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A. M. D. G.

BULLETIN

of the

American Association of Jesuit Scientists

(Eastern Section)

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EASTERN STATES DIVISION

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PONTIFICAL ACADEMY OF SCIENCES

THE NEW PONTIFICAL ACADEMY OF SCIENCES

REV. EDWARD C. PHILLIPS, S.J.

Under the date line of October 12, 1936, Science Service sent out to its press subscribers the following item:—

"Announcement from the Vatican of the impending formation of a Pontifical Academy of Science adds a new page to the Catholic Church's long history of encouragement to the highest development of human learning."

The Editor has requested me to prepare for the present issue of the BULLETIN what information may be now available concerning this Academy. Like many institutions in the Church the Academy is both new and old: its present form is new, but the Academy itself has had a long and honorable history though its activities have suffered at times partial and even total eclipse between periods of useful and brilliant scientific life. The new Academy is the immediate descendant of the "Pontificia Accademia delle Scienze dei Nuovi Lincei" and this in turn was a Papal adoption and development of the original "Lynceorum Philosophorum Academia" which had been established over two centuries earlier.

The most satisfactory compendious account at hand of the history of the Academy is found in the new Enciclopedia Italiana, Vol. XXI (1934), p. 173, sub voce *Lincei.* There is a briefer but accurate account in the Catholic Encyclopedia, Vol. I (1907), pp. 84-85, sub voce *Academies*, and a very brief (12 lines), less reliable notice in the Encyclopedia Britannica, Thirteenth Edition, Vol. I (1926), p. 99, sub voce *Academies* which totally ignores the papal character of the restored Academy and mentions only the national society which branched off from the pontifical society subsequent to the suppression of the Papal States.

The birth of the institution occurred in the early seventeenth century when in collaboration with three of his friends the Roman nobleman, Federigo Cesi, Marchese di Monticelli, founded in August, 1603, the "Lynceorum Philosophorum Ordo, seu Concessus, seu Academia", the purpose of the founders being to give an opportunity to their contemporaries interested in science to gather together to discuss scientific problems, to communicate to each other and to publish for the benefit of the learned world the results of the scientific labors of themselves and of others. The aim and object therefore of the Accademia dei Lincei were very similar to those of our own Jesuit Science Association. The Academy took its name from the Lynx on account of the reputation for exceptionally keen sight enjoyed by that animal. The young society was very active during many years and drew to itself the elite of the scientific workers of its age, including Galileo who is styled in the Enciclopedia Italiana "Il Linceo per ecclenza". Cesi was not only founder and President of the Academy but almost its soul and the chief promoter of its activities; as often happens in such cases, those activities languished when he was no longer at the helm to guide and stimulate them, and at his death in 1630, the Academy dwindled away and finally disbanded. In this connection we might call attention in passing to the prudence of the eleventh of the Regulae Operariorum S. J.

Among the works published under the auspices of the Academy was the famous Americanum, the "Tesoro Messicano o Rerum Medicarum Novae Hispaniae Thesaurus"; the *printing* of this monumental and pioneer work together with copious annotations was completed in 1628 —two years before the death of Cesi—but it was not published until 1651.

The Academy was resuscitated in Rimini in 1745 by Giovanni Bianchi under the title of "Academia Lyncea Ariminensis restituta"; but this also languished and disappeared about ten years later on the death of its initiator.

At the turn of the new century, in 1801, it sprang once more into active life at Rome and at the same time received the name of the "Accademia dei Nuovi Lincei". In 1847 it was taken under the special patronage of the Holy See, and as the "Pontificia Academia Novorum Lynceorum" pursued with still greater efficiency its purpose of "promoting through the diligent labors of its members the study and development of the more important branches of learning." As we all know, the Papal States as well as almost all the external Papal institutions suffered suppression or curtailment at the time of the national unification of Italy: those of the members of the Academy who were more devoted to exclusive national ideals than to the universality of religious and scientific interests refused to continue as members of a Pontifical or Papal society, and in 1870 a distinct organization was formed and shortly afterwards received the approval and patronage of the civil government; it still holds a notable place in the national scientific life of Italy as the "Reale Accademia Nazionale dei Lincei". The Papal Academy however also continued in existence and received added life and amplification of its activities under the new Statutes given to it by Leo XIII in 1887 and its organization was still further perfected and strengthened under Pius XI in 1922. Though most of its members were Italians, it had ceased to be an Italian institution and was of truly international catholicity—"di cattolicita internazionale." The perseverance and vitality of its labors is evidenced by its publications: from 1847 to 1934 it published 85 annual volumes of the "Atti" or Proceedings; since 1887 it also published the "Memorie" or Memoirs including 32 volumes of series 1 and 16 of series 2, and in 1930 it added the "Annuario". Under Pius XI its meetings have been held in a special building in the Vatican Gardens (the Casina de Pio IV) devoted to its use and housing its valuable library. The Society of Jesus had its own share in these later developments, as it was to Father Joseph Gianfranceschi, S.J., that Pius XI entrusted the work of reorganization: he had already been appointed President of the Academy by Pope Benedict XV shortly before the latter's death in 1921; and Pope Pius XI confirmed him in this office, which he exercised with great zeal and success until his death in 1934. His successor as President of the Academy was Father Augustine Gemelli, O.F.M., the Rector Magnificus and Professor of Experimental Psychology of the University of the Sacred Heart in Milan.

We now come to the present reorganization, or new establishment, which we may most readily describe by summarizing the documents of the Holy See upon which the reorganization rests. The new Academy was established on October 28, 1936, by the MOTU PROPRIO of His Holiness Pius XI, De Pontificia Academia Scientiarum, "In multis solaciis", (Acta Apostolicae Sedis, Vol. 28, N.13, pp. 421-452.) He first calls attention to the indubitable fact that there can be no conflict between science—even experimental science—and religion. He states that one of the consolations granted to him by God (a consolation which we surely should share) is the realization that in recent years scientists have abandoned the inimical attitude, which is based on the pretended opposition between science and revelation, so that now there can scarcely be found a single scientist of real repute who upholds this erroneous and unfounded opinion. Nay more, adds the Sovereign Pontiff, many scientists including those most highly honored in their own countries have, on the occasion of their coming to Rome for scientific congresses, sought audiences with the Successor of St. Peter to pay their respects, "ut sua humanitatis officia deferrent", to the authority inherent in the Apostolic See. Among these were also found men who, whilst not possessing the precious gift of the Catholic Faith, desired to express with reverence their conviction that all true science opens the way towards Christian Faith. He concludes that this is an auspicious time to give further improvement to the Academy. It might be well to note here that the Pope establishes this "Pontificia Academia Scientiarum" not as an entirely new institution but as the older one "ad novas normas redactum."

In order that the dignity of the remodelled society may be and clearly appears to be worthy of its high aims the Holy Father has appointed the first members of the Academy directly and on his own personal initiative. For the future the actual appointment to membership is reserved to him personally but the choice of the candidates is entrusted to the Academy itself under the guidance of the Council. In making the initial choice he has picked the members from among the leading scientists of all nations and has considered both the extent and importance of their past scientific labors and achievements and also the public reputation they enjoy in the scientific world. He looks upon this "Senate of Scientists" as an auxiliary to the Church in offering to God that reasonable service "debitum humanae rationis obsequium," which is due to Him as the Sovereign Truth. That is the final end of the Academy; but what is demanded immediately and formally of the Academicians is a sincere devotion to the progress and development of the natural sciences.

He is not unmindful of the scientific labors and devotion of the members of the parent society, the "Nuovi Lincei", and assures to them for life the continued possession of the honors and privileges that they have enjoyed in the past.

He closes the Motu Proprio by imparting the Apostolic Benediction to all the New Academicians and to all those who have been or may in the future become benefactors of the Academy.

Another evidence of the Pope's very special interest in the Academy is found in the Christmas radio message of His Holiness broadcast to the world: therein he makes this reference to it: "Our heart rejoices also because of two works which have taken on a new form—one in stone and the other in thought. We mean the new Palace of the Congregations and the Pontifical Academy of Science."

The Statutes of the Academy which follow the Motu Proprio contain 34 articles giving the usual matter set forth in any society's "Constitutions". The name, the aim of the Academy and a number of other items have already been indicated above and it seems necessary to note here only those articles which in some way differ considerably from the Constitutions of our own Association and similar organizations.

Art. 3. Limits the ordinary membership to 70. Hence the Academy is a very exclusive society, much more so, e.g., than our own American National Academy of Sciences which limits its membership to 300. The members have the title of "Pontificii Academici" (Pontifical Academicians). There are five "Pontificii Academici Supranumerarii" who hold that title, ex officio, namely the Director of the Vatican Astronomical Observatory (now Father John Stein, S.J.); the Head of the Astrophysical Laboratory of the Vatican Observatory (now Father Aloysius Gatterer, S.J.); the Vatican Librarian, the Vatican Archivist (Praefecturs Tabularii Vaticani) and the Scientific Director of the Missionary Museum of Ethnology. There are also Honorary Academicians, a title granted to special benefactors of the Academy.

Art. 6. Among other privileges the Academicians have a special section of the Papal Chapel or of the Church reserved for them at solemn religious functions.

Art. 7. The Holy Father himself is the Protector of the Academy. Note: Most religious congregations, and papal organizations have a Cardinal Protector to promote their interests, but the Academy is so dear to the Pope that this office has not been delegated to a Cardinal (as was the case in the parent Accademia dei Nuovi Lincei) but has been assumed by himself.

Art. 8. The President, who holds office for four years and may be confirmed for a further period thereafter, is appointed *motu proprio* by His Holiness.

Art. 15. The financial resources for carrying on the work are to consist of the foundation or dowry ("dos") contributed by the Pope (and administered by the Administrator of the Papal temporal goods), of gifts and legacies which may be left to the Academy, and of the revenues received from the works (publications) produced by the Academy. Five percent of the yearly revenues must be put aside to constitute a permanent Fund.

Art. 16. The academic year begins on the first of November, (1st of December) and closes on July 31st. The opening is marked by a solemn religious function to call down God's blessing on the work of the Academy, on the Church and the Holy Father, and to offer up prayers for the deceased Academicians; and by a Solemn Session of the Academy to which the Pope is to be invited and at which the President gives a short Presidential Address.

Art. 19. The papers to be presented may be written in the native language of the author but a Latin resume must be added.

Art. 22. The residential Academicians have the obligation of attending the regular meetings. If they absent themselves without excuse for a period of three years, they are presumed to have resigned their membership.

Art. 23. Appointment of new members to fill vacancies will be made by His Holiness from a terna (three names) of scientists in the same field of research which is to be selected under the direction of the President and Council by a majority vote of the whole Academy, meeting in secret session, from among all the names recommended in writing by two or more Academicians. (Note: The official Italian version of the Statutes has for the Latin phrase "delecti ex ejusdem disciplinae cultoribus" (which might mean from the same field of science as that to which the previous holder of the vacancy belonged) the phrase "scelti fra i cultori di una stessa disciplina" namely from "some one field of science." Hence the fields of science represented in the Academy may change as time goes on.)

Art. 26. The Academy may confer on non-member scientists as well as upon its members prizes, subsidies, honoraria and medals.

Art. 27. The members receive honoraria and expenses (indemnitates) for their participation in the activities of the Academy. Those who have performed some extraordinary service are to receive special compensation. The Secretary and Librarian are to receive a fixed annual salary.

Art. 28. The Academy will publish periodically each year its "Acta" (Proceedings) including reports of the meetings, the papers presented etc.; and the "Commentationes" (Memoirs) which will appear at irregular intervals and contain scientific writings of special importance accepted by the Academy for publication and also those works which will have been honored by one of the Academy's Prizes (Opera coronata). Note: We are familiar with works of this nature designated as "Couronne par l'Academie Francaise".

Art. 29. The Academy will also publish accounts of its activities in an "Annuario" and by radio broadcasts.

Art. 30. Amendments may be made to the Statutes by vote of the Academy, which vote, however, to become effective must receive the approval of the Pope.

LIST OF ORIGINAL MEMBERS

Naturally the list of the first seventy members was awaited with interest and some curiosity. In the press release of Science Service referred to above we read: To attempt to give a full list of possible candidates, even from America, would perhaps be invidious; but American (Catholic) possibilities would include Prof. H. S. Taylor of Princeton, Prof. K. F. Herzfeld of Catholic University, Drs. A. M. Schwitalla and J. B. Macelwane of St. Louis University, and Dr. Stephen Maher, noted for his researches on tuberculosis." The American scientists actually included in the list are six: Prof. George D. Birkhoff of Harvard, Dr. Alexis Carrel of the Rockefeller Institute for Medical Research, Prof. Robert A. Millikan and Prof. Thomas H. Morgan of the California Institute of Technology, Dr. George S. Sperti, Jr., of the Institutum Divi Thomae of the Athenaeum of Ohio, and Prof. Hugh S. Taylor of Princeton University. Of these Carrel, Sperti and Taylor are Catholics, the others as far as I know are non-Catholic. The only Jesuit among the seventy is Father Ernest Gherzi, S.J., Director of the Zi-ka-wei Observatory, Shanghai, China.

The total list contains naturally enough a larger number of Italian scientists than those of other nations; this will always be necessary since there must be a fairly large number of members resident near Rome to enable the Academy to hold regular sessions with a respectable attendance. The numbers belonging to each of the countries represented (and this means the country of residence and not the country of birth of the members) are as follows: Italy, 33; U. S. A., 6; Belgium, France and Germany each 5; Holland, 4; England, 3; Austria, 2; Argentina, Czechoslavakia, China, Denmark, Norway, Poland and Portugal, one each.

