~~J. A. O'Donnell S.J.~~

S.J.B.

A. M. D. G.

BULLETIN

of the

American Association of Jesuit Scientists

(Eastern Section)

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For Private Circulation

LOYOLA COLLEGE
BALTIMORE, MARYLAND

VOL. XI DECEMBER, 1933 NO. 2

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EASTERN STATES DIVISION

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EDITORIAL

The principal theme of the Century of Progress Exposition was the dependence of the various industries upon the pure sciences. For the convenience of display, the pure sciences were grouped in seven different sections: Mathematics, Astronomy, Physics, Chemistry, Biology, Geology and Medicine.

In the Adler Planatorium, the only permanent building in the Fair Grounds, we have one of the marvels of modern science: the Zeiss projector, which gives a reproduction of the stars and planets, that are visible to the naked eye, not only as they appear from any locality on this earth, but as they were or would appear at any time in the past or future. This projector also shows the relative motions of the various stars and planets.

In the Great Room in the Hall of Science were many outstanding scientific features. The Geological Time Clock represented in dramatic fashion the passing of time from infinite past to infinite future and epitomized the geological history of the world and its inhabitants. The dial of the clock is in the shape of a spiral, the small end of which reaches back into the illimitable past before the planets were formed. No commitment of the duration of this time is made. Part of the dial is traversed by a large hour hand and is divided into 100-million-year sections, each compartment being illuminated as the hand reaches it. Groups of these compartments make up the great eras of Geological Time: Azoic, Archeozoic, Proterozoic, Paleozoic, Mesozoic and Cenozoic. Each area has its individual color and is brightly illuminated while the hour hand is passing through, but as the hand moves into another area, the previous one dims and remains so to the end of the cycle when all the lights go out.

Another ingenious exhibit in the Great Hall was the dynamic model of a molecule of sodium chloride. Two spherical structures represented a positive ion of sodium, and a negative ion of chlorine. The number of white lights shining at any one time represented the number of electrons; the colored lights represented the nuclei, in which nearly all the mass of the atom is concentrated.

In this Hall was a cylindrical cabinet containing a collection of the ninety-two chemical elements showing their periodicity in their physical and chemical properties. A remarkable collection. Other exhibits here were; the Gyroscopic Compass, the Rotating Magnetic Field and a Van de Graaff Electrostatic Generator.

The main features of the matematical section were; historical, arithmetic, algebra, geometry, analysis, applied mathematics; e.g. the Barnett Effect, the Gyrocompass Bearing Repeaters, and the Madaras Rotor Power Plan.

It would take a book of two hundred pages merely to give an outline of all the exhibits in the basic sciences of physics, chemistry, biology, geology, and medicine.

The outstanding feature of the display of these basic sciences, was the dynamic exhibits which made the fundamental principle clear and intelligible to interested people.

Commercial advertising was on a collosal scale. However, this is a necessary evil at all Fairs, because without this financial help the scientific exhibits would be impossible.

If the essential idea of "THE CENTURY OF PROGRESS" was to portray "*scientific*" progress, the Chicago World's Fair was a huge success. Progress in some other fields was certainly lacking. However, Professors of science in any branch found many new and ingenious methods to use as lecture demonstrations.

A NEW VENTURE

We are pleased to present in our pages articles of common interest to science and philosophy. For several years we attempted to bring about this coalition of science and philosophy—and we were unsuccessful. This attempt is in the right direction and if it finds favor with our readers it should bring about helpful discussions among our Scientists and Philosophers. *Prospere procede!*

R. B. S.

SCIENCE AND PHILOSOPHY

SCHOLASTIC VITALISM*

Rev. Joseph C. Glose, S.J.

Scholastic Vitalism is historic. Nor does it make a secret of this affiliation with antiquity. It is a piece of the **Philosophia Perennis** which is not abashed to hitch its teaching to Plato or even more so to Aristotle. St. Thomas was candid in his following of the Stagirite, and the commentators of the Angelic Doctor have been equally as enthusiastic in their allegiance to the Greek Philosopher. Even in their differences the Scholastics have always felt that they could score a point upon an adversary, if they were able to emphasize their doctrine by citing a favorable reading from Aristotle. This has been especially true in those branches of philosophy ordinarily classed as Natural Philosophy, where the bearing on scientific fact is very close. To explain then, in a compact way the meaning of Scholastic Vitalism, I have deemed it advisable, to link it up with Aristotelian thought.

Scholastic Vitalism may be summed up in three distinctive doctrines; in opposition to Monism it believes that the organism is dual in its ultimate Ontological principles, in opposition to an extreme Dualism it teaches that though these principles are really distinct, they unite in an unum per se, in opposition to every form of Materialism it professes a finality immanent in all organisms. This seems to have been the Vitalism of Aristotle, and Scholastics with rare exceptions have held the same. Aristotle was led to espouse these views of the organism by his observations of phenomena in the field of natural science, and the application to these phenomena of his theories of change and cause. These theories, it must be borne in mind, were not merely a priori, but were logical conclusions from facts. Yet not so intimately bound up with any one particular fact as to make the principle invalid, when the fact would be shown to be invalid.

In order to appreciate fully Aristotle's proof for a twofold essence in the organism we must proceed rather lengthily. He had agreed with his predecessors that nothing can come from nothing, moreover that change takes place between contraries. He took issue, however, with their further assertion that contraries of themselves explain changes. Aristotle declared that contraries as such cannot act upon nor pass over into each other; heat, for example, cannot act on cold nor does heat

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*Presented at the Symposium: "Recent Bio-philosophical Theories", Annual Convention of Jesuit Scientists, Georgetown University.

itself become cold. He would admit that a hot body could act on a cold body, and a hot body could become cold. Accordingly he postulated a third reality to act as intermediary between contraries; a persistent substrate in which the contraries that yield place to each other may inhere. Change for him implied consequently, a body passing from a state in which it lacked a particular perfection, let us say heat, to a state in which it possessed this perfection. And at each step of the change he gave a name. The substrate or recipient of the perfection is the "Matter"; the previous absence in the substrate of the perfection acquired, is the "Privation"; the newly acquired perfection is the "Form". Since however, privation is merely the absence of a form from matter, it is neither positive reality nor an independent principle. This leaves matter and form as the only principle of change. Change would thus give need for two elements in a being; one permanent, matter, the other shifting, form.

In his Metaphysics Aristotle discusses change under another aspect, yet arriving at the same conclusion. There he asserts that since change connotes the realization of what is possible, it implies a distinction between the possible and the actual. Once the fact of change is admitted one cannot escape admitting the reality of that which can exist, but does not yet exist. All change may, in keeping with this principle, be described as a transition from potency to actuality. Because nothing can come from nothing, change begins with "Matter" i.e. being in potency and the new reality brought into existence by the change is actualized being or being in actuality; a body for example, changing from hot to cold was in potency to the cold which has become actual, and can become colder or return to its former state. The actuality is fully described by the accession of a new form. Here again change points to a dualism in being; the potential, matter, the actual, form.

So far Aristotle has illustrated his theory of dualism by accidental change. Though he wishes to include all change the examples might be misleading. For there is injected into this line of argumentation the ontological problem of substance and accidents. His keen mind did not miss the difficulty. He had a proof at hand for substantial changes. The natural science of his day furnished him with the data. Like Plato and others of his predecessors he thought that every substance was ultimately reducible to either water or fire or air or earth, and that these four were irreducible. With his predecessors he also defended the transmutation of the elements and the formation of new substances from their composition. The keynote of this demonstration was his acceptance of sensible qualitative differences as fundamental. Each bodily substance in his opinion has its own distinctive set of sensible qualities, and a total change of that set involves a change of substance.

The empirical proof for the transmutation of the four elements he took substantially from his Master. Plato had written: "In the first place we see that water, by condensation, becomes stone and earth;

and thus this same element, when melted out and dispersed passes into vapor and air. Air again when inflamed, becomes fire, and fire when condensed and extinguished, passes once more into the form of air; and once more air when collected and condensed, produces cloud and mist, and from these when still more compressed, comes flowing water, and from water comes earth and stones once more; and thus generation appears to be transmitted from one to the other in a circle". The only satisfactory solution of these facts of experience, according to Aristotle, is the admission of substantial generation: water for example, with its distinctive qualities ceases to exist and air with its distinctive qualities begins to exist. A true mixture, moreover, is a new substance generated by the union of the four elements. He illustrates it from animals. In them the four elements are so completely changed that every part of the mixture is homogeneous with the whole, for the smallest particle of flesh is as much flesh as the whole. Surely no one would really believe that the elements are merely insets in animals like bricks in a chimney stack.

Employing a form of reasoning similar to the reasoning from accidental changes Aristotle concluded from substantial generation to a twofold essence in all bodies. A change in substance, he argues, is impossible unless on the one hand, some portion of the old substance remains; and on the other, some portion of it passes away and yields to an incoming portion of new substance. To deny this would be to deny change and declare for the annihilation of the old and the creation of the new. As results show the persisting part is an indeterminate principle capable of uniting successively with that other part whence spring the characteristic and specific qualities of bodies. To the indeterminate element he gave the name of "Matter"; to the element departing and the element coming, each a specific principle, the name of "Form". And hence bodies in spite of their unity of substance are made up of two constituent principles.

Besides this demonstration from substantial changes Aristotle developed another from the contingent nature of sublunary bodies. It runs thus: since all sublunary bodies come into and pass out of existence they must possess some principle capable of existing or not existing. Otherwise annihilation and creation. It is also evident that this principle must be distinct from whatever it be that gives it actually existing and specific activity; or the being would be a necessary being. In order to explain, then, the essence of bodies one must postulate two distinct principles, one which makes them neither necessarily existent nor necessarily non existent, another which makes them for a time actually existing and specifically active substances.

Throughout the preceding discussion it has been clear that the Stagirite wished his doctrine to be applied to bodies generally. Still to make certain that he included organisms we might quote his definition of the soul from the treatise "De Anima": There he describes the soul as the substantial form of living beings, and the first actuality of a natural body endowed with the capacity for life. The soul is called an "actuality" because it perfects matter and "first" because it precedes all the qualitative properties found as specific attributes in the fully formed substance. The description tallies in every way with the proof from substantial changes given above.

The Schoolmen adopted Aristotle's dualism and accepted his two proofs. They added a third from opposites in the one essence. It has received different wording at the hands of the leaders of different schools. The Greek philosopher denied substantial changes in the heavenly bodies, and quite probably also denied to them a dual essence. The Schoolmen concurred with him in the former denial, but set out to find another proof for a twofold essence even in heavenly bodies. St. Thomas came upon one in the analysis of the concepts of Prime Matter and Substantial Form. These bodies he argued, could not be prime matter alone because they are active; nor substantial form alone because they are not spiritual. St. Bonaventure gave the proof a little different twist; since extension requires a corporeal nature, no body can exist without it, and certainly no body can exist without a form. Suarez ventured a third interpretation: every accident of matter is in the heavenly bodies except corruptibility; quantity is there, density, rarity; other accidents of the active kind are also there, such as light. These latter point to form as the former indicate the existence of matter in the heavenly bodies.

With the new discoveries in chemistry and physics emphasizing the discontinuity of matter and the permanency of the elements in all chemical composition, the theory of substantial changes was considerably upset. Many Neo-Scholastics will no longer subscribe to its validity in the inorganic world. Those who believed it the only reasonable proof of a dual essence in inanimate bodies have espoused a monistic explanation of these bodies all the way down the scale to the electron and proton. There are a few who even deny the force of the argument from opposites in the electron and proton. These would have a universal monism for the inanimate world and would explain all inorganic composition by a dynamic union. The organism seems to have survived this slaughter of Monism. Here the verdict among Neo-Scholastics is almost unanimous in favor of dualism. It is true some are pressing for a monistic explanation of biologic life, a very few and sotto voce can find a sufficient reason for dualism only in the conscious life of man. For those who prefer dualism the demonstration of a twofold essence in the organism proceeds along the course of Aristotle's argument from substantial changes. The experimental data is at present taken for the most part from the science of Embryology. From it we learn that the individuality of the living being gives evidence of remaining intact from the seed to the mature organism; all the chemical and physical forces seem to unite in a remarkable oneness of action with the whole being as a goal; as is especially apparent when parts are amputated or fragments cut off in the early period of development. Such activity does not seem reasonably reducible to any chemical or physical force existing outside the organism. These facts consequently exhibit an element common to bother the inorganic and the organic, chemical and physical forces; and an element unusual, an immanent finality which does not appear to be a mere addition, but rather permeating and unifying in a peculiar manner the entire physical and chemical makeup of the organism.

The union of matter and form, the two ultimate ontological principles of bodies is much more close in the system of Aristotle than of Plato. The soul is not to matter as the pilot is to his ship or the rider to his horse. Aristotle's metaphor makes matter like a mother in co-operating with the form to bring about the completed substance. It is the union Our Lord describes as being very intimate: They shall cling to each other and be as one, in which union their very selves merge into a new one self. The union of matter and form gives a complete substance. They are to each other what the wax is to the impressed seal. Matter and form are one and the same thing, the one in potency, the other in actuality. But it is to be noted that Aristotle does not wish to deny by these illustrations and descriptions the real difference between matter and form. To maintain that he goes to the opposite extreme of Plato's view and regards matter and form as different ways of looking at one and the same reality would contradict his whole system. It would not agree with his teaching on their separability, the origin of one from the other, and his doctrine on potency and actuality. To the Schoolmen generally the organism has also been an unum per se and not an unum per accidens; and their proof is the same as Aristotle's. Soul and body, matter and form are not individuals, they constitute the individual. In the Metaphysics of the Greek philosopher we read: No One makes or begets the form, but it is the individual that is made i.e. the complex of form and matter that is generated. Again—body and soul make the animal. Nor is there an escape through Psycho-Physical Parallelism or a union accomplished efficiently. When speaking of formal and efficient and final causes, Aristotle mentions that in the non-living as well as in the living the substantial form exercises the threefold causality; but warns us that the ontological identification of the formal, efficient and final cause must not lead us to confound the three; the substantial form as such exercises only formal causality i.e. actuates matter; and it is not in its function of substantial form that it acts efficiently and finally. The other two requirements for an unum per se, that matter and form be mutually complementary and by nature so, the Schoolmen found in Aristotle's theory of potency and actuality. His examples are myriad, but we might be forgiven for quoting the most striking one: "Matter may be likened to the female seeking the male and form may be likened to the male seeking the female."

The third mark of Aristotelic-Scholastic Vitalism, immanent finality, has been the most prominent of the three marks in modern discussions on the theory of life. Driesch is responsible for this revived interest in the Entelechy of Aristotle. Unlike his materialistic contemporaries Aristotle was not agreeable to explaining the whole of material being by matter and efficient cause. "When you ask yourself", he says, "why such and such a state of things exists in the universe, four partial answers may be given and each of these corresponds to a cause. Consequently a complete theory of matter requires the enumeration of all four." His view of causality had its origin in the observation of artificial products and the biological processes of reproduction and growth, for example: a coalvase is constructed out of copper; copper is its material cause; it has a special shape or structure which marks it off from all other articles made out of the same metal, this structural shape is its formal cause; it gets this shape from the artificer—he is the efficient cause; it was made for the purpose of holding coals or of wage-earning or of fame—these are its final causes. An oak tree starts from a particular kind of germ, an acorn—the acorn is its material cause; it develops perfections characteristic of an oak and not of an ash—these perfections are its formal cause; the acorn itself did not come from nothing, it was produced by another oak—that parent oak and its acorn-bearing activity are its efficient cause; the whole process of growth leads up to a final stage, in which the whole perfection that was, at the beginning, present in the efficient cause is fully realized in the material cause—the adult oak is the final cause of the acorn.

