the Eastman Commercial plate; if these prints are flat or very soft, i.e., lacking in contrast use the Hammer Slow—for "natural" objects, such as minerals, plants or small animals (caterpillars, etc.) use the Eastman Commercial—If the animals are living and lively, slow down their activity with a little ether or chloroform, or use direct sunlight and a shutter exposure with the Eastman 40. All other exposures are made in diffused light and such lighting with careful exposures usually produces better negatives.

To give directions for the proper timing of exposures is not practicable without a knowledge of all the conditions. In general, with a good morning light, a line diagram of fair size, for example 12″ square, on flat white paper, brought down to slide dimensions with lens aperture of f64, would require 8 to 10 seconds exposure with Hammer Slow plate. With the same lens opening and the same lighting, a natural object such as a group of green leaves against a black background, might require 15 seconds with an Eastman Commercial, a much faster plate than a Hammer Slow. As a rule, when the background is dark, a slight overexposure will do not harm. To sum up:

Black and white, lines or dots		Hammer Slow
Continuous shading (photos)	strong	Eastman Commercial
	flat	Hammer Slow
Natural objects	in exposure room	Eastman Commercial
	outside exposure room	Eastman 40 or Commercial

The use of the small stop in the lens (f64 or f32) will help to neutralize any lack of coincidence between the focal plane of the image on the ground glass and the plane of the sensitive film in the plate-holder.

Cut films of all plate sizes and varying speeds may be bought at the Eastman Stores. If these are used carefully and with the necesssary appliances, they will give excellent results, but the ordinary amateur will be better satisfied with plates until his experience widens. The cut films are coated with gelatin on the back to prevent curling; this coating, especially when wet, is very easily stained and scratched. Plates may be handled in developing, fixing and washing, more quickly and more roughly without injury.

Having mounted our subject carefully, we are going to set the camera, expose the plate, develop, fix, wash and dry the negative. As we are taking our negatives mainly for slide reproduction, it will be better in most cases to arrange the lens distance for a negative that will serve for contact printing. Center the picture on the ground glass by means of the intersecting guide lines and bring it inside the three-inch square. For most line work a 3¼ x 4¼ plate will do; for natural history subjects a 4 x 5 plate will leave more room for notes on the margin (in ordinary ink on the film side of the dried negative). We shall speak of the reproduction of large negatives when treating of the actual slide making. One of the most annoying problems sometimes given to the amateur worker is to make a presentable slide from a poorly focused, blurred photograph, of, for example, a geological formation, a rare botanical specimen or a snapshot of a scientific instrument. You cannot make an image sharper than the original; you may cause it to look sharper by reducing it in size, but a slide on the screen means magnification. Very few eyes can distinguish between the least blurred image and one a bit more out of focus. A magnifying glass makes it worse, and the long time spent in trying to get the best result will so tire the eyes that one is tempted to give up the job. Select a halftone print of not too fine a "grain" (not more than 133 to the inch) made on good-surfaced thin paper, with a fair area of middle tones. This will prove a "life saver" in focusing blurred photos or lithographs and photogravures which are rather dark and full of small detail. Set the "problem-copy" on the exposure board, bring it down to slide size on the ground glass, making it approximately sharp by eye. Then take the halftone print, place it over the blurred copy in good contact, pick up your magnifying glass, sharpen the dots on the ground glass and your worry is over. The thin halftone is practically in the same plane as the "copy" and if the image of one is sharp, that of the other will be sharp also, that is, as sharp as possible.

The beginner is apt to over expose 'time' pictures and under expose snapshots. Of the two faults over exposure is the lesser for with it one will surely have all that is wanted on the plate. Over exposure however tends to flatness, loss of contrast, and so a developer that leans towards contrast should be welcomed.

The following is a good, easily kept, flexible, two solution stock developer for negatives, plates or films, and for lantern slides, not for paper prints.

Solution A:

Water (hot)	30 fluid oz.
Sodium sulphite (dry)	2 oz.
Conc. sulphuric acid	1 dram
hydroquinone	360 grains
Potassium bromide	30 grains

Solution B:

Water	30 fl. oz.
Sodium hydroxide	1 oz.

To make up A: Weigh out the dry materials and have the sulphuric acid in a small graduate; take a 2 quart beaker containing 30 fluid oz. hot water (ordinary tap water will do) add the sodium sulphite but do not shake or stir; then carefully pour in the sulphuric acid (thin stream) and swirl the mixture. In this way the acid mixes with the water and reaches the sulphite at the bottom of the beaker, liberating slowly some SO_2 which is prevented from escaping by the water above it and so the needed bisulfite is formed. Then add the hydroquinone and potassium bromide mixing well without too much exposure to air and immediately pour into two 16-oz. glass stoppered bottles. The full bottle should be used last as with scarcely any air in it, it will hold a long time.

Solution B: is easily made by placing 30oz. water (ord. temp.) in a glass stoppered bottle and adding one ounce of sodium hydroxide. The stopper of this bottle should be dried and vaselined.