The fields of science to which the members belong are as follows: Physics, 9; Engineering, Mathematics, Physiology and Zoology, 7 each; Astronomy, Chemistry and Natural Science (Naturkunde) 3 each; Aeronautics, Biology, Botany, Experimental Psychology, Geology and Radio Communication, 2 each; Anthropology, Embryology, Geodesy, Geography, Geophysics, Medicine, Meteorology, Pathology, Spectroscopy, Statistics and Telegraph one each. Also General Science represented by the Perpetual Secretary of the Academy of Science of the Institut de France, Emil Picard.

SCIENCE AND PHILOSOPHY

THE COURSES IN "QUAESTIONES SCIENTIFICAE"

EVERETT H. LARGUIER, S.J., and GEORGE TIPTON, S.J.

Some years ago Father Leo W. Keeler, S. J., writing on *The New Course of Ecclesiastical Studies* [*Modern Schoolman, vol. x, pp.* 30-32], expressed the fear that

> "the courses in "scientific questions related to philosophy" are likely to create no small embarrassment. As a rule, neither our scientists nor our philosophers are adequately prepared to handle it, especially as . . . they will be without text-books that provide help and direction. There is danger lest it be quietly replaced by some such course in science as has hitherto flourished in most of our philosophates, the old number of hours being gradually resumed."

Apparently his fear was not without foundation. For anyone who has had any contact with these courses in *Quaestiones Scientificae* must confess that something seems to be lacking. They are usually abbreviated [due to fewer class-hours] courses in physics, chemistry, etc.; but they, for the most part, hardly merit the name "scientific questions related to philosophy." Some might argue that the present courses are all that can be taught in view of the lack of scientific training among the students of philosophy. But, on the other hand, such training is presupposed to some degree by the *Congregation of Studies* by requiring preliminary courses in science before the student begins philosophy. Hence, where the *Constitutio Apostolica* and the *Ordinationes* of this Congregation are faithfully carried out, this lack of training should not exist. Yet, even in such cases, the *Quaestiones Scientificae* are, generally speaking, failing to attain the desired goal,—the discussion of scientific questions related to philosophy.

Perhaps the difficulty suggested by Father Keeler—lack of "text-books [or an adequate syllabus] that provide help and direction"—lies at the bottom of the trouble. Lack of correlation between the *Quaestiones Scientificae* and philosophy seems to be the major difficulty, and this could be remedied considerably if text-books, or at least a syllabus, were supplied for guidance and direction. Hence a serious attempt to prepare and provide such syllabi for the various sciences should be made.

And what better place is there to discuss this problem than in this BULLETIN? Suggestions, criticisms, alternative syllabi could be presented through its pages by and to Jesuit scientists and philosophers throughout the country. Therefore, to "start the ball rolling," we submit the following syllabus, recognizing its inadequacy but hoping that the resulting discussion will produce suitable syllabi for the sciences taught in the courses of "scientific questions related to philosophy."

A PROPOSED SYLLABUS FOR "QUAESTIONES SCIENTIFICAE"

[Author's Note. It is suggested that the courses be given consecutively (rather than simultaneously) in the order in which they are presented here, with examinations for each section following two or three days after its completion. The lectures for each section should be given by a man adequately prepared in the respective fields of science, although there should be one professor in charge of the entire course supplying introductory lectures as well as lectures connecting the various parts.]

I EX PHYSICA

1. *Subject matter and divisions of Physics*:
   a. Mechanics: force, velocity, motion, mass, inertia, energy, direction, etc.; by direct contact (machines, levers, pulleys, etc.) or indirectly (gravitation, magnetism, etc.).
   b. Kinetics: gases, liquids, solids, pressure, viscosity, density, heat, conservation of energy, entropy, etc.
   c. Electricity: static, dynamic, atomic nature, induction, potential, magnetism, etc.
   d. Wave Mechanics: sound, light, electric waves, cosmic rays, De Broglie waves, the electron—a packet of waves?, the Heisenberg principle, etc.
   e. Relativity and Cosmic Physics: space-time dimensions, equivalence of mass and energy, description of heavens, stellar spectra, constitution of stars, Doppler effect, etc.

   [Note. This section need not be much more than a review of material already seen or a cursory explanation of the newer topics. More extensive explanation will have its place in part 3.]

2. *Historical*:

   Chaldeans and Egyptians; Greeks: Thales, Eudoxius, Democritus, Archimedes, Aristotle; Copernicus and Ptolemy; Galileo; Newton; Boyle, Dalton, Avogadro (kinetics); Joule, Watt, Carnot (heat and electricity); Franklin, Coulomb, Faraday, Volta (electricity); Gilbert (magnetism); Joule, Ohm, Ampere (electro-dynamics); Helmholtz, Thompson, Roentgen, Millikan (electron structure); Becquerel and the Curies (radioactivity); Bohr, Fraunhofer (spectra and relation to elements); Moseley (X-ray spectra and atomic number); Einstein and Le Maitre (relativity physics); Alexander, Jeans, Eddington (cosmic physics, expanding universe); Heisenberg, de Broglie, Planck (quantum mechanics).

[Note. This section is primarily intended to show the development of thought in physics.]

3. *Selected Topics*:

Energy and Mass: nature of force and energy; kinds; medium; relation of energy to mass; quantum theory of energy and mass; etc.

Heat: nature of heat; means of propagation; problem of entropy; its significance in creation theory; absolute zero; etc.

Matter: the electric structure of matter; the elements of this structure; nature of the electron, proton, neutron, etc.; relation to problem of hylomorphism; etc.

Light: The corpuscular theory of light; the wave theory; the quantum theory; propagation, dispersion, spectra; interference; spectra; visible light; infra-red and ultra-violet radiation; selective absorption; relation of Bohr theory to line spectra and atomic structure; etc.

Sound: The wave theory of sound; nature of sound; propagation; resonance; frequency; velocity; wave-length; etc.

Cosmic Physics: significance and meaning of relativity and the space-time continuum; order in the universe; the expanding universe; nature of cosmic radiation; significance of stellar spectra; problem of extension (finite or infinite) of the world; etc.

Electricity and Radioactivity: electro-kinetics; quantum theory; induction; static and dynamic electricity; radioactive radiation; natural and artificial; radiating particles; electricity and radioactivity in atomic structure; sub-atomic physics; existence of neutron and positron, neutrino, etc.

Nature of Physical Theory: basis in reality; relation of reality to a physical theory; quantitative aspects of qualities; development of a physical theory; certitude of a theory.

[Note. It is expected that the instructor will indicate the connections which these topics have with philosophical problems and furnish a partial solution.]

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II Ex Chimia

1. *Subject matter and divisions of Chemistry*:
   - a. Inorganic Chemistry: the study of the elements and non-carbon compounds.
   - b. Organic Chemistry: the science of carbon compounds; aliphatic (straight-chain compounds) or aromatic (cyclic compounds).
   - c. Biochemistry: the study of the chemistry of living beings, in particular of man.
   - d. Theoretical Chemistry: the aggregate study of chemical law and theory.
   - e. Analytic Chemistry: qualitative: inorganic compounds and elements; organic compounds. Quantitative: volumetric and gravimetric.

2. *Historical*:

Greek concepts of matter (four elements) and of affinity; Greek atomism; Aristotle's theory of matter and form; the Alchemists; the Phlogiston theory; the discovery of oxygen; Lavoisier and Priestley; Dalton's atomic theory; Prout's hypothesis; Faraday's laws of electrolysis; Kekule concept of valency; Dobereiner's triads and Newland's table of octaves; Mendeleeff's Periodic Table; Helmholtz and the new atomic theory of electricity; J. J. Thompson and his study of electrons; the inert gases; the Rutherford atom; Bohr and his theory of atomic structure; Moseley and atomic numbers; Lewis Langmuir theory; the rare earths.

3. *Selected Topics*:

Structural Order in Matter: *Electrons and protons*: development, foundation of the theory in electrolysis and radioactivity, nature of the particles, orbits of movement. *Atoms*: Bohr theory of atomic structure, Periodic Table—short periods, long periods—, rare earths, relationships of atomic weights and atomic number, isotopes. *Molecules*: kinetic theory of gases, liquids and solids, compounds, mixtures. *Ions*: foundations, anions, cations, ionogens and non-ionogens. *Crystals*: types, their properties, X-ray analysis and uses. *Solutions*: their physical nature and properties, theory of solutions. *Colloids and Emulsions*: theory as to their nature, application.

Valence: nature, electro-valence, normal covalence, coordinate covalence, relation of valence to solutions, colloids and compounds, electrolysis, properties of physical bodies.

Chemical Thermodynamics: energy changes and entropy, adiabatic processes, three laws of thermodynamics.

Chemical Psychology: inability to explain life by theory of solutions, colloids or affinity; chemistry of endocrine secretions: structure and properties, ineffectiveness as a sole source of all activity, effect on freedom of the will.

III Ex Mathesi

1. *Divisions of Mathematics*:

Obviously there is an intimate connection between all fields of mathematics and consequently the divisions will not be mutually exclusive but only broad sections worthy of special note.

a. Analysis: Theory of Functions, Calculus, General Analysis, etc.
b. Geometry: Metric, Projective, Differential, non-Euclidean, n-space Geometry, etc.
c. Algebra and Arithmetic: Algebra (commutative and non-commutative), Theory of Numbers, Algebra of Logic, etc.
d. Applied Mathematics: Probability, Statistics, Quantum Mechanics, Relativity, etc.

[Note. The instructor might attempt in this section to give, according to the abilities of the class, some understanding of these branches in mathematics. Articles in the *Encyclopedia Britannica* would prove useful.]

2. *Historical:*

Suggested names for treatment: Euclid (geometry); Archimedes (geometry and mechanics); Diophantus (algebra, theory of numbers); Napier (logarithms); Descartes (analytical geometry); Pascal (geometry, probability, theory of numbers); Newton and Leibnitz (differential and integral calculus); Euler (analysis and mathematical physics); Gauss (theory of numbers, geometry, analysis); Legendre (elliptic functions, theory of numbers); etc.

[Note. In addition to the above, some outstanding Jesuit mathematicians might be included. For biographical information: Smith, D. E., *History of Mathematics*, 2 vols, and Sanford, Vera, *A Short History of Mathematics* will usually be found satisfactory; and also the *Mathematics* Teacher has published in recent years brief biographical sketches of prominent mathematicians.]

3. *Selected Topics:*

Continuum: philosophical and mathematical definitions, their connection; mathematical continuum does not *necessarily* imply atomistic dynamism; limiting processes.

Infinite: Philosophical (*actu*, *potentia*); mathematical; false notions about mathematical infinite.

Non-Euclidean Geometry: historical origin; attempts to prove parallel postulate, meaning of non-Euclidean geometry; examples; under this heading might also be included a discussion of n-space geometry.

Objects of Mathematical Thought: obtained through the second degree of abstraction; their existence and truth.

Foundations of Mathematics: schools of thought in modern mathematics; their value, deficiences; a scholastic approach.

Mathematical Philosophers: influence of mathematics on the philosophy of Pythagoras, Plato, Descartes, Leibnitz, et alii. Influence on modern cosmological theories—Jeans, Eddington, Whitehead, etc.; modern symbolic logic.

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IV Ex Biologia

1. *Biology: Its Divisions:*
   a. Morphology: exterior structure and interior structure.
   b. Physiology: functions of organs.
   c. Biogeny: ontogeny and phylogeny.

2. *History of Biology and relation to Philosophy:*
   a. Historical: 1st period: Aristotle, Galen, Albertus Magnus, Roger Bacon. 2nd period: Vesalius, studies of anatomy. 3rd period: von Linne, new system of classification. 4th period: Schleiden and Schwandt, theory of cell.
   b. Relation to Philosophy: to Cosmology: with regard to order of the universe; to Psychology: essential difference between life and non-life; relation of nervous system to knowledge; to Ethics: hormone effects on the mind, heredity; to Theodicy: design in the universe.

3. *Special Topics:*

   Chemical Constitution of Living Beings: elements, organic compounds, inorganic compounds, emulsions, chemical synthesis, parthenogenesis.

   Endocrine Glands: names and their location, function, effect on the organism.

   Spontaneous Activity: irritability, tropism, failure of latter to explain irritability, growth, metabolism.

   Structure of Cell: cytoplasm, spongeoplasm, hyloplasm, karyoplasm, size, shape, modes of division, amitotic, mitotic, prophase, metaphase, telephase.

Reproduction of Organism: Asexual: fission, sporulation, budding; sexual: parthenogenesis, amphimixus; maturation process; fertilization process.

Heredity: environment, training, heredity proper, physical bearers, transmission and expression, Gregor Mendel, laws of unit character, of dominance, of segregation, extent of heredity.

Evolution: meaning, forms of evolution, restrictions, theory, no relation to origin of life, scientific question not religious, etc.

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V Ex Anthropologia

1. *Anthropology*:

Aim and purpose of the science; functional view; theory of unilinear cultural evolution; *Kulturkreistheorie;* culture origins and culture development.

2. *Selected Topics*:

Primitive Mentality: primitive and civilized peoples; their mental processes; practical knowledge; primitive technique; power of memory and learning ability; mingling of truth and error in primitive mentality; primitive languages.

Marriage: views on marriage among primitives; rejection of primitive promiscuity; the family a universal institution; exogamy; role of women and children in primitive society; importance of primitive social organization.

