6. Many experiments with technique have been made, showing: (*a*) Schaudinn's fluid with a little acetic acid added is probably the best fixing fluid for all these organisms, except *Dientamoeba fragilis;* this species fixes better when 10 to 20 per cent of acetic acid is added to Schaudinn's fluid or when fixed in modified Bouin's fluid containing 10 per cent of acetic acid; (*b*) Schaudinn's fluid with 10 to 20 per cent of acetic acid added causes the endosomes to stain less readily in *Endolimax nana* and in *Iodamoeba bütschlii;* (*c*) after Bouin's fluid the endosomes of *Endamoeba histolytica* and of *E. coli* do not stain well; (*d*) picromercuric fluid causes more protoplasmic extrusions, or "buds," to form on the cysts of *Endamoeba coli* and of *Endolimax nana* than does Schaudinn's fluid; alcoholic Bouin's fluid causes such "buds" on *Iodamoeba* cysts; (*e*) the endosomes of *E. histolytica* and of *E. coli* stain poorly or not at all with Haemalum; (*f*) the Feulgen technique stains very little or nothing in the nuclei of *E. histolytica* and *E. coli;* nothing in the nuclei of *Endolimax nana;* only the periendosomal granules in the nuclei of *Iodamoeba;* but all the nuclear granules of *Dientamoeba.*

WENRICH, D. H., 1937. Studies on *Iodamoeba bütschlii* (Protozoa) with Special Reference to Nuclear Structure. Proc. Amer. Philos. Soc. **76**: 183–205.

J. W. BEAMS and L. B. SNODDY, University of Virginia

Grant No. 60 (1935). (*a*) Acceleration of protons and deuterons to high velocity (several million volts) by a new method developed by the applicants and collaborators. (*b*) To study the effects produced by protons and deuterons with energies above three million volts when they collide with nuclei of other atoms, also their scattering in hydrogen.

Grant No. 99 (1936). Study of the nature of lightning. Photography of lightning discharges and measurement of electrical polarity and electrical moment of the flash. Special study of inter-cloud flashes. Continuation of study of cloud to earth flashes.

This abstract briefly describes an attempt to develop a method of accelerating ions to high energies by what may

be called the "surf board method."[1] In this "surf board" method the ions are accelerated by an electrical field which moves with the same speed as the ions. An investigation of this method is of considerable importance because if a practical apparatus could be worked out, ions with extremely high energies could be obtained without the use of high voltages.

The apparatus consisted of an evacuated long straight glass tube in which were mounted a large number of coaxial cylindrical electrodes properly spaced along the tube. An ion source was placed in one end of the long tube while a thin window projecting into a cloud chamber was placed at the other. The former was to supply the ions for the tube and the latter to measure the number and final energy of the ions. The electrical field which accelerated the ions was applied to the various electrodes in succession and at the proper time to give a maximum acceleration of the ions, by an electrical transmission line. It was soon found that in order to make the method of practical value two developments had to be made. First, it was necessary to work out the proper spacing and shapes of the accelerating electrodes to give the ions maximum acceleration and at the same time keep the ion beam properly focused. Second, an electrical transmission line was required which was free from attenuation and distortion even when considerable energy was required to charge the electrodes. Furthermore, it was not only necessary to apply the potential to successive electrodes in time intervals of from 10^{-7} to 10^{-8} sec., but it was desirable to decrease this time interval progressively down the tube as the ions speeded up. The first of these requirements offered no fundamental difficulties because it could be solved by carefully applying the established rules of electrostatic focusing of ions. However, the second requirement turned out to be very difficult and in the end has resulted in the development of a funda-

[1] Beams and Snoddy, Phys. Review **44**, 784 (1933).

mentally new type of transmission line which we have called the gas transmission line.