For normal developer take 1 oz. A, 1 oz. B, and 4 oz. water. This working solution, 6 oz. will in a 4 x 5 tray develop 6 plates very uniformly. It may then be economically thrown away.

Do not wet the exposed plate before putting it in the tray, and when pouring the developing solution try to cover the whole plate at once. Rocking the tray promotes contrast and keeping the developing plate away from strong light, even red, will help to avoid fog. The plate is less sensitive to light when wet than dry.

Do not take the appearance of the back of the plate as the index of completion. Different emulsions vary in thickness. Examine the face of the plate occasionally, keeping it in the tray, and when the normally cream colored parts of the plate begin to veil over the operation is done. Over-development will produce fog but a little fog will not prevent a negative from giving good results. If the normal developer does not give sufficient contrast with the plate used and approximately the correct exposure, add one or two drops of a 10% potassium bromide solution to every ounce of developer. If the negatiove is too harsh, add more water, up to fifty or one hundred per cent.

It will be interesting and instructive to give the same exposure to two or three plates (same speed) on the same subject, varying the makeup of the developer as suggested. Allowing the solution to act quietly on the plates, without rocking, will also help to diminish contrast. As soon as the development is completed, put the plate immediately in running water to wash for three or four minutes. The washing lessens the chance of stains and accelerates the "fixing".

The "fixer", a solution of Sodium thiosulphate, or Hypo in photographic parlance, removes all the unaltered silver halide, making the negative permanent or "fixing" it. Any of the standard formulas for fixing baths may be used, with or without hardener for plates and films. It has been the writer's good fortune for years to have a supply of cool spring water for developing, fixing and washing, and so he has used only a plain fixing bath not weaker than 1 lb. Hypo to 2 quarts of water. Weaker solutions may form the silver thiosulphate, but not dissolve it.

A convenient and harmless hardener may be made by adding 1 oz. commercial formalin to 15 oz. of water; immersion of the negative for five minutes in this solution will remove all tendency of the gelatine to soften or frill; this solution may be used at any time during the developing or fixing. Negatives made with a plain fixer are apt to last longer, and lantern slides made with a hardening fixing bath are often difficult to color.

When the plate seems to be thoroughly fixed (all the silver salts removed), leave it in the Hypo five minutes longer: this may save time later on. Once the negative is fixed, place it in the washing water, running if possible, and leave it in the washing tray for half an hour; then remove it, set it upright on a rack in a dustless room to dry.

Quick drying without too much heat gives a slightly stronger negative; but if a negative is half dry, do not change conditions—the change will be recorded by the film. If one is in a hurry to dry a negative, let him place the drained plate in a tray of 95% alcohol for five minutes, rock well, remove to rack; and it will dry quickly.

(To be continued)

PHYSICS

MODERN PHYSICS EXPERIMENTS

REV. JOHN A. TOBIN, S.J.

In teaching of Richtmyer's Introduction to Modern Physics in the Senior B. S. classes, we found it very difficult to lift the textbook facts from the mathematical world to the realm of demonstrated phenomena. For this reason the Seniors are now required to measure the charge on the electron following the method of Prof. Millikan. Then they measure the ratio of the charge to the mass, and we use two methods. In one experiment an ordinary commercial cathode ray tube with a unique torodial coil to supply the magnetic field is used and the equality between the fall distance of the electron stream is measured when the distance is produced by the magnetic field and then by the electric field. The second method is the magnetron method. This consists of a two element tube surrounded by a coil carrying a current which give the tube an axial magnetic field. This field is adjusted until the force on the electron caused by the plate is balanced by the force caused by the magnetic field. In this way the charge mass ratio is related to the dimensions of the tube, the strength of the magnetic field and the voltage on the plate.

Another interesting case is the textbook knowledge that the velocity of emission of the photo-electrons is dependent on the frequency of the incident light while the number of photo-electrons emitted is proportional to the intensity of the incident light. To verify these two laws a compact piece of apparatus was constructed using the latest type vacuum photo-electric cell with a filter box over a photo-flood bulb. The filter determines the frequency of the light and a variable aperture determines the total light flux falling on the photo cell. Plank's constant is also measured by using an electrometer.

In the textbooks a Geiger counter is used to detect the radio-activity of substances or the cosmic rays. These radiations produce cumulative ionization in a chamber charged to a potential of several thousand volts. The resulting current from the ionization is amplified and made to record the initial ionization. A full wave bridge mercury vapor rectifier was built here which has a variable output voltage up to 3000 volts. The cumulative ionization current is amplified by a pentode amplifier which is made to 'trip' a cold cathode thyraton or strobtron. The tripping of the thyraton produces a visible radiation from the tube and the high current through the tube is made to actuate a loud speaker. In order to produce the loud shocks heard in the speaker both the speaker voice coil current and field current are boosted simultaneously. This apparatus is arranged in a box so that there is no danger from the high voltage. Also a Wilson cloud chamber (Knipp form) is used to show the tracks of rays and a mass spectrograph to show isotopes. Another interesting piece of apparatus was built as a visual null indicator to replace the galvanometer and head phone in ompedance bridge measurements when high frequencies were used. The 'null point' is indicated by the magic eye cathode ray tube. The bridge off balance voltage is amplified by a 6N7 tube operating in cascade. It requires only 110 A. C., as a power source and can be used in rooms where the noise cannot be controlled. It was found that these new experiments were very helpful to put Physics back in the Modern Physics course and prevent it from being a textbook course of mathematics.