Primitive Law and Ethics: primitives guided by the moral law; material vs. spiritual culture; instances of a primitive moral code; taboos and regard for law; classes of "sins"; apparent disregard of moral laws; true form of morality; lights and shadows of primitive life.

Primitive Culture: primitive languages; richness of primitive speech; cave art, geometric art, Bushman art; primitive music;

religion and art; primitive literature, primitive song; ancient myth-makers.

Primitive Religion: definition and divisions; four types of religion; facts and their interpretation; *Kulturkreistheorie*; the degeneration theories; fundamental weakness of these theories; difficulty of constructing a theory of ultimate origin of religions.

[A. Muntsch, S.J., *Cultural Anthropology* (Bruce, Milwaukee) upon which this syllabus is based, contains ample bibliographical material.]

CONCLUSION

Recognizing the fact that the syllabus submitted above will, almost necessarily, contain many *lacunae*, the authors request that readers will point these out, offer alternative syllabi, and in a word discuss the problem with a view to obtaining a more satisfactory course in *Quaestiones Scientificae* for our scholasticates.

THE FUNCTION OF SCIENCE

REV. JOHN A. TOBIN, S.J.

At the very outset a sharp distinction must be made between 'Science' as we understand that term today, and 'Philosophy', as well as between the philosophy of a scientist and the science of a philosopher. Because of the confusion of all these terms we find that science is being attacked today because it fails to function as a philosophy or a religion. Science that is most exact, accurate and reliable as regards the study of relationships between facts is blamed for the confusion of thought in morality and religion. An example of this type of criticism is found in the address of Dr. Iago Galdston in the meeting of the American Institute. 'At rock bottom science is amoral, devoid of ethics, and not concerned with the good, the true, and the beautiful of Socrates and Jesus'. After the long battle of the last three centuries against false philosophers and mistaken theologians, scientists are admitting that religion and politics are outside the function of science, yet today they are blamed for the false philosophy that hides under the name of science. We need today the retort of Pasteur when he head the inscription, "*la science* n'a ni religion ni patrie,"—"But *scientists* have a religion and a country." And the criticism today should be directed where it belongs, to the philosophy of the scientist. There is no person in the concrete enthroned above the clouds called science. Science exists in the abstract. But men and women of finite intellects and most human in their moral and social and political worlds write our books, and give the talks that are blamed for the confusion today. If in these lectures and books the scientist is accurate and reliable in the observation and measurement of the facts and correct in his inductive reasoning to the general principles and laws of nature, and orderly in his classification of these principles his science may be experimentally verified by all the world. We limit science then to this quantitative measurement of observed quantities and to the inductive reasoning to the general principles and their orderly classification. And it is self evident that science in this limited sense is not concerned with morality and politics. But if men in their selfishness use the facts of science to destroy their fellowmen and their countries, the blame does not belong to science but to the false philosophy of the scientist. Because I discover some great labor saving machine that is a great blessing to humanity, I am not to blame for the selfishness of men who use that machine to grind down to poverty their fellow men. It is not immoral to give the facts about high voltage electricity. It is immoral to apply those facts and murder innocent people by electrocuting them.

We use the word 'Philosophy' as understood today as that branch of knowledge which by the light of natural reason studies the first and ultimate causes of all things. It contains the principles that are common to all sciences as causality, matter, trustworthiness of the senses and the self evident principles of contradiction and identity. These principles admitted as common sense are called Metaphysics. It is in the application of these certain principles to the certain facts of science that we find the confusion today. In this 'no man's land' we find two great errors that have poisoned the philosophy of the scientist and caused the confusion that is attacked today.

The first error is the exaggerated conclusion that, since we do nothing in science except observe measured quantities, nothing else can be known. This error denies the knowledge of qualities that cannot be measured. Because I am justified in my scientific work of only considering measured quantities, I am not justified as a man in denying any other knowledge. Why should I contradict my common sense and state that I do not know such things as a Mother's love or the heroic self sacrifice of my friend, or that I do not suffer pain or experience pleasure? Because I measure the weight and height of a man by pointer readings, must I deny that the whole man vanishes after that? This 'nothing but' philosophy has poisoned the minds of many today and the natural reaction of common sense has attacked it as most unreasonable.

The second error that permeates the philosophy of the scientist is the denial of any knowledge from the process of reasoning called deduction. 'Beware of metaphysics' is still the cry in many lectures of scientists. It is perfectly correct for the scientist as a scientist to limit his knowledge to measured quantities and induction, but it is an error for him as a man gifted with reason to claim that all knowledge is limited to pointer readings.

How did these two errors in the philosophy of the scientist become so widespread? It is natural to extend a method that is so successful to other branches, and nobody can deny the success of the experimental method. Like the pendulum, the position of equilibrium is reached slowly when the mind is disturbed. The first exaggeration that scientific facts can be found by deduction from abstract principles caused such a reaction that the mind swung to the opposite extreme and denied all knowledge from deduction. And now after the three centuries when the equilibrium of common sense has been found in science, we have the strange attack that science ought to be shackled to politics or morality. To avoid this slavery of science to politics and false philosophy requires an unwearied struggle again today to preserve the liberty of science. The weakness in the philosophy of the scientist today had its start in the philosophy of Descartes. Descartes locked up the soul within the body as a prisoner within the walls of a cell through which he could not see. Common sense has always treated the soul as vivifying the body and acting with the body. It was easy then for Hobbes, Locke, Hume and Comte to put an exaggerated emphasis on the body and soon the soul was forgotten in materialistic philosophy that has developed today into the philosophy of Communism. On the other side Hegel and Berkeley put an exaggerated emphasis on the soul and we have the Idealism that is useless in science work. Common sense demands that our knowledge start from the senses and from material things. Then Kant tried to justify these systems of philosophy by building a system that only knows the appearances of things and demands that all knowledge is sensible. A common sense philosophy asserts that knowledge starts with the senses but denies that it stops there. Common sense denies that the facts of science can be solved from abstract principles without experiment, yet it does not deny that there is a knowledge derived by the mind with its power of abstraction. Yet there still exists the great difficulty of applying these principles that are universally true to the facts that are true from experimental knowledge. The facts are like beads, the philosophy is like a thread. The difficulty is to thread the beads. Again we insist it is perfectly correct for the scientist to limit his scientific knowledge to the facts or beads and to his theories in connecting the beads in orderly groups. It is perfectly correct for the philosopher in his general metaphysical principles to study the thread and give us its true value. But it is absolutely false for the scientist as a man gifted with reason to claim that all knowledge is limited to his facts, or for the philosopher as a man gifted with senses to deny the existence of the facts. The scientist is by nature a philosopher but being limited by his work must turn to the philosopher for the correct and true principles. The philosopher limited by his studies must turn to the scientist for the facts. But we must have patience with the finite minds that are struggling in the dark forests of the philosophy of the scientist and the science of the philosopher. Both are going into the house of truth. One goes in the front door of facts. The other enters by the rear door of philosophy. There must be some place that they meet. And it is in this sincere and honest quest of truth that we see the return of many scientific writers to the common sense philosophy that has come down to us from Aristotle through the Scholastics. It is true that many ignore this philosophy completely from some bigotry that sneeringly calls it dogmatic, and others attack it for some one defect forgetting all its good points. It is nothing else but the accumulated intellectual treasures of the great minds in all centuries built into a closely knit system of thought. It is not a history of philosophy but a system built by the toil and patience of great minds. It gathered and preserved the writings of the ancient philosophers, analyzed them, and contributed the results of the great minds of each century. It studies all things in so far as they are known by natural reason. There is no supernatural and revealed element in the reasoning. But it cannot permit one truth to contradict another truth, so the system is built from certain principles that all men in the last twenty centuries have found to be true.

In the near future it is not difficult to imagine a projection machine that will give the shape, color, and speech of man as we see him in actual life. A person ignorant of the apparatus could not easily explain what it is that has color, apart from the color, or what causes the sound. And yet a child who knew about the machine would tell you that there was no man there but only an image from the moving picture machine and the sound from the loud speaker. But the image on the screen would in itself be far removed from the reality from which it proceeded. Our knowledge of the world outside comes from our senses, but what is the reality underlying these qualities that affect our senses? What is the thing itself? All intelligent people ask themselves that question, and that is the first step in philosophy. It is a natural result of the knowledge of nature which we gain from our senses. We know what our senses tell us of the outside of nature. But it is almost as difficult to understand the reality in back of the sensible world as it would be to get an idea of the projection machine in the booth from the image on the screen. Yet in both cases it is common sense to conclude that there is some reality giving rise to the appearance in each case. And during the many centuries that man has studied the appearances in Experimental Science, there has been the struggle to understand the reality. And to-day when we explain the phenomena which are apprehended by our senses as due to radiations of light, heat, and sound issuing from some apparatus invisible in itself, we still need common sense to reason to the cause of those radiations. There is no difficulty about the observed phenomena of Experimental Science. There is no great difficulty about the fundamental truths which we call common sense or philosophy or metaphysics. But the great battle ground to-day is in that no-man's-land where we try to reason from the facts to reality.

Max Planck in his book, "The Universe in the Light of Modern Physics" explains the three worlds which must be distinguished from one another.

The first is the world of man's sense impressions, like the picture on the screen. In common with other animals we have many senses by which we come in contact with the world. At the surface of our body we have sight, hearing, touch, taste and smell. We also have a temperature sense and a muscular sense that informs us of our movements and positions of the parts of the body. We also sense hunger and thirst and pain and comfort. These senses then perceive only individual material objects. For example I observe that the pressure of a gas increases when the volume decreases if the temperature remains constant. That is the first step in science,—observation. Then in an experiment I measure the pressures and the volumes and find that within the limits of my experiment the pressure multiplied by the volume gives a constant number. The second step is the measurement and determination of a constant ratio, no matter how the two quantities vary. If the experiment is varied and many scientists all over the world obtain the same result, then by inductive reasoning I can make the general statement that the pressure of the gas varies inversely as the volume when the temperature is kept constant. Science consists of an orderly classification of these general statements. It studies the picture on the screen.

The second world is the REAL world which lies beyond my senses, as the motion picture projector is concealed from the audience. This world exists independently of man, and reason compels me to postulate the something that affects my senses. Our minds or intellects, are much superior in nature, purpose and functions to our senses. It is our soul that thinks, judges and reasons. Our senses can only represent material, concrete, single things. So can our mind, but it can also abstract from individual notes and represent an element that is common to all. I can think of "Man" but I sense this of that man. Our mind can form judgments from the ideas that are known from experience. "The whole is greater than a part". Our mind can reason. From two or more judgments already known I learn some new truth not known explicitly before. "Evil is to be avoided. But stealing is evil. Therefore stealing is to be avoided." We can call this second world, the world of metaphysics. It studies the motion picture projector.

The third world is the application of the metaphysical truths to the truths from the experimental science. Thus Metaphysics is applied by the philosopher to inorganic nature in Physics and Chemistry and is called Cosmology; applied to Biology-Psychology; and to Sociology-Ethics. On the part of the scientist it is taking his truths and facts and trying to reach reality by applying the right reasoning of Metaphysics. One goes in the front door. The other the back door. There must be some place that they meet. In this world then of modern science, sincere and honest students make deliberate guesses to explain the facts that they have measured. When the guesses are tried and found to explain the facts and what is more, are fruitful sources of discovery, they are called theories. For example in physics we have the Quantum Theory of Max Planck and the Theory of Relativity of Einstein. As their theories become more perfect, the nearer they approach to the real world of truth. It is in this world that scientists and philosophers try to connect the facts of structure in the first world of sense with the second world of reality and truth. And it is the work in this world that has brought about the queer return to scholastic philosophy.

The separation of philosophy and science started in the times of Galileo and Newton. When the scientists in the last three centuries accomplished such wonders, it is not difficult to see how they lost sight of metaphysics. Astronomy revealed a new universe, Geology made known the history of the Earth, Biology helped conquer disease, Chemistry gave us new substances, and Physics gave us new mechanical and electrical devices that revolutionized our way of living. On the other hand many of the false philosophies went off to empty speculations and lost sight of the experimental truths. The great success in the experimental method caused the pendulum to swing over to one side where not only was there supposed to be no need of philosophy but that science was *the* philosophy. On the other side, false philosophy despised the facts of science so "beware of Metaphysics" was the cry heard in science. Then came the startling discoveries in the sciences after 1900 and science swung like the pendulum to the other extreme and we had mathematical scientists making all consist in their symbols and figures. But like a pendulum it is returning to equilibrium and back to the middle position of common sense philosophy.

In both extremes the scientist finds himself lost in a great forest of confusion, he has to consider the concepts of time, space, action, simultaneity and causality. For that he needs metaphysics and clear reasoning. On the other hand common sense requires that he observes with his senses, so he needs science for facts. And so to use the analogy of divorce, science is returning to her first husband because she cannot live alone, as she tried to do in the last century.

This great change is manifest in the many writings of 1936. Time permits only a few examples. Treadwell Cleveland in the Technology Review for April 1936, discusses the changes that have taken place in the last seventy-five years since Mass. Inst. of Tech. received its charter. "When the sciences first began to know their strength, especially in the closing years of the last century and the earlier years of this, they prided themselves on their precision and their quantitative results. They tended, indeed, to insist that quantitative results alone were worth while. As a result, there crept upon Philosophy a new mechanistic and materialistic palsy, which deprived it of its steadiness and self-reliance. Science has now waived these claims to be the universal tutor and the final arbiter of values; a new idealism is taking courage and finding strength. Philosophy is reasserting its rights as critic and reconciler of that many sided knowledge which flows to the mind from every source."