He is ever fond of likening the soul to a hidden architect within the composite unifying and actualizing its indeterminate co-principle matter into a determinate substance. And because the realized substantial form implies the completed perfection of substance, it is for him an Entelechy. Driesch caught this meaning above all other meanings of the soul. Others have stressed its efficiency, but never a one save the Scholastics has glimpsed the remarkable inner continuity and co-ordination of formal, efficient and final causality. Here I quote: "Substantial form is the principle of causality in each substance. Its proper causality is formal, and consists in the immediate communication of itself to primordial matter for the purpose of forming a substance; this formal causality must not be interpreted as the production in the substrate of any reality distinct from the substantial form itself; it implies not efficiency but communication, and is the mere clothing of the substrate with its own perfections. But once embowelled in that substrate, the substantial form may be regarded as a source of efficiency and finality. Its efficient causality is manifested, within the substance, as a principle fashioning unto its own ends the primordial matter; and, without the substance, as a principle fashioning to the same end other substances." This doctrine is brought out most clearly in Aristotle's views upon the soul. The soul acts as efficient cause within and without the organism;

within the organism it brings about nutrition, growth and decay in plants; without the organism it reproduces its like, plant begetting plant. And all this efficient causality for Aristotle, is towards a definite goal, this efficiency becomes forthwith final causality. This finality is best observed in living beings. Every living being is a microcosm the parts of which subserve the whole: and that adjustment of means to ends within each organism is effected by its soul. It is ever regulating and directing all living processes to its own definite purpose. It not merely grows the organs as efficient cause, but it shapes them when growing them towards fixed results.

The Schoolmen have never faltered on the problem of finality. Aristotle's reasons for goals in nature were most convincing to them. Thus the organism is overwhelmingly regular in its processes, something foreign to chance; a series of changes constantly leading up to a last stage, for example, the organism periodically reproducing its kind, necessarily makes us think of the changes as directed towards this product; art either perfects or imitates nature, and art always aims at some end, hence also nature. This Aristotelian theory of finality is neither extrinsic nor anthropomoric, it means simply the natural activity of organisms, their constant mode of acting, are not governed wholly by fortuitous external contacts and collisions but partly, and indeed principally, by determining internal principles: organisms are directed by their internal qualities to a definite end; and as this end is the perfection of the organism itself, it is aptly called immanent finality.

I have given a summary of Scholastic Vitalism and for the most part a descriptive summary: I have omitted intricate theories within the skeleton, because they are more of philosophical than experimental interest.

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LAWS OF NATURE IN SCIENCE AND PHILOSOPHY

REV. JOSEPH P. KELLY, S.J.

One need not be a scientist or philosopher to become aware of the order and regularity in the physical world. The succession of day and night, of the seasons of the year, of the general effects of heat and cold, are obvious. So obvious are they that we take them for granted as a part of everyday life. It is only the unusual and irregular that draws our attention. We make implicit judgments about them and more or less vaguely attribute them to some rule or measure. "Nature acts that way", we say. The scientist and the philosopher, however, examine these phenomena more systematically to discover, if possible, the reasons for the sequences and regularities that fall under his observation. Both arrive at some definite conclusions which attempt to explain in some way the deeper content of the events. It seems evident that since the scientist and the philosopher are investigating the truth of the same reality, certain, definite relations should exist between their expositions. If then, we wish to set forth and discuss these relationships, our first duty should be, to examine the conclusions and see what are the relations of the more fundamental concepts and principles upon which the conclusions are based. In this way we may be able to find a groundwork common to both branches of knowledge and thus build up the relations between the two disciplines.

A slight acquaintance with modern science will reveal a manifold aspect of the matter. The tendency to emphasize the mathematical and statistical view of what are termed, "laws of nature", is abundantly evident. But the limits of so brief an essay as this will not permit us to enter into detailed explanations. We will confine ourselves to some of the more fundamental relations, leaving to another time the mathematical and statistical aspects of the laws of nature. Apart from any explicit designation of the phrase, law of nature, there is in its implicit content, something denoting a rule or measure of action. Let us therefore, examine the meaning of the term, "law" and having defined its limits, we can judge more easily its objectivity and validity in science and philosophy.

Use and Meaning of the Term "Law".

Our first problem is to determine the meaning of the word, "law", when it is applied to physical, inanimate nature. To speak of a law of nature, is to many scientists, a misnomer. For a law implies the notion of obligation, compulsion and obedience. Nature does not obey; nature is not commanded or obliged. Therefore, we misuse the term, law, when we attempt to discuss laws of nature. "Laws of nature are not a primeval sort of legislation of enactment to which nature must conform".[1] "A law of nature does not prescribe that something shall happen, but only states what relations exist. For this reason, the term law, borrowed from jurisprudence, is not very suitable for expressing the regularities that are found in natural phenomena".[2]

Scholastic philosophy has never understood the word, law, in its application to physical nature, that is, outside the sphere of rational activity, in anything but an analogous sense. Suarez, in his divisions of law, speaks of the "lex ordinis vel propensionis naturae", understanding by this term, a natural law, that which belongs to all things from an inclination or tendency, placed in them by the Creator of nature". The explanation is taken from Plato. "Hence", he adds, "this law, as applied to natural beings, has a metaphorical sense, because things which lack reason are not capable of obedience".[3] It is called law because it is the measure of action to which the being is inclined. It follows from this, that all notions of law, compulsion and obedience, when applied to physical nature, are used in an analogous sense. To justify our use of this term, we begin, as do the scientists, with the constancy and uniformity of activity that is everywhere observed. This idea of the "Uniformity of nature", is one of the tacit assumptions upon which science is built. Now science deals with an external world, whose operations follow from necessary causes. "Natural, non-free causes operate in the physical world, independently of the free will of man and when they are in similar circumstances, they always produce the same effects".[4] This implies that there is in beings of nature a tendency or determination, whereby they are limited and necessitated to a certain mode of action. Since these beings are not endowed with free will, they must of necessity produce their effects, when placed in given conditions. All this is contained in what the scientists call: "the deterministic scheme of nature". When a cause is, by nature, determined, the effect, which is virtually contained in the cause, is also determined. The two principles, the uniformity of nature and the principle of causality, are absolutely necessary for science. "For the convert to Science, it is necessary to accept the principle of the uniformity of nature and the absolute validity of the principle of causality".[5] Unless these two principles are accepted in their absolute validity, science becomes an impossibility. From these principles, in their actual operation in nature, there follow those sequences and relations of events that furnish men of science with data for correlating physical phenomena, for formulating

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I. "Science and the Scientific Mind", Saidla and Gibbs. p. 152.
II. "Principles of Inorganic Chemistry". Ostwald. p. II.
III. "De Legibus". Suarez. Lib. I, Cap. I.
IV. "I Sent; Dist. III; q. IV, 9". Scotus.
V. "The Catholic Church and Its Reactions to Science". Windle, p. 53.

the laws that govern these operations and that enable them to predict future events in the physical order. Science, if it is to be a science, supposes a coordination and unification. Individual and isolated events can never become a science. There must exist among these phenomena, some connections and relations by which they are correlated and united. This unification is based on the principles of the uniformity of nature and the principle of causality and thus science is formed.

To return to the justification of the analogous use of the term, law. The philosopher notes a constancy and sequence among phenomena, in similar circumstances. A similar constancy is observed among rational beings who observe a command of a legislator. Law, in the strict sense is defined as: "a prescriptive norm by which rational beings are commanded or forbidden to do a certain thing".[6] Such a law has place only among rational beings. Any other application of the term must be analogous. When rational beings act according to law, they act in the same way and there is constancy and uniformity of action. In the case of a traffic law, it is prescribed that all vehicles shall use the right hand side of the road in the direction of motion. Motorists understand this to be the will of the legislator and all act according to this desire. There is uniformity of action in as much as all traffic moves in the same direction on the same side of the road. Accidents result from disobedience to this law and there results not uniformity but chaos. In the inorganic world, in physical and chemical operations, we note a similar constancy and uniformity. Hydrogen and Oxygen always unite in the same proportions to form water. No other elements will unite to produce this same compound. Heat expands metal according to definite laws, etc. From this constancy, we argue to the existence of something in the being, that causes it to act in this way. In philosophy, we call this cause, a natural tendency or inclination, inherent in the physical agent, which is the principle of activity. This tendency or inclination is called the "law of nature". The foundation of the analogy between the law in the strict sense and the law, as applied to things of nature, lies in the similarity of uniformity and constancy which is observed both in rational and irrational beings. Among men, this uniformity follows from the will of the subject, in conformity with the mind of the legislator. We argue, therefore, that there must be in natural agents, something analogous, which is the principle of activity and which causes that constancy and uniformity in the physical kingdom. That "something analogous", we call a natural tendency or inclination; scholastic philosophers call it a law of nature. Hence we argue by analogy; as among men, a legislative prescription, which obliges and determines subjects to a uniform mode of action, is called a law in the strict sense, so also, these tendencies and determination whereby natural agents act in a uniform and constant manner, are called laws of nature.

VI. "Summa Theologica". St. Thomas. Ia IIae; q. XC; Art. I.

Every analogy is founded on a likeness of things or better, as Jevons says, on a similarity of relation.[7] In our present case, the relation is the uniformity of action, that is common to both rational and natural beings. Many difficulties have arisen from a misunderstanding of the analogy or an attempt to press it too far. Echoes of this we see in the citations quoted above. (c.f. notes I and II.) When the Scientist asserts that nature is not commanded and does not obey, we are quite ready to agree with them. Nature cannot be commanded in the proper sense because nature is not rational. Our use of the terms, law, command, and obedience when applied to nature are analogous terms by reference to the use of the same terms when applied to rational beings. Hence we must note the following:

I. A law, properly so called, is found only among rational beings. A law, in the analogous sense, may be found among irrational, physical beings.

II. The subjects of a law, in the strict sense, are endowed with free will and may obey or disobey the law.
The subjects of the law, in the analogous sense, are not free but determined in their actions. There can be no question of disobedience in the real sense.

III. In the case of a law, in the formal sense, the will of the subject is the immediate principle from which flows that uniformity and constancy of action. Among inanimate beings, the cause is a determined potency or tendency which is implanted in the very nature of the beings. It has no freedom but in given circumstances must always act in the same way and produce the same effect.

The foregoing distinction in the use of the term, law, will help us to solve many of the apparent contradictions between science and philosophy, on the question of laws of nature. However, a new difficulty has arisen in the changed outlook of modern science. Formerly, both scientist and philosopher worked along similar lines, the former to discover the proximate causes of physical phenomena and the latter, the ultimate causes. Both held the validity of causality and the distinction between proximate and ultimate causes. Thomas Huxley wrote: "The object of the scientist is to discover what the logicians call, "verae causae", true causes, that is, causes which exist in the real order". The "why" of things was the object of scientific investigation. But the revolt of Descartes and Bacon against prilosophy had its far reaching effects. It was their attempt to separate science from philosophy. "The attempt has been made to establish an abstract separation beween philosophy and science or beween science and faith. But the artificial hypotheses that have been framed in support of such a division, have

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VII. "The Principles of Science", Jevons. p. 627.

by their futility, betrayed the unsoundness of the arguments, which might have been discovered by close examination even before they have been put to the test".[7a] The results of the revolt, have been Positivism and Materialism. These systems tended to specialize and individualize science. Facts and phenomena became the sole working tools of the scientist; experience was the sole criterion of knowledge. Anything like metaphysical speculation, the principle of causality or of finality were considered outside the sphere of scientific investigation. Science treats of facts. This new outlook is called the "operational viewpoint". It merely expresses the notion, "Does it work?" It is thus summed up in a recent book: "The essence of this movement is the attempt to throw out of all physics, all material of a purely speculative nature, leading to conclusions that cannot be tested. It requires that every prediction of a theory, called physical, shall be capable of proof or disproof by having recourse to experiment, for when this is not the case, there is danger of ending in a maze of speculation".[8] This attitude has brought about a new way of regarding the laws of nature. The law of nature, according to the present day scientist, deals with the constant mode of action, which he observes in nature. He is not concerned with the tendencies or potencies from which the action springs. Such tendencies cannot be subjected to a laboratory test. He places the whole of the law in the activity. It is the application of the operational viewpoint. It reduces the law to a quantitative value. Motions of a projectile can be measured and expressed in terms of force and velocity. Chemical compounds can be resolved; the elements can be weighted and valued. As philosophers, we do not quarrel with the scientist who thus states his position. He has the right to limit his field of research. He may decide to seek the proximate and not the ultimate; to give an approximation and not the final analysis of nature; to tell how things act and not why they are so. They are right within the realm of their science and their conclusions are valid limits of their fundamentals.

PART II.

The Definition of a Physical Law.

A law of nature, scientifically considered, expresses a relation of regularity; it describes a constant and uniform mode of action. Science, ex professo, deals with physical phenomena and the relations that are observed among them. The purpose of science is to correlate these facts and formulate the laws that govern them. These laws are the rational links between experienced and non-experienced events. For

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VIIa. "Transitional Eras of Thought". Armstrong. p. 90.
VIII. "Atomic Physics". Physics Staff of the Univ. of Pittsburgh. p. 324.
VIIIa. "The Logic of Modern Physics". Bridgman. Ch. I.

although science has definitely limited its field to experience, yet from the very nature of things this must include in some way, both experienced and non-experienced facts. Predictability is an important factor in all science and prediction connotes a future event, which has not yet come within the scope of experience. In spite of this, the definitions generally given in scientific works seem to limit a law of nature to a summary of past experience. Let us note a few definitions:

"A law or generalization is a brief statement, describing some general fact or a constant mode of behavior". Smith, "Organic Cremistry", p. 33.

"A law of nature is only a summary of observed facts. It does not prescribe that something shall happen but only states what relations exist". Ostwald, "Principles of Inorganic Chemistry". p. 11.

"Scientific laws might better be termed generalizations, because they are merely formulations of experience". Curtis, in "Science and the Scientific Mind". p. 149.

From these definitions it will be seen that the scientist bases his law of nature on experience and we might say, totally on past experience. Hence we may define a law of nature as: "A generalization which expresses an observed relationship of constancy and uniformity of action in nature". If we consider the law as expressed by the scientist and by the philosopher, we note:

I. The scientist expresses in his law, what the philosopher considers the effect of the law. The scientific law embodies the uniformity and constancy of action ,while the philosophic notion places the law in the tendency or determination of a material being. This he conceives as the cause of the constant and uniform action. Between these two there is no conflict, when the points of view are clearly understood and the definitions of law are weighed in the light of fundamental concepts. Both are right according to their starting points. The scientist expresses a de facto relationship; the philosopher makes a deeper investigation into the cause and nature of this relationship. The scientist is content to describe what happens; the philosopher tries to tell why it happens.

II. The scientist limits the scope of his law to observed facts. His law is the generalization of experience. Logically, he cannot apply his law, with certainty, beyond his field of experience. Under this limitation, a physical law cannot be the rational link between experiences and non-experienced facts, between the known and unknown. But this would hardly be admissible in science. The philosopher, on the other hand, by placing the essence of the law in the nature of material beings, or in a natural tendency, universalizes the relationship and thus makes it valid not only in the cases of observed phenomena but also in all other beings which have the same nature as those observed. This follows from the principles of Induction, whereby from the nature of a few individuals, we learn the nature of all individuals in the same class. Moreover, this view of the philosopher, founding the law on the nature of physical beings, is in keeping with his purpose of seeking the ultimate causes of things. The nature of essence is the ultimate reality of any being. If however, we accept the fundamental position of the scientist, we see that he is, at least, in theory, logical in his conclusions and there is no conflict with the view point of the philosopher. Both define the law as they conceive it and extend it only within the limits of their conceptions.