At the beginning of this work, it was thought advisable to investigate both theoretically and experimentally all of the known types of transmission lines that seemed to hold any promise of solving our problem. To do this, it was necessary to construct an oscillograph which could resolve time intervals of 2×10^{-9} sec. as well as a rotating mirror that could resolve times of this same order. Briefly, these investigations [2] showed that with the proper modifications the known type of transmission line could be used for our purpose, provided ions over a million or so volts were not required. However, if the method was to give ions with energies much in excess of this, a new type of transmission line must be found. Fortunately, it was observed [3] that, if a long glass tube was evacuated to a fraction of a mm mercury pressure, a high impulsive voltage either negative or positive applied to one end, a potential wave traversed the tube from the high voltage end of the tube to the grounded end. If the pressure was adjusted properly, the wave front of the voltage impulse showed no appreciable flattening or attenuation. Furthermore, the velocity of the voltage impulse could be varied from 10^8 cm/sec to 10^{10} cm/sec by varying the pressure, applied voltage and tube diameter. Clearly, this type of transmission line possessed the characteristics [4] that were needed so a thorough investigation of its properties has been undertaken.

Besides its immediate practical use for the development of the gas transmission line, an investigation of the propagation of potential and luminosity in long discharge tubes should give information on the general problem of the initiation of discharges in gases. While as yet this investigation has not been completed, much new information on the breakdown in gases has been secured.

[2] Snoddy, Trotter, Ham and Beams, Jour. Frank. Inst. 223, 55 (1937).
[3] Snoddy, Beams and Dietrich, Phys. Rev. 50, 469 (1936).
[4] Snoddy, Beams, Ham and Trotter, Nature 138, 167 (1936).

The experiments consisted in measuring the speed of propagation of luminosity in long discharge tubes by the rapidly rotating mirror driven by an air turbine and in measuring the velocity of propagation, wave form, voltage attenuation and energy carried in the wave front, by means of the high speed cathode ray oscillograph. Each of the above quantities has been studied in dry air as a function of pressure and applied impulsive voltage in four long glass tubes with internal diameters of 1.7, 5, 18 and 142 mm respectively. A Marx circuit spark gap arrangement supplied an impulsive potential either positive or negative (approximately 125 kv in most cases) to one end of the long discharge tube, while the other end could be insulated or grounded. In every case it was found that the luminosity and potential waves started at the high voltage (positive or negative) end of the tube and traversed the tube to the grounded end at a velocity between 10^8 and 10^{10} cm/sec depending upon the pressure of the gas, the magnitude and sign of the impulsive potential applied, and size of the discharge tube. The luminous and voltage waves were found to move with approximately the same speed, but no definite experimental observations have as yet been obtained which show whether or not they are coincident. As soon as these initial waves arrived at the grounded end of the tube, a discharge wave starting at the grounded end and moving with about 1/3 the velocity of light returned to the input end. The velocity of this return wave was apparently independent of the tube diameter. There was a slight increase in speed with pressure.

In general, for the initial wave in the low pressure range, the speed increases with increasing pressure. From 0.01 to 0.2 mm the pressure vs. speed curves are steep. Above this range there is a decided flattening. At relatively high pressures the speed decreases and the wave shape is greatly distorted. The speed of the waves for a negatively applied voltage was much greater (a factor of 2 in some cases) than for the case of a positively applied

voltage. No appreciable difference between the speeds in dry air, CO_2 and H_2 was observed in the 5 mm tube. The speed at contrast pressure in dry air was an approximately linear function of the applied voltage (75–180 kv in the 5 mm tube). In general, over considerable ranges, the speeds were found to obey a principle of similarity, i.e., the same speed was observed in two tubes when the pressures were in the inverse ratio of their diameters.

The above experiments show that the initiation of the discharge in a long discharge tube very closely resembles the initiation of the lightning discharge, i.e., the initial luminous wave in the discharge tube can be identified with the well established[5] leader stroke of the lightning flash while the return wave in the discharge tube is very similar to the return stroke of the lightning flash. The phenomenon is also similar to the breakdown in long sparks.[6] Furthermore, the experiments indicate that it is possible to extrapolate from the phenomena obtained with the long discharge tube to those of the lightning flash. Or, in other words, a miniature lightning flash is produced in the laboratory where it can be subjected to a more complete investigation than is possible in the field.