Again in the mid-summer number of the Yale Review, R. M. Hutchins, President of the University of Chicago, insists on the importance of metaphysics not only for science, but also to establish rational order in the modern world as well as in the universities. He postulates metaphysics as the Principle of Unity in Education. It is required in the study of any science. In the natural sciences and the social sciences we postulate causality, matter, trustworthiness of the senses, logic of induction, certitude, principle of contradiction, meaning of being. In the confusion of false reason—all of these have been denied. Now we return to them. In the natural sciences, we abstract from the individuating conditions, as this velocity or that, and treat of velocity. In Mathematics we have a further abstraction from all sensible qualities except extended quantity. But in Metaphysics we abstract from matter altogether and consider the concrete things that we viewed in science, as subject to motion and change, and in Mathematics, as a quantity,—now as a *thing*. The principles and laws then of Metaphysics are first principles and can be applied to all natural sciences. In this way Metaphysics is the principle of unity, and as a school is concerned with thought, we will find that the three faculties of metaphysics, natural sciences and social sciences will take the place of the research institutes that have reduced college education to gathering facts. All three branches will have to be taken, but the student will emphasize the branch that he needs. An engineer will take metaphysics and social sciences but will emphasize the natural sciences. A lawyer will take metaphysics and the natural sciences, but will emphasize the social sciences. But all will have to take the three branches. You will notice how this is a return to the mediaeval idea of education except that religion was the principle of unity.

One more example of the trend of our times comes from Dr. Carrel in his book "Man the Unknown". He states clearly that the great error to-day comes from the wrong interpretation of Galileo's measurements. Galileo distinguished the primary and measurable quantities from the secondary which cannot be measured, and the measurements helped us so much to advance in civilization that we forgot the qualitative. The abstraction of the quantitative in the natural sciences was legitimate, but the overlooking of the qualitative was wrong. We may measure the length, mass, velocity, and forces of a man. For example this is what happens to George Washington. There are many qualities and quantities that we could study in him but we reduce him to a height of five feet and a weight of 150 pounds. George Washington fades out and we have two pointer readings on the divisions of a scale for *height* and *weight*. It is self-evident that this is not all that we can know about this great man. To deny the existence of his thoughts, sorrows, self sacrifices and pleasures is ridiculous. The second defect came from Descartes who put emphasis on the soul as if distinct from the body, like a person in a dark cell, and Locke who put emphasis on the body, and Hegel who considers only the mind. So we had two distinct schools of exaggeration. Materialism made the soul matter, and Idealism made that matter the soul. But to-day, facts in science require mind and matter, body and soul. That was the cause of this swing back to Catholic philosophy in the last few years. It would be sheer folly to deny that the brilliant work in exact measurements, or pointer readings if you wish, has not given us a changed outlook on the universe. It is foolish to deny that the great success in the use of mathematical symbols in advanced mathematics has opened up new visions of the universe. But must there be a new philosophy for the changed conceptions of science? Because science changes its clothes, must philosophy also buy a new outfit? Is there any justification for the new gods, new morals, new ethics and new religions? The object of science today is to study cold facts and formulate laws of activity. The scientist keeps asking HOW they happen. But the philosopher keeps asking WHY. To satisfy this hunger, a philosophy of science was developed that denied any metaphysics. It is called Positivism or Materialism, and limits itself to facts, or is guided by the higher discipline of mathematics. Of course, then, this philosophy can change, but not true Metaphysics, with its unchanging, necessary, and universal principles, but when these immutable principles are applied to science then their application depends on the facts of science. In the Encyclical of Pope Leo XIII "Aeterni Patris" we find the following "When the Scholastics following the teachings of the Holy Fathers everywhere taught throughout their anthropology that the human understanding can only rise to the knowledge of immaterial things by the things of the sense, they well understood that nothing can be more useful than to investigate carefully the secrets of nature, and to be conversant long and laboriously with the study of the physical sciences.' Since knowledge comes from the senses, Catholic Philosophy has always recognized and accepted the proved results of science, and has used the facts of science as a check if she strayed away in the paths of speculation. "He who neglects the experimental order in natural science falls into error," comes, strange as it may seem, from St. Thomas Aquinas. (De Trinitate Boethii, P. 6 Art. 7.) You cannot find a single Catholic philosopher of any note who holds that the facts of science can be solved by deduction from some abstract principle, yet the ignorant say this philosophy did try to prevent the knowledge of facts. Each year new facts are discovered. The facts today in Physics, Chemistry and Biology were not known a few centuries ago. But the principles by which these facts are interpreted are the same, for these common sense principles do not change. Aristotle, St. Thomas and Suarez would astound us today, if they were alive, and applied the same principles that they used to facts known in their time, to the facts discovered in this century. We are apt to forget that our great advance in science is due to superior instruments of measurement, and we find little in the writings today to indicate that the application of principles is any better than in the writings of the great Scholastic Philosophers. I doubt if St. Thomas would deny the Principle of Causality because some facts were explained by a Quantum Theory. And we must always remember that the farther we get away from the certain principles of Metaphysics and from the certain facts of Science, the farther we get away from certitude. So our poor finite intellects make many theories to explain the reality of nature from the limited data of our senses.

BIOLOGY

PERILAMPUS, A SECONDARY PARASITE

Rev. John A. Frisch, S.J.

Ford[1] reports finding a planidium of Perilampus attached to a long-horned grasshopper, *Conocephalus fasciatus*. She considers it quite improbable that Conocephalus is the true host of the Perilampus, and that quite likely the planidium is a secondary parasite of some parasite of Conocephalus, because Perilampus has been reared as a secondary parasite from several species of Sarcophagids, though not from Sarcophagids on long-horned grasshoppers.[2,3]

I have reared a Perilampus n. sp.[4] from one of three puparia collected from the cell of the digger wasp, *Ammobia pennsylvanica* which uses katydids, *Microcentrum rhombifolium* (*M. laurifolium*) for provisioning her cells. The other two puparia yielded a Brachymeria n. sp., and a Sarcophagid fly. The fly was in too poor a condition to allow of identification beyond Sarcophagidæ. The puparia, which were all identical in structure, were new and yet unidentified, making it impossible to use them as a means of identifying the fly. The find at least establishes the fact that Perilampus is a secondary parasite on a Sarcophagid parasitic on katydids.

From a collection of over fifty puparia of the Tachinid, *Serotainia trilineata* (V. d. W.) found in the cells of the same digger-wasp, I reared 2 specimens of *Perilampus hyalinus* (Say). This establishes the fact that Perilampus is a secondary parasite on *Senotainia trilineata* parasitic on katydids. I have also reared, however, *S. trilineata* from puparia found in the cells of the digger wasp *Ammobia ichneumonea* which provisions her nest with long-horned grasshoppers of the species *Neoconocephalus ensiger* (*Conocephalus ensiger*) and *Conocephalus attenuatus* (*Xiphidium attenuatum*). This confirms the opinion of Ford that the planidium found in *Conocephalus fasciatus* is a secondary parasite of a Tachinid parasitic on long-horned grasshoppers, in this case *Senotainia trilineata*.

1. N. Ford, Canad. Ent., 54:199-204, 1922.
2. H. S. Smith, U. S. Dept. Agr., Bur. Ent., Ser. 19. (4) :33-69, 1912.
3. E. O. G. Kelly, Jour. Agri. Res., U. S. Dept. Agr., 2:435-445, 1914.
4. Identifications were made by the staff of the Bur. Ent. and Plant Quar., U. S. Dept. Agr. as follows: Orthoptera, A. N. Caudell; Perilampus, A. B. Gahan; Sarcophagids, J. M. Aldrich and C. T. Greene.

CHEMISTRY

APPLICATION OF STATISTICAL METHODS TO ANALYTICAL AND PHYSIOLOGICAL CHEMISTRY

REV. FRANCIS W. POWER, S.J.

Part II

To illustrate the value of the statistical method in pointing out significant differences even though their cause may not be clear at the time the experiment was conducted, the excellent paper of Scott already cited will serve as a good example. He made a thorough statistical study of the blood sugar of 1000 rabbits in which he went to the trouble of dividing this series of measurements up into

200	groups	of	5
100	"	"	10
50	"	"	20
33	"	"	30
25	"	"	40
20	"	"	50
10	"	"	100

calculating all the necessary statistical functions for each of these groups. The mean for the whole series of 1000 was 124. mg. glucose per 100 cc. of blood, with a standard deviation of 14.2 mg. On looking over his tables, one finds two groups of 50 measurements whose mean values differ widely; I have calculated the statistics for these two series, which come out as follows:

	3rd Column	8th Column
Mean blood sugar	116.1 mg.	132.9 mg.
S (of individual determinations)	10.51 mg.	15.85 mg.
S_M (of the mean)	1.48 mg.	2.24 mg.
Number of determinations	50	50

Using the usual procedure as already explained (i.e., assuming the normal curve), we have

$$S_D = \sqrt{S^2_{M_3} + S^2_{M_8}}$$

$$= 2.69$$

$$\Delta x = 132.9 - 116.1 = 16.8$$

$$t = \frac{\Delta x}{S} = \frac{16.8}{2.69} = 6.25$$

There is no need of looking up the probability in this case since it differs from unity by only about 10^{9} That is to say, there is not the slightest chance that the measurements were made by identical methods on the same kind of animal; the figures clearly point out some enormous difference either in the condition of the animals in these two series or in the experimental procedure followed. Yet all measurements were made by the same person using the same method, and presumably on the same species of normal animal. It was not until several years later, as Dr. Scott told me recently, that the cause of the discrepancy came to light. In the course of a later and more extended study of the same type he found a *secular* variation in the blood sugar; the amount varies in the normal animal according to the time of the year. In the table of "raw data" given in the paper, the observations are set down in vertical columns of 50, the top figure in each column representing the 1st, 51st, 101st, 151st etc. individual observation respectively. Thus the rabbits in the two columns which differ so widely were experimented on at different times in the year and the difference shows up clearly by the statistical method even though the reason is not apparent. As Dr. Scott told me, if I had gone along the rows in the table instead of the columns the difference would not appear since this would be as it were cutting across the time curve and more nearly balancing out the secular variations.

In the paper itself at any rate, long before this phenomenon had come to light, Scott wrote (in reference to some other similar series he is analyzing) " . . . . it is interesting to speculate on the value of conclusions which might have been drawn from any one of a number of pairs of consecutive means which differ from one another by what ordinarily would be considered a perfectly safe margin. An investigator trusting to such differences might well be sorely embarrassed by subsequently refuting his own work. Assuming that the (3rd) represents a control series while the (8th) represents a series that has been exposed to some experimental conditions it would have resulted that had the investigator said 'abracadabra' when drawing the blood of the (8th series), a profound and hitherto unknown biological 'law' would have been 'discovered'. The evidence for this new law would have been considerably better than that submitted in support of much that is actually and seriously presented". As it turned out, this new "law" was really latent in the figures and awaiting discovery; and it also turned out that the magic word which made the difference was not abracadabra, but the name of the month in which the blood sample was taken. Scott also emphasizes the fact that one must interpret statistical data with the greatest caution until he has made enough measurements to get a value for his mean and his standard deviation which will not be materially altered on further increasing the number of measurements. Once this has been done one knows where he stands and interpretations and predictions can be made with some assurance.

This leads one to ask, naturally enough, how many measurements will have to be made in order to confer a certain given stability to some given mean value? The answer to this question is given by some of the authors, but Shewhart puts it about as well as any. He says (p. 390) "Assuming that we know that a quality X is normally controlled with standard deviation sigma, how many measurements of this quality must be made in order that the probability will be, let us say, 0.9973 that the deviation of the average of n observed values from the true but unknown arithmetical mean X be no greater in absolute magnitude than some given value Δ X. From what has previously been said we see that the size n of the sample required in this case is rigorously given by the relation

$$\Delta x = \frac{3\sigma}{\sqrt{n}}."$$

The standard deviation he is speaking of is that of the sample—i.e., that of the individual determinations—what I am calling S. The only difficulty is that we have to estimate this standard deviation as best we can from what may be a comparatively small number of determinations; even in Scott's data involving 1000 measurements, S varies (for series of 50) from 9.3 to 18.6 mg., averaging 14.2 mg. for the entire list of 1000. The figure 3 which Shewhart takes as his coefficient of the standard deviation is our "coefficient of certainty" $t=\frac{x}{S}$, which he takes here arbitrarily according to the degree of certainty desired. The larger it is the more certain we shall be that our proposed number of measurements will be large enough.

I said a while back that the lower we make the value of $\frac{x}{S}$ the stricter we are with our criterion and the fewer measurements there will be which we are prepared to admit into our series. The reader may wonder why in this present connection we try to attain a greater certainty by making t larger (e.g., 3) rather than small. The reason for this is that here the situation is just reversed; we are not looking for a criterion of rejection with the mean value already given; here we are trying for an invariable average, which shall not be upset more than Δ x by making still more measurements, and we are prepared to accept all of these that we make except those that would deviate from the true mean by more than 3 S. Hence, in order to include all the possible measurements, even those which objectively might on a strict criterion be open to suspicion, we make the range as wide as possible, or at least as wide as the nature of the problem demands. Note that the precision of the final result is a function not of N but of $\sqrt{N}$; that is to say, the precision of two series of 25 and 100 measurements respectively is not 1 to 4 as one might expect, but only 1 to 2; in order to get double the precision, other things being equal, we must make four times as many determinations. I suppose the corollary of this for the chemist would be to spend more time and thought in perfecting his technique rather than in running many determinations in a careless and uncritical manner.