There is one point in which the philosopher seriously disagrees with the scientist and that is the question of the certitude of the laws of nature. As philosophers, we attribute to the laws of nature a physical certainty. They are necessary, with an hypothetical necessity, that is to say that excluding any divine intervention, they must of necessity act and produce their effects, supposing the requisite conditions. In a word, they are necessary causes. With regard to the attitude of the scientist, it is well to distinguish between his theory and practise. In his scientific investigation, the man of science has not the slightest doubt of the certainty of the laws of nature. The astronomer who predicts for years to come, the eclipses, the rising and the setting of the sun, is fully confident that his predictions will eventuate. The chemist, investigating the composition and resolution of chemical substances, prepares his elements according to definite proportions and under specific conditions, with the full assurance that the chemicals will react in accordance with the laws formulated for the past century. Einstein made his prediction about the bending of a ray of light as it passed near the sun and did not dream of making provision for the possibility of the laws of nature not being valid in this case. In practise, the scientist accepts the absolute validity and certainty of the laws of nature, as does the philosopher. This is clear also from the general practise of the scientist in his predictions of future events. If a phenomenon does not happen according to his calculations, he does not immediately conclude that the laws of nature are not valid in this case, indeed, that is the last supposition that would be made, but he at once suspects that there is an unknown factor present that causes the disagreement between the actual experiment and the calculated results. The foundation of Hume's denial of miracles is based on the absolute certainty of the laws of nature.[9]

The writings of some of the moderns present an entirely different aspect of the problem. There are many who assert that we can predicate only a probability of the laws of nature. Jevons says: "On the assumption that our experience is of adequate extent and that no arbitrary interference takes place, we are then able to assign the probability,

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IX. Hume. "Enquiry Concerning Human Understanding". Sec. 10.

always less than certainty, that our next object of the same apparent nature will conform to the same laws".[10] And Ostwald: "In other words, the law of nature cannot have a necessity whereby events must be repeated and it is quite possible that following many confirmatory cases, some should be found which do not conform to the law".[11] Others speak in the same strain.

If we consider this position from a strictly philosophical point of view, it is not easy to find a rational justification for one who holds as fundamental, at least implicitly, the principle of causality and the uniformity of nature and then asserts that the laws of nature are only probable for future events. His basic principle supposes that he is not founding the constancy of activity, which he observes in nature, on this or that particular phenomenon or upon mere experience but on something more stable and fundamental in material beings, in which experience has its reality. The validity of experience and the reason why the scientist is able to correlate regularities of nature, is simply because they are founded on the natures and essences of things and not on particular events in themselves. Therefore, if a given, material being acted uniformly in the past, by the same token, it will act in the same way in the future. For if these basic principles are certain, as we have proved them in philosophy, and if the method of scientific induction is logically sound, then we are driven by logical necessity to the conclusion that the laws of nature will be as certain in the future as they have been in the past. Though many scientists may be excused for the lack of a philosophical training, we may justly criticise their position for all men who are seeking the truth, are bound by the laws of right thinking.

Nevertheless, we cannot deny that there is a certain logic in their stand, if we prescind from their fundamental principles. The law of nature is a generalization which expresses an observed constancy of action in nature. The purpose of this law is not to explain the "why" of things but merely to tell how they act. This point of view is a purely "a posteriori" one and the law is a summary of experience. The scientists simply asserts that as far as his experience tells him, nature acts in this or that definite way. Will it act so in the future? Perhaps, yes; perhaps, no. That will depend on experience. It is evident that some laws have been changed in the past and perchance this will happen in the future. In criticising this attitude, we must note that the scientist does not pretend to express in his law, the complete, objective working of nature but merely **that which he has observed.** There is an evident distinction between the objective way in which nature works, which is independent of any observed action and a scientific expression of the observance of this action. When science says that the laws of nature are only probable, it really means to say that with greater experience

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X. "Principles of Science". Jevons, p. 738.
XI. Ostwald, op. cit. p. II.

and precision of experiment, we may be forced to change the expression of our law. A law may at first be held as universal but experience may afterwards show that the law is valid only within certain limits. We would say that the law was changed, meaning of course, that what we observed in nature in one case has been modified by later experience. Our philosophic definition of the law of nature refers to the objective working of nature, that is in itself, constant and independent of the will of man. There is no difficulty in admitting that the expression of a law may become more and more precise as our knowledge increases. Broader experience will sharpen the lines which define the limits within which the law operates but this does not effect the operation of nature, in itself. Our knowledge and the expression of this knowledge of the operations of the physical order may be called the law in the subjective sense. It is this that is probable and changeable. Objectively, nature is constant and unchanging.

In conclusion, we shall note the following relations between the scientific and the philosophical aspect of the laws of nature:

I. The philosophic question is distinct but not separated from the scientific question. They supplement each other. For science seeks to explain "how things act", while philosophy answers the question, "why things are so".

II. In both science and philosophy, we are dealing with a relation of uniformity, order and sequence of natural events, which are the manifestation of the presence of natural laws. These relations of regularity are considered in philosophy, in their causes; and in science in their effects.

III. Hence, the philosopher and the scientist disagree in their fundamental definitions of laws of nature. This, at first sight, offers an apparent difficulty in the solution of the problem but when the definitions are clearly understood, we see that they can easily be brought into harmony.

IV. The certainty which the philosopher predicates of the laws of nature is founded on the nature and essences of material beings. Since these essences and natures are constant and unchanging, we can attribute to the laws, an absolute, physical certainty. The scientist, on the contrary, adds the note of probability, because he states his law as the generalization of experience, and this may be a changeable factor. Therefore, his generalization may vary with his experience.

Joseph P. Kelly, S.J.
Weston College,
Weston, Mass.

CHEMISTRY

MICRO DETERMINATION OF CARBON AND HYDROGEN

REV. RICHARD B. SCHMITT, S.J.

In the previous issue of the Science Bulletin, Vol. XI, No. 1, we gave the methods for correcting two sources of error in the carbon and hydrogen determination of organic substances: the purification of the oxygen, and the standardization of the absorption tubes by means of sweeping out both absorption tubes with the same amount of clean, dry air.

The next step in the procedure is as follows: The Standard Pregl absorption tubes, which have been properly filled according to directions, are first weighed. The capillary constrictions at the ends are first cleaned with a fine cotton wad twisted around the roughened end of a coarse iron wire. The copper or silver wires are then placed into the capillary constrictions in such a way that all of each wire including the loop at the end, is in the capillary. The tubes are then wiped. A tube is first wiped with a moderately moist flannel cloth; it is held by means of a clean chamois with one hand and wiped with the other. The moist flannel is moved from the center towards and over one capillary ending. The tube is then reversed and the other half similarly cleaned. The moist flannel is then changed for a dry chamois and the absorption tube again wiped by holding with a piece of dry chamois and wiping from the center to the end with the other chamois. Provided the flannel has not been too moist, three such wipings are generally necessary. The wiping is repeated until the chamois slides over the surface without noticeable friction; the procedure must not be repeated too often as electrical charges will accumulate and cause trouble in weighing. The side just wiped is covered by the dry chamois and held while the procedure is repeated for the second side. Caution must be observed not to crush the fragile absorption tubes when holding them. The tubes after being wiped are placed on a weighing rack and must not be touched except with a dry chamois or the special form designed for their manipulation. After ten minutes the water absorption tube is placed on the balance with the aid of a special fork. The tube is weighed to 0.01 mg. removed to the weighing rack, and replaced by the carbon dioxide absorption tube. This second tube is also weighed with the same precision (0.01 mg.)

The water absorption tube is then reweighed; weighing of both tubes are repeated until a constant weight is obtained. Deviations of 0.02 mg. are permissible.

After the constant weight within the given limits has been attained, the copper or silver wires are removed by means of a platinum hook. The water absorption tube is then attached to the other absorption tube so that the two removable capillary stoppers are adjacent. Seamless, specially prepared rubber tubing is used to make the connection; The bore must be small enough to hold the tubes tightly. A familiar type of tubing 15 mm. long is attached to the free end of the water absorption tube. The absorption train is then connected to the capillary end of the combustion tube, the water absorption tube is put first. When it is found that the rubber tubing connectors adhere too tightly, they are lubricated. A small wad of cotton moistened with a trace of glycerine is twisted on an iron wire and pushed through the holes of the stoppers. A clean cotton wad is used to clean out the excess of glycerine. This is repeated to insure no excess glycerine which would vitiate the results of analysis. Such lubrication is usually needed once for approximately each ten combustions. The rubber connector nearest the combustion tube, due to exposure to heat, needs replacement about each five combustions.

The Preparation and Weighing of the Sample;

It is most convenient to weigh out a sample for combustion either while the absorption tubes are on the rack, or during the second half of the combustion when the gaseous products of combustion are being washed out in a stream of oxygen. The platinum boat or foil is cleaned by boiling in dilute nitric acid and heating to red heat in the non-luminous flame of a Bunsen burner. A 3-5 mg. sample is weighed out in the usual manner. Solids are weighed directly in the platinum boat; liquids are weighed in a capillary pipet. The weighed sample is placed on the copper block of a micro-dessicator. The dessicator is then carried to the combustion apparatus.

Introduction of Sample;

After the weight absorption tubes are attached to the combustion tube (the Mariotte flask must not be attached), the combustion tube is opened and the platinum boat or foil from the previous combustion is removed by means of a platinum hook attached to a glass rod; it is imperative that the glass rod be clean and dry. The dessicator and sample are placed as close as possible to the mouth of the combustion tube, care being taken to keep far enough away from the heating device. The top of the dessicator is removed and the copper block with the weighed sample is brought with one hand as near as possible to the open end of the combustion tube. The platinum boat, or foil, is then introduced into the combustion tube by means of clean platinum forceps. It is inserted about 10 mm. Care must be exercised that the open end of the combustion tube is kept clean. The sample is pushed into the cold end of the combustion tube about 50 mm. from the oxidation filling. A clean dry glass rod is used for this purpose.

The combustion tube is then closed. If a side arm combustion tube is used and this type is recommended, a cork stopper is suitable. With the older type of combustion tube a one-hole rubber stopper carrying the gas inlet tube from the purifying train is used.

The bubble counter is now observed; oxygen gas must flow through the system. Now the Mariotte flask may be attached. The side arm of the flask is lowered until water drips out, then the safety tube of the flask is attached to the free end of the carbon dioxide absorption tube.

The velocity of the gas flow in the system should now be observed. This may be done by observation of the water flow from the Mariotte flask or by counting the number of bubbles per unit of time passing through a previously standardized bubble counter. The proper gas flow can be obtained by adjusting the pressure regulator. The glass ball of the regulator is raised or lowered until 4.5 cc. of water per minute flow is had from the Mariotte flask.

The heating mortar should now be examined, the liquid must be boiling. It is obvious that the long heater of the combustion filling must also be properly functioning, the combustion tube filling must be at the proper operating temperature.

The Combustion;

All the preliminary steps and observations having been performed, the combustion is begun. A movable Bunsen burner with a flame of such size that the outer one is about 5 cm. in total height is used to start the combustion. A nichrome or iron gauze must always be around the combustion tube over the area being heated by the movable burner. The metallic gauze is moved simultaneously with the Bunsen flame. The combustion is started by applying the flame about 50 mm. from the sample in the direction of the mouth of the combustion tube. The flow of gases through the bubble counter will slow down immediately, but soon resume normal speed. Then the size of the flame is gradually increased so that at no time is the speed of the gas passing through the bubble counter greatly altered. The final flame size should be such that the combustion tube is entirely enveloped in the flame cone and so that the flame cone extends about 10 mm. above the metal gauze. When the speed of gases is normal, the burner and gauze are moved in the direction of the gas flow towards the sample. The sole regulation of pressure (as noted by the speed of the bubbles in the counter) from this moment on must be done by means of the movable burner. The pressure must be kept reasonably constant, and this is done by removing and reapplying the flame. It is absolutely prohibited to change the pressure in any other way during the combustion; the pressure regulator must under no circumstances be interfered with. Caution should be doubled as the sample sublimes, distills or decomposes. If the substance sublimes or distills, the ring of sublimate or distillate can be driven slowly towards the heated filling and the progress of the combustion visually observed. Substances which decompose with charring require prolonged heating directly under the boat until no organic (black) residue is left in the boat. The combustion should be carried out with 75 cc. of oxygen at the standard speed of about 5 cc. per minute (about 15 minutes in all). This combustion is the most important step in the entire determination and must be performed with the greatest care possible. The movable burner and its accompanying gauze should now be up to the tube oxidation filling; both are now moved to their initial position and again moved towards the oxidation filling. This time only about 5 minutes are required. The boat and combustion tube should be examined while doing this for carbon deposits or other organic residue and these must all be burned off. The movable burner is then turned off and the gaseous products of combustion further washed out. 100 cc. of oxygen are necessary for this requiring about 20 minutes. As has been stated elsewhere this time may be utilized by weighing out the next sample. If during the combustion water condenses in the capillary construction of the water absorption tube it may be vaporized by the heating the end of a file, and applying it to the constriction.

Removal of the Absorption Tubes;

After the combustion and washing through of gases is complete, the Mariotte flask is disconnected at the safety tube, and its sidearm is then raised. The air filter is then brought to the combustion apparatus the water absorption tube is disconnected from the combustion tube and immediately attached to the air filter. The carbon dioxide absorption tube is *not* detached from the other tube at this time. The entire absorption train: air filter, water absorption tube and carbon dioxide absorption tube, is then brought into the balance room. The side arm of the Mariotte flask there is lowered until water drips out and its safety tube is then attached to the free end of the carbon dioxide absorption tube. Air is then drawn through the system at a rather rapid rate (about 10 cc. per minute). About 50 cc. of air is drawn through. The tubes are then disconnected, cleaned and weighed as previously described.

Calculation:

% H:

Neg. log of weight of sample; plus log of weight of water; plus 04875 (factor)

% C:

Neg. log of weight of sample; plus log of weight of CO_2 plus 43573 (factor)

SULFUR METABOLISM AND MERCAPTURIC ACID

ALBERT F. McGUINN, S.J.

Sulfur metabolism is chiefly concerned with the amino acid cystine, which is the main sulfur-containing constituent of animal and vegetable protein. Although cystine is present only in small quantity in proteins, the results of nutrition experiments have shown this amino acid to be essential for the growth and maintainance of animals. The animal organism seems to be incapable of synthesizing it from inorganic materials or from related organic compounds, and unless it is present in the food, one type of building stone is lacking for the formation of new tissue and the repair of worn tissue.

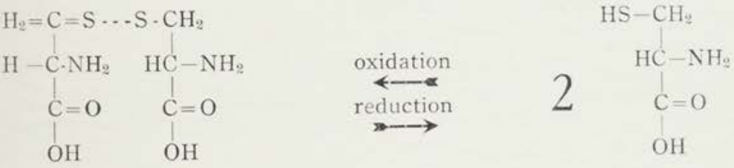
When cystine is fed in small amounts to a normal animal, it is rather completely oxidized, and its sulfur can be accounted for by the increased excretion of sulfate in the urine. Also during starvation or on a protein-free diet, there is some excretion of sulfate, which, under these conditions, must have resulted from the catabolism of tissue cystine. Although only small amounts of cystine are present in normal urine, in the rare abnormality known as cystinuria, comparatively large amounts of cystine are excreted, and this continues even on a non-protein diet. When cystine as such is ingested by a cystinuric, it does not increase the excretion of cystine, but, as in the normal subject, it is oxidized to sulfate. It is true that a high protein diet in such cases increases the output of cystine, but a high protein diet containing little cystine is as effective in this respect as one containing much cystine, and the effect is best explained by an increased metabolism stimulated by the high protein diet. All these facts point to a marked difference between the metabolism of endogenous and exogenous cystine in the cystinuric organism. In the normal subject, if we judge merely from the normal excretory products, this difference does not exist, but it long has been a disputed point.

The problem may be stated as follows. If we hydrolize protein with acid, cystine may be isolated from the hydrolysate. Peptic and tryptic digestion of protein in vitro will yield the same produce. In the normal process of digestion of protein, cystine is formed in the intestine; this passes into the blood stream, and is then used to form tissue protein, or is used as fuel after deamination in the liver. But what happens during the catabolism of tissue protein? Is there in the active protoplasm a similar hydrolytic process which converts tissue proteins to amino acids, and thus sends cystine into circulation for use as fuel or for building of new tissue, or, as some thought, does this process produce complex compounds which are oxidized without going through the intermediary stage of amino acids?

