the American Association of Scientific Workers in the Engineering Societies Building, New York City, on November 17 at 8:15 P.M. The speakers announced are: Dr. Waldemar Kaempffert, science editor, *The New York Times,* and Dr. Leslie C. Dunn, professor of zoology at Columbia University.

DR. VICTOR G. HEISER, consultant for the Committee on Healthful Working Conditions of the National Association of Manufacturers, formerly director for the East of the International Health Board of the Rockefeller Foundation, spoke on November 2 before the Lancaster Branch of the American Association for the Advancement of Science. His subject was "Adventures in International Health."

DR. ELLICE MCDONALD, director of the Biochemical Research Foundation of the Franklin Institute, made a report on the work of the foundation at a stated meeting of the institute on the evening of November 15.

DR. JOHN T. AUTEN, silviculturist at the Central States Forest Experiment Station, spoke at the Iowa State College on October 24, at a meeting of Sigma Xi on "Forests and Soils" and on October 26, under the auspices of the Research Council, on "The Significance of the Physical Properties of Forest Soils."

DEAN B. E. LISCHER, of the School of Dentistry of Washington University (St. Louis), gave a course of lectures on the "Diagnosis of Dento-facial Anomalies" to graduate students of the School of Dental and Oral Surgery of Columbia University, during the week of November 6 to 11.

THE forty-first annual meeting of the American Physical Society will be held in Columbus, Ohio, on Thursday, Friday and Saturday, December 28, 29 and 30, in affiliation with the section of physics of the American Association for the Advancement of Science.

THE fourth annual meeting of the Carolina Geological Society was held at Spruce Pine, N. C., on October 21 and 22. B. C. Burgess, of Tennessee Mineral Products, Incorporated, was chairman of the local committee, which arranged visits to mines and plants in the region. About twenty-five members and forty-five guests were present. The pegmatites with their associated minerals and the kaolins were studied and discussed in the field. The following were elected officers for the coming year: *President,* Major J. H. Watkins, Charleston, S. C.; *Vice-President,* W. J. Alexander, Bryson City and Spruce Pine, N. C.; *Secretary-Treasurer,* Professor Edward Willard Berry, Duke University; *Chairman Membership Committee,* Professor J. J. Petty, University of South Carolina.

THE American Association for the Advancement of Science is desirous of obtaining for its annual exhibition, which this year will be held at Columbus, Ohio, exhibits of recent advances in the various fields of pure and applied science. Space will be provided for exhibits of special interest to members of the association attending the meeting. Applications should be made to the Director of Exhibits, 3941 Grand Central Terminal, New York, N. Y.

ANNOUNCEMENT has been made by the Finney-Howell Research Foundation, Inc., that all applications for fellowships for next year must be filed in the office of the foundation, 1211 Cathedral Street, Baltimore, by January 1. This foundation was provided for in the will of the late Dr. George Walker, of Baltimore, for the support of "research work into the cause or causes and the treatment of cancer." The will directed that the surplus income from the assets of the foundation together with the principal sum should be expended within a period of ten years to support a number of fellowships in cancer research, each with an annual stipend of two thousand dollars, "in such universities, laboratories and other institutions wherever situated, as may be approved by the Board of Directors." Fellowships carrying an annual stipend of $2,000 are awarded for the period of one year, with the possibility of renewal up to three years; when deemed wise by the Board of Directors, special grants of limited sums may be made to support the work carried on under a fellowship.

THE 1939 award for achievement in chemical engineering of the American Institute of Chemistry has been given to the Standard Oil Development Company "for its work in developing processes for the large-scale production of new aviation fuels and other synthetic chemical products from petroleum." The award was established in 1933 by *Chemical and Metallurgical Engineering.* It will be presented by the publishers to a representative of the company on December 4 at the opening of the national exposition of the chemical industries in the Grand Central Palace.

DISCUSSION

THE ALLOWED DIRECTIONS OF COSMIC RAYS AS AN EXISTENCE PROBLEM OF MATHEMATICAL ANALYSIS

IT is a wide-spread opinion and a matter of fact that the physicist may be interested only in an actual solution of a mathematical problem, whereas the question of the *existence* of a solution is without interest to him, for the existence of a solution may be always easily inferred from the physical meaning of the mathematical formulation of the problem.