REFERENCE LIBRARY FOR SCIENCE COURSE IN PHYSICS AND MATHEMATICS

PART V.

REV. THOMAS J. LOVE, S.J., REV. THOMAS H. QUIGLEY, S.J.,
REGIS B. WINSLOW, S.J.

Part I —This Bulletin, March 1937, pp. 138-142.
Part II —This Bulletin, May 1937, pp. 193-198
Part III—This Bulletin, December 1937, pp. 83-84
Part IV —This Bulletin, March 1938, pp. 134-135

(The books listed below are part of the Science Library of Loyola College, Baltimore, Maryland. Cf. Bulletin A.A.J.S., March 1937)

PHYSICS SECTION

Author	*Title*	*Publisher*	*Date*
Abraham	Theorie der Elektrizitat (2 vol.)	Teubner	1908
Bragg	Electricity	Macmillan	1936
Carnot	Reflexions sur la puissance motrice	Bachelier	1824
Champion	Properties of Matter	Prentice-Hall	1937
Crowther	Ions, Electrons and Ion. Radiations	Longmans	1934
Feather	Nuclear Physics	U. P. Cantab.	1936
Fermi	Thermodynamics	Prentice-Hall	1937
Fleming	Electrical Wave Telegraphy	Soc. Chr. Knowledge	1902
Fletcher	Optical Indicatrix	Frowde	1892
Flint	Geometrical Optics	Methuen	1936
Gamow	Structure of Atomic Nuclei	Oxford U.P.	1937
Gatterer	Spark Spectrum of Iron	Vatican Observ.	1935
Kohlrausch	Physical Measurements	Churchill	1883
Maxwell	Electricity and Magnetism (2 vol.)	Clarendon Press	1904
Monk	Light	McGraw-Hill	1937
Morse	Vibrations and Sound	McGraw Hill	1936
Oseen	Hydronamik	Akad. Verlag.	1927
Parr	Low Voltage Cathode Ray Tube	Chapman	1937
Perrin	Les Atomes	Alcan	1913
Ramsey	Experimental Radio (4th ed.)	Ramsey	1937
Reyner	Testing Radio Sets	Chapman & Hall	1936
Rider	Cathode Ray Tube at Work	Rider	1935
Routh	Dynamics of a Particle	U. P. Cantab.	1898
Saha	Modern Physics	Indian Press, Ltd.	1934
Spencer	Photography Today	Oxford U. P.	1936
Starling	Electricity and Magnetism	Longmans	1937
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Taylor	Workshop Practice	Tech. Press, London	1935
Whitney	Bridges	Rudge	1929

MATHEMATICS SECTION

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Carslaw	Infinitesimal Calculus	Longmans	1912
Chrystal	Introduction to Algebra	Black	1927
Dickson	Modern Algebraic Theories	Sanborn	1926
Harkness and Morley	Analytic Functions	Stechert	1924
Hobson	Plane Trigonometry	U. P. Cantab.	1928
Kennelly	Hyperbolic Functions	Hodder	1912
Kennelly	Pre-metric Weights	Macmillan	1928
Piaggio	Diffenential Equations	Bell	1933
Todhunter	Spherical Trigonometry	Macmillan	1886

Note: Among the journals which will be found useful for the B. S. Science Course in Mathematics we would like to make special mention of "The Mathematical Gazette". Membership in "The Mathematical Association" (England) entitles one to receive a copy of all the numbers of "The Mathematical Gazette" and of all Reports issued during the period covered by his subscription. The Mathematical Association is "An Association of Teachers and Students of Elementary Mathematics". The subscription to the Association is 15s. per annum. Those who wish to join the Association are requested to communicate with one of the Honorary Sec etaries of the Association; v. g. G. L. Parsons, Peckwater, Eastcote Road, Pinner, Middlesex, England.

It may be of interest to list a few concerns who deal in both new and secondhand books:

Barnes & Noble, Inc., 105 Fifth Ave., New York, N.Y.
B. H. Blackwell, Ltd., 50 Broad St., Oxford, England.
Bowes & Bowes, 1 Trinity Street, Cambridge, England.
Henry George Fiedler, 89 Chambers St., New York, N.Y.
Buchhandlung Gustav Fock, G. m. b. H., Sternwartenstrasse 8, Liepzig Cl. Germany.
145 West 44th Street, New York, N. Y.
Leary's Old Book Store, 9th & Market Sts., Philadelphia, Pa.
The Missouri Book Store Co., Columbia, Missouri.
The Sherwood Press, Box 522 Edgewater B:anch, Cleveland, Ohio.
G. E. Stechert & Co., 31 East 10th Street, New York, N.Y.
Swets en Zeitlinger, Keizergracht 471, Amsterdam, Holland.