One method of attacking this problem has been through the study of the mercapturic acid synthesis. When brombenzene is fed to a dog on an ordinary meat diet, the foreign compound is detoxicated probably in the liver by conjugation with cysteine, and the acetylated product, mercapturic acid, is then excreted through the kidneys. The cystine resulting from the digestion of meat protein, instead of being oxidized or used for tissue formation, is thus side-tracked by the brombenzene, and a sort of artificial cystinuria is produced. We have then in brombenzene a toxic substance which reacts with cystine in the organism, to form a compound which can be readily isolated from the urine. The amount of mercapturic acid can be increased by simultaneous feeding or injection of cystine, and it is thus evident that at least a large part of the cystine used for this detoxication comes directly from the diet. If now we exclude all cystine from the diet over a period of days, and feed brombenzene, will the catabolism of tissue protein yield its cystine for the mercapturic acid synthesis? If so, we have evidence that the catabolism of tissue protein passes through the intermediate stage of amino acids; if not it would appear that the opposite is true, and consequently that the intermediary stages of endogenous and exogenous metabolism are different.

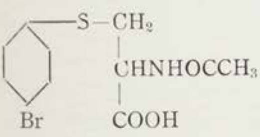
Earlier work designed to test this point always yielded negative results, and it was commonly accepted as a fact that endogenous cystine cannot be used for the formation of mercapturic acid. More recently all this work was criticized by Abderhalden, who being convinced by evidence from other sources that the break-down of tissue protein yields amino acids to the blood, thought that under the proper experimental conditions the cystine of endogenous metabolism could be detected by feeding brombenzene. He limited the starvation period to six days and using small doses of the toxic substance, he succeeded in isolating small quantities of mercapturic acid. The results were not always positive, and his experimental period seems a bit short, but he showed definitely that cystine is available in the body after six days of cystine starvation. He gave a plausible reason for the negative results of previous investigators. The longer period of protein starvation would have depleted the sulfur resources of the body to such an extent that the smaller amount of cystine resulting from tissue breakdown would be preferentially utilized again by the organism for the building of insulin, glutathione and taurine, all important physiological substances, and hence would not be available for the reaction with brombenzene. Although the living organism does display a remarkable power of conserving its resources during the stress of starvation, this explanation assumes, that even though the two substances were intimately present, no reaction could occur between brombenzene and cystine, if the latter were needed for other purposes. We know that in the case of many foreign organic compounds introduced into the body, reactions occur which are very unfavorable to the organism, and about which the organism has no decision. It seemed likely that the effect of a limited supply of cystine could be merely a much limited synthesis of the detoxication product. Also it was desirable to conduct an experiment in which the protein starvation period would be extended more than six days in order to preclude the least possibility that the cystine originated not from the tissues, but from the last traces of food cystine which had not yet been used for the formation of tissue.

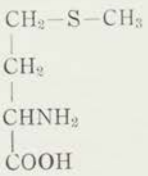
While working on another phase of this subject, we had developed a new method of isolating mercapturic acid from urine, more sensitive more reliable than the methods used hitherto, and this gave us reason to believe that we might succeed in obtaining mercapturic acid under more extreme conditions. The existing methods depended on the slow crystallization of the compound from acidified urine, the new method is based on extraction of the urine with chloroform, and was found in certain cases to give positive results where the older methods had failed. For our experiment a dog was starved for five days, and on the nine succeeding days he received sufficient corn starch and lard to satisfy caloric requirements. Brombenzene was administered by mouth on the seventh day and by injection on the fourteenth day, and each time an appreciable quantity of mercapturic acid was isolated from the urine, and identified by the usual methods. This experiment seems to offer the strongest evidence that cystine which has entered into the makeup of tissue protein is reproduced as such during the break-down of this protein. It also shows that appreciable quantities of this cystine may be side-tracked by brombenzene, even though the organism is starving for the substance, and the limited supply is needed for the synthesis of important physiological substances. This is a typical example of the application of detoxication chemistry to the solution of problems of intermediary metabolism. It is hoped that further study of the mercapturic acid synthesis in the near future, as planned in the Fordham laboratory, will clarify the physiological relationship of methionine to cystine.



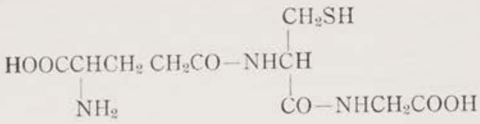
Cystine

Cysteine


Mercapturic Acid

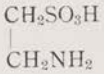

$$\begin{array}{l} CH_2-S-CH_3 \\ | \\ CH_2 \\ | \\ CHNH_2 \\ | \\ COOH \end{array}$$

Methionine



$HOOCCH(NH_2)CH_2CH_2CO{-}NHCH(CH_2SH)CO{-}NHCH_2COOH$

Glutathione



$CH_2SO_3H{-}CH_2NH_2$

Taurine

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CHEMO-MEDICAL RESEARCH INSTITUTE, GEORGETOWN UNIVERSITY, WASHINGTON, D. C.

Report for the Yearly Period July 1, 1932, to June 30, 1933

Since the founding of the Institute three main lines of research have been carried on: (A) sulfur metabolism in health and disease; (B) the study of the urine in cancer and the development of tests of value in the early diagnosis of cancer; (C) the development of more specific tests for amino acids, amines, and other biologically important constituents of body fluids and excretions. At times the three projects were identical but at other times entirely distinct.

During the year covered by this report most of the work was on project (A) which at the time dovetailed into (B) and (C).

Project (A): **The cystine content of the finger nails.**—The study of the cystine content of the finger nails in arthritis by the specific Sullivan test was continued and completed and a paper prepared for publication. The cystine content of the normal finger nail was found to vary from 11 to 13 per cent. The average for 26 normals was 11.69. The finger nails of arthritics were found to vary from 7.2 per cent. cystine to 13.11 per cent. with an average of 9.77. Of the arthritics 22 per cent. were below 10.

Total sulfur.—The average total sulfur of the finger nails was found to be: normals, 3.2535 per cent. equivalent to 12.2 per cent. cystine; arthritics, 2.78 per cent., equivalent to 10.425 per cent. cystine. In the case of normals the cystine sulfur was 98 per cent. of the total sulfur, while in arthritics the cystine sulfur varied from 76 to 98 per cent. of the total sulfur and on the average the cystine content of the nails explained approximately 90 per cent. of the total sulfur. Sulfur therapy in the form of injections of colloidal sulfur by intramuscular and intravenous routes applied to cases with low cystine nails increased the cystine content of the finger nails and improved the physical signs of arthritis.

The work on arthritis suggests that in the arthritic economy probably as a result of activity of micro-organisms there are injurious substances which draw on the normal sulfur complexes and thus divert the sulfur metabolism from the normal channels which would lead to a finger nail containing at least 11 per cent. cystine.

The cystine content of various enzymes and hormones.—In extension of the study of sulfur and cystine to bodily activities on our own initiative or on request from others in these special fields cystine studies were made by the Sullivan method on the enzymes pepsin trypsin, papain, steapsin, invertase, rennin, and urease and on the hormones regulating metabolism such as secretin, prolactin, insulin, the Parke Davis pituitary hormones, pitressin and pitocin, and MacArthur's active principles from the pituitary. All the enzymes excepting invertase contained considerable cystine. Crystalline pepsin and trypsin sent us by Dr. John H. Northrop of the Rockefeller Institute for Medical Research were richer in cystine than our crude samples. Crystalline urease contained much more cystine than the Jack bean meal it was derived from. A number of other considerations show that the cystine is playing a part in the activity of the enzymes. All the hormones contained cystine. Secretin, the hormones stimulating the flow of digestive juices and prolactin the hormone stimulating milk flow contained fair amounts of cystine while insulin the hormone regulating sugar metabolism and the pituitary hormone regulating other bodily activities were rich in cystine, 8.5 per cent. cystine in insulin and 12.7 per cent. in MacArthur's pituitary hormone. In both of these cases, cystine explains most of the total sulfur, entirely in the case of the active principle of the pituitary.

Many other applications were made of the Sullivan cystine reaction: the estimation of cystine and glutathione in the lens of the eye normal and cataractous and of the blood before and after lactation; the sulfur and cystine content of hair and of certain plant materials, used medicinally, and of various purified foodstuffs and body proteins. A finding which may have some application to cataract is that the lens of the normal eye contains glutathione, a tripeptide of glutamic acid cystine, and glycine, while the cataractous lens contains little of any gutathione. One interesting finding was that serum albumin contains about 5.7 per cent. cystine. In health the blood contains much more serum albumin than serum globulin while in diseases associated with infection the ratio is claimed to be reversed.

Improvements in methods of analysis.—In work with the serum globulin analyzed at the request of Dr. Mirsky of the Rockefeller Institute for Medical Research methods of hydrolysis that hydrolysis were so improved by use of a catalyzer that hydrolysis and cystine estimation can be made in one morning instead of the 7-20 hours hydrolysis employed by others.

Project (B). **Tissue work.**—Occasion was offered us to study the constituents of the cancerous part of human stomach as compared with the neighboring relatively sound part and of cancer nodules of a liver compared with the relatively normal portion. Many other studies were made of cancerous tissue but doubts arose as to the validity of the methods when applied to such complex material.

Urine work.—In the study of the urine in cancer, promising leads were obtained in the study of decomposition products of nucleic acid and in derivatives of oxyproteic acid. This study however, was time taking, and did not lend itself to clinical testing. Accordingly, it was laid aside temporarily in an endeavor to devise and authenticate tests more useful clinically. Attention was focused on the development of color reactions. Finally a simple colorimetric reaction was devised which has been tested in cancer, in non-cancer cases, and in normals. Up to October 1932 the results were:

	No. tested	Positive	Negative	% Positive
1) Cancer cases	50	45	5	90.0
2) Other pathological conditions	52	5	47	9.6
3) Normal	45	0	45	0.0

A preliminary report covering sulfur studies, polypeptide in urine urinary proteose, nucleo proteid decomposition products, and the color reaction in cancer urine was given in Medical Annals 1, No. 10, October 1932.

Most of the cancer cases listed were marked cases. In more recent work with cancer suspect it became evident that the only way to evaluate the test is to go to cancer hospitals and to test authenticated cases of marked cancer, mild cancer, and patients which clinical experience suggests are probably cancerous but not proved so. This work we shall do this fall since facilities have been offered by Dr. Ellice McDonald of the Cancer Research Hospital, University of Pennsylvania.

Thiocyanate in urine.—Work was done on thiocyanate which Saxl (Biochem. J. 1913, 55, 234) concluded was quantitatively increased in cancer. A study was made of a large number of cases of cancer with the same method that Saxl used. A number of cases of marked cancer involvement showed high apparent thiocyanate, as found by Saxl, but other marked cases were within normal limits and sometimes below normal. From our work we concluded that thiocyanate is not necessarily increased in cancer though the apparent thiocyanate is increased on the average because in the method used some cases as, for example, multiple myeloma or cancer of the bone are exceedingly high. While studying and evaluating the Rupp-Schied-Thiel thiocyanate procedure as applied by us to pathological urines, cancerous and non-cancerous, and to normal, it was found that other substances potentially or actually present in urines behaved in this reaction like thiocyanate. These substances are ergothioneine urinary proteose, and oxyproteic acid and to some degree uric acid. The thiocyanate value of each of these substances was determined. The conclusion was drawn that the Rupp-Schied-Thiel method used by Saxl is not a measure of thiocyanate if applied directly to urine. A new procedure was devised to eliminate the interfering substances and give much less thiocyanate in normal urine than shown by the older work. As yet the new procedure hasn't been applied to the urine in cancer.

Ergothioneine in urine.—The evaluation of Saxl's cancer urine work led us to the discovery of a compound hitherto unreported. Ergothioneine is a sulfur compound, the betain of thiohistidine, which previously had been found in ergot and in the red blood cell. Applying to urine the methods used for the estimation of ergothioneine in blood there was found the following amounts of ergothioneine—like material.

Normal	89.5	mg.	per	liter	(ave.	of	11	normal	urines)
Cancer	147.0	"	"	"	"	"	13	cancer	"
Arthritis	98.1	"	"	"	"	"	9	cases	
Other pathological cases	88.5	"	"	"	"	"	20	"	

By isolation methods applied to normal urines only 5-6 mg. per liter of ergothioneine was found and at least one other substance as yet unidentified was found behaving like ergothioneine in precipitation with silver lactate and colorimetric reaction but behaving differently in precipitation with Cu_2O and in certain chemical reactions.

Other phases of cancer research are being continuued.

Project (C). **The development of more specific tests for amino acids, amines, and other biologically important constituents of body fluids.**—In work with various urines normal and patheological, it was found that oxyproteic acid was increased over the normal in cases of cancer, tuberculosis, and pregnancy. In applying accepted uric acid methods to these urines it was found that the oxyproteic acid fraction would lead to erroneous conclusions in the colorimetric estimation of uric acid since like uric acid it is precipitated by silver lactate, is extracted similarly by acid sodium chloride, and reacts more or less with the uric acid reagents. A search for a more specific test for uric acid was made and progress in devising such a test has been made.

Test for proline.—Proline $C_4H_7NHCOOH$ is an imino acid containing NH where the rest of the primary protein decomposition products contain (NH_2). Proline is resistant to agencies which destroy amino acids (NH_2). It might be expected to increase in cancer tissue if agencies injurious to ordinary amino acids are at work. Accordingly, a colorimetric test which can be used to estimate proline in mixtures of amino acids has been devised and has been applied to the estimation of proline in casein and gelatine. As yet it has not been applied to cancer tissue. In all our work we are compelled to pioneer, evaluating old tests and developing and standardizing new ones where the accepted tests have been found wanting. This makes our labor great but findings satisfactory and later appreciation sure.

Publications.—The different phases of the work detailed in these pages have been or will be detailed in publications.

The papers on the work to date are:

(1) Chemo-Medical studies of pathological conditions. M. X. Sullivan. Medical Annals 1, No. 10, 1932.

(2) The o-benzo-quinone test for cysteine. W. C. Hess and M. X. Sullivan. J. Biol. Chem. XCIX 95, 1932. (This refutes the claim of Dyer and Baudisch that this test is as specific as the Sullivan 1, 2 naphtho-quinone test.)

(3) Studies in Cancer; The application of the Rupp-Schied-Thiel thiocyanate reaction to the urine. M. X. Sullivan and W. C. Hess. Proc. Exp.Biol. and Med. XXX, 804, 1933.

(4) Evaluation of the Rupp-Schied-Thiel method as a test for thiocyanate in urine. M. X. Sullivan and W. C. Hess. Proc. Exp. Biol. and Med. XXX, 805, 1933.

(5, 6) Detailed papers on same subject as No. 3 and 4 will appear in J. Wash. Acad. Sci. Aug. and Sept. 1933.

(7) Ergothioneine in the urine. M. X. Sullivan and W. C. Hess. J. Biol. Chem. Sept. 1933.

(8) The cystine content of the finger nail in arthritis. M. X. Sullivan and W. C. Hess. In Manuscript.

(9) The gasometric determination of cysteine and cystine. W. C. Hess. (Errors in this method are pointed out). Proc. Am. Soc. Biol. Chem. VIII, LIV, 1933.

(10) Detailed paper, same title in manuscript, to be sent to J. Biol. Chem.

(11) Methods for estimating thiocyanate in urine. M. X. Sullivan, Proc. Am. Soc. Biol. Chem. VIII, XCI, 1933.

At the fall meeting of the American Chemical Society in Chicago, Sept. 10-15 four papers on our work will be presented as follows:

1) Further studies on arthritis. M. X. Sullivan and W. C. Hess. Before Division of Medicinal Chemistry.

2). Recent studies on urinary constituents. W. C. Hess and M. X. Sullivan. Before Div. of Medicinal Chemistry.

3) Improvement on methods of hydrolysis. M. X. Sullivan. Before Div. of Biological Chemistry.

4) Some amino acid constituents of finger nails. W. C. Hess. Befor Div. of Biological Chemistry.

CHEMICAL RESEARCH AT FORDHAM UNIVERSITY

REV. FRANCIS W. POWER, S.J.

The visitor to the main office of the Fordham University Chemistry Department will perhaps be surprised at being greeted by a large white dog covered with black spots, much as if he had been caught in a shower of ink. This is Rex, the Dalmatian coach dog, at one time an honorary member of the New York Fire Department, who (when he is not "working") takes great delight in searching the visitors' pockets for something to eat. He is supposed to be a pure-bred Dalmation, but his appetite leads one to suspect that he is at least 75% lunch-hound. When he is working, however, he has his quarters in a metabolism cage and becomes for the time being a chemical dog.