In spite of this well-known fact, the theory of cosmic rays, as developed by Professor M. S. Vallarta,[1] provides a very clear example (and probably a first one) in which the question of the existence of a solution is the only one of interest. The knowledge of the conditions under which the solutions exist is here the only one way available for an experimental verification of the theory, whereas the solution itself—represented by the trajectory of an electrical particle coming from far cosmic regions—is beyond experimental means.

Let this statement be explained in more detail. The theory of cosmic rays, considered as a motion of charged primary particles, is ruled by a system of three ordinary differential equations of second order in three unknown functions (the coordinates of the particle) and one independent variable, the time t. The solutions of this system are trajectories of the particle, so that the problem appears to be a boundary problem, the boundary conditions being expressed by the values of three coordinates of the point P on the earth's surface, through which the trajectory passes, and by the infinite length of the radius vector for $t = \infty$. A fifth condition is given by the value of the energy of the particle, which is equivalent to the value of the velocity for instance at P. As a sixth condition, such a relation between the angles which the velocity vector in P forms with two fixed axes is required that a solution exists. This condition geometrically interpreted leads to the allowed cone[2] of Vallarta.

By means of the Lagrange's function the problem can be reduced to an extremum problem of the calculus of variations.[3]

The method with which Professor Vallarta solved the problem is an inductive one, based on an actual evaluation of the solutions. A direct method for the determination of the existence conditions is unknown, and perhaps there is no one example in the Mathematical Analysis, in which the existence and non-existence conditions for a boundary problem are as completely known as is required by the theory of cosmic rays.

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[1] See, for instance, the recent papers of M. S. Vallarta, "An Outline of the Theory of the Allowed Cone of Cosmic Radiation," The University of Toronto Press (1938) and "Present Status of the Effect of the Earth's Magnetic Field on Cosmic Rays," *Jour. of the Franklin Institute*, 227: 1, 1939.

[2] Actually there is another supplementary condition due to the fact that the earth acts as an impenetrable body. However, the first step in the solution of the problem is that related to the pure boundary conditions.

[3] T. Levi-Civita, *Archiv f. Mathem. og Naturvid.*, 31: 1911; and I. Opatowski, *Comptes Rendus*, 208: 638–640, 1939.

REVISION OF DENTAL SYMBOLS

UNDER this heading there appeared in the issue of SCIENCE for April 7 an article by E. S. Riggs. No doubt, Mr. Riggs's suggestions aid in simplifying the typographical complexity of dental formulae used in various stages of paleontological and anthropological representations. It seems to the present writer that Mr. Riggs's proposition is not exhaustive enough to meet all the exigencies of the situation.

In his inventories and literary work, the present writer has availed himself of a system of listing dentures and individual teeth which he gradually developed in long years of practice and study and which has proven satisfactory in anthropological use and, in its fundamentals, should be adaptable without difficulty to any branch of the reptilian or mammalian sciences.

In his system, then, teeth are recorded with regard to their denomination and state of preservation as well as to their presence or absence in the dentures of the upper and lower jaws. The method employed by the writer of accounting for the teeth in cataloguing or describing a special skull or series of skulls is by numbers, which holds for both the adult or permanent and the infantile or deciduous generation of teeth, when for the former he uses the Arabic, for the latter, the Roman characters. The two schemes following here represent the conditions mentioned:

Adult (permanent) dentition:

8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

Infantile (deciduous) dentition:

V	IV	III	II	I	I	II	III	IV	V
V	IV	III	II	I	I	II	III	IV	V

The figures in these schemes account for the number and denomination of teeth in each jaw-half, namely, eight (8) in the adult and five (V) in the infantile. In cases of gradual replacement of the deciduous by the permanent teeth or by the addition of the gradually erupting molars, the infantile scheme is to be varied by the substitution or addition of Arabic numbers according to the individual status of the developing dentures.

Counting from the cranial, *i.e.*, dental midline to either side of the orientation conforms to general topographic concepts, the left sides of the schemes representing the right dental halves, and *vice versa*. Incisor teeth, then, in these schemes are enumerated as 1 and 2 (I and II); canines as 3 (III); premolars, corresponding to infantile molars, as 4 and 5 (IV and V), and the permanent molars as 6, 7 and 8.

Customarily the individual teeth of the dental generations and in each jaw-half are symbolized by initial letters, capitalized for the adult or permanent teeth and indicated by small letters for the infantile or deciduous teeth, and in addition to their serial numbers either above or below the line indicative of their posi-