PUBLICATIONS OF THE VATICAN OBSERVATORY

(Le pubblicazioni notate con asterisco * non sono distribuite gratuitamente)

SERIE I METEOROLOGICA-ASTRONOMICA
SERIE II ASTRONOMICA

I. **J. G. Hagen S. J.**, La Rotation de la Terre, ses Prevues mécaniques anciennes et nouvelles, Rome, 1911, pp. VIII et 189 fa parte del Vol. I) L. 40

App. 1. **J. Stein S. J.**, La Rotation de la Terre, les Preuves de M. Kamerlingh Onnes. Rome, 1910, pp. 72 (fa parte del Vol. I) 20

App. 2. **J. G. Hagen S. J.**, La Rotation de la Terre, continuation des Expériences. Rome, 1912, pp. 53 (completa il Vol. I) 20

II. **J. Stein S. J.**, Calixte III et la Comète de Halley. Rome, 1909, pp. 41 (fa parte del Vol. II) 15

III. **J. G. Hagen S. J.**, Colori stellari osservati a Roma negli anni 1844-1846 da Benedetto Sestini S. J., esposti in nuovo ordine e riosservati. Roma, 1911, pp. XLVI e 119 (fa parte del Vol. III) 25

IV. **Mquis de Mauroy**, Catalogue de la collection de Météorites de l'Observatoire du Vatican. Rome, 1913, pp. IV et 53 (completa il Vol. II) 20

*V. **J. G. Hagen S. J.**, Die veranderlichen Sterne. Geschichtlich-technischer Teil (fa parte A del Vol. IV). **In commissione Herder**, Freiburg im Breisgau, Baden, 1921, pp. XX u. 811 ...... —

*VI. **J. Stein S. J.**, Die verärderlichen Sterne. Mathematisch-physikalischer Teil (fa Parte B del Vol. IV) **In commissione Herder**, Freigurg im Breisgau, Baden, 1924, pp. XX u. 383 ...... —

VII. **F. Kruger**, Neuer Katalog farbiger Sterne zwischen dem Nordpol und 23 Grad südlicher Deklination. Wien, 1914, pp. XX und 130 (fa parte del Vol. III) 30

VIII.	**H. Osthoff**, Die Farben der Fixsterne, auf Grund eigener Beobachtungen. Wien, 1916, pp.XLIV und 52 (fa parte del Vol. III)	**30**
IX.	**F. Kruger**, Indezkatalog nebst Ergänzungen zu den Sternfarbenverzeichnissen von Hagen, Krüger und Osthoff. Wien, 1917, pp. XXVI und 131 (completa il Vol. III)	**30**
X.	**J. G. Hagen S. J.**, A Preparatory Catalogue for a "Durchmusterung" of Nebulae. The Zone Catlogue (fa parte A del Vol. VI)	**120**
XI.	**J. G. Hagen S. J.**, Aggiunte al Catalogo dell'Atlas stellarum variabilium. Roma, 1916, pp. 272 (fa parte del Vol. V)	**10**
XII.	**J. G. Hagen S. J.**, Aggiunte alle Carte dell'Atlas stellarum variabilium. (completa il Vol. V)	**70**
XIII.	**Fr. Becker**, A Preparatory Catalogue for a "Durchmusterung" of Nebulae. The General Catalogue. Edinburgh, 1928, pp. XXVI and 95 (fa Parte B del Vol. VI)	**60**
XIV.	**J. G. Hagen S. J.**, Rassegna delle Nebulose Oscure. Edinburgh, 1931, pp. XVI e 34. (Vol. VII)	**40**
	App. **P. Emanuelli**, Tavole per la trasformazione delle Coordinate equatoriali in Coordinate Galattiche. Roma, 1929, pp. XIX e 109	**15**
XV.	**W. S. Franks** and **J. G. Hagen S. J.**, the Letter- and Number-Scales of visual Star Colours. Roma, 1923, pp. XII e 74 (Appendice al vol. III)	**20**

SERIE IV ASTRONOMICA

	Inaugurandosi in Castel Gandolfo la Specola Astronomica. Roma, 1935, pp. 16	
XVI.	**A. Gatterer S. J.**, Il Laboratorio Astrofisico della Specola Vaticana. Innsbruck, 1935, pp. 64, (Vol. I, 1)	**L. 20**
	—— (Ediz. tedesca) Das astrophysikalische Laboratorium der Vatikanischen Sternwarte. Innsbruck, 1935, pp. 64	**20**
XVII.	**J. Stein S. J.**, La Specola Vaticana di Castel Gandolfo. Roma, 1937, pp. 32, (Vol. I, 2)	**15**

Comunicazioni

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SERIE III ASTROFOTOGRAFICA

1.—Catalogo astrografico stellare

Zona + 64° a + 55°: voll. I-X, e vol. XI.........per ogni volume 40

Appendice I.—**V. Cerulli**, Prontuari per la conversione delle Coordinate rettilinee in Coordinate sferiche nelle Zone Vaticane, Roma, 1917, pp. xxiii e 67 15