During the summer of 1936, a photographic study of the lightning discharge with moving film cameras was carried on in the vicinity of Albuquerque, New Mexico by E. J. Workman, R. E. Holzer and L. B. Snoddy. The photographic equipment consisted of four cameras with fixed lenses, three of which were provided with films mounted on rotating drums, and one with a fixed film. Two of the rotating drum cameras were mounted so film motion was mutually perpendicular, thus providing vertical and horizontal time axes. Mounting two rotating drum cameras perpendicular to each other is very useful in studying

[5] Schonland and Collins, Proc. Roy. Soc. **A143**, 654 (1934); Schonland, Malan and Collins, Proc. Roy. Soc. **A152**, 595 (1935); McEachron, Elect. J. **31**, 251 (1934); Workman, Beams and Snoddy, Physics **7**, 375 (1936).

[6] Allibone and Schonald, Nature **134**, 736 (1934); Allibone and Meek, Nature **140**, 804 (1937).

complicated discharges in which stroke directions differ by as much as 90°. The photographic results lend themselves to a simple method of analysis.

The majority of the photographs were cloud-ground flashes, showing leader strokes and repeated strokes similar in all essentials to flashes reported by other investigators. Two air discharges, however, exhibited unusual features, and a third stroke was unlike any previously recorded.

Flash 1 was an air discharge from one cloud base to the second, initiated by a stepped leader (projected velocity 3×10^7 cm/sec) from one cloud to a region below a second cloud. .08 of a second after the leader stroke, a stroke proceeded between the ground and a second cloud which was immediately followed by a fast (4×10^9 cm/sec) discharge over the path blazed by the stepped leader. This delayed return stroke over air discharge path is apparently due to the fact that the cloud-ground stroke which immediately preceded it established a large difference of potential between the two clouds. The normal absence of return stroke in an air discharge between clouds is apparently due to the small difference of potentials which existed between adjacent parts of the same cloud.

Flash 6 was an air discharge between one cloud base and the region below the base of a second cloud. It consisted of 12 repeated strokes over essentially the same path at intervals varying from 1 to 33 milliseconds. The strokes were of the "dart leader" type, with no return strokes. Not all of the strokes were of the same length, and in some only a portion of the path, near the middle or the end, was luminous. The strokes may have been continuous over the entire path, but of intensity so low that they were not recorded photographically, as is apparently the case in some "stepped leader" strokes.

Flash 7, unlike any previous discharge, which has been photographed with moving drum cameras, is a complicated air discharge which occurred at the close of a cold front

type thunderstorm, a hundred microseconds after an intense cloud-ground flash four miles away. The flash, about 1000 feet from the cameras, followed a path which had a maximum height of about 350 feet above the ground. The total projected length of the path was about 0.8 mile. The discharge consisted of at least four apparently unrelated elments. Each element was a moving luminous dart less than 15 feet in length, traveling with variable velocity between 10^7 and 10^8 cm/sec. The most interesting features of the discharge are first, the number of very sharp reversals in the path, and second, the fact that at several points the stroke built up from a single point in the path and moved in opposite directions along the path.

In conclusion, it should be pointed out that many interesting phenomena observed on lightning photographs cannot be explained adequately because of lack of definite knowledge of the electrical field conditions. During 1937, a study in which photographic records will be correlated with extensive electrical measurements will be carried on under a grant of the American Philosophical Society.

BEAMS, J. W., 1936. Experiments on the Production of High Velocity Ions by Impulse Methods. Proc. Amer. Philos. Soc. **76**: 771–772.

WALKER BLEAKNEY, Princeton University

Grant No. 61 (1935). Investigation of the isotopic constitution of natural and treated substances with particular emphasis on the study of the relative abundance of isotopes as related to chemistry, geology and biology.

The grant-in-aid from the Penrose Fund of the American Philosophical Society which was made to me in 1935 was used to great advantage in several ways. The principal basis for the request was the help needed in the isotopic analyses of many samples of gas submitted to me by many chemists and physicists scattered throughout the country. This work was of a somewhat routine nature but highly important to the men concerned. With the aid received several hundred samples were analyzed which would

have otherwise remained undone. Although the work, naturally, did not lead to publications under my name, it has helped materially in orientation problems connected with the separation of isotopes.

This grant further permitted the construction of improved apparatus first in the form of a permanent magnet spectrograph and later a large electromagnet. With the former the knowledge of the isotopic constitution of Ba, Sr, In, Ga, Li, Na, Mn, Cb, Pd, Pt, Rh, and Co was greatly extended. The following publications resulted from researches supported at least in part by the grant.