Referring to Scott's work again, let us put the question this way: on how many rabbits must the blood sugar be determined so that the mean of this number shall not differ from the "true mean" by more than 5 mg. 99 times out of 100? The quantity P is thus set at 0.99, and the quantity $t = \frac{x}{S}$ which corresponds to this in the tables is found to be t = 2.57. The quantity Δx is given as 5 mg. Scott gives as the standard deviation of his whole series the value S = 14.2. Putting the equation into the nomenclature I have been using we then have that

$$N = \left(\frac{tS}{\Delta x}\right)^2$$

$$= \left(\frac{2.57 \times 14.2}{5}\right)^2$$

$$= 53$$

That is to say, if we run several series each comprising 53 blood sugar measurements, the mean of each series will come within 5 mg. of the "true" mean value 99 times out of 100 providing that the variations are due to accidental errors.

In this connection it seems to me that this equation could often be applied to analytical work more conveniently if we were to express both the standard deviation and the allowable discrepancy in parts per thousand of the mean. For example, the iron ore mentioned on a previous page had a mean value of 21.68% Fe, the individual determinations being distributed with a standard deviation of 0.238%, or

$$\frac{0.238 \times 1000}{21.68} = 11.0 \text{ parts per } 1000$$

which may be called the relative standard deviation. If it is required to know the iron content of this sample to within 0.10% Fe, it is the same as saying that we desire a precision of

$$\frac{0.10 \times 1000}{21.68} = 4.6 \text{ parts per } 1000 \text{ of Fe}$$

The original equation

$$N = \left(\frac{tS}{\Delta x}\right)^2 \text{ will then appear as } N = \left(\frac{\frac{1000\ tS}{\text{mean}}}{\frac{1000\ \Delta x}{\text{mean}}}\right)^2$$

which we may write as

$$N = \left(\frac{te}{E}\right)^2$$

where e is now the relative standard deviation and E the desired precision of the mean, both expressed in parts per thousand of the mean; it is set arbitrarily as before. If the precision of 4.6 parts per 1000 of iron is desired 99 times out of 100 we have

$$P = 0.99, \quad t = 2.57$$
$$e = 11.0$$
$$E = 4.6$$
$$N = \left(\frac{2.57 \times 11.0}{4.6}\right)^2 = 38$$

That is to say, 99 series out of 100, each of 38 determinations, will come within 4.6 parts per 1000 of the true iron content of this sample. This large number is evidently made necessary on account of the high standard of deviation of the individual iron determinations.

In order to make full use of this relation between the number of measurements made and the precision to be expected of them, I shall have to introduce another measure of dispersion which, however, is more familiar to chemists than is the standard deviation. If the reader will refer back to the series of iron ore analyses previously mentioned he will note that the differences between each individual measurement and the mean (taken without regard to sign) sum up to

$$\Sigma\ d = 3.76$$

This measure of dispersion which I introduce here is merely the familiar "average deviation":

$$a = \frac{\Sigma\ d}{N} = \frac{3.76}{20} = 0.188\% \text{ for this particular series.}$$

It is commonly employed in text books of quantitative analysis (7) and goes also by the name of average error (Mellor, Daniels); Ostwald-Luther's book refers to it as the "durchschnittlicher Fehler". It is naturally easier to calculate than is the standard deviation, but all the statistical writers agree that it is a mathematically inefficient measure of dispersion principally because it does not treat deviations by the method of least squares. On a normal probability curve, however, it bears a certain theoretical relation to the standard deviation:

$$S = \sqrt{\frac{\Pi}{2}}\, a = 1.253a$$

and $$a = 0.798\ S.$$

On a frequency curve following the *median* law (instead of the normal curve of distribution) this relation becomes

$$S = \sqrt{2}\ a = 1.414\ a$$

The median is simply the mid-point measurement of a series, and the curve of measurements grouped around this median (instead of around the arithmetical mean) is based on the following specifications: the precision of the individual measurements is not constant throughout but varies in a haphazard manner from experiment; positive and negative errors are taken to be equally common; the central value is taken by setting all measurements up in a column and selecting the middle one or "median". Bond uses the ratio

$$\frac{S}{a}$$

as an approximate test to see whether a distribution of measurements follows the normal curve or the median curve. For a long list of the most diverse kinds of physical measurements whose statistics I have calculated I find the actual value of this ratio to be on the average

$$\frac{S}{a} = 1.300$$

the limits being 1.127 and 1.695; this is about halfway between the values it should have for the normal and the median distribution. For 7 series of student analyses of sodium carbonate, iron ore, and arsenic oxide the ratio came out 1.31.

When actual data are available from which the standard deviation may be calculated directly, its calculation from the average deviation is not mathematically sound. There is one case, however, where such a calculation has at least a pragmatic justification. This is the case (often met with in analytical work) where one or more analysts report results on the same constituent in samples whose composition with respect to this constituent is different. For example suppose a student analyzes ten different samples of iron ore whose iron content is accurately established and which varies from say 19% up to 68% iron. The standard deviation of his analytical results cannot be calculated directly since there is no question of establishing a mean iron content of all the samples. What can be done, however, is to calculate the analyst's deviation from the "theoretical" value and express this deviation in parts per 1000 of the iron, for each analysis; then average these deviations up. This gives us after a fashion the relative average deviation of his results, from which the standard deviation can be estimated by the relation

$$S = 1.25a \text{ (approximately)}$$

To illustrate this I shall list various micro determinations of carbon on substances of known composition.

Substance	%C found	%C calc.	Difference in p. p. 1000
Salicylic acid	60.75	60.85	1.6
Acetanilide	71.00	71.08	1.1
"	70.97	"	1.6
Phenanthrene	93.38	94.34	10.2
"	93.46	"	9.3
Ephedrine HCl	59.50	59.53	0.5
"	59.85	"	5.3
Vitamin B HCl	42.47	42.71	5.6
	Mean of the relative average deviations		4.4 parts per 1000 of carbon

Whence the standard deviation in parts per 1000 of carbon should be about

$$S = 1.25 \times 4.4$$
$$= 5.5 \text{ parts per 1000 of carbon}$$

A YEAR'S ADVANCE IN CHEMISTRY

REV. R. B. SCHMITT, S.J.

The *Abstracts* of the American Chemical Society record many thousands of research problems each year. The *Author Index* of the *Abstracts* for 1936 lists 477 pages of names and titles; and the *Subject Index* will, no doubt, exceed six hundred pages. Naturally we inquire about the practical results of these intensive, intellectual and painstaking efforts. Many of these problems merely supply theoretical data, some negative information, and others are highly important to science and to mankind in general. We wish to record here, in a brief way, some of the practical results in the science of chemistry as recorded in the literature.

After five years of research, Fordham University chemists have worked out a process which eliminates more than half the steps in the older process, and does away with the use of the expensive chemicals involved in isolating pure vitamin B_1. This process was accomplished by Professor Leopold R. Cerecedo, assisted by Douglas J. Hennessy, John J. Thornton and Frank J. Kaszuba.

Robert R. Williams, Chemical Director of the Bell Telephone Research Laboratories, has been interested in the study of vitamin B_1 for twenty-six years. Only recently Dr. Williams and his associates perfected a successful large-scale method of extracting the vitamins from natural sources in pure crystalline form. Then too, the empirical formula was established as C_{12} H_{18} N_4 Cl_2 S O. In August 1936, Dr. Williams announced the structural formula for the molecule.

An eighth form of rickets-preventing vitamin D was discovered by Dr. Charles E. Bills, Evansville, Ind. This success was achieved by irradiating with ultra-violet rays a pro-vitamin or parent substance from plant sitosterol, which corresponds to the more familiar animal cholesterol.

Theelin, one of the two sex hormones responsible for female characteristics, was synthesized by Russell E. Marker and Thomas S. Oakwood at the Pennsylvania State College. This synthesis from ergosterol yielded a crystalline product. This is the third sex hormone to be synthesized, the other two are corpus luteum, a female hormone, and testosterone, the male hormone.

In the research of sub-atomic physics, new transmutations were accomplished by bombarding the nuclei of atoms with neutrons, protons, and deutrons. These atomic bombardments take place in electric fields of extremely high magnitude ranging up to sixteen and to seventeen million volts which provides enormous amounts of energy. Lauritson of the California Institute of Technology formed beryllium atoms from lithium atoms using proton bombardment. Lawrence and Cork of the University of California succeeded in transmuting tiny amounts of platinum into gold using deutrons as missiles. Pegram of Columbia University, using a slow-moving neutron, changed sodium atoms into magnesium. In this field of activity the most striking development has been the imparting of radioactivity artificially to different atoms. So far more than forty elements have been used in these experiments and to each of them has been imparted an artificial radioactivity. In discussing this matter, Enrico Fermi of the University of Rome, a leader in this work, suggests that this method of studying atomic structure may have important values in producing new elements to be added to the present periodic system.

Dr. David Richardson at Massachusetts Institute of Technology developed a new method of taking motion pictures through a spectroscope. This method greatly increases the sensitivity and accuracy of the spectroscope in detecting traces of elements. The record of the changing spectrum of a flame containing the material under investigation shows the presence of elements in such minute quantities as to cause merely a flash of color which might be overlooked by the observer and might be missed by a single photographic exposure.

A new type of insulin was synthesized by Dr. Hagedorn of Copenhagen, which increases the effectiveness of ordinary insulin eight times, so that only one injection a day is sufficient. It is known as protamine insulin.

A new preparation of iodine has been prepared, i.e., iodocholeate; it is non-poisonous and possesses a high germicidal value. The new compound causes no irritation, as is found in tincture of iodine, because of its low volatility.

Synthetic resins are being used in the manufacture of a new type of contact lenses to replace eye-glasses. The actual lens is made of glass and fitted in a shield molded to the wearer's eyeball and placed beneath the eyelids.

The Chemo-Medical Research Laboratories of Georgetown University are continuing their work in three main lines of research: sulfur metabolism in health and disease; the study of urine in various pathological conditions; and the development of more specific tests for amino acids, amines and other constituents of the body fluids and excretions. These problems include: studies in arthritis, rheumatic fever, cystine in blood serum, muscular dystrophies and ascorbic acid.

Science marches serenely on.

MATHEMATICS - PHYSICS

A REFERENCE LIBRARY FOR THE SCIENCE COURSE IN MATHEMATICS AND PHYSICS

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MATHEMATICS SECTION

Author	*Title*	*Publisher*	*Date*
Adams	Polyconic Projections	Govt. Print. Off.	1919
Aitken & Turnbull	Canonical Matrices	Blackie	1929
Baker	Principles of Geometry 6v.	U. P. Cantab.	1932
Bateman	Partial Differential Equations	U. P. Cantab.	1932
Bisaere	Applied Calculus	Blackie	1922
Blickfeldt	Finite Collinear Groups	U. Chic. P.	1917
Bliss	Calculus of Variations	Open Court	1925
Bocher	Introduction to Higher Algebra	Macmillan	1929
Bocher	Linear Dependence (pamphlet)	Salem Press	
Bolza	Calculus of Variations	Stechert	1931
Briggs & Bryan	Coordinate Geometry	Univ. Tutor., P.	1891
Burnside & Panton	Introduction to Determinants	Hodges (Dublin)	1899
Burnside & Panton	Theory of Functions	Hodges (Dublin)	1918
Byerly	Fourier Series & Spherical Harmonics	Ginn	
Cajori	History of Mathematics	Macmillan	1922
Carslaw	Fourier Series & Integrals	Macmillan	1930
Chauvenet	Elementary Geometry	Lippincott	1891
Cohen	Differential Equations	Heath	1933
Comstock	Least Squares	Ginn	1895
Courant	Differential & Integral Calculus 2v.	Blackie	1934
Courant	Differential-und Integralrechnung 2v.	Springer	1927
Curtiss	Functions of a Complex Variable	Open Court	1930
Dantzig	Number, the Language of Science	Macmillan	1930
Davies	Mathematical Dictionary	Barnes	1856
De Morgan	Differential & Integral Calculus	Baldwin	1842
Dickson	Algebras and Their Arithmetics	U. Chic. P.	1923
Dickson	History of Theory of Numbers 3v.	Stechert	1934
Dickson	Introduction to Theory of Numbers	U. Chic. P.	1929
Dickson	Studies in Theory of Numbers	U. Chic. P.	1930
Doherty & Keller	Mathematics of Modern Engin.	Wiley	1936
Duhamel	de Calcul Infinitesimal 2v.	Gauthier-Villars	1874
Edwards	Differential Calculus	Macmillan	1921
Edwards	Integral Calculus 2v.	Macmillan	1894
Eisenhart	Non-Riemannian Geometry	Amer. Math. Soc.	1927
Forsyth, A. R.	Calculus of Variations	U. P. Cantab.	1927
Forsyth	Differential Equations	Macmillan	1933
Forsyth	Differential Geometry	U. P. Cantab.	1920
Forsyth	Solutions of Examples in D. E.	Macmillan	1931
Forsyth	Theory of D. E. 6v.	U. P. Cantab.	1906
Forsyth	Functions of Complex Variable	U. P. Cantab.	1893
Fry	Differential Equations	Van Nostrand	1930
Gheury de Bray	Exponentials Made Easy	Macmillan	1928
Gibbs-Wilson	Vector Analysis	Yale U. P.	1925
Goursat-Hedrick	Mathematical Analysis 3v.	Ginn	1904
Goursat	Cours d'Analyse Mathematique	Gauthier-Villars	1927
Graustein	Differential Geometry	Macmillan	1935
Gray, Matthews, etc.	Bessel Functions	Macmillan	1931

