over a considerable spectral region, consist of bands of definite frequency, or color, like the light from a neon lamp or from a Cooper-Hewitt mercury arc.

The general spectral region, however, in which these bands are found, corresponds to frequencies 100,000,000,000 times greater than those emitted by the aforementioned lamps. This is why these cosmic radiations are powerful enough to penetrate 200 feet down into a mountain lake before they are completely absorbed.

The rays brought to light by this most recent work correspond to four main radiations extending over a spectral region three octaves wide and having frequencies identical with those which are computed theoretically from the loss of mass which would occur in accordance with the foregoing equation of Einstein, first, when the helium atom is created out of the nucleus of the hydrogen atom (the positive electron) two negative electrons acting as the binding agents; second, when oxygen and nitrogen atoms are similarly created out of hydrogen; third, when silicon and magnesium are so produced, and, fourth, when the atom of iron is born.

Hydrogen and helium are extraordinarily abundant gases, while the four elements—oxygen, magnesium, silicon and iron—are the most abundant elements found in meteorites and constitute a not unlike percentage of the earth. The agreement between the observed and computed frequencies is so good as to make it highly improbable that it represents an accidental coincidence.

The quantitative nature of the agreements obtained is illustrated as follows: While the atomic weight of hydrogen is 1.00778, the atomic weight of helium is 4.00054; when helium is created by the union of four hydrogen atoms an amount of matter disappears which is equal to four times 0.00778.

The difference—namely, .03058 grams—must, according to Einstein's equation (MC^2-E), go off in the form of radiant energy when the helium atom is formed, and the appearance of this amount of energy in the form of a monochromatic ether wave would give that ether wave the penetrating power which is represented by an absorption coefficient numerically equal to .305.

This is within a few per cent. of the absorption coefficient directly observed by Millikan and Cameron for the most conspicuous band in their cosmic ray spectrum.

There is, further, a philosophic argument which supports the results of this observation. We have long known that all elements have a structure which indicates that they are exact multiples of the mass of the positive electron, which is the nucleus of the hydrogen atom.

We have also known for thirty years that in the radio-active process the heavier atoms are disintegrating into lighter ones. It is, therefore, to be expected that somewhere in the universe the building-up process is going on to replace the tearing-down process represented by radio activity.

Up to the present, however, no evidence had ever been found that this building-up or creative process is going on now. The present experiments constitute the first discovery of such evidence.

It must be taken with some reserve and must be subjected to further critical analysis and further experimental tests. But, so far as they go, these experiments are at least indications, and the first direct indications, that all about us, either in the stars, the nebulae or in the depths of space, the creative process is going on, and that the cosmic rays which have been studied for the past few years constitute the announcements broadcast through the heavens of the birth of the ordinary elements out of positive and negative electrons.

When it is remembered that the positive electron is the nucleus of the hydrogen atom, and that the spectroscopic survey of the heavens shows the extraordinary abundance everywhere of hydrogen; and when we reflect that we have known for fifteen years that all the elements have weights that are practically exact multiples of the weight of the hydrogen atom as it appears in the structure of helium, the foregoing conclusion that the process of atom-building out of positive and negative electrons (the latter have a mass that is negligible in comparison with the former) is now going on gains additional plausibility.

If it is confirmed it will constitute new proof that this is a changing, dynamic and continuously evolving world instead of a static or a merely disintegrating one.

Further qualitative support for the validity of the foregoing evidence is derived from the fact that so far as we can now see there are no sorts of nuclear changes which could take place powerful enough to produce the observed cosmic rays except those herewith suggested.

Putting together, then, the quantitative and the qualitative evidence, we may have some confidence in the conclusion that the heretofore mysterious cosmic rays, which unceasingly shoot through space in all directions, are the announcements sent out through the ether of the birth of the elements.

R. A. MILLIKAN,
G. H. CAMERON

FORMS AND PROPERTIES OF WATER SOLUBLE PHOSPHORUS IN SOILS

A RECENT publication from this laboratory gave a method for the quantitative determination of organic

and inorganic phosphorus in soil solutions and extracts. Another paper gave data showing the amounts of each form of phosphate in the displaced solutions and 1:5 water extracts and also presented results showing that the organic phosphate was not absorbed by plants. Subsequent studies have given additional data on the forms and properties of the water soluble phosphorus in soils.