Ever since 1915 research in physiological chemistry has been the chief interest at the Fordham laboratory, and at one time or another there have been in the building dogs, cats, mice, rats, rabbits, an alligator, a snake, a monkey, some chickens and guinea pigs, and one large garden variety of pig. Animal experimentation is, of course, the usual thing in most types of biochemical research, but the chemists do not always stop at the animals; they very frequently use themselves as experimental subjects. One man dosed himself with about one-sixth of an ounce of a particularly nasty compound called phenylacetic acid every 8 hours for 3 days and worked along in the laboratory all the time until the 9th dose when he had to go home sick. This sort of work is connected with one of the general lines of Fordham research which is called detoxication and which may be described as the inverse of the problem of toxicology.

The toxicologist is interested in finding out what a poison will do to an animal; we are interested in finding out what the animal does to the poison. This work of ascertaining the fate of foreign organic compounds in the animal body differs from toxicology also in this, that our studies concern the chemical side of metabolism—a vital function of a living and, as far as possible, normal organism—hence we cannot use any of the more dangerous poisons nor even very large doses of the milder ones. If a rabbit for instance is given by mistake a lethal dose of picric acid, his death is mourned by the chemist because the latter has lost perhaps a month's work spent in studying the sulphur and nitrogen metabolism of the rabbit under normal conditions of diet before he was fed the dose which caused his regrettable demise.

The experimental animals, therefore, are exceptionally well cared for; the two "synthetic pups" which one of the research men has raised from babyhood to their present age of one year are the sleekest, liveliest, roly-poly pups one would care to see, yet they have never gnawed a bone nor have they ever tasted meat, or milk either, after they were weaned. They are fed specially devised synthetic diet and have not been used as experimental subjects for detoxication studies. The object of the experiment in their case is primarily to obtain the complete metabolic history of a growing animal, and to correlate this with his general physical growth.

The chemistry of the digestive process is pretty much the same in humans as it in animals, but there are a few interesting differences. For example, certain constituents of meat are changed by the body into uric acid, but the same meat is converted by the dog into a slightly different compound called allantoin. It seemed like a good point for evolution when it was discovered that apes followed the human system of metabolism in this respect until a chemist at Yale found out that this behavior is shared to a large extent at least by the spotted Dalmatian coach dog (but by no other dog as far as we know) hence if our family tree has an ape or two in its lower branches we might well expect to find a coach dog there too. At all events, Rex is put to work every now and then on uric acid studies and is almost as good as a man in that regard, besides making things much easier for the chemists who don't have to dose themselves with the compounds being studied but can "try it on the dog first".

Another very interesting difference between the metabolism of men and animals lies in their method of eliminating phenylacetic acid. The digestive systems of all the lower animals, including the monkey, perform a chemical combination of this substance with the simplest of the so-called amino acids (of which 19 are known to occur in nature) and the resulting compound which is excreted is entirely non-toxic. All the Fordham chemists have taken more than their share of this phenylacetic acid, and when they do take it its detoxication process is found to be quite different; it is a chemical combination of the ingested acid with one of the rarer and more complicated amino acids called glutamine.

Since the monkey falls into the class of lower animals both by this detoxication process and by anatomical considerations, the obvious thing to do was to feed psenylacetic acid to an ape and see whether he performed the reaction according to the monkey system or the human system. To test this out I was very kindly accorded the fullest co-operation of the officials of the Bronx Zoo and we made use of "Buddy", the little chimpanzee whose antics are the delight of visitors to the Primate house. He rather seemed to enjoy eating the phenylacetic acid we gave him. It turned out that Buddy used the human method of eliminating the test substance, and not that of the lower animals, thus adding another similarity to the many others that have been noted beween man and the apes. However, none of the leading investigators take these so-called homology arguments very seriously as irrefragable proofs of man's animal descent, since they all rest on the unprovable assumption that structural or functional similarity necessarily involves genetic relationship. Still it is a very interesting piece of scientific information and illustrates one ramification of the extensive field of physiological chemistry.

The problem that is claiming the greatest attention of the Fordham chemists just now is that of the chemical and physical properties of vitamin B-1. Lack of this vitamin causes in humans the disease known as beri-beri, still rather prevalent in the Far East and which can be simulated in many experimental animals by feeding them a special diet deficient in this vitamin. Such a diet induces in them a condition known as polyneuritis, and for the purpose of studying the vitamin, pigeons, chickens, rats and mice are commonly used in many laboratories. After the deficient diet has been fed for some time the animal so to speak goes into a decline and cannot long survive unless the missing vitamin is supplied. This is done in the form of a concentrated extract made from substances known to be rich in the vitamin, which bring about a very striking and almost miraculous recovery of the animal.

At Fordham we use white mice as experimental animals and we obtain our vitamin concentrate from three different sources, wheat germ, yeast, and rice polishings. The reason for the mice is that so far no chemical tests for the quantitative estimation of vitamins have been worked out and the only way the chemist can tell whether or not he has a potent extract is to try its effect on experimental animals who have been maintained on a deficient diet. Mice kept on a vitamin B deficient diet lose their appetite and hence body weight, their hair becomes ragged and eventually their legs become paralyzed. Our extracts at present are so rich in vitamin B-1 that they will cure these symptoms in a mouse, and keep him in good condition even on a deficient diet if as small an amount as 6 thousandths of a milligram of the vitamin per day is injected. This is about one ten thousandth the weight of a postage stamp, and amounts to about one twenty millionth of the body weight of the mouse.

Once the professor is satisfied that he has a potent extract he puts it through a very elaborate series of purifications until eventually a crystalline substance is obtained which is extremely potent and which shows all the characteristics of a pure chemical compound. When this stage is reached, the next step will be to determine the simple chemical formula for the substance; next, and much more difficult, to determine its chemical structure; and finally to go back and synthesize the compound itself in the laboratory. All the naturally occurring organic substances which have been synthesized have gone through this process; but in the case of vitamin B it is all the more difficult owing to the minute amounts present in the original substances and the great danger of destroying it during the long process of purification.

At least five other groups of chemists in different parts of the world are also working on this same problem, some of them better equipped for large-scale work than we are. Nevertheless, although they have gone through literally tons of rice polishings to get their concentrated extracts, there is still very little agreement among them even as regards the simplest chemical formula for vitamin B-1. We realize that many able chemists are working in this field but at the same time we are confident that the Fordham laboratory will have some very valuable contributions to make to this subject in the near future.

To carry out these and other research problems a very considerable amount of equipment is needed, and from what I have seen visiting various other laboratories in different cities I think that for the sort of work we are doing we are quite as well off in respect to building and apparatus as some universities and rather better than most. Our analytical work on organic compounds is run by the so-called micro-chemical technique which has not yet been introduced in many American laboratories. The micro balances are sensitive to one thousandth of a milligram and will detect a difference in weight of one part in twenty million. The Fordham chemistry library is supplied with all the standard chemical journals needed in biochemical work (most of them in German) and also with all the usual text-books and works of reference needed both by the research students and by the undergraduates.

Father Muenzen the Head of the Chemistry Department has 16 professors and instructors on his staff. During the year as many as 1000 students take some course or other in chemistry in the building. The Department has published during the past 16 years about 70 papers in the American and foreign chemical literature and our collection of reprints from these articles makes a volume of about 300 pages. This is, of course, the criterion by which scientific men judge the standing of a university, i.e., by the quality and number of its scientific publications, and in this respect the Fordham Chemistry laboratory is as well known in scientific circles as any other American university doing this sort of work.

Our research program is supported by Fordham for the same purposes as are similar ones in other universities, namely, to add to the sum of human knowledge about the phenomena of nature and to provide advanced students with the facilities for bettering themselves along scientific lines. As a Catholic university, however, we have the added incentive to emulate and if possible to surpass the achievements of those of our ancestors in the Faith who in past centuries laid so many of the foundation stones in our modern structure of scientific knowledge. We thus present a current and living refutation of that most persistent and widespread of modern fables, that the Church is opposed to science. We know that it is not, but in addition to the many books available which refute this charge as far as the past is concerned, we consider it to be an incidental feature of our work that it refutes this charge in the present.

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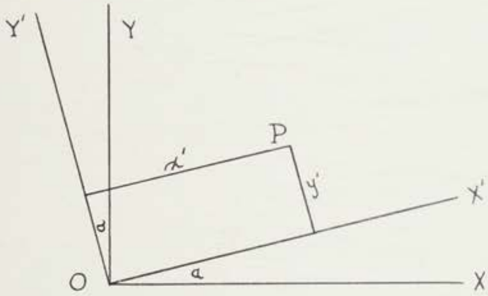
MATHEMATICS

AN UNUSUAL APPLICATION OF THE DISTANCE FORMULA

REV. T. P. BUTLER, S.J.

In the study of rotation of axes in Analytical Geometry, the first problem is to find the coordinates of a point refered to the new axes X^1 Y^1. The simplest and most logical method of doing this is by application of the very fundamental formula for finding the distance from a given point P (x, y) to a given line: $Ax + By + C = O$.

Suppose the axes rotated through α°. First determine the equations of the new axes, and then determine the distances (x^1, and y^1) from the given point P to the new axes.



In the above figure, for any point on the OX^1 axis, $y/x = \tan\alpha = \sin\alpha/\cos\alpha$ or $y\cos\alpha = x\sin\alpha$. Therefore the equation of the OX^1- axis is:-

$$y\cos\alpha - x\sin\alpha = O \qquad (1)$$

Likewise for any point on the OY^1 axis, $-x/y = \tan\alpha = \sin\alpha/\cos\alpha$ or $y\sin\alpha = -x\cos\alpha$. Therefore the equation of the OY^1 axis is:-

$$y\sin\alpha + x\cos\alpha = O \qquad (2)$$

Note that in equation (1) the coefficient of x is $-\sin\alpha$ and the coefficient of y is $\cos\alpha$, while in equation (2) the coefficient of x is $\cos\alpha$ and the coefficient of y is $\sin\alpha$. Furthermore, note that since both lines pass through the origin, there are no constant terms.

Applying the distance formula, $d = \dfrac{Ax + by + c}{\sqrt{A^2 + B^2}}$ we obtain

$y^1 = \dfrac{-\sin\alpha\, x + \cos\alpha\, y}{\sqrt{\sin^2\alpha + \cos^2\alpha}} = \cos\alpha\, y - \sin\alpha\, x$ and $x^1 = \dfrac{\cos\alpha\, x + \sin\alpha\, y}{\sqrt{\cos^2\alpha + \sin^2\alpha}} =$ $\cos\alpha\, x + \sin\alpha\, y$

METEOROLOGY

ATMOSPHERIC CONDITIONS ON THE NIGHT OF THE AKRON DISASTER

LEO W. WELCH, S.J.

The Akron crash aroused a great deal of speculation concerning the safety of airships in thunderstorms, and especial attention to the atmospheric conditions which prevailed along the New Jersey coast on the night of April 3-4, 1933. The situation is by no means easy to analyze, as the cause of the thunderstorms was found only in the upper air, over 3,000 meters above the surface. This discovery shows the paramount importance of obtaining upper-air data for use in working out accurate and detailed forecasts, such as are needed by aviators. The following summary is based chiefly on the analysis made by Mr. Charles L. Mitch-

Track of secondary depression and stations which recorded thunderstorms during the night of April 3rd and 4th, 1933.

ell, principal meteorologist of the Weather Bureau, as given in a personal interview and in his statements before the Joint Committee investigating the Akron disaster.

The Weather Bureau map for the morning of April 3, showed a low pressure area of wide extent but occluded, centered over the Upper Great Lakes. This depression was dying out and had no influence on the events which followed. To the northeast, over the mouth of the St. Lawrence River, was an anticyclone which caused the surface winds along the coast, from Maryland northward, to blow from the east and northeast, thus introducing a low wedge of moist maritime air into the region which was to be the scene of much disturbance. But the more important factors in the situation existed further southward. Over Virginia was a small area of relatively high pressure. To the west and southwest of this area can be identified the first indications of the development of a secondary depression—very small pressure gradient with the lowest pressure in a narrow trough from Knoxville southeastward to Augusta, and just west of the low pressure trough was an ill-defined cold front. The secondary deepened and advanced northeastward. Its successive positions at the hours 8 P. M., midnight and 8 A. M., are shown on the accompanying map.

Upper Air at Lakehurst, 3:35 P. M., April 3, 1933.

Altitude (meters)	Direction	Velocity (meters per second)
Surface	E	5 m/s
250 m	E	4 m/s
500 m	S	2 m/s
750 m	SW	3 m/s
1000 m	W	4 m/s
1500 m	SW	9 m/s
2000 m	SW	17 m/s
2500 m	SW	16 m/s
3000 m	WSW	20 m/s

The airplane observations made at Atlanta on the morning of April 3, show, according to Mr. Mitchell, that there was a very rapid movement of cold air, at and above 4,000 meters, from southwest to northeast over the Eastern portion of the United States. This air was travelling with a velocity of from 45 to 55 miles per hour. The temperature at 4,000 meters and 5,000 meters was 8 and 9 degrees centigrade cooler than the preceeding morning. This cold air had travelled from the north southeastward to Texas, then eastward to the Gulf States and northeastward over the south Atlantic States. Within the next 12 to 16 hours it was transported northeastward over the region where the numerous thunderstorms developed on the night of April 3-4.

These thunderstorms were quite unusual in some respects. They were reported from every costal station from Jacksonville, Florida, to Portland, Maine, with the one probable exception of Hatteras. (Cf. map.) These storms were situated indifferently over land and sea, at least they extended as far out to sea as the Akron flew, and were observed at such inland stations as Knoxville, Washington and Trenton. Moreover, they were all high thunderstorms. When it began raining in Washington, the ceiling was 6,000 feet or about 1,800 meters. The fog and low ceiling at such places as Lakehurst and Atlantic City, were properties of the low maritime air and were not indicative of the height of the thunderstorms.

The upper-air data obtained by pilot-balloon observations at Lakehurst, N. J., at 3:35 P. M., April 3, indicate the different strata of air which account for the fact that the storms were of the high type. (Cf. table.) From the surface up to 250 meters the air was moving from east to west. At 500 meters the air was coming from the south and had very little movement. This was about the height of the Akron during most of its flight. Mr. Mitchell said he was informed that the air temperature measurements made on the Akron showed a marked inversion of temperature above the maritime air near the surface. This layer of warm air extended, it would seem, up to 1,500 or 2,000 meters, where the air from the southwest was moving forward with rapidly increasing velocity with increase in altitude. The instability of the warm air when overrun by the cold air, accounts for the violent convection which caused the thunderstorms. The rate of progressive development of the storms was practically the same as the velocity of the cold air aloft measured at Atlanta on the morning of April 3.

At the time of the Akron crash, the papers reported statements from various dirigible authorities who gave their opinions as to the cause of the disaster. As some of these statements attributed the crash to the turbulence in the thunderstorms; and others, including that of such an eminent authority as Dr. Hugo Eckner, denied that thunder squalls could force a dirigible into the sea, it is of interest to consider some of the characteristic air movements in a thunderstorm, with a view to the dangers to airships in such squalls.

Although not all convectional currents produce thunderstorms, no thunderstorm can develop without convection. A large mass of air which is warmed to instability or is rendered unstable by the introduction of cold air above it, will be forced by the colder air above and around it to ascend in vigorous updrafts. If the warm air carries sufficient water vapor along with it, the lapse of temperature at higher altitudes will produce saturation and condensation. The release of the latent heat of vaporization will again raise the temperature of the originally warm air and give it increased instability, so that it is forced up to still greater heights. As the warm air rushes up, vertical downdrafts of colder air are taking place behind and around it.