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Hancock	Elliptic Functions vol. 1	Wiley	1910
Hardy, G. H.	Pure Mathematics	U. P. Cantab.	1933
Hardy, A. S.	Quaternions	Ginn	1887
Hitchcock and Bobinson	Differential Equations	Wiley	1927
Hobson	Functions of Real Var. 2v.	U. P. Cantab.	1936
Hobson	Spherical & Ellipsoidal Har.	U. P. Cantab.	1931
Ince	Differential Equations	Longmans	1927
Johnson, W. W.	Differential Equations	Wiley	1906
Johnson, W. W.	Ordinary & Partial D.E.	Wiley	1896
Klein	Elem. Math. from Adv. Standpt.	Macmillan	1932
Klein	Lectures on Mathematics	Macmillan	1894
Klein	Reimann on Algebraic Functions	U. P. Cantab.	1892
Klein	Problems of Elem. Geometry	Stechert	1930
Knopp	Infinite Series	Blackie	1928
Kowalewski	Kontinnierlichen Gruppen	Akad. Verlag	1931
Kowalewski	Determinantentheorie	Veit (Leipzig)	1909
Lamb, Horace	Infinitesimal Calculus	U. P. Cantab.	1912
Lane	Projective Diff. Geometry	U. Chic. P.	1932
Levi-Civita	Absolute Calculus	Blackie	1929
Lovitt & Holtzclaw	Statistics	Prentice-Hall	1929
MacRobert	Complex Variable	Macmillan	1925
Madelung	Math. Hilfmittel der Physikers	Springer	1922
Mellor	Higher Mathematics	Longmans	1926
Miller, G. A.	Historical Intro. to Math. Lit.	Macmillan	1916
Muir & Metzler	Theory of Determinants	Longmans	1933
Muir	History of Determinants 4v.	Macmillan	1923
Muir	Determinants	Blackie	1930
Osgood	Advanced Calculus	Macmillan	1928
Page	Differential Equations	Macmillan	1897
Phillips	Differential Equations	Wiley	1924
Phillips	Vector Analysis	Wiley	1933
Pierpont	Theory of Functions 2v.	Ginn	1905
Prasad	Mean-value Theorem	U. of Calcutta P.	1931
Rigge	Harmonic Curves	Creighton U. P.	1926
Russell	Intro. to Math. Philosophy	Allen	1930
Salmon	Conic Sections	Longmans	1924
Schubert	Math. Essays & Recreations	Open Court	1917
Sestini	Infinitesimal Calculus	Murphy	1871
Shorter	Vector Analysis	Macmillan	1931
Smith	Hist. of Math. in America		1934
Smith	History of Math. 2v.	Ginn	1925
Smith	Source Book in Mathematics	McGraw-Hill	1929
Smithsonian	Tables of Elliptical Functions		1922
Smithsonian	Tables of Hyperbolic Functions		1931
Sohon	Seismometry	Wiley	1932
Sokolnikoff	Higher Mathematics	McGraw-Hill	1934
Taylor	Geometry of Conics	Bell	1881
Thompson	Calculus Made Easy	Macmillan	1922
Todhunter	Theory of Equations	Macmillan	1867
Todhunter	Coordinate Geometry	Macmillan	1880
Townsend	Functions of Real Variables	Holt	1928
Veblen & Lennes	Infinitesimal Analysis	Stechert	1935
Volterra	Theory of Functionals	Blackie	1931
Weatherburn	Elementary Vector Analysis	Bell	1928
Webster	Partial Diff. Equations	Stechert	1933
Whittaker & Robinson	Calculus of Observations	Blackie	1932
Whittaker & Watson	Modern Analysis	U. P. Cantab.	1920
Wiener	Fourier Integral	U. P. Cantab.	1933
Wilson	Advanced Calculus	Ginn	1911
Woods	Advanced Calculus	Ginn	1926
Wyckoff	Theory of Space Groups	Carnegie I.	1930
Young	Monographs on Mathematics	Longmans	1914
Young	Projective Geometry	Open Court	1930

PHYSICS SECTION

Adlam	The Science Master's Book	Murray	1931
Airy	On Sound, Vibrations & Music	Macmillan	1871
Allen	Electrons and Waves	Macmillan	1932
Ames	Theory of Physics	Harper	1899
Ames & Murnaghan	Theoretical Mechanics	Ginn	1929
Anderson	Physics for the Technical Student	McGraw-Hill	1932
Andrade	The Structure of the Atom	Bell	1923
Aston	Mass-spectra & Isotopes	Arnold	1933
Bacher & Goudsmit	Atomic Energy States	McGraw-Hill	1932

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Ball	Experimental Mechanics	Macmillan	1888
Baly	Spectroscopy 3v.	Longmans	1927
Barker	Physics—Advanced Course	Holt	1892
Barton	Textbook of Sound	Macmillan	1926
Bethencourt	Physique 4v.	Hachette	1931
Bloch	Kinetic Theory of Gases	Methuen	1930
Bloch	Thermionic Phenomena	Dutton	
Bohr	Atomic Theory & Nature	U. P. Cantab.	1934
Bolton	Intro. to Relativity	Dutton	1921
Boltzmann	Gastheorie 2v.	Barth	1896
Born	Atomic Physics	Stechert	1936
Born	Mechanics of the Atom	Bell	1927
Born	Constitution of Matter	Dutton	1921
Bowie	Gravity & Isostasy	Govt. Pr. Off.	1917
Bowie	Isostatic Investigations	Govt. Pr. Off.	1924
Bragg, W. H. & W. L.	The Crystalline State	Macmillan	1934
Bragg	The Universe of Light	Macmillan	1933
Bragg	The World of Sound	Dutton	1930
Brand	Vectorial Mechanics	Murray	1931
Brewster	Treatise on Optics	Lea	1850
Bridgman	Logic of Modern Physics	Macmillan	1927
Bridgman	Thermodynamic Formulae	Harvard U. P.	1925
Brown, E. W.	Resonance in the Pendulum	U. P. Cantab.	1932
Brown, H. L. & Lauer	Radio Engineering	McGraw-Hill	1920
Buckingham	Matter & Radiation	Oxford U. P.	1930
Buckley	History of Science	Appleton	1892
Cajori	History of Physics	Macmillan	1917
Carslaw	Math. of Heat Conduction	Macmillan	1921
Clark	Hydrogen Ions	Williams & Wilkins	1925
Claydon	Cloud Studies	Dutton	1925
Cohen, L.	Formulae for A. S. Probs.	McGraw-Hill	1913
Compton & Allison	X-rays in Theor. and Experiment	Van Nostrand	1935
Cork	Heat	Wiley	1933
Crabtree	Tops and Gyroscopic Motion	Longmans-Green	1909
Crandall	Vibrating Systems & Sound	Van Nostrand	1926
Culver	Electricity & Magnetism	Macmillan	1930
Daguin	Physique 4v.	Privat	1867
Dampier-Whetham	History of Science	Macmillan	1930
Dampier-Whetham	Development of Physical Science	Blakiston	1906
Dana	Elementary Mechanics	Wiley	1898
Daniell	Principles of Physics	Macmillan	1895
Darrow, F. L.	Masters of Science	Harcourt	1923
Darrow, K. K.	Intro. to Contemporary Physics	Van Nostrand	1926
Darrow, K. K.	Electrical Phenomena in Gases	Williams & Wilkins	1932
Davey	Crystal Structure & Applic.	McGraw-Hill	1934
Davison	Recent Earthquakes	Scott (Lond.)	1915
de Broglie, L.	Wave Mechanics	Dutton	
de Broglie, M.	X-rays	Methuen	1925
Debye	Dipole Moments	Blackie	1931
Dirac, P. A. M.	Les Principes de la Mec. Quantique	U. of France P.	1931
Dressel	Elementares Lehrbuch der Physik	Herder	1905
Drude	Theory of Optics	Longmans	1933
Duckworth, E. H. & H. R.	Laboratory Workshop	Bell	1933
Duncan & Starling	Textbook of Physics	Macmillan	1922
Dunoyer	Vacuum Practice	Bell	1926
Eddington	The Expanding Universe	Macmillan	1933
Eddington	Nature of the Physical World	Macmillan	1927
Eddington	Math. Theory of Relativity	U. P. Cantab.	1923
Edser	Heat for Advanced Students	Macmillan	1917
Edser	Light for Advanced Students	Macmillan	1913
Edwards	Analytic and Vector Mechanics	McGraw-Hill	1933
Einstein	Theory of Brownian Movements	Dutton	
Euler	Letters of-on Natural Phil.	Harper	1833
Ewald, Poeschel, Prandtl	Physics of Solids & Fluids	Blackie	1932
Fajans	Radioactivity	Dutton	1922
Faraday	Lectures on Forces of Matter	Harper	1868
Ferry	Applied Gyrodynamics	Wiley	1932
Ferry & Jones	Practical Physics	Longmans	1908
Findlay	Phase Rule & Applications	Longmans	1923
Fleming	Lectures to Electrical Artisans	Spon	1886
Flint	Wave Mechanics	Dutton	1928
Foote & Mohler	The Origin of Spectra	Chem. Cat. Co.	1922
Fournier	The Electron Theory	Longmans	1916
Frank, N.	Intro. to Mechanics & Heat	McGraw-Hill	1934

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Gerlach	Matter, Electricity & Energy	Van Nostrand	1928
Gilbert	Electricity & Magnetism	Macmillan	1932
Glazebrook	Dict. of App. Physics 5v.	Macmillan	1922
Goodenough	Principles of Thermodynamics	Holt	1929
Goodwin	The Precision of Measurements	McGraw-Hill	1913
Gray	Absolute Measurements in Electricity	Macmillan	1889
Grimsehl	Textbook of Physics 5v.	Blackie	1933
Grotian	Graphische Darstellung der Spektren 2v.	Springer	1928
Haas	The New Physics	Methuen	1924
Haas	The World of Atoms	Van Nostrand	1928
Hallock & Wade	Evolution of Weights & Measures	Macmillan	1906
Harnwell & Livingood	Experimental Atomic Physics	McGraw-Hill	1933
Hart	The Makers of Science	Oxford U. P.	1924
Harvey-Gibson	Two Thousand Years of Science	Macmillan	1929
Heisenberg	Phys. Prin. of the Quantum Theory	U. Chic. P.	1930
Helmholtz	On the Sensation of Tone	Longmans	1895
Helmholtz	Popular Lect. on Scientific Subjects	Appleton	1873
Helmholtz	Physiological Optics 3v.	Opt. Soc. of Amer.	1925
Hehoe & Morecroft	Continuous Current Circuits 2v.		
Heyl	New Frontiers of Physics	Appleton	1930
Hoag	Electron Physics	Van Nostrand	1929
Holman	Telescope, Mirror-Scale Method	Wiley	1898
Houston, R. A.	A Treatise on Light	Longmans	1930
Houston, W. V.	Principles of Math. Physics	McGraw-Hill	1934
Hughes & du Bridge	Photoelectric Phenomena	McGraw-Hill	1932
Humphreys	Physics of the Air	McGraw-Hill	1929
Hund	Linienspektren	Springer	1927
Hutchinson	Adv. Text. of Elec. & Mag. 2v.	U. Tutor. P.	1935
	International Critical Tables 7v. & index	McGraw-Hill	
Jauncey	Modern Physics	Van Nostrand	1932
Jeans	Math. Prin. of Elec. & Mag.	U. P. Cantab.	1925
Jeans	Dynamic Theory of Gases	U. P. Cantab.	
Johnson	Lecture Experiments in Optics	Arnold	1930
Joos	Theoretical Physics	Stechert	1934
Kaye	X-rays	Longmans	1914
Klein & Sommerfeld	Theorie der Kreisels	Teubner	1897
Kohlrausch	Leitfaden der Prak. Physik	Teubner	1932
Lamb, Horace	Hydrodynamics	U. P. Cantab.	1924
Lamb, Horace	Dynamical Theory of Sound	Arnold	1931
Lamb, Horace	Statics	U. P. Cantab.	1928
Larmor	Math. & Physical Papers 2v.	U. P. Cantab.	1929
Lawrence	Prin. of Alternating Currents	McGraw-Hill	1922
Laws	Electrical Measurements	McGraw-Hill	1917
Lenzen	The Nature of Physical Theory	Wiley	1931
Lewis	System of Thermodynamics 3v.	Longmans	1932
Lindsay	Physical Mechanics	Van Nostrand	1933
Lindsay & Margenau	Foundations of Physics	Wiley	1936
Lodge	Modern Views of Electricity	Macmillan	1889
Loeb	Kinetic Theory of Gases	McGraw-Hill	1927
Lorentz	Theoretical Physics 3v.	Macmillan	1931
Love	Math. Theory of Elasticity	U. P. Cantab.	1934
Love	Theoretical Mechanics	U. P. Cantab.	1921
Luckiesh	Artificial Sunlight	Van Nostrand	1930
Luckiesh	Color and its Applications	Van Nostrand	1927
Luckiesh	Foundations of the Universe	Van Nostrand	1929
Luckiesh	Light & Shade	Van Nostrand	1916
Luckiesh	Ultraviolet Radiation	Van Nostrand	1927
Luckiesh	Visual Illusions	Van Nostrand	1922
Lummer-Pringsheim	Specific Heats	Smithsonian	1898
Mach	Principles of Physical Optics	Dutton	1925
Macelwane-Sohon	Theoretical Seismology 2v.	Wiley	1936
Mach	Science of Mechanics	Open Court	1893
MacMillan	Statics and Dynamics of a Particle	McGraw-Hill	1927
MacMillan	Dynamics of Rigid Bodies	McGraw-Hill	1936
MacMillan	The Theory of the Potential	McGraw-Hill	1930
Magie	A Source Book in Physics	McGraw-Hill	1935
Martin	Optical Measuring Instruments	Van Nostrand	1924
Maxwell	Theory of Heat	Appleton	1883
Maxwell	Matter and Motion	Macmillan	1920
Mayer	Light	Appleton	1887
Mayer	Sound	Appleton	1878
Mees	Fundamentals of Photography	Eastman Kodak	1931
Meyer	Diffraction of Light, X-rays & Particles	U. Chic. P.	1934
Michelson	Studies in Optics	U. Chic. P.	1917