While studying the decolorization of soil solutions by the use of carbon black, it was noted that the carbon absorbed a considerable portion of the organic phosphate but very little of the inorganic phosphate. Further studies showed that while a considerable part of the organic phosphate was readily absorbed by the carbon black, another portion was not easily removed by the use of carbon black. This is evident from the results of an experiment in which 100 cc. portions of two soil extracts were treated with 0.20, 0.50, and 2.00 gms. of carbon black. The results of the experiment are given in table 1.

TABLE 1

AMOUNTS OF INORGANIC AND ORGANIC PHOSPHATE IN SOIL EXTRACTS RECEIVING THE CARBON BLACK TREATMENTS INDICATED.

Treatment per 100 cc. extract	Extract 449		Extract 561	
	Inorganic PO_4	Organic PO_4	Inorganic PO_4	Organic PO_4
	p.p.m.	p.p.m.	p.p.m.	p.p.m.
None	0.58	0.38	Trace	0.24
0.20 gm. carbon	0.61	0.23	Trace	0.12
0.50 gm. carbon	0.61	0.23	Trace	0.12
2.00 gm. carbon	0.51	0.21	Trace	0.12

The treatment with 0.20 grams resulted in the adsorption of 0.15 p.p.m. and 0.12 p.p.m. organic phosphate. Increasing the amount of carbon black to 2.0 gms. did not increase the amount of organic phosphate adsorbed. Similar results have been secured with extracts of other soils and with some displaced soil solutions.

In another experiment two soil extracts and a soil solution were treated one, two and three times with 0.50 gms. of carbon black. In all cases the first treatment resulted in the adsorption of considerable organic phosphate while the second and third treatments removed very little additional phosphate.

These results seem to indicate the presence of at least two forms of organic phosphate in soil extracts and solutions. One form is very readily adsorbed by carbon black while the other form is adsorbed in small amounts if at all. The relative amounts of the two forms seem to vary somewhat in the extracts and solutions from different soils. In general, however, they are usually present in approximately equal amounts. Neither form seems to be associated with the coloring matter of the extract or solution as many extracts that are practically colorless contain considerable amounts of both forms.

All the organic phosphate is apparently rather stable toward heat. Soil extracts and a soil solution were boiled two hours under a reflux condenser without materially increasing their content of inorganic phosphate.

Experiments with aluminum hydrate, prepared by the method of Emerson, as a decolorizing reagent have shown that it removes all of the inorganic phosphorus from solution but does not adsorb all of the organic phosphate. It does, however, adsorb some organic phosphate, probably the same portion that is readily adsorbed by carbon black. Increasing the amount of aluminum hydrate ten times did not increase the adsorption of organic phosphate.

These results confirm those previously reported showing that soil solutions and extracts contain considerable quantities of organic phosphate as well as inorganic phosphate. They further indicate that there are at least two forms of organic phosphate. Additional studies should be made to determine other properties of the organic phosphate including its rate of decomposition by biological action.

F. W. PARKER

SOILS LABORATORY,
ALABAMA AGRICULTURAL EXPERIMENT STATION

THE AMERICAN PHILOSOPHICAL SOCIETY

THE annual general meeting of the American Philosophical Society will take place in Philadelphia on April 19, 20 and 21. Following is the preliminary program of the sessions for the reading of scientific papers:

Thursday, April 19, at 2:00 P. M.

Francis X. Dercum, president, in the chair

Tundra vegetation of Central Alaska: JOHN W. HARSHBERGER, professor of botany, University of Pennsylvania.

Features of cells that live long: DANIEL T. MACDOUGAL, director of the laboratory of plant physiology, Carnegie Institution of Washington.

A geno-geographical study of the genus Bursa: GEORGE H. SHULL, professor of botany and genetics, Princeton University.

Trianaeopiper, a new genus of Piperaceae: WILLIAM TRELEASE, professor of botany, University of Illinois.

Cell division and differentiation: EDWIN G. CONKLIN, professor of biology, Princeton University.

Probable rôle of internal secretions in structure and growth as illustrated by breeds of dogs and peculiar types in man: CHARLES R. STOCKARD, professor of anatomy, Cornell University.