There are some indications of the velocity of these up- and down-drafts, the most conspicuous of which are the turbulent cauliflower heads of cumulus clouds and the frequent presence of hail in thunderstorms. The structure of hailstones shows successive layers of snow and ice. These point to a number of trips up and down through the cumulus cloud from colder to warmer positions. Stones the size of hen's eggs are not exceedingly rare, and experiments show that the transportation upward of such stones by an air current requires a vertical velocity of the air of about 50 miles per hour. At times stones over one foot in circumference have been found. From all the evidence it seems very probable that the updraft in thunderstorms often reaches a velocity of 100 miles per hour. The rapidity of the downward movement of the cold air is shown by the sudden increases and oscillations of barometric pressure which take place with the arrival of a thunderstorm. Dr. W. J. Humphreys claims that it takes a downward velocity of 50 miles per hour to produce a jump of the barometer of one tenth of an inch. The downward movement of the air could not continue at a vertical velocity of 50 miles per hour closer than about 500 feet above the ground; but below that, even though it acquires a horizontal component, its vertical movement will still be comparatively rapid. Dr. Humphreys stated before the Joint Committee investigating the Akron disaster that these up and down currents can come within 200 and 300 feet of each other, perhaps even closer. The Akron was 785 feet in length, so one end of it could easily have been in an updraft while the other end was in a downdraft.

The turbulence of a thunderstorm is not only a system of upward and downward currents, but due to friction, the air moves in spirals and eddies of all sizes and in all directions, as the motions in the cauliflower head indicate. The movement to tobacco smoke in a room where there is not much of a draft, will illustrate some of this turbulence on a miniature scale.

Some aviators have been through thunderstorms and lived to tell us about it. Their stories confirm the conclusions we have already arrived at. The experience of the German naval airship, the L-1, was brought to the attention of the Committee investigating the Akron disaster. This German ship was caught in a line squall on September 9, 1913, in which it was lifted up and thrown through a range of 3,000 feet before the final plunge sent it into the water bow first. The Shenandoah was hurled upward about 5,000 feet and then broken into three parts. That also happened in a thunderstorm. A balloon experience of Professor John Wise in 1843, is described in the work by William Basius, **Storms, Their Nature and Classification,** pp. 141-145. Professor Wise was drawn up into a cumulus cloud where he was whirled up and down through the cloud eight or ten times at a fearful rate of speed. The balloon was also given a gyratory motion, and the car 16 feet below, was spun around in great circles through the cloud. Neither the discharge of ballast nor of gas would set him free either at the top or the bottom of the cloud for a space of twenty minutes, when he finally fell clear of it. He also noticed in the cloud a convolutionary motion of the water drops and a promiscuous scattering of hail and snow, as though it were projected from every point of the compass.

These examples along with many others which could be cited, illustrate very well the violent commotion which takes place in a cumulus cloud, the parent of all thunderstorms, and give us reason to think that aviators who give a wide berth to thunderstorms are displaying that prudence which is the better part of valor.

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PHYSICS

THE DRUMM STORAGE BATTERY

REV. HENRY M. BROCK, S.J.

It is rather noteworthy, considering the number of primary cells discovered and used during the nineteenth century, that the first successful secondary cell, developed originally by Plante many years ago, has been the only one ever used extensively for industrial and commercial purposes. To mention only one use, millions of motor vehicles depend upon it for starting and lighting. Its only rival in this country is the more recent Edison cell which is not seen very often. While both types have their advantages and disadvantages, they are far from perfect and no one can suppose that they have exhausted all possibilities for further improvement. A few years ago Catholic journals published accounts of a new type of storage battery invented by Fr. Almeida of one of our Spanish Provinces. Great hopes were entertained for it. A description was given in the Bulletin, Vol. V, No. 1; (Sept.-Oct., 1927). It was a translation by Fr. Morgan A. Downey, S.J., of extracts from an article by Fr. I. Puig, S.J., of the Ebro Observatory in ''Estudios'', an Argentine Magazine. An editorial note appended to the article in our Bulletin stated that, according to the Elektrotechnische Zeitschrift for June 30th, 1927, extensive tests of the battery in Germany had not been favorable. I have heard nothing about it since then.

In the meantime Dr. James J. Drumm of the National University of Ireland has been carrying on extensive researches and has developed a new type of storage cell which has some interesting properties. It has already emerged from the experimental stage and has been in successful operation for traction purposes in Ireland. The National University Handbook published in 1932 contains a sketch with portrait of Dr. Drumm and also reprints two articles on his new battery. He made his preliminary studies at St. Macartan's Diocesan College at Monaghan and received the degree of Master of Science in 1917 in the School of Chemistry of University College, Dublin. He received the doctorate in Science from the National University in 1931. The first of the articles referred to was taken from the London Times for Feb. 15th, 1932, and the other, written by Prof. A. J. Allmand of King's College, London, from Nature for March 12th, 1932. It may be of interest to point out some of the features of the battery as described in these articles.

Dr. Drumm was apparently induced to attack the problem by the transportation situation in Ireland. Coal has to be imported for the railroads and gasoline for motor vehicles. On the other hand the completion of the Shannon hydro-electric project has made available abundant electrical energy, presumably at low cost. Electrification of the railroads might suggest itself but this demands much capital and is only warranted where there is considerable density of traffic. Railroad travel is not heavy in Ireland. A storage battery suitable for train use would evidently save fuel and provide an outlet for the Shannon power.

The Drumm battery resembles somewhat the Edison type. The positive plates are composed of nickel peroxide and the negative plates are grids of nickel gauze. The electrolyte is a solution of zinc oxide in potash. The following reactions are given by Prof. Allmand.

$$\text{Discharge: } Ni_2O_3 + Zn + OH = 2NiO + HZnO_2$$

$$\text{Charge: } 2NiO + HZnO_2 = Ni_2O_3 + Zn + OH.$$

The special feature of the battery which distinguishes it from other types and which makes it valuable for the purpose for which it was designed is the very high charging and discharging rate of which it is capable. The normal charging rate is four times and the discharging rate is twice that of any other alkaline cell. These rates can be exceeded when necessary without appreciable deterioration. The reason for this seems to be that the metallic zinc dissolves freely on charge and is readily deposited again on charge. This property makes rapid acceleration possible in trains operated by the battery. The voltage of the charged cell is about 1.86 volts. This is lower than that of the lead cell but considerably higher than that of the Edison cell. The energy efficiency is about 75 per cent. The specific watt-hour capacity is not high but this is compensated for by the fact that it can be charged very quickly. In fact it can be put through twenty or more cycles a day.

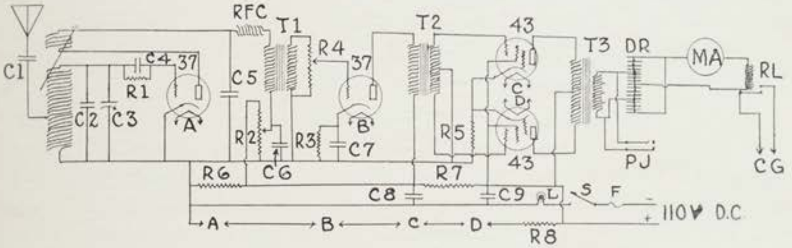
In the spring of 1932 the battery was successfully installed in a train of the Dublin-Bray line of the Eastern Section of the Great Southern Railway of Ireland. This line is 14½ miles long with eleven stops. Accelerations of one mile per hour per second and speeds of forty to fifty miles per hour are possible. Regenerative braking is used. The Chicago, Milwaukee and St. Paul Railroad was the first to use this ingenious system on a large scale on its 440 miles electrified line crossing the Great Continental Divide. Its electrical energy is supplied by the mountain streams and the locomotives receive 3000 volt direct current from a catenary supported trolley wire. On the steep down grades in the mountains the motors act as generators. Work is done with the aid of gravity slowing up the train. The electric energy developed is fed back into the line. The railroad receives credit for it and it serves to run other trains. In like manner the Dublin-Bray train on down grades and when coming to stops operates its motors as generators. The current produced is fed into the batteries thus partially recharging them. This saves brakes and increases economy of operation. It will be interesting to watch further developments and applications of this battery.

ASTRONOMY

A NEW TIME SIGNAL RECEIVER FOR WOODSTOCK COLLEGE OBSERVATORY

A. Robert Thoman, S.J.

The Physics Department was recently asked by the observatory staff to build a new D.C. radio receiver for occultation work. The completed set is so satisfactory that we feel it should be made known to others, because a system similar to this has been found useful for automatic time signal recording in connection with seismographs.



2650 METER RECEIVER

C1	.002 MF	R1	5-10 MΩ	T1	6-1 Audio Transformer
C2	.0005 MF	R2	500,000 Ω POT.	T2	Kenyon P.P. Input "
C3	.00017 MF (7 PLATE)	R3	2,700 Ω (1W)	T3	Kenyon Universal Output " Transformer (Type KUO)
C4	.00025 MF	R4	500,000 Ω POT.		
C5	.00025 MF	R5	200 Ω (2W)	R.F.C	85 M.H. R.F. Choke
C6	1.0 MF	R6	50,000 (1W)	D.R.	Kuprox Dry Rectifier
C7	5.0 MF	R7	2000 Ω (2W)	MA	0-50 Milliammeter
C8	4.0 MF	R8	200 Ω (20W)	RL	150 Ω Bunnell Relay
C9	8.0 MF			C.G.	Leads to Chronograph

The wave-length decided on was 2655 meters, because the NAA (a) signals are now broadcast six times a day, at 0, 3, 5, 8, 17 and 21 hours Greenwich Civil Time. Three factors were of importance:

1. It was desirable to operate the set from the 110 volt D.C. power line;
2. The receiver had to work a relay for registration on the chronograph;
3. The cost had to be kept low, and as a matter of fact the total expenditure was considerably under ten dollars.

Due to a hint given in a description of a Universal Public Address Amplifier, the tubes decided on were thirty-seven's for detector and first amplifier, and forty-three's in push-pull for second amplifier. A two hundred ohm resistor in series with the heaters takes care of the filament current. The "forty-three" tubes are specially designed power tubes for use with low plate voltages, and give as much as two and a half watts in push-pull with ninety volts on the plates—more than sufficient, we thought, to operate a sensitive relay.

Anticipating difficulty on the relay, we procured the universal output transformer because it offered wider variation on the output impedances. The amplifier was wired up temporarily and connected to a single honeycomb coil battery detector using a U.V. 200 tube. The signals were received on the first attempt, but the commutator ripple was too great for good results. Variation of condensers and resistors eliminated the difficulty and increased the signal strength. With a high-voltage dry rectifier the output was only two milliamperes; but this would be sufficient for a sensitive relay, such as the Miniature type put out by Weston. By making various trials with a step-up transformer after the output, we succeeded in getting about five milliamperes on night signals. A low-voltage rectifier (intended for a trickle charger) was then tried, and the resulting ten to twelve milliamperes worked an ordinary 150 ohm Bunnell relay with very positive action. At first considered too heavy and insensitive, this relay was found to work quite well on even six milliamperes, much to our surprise.

A detector unit, operating from 110 volt D.C., was then assembled, using a thirty-seven tube in a slightly modified form of the single coil circuit used before. Poor results made us try first a thirty-six tube as a biased detector and then a two-circuit tuner; three coils brought some results but the tuning was very difficult. Among the old apparatus of the Observatory was a universal long-wave crystal set with switches and binding post for use with a tube detector; among its coils and condensers was a bank-wound vario-coupler with five taps on the main winding. We shunted it by a forty-three plate condenser and hooked the antenna to the tap switch. The afternoon signals were heard on the first attempt, though weakly; the antenna switch was moved to another tap, and the signals came booming in. The vario-coupler is bank-wound in two layers on a form of three and a half inches diameter, and contains two hundred and twenty turns of Litz wire in a coil three and three quarter inches long. The coil is tapped in five places, and the tap at one hundred and thirty turns from the rotor end was found to be the best for the antenna connection. The rotor is a flat spool three inches in diameter and three quarters of an inch long, wound with about one hundred turns of Litz wire. Since the rotor is layer-wound between the walls of the spool, it is impossible to count the turns exactly without unwinding it.

Further experimenting showed that a .0005 Mf. fixed condenser shunting a seven plate variable condenser gives vernier control, still keeping station NAA (a) in the center of the dial. This arrangement has the further advantage of restricting the wave-length range to within a few meters of the station desired. It was also found that the reception was better with no ground connection. Any ground that could be made had to be with a condenser in series, since the negative power lead is the live one. To prevent any danger of short circuit by accidental grounding of the antenna, a condenser in series was desirable; a .002 Mf. condenser did not affect the signal strength.

The set is most satisfactory in every way. A maximum relay current of twenty-five milliamperes has been obtained; regularly more than fifteen milliamperes are available. The meter is used in tuning because the rectified current is not a maximum when the audible volume is maximum. Potentiometer R2 controls the detector plate voltage, while R4 controls the volume. Both were thought advisable so that under poor conditions better control would be had. The filtering action of R7, C_8 and C_9 was found wholly adequate and as good as a choke filter. The output transformer, costing a little over a dollar, has a tapped low-impedance secondary. The highest impedance (approximately twenty ohms) gives the greatest rectified current. The fuse and switch are in the negative lead because that is the live one on our power line. The pilot light, a two and a half volt, half ampere Mazda, is simply an indicator that the set is turned on.

By adding a 25Z5 rectifier and filter for the plate current, and by making the series circuit to the heaters of all tubes (and a 120 ohm resistor in place of R8) independent of the plate supply, this set can be made to give equally good results when operating on alternating current.

OBITUARY

FREDERICK L. ODENBACH, S.J.

"One month's confinement in the hospital was the only period of rest Father Odenbach ever took". Thus the life of this prominent American, Jesuit Scientist has been appositely summarized in the Province News-Letter of the Missouri and Chicago Provinces, a life which was terminated just two short years after the completion of fifty long, laborious and fruitful years in the service of God and fellow man, forty of those years having been spent in the classroom and in scientific research at John Carroll University, Cleveland, Ohio.

Born in Rochester, N. Y., October 21, 1857, Frederick L. Odenbach received his classical education at Canisius College, Buffalo. Upon his graduation from Canisius, the young man seriously considered devoting his life to suffering humanity as a member of the medical profession, but finally chose the service of God and man in the ranks of the Society Jesus, and entered the Jesuit Novitiate at Exaaten in Holland on September 26, 1881, at the age of twenty-four. Upon the completion of the first five years of training, he returned to Canisius for his regency, and again sailed for Europe for his theological studies which were pursued in England.

Returning to the United States in 1893, Father Odenbach was sent to Cleveland, where for the next forty years as Professor of Physics and Chemistry, then as Professor of Astronomy and Metereology, as Seismologist, and as Prefect of Discipline, he was associated with John Carroll University, at that time Saint Ignatius College, and it was during these years that he gained national prominence as a man of science. In 1895, two years after his return from Europe, he founded the Secchi Metereological Observatory. From 1896-1899, at the invitation of the United States Weather Bureau, Father Odenbach participated in an internationally undertaken study of clouds, and he has been officially recognized as the sixth observer of the Helvetian halo, this observation having been made on December 6, 1901.

About this time the seed which was to reach maturity in the present Jesuit Seismological Association was sown in the prolific mind of Father Odenbach by Professor Willis L. Moore, chief of the United States Weather Bureau, in a remark concerning the extraordinary advantages possessed by the Society in relation to the development of the science of meteorology. At the time the remark was fully appreciated by Father Odenbach, but his appreciation was fated to remain just that and nothing more as far as meteorology was concerned. In the year 1909, upon learning of the proposed organization of a world-wide seismic service, with a central station at Strassburg, Father Odenbach was quick to perceive the application of the same peculiar advantages possessed by the Society and stressed by Professor Moore to the rapidly growing science of seismology. Accordingly, on the Feast of the Purification, 1909, he addressed a letter to all the Jesuit Colleges and Universities in the United States and Canada, explaining in great detail his plans for a continental, and, if possible, an international Jesuit Seismological Service.