II.—**V. Cerulli**, Prontuari per la conversione delle Coordinate sferiche in Coordinate rettillinee nelle Zone Vaticane, Roma, 1921, pp. xiii e 43 15

III.—**J. Stein S. J.**, Stelle Doppie nel Catalogo Astrografico Vaticano 12

IV.—**J. Stein S. J.**, Catalogo di 982 stele legli Ammassi h *e x* Persei 6

2.—Carte fotografiche del cielo per ogni carta 5

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Zona + 59° N° 497-506, 508-513, 515, 516, 562, 565-585.

Zona + 61° N° 776, 777.

3.—Altas Stellarum Variabilium

Series I-VI (esaurite),

Series VII—**M. Esch S. J.**, e **J. G. Hagen S. J.** (41 carte e Cataloghi). In commissione Herder, Freiburg in Breisgau, 1927.

Series VIII—**M. Esch S. J.** e **Fr. Becker** (41 Carte Cataloghi) 80

Series IX—(in preparazione).

SERIE SPETTROGRAFICA

A. Gatterer S. J. and **J. Junkes S. J.**, Spark Spectrum of Iron, from 4650-2242 A, Reproduced on 13 Photographic Plates, Text pp. Roma 1935.
In commissione: Pontifica Università Gregoriana, Roma, Deposito Libri 75

A. Gatterer S. J. and **J. Junkes S. J.**, Arc Spectrum of Iron, from 8388-2242 A, Reproduced on 21 photographic Plates, Text pp. 10, Roma 1935.
In commissione: Pontificia Università Gregoriana, Roma, Deposito Libri 150

A. Gatterer S. J. und **J. Junkes S. J.**, Atlas der Restlinien von 30 chem. Elementen 28 photo.
Tafeln 30×40 cm. Begleittext 33 S., Wellenlängenverzeichnis 36 S. Roma 1937.

In commissione: Pontificia Università Gregoriana, Roma,
Deposito Libri 400

A. **Gatterer S. J.** und **J. Junkes S. J.**, Spektren der seltenen Erden, 33 phohogr. Tafeln 30x40 cm (in preparazione).

Note: The above publications can also be purchased from Swets and Zeitlinger, Keizergracht 471, Amsterdam, Holland.

SEISMOLOGY

THE INTERIOR OF THE EARTH

REV. J. JOSEPH LYNCH, S.J.

One of the unsolved problems of Geophysics is the nature of the earth's interior—and more specifically, the nature of the earth's core, the central portion of the earth, of radius about half that of the earth itself. The trend of seismologists is toward a solid core, but the liquid core has not been abandoned. At Fordham we are working on a third possibility, a solid solution core, i. e., a solid core heavily occluded with a gas. We are tackling the problem from three angles—(1) The effect of such an occluded gas on the energy of a transmitted transverse wave. (2) By examining actual earthquake records we are looking for further proof of the transmission of transverse waves through the core and more particularly the decrease in energy of such waves as they traverse the core. We are examining the recent Indian earthquake from the records of a number of stations and are comparing these results with readings from a number of different quakes (at corresponding distances), recorded at our own station. (3) The physical possibility of such a solid solution as core. The present paper discusses the problem from the first angle only.

As a preliminary background we can by reasonable and generally accepted conjecture attribute the following properties to the earth's interior:

1. A steadily increasing density as we advance from crust to center. Good figures for the crustal density are around 2.7 (Handbuch der Geophysik, p. 459, Band II). The mean density of the earth as determined by Boys and others is 5.5. Reasonable conjecture therefore pictures a density increasing from 2.7 in the crust to about 11 in the core, giving an average of 5.5 as found by Boys.

2. A steadily increasing pressure. Since pressure at any depth is a function of density and g ($dp = -\rho g\, dr$), reasonable figures for internal pressure are accepted as one and one-half million atmospheres at the beginning of the core and three to three and one-half million atmospheres at its center. (Handbuch Band II.)

3. An increasing temperature with depth. Less reason for conjecture exists in the case of the values of internal temperature. Actual experiment has barely scratched the surface but shows a

temperature gradient of roughly one degree centigrade per 30 metres. Conservative figures for the temperature at the center of the earth following Gutenberg are 2000°-5000°C. (Handbuch Band II, p. 35.) However, a minimum of 11000°C. would not seem improbable (Daly, Igneous Rocks, 1933, p. 231 footnote.)

4. A more or less steady increase in the velocity of seismic waves from crust to core. The compressional wave increases in the crust (about 50 km. thick) from five to eight km. per second; then from 50 km. to the core it increases from 8 to 14½ km. per second, reaching its maximum of 14½ km. per sec. just before reaching the core and dropping to 14 km. per sec. at the core. In the core there is a sudden decrease to about 8½ km. per sec. with a gradual rise therefrom to about 11 km. per sec. at the center of the earth. The transverse wave increases similarly from 3 to 5 km. per sec. in the crust; thence 5 to 8 km. per sec. at the core. Little is known of the transverse waves inside the core. (Gutenberg's Grundlagen der Erdbebenkunde, p. 145.)