BLEAKNEY, WALKER, 1936 (with SMITH, L. G.). The Ionization Probability of He^{++}. Phys. Rev. **49**: 402.
—— 1936 (with SAMPSON, M. B., and RIDENOUR, L. N.). The Isotopes of Cobalt and Their Radioactivity. Phys. Rev. **50**: 382.
—— 1936 (with SAMPSON, M. B.). A Mass-Spectrograph Study of Ba, Sr, In, Ga, Li and Na. Phys. Rev. **50**: 456–460.
—— 1936 (with SAMPSON, M. B.). The Relative Abundance of the Isotopes in Mn, Cb, Pd, Pt, Ir, Rh and Co. Phys. Rev. **50**: 732–735.
—— 1936. Isotope Analysis with the Mass-Spectrograph. Proc. Amer. Philos. Soc. **76**: 774–776.
—— 1937. The Relative Abundance of Isotopes. Proc. Amer. Philos. Soc. **77**: 395–409.

LUCY B. ABBE, Cornell University (Now at University of Minnesota)

Grant No. 62 (1935). Determination by means of quantitative and qualitative analysis of the histological background for inherited size differences in *Zea mays*. This study is planned to be preliminary to selecting a few characteristic corn dwarf mutants for a developmental study of the plant as a whole and its histology from the embryo and growing point to the mature plant.

A comparison was made of the cells from previously measured internodes and leaves of several dwarf and dwarf-like corn types [1] and their normal sibs, and the following differences noted:

[1] Dwarf types studied were D_1 D_6, $Nana_1$, $Nana_2$, DF, Wiggan's Dwarf, and Hayes' Dwarf.

1. Cells of dwarf plants were slower in coming to maturity than cells of their normal sibs, the more extreme dwarf types having a slower cell development than larger types.

2. Differences in cell diameter were found to be comparable to differences in internode diameter.

3. Differences in length between comparable dwarf and normal internodes were found to be correlated with differences both in cell length and cell number.

ABBE, LUCY B., 1936. The Histological Background for Dwarfism in Zea Mays. Proc. Amer. Philos. Soc. **76**: 743–747.

J. C. JENSEN, Nebraska Wesleyan University

Grant No. 63 (1935). Determination of the relation between evaporation from shallow lakes and ponds and the precipitation from local or "heat" thunderstorms. This will also involve the amount of moisture added to the atmosphere by transpiration from growing vegetation.

Grant No. 107 (1936). Investigation of relation of evaporation from lakes and ponds to rainfall from local thunderstorms.

JENSEN, J. C., 1936. Evaporation and Rainfall Studies in the Northwest Minnesota Lake Region. Proc. Amer. Philos. Soc. **76**: 747–759.

—— 1938. Evaporation and Rainfall Studies in the Northwest Minnesota Lake Region. Proc. Amer. Philos. Soc. **78**: 651–670.

DONALD F. JONES, Connecticut Agricultural Experiment Station

Grant No. 65 (1935). Study of the genetic and cytological basis for atypical growth.

Paired changes, visible in adjacent areas, have been found to be frequent in maize aleurone and endosperm. They are the result of a shift of known color and texture genes and are similar to previously described paired alterations in pome and citrus fruits, maize pericarp and in bristle and body color characters in Drosophila. These paired changes are not due to a loss of genes but to an unequal mitosis such that genes are removed from one daughter cell and doubled in the other.

In both paired and unpaired somatic changes, linked genes are lost or shifted together or separately. Seeds treated with X-rays shortly after fertilization show a marked increase of inter-chromosomal mosaics in adjacent areas.

The dark part of a paired aleurone color mosaic may revert to normal, to colorless or may become still darker. Some of these secondary changes are paired alterations. Linked genes may shift together or separately in these secondary changes.

Tissues that have lost one or more genes are highly unstable and may show frequent losses of other genes on the same chromosome in subsequent cell generations. Chromosome stability, as measured by the frequency of mosaics varies widely in different families and from one generation to the next in the same family.

Reciprocal gene exchanges occur between non-homologous chromosomes. There may also be an interchange between homologous chromosomes during development, but whether this is somatic crossing over at homologous loci or some form of unequal translocation, remains to be determined.

