

shrimp", and this prevented determining the porpoise's minimum threshold. The porpoise was taught to acknowledge acoustic signals by surfacing for her reward—a fish. Tones from 0.15 to 153 kc were tried and all elicited some response. 100 percent audibility was found from the lower limit to 120 kc ("the occasional negatives being clearly attributable to psychology rather than to acoustics"), and declined to 13 percent at 153 kc. The emission spectrum of the porpoise was not investigated comprehensively, but it was found that, although most of its sounds are in the low frequency region, some components were 8 to 12 db above the shrimp background at 196 kc, the upper limit of the apparatus used.

Fission induced in uranium by negative pi- and mu-mesons is the subject of a paper in the September 1st issue of *The Physical Review*. The endings of pi-minus and mu-minus meson tracks in nuclear emulsions exposed at the University of Chicago's cyclotron were studied, and several fission events were found. The large difference in nuclear excitation between the two particles is believed to be responsible for the greater number of pi-minus fissions observed.

Brookhaven's Cosmotron is making V-particles again, this time by the interaction of 1.5 Bev negative pi-mesons in a hydrogen-filled diffusion cloud chamber. So far two events have been obtained that show a pi-minus track ending with the familiar "V" caused by the decay of the V_1^0 into a proton and a pi-minus meson a short distance away. In order to conserve energy and momentum at least one other neutral particle must also have been created at the end of the incident meson track; the mass of such a single particle would be about 1350 electron masses. Since no decay was observed in a path of 23 cm the particle's lifetime must be greater than 4×10^{-10} sec. The work is described in a Letter to the Editor in the September 1st *Physical Review*.

Responses from single photoreceptors, a topic that can be studied only with eyes that have very simple retinas, are discussed in a review article by D. D. Michaels entitled "The Electrical Responses of the Eye, Part I" which appears in the September issue of the *American Journal of Optometry and Archives of American Academy of Optometry*. Electrical phenomena following illumination of the photosensitive ends of single optic nerve fibers vary with the duration, intensity, and wavelength of the light used, and an accumulation of data on these characteristics are summarized. One interesting point is that curves of the intensity of visual response of the photoreceptors, plotted as a function of wavelength of the stimulating light, differ for fibers coming from different sections of the eye. Part II of the article, devoted to optic nerve responses of complex eyes, appeared in the October issue of the same journal.

The electric charges of raindrops falling during thunderstorms have been measured by Ross Gunn and Charles Devin, Jr. of the U. S. Weather Bureau, who found an average free charge of 0.022 esu per drop for

positively charged rain and 0.031 esu per drop for negatively charged rain. The ratio of the negative free charge to the positive free charge brought down in this way was 1.2, with the ratio of the number of drops in each category being 0.88. The apparatus that was used consisted of an insulated cup connected to an oscillograph through an appropriate amplifier; the surface electric field and the precipitation rate were measured simultaneously using an induction-type meter and a tipping bucket rain gage. From this work the explanation for the existence of charged drops based on corona currents from sharply pointed terrestrial objects (grass or trees) seems unlikely, since in such a case the drop charges should all be of the same sign as that of the free charge on the earth's surface. As the authors state, "the convected current to the earth frequently exceeds the conduction currents by a large factor, and, therefore, the charged rain may determine the electric field at the surface", rather than the other way around. These experiments are described in the August 1953 issue of the *Journal of Meteorology*.

A temperature difference between the sun's pole and equator has been predicted on the basis of the thermohydrodynamic solar theory of Bjerknæs. Until recently no such measurements had been made, the principal reason being a lack of precision of the order of 400° or 500° with the usual temperature determination methods. The actual difference might be only about 100° or so, and therefore more precise techniques are required. Das and Abhyankar of the Kodaikanal Observatory, India, have evaluated the equivalent widths of the λ 4227 line of neutral calcium and the λ 3933 line of Ca^+ at both the pole and equator of the sun, and used this information to calculate the temperature difference. This quantity was found to be about 90° , the polar temperature being the higher one. These results are described in the September 12 issue of *Nature*.

Equipment and Techniques

Printed circuits made by etching metal-clad plastic sheets are described in an article in the September 1953 issue of *Mechanical Engineering*. This method, which offers many significant advantages over older techniques such as fusing silver-ink patterns on ceramics, uses extremely thin copper sheets which are bonded to a thermosetting laminated plastic. Other metals, brass, aluminum, and silver, are sometimes used as well. The etching solutions are ferric chloride for copper and brass, hydrochloric acid for aluminum, and nitric acid for silver; the process takes about two minutes for 0.0014-inch copper. For complicated circuits both sides of the plastic layer can be employed. Circuit components are attached by drilling holes through the conductor and the plastic, inserting the appropriate leads, and soldering them in place.

An ion-resonance mass spectrometer designed to meet process instrumentation requirements in the gas, petroleum, pharmaceutical, and chemical fields has been developed by the General Electric Engineering Labora-

tory for operation over an approximate range of 1 to 100 mass units.

British nucleonic and radiological instruments are now available in this country from the Atomic Center, 489 Fifth Avenue, New York 17, New York. The Atomic Center is exclusive American distributor for several major British manufacturers of this equipment, and will supply catalogs and descriptive literature on request.

A new beryllium-copper alloy that combines high strength and high conductivity has been announced by The Beryllium Corporation. Termed "Beryldur", the alloy is expected to find application in the field now occupied by phosphor bronze and brass. Other new products of this company, including a flake form of metallic beryllium of 99.5 percent minimum purity, were exhibited at the 35th National Metal Exposition and Congress held in Cleveland during the week of October 19.

The department of physics at Tennessee A & I State University, Nashville, Tennessee, has announced the availability of its infrared spectroscopy laboratory facilities to industrial research laboratories and universities in the southeastern section of the country. The laboratory will supply spectrograms and analyses of spectra for samples furnished embracing the spectral region 2 to 25 microns. Professor James R. Lawson is in charge of this service.

Calutrons, large mass spectrographs designed for isotope separation, have been used at Oak Ridge since 1946 in a program devoted to the isotopic enrichment of forty-three elements. At present elements enriched in any of 177 different isotopes are available in amounts ranging from milligrams to grams, with purities as high as 99.99 percent in some cases; a goal of 257 isotopes of fifty-nine elements is contemplated. A review of the electromagnetic separation of stable isotopes by C. P. Keim of Oak Ridge National Laboratory appears in the October issue of the *Journal of Applied Physics*, and covers the subject in a fairly comprehensive way. The principles and operating technique of the calutron are discussed qualitatively, and some of the applications of enriched stable elements are mentioned as well. An especially useful feature of this article is a table giving the isotopes involved in the Oak Ridge program, their natural percentage abundance and the abundances attainable by enrichment.

Fred E. Wright, former president of the Optical Society of America (1918-20) and physicist at the Carnegie Institution, died on August 25th at the age of 75. Dr. Wright studied in Germany, receiving his PhD from the University of Heidelberg and later teaching at the Michigan State College of Mines. He served as petrologist and research physicist at the Geophysical Laboratory of the Carnegie Institution from 1906 to 1944 and as chief physicist in the Air Force, U. S. War Department, from 1942 until 1946. He was a fellow of the American Physical Society.

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