The peculiar advantages possessed by the Society lay in its world-wide network of colleges and in the centralization of its government, and these advantages were emphasized by Father Odenbach by his proposal of a chain of stations all equipped with the same type of instrument, to be handled according to the same technique. With characteristic breadth of vision and dynamic enthusiasm, the plan was conceived to embrace all the Jesuit Colleges and Universities in the world, and he forwarded copies of his letter to several institutions in Europe. Well planned, carefully expounded, the proposal met with the encouraging approval of fifteen of our Colleges and Universities on this continent, and the purchase and installation of fifteen horizontal and three vertical components within the next year imparted to seismological research in North America what is undoubtedly the greatest impetus it has ever received. How the plan was received abroad, we know not.

Always plain of speech and abrupt in manner, positive in his assertions, and firmly decisive, after an unfortunate difference of opinion in regard to the execution of the plan as proposed and adopted, Father Odenbach, in 1911, severed all connection with the then two-year-old Jesuit Seismological Service, and, deprived of his driving interest, infectious zeal and untiring labor, the plan came to a premature end. His disappointment in no way affected his personal interest in seismological research, and this fact is well attested by the invention of an electric seismograph, the product of his really scientific habit of improving upon any instrument that failed to satisfy his needs. During the years he continued to acquire and improve upon his instruments, until a short time before his death he was able to state that he could add nothing of importance to his laboratory. The ceraunograph, an instrument for the recording of distant thunderstorms by the use of Herztian waves, is accredited to his genius.

For many years before his death, the veteran scientist must have derived some consolation from the organization and work of the present Jesuit Seismological Association, reorganized in 1926, which must trace its beginning to Father Odenbach's pioneer efforts, and "Thus it is", says the *Cleveland Plain Dealer*, in reference to Father Odenbach's work, "that throughout the country the public has learned to look to the nearest Jesuit college when the earth quivers".

Within a year after the celebration of his Golden Jubilee, Father Odenbach, the first to establish himself at the new John Carroll University, had the pleasure of personally installing his scientific instruments in the unfinished buildings, and in a rude set of rooms "spent nearly the whole winter alone with his instruments and his dog and the plans for his future observatory. Severe weather conditions caused superiors to recall Father Odenbach from his voluntary exile. He was quick to return, to all appearances a younger, more active man than when he had taken up his lone position 'on the Heights'.

"About two months before his death he began to complain of pains in his stomach. An abdominal disorder, which was given later as the cause of his death was beginning to place the stamp of age upon one who seemed to enjoy perpetual youth. One month's confinement in the hospital was the only period of rest Father Odenbach ever took. He died March 15, 1933."

One of the early members of the American Seismological Society, a member of the Ohio State Academy of Science, of the American Metereological Society, the Cleveland Astronomical Society, and of the American Association for the Advancement of Science, from which he resigned because of what he believed to be an undue emphasis placed on evolution, Father Odenbach was first and foremost a member of the Society of Jesus, exact in his studies and in the duties of his spiritual life. May he rest in peace.

Joseph G. Doherty, S.J.

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RECENT BOOKS

The books mentioned in this column are recommended by our Science Professors as suitable for the Science Libraries.

BIOLOGY

Man and the Vertebrates, by Alfred S. Romer, University of Chicago Press, Chicago, Ill.

Cold Spring Harbor Symposia in Quantitative Biology. The Biology Laboratory, Cold Spring Harbor, Long Island, N. Y.

Introduction to the Vertebrates, by Leverett Allen Adams; John Wiley & Sons, Inc., N. Y.

Biology of the Protozoa, 2nd Edition, by Gary N. Calkins, Lee & Febiger.

CHEMISTRY

Great Men of Science. A History of Scientific Progress, by Philip Lenard. From the German by H. Stafford Hatfield. Macmillan Co., N. Y.

A Manual of Practical Inorganic Chemistry. Qualitative Analysis and Inorganic Preparations, by E. H. Riesenfeld. Translated by P. Ray. Churckervertty, Chatterjee & Co., Calcutta, India.

Some Physical Properties of the Covalent Link in Chemistry. George Fisher Baker Lectureship, Cornell University Press, Ithaca, N. Y.

Inorganic Colloid Chemistry, Vol. I; by Harry Boyer Weiser, John Wiley & Sons, Inc., N. Y.

Annual Survey of American Chemistry, Vol. VII. Edited by Clarence J. West. National Research Council, Chemical Catalog Co., N. Y.

Phase Rule Studies, by J. E. Winfield Rhodes. Oxford University Press, England.

The Physical Chemistry of Living Tissues and Life Processes. The Williams and Wilkins Co., Baltimore, Md.

Second Year College Chemistry. Third Edition; by William H. Chapin. John Wiley & Sons, Inc., N. Y.

The Conductivity of Solutions, Second Edition. Revised and Enlarged; by Cecil W. Davies. John Wiley & Sons, Inc., N. Y.

The Sorption of Gases and Vapours by Solids, by James William McBain, F.R.S. George Routledge & Sons, London, England.

PHYSICS

Conduction of Electricity Through Gases..........J. J. & G. P. Thomson
Vol. 1 (1928)
Vol. 11 (1933) The Macmillan Co.

Laboratory Physics (New Edition).........................D. C. Miller
Ginn & Co., (1932)

Experimental Atomic Physics ....Harnwell & Livingood
McGraw-Hill (1933)

Smithsonian Physical Tables...................(Eighth Revised Edition)
Smithsonian Institution (1933)

Heat ....J. M. Cork
John Wiley & Sons (1933)

Recent Advances in Physics (Non-Atomic)...............F. H. Newman
P. Blakiston's Son & Co. (1932)

Introduction to Theoretical Physics ....Max Planck
Vol. I General Mechanics
Vol. II Mechanics of Deformable Bodies
Vol. III Electricity and Magnetism
Vol. IV Introduction to Theoretical Optics
Vol. V Theory of Heat
The Macmillan Co.

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BOOK REVIEWS

Elementary Quantitative Analysis. Theory and Practice. By HOBART H. WILLARD, Ph.D., Professor of Analytical Chemistry, University of Michigan, and N. HOWELL FURMAN, Ph.D., Associate Professor of Chemistry, Princeton University. D. Van Nostrand Company, Inc., 250 Fourth Ave., New York, 1933. viii + 406 pp. Illustrated. 14.5 × 22.5 cm. Price, $3.25.

This book should be welcomed by all chemists interested in the teaching of quantitative chemistry. It can be characterized as quantitative analysis *per se*, not a pre-professional hurdle nor preliminary practice in technical analysis. The practice determinations are well selected, varied in nature, and in such numbers that flexibility is allowed the teacher in choice of exercises. Recent developments in quantitative methods are introduced through appropriate exercises and combined with the best of well-established, long-standing methods. Directions are written in a simple straightforward style that will impress the student with the essentials of the processes being carried out.

However, the book is more than a collection of conventional directions for carrying on specific determinations designed to familiarize the student with quantative technique. It is especially characterized by a generous amount of space devoted to the fundamental theory of quantitative chemical processes. In a series of chapters, judiciously distributed among chapters of practical laboratory directions, the modern theoretical basis of analytical chemistry is simply but thoroughly discussed. This material is a natural continuation of the general theory of the introductory course and of quantitative analysis. Many teachers, whose training was secured more than a decade ago, will find interesting information in these theoretical chapters.

Fundamentally sound as the book is, the reviewer cannot but express regret that the authors did not continue to use their original order of treatment; that is, place gravimetric processes before volumetric. This order seems to be the more logical and more in accord with the nature of this text. To be sure, the order of treatment used is well connected and teachable, but it has been the hope of the reviewer that one good quantitative analysis might continue to place first things first, and resist the demand for pre-professional short courses, that is, for the teaching of applications before the fundamentals are thoroughly presented.

With regard to detailed criticisms few objections can be raised. The work is well written and printed throughout, although reading the preface might not seem to promise this, as, in the second paragraph, there is an error in printing and a split infinitive. The authors have included a number of problems and review questions but not too many, and more discussion of methods of solving quantitative problems, the use of reference tables, handbooks, slide rules, etc., might be included. Since some students are familiar with proton chemistry, mention of Bronsted's concepts might have been included in Chapter VI.

The authors have avoided specifying complicated or highly specialized apparatus and only occasionally references are made to specific forms of conventional apparatus or materials. This is commendable since such practical details are administered differently in different laboratories. For example, the reviewer would not agree that the type of buret described and illustrated is the best even for general use, or that a certain excellent rubber paint is the preferred method of lining standard alkali bottles.

There are admittedly other details, described in the book, on which opinions differ, but they are after all mere details. The general impression remains that the authors have produced a thoroughly good text book of elementary quantitative chemistry, commendable both as to teachability and scope of information presented. C. R. H.

GENERAL PHYSICS

By J. Joseph Lynch, S.J.

Fordham University Press, New York, 1933.

In his book, General Physics, Father Lynch admirably achieves the purpose proposed in his Preface: his book is an excellent collection of lecture notes. In its make-up, it reminds one somewhat agreeably of an older but highly regarded text, Carhart's College Physics: it is logical in its make-up, and forceful in its short, almost cryptic, statements.

Most of the important topics have been covered in a very satisfactory way. One or two omissions may be noted. Nothing is said of standing waves, although they have such important applications in recent methods of measuring the velocity of sound, in the formation of nodes and loops in organ pipes, and in Lippmann's direct process of color photography. Most teachers would like to see a very elementary treatment of the phenomena of interference in the chapter on Wave Motion.

Of the matter actually given, too much attention seems to have been paid to the treatment of cells. On page 79 a better sine curve might be inserted.

Particularly commendable is the treatment of the Mechanics of Fluids and the Formation of Images. The arrangement of matter, the paragraph headings, the clear and numerous diagrams, all contribute to ease in studying the book. Would it make the book too bulky to interleave it with blank pages? Since the book offers such an excellent skeleton, the flesh and blood of fuller discussion might be inserted by the student if the opportunity of blank pages were offered him. A list of authors for supplemental reading, and finally an index, would add greatly to the merit of the book.

It is to be hoped that the clear conciseness of Father Lynch will soon find expression in more detailed treatment of the recent contributions to Atomic Physics.

NEWS ITEMS

Fordham University. Chemistry Department

Dr. Leopold R. Cerecedo replaces Dr. Carl P. Sherwin as Professor of Physiological Chemistry and is in charge of research in this field. Dr. Ambrose has also severed his connections with Fordham; Mr. J. A. Stekol replaces him as instructor in Physiological Chemistry, and Fr. Power takes over his course in Organic Microanalysis. Fr. Power spent most of the summer at the Columbia University Medical School studying microchemical technique under the direction of Dr. Oskar Wintersteiner. Dr. Werner Freudenberg has come from Iowa State University to take over the courses in Organic Chemistry and to direct Organic Research.

There are 15 graduate students in the Chemistry Department of whom 10 are candidates for the Doctorate. The problems in hand last year are being continued; especially, a complete chemical study of metabolism during growth, and the isolation and study of Vitamin B-1.

The library has recently acquired a complete set of Hoppe-Seyler's Zeitschrift der Physiologischen Chemie, and the Index Medicus, and about 80% of all the literature references needed for research work may now be consulted in our library in Chemistry Hall.

Mr. William H. Hamill, Professor of Physical Chemistry, recently passed his qualifying examination for the Doctorate at Columbia, and will do his research problem at Fordham under the direction of Dr. Victor K. LeMer of Columbia; it will be an investigation of some phase of the problem of "heavy hydrogen" and the corresponding "heavy water" in which the Columbia physical chemists are greatly interested. Mr. Hamill has recently constructed two very efficient constant temperature baths for the laboratory embodying several original details of his own.

A total of 950 students are taking Chemistry in one form or another in Chemistry Hall; the total staff of professors and instructors now numbers 18.

The following is a list of the publications in the chemical literature by members of the Department for the years 1932-33:

Determination of Beeswax in Candles—Power, F. W. and Hauber, E. S.,—Ind. Eng. Chem. (Analyt. Ed.) 4, 389 (1932)

Detoxication Mechanisms—Ambrose, A. M. and Sherwin, C. P., Ann. Rev. Biochem. 2, 377 (1933)

The Chemistry and Metabolism of the Nucleic Acids, Purines, and Pyrimidines—Cerecedo, L. R.,—Ann. Rev. Biochem. 2, 109 (1933)

The Preparation of 5-Bromfuroic Acid—Whittaker, R. M.,—Rec. trav. Chim. 52, 4 (1933)

Studies on the Physiology of the Pyrimidines VII—The Metabolism of Isabarbituric Acid in Man.—Stekol, J. A. and Cerecedo, L. R.,—Jour. Biol, Chem., 100, 653 (1933)

Further Studies on the Detoxication of Phenylacetic Acid—Ambrose, A. M., Power, F. W. and Sherwin, C. P.,—Jour. Biol. Chem., 101, 669 (1933)

Mercapturic Acid Formation in Rabbits—McGuinn, A. F. and Sherwin, C . P.,—Prov. Soc. Exp. Biol. and Med., 30, 1115 (1933)

Acetylation Studies—Harrow, Benjamin, Mazur, A. and Sherwin C. P.,—Jour. Biol. Chem.—102, 35 (1933)

Studies in Acetylation—The Fate of p-Aminobenzoic Acid in the Rabbit—Harrow, Benjamin, Mazur, A. and Sherwin, C. P.,—Jour. Biol. Chem.—102, 35 (1933)

Also a popular article by Fr. Power was published in "Bronxboro", (Sept. 1933) the magazine of the Bronx Board of Trade; this dealt with the research work now going on at Fordham. It is expected that this article will soon be reprinted in the Holy Cross Alumni magazine.

Fr. Muenzen is preparing a pamphlet listing the names and academic records of the professors, the courses offered by the Department, the requirements of graduate degrees, and the complete list of publications.

Teachers of Chemistry will be interested to learn the Basic Analysis part of Fr. Coyle's Qualitative Analysis has been revised by Dr. Walter A. Hynes of the Fordham staff and is now available through Fr. George Strohaver at Georgetown where the new edition is being published.

Loyola College, Baltimore, Md. Chemistry Department

Micro Organic Analysis is now one of the regular courses of the Chemistry Schedule. It is elective for seniors. The Pregl methods are used exclusively.

The regular meetings of the Loyola Chemists' Club are as popular as in previous years. The first lecture was given on Tuesday, October 31st, by Dr. L. W. Shank of the Ethyl Gasoline Corporation of New York. The chemistry amphitheatre was filled to overflowing.

On Tuesday, November 14th, Dr. G. E. F. Lundell, Analytical Chemist of the National Bureau of Standards, lectured to a large audience. The subject: "The Practical Use of Standard Analytical Standards."

Georgetown University. Physics Department

The search for a clean brilliant monochromatic light source noted in the Bulletin last year has ended by the purchase of the new G. E. Sodium Vapor Lamp. Its convenience and power are, perhaps, best illustrated by the use to which we can put it: the illumination of a very narrow slit in the determination of the wave length of light by the grating. The slit is only as wide as the thickness of 20-lb. paper stock; the grating is the large-space grating sold by the Ceneral Scientific Company for about $2.50 and having approximately 250 lines to the centimeter.

With the salt-in-Bunsen flame held less than 4 inches from the slit it was possible to observe and measure only some half dozen orders when the grating was 90 centimeters from the slit. Even then the scale on which the spectra appeared to fall had to be shielded from the light of the room. This made the reading still more difficult as the scale had to be read while observing the spectra through the grating.

With the intense illumination from the sodium vapor lamp 15 to 20 orders may be comfortably observed when the grating is 90 centimeters from the slit and the light source is as much as 10 meters from the apparatus. The experiment was performed by one of the students in a fully lighted room without any shading of the scale.

We plan to set the single sodium vapor lamp in the middle of open laboratory and point eight instruments at it at one time.

Perhaps a word about the instrument would be interesting: A 100 centimeter support rod, 19 mm. square and not graduated (to hold down expense) is mounted on a pair of 'single rod end supports' to make a simple optical bench. Two right angle clamps take 10 mm. rods on the top of which are mounted blackened brass discs. The grating is held by small spring clips over a central hole in one of the discs, and a scale with a metal slit at its middle is mounted over the central hole in the other disc. The scale is a 50 cm. K & E paper scale glued to a strip of wood—it cost about 20 cents.