5. A rigidity which, if not lessening steadily with depth, is at least of lower value in the core than in the crust. Increasing pressure would tend to increase rigidity, but increasing temperature to decrease it. Tidal phenomena, the Eulerian period and seismic phenomena all seem to postulate a core less rigid than the crust. For perfect rigidity, an Eulerian period of about 306 days would be required (Slater & Frank, p. 99). For zero rigidity a period of infinity would be required, whereas the only period observed (from changes of latitude) is the Chandler period of 427 days. To explain this low interior rigidity a liquid core was, and to some extent still is, postulated. The seismic arguments on the nature of the core will be gone into more fully, so with this sketchy picture of the earth's interior as our background, we proceed to our more specific problem of the precise nature of the core.

One of the few tools with which we can probe the earth's interior is the seismic wave. In fact the existence of the earth's core has only been conclusively proven by the reflection and refraction of seismic waves at its boundary. The position of the core is generally accepted by seismologists as being at approximately 2900 km. depth as determined by Prof. Gutenberg. As previously stated, the rigidity of the core must be less than that of the crust—even to satisfy seismological results The seismologists' tools for the analysis of the core are the compressional or longtitudinal wave and the transverse or torsional wave. The compressional wave being due to the elasticity of volume of the medium, is to be found in solids and fluids. The transverse wave, being due to the elasticity of shape, is to be found only in solids. The compressional wave has been regularly recorded even at antipodal distances, i. e. at stations 180° from the earthquake, to reach which the wave must necessarily pass through the core.* The torsional wave had not with any certainty been so recorded. The conclusion drawn from this was that the core was liquid and could not transmit a torsional wave, a view which fitted in with the demands of tidal phenomena and the Eulerian nutation previously mentioned.

More recent and more careful investigation of the records of some specially opportune earthquakes has led several investigators in New Zealand, Japan and America (Gerland's Beitraege zur Geophysik Vo. 28) 1930, p. 190), Nature Vol. 134, 1934 pp. 134-157) to modify this view. They have traced what they feel reasonably sure is the torsional wave up to and through the core. In no case, however, after passing through the core does it appear with an amplitude nearly as pronounced as that of the compressional wave under similar circumstances. As Father Macelwane points out, this slight energy of the S prime wave or the torsional core wave, coupled with the fact that it is sandwiched in between multitudinous other phases, readily explains the previous failure of observers to recognize it. But what is the explanation of this slight energy of the torsional core wave? What property can one attribute to the presumably solid core which would dissipate the torsional energy so readily?

The writer suggested that the core might be a solid solution, i. e. a metallic core heavily occluded with gas. The idea was suggested by the readiness with which palladium could be occluded with hydrogen. It seemed plausible to suppose that since a gas could not transmit torsional energy, its presence in the solid would lessen the solid's ability to do so. Experiments were begun to determine the effect of occlusion on the rigidity of palladium. During their course, it was discovered that H. R. Koch had earlier investigated the effect of occlusion on elastic constants (Annalen der Physik Band 54, 1917, p. 1). His results which showed that occlusion diminished the rigidity, were somewhat erratic—and it was not clear what allowance he had made for an extrinsic viscous effect that should hâve been present. (He suspended a meter length of palladium wire in a glass tube kept filled with inflowing dilute sulphuric acid as electrolyte for electrolytic occlusion—the whole apparatus constituted his torsion pendulum.) In any event it was considered worthwhile to repeat the investigation, using an entirely different and somewhat more refined method—a method moreover which would permit the determination not merely of the change in rigidity but also the internal viscuous action of the occluded gas which would seem to be an important factor in the dissipation of torsional energy. The torsion pendulum consisted of a small magnetized needly suspended by a palladium wire, half a millimeter in diameter and about 2. 5. cm. long. The

*This does not imply that a compressional wave cannot reach an antipodal point without passing through the core. Many do, by reflection from surface or core or by diffraction around the core, but these can be identified as distinct from the P prime or compressional core wave.)

needle was placed in an oscillating magnetic field of variable frequency. The period of the pendulum was obtained by measuring the frequency of the oscillator at resonance which was found to be quite sharp. In the formula