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Miller, D. C.	Science of Musical Sounds	Macmillan	1926
Millikan	The Electron	U. Chic. P.	1917
Millikan	Electrons (pos. & neg.)	U. Chic. P.	1935
Morecroft	Continuous & A. C. Machinery	Wiley	1914
Nernst	The New Heat Theorem	Dutton	1926
Newman	Electrolytic Conduction	Wiley	1931
Newman & Searle	The General Properties of Matter	Macmillan	1933
Northrup	Measure of Electrical Resistance	McGraw-Hill	1912
Page	Intro. to Theoretical Physics	Van Nostrand	1935
Page & Adams	Principles of Electricity	Van Nostrand	1931
Page, N.	Lessons & Problems in Electricity	Macmillan	1936
Pauling-Goudsmit	Structure of Line Spectra	McGraw-Hill	1930
Perrin	Brownian Movement	Taylor	1910
Pierce	Newtonian Potential Function	Ginn	1888
Planck, Max	Intro. to Theor. Physics 5v.	Macmillan	1932
Planck, Max	Survey of Physics	Dutton	1925
Planck, Max	Treatise on Thermodynamics	Longmans	1927
Planck, Max	Universe in Light of Mod. Phys.	Norton	1931
Planck, Max	Where is Science Going?	Norton	1932
Pohl	Physical Principles of Elec.	Blackie	1933
Pohl	Physical Principles of Mech.	Blackie	1932
Poincare	Capillarite	Carre (Paris)	1895
Porter	Method of Dimensions	Methuen	1933
Preston	Theory of Light	Macmillan	1901
Pupin	From Immigrant to Inventor	Scribner	1925
Rasetti	Elements of Nuclear Physics	Prentice-Hall	1936
Rayleigh	Theory of Sound 2v.	Macmillan	1929
Rayleigh	Scientific Papers 6v.	U. P. Cantab.	1899-20
Reiche	The Quantum Theory	Dutton	
Reymond	Hist. of Sc. in Graeco-Roman World	Dutton	
Richardson, E. G.	Sound	Arnold	1929
Richardson, O. W.	Emission of Elec. from Hot Bodies	Longmans	1921
Richtmyer	Intro. to Modern Physics	McGraw-Hill	1934
Roberts	Heat	Blackie	1933
Robertson	Intro. to Physical Optics	Van Nostrand	1931
Robinson	Elements of Electricity	Wiley	1922
Routh	Dynamics of Rigid Bodies	Macmillan	1877
Routh	Analytic Statics 2v.	U. P. Cantab.	1891
Rowland	Physical Papers	J. Hopkins P.	1902
Ruark & Urey	Atoms, Molecules & Quanta	McGraw-Hill	1930
Rutherford	Radioactive Transformations	Yale U. P.	1906
Rutherford, Chadwick & Ellis	Radioactive Substances	U. P. Cantab.	1930
Schonland	Atmospheric Electricity	Methuen	1932
Schroedinger	Science & Human Temperament	Norton	1935
Sheldon	Television	Van Nostrand	1929
Slater & Frank	Intro. to Theoretical Physics	McGraw-Hill	1933
Smithsonian	Geographical Tables	Smithson. Inst.	1894
Smithsonian	Meteorological Tables	Smithson. Inst.	1931
Smithsonian	Physical Tables	Smithson. Inst.	1933
Smythe	Adv. Electrical Measurements	Van Nostrand	1932
Soddy	Interpretation of Radium	Putnam	1912
Soddy	Matter and Energy	Holt	1913
Sommerfeld	Atombau und Spectrallinien	Vieweg	1922
Sommerfeld	Atomic Struct. & Spectral Lines	Dutton	1923
Sommerfeld	Three Lectures on Atomic Phys.	Dutton	
Sommerfeld	Wave Mechanics	Dutton	1928
Southall	Mirrors, Prisms & Lenses	Macmillan	1933
Starling	Electricity & Magnetism	Longmans	1921
Stetson	Earth, Radio & Stars	Whittlesey	1934
Stewart	Introductory Acoustics	Van Nostrand	1932
Stoner	Magnetism	Dutton	1929
Tait	Properties of Matter	Black (Edinb.)	1885
Terry	Adv. Lab. in Elec. & Magnetism	McGraw-Hill	1929
Thompson, S.	Dynamo-electric Machinery	Strong	1902
Thompson, S.	Electricity & Magnetism	Macmillan	1892
Thompson, S.	Electromagnet	Johnston	1891
Thompson, S.	Light, Visible & Invisible	Macmillan	1912
Thomson	Conduction of Elec. thru Gases	U. P. Cantab.	1928
Thomson	Electricity & Matter	Yale U. P.	1904
Thomson	James Clerk Maxwell	Macmillan	1931
Thomson	Rays of Positive Electricity	Longmans	1913
Thomson	Corpuscular Theory of Matter	Constable	1907
Tyndall	Fragments of Science	Appleton	1873

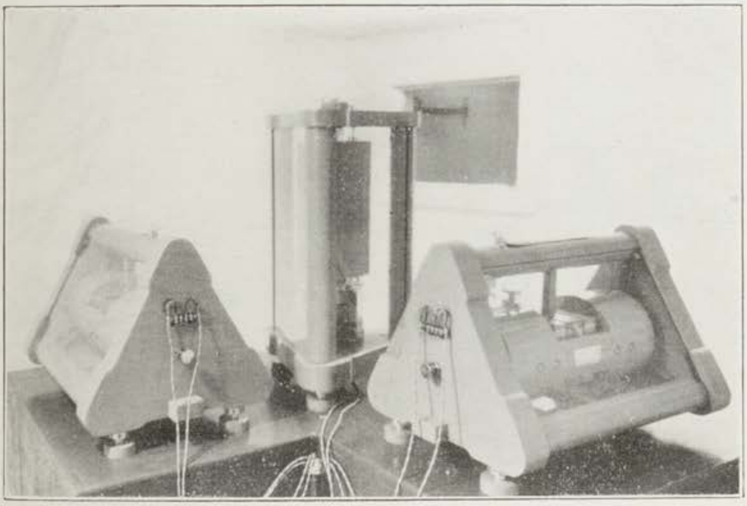
Author	*Title*	*Publisher*	*Date*
Tyndall	Light	Appleton	1878
Tyndall	Sound	Appleton	1867
Van der Byel	Thermionic Vacuum Tubes	McGraw-Hill	1920
Van Vleck	Quantum Principles & Line Spectra	Nat. Research Council	1926
Vernon	Light	U. P. Cantab.	1929
Watson	Textbook of Physics	Longmans	1927
Watson	Practical Physics	Longmans	1913
Webster	Dynamics	Stechert	1932
White	Intro. to Atomic Spectra	McGraw-Hill	1934
Whittaker	Analytical Dynamics	U. P. Cantab.	1927
Whittaker	Hist. Theor. of Ether & Elec.	Longmans-Green	1910
Whittaker	Theory of Optical Instruments	U. P. Cantab.	1915
Williams	Applications of Interferometry	Dutton	1928
Wilson	Theoretical Physics 2v.	Dutton	1931
Wood, A.	Sound	Macmillan	1930
Wood, A.	Sound Waves	Blackie	1928
Wood, A.	Planning for Good Acoustics	Methuen	1931
Woods, R. W.	Physical Optics 3d ed.	Macmillan	1934
Worsnop & Flint	Advanced Practical Physics	Methuen	1931
Worsnop	X-rays	Dutton	1930
Wulf	Die Bausteine der Korperwelt	Springer	1935
Wulf	Lehrbuch der Physik	Herder	1926
Wulf	Modern Physics	Dutton	1929
Wulf	Universalelektroskops	Duemmler	1928
Wyckoff	Structure of Crystals	Chem. Cat. Co.	1924
Zahm	Sound & Music	McClurg	1892
Zworykin	Photocells	Wiley	1932

SEISMOLOGY

WESTON SEISMOLOGICAL OBSERVATORY

Daniel Linehan, S. J.

It has been previously mentioned in the pages of the "Bulletin" that friends of the Reverend M. J. Ahern, S.J., on the occasion of his 25th anniversary of ordination, presented him with a fund to be employed in modernizing the equipment at our Observatory. It was also stated that Benioff seismometers, after Henson, with suitable recording assemblies, were to be purchased with this fund.

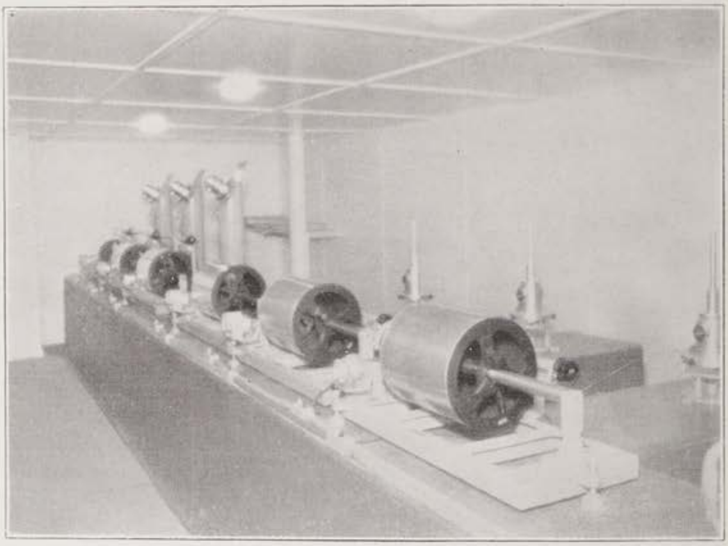


Seismometer Room. Left: E-W Component; Right: N-S Component; Center: Vertical Component.

Recently these instruments were delivered and are at present in operation. The intervening months between order and delivery were spent in preparing piers and housing for this equipment, and we think that readers of the "Bulletin" might be interested to learn of our general floor plan and highlights on laboratory equipment.

The Benioff instruments include three pendulum type seismometers each of an approximate pendulum mass of 100 Kg.; six recording assemblies, each equipped with three variable speeds and two variable lateral drives; three short period galvanometers (0.25 sec.) and three long-period galvanometers (60 secs.). There are also the various resistance boxes, testing equipment, etc., that complement these instruments.

The seismometer pier has an effective area of 5 square feet, with a mean depth of 4½ feet. As is shown in the photograph, unused area was removed in design to permit easy access to all sides of the instruments. This pier is anchored to a gabbro-diorite batholith, an intrusive rock in this vicinity. Polaris observations employed in determining the azimuth of the pier were conducted during the month of December, 1935, under the direction of Mr. J. K. Connolly, S. J.



Recording Room. Three drums and galvanometers in foreground for long periods. Those in background for short periods.

The recording pier was erected in another room, which allows access to the recording assemblies and galvanometers, without disturbing the seismometers. This pier is 21 feet in length and 2 feet wide. The extension length for each of the long period galvanometers is 4 feet, and 18 inches for the short period ones. The design of this pier also allows easy working room on all sides of the instruments. The six drums are mounted in line of axis on the one pier.

The walls and ceiling of both rooms are insulated with four layers of "celotex" and "sheet rock" separated by air spaces. At the point where walls meet floor, the junction has been sealed with pitch. During a period of high humidity last summer, these rooms remained quite dry in comparison with the rest of the cellar. To date, the use of a drying agent has not been necessary.

All electrical circuits lead back to a central panel in the radio room, where they are permanently connected to meters. Their current or voltage may be readily ascertained by pressing a button. Varying voltages from 6v to 220 A. C. or 2v to 64 D. C., are available from this panel, either for instrumental work or experimenting in the radio room. This panel also encloses automatic relays which throw in an emergency line in the event of fuse trouble or break in the normal line. If the "house" power is halted, due to storms, etc., our instruments are automatically changed to a converter line which is operated on batteries.

The clock in use at present is a Howard, donated by Holy Cross College. It is corrected automatically four times daily from NAA (113 kc). The receiver for this frequency was constructed by the General Radio Co. of Cambridge according to our specifications. A National FB-7 is used for the Ottawa continuous signals on both 3332 kc and 7335 kc. These latter signals are extremely handy for both coincidence work in the laboratory and timing blasts in the field, where the FB-7 is used as a portable set. Dr. Gager of the Boston College Physics Dept., presented us with two of his recently developed "Selectosphere" loud speakers. These are designed for code reception only, and give a very excellent note and fine tuning where several stations are crowding one another. We employ one, which is power balanced, on the NAA signals, the other, for any code reception, on the FB-7.