In use the bench is pointed at the light source and the spectra are observed by placing the eye immediately behind the grating. The yellow images of the slit appear spread out over the scale in both directions from the slit and their positions may be read directly on the scale. The distance between the grating and the slit is measured with a meter stick.

COLLEGE PHYSICS by Arthur L. Foley is the text adopted for both the Junior classes and the Freshman B. S. classes.

A second hand milling machine is now being installed in the shop of this department. It is a Van Norman No. 1/2 Duplex, equipped with a Culman drive and a 1 H. P. 3 phase motor.

Georgetown College Observatory

The Observatory is offering the following popular lectures to be given individually or as a series, to colleges and academies.

Astronomy: "The Universe in Which We Dwell"; "The Solar System"; and "Neighboring Stars and the Galaxies Beyond", by Rev. Paul A. McNally, S.J., Ph.D.

Seismology: "Earthquakes and their Causes"; "The Seismograph"; and "Lessons from Earthquakes", by Rev. Frederick W. Sohon, S.J., D.Sc.

BIOLOGY DEPARTMENT.

The appointment of Fr. McCauley as Director of the Biology Department has left Dr. Bennett free to devote full time to his task as Professor of Histology at the Medical School. But since Fr. McCauley's work at Woodstock permits him to spend only a small part of each week here it was necessary to engage an additional lay instructor.

Recent acquisition of physiological apparatus for class room demonstrations has aroused unusual interest in this course. Though the College offers no credit for laboratory work in physiology some of the students have requested permission to do experiments in their own free time.

We have purchased a complete set of embryological slides for each student and a friend of the University is donating full sets of histological slides.

Holy Cross College, Worcester, Mass.—Chemistry Department

1. Students in undergraduate courses with respective professors.

Subject	No. of students	Prof.
Chem. 1 (Pandemic)	250	Fr. Sullivan, S.J.
Chem. 2 (Inorganic)	130	Mr. Keleher, S.J.
Chem. 13 (Qualitative)	72	Mr. Charest
Chem. 12 (Chem. Problems)	75	Mr. Keleher, S.J.
Chem. 5 (Organic)	64	Mr. Kelly
Chem. 6 (Colloid)	10	Mr. Kelly
Chem. 7 (Physical)	10	Dr. Haggerty
Chem. 9 (Organic Analysis)	10	Mr. Baril
Total	621	

2. There are five graduate students working for their degree of Master of Science.

Subject	Prof.
Chem. 101 (Advanced Inorganic)	Fr. Sullivan, S.J.
Chem. 102 (Inorganic Synthesis)	Fr. Sullivan, S.J.
Chem. 107 (Thermodynamics)	Dr. Haggerty
Chem. 109 (Early History of Chemistry)	Mr. Kelly

Second Semester the above will give way to the following:

Chem. 103 (Advanced Organic)	Mr. Kelly
Chem. 104 (Advanced Organic Synthesis)	Mr. Kelly
Chem. 108 (Reaction Rates)	Dr. Haggerty
Chem. 110 (History of Modern Chemistry)	Mr. Kelly

A seminar in Subatomics and a general Seminar.

3. Seminar Program for the year announced. Subjects represent advanced topics from various branches as outlined above.
4. Hormone—Holy Cross Chemistry Club publication makes its appearance after almost a year of silence.
5. Fr. Sullivan, new Dean of Chemistry, elected to Executive Council of the Worcester Chemists Club, also to the Committee on Membership in the New England Section of the American Chemical Society.

St. Joseph's College—Department of Chemistry

During the past summer a Physical Chemistry laboratory was installed at the College. Up to the beginning of the present school year Physical experiments have been performed in the other laboratories, where space would permit. Such an arrangement was not satisfactory and the need of a separate laboratory was evident as the number in the Physical Chemistry course increased.

Five tables, containing sixty-seven (67) lockers, were erected in a large lecture room, adjacent to the balance room, in the front of the building. The tables are equipped with gas, hot and cold water, 110 volt, 60 cycle, alternating current, and 32 volt direct current. This equipment will accommodate a class of thirty-five (35).

Plumbing and electrical connections have been made for two (2) additional tables which will be installed when needed.

The motor generator and a switch-board for the direct current have been placed in a small ante-room convenient to the laboratory. Another switch-board, with volt-meter and ammeter, for the convenience of the students, has been placed in the laboratory.

The added space and new equipment will facilitate the performance of many new and varied experiments in Physical Chemistry.

CHEMICAL REFERENCE LIBRARY

Another addition to the Chemistry Department is the new reference library which was opened to the students this fall. The library contains, besides the usual volumes of various branches of Chemistry, bound volumes of the following:

Chemical Abstracts.
Journal of the American Chemical Society.
Industrial and Engineering Chemistry.

Analytical Edition of Industrial and Engineering Chemistry.

Journal of Chemical Education.

Chemical Reviews.

Current issues of various journals, reviews of recent chemical literature, and other publications of interest to the students of Chemistry, are of easy access in the periodical rack.

At present there are approximately five hundred (500) volumes on the shelves and additions will be made as the need arises.

Books may not be taken from the library under the present plan, but the library is open at all times for the use of students.

Boston College—Department of Physics

The number of students following the various courses in physics is larger than ever this year. More than four hundred students are registered for laboratory work. Besides the regular year of physics in the Junior A. B. schedule, there is a four year course in physics leading to a degree of B. S.; and a year of graduate physics for those majoring in physics for an M. S.

Rev. John A. Tobin, S.J., head of the department, lectures in the A.B. and Ph.B. courses; Mr. James K. Connolly, S.J., in the Freshman B.S. Mr. Frank M. Gager, M.S., lately of Massachusetts Institute of Technology, comes to Boston College this year to lecture in the Sophomore B.S. Mr. Harold A. Zager, M.S., conducts the physics courses in Junior and Senior B.S. Mr. Gager also directs the students working in the Graduate School for the M.S. degree.

Father Tobin will continue to direct the Radio Club and Physics Academy. The latter group, composed of physics B. S. students from the Graduate School and from Junior and Senior B. S., will have this year, as its general topic,—Electronics.—

The physics B. S. course includes a four year course in mathematics. Mr. John J. A. Devenney, S.J., is the professor of Freshman, Sophomore, and Senior. Mr. James G. Connolly, S.J., teaches Junior. Mathematical Analysis is the subject of the first two years. Differential Equations are studied in Junior year and Vector Analysis in Senior.

Woodstock College

CHANGES IN THE SCIENCE FACULTY:

For the second year Philosophers, Father John S. O'Conor, S.J., is teaching the new course of "Scientific Questions Connected with Philosophy" from the standpoint of the physicist.

Father David V. McCauley, S.J., will lecture on Scientific Questions pertaining to Biology, and Father Joseph C. Glose, S.J., on Scientific Questions from Anthropology. Father Frederick W. Sohon, S.J., is giving an optional course of biweekly lectures on "The Philosophy of Mathematics". There is an advanced class in Vertebrate Zoology, Mr. Joseph G.

Keegan, S.J., lecturing on Anatomy during the first semester and Father James L. Harley, S.J., lecturing on Physiology during the second.

Father J. A. Brosnan, S.J., has an advanced class in Analytic Chemistry. During Summer School Mr. E. S. Hauber, S.J., taught Physical Chemistry.

The teaching of Griffin's **Introduction to Mathematical Analysis** to the first year class was begun during the 1933 Summer School by Mr. Thomas A. Duross, S.J., and continued by Mr. Walter J. Miller, S.J., until the middle of November; during the rest of the year the first year Philosophers study Physics under Father O'Conor. Mr. Leo W. Welch, S.J., teaches Griffin's **Higher Course of Mathematical Analysis**, while Father Frederick W. Sohon, S.J., is in charge of an advanced class in Differential Equations.

NEW TEXTS:

Allen's **Electrons and Waves** is one of the new texts in the Scientific Questions course; Dampier's **History of Science** and Bavink's **The Natural Sciences** are also used. Cohen's newly revised **Differential Equations** has been adopted, as well as Robertson's **Introduction to Physical Optics.**

THE OBSERVATORIES:

With the cooperation of the Physics Department and a number of the Philosophers (esp. Mr. L. C. McHugh, S.J., Mr. W. G. Perry, S.J., and Mr. A. R. Thoman, S.J.), the Astronomical Observatory has been reconditioned, the instruments have been repaired and relacquered, the building rewired, and a new work-table and set of tools acquired. Besides other miscellaneous improvements befitting an observatory soon due to celebrate its golden jubilee, a new long-wave radio receiver has been installed. It was built by Mr. A. R. Thoman and Mr. E. S. Hauber, S.J., exclusively for NAA (a) time signals, now conveniently available six times a day. A definite program of observations of occultations and of variable stars has been initiated, and already the first report on the latter has been commended by the recorder of Harvard College Observatory, the headquarters of the American Association of Variable Star Observers. Tuesday has been set apart as Visitor's Night for the Philosophers, and members of the staff act as "celestial pilots" at the altazimuth telescope erected temporarily on the observatory lawn, and at the three-inch transit in the transit house, and the four-inch Brashear equatorial telescope under the dome. On the nights of Nov. 14-15, 15-16, and 16-17, about a dozen of the Philosophers will take part in observations to be made of the 1933 shower of Leonids, in cooperation with the Flower Observatory of the University of Pennsylvania, the U. S. Naval Observatory, Georgetown College Observatory, Williams Observatory and many others. Meteor photography will be attempted for fireballs and long enduring meteor trails; a home made prism spectograph will also be used. For the method, cf. the article "Amateur Meteor Photography" by Peter M. Millman, **Popular Astronomy,** Vol. XLI, No. 6, June-July 1933.

The Observatory's position is to be published in future editions of the **American Ephemeris and Nautical Almanac.** Mr. Lawrence C. McHugh, S.J., succeeds, as Director of the Observatory, Mr. Miller, who has returned to Georgetown College Observatory for private studies. Mr. James K. O'Brien, S.J., Mr. Richard T. Zegers, S.J., and Mr. Theodore A. Zegers, S.J., are in active charge of the Woodstock Seismological Observatory.

Weston College

Regular observations of occultations are made by Mr. Sidney Judah at the Weston College Observatory. To date nearly sixty reductions of these observations were made by Fathers Barry, Blatchford, Quigley, T. Smith and Mr. Judah and have been published in "The Astronomical Journal".

Two new mineral cases for the Geological Museum have been purchased. These cases hold two thousand specimens to illustrate, in an elementary way, Mineralogy, Lithology, Dynamic Geology, Structural Geology and Historical Geology.

The Geology Department recently acquired a collection of one hundred and twenty prepared specimens of rocks from the Smithsonian Institution in Washington. Father George O'Donnell donated two hundred specimens of rocks from the Rocky Mountains, which he collected on his field trip. A new Geological Map of the United States has been obtained from the U. S. Geological Survey; it is the most recent published with all the recent data. It cost two dollars and fifty cents. The mounting is of the "dissected" type in sixteen equal parts. This type of map, may be easily stored in a filing cabinet.

The Biology Department have added a new double binocular microscope by Spencer, to their equipment.

Two Jesuits have been invited to take places on the committee preparing for the Winter meeting of the American Association for the Advancement of Science, which will take place in Boston and Cambridge during the Christmas holidays. This committee is made up of at least one representative from each of the colleges in Boston and vicinity. Father Louis Gallagher represents Boston College and vicinity. Father Ahern will represent Weston College. In sight-seeing tours arranged for the visitors the Boston College library will be one of the features visited. It is expected that over 5,000 delegates from 106 affiliated scientific societies will come to Boston for the meeting.

Courses in Science at Weston this year are the following:

General Biology and Experimental Psychology-Special Reference on Neurology—Father Gookin.

General Physics—First Year—Father Brock.

Theoretical Physics—Second Year—Father T. Smith.

Theoretical Physics—Third Year—Father Brock.

General Chemistry—General Course—Father Gookin.

General Chemistry—Special Course—Father Butler.
Organic Chemistry—Special Course—Father Butler.
First Year Mathematics—Father Butler.
Second Year Mathematics—Father T. Smith.

Father Ahern will lecture before the Middletown Scientific Association of Middletown, Connecticut on Tuesday, November 14, at 8.00 P. M. on "Science and Religion Up To Date". The President of this Association is Dr. Towle, Professor of Geology at Wesleyan University, and the meeting will be held in Shanklin Laboratory of Biology of the university.

The Chemical Broadcasts under the auspices of the Northwestern Section of the American Chemical Society over the Yankee Network in New England will be resumed on Friday, November 17. The chairman of the Committee in charge of these broadcasts is Father Ahern, who organized the broadcasts nearly three years ago. He has been made a member of the National Committee, of the Division of Chemical Education, on Chemical Education by Radio. The chairman of the latter committee, Dr. MacCracken of the Richmond Medical College, had stated repeatedly that the broadcasts of the Northeastern Section of the A. C. S. are the most successful of their kind. The Boston Evening Transcript will hereafter give a column in their Saturday Evening Edition to these broadcasts. Father Ahern was elected Vice-Chairman of the Division of Chemical Education of the A. C. S. at the Chicago meeting.

Manila Observatory, Philippine Islands

May 6th, 1933.

My dear Father Selga:

The Chief of Naval Operations desires to express to you and to your notable colleagues, appreciation for the constant, accurate, and complete data furnished Naval authorities for dissemination of time signals and weather forecasts to the Asiatic Naval Service and maritime in general. The timely warnings of approaching typhoons for safeguarding life and property are of inestimable value to all maritime and commercial land activities, to the Asiatic Fleet, and to Service shore stations, and is a matter of international recognition.

The ever cordial cooperation between your Observatory and the Naval Service has been a source of extreme satisfaction to the Navy Department and reflects favorable comment throughout the Navy.

Respectfully yours,
W. V. PRATT,
Admiral, U. S. Navy,
Chief of Naval Operations.

Rev. Father Miguel Selga, S.J.,
Manila Observatory,
Manila, Philippine Islands.

Santa Clara College, California

The Ricard Memorial Observatory of the University of Santa Clara will come to the aid of orchardists in the expansive Santa Clara Valley in the event that the United States Weather Bureau station here closes, it was announced.

Announcements received here by Observer George F. Von Eschen from Charles F. Marvin, chief of the Weather Bureau at Washington, indicates that the local station will close.

A statement issued by Dr. Albert J. Newlin, who as acting director of the Memorial Observatory is carrying forward the work of the late Father Jerome Sixtus Ricard, S.J., noted "Padre of the Rains", said: "The United States Weather Bureau has given orchardists an invaluable service. It is to be greatly regretted that an economy program makes it necessary to close the station. I am certain that no long period will pass before the station will again serve the public."

The Ricard Observatory is to supplement its daily observations and reports in giving service to Santa Clara Valley growers. With the approach of the next frost season, if no provisions are made by the federal government for a frost warning service, the observatory will arrange to supply infomation to the orchardists. Nightly weather bulletins will be posted with the university switchboard operator, and if necessary, the switchboard will be kept open until midnight so the orchardists may avail themselves of accurate forecasts.

Ziccawei Observatory; Shanghai, China

Father P. Lejay, S.J., Director of the Ziccawei Observatory at Shanghai, has been conferring with General Chiang Kai-shek concerning the feasibility of mapping the whole of China within a few years, and at a minimum cost. Father Lejay and his assistants will accept no salary, and the expenses will be only food and transportation costs.

Using a new metal, elinvar, which neither contracts nor expands at any degree of heat or cold, Father Lejay has invented a pendulum device which weighs only twenty pounds, and permits observations to be made in a few minutes which heretofore have required many men many days.

He says that in five years he can survey all of China—a work which normally would require fifty years and at least $10,000,000. He offers as proof of this survey of 500,000 square kilometers in Hupeh and Shensi Provinces, made this Summer in a period of two months. Normally; he says, a labor of this kind would have required five years, and the employment of a large staff. Father Lejay had only one assistant on this recent survey.

The director of Ziccawei says that as he went westward the gravity of the earth decreased as mountainous areas were approached, thereby, as he believes, proving "the theory of compensation as to the composition of the earth's crust, long held by the heads of the United States Geographical Survey Bureau."

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