Changes in cell size and arrangement occur alone or may accompany changes in color and texture. These tissue alterations result in depressions and outgrowths which are sometimes paired. Atypical growth in both plants and animals is considered to be the result of the removal from, or concentration in, certain cells of essential growth-regulating substances brought about by unequal mitosis, with or without visible alteration of the chromosomes. This unequal mitosis may be induced by external agencies or by inherited defects of the mechanism of cell division transmitted in part by the female parent.

In both animals and plants external agencies can do little, if anything, more than what may occur spontaneously in the organism itself. When normal mitosis is interfered with the resulting cells, if viable, may change their usual

activities and regulatory powers. This deviation from normal during development is not dependent upon visible derangement of the mitotic structure since it has been shown for both animals and plants that chromosomes with mutant genes or small deletions may be substituted for normal members in somatic cell division. But the departure from normal growth may become wider in succeeding stages, as more and more essential genes are lost with the increasing irregularity of the mitotic mechanism, until finally the cells die or lose, in varying degrees, their ability to coordinate growth with the other parts of the organism.

JONES, DONALD F., 1936. Report of Progress. Miscellanea, Amer. Philos. Soc. 1: 2, 60.
—— 1936. Atypical Growth. Amer. Nat. 70: 86–91.
—— 1936. Segregation of Color and Growth-Regulating Genes in Somatic Tissue of Maize. Proc. Nat. Acad. Sci. 22: 163–166.
—— 1936. Mutation Rate in Somatic Cells of Maize. Proc. Nat. Acad. Sci. 22: 645–648.
—— 1937. Tumors in Drosophila Melanogaster Resulting from Somatic Segregation. Science, 84: 135.
—— 1937. Somatic Segregation and Its Relation to Atypical Growth. (Preliminary Report.) Proc. Amer. Philos. Soc. 77: 411–416. (Full report.) Genetics, 22: 484–522.

ROBLEY D. EVANS, Massachusetts Institute of Technology

Grant No. 68 (1935). Perfection of a new instrument for detecting radium poisoning before the appearance of clinical symptoms, for the study of the progress of patients under medical treatment for radium poisoning, and for detecting poisonous radioactive contaminants in face creams, tonics, medicinal waters, and patent nostrums.

A portable, rugged amplifier, with a direct reading counting-rate-meter has been developed for the study of feeble gamma rays. The instrument has been simplified so as to permit successful operation for those not specifically trained in experimental physics. Quantities of radium of the order of 5×10^{-8} gm. or more may be determined in a few minutes. Calibrations have been made for determining the amount of radium contained in living victims of radium poisoning.

By means of such measurements, the presence of chronic radium poisoning in humans may be established five years or more before the appearance of any clinical symptoms. The possibility of administering early and more helpful therapy is thereby greatly increased.

EVANS, ROBLEY D., 1936 (with GINGRICH, N. S., and EDGERTON, HAROLD E.). A Direct Reading Counting Rate Meter for Random Pulses. Rev. Sci. Instr. 7: 450–456.
—— 1937. Quantum-Counter Amplifiers for Gamma Ray Detection, and Applications to Studies in Radium Poisoning. Proc. Amer. Philos. Soc. 78: 11–21.

WILLIAM R. AMBERSON, University of Tennessee
(Now at University of Maryland)

Grant No. 70 (1935). Study of the physiological significance of the plasma proteins. The research is directed to the study of the functional meaning of the proteins of the blood plasma.

Grant No. 145 (1937). Study of the behavior of the mammalian body when its normal blood colloids are replaced by gum acacia; the determination of the interrelationships between the various colloids in the blood stream during the period of recovery from "total plasmapheresis."

1. Most of the chloride of the cat's body is diffusible. It may be removed by long perfusion with Ringer-Locke solution made up with the sulfates of sodium, calcium and potassium instead of the chlorides. To this solution are added chloride-free beef cells and gum acacia.

2. By this technic plasma chloride has been reduced to as low as 6 per cent of normal.

3. In certain tissues, such as the red cells, skeletal muscle, the liver and the kidney all of the chloride is diffusible and tissue chloride varies directly with plasma chloride.

4. In other tissues such as stomach, spleen and salivary glands there is evidence for an indiffusible chloride fraction which is not accessible to perfusion, in addition to a diffusible fraction which varies directly with plasma chloride.

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