A second hand "Pako Photo-Dryer", which was originally gas heated, is used for drying the records. The gas unit was removed and four elements of the "sun-bowl" type substituted. Drying time has been reduced from hours to about three minutes.

Short period records of blasts and local quakes are enlarged and projected on graph paper. The amount of enlargement varies according to the gram studied, but we have found that 10x has been the most satisfactory for our work. This permits accurate reading to 0.1 second and interpolation to 0.01 second.

After experimenting with several types of record paper from various manufacturers, we have found Eastman News Bromide (Contrast) the most suitable. Although somewhat more expensive and brittle than the others, it is worth the difference both in the clarity of detail, especially where enlargement is necessary, and in the abuse it takes under exposure to red or dim white lights. The red lights in the recording room (three 25w) may be left on over a period of four hours without halation on the paper. Careful inspection of the paper under the red light during process of development is feasible. Harvard University has now adopted this type of paper after seeing the results we have obtained.

We owe a great debt of gratitude to very many benefactors whom space will not allow us to mention. In particular, however, we are very grateful to Mr. S. Rosenthal, of Boston, for most of the design and installation of the electrical circuits in the Observatory, and especially to Mr. James F. Burke, also of Boston, for the material aid and scientific advice he afforded us. Without the assistance of these two men our station would not have arrived at its present state of efficiency in so short a time.

NEWS ITEMS

LOYOLA COLLEGE, Baltimore, Md.—Chemistry Department

On Thursday, December 10th, Mr. E. P. Coffey, Director of the Technical Laboratory of the Bureau of Investigation, Department of Justice, Washington, D. C., lectured to the members of the Loyola Chemists' Club. The subject: "Chemistry in the Detection of Crime". The chemistry lecture-hall was too small to accomodate the large attendance, so the lecture was delivered in the library hall.

After the lecture, Mr. Coffey inspected the laboratories of the Chemistry Department. On December 13th, the Reverend Dean received the following letter from Mr. John Edgar Hoover, Director of the Federal Bureau.

FEDERAL BUREAU OF INVESTIGATION
UNITED STATES DEPARTMENT OF JUSTICE
WASHINGTON, D. C.

December 12, 1936

Reverend Lawrence C. Gorman, S. J., Dean,
Loyola College,
Evergreen, Baltimore, Maryland.

Dear Father Gorman;—

Mr. Coffey has informed me of the interesting visit he had at Loyola College on December 10, 1936, at which time it was his privilege to address the meeting of the Chemists' Club.

After his tour of inspection of the College, Dr. Coffey was quite impressed with the microchemical laboratory under Father R. B. Schmitt, and has advised me of the excellent equipment of the laboratory and the advanced work that is being done. Although the Technical Laboratory of this bureau is not presently equipped for the various microanalytical techniques, I think it would be profitable to us if it could be arranged for one of our technical men to visit Father Schmitt and look over the microchemical laboratory. If you find it possible to arrange this and will advise me of a time convenient to Father Schmitt, I will be glad to instruct Mr. R. A. Lovett of our Laboratory to proceed to Baltimore for this purpose.

Thanking you for your continued interest in the work of this bureau, I remain

Sincerely yours,

(Signed) John Edgar Hoover,
Director.

Dr. Walter H. Hartung, Professor of Organic Chemistry at the University of Maryland, lectured at Loyola College on December 15th. The topic of his lecture: Propiophenone in Iatro-Chemistry.

An illustrated lecture was given by Dr. A. Herman Pfund of the Johns Hopkins University to the members of the Loyola Chemists' Club, on Wednesday, February 10th. Dr. Pfund is a well known experimentalist and his lecture was intensely interesting. The topic: The Analysis and Synthesis of Color.

CATHOLIC ROUND TABLE OF SCIENCE

During the convention of the American Association for the Advancement of Science, held at Atlantic City, December 28th to January 2nd, the Catholic Round Table of Science held its annual meeting. There were seventy-one members present, and twenty of these were Jesuits. Of the thirty-three clergymen present, twenty were of the Society. Reverend Francis P. LeBuffe, S.J., acted as Chairman.

JESUIT SCIENTISTS MEET AT ATLANTIC CITY

On Wednesday, December 30th, the Jesuits attending the convention of the American Association for the Advancement of Science, held a meeting in the Club Lounge of the Knights of Columbus Hotel. This meeting was arranged at the request of Rev. Daniel M. O'Connell. The following Provinces were represented: New England, Maryland-New York, Chicago, Missouri and New Orleans. The Chairman: Rev. Richard B. Schmitt, Loyola College, Baltimore; the Secretary: Rev. Emeran Kolkmeyer, Georgetown University, Washington. Anyone wishing to have a copy of the minutes of the meeting, may communicate with Father Kolkmeyer.

NEW ENGLAND CHAPTER OF THE C. R. T. S.

A meeting of the New England Chapter of the Catholic Round Table of Science was held on December 5th, at Regis College, Weston, Mass. After the business meeting, there followed a discussion on the Laws of Nature:

Philosophy and the Laws of Science, Rev. J. P. Kelly, S. J., Weston College.

Chemistry and the Laws of Nature, Dr. F. J. Guerin, Boston College.

Biology and the Laws of Nature, Dr. A. M. Kerrigan, Teachers College, Boston.

Physics and the Laws of Nature, Dr. A. L. Quirk, Providence College.

The Secretary of the Chapter is Rev. John A. Tobin, S. J., Boston College.

RIVERVIEW OBSERVATORY, Sidney, Australia.

The recent publications of the Astronomical Observatory of Riverview are:

A New Cepheid Variable in Puppis, by Rev. W. O'Leary, S.J.

Photographic Light Curves of Five Cepheid Variables: C. P. D. —59° 4388; C. P. D.—61° 3585; R Crucis; T Crucis; and UZ Centauri; by Rev. D. O'Connell, S.J.

Two New Eclipsing Variables in Puppis, by Rev. W. O'Leary, S.J.

Note on Irregularities in the Light Variation of Some Cepheid Variables with Periods of About Three Days, by Rev. D. O'Connell, S. J.

A New Long Period Variable in Puppis, by Rev. W. O'Leary, S. J.

CANISIUS COLLEGE—Department of Biology.

Professors John A. Frisch, S. J. and Albert P. Lorz attended the Atlantic City meeting of the American Association for the Advancement of Science.

As a result of the Materials Exchange program, agreed upon by the biologists, at the last meeting of the Western New York and Pennsylvania Round Table, we have supplied cultures of Paramecium, Amoeba and Euglena to Fr. Wenstrup, O.S.B. of St. Vincent's College, Latrobe, Penn., and have taken in exchange cultures of various mutants of Drosophila.

"Chronica Botanica" has been added to our list of botanical journals.

Since the establishment of a Sigma Xi chapter at the University of Buffalo last summer, Fr. Frisch and Dr. Lorz attend the regular quarterly meetings and luncheons of the Buffalo Chapter as representatives of the Johns Hopkins and the University of Virginia chapters respectively.

The following public lectures have been given by the department under the auspices of the Mendel Club:

"Believe It or Not in Medicine"
John J. Elliot, B. S., M.D., Professor of Histology,
Canisius College.

"The Life History and Habits of the American Beaver"
Albert R. Shadle, Ph. D., Professor of Biology,
University of Buffalo.

"The Search for a Cancer Parasite"
A. A. Thibaudeau, M. B.,
State Institute for Malignant Diseases.

"Heredity in Human Beings"
Albert P. Lorz, Ph.D., Assistant Professor of Biology,
Canisius College.

ST. PETER'S COLLEGE—Department of Chemistry

Dr. Hugh S. Taylor, of Princeton University, lectured before the Collins Chemistry Society on Friday, January 8th. The subject: Heavy Water and Its Uses in Chemical Investigations.

BOSTON COLLEGE—Department of Physics—Post Graduate Div.

Two new devices, the 'SELECTOSPHERE', a high selectivity loudspeaker, and the "SELECTOPHONES', or high selectivity head telephones, are products of the research work of the M. S. students in Physics. The various phases of their development have offered excellent thesis material for the men in graduate physics. The device called the 'Selectosphere' is described in the October 1936 issue of 'Radio' and in the Dec. 1936 issue of the same magazine. In the Feb. 1937 issue of 'Radio' a third article on the 'Selectophones' will be printed. These devices differ from the ordinary loudspeakers or phones in several aspects. In one aspect it combines electrical, mechanical and acoustical resonance together with extreme selectivity comparable with that of a piezo-electric filter. The second aspect is that of the output amplitude limiting as a function of the driving force which exhibits a saturation point at a comfortable volume level, and acts as an automatic volume control. These units are used in our radio station W1P.R. and two units are used on the two time receivers in the Weston Seismograph station. Prof. F. Malcolm Gager has directed this work of research. This year four M. S. students in physics are working for their degrees.

N. B. The 'Selectosphere' is now available in 'kit' form.

FORDHAM UNIVERSITY—Department of Seismology

In *Science* for February 8th, is an article by Father J. Joseph Lynch, on "The Earth's Core." The article presents the theory that the core of the earth is a metal occluded with hydrogen. The effect of the occluded gas would be to damp out transverse waves and give the core the properties partly of a liquid and partly of a solid.

In the new magazine *Science Digest* for February 1937, appears a reprint from the Scientific Monthly of a radio talk on "Earthquakes" by Father Lynch.

A new Benioff vertical seismograph will be installed at the Fordham University Seismological Station in March.

GEORGETOWN UNIVERSITY—Department of Mathematics, Post-Graduate Division.

The graduate students in Mathematics and Physics at Georgetown have completed the work of the first term. Reverend Thomas Smith and Reverend Joseph O'Callahan, and the Scholastics Joseph

Cohalan, Charles McCauley and William Schweder are numbered among those who take the courses.

In the first semester Fr. Sohon offered a course in the Dynamics of a system of particles. With Webster as a text book but using vectorial treatment wherever possible, such topics as damped motion, the spherical pendulum, Lagrange's equations, Hamilton's principle, the Hamilton-Jacobi equation, small vibrations about a state of equilibrium, motion of a string of beads and similar subjects were handled. In the second term the Dynamics of a rigid body will be discussed, the interesting feature being the use of dyadics or the linear vector function. Fr. Sohon also worked privately with Fr. Smith in Seismology and with Mr. Schweder in the fundamental concepts of Mathematics.

Dr. Henri Jordan offered a course in Analytical Functions. Such topics as conformal mapping, the general bilinear transformation, stereographic projection, Riemann surfaces and analytical continuation were treated. This course will be continued next term. Dr. Jordan also presented a course in abstract groups and seminars in Integral Functions and Infinite Series.

Courses in Modern Algebraic Theories, Differential Equations, Statistics and Modern Physics helped round out the schedule. In the physics course Richtmeyer was used as a text and the work was supplemented with various papers from original sources pertinent to the matter at hand.

Perhaps the outstanding event of the first term was the meeting of the Angelo Secchi Academy in December. This organization formed of the members of the Science Faculties and the graduate students at Georgetown presents papers four times a year on scientific subjects with an eye to their philosophic import. At the December meeting Mr. William Schweder presented a paper on Some Advantages of Symbolic Logic. Most of the philosophic faculty attended and the discussion that followed was quite lively. Reverend John Toohey made some very interesting observations on the nature of categorical and hypothetical propositions. At the next meeting which will be held soon Reverend Frederick W. Sohon will present a paper on Logical Reference Systems.

WESTON COLLEGE—Seismological Observatory

The recent severe quake of January 7th, which was located by the U. S. Coast and Geodetic Survey at 35.5 N. and 97.5 E., was considered by most seismologists to have been the strongest in over a year. Both at Weston and Harvard whose instruments are operating at magnifications over 200,000 times, the preliminary phases were very slight if they appeared at all. The surface waves were extremely large, in many cases exceeding the limits of the lenses by several inches.

Those interested in the history of the horizontal pendulum, so widely in use in seismology, might consult an article on "Hengler, Lawrence" by Fr. Odenbach, S.J., in the Catholic Encyclopedia.

The discovery of this instrument is usually ascribed to Zollner, but from Fr. Odenbach's article we find that Father Hengler preceded him by more than a score of years by publishing an article on his invention.

WESTON COLLEGE—Astronomical Observatory

During 1936 the observation of stars occulted by the moon was continued. Only dark limb immersions of stars brighter than ninth magnitude were recorded. Observations for 1934 and 1935 were computed and published in No. 1043 of the Astronomical Journal. Observations for 1936 are being computed for publication in the near future. The occultations were all observed with a Clark five inch refractor.

CANISIUS COLLEGE—Department of Physics.

The recent bequest of the handsome sum of one hundred thousand dollars to Canisius College for the purpose of erecting a new science laboratory to be named after the donor, Marian Horan, fulfills a most pressing need for relief of present cramped laboratory facilities. Though excellently equipped, the present science laboratories are not adequate for the ever increasing numbers of students in the science courses. Plans for the new science building are well under way.

The well known constancy of the Weston Standard Cell is exemplified impressively in the recent Bureau of Standards calibration of a cell in use at Canisius College. After ten years of routine laboratory service the cell delivers 1.01841 volt, a difference of only 0.00045 from the original certificate of the manufacturer.

A number of the larger universities have lately adopted the neon glow lamp in place of the sodium flame in optical experiments, a substitution made at Canisius College several years ago. The electric eye, used for several years at Canisius College in photometry, is being applied to this purpose in new instruments appearing in the latest manufacturers' catalogs.

After a number of recent earthquakes, notably in Tibet, the telegraph reports from Canisius College Observatory were the first to reach Washington.