$$\mu = \frac{8 \Pi I l}{r^4 T^2}$$

1, r and T were determined before and after occlusion, which was produced by electrolysis. Some fifty different wires were tried and the experiments were carried out in vacuo, in hydrogen and in air, with no measureable difference in period in the latter three cases. The average decrease in rigidity on occlusion to capacity was found to be 13.4%, agreeing with 13.1% obtained by Koch. However, one reason for the erratic results of Koch (and also in our own earlier experiments) lay in the fact that no account was taken of the amount of hydrogen initially contained in an ordinary palladium wire. All palladium normally contains a certain amount of hydrogen apparently, and if this be driven off by passing a current through the wire, the figures for its rigidity will be raised about 12%. Starting with a piece of normal or unoccluded wire, a current of 10 amps. was passed through for a few seconds, heating the wire to redness. The rigidity increased 1.7%. The current was again passed through for about a minute and the rigidity increased a further 8.4%. The wire was then occluded with about 400 times its volume of hydrogen. The rigidity decreased 16.6%. Current was again passed through to drive out the hydrogen, this time for several minutes. The rigidity increased 22.8%. The wire was again occluded with about 450 times it volume of hydrogen, and the rigidity decreased 21.6%. We can, therefore, reasonably conclude that hydrogen occluded in palladium lessens its rigidity, and if we take palladium from which the initial hydrogen has been driven off, the rigidity is decreased about 23%. The actual figures will be found elsewhere. If then we prescind from the effects of unusual pressure and temperature, the effect of hydrogen heavily occluded in the core might be expected to give a rigidity only three-quarters that of a solid metallic core.

(To be continued)

NEWS ITEMS

GEORGETOWN UNIVERSITY SCHOOL OF MEDICINE

The 100th meeting of the Washington Branch of the Society of American Bacteriologists was held on the evening of Tuesday, March 22nd, at the Georgetown University Medical School. Dr. Mollari and the other members of the Department of Bacteriology were hosts for the evening.

About 75 members of the local branch and their guests were present. During the course of the meeting two papers were presented, one, by Mr. Pelczar of the University of Maryland, discussed the results of experiments attempting the implanation of Lactobacilli in the animal intestine, and the other, by Col. Hitchens of the U. S. Army School, presented an interesting insight into the history of bacteriology with his account of the introduction of agar-agar into bacteriological technique. After the reading of the papers Dr. Mollari briefly summarized the history and the aims of the American Type Culture Collection.

At the close of the meeting refreshments were served and the guests took the opportunity of visiting the laboratories of the Department of Bacteriology and of the American Type Culture Collection.

At the Baltimore meeting of the Federation of American Societies for Experimental Biology on March 31, April 1 and 2, the members of the Departments of Physiology and Pharmacology of the School of Medicine presented the following papers:

1. "The distribution of water and chlorides following massive infusions of isotonic glucose solution"—Drs. R. A. Cutting, A. M. Lands and J. S. Larson.
2. "The action of physostigmin on the acetylcholine and nicotine contractures of the rectus abdominis muscle of the frog" —Dr. A. M. Lands.
3. "Treatment of acute barbiturate poisoning by lavage du sang" (Illustrated by motion pictures)—Drs. R. A. Cutting and T. Koppanyi.
4. 'Experimental analysis of mechanism of action of representative drugs" (Illustrated by motion pictures)—Drs. T. Koppanyi, R. P. Herwick and C. R. Linegar.
5. "Factors controlling the vasomotor reversal to epinephrine"—Drs. R. P. Herwick, C. R. Linegar and T. Koppanyi.

6. "Analysis of the "nicotine-like" action of acetylcholine"— Drs. T. Koppanyi, C. R. Linegar and R. P. Herwick.
7. "The nicotine reversal of the acetylcholine pressor effect"— Drs. C. R. Linegar, R. P. Herwick and T. Koppanyi.

FORDHAM UNIVERSITY

DEPARTMENT OF PHYSICS

Summer School

Dr. Karl Herzfeld will give the followig courses this Summer:

Phys. S215. Selected Topics in the Physics of the Earth's Interior; Elastic waves, Thermodynamic properties.

Phys. S216. Introduction to Theoretical Physics, II.
Text; Slater and Frank—selected chapters, XXII to end.

Seminar. Atomic and Molecular Spectra.
The courses above will be telescoped so as to end Aug.. 5th. In addition courses will be offered in Vector Analysis, Analytical Mechanics and Physical Optics.

The following papers will be presented at forthcoming meetings;

American Geophysical Union, Washington, April 28 and 29;
"Doubly Reflected Body Waves at 140°".
Dr. W. A. Lynch and J. J. Lynch, S. J.

Seismological Society (Eastern Section), Boston, May 2nd.
"The S and SKS Curves for 250 Km. depth of focus from the quake of November 14th, 1937".
J. J. Lynch, S. J.
"Traffic and Local Phenomena as Recorded on the Benioff Vertical".
Dr. W. A. Lynch.

The Ameteur Astronomical Association of New York on April 5th., will hold their regular field meeting in the Fordham Geophysics Laboratory.

Publications:

An interesting article "Atmospheric Electricity and Lightning" by Dr. Lynch appeared in the Science Counselor for December and March.

BIOLOGY DEPARTMENT

In June the Graduate School will confer three Master of Science and three Doctor of Philosophy degrees to students in the Biology Department.

Many of the Seniors have been accepted in various Schools of Medicine and Schools of Dentistry. The success of their former colleagues has reflected in favor of the new applicants as was reported from recent interviews.

The mascot of the department, Jaminka a Macacua sinicus, died in the second week of March. She was obtained from Manhattanville in 1930. The mascot will be mounted and placed in the Museum.—The new mascot is a talking parrot and well imitates the hearty laugh of Father Assmuth.

The Biology Building is now known as Larkin Hall and is now being redecorated.

LOYOLA COLLEGE, Baltimore, Md.

CHEMISTRY DEPARTMENT

On Wednesday, February 16, Father Richard B. Schmitt lectured to the Chemistry Department at the Johns Hopkins University on the subject: "Methods in Micro-Analysis."

Dr. Francis O. Rice, D.Sc., Associate Professor of Chemistry at the Johns Hopkins University lectured to the Loyola Chemists' Club on March 21st. His subject: "The Possible Genesis of Some Important Biological Compounds."

The final meeting of the scholastic year of the Chemists' Club will be held on Tuesday, May 3rd. The lecture will be delivered by Dr. Robert D. Fowler, Ph.D., Associate Professor of Chemistry at the Johns Hopkins University on the important subject: "The Transmutation of the Elements."

BOSTON COLLEGE

PHYSICS DEPARTMENT

Prof. F. Malcolm Gager had an article 'A Regenerative Receiver with High Audio Selectivity' in QST for Feb. 1938 and another article 'Cathode Ray Electron Ballistics' in Communications for March 1938.

The eleven Seniors who are to receive their B. S. in Physics have given one hour seminars on Modern Physics and their papers are being bound into a volume with their Senior Theses. In their Theses an explanation was given mathematically using Vector Analysis and Partial Differential Equations, and then the problem was checked by taking data in the laboratory.

The Physics Library has now fourteen of the Journals and Reviews requried for M. S. work. The current journals and the complete bound volumes were checked on the list sent by the committee. A complete set of the 'Tables Annuelles Internationales de Constantes et Donnes Numeriques' has been obtained for the Physics Library.

Three graduate fellowships in Physics will be granted for next year.

HOLY CROSS COLLEGE

CHEMISTRY DEPARTMENT

Hormone

With the closing of 1937 the Hormone has completed its 10th year of publication. During that time 10 volumes have been published, 8 numbers to a volume. Each volume contained about 20 articles, 16 abstracts of seminars, 12 indicators, and 12 editorials. At the present time we are working on a Decennial Index.

Lectures

On March 22nd, Dr. Martin J. Healy, '34 of Cornell Medical School lectured to the premedical students. His subject was "Premedical Training for Medical School".

On April 17th, the entire chemistry student body had the pleasure to hear Dr. Joseph M. Looney, Director of Research, Worcester State Hospital, speak on "The Endocrine Aspects of Personality".

Glass Blowing

The chemistry students are becoming glass-conscious this year. A new glass-blowing table has been installed with asbestos top, equipped with blow-torches, and the usual glass-blower's accessories. Two professional demonstrations have thus far been held. The Seniors majoring in Chemistry are required this year to submit three samples of straight seals and three "T's" as part of their laboratory assignments.

Seminars

The following seminars were held during March and April:

Identifications of Oxidized Nitrogen Compounds, Ugo J. Tassinari.
Chemistry of Sea-Water, James J. Morris.
Semi-Micro Qualitative Analysis, John E. Newman.
Methods of Determining Surface Tension, William P. Roos.
Deuterium in Organic Compounds, William F. Sheehan.
Quantative Methods for the Determination of Copper, Robert M. Smith.

WOODSTOCK COLLEGE

PHYSICS DEUARTMENT

Father John S. O'Conor is at present engaged on the design and construction of a new beta-ray spectrometer of the electron lens type. This will be used to study the artificially produced radioactivity of the target materials used in the Columbia cyclotron, which will be completed within the next month.

LOYOLA UNIVERSITY, New Orleans, La.

CHEMISTRY DEPARTMENT

The Loyola Chemistry Club has completed six successful years. The schedule of the Club was changed to one business meeting and one demonstration each month. All the demonstrations have been conducted by the student members of the Club.

Many new books and periodicals have been added to the Chemistry Library. Among these is a complete set of A. S. T. M. Standards. The students in the course of Technical Methods of Analysis have a separate laboratory completely equipped.

Two of the Professors of the Chemistry Department have published a Laboratory Manual for Inorganic Chemistry.

ST. JOSEPH'S COLLEGE

BIOLOGY DEPARTMENT

A series of sound motion-pictures were shown to the Pre-Medical students on March 24th. The subjects shown were: Mechanism of Breathing; The Nervous System; Heart and Circulation; Body Defense against Disease; Reproduction among Mammals, and Digestion. These pictures were shown by The Erpi Class-room Films, Inc. These films were produced under the direction of the Biologists of the University of Chicago, and are highly recommended for Pre-Medical students.

BULLETIN OF THE AMERICAN ASSOCIATION OF JESUIT SCIENTISTS

INDEX TO VOLUME XV, 1937-1938

SEVENTEENTH ANNUAL MEETING

of the

AMERICAN ASSOCIATION

of

JESUIT SCIENTISTS

August, 1938