PHYSICS

Cosmic Rays Are Photons, Dr. Millikan Declares

Latest Observations at Great Altitudes Held to Support Theory of Interstellar Origin of Penetrating Radiations

By Dr. R. M. LANGER, California Institute of Technology

COSMIC RAYS are primarily light rays, or photons, which may be mixed to some extent with secondary charged particles, even when they enter the atmosphere. The rays originate out in interstellar space. These were the conclusions of a discussion of cosmic rays presented at the Mt. Wilson Observatory by Dr. R. A. Millikan, based on results made possible by recent advances in experimental technique developed at the California Institute of Technology.

Dr. Millikan acknowledged the assistance in this work of three especially able and resourceful young men, Drs. I. S. Bowen, C. D. Anderson, and V. H. Neher. Dr. Millikan said it was largely through their ingenuity that the new improvements were attained. The work was supported by the Carnegie Institution of Washington.

All observers, said Dr. Millikan, agree that the immediate agents through which the cosmic rays make their presence known are charged particles moving at such high speed that they disrupt atoms all along their path. There has been developed at the California Institute of Technology a photographic technique by which the energy of these particles has for the first time been directly measured. Over six hundred such photographs have been taken during the past year. They show the rays to be of enormous energy. They range from 40 million to 1,000 million volts, at least a hundred times larger than any that have been measured previously. The voltages below 500 million predominate. This has an important consequence, for it means that all those of less energy than 500 million must be secondary rays, produced in our atmosphere by primary cosmic rays, because charged particles with energy of even 1,000 million volts could barely penetrate the atmosphere. Indeed, Dr. Millikan showed photographs in which the actual formation of these secondaries could be seen taking place, for tracks sprang out of lead interposed in the path of the cosmic ray beam when no tracks entered the lead.

The only agents which could produce such tracks without being seen themselves are photons. Dr. Millikan pointed out that this conclusion received complete support from all the recent careful experimenters working on the so-called latitude effect. They agree that there is no latitude effect in regions more than 30 degrees from the equator. Dr. Millikan himself has been looking for such an effect for several years with ever-improving methods. So far he has failed to find any evidence of it at sea level. At very high altitudes—in airplanes at 21,000 feet—there may possibly be some indication of a small effect.

Now, some observers have found small influences within 30 degrees of the equator. Dr. Millikan has not yet explored this region with his latest instruments and would not deny the possibility of such an effect. However, it does not weaken his argument that the cosmic rays as they come into the atmosphere are primarily photons. A few electrons are necessarily generated by the photons in passing through tenuous matter in interstellar space. These would surely show a latitude effect if we could go to high enough altitudes and use sensitive enough instruments.

One of the most interesting results of the airplane flights was the rapid and continuous increase in cosmic ray intensity with altitude, especially between 19,000 and 21,000 feet. This is in agreement with previous work and shows a less penetrating component of the cosmic radiation which must account for most of the intensity observed near the top of the atmosphere. The primary rays at high altitudes are photons, most of which, from their penetrating power, are found to have energies in the neighborhood of 25 million volts.

Even the trained physicist must reflect a while before he can appreciate how conclusive a proof of the photon nature of cosmic rays is provided by this rapid rise in intensity with altitude coupled with the absence of any great latitude effect.

The interstellar origin of cosmic radiation is shown by the absence of any large or regular effect of the sun on cosmic rays. If the sun or milky way were responsible for a considerable portion of the cosmic radiation, the intensity would have to rise and fall according to the posi- (*Turn to Next Page*)

ASTRONOMY

Diminishing Moon to Eclipse Bright Star Regulus

STAR GAZERS in the southern and eastern parts of the country will see an interesting sight on the evening of Sunday, December 18, when the moon occults, or "eclipses," the bright star Regulus. Though every night the moon passes in front of some stars, it is very seldom that one as bright as Regulus is occulted.

Astronomers at the Naval Observatory in Washington will see the moon cover the star, which is of the 1.4 magnitude, at 9:41 p. m., Eastern Standard Time. At that time the moon, approaching last quarter and in a gibbous phase, will be low in the east. At 9.54 p. m. the star will reappear. Farther north the time will be shorter, while in the southern part of the country it will be a little longer, and the times different. In the middle west and west, the occultation will be over when the moon rises.

Observations of the exact time of such occultation are important to astronomers, because by their aid the correctness of predictions of the moon's wandering through the sky can be checked. The positions of the stars are accurately known, and when the time of an occultation is found the exact position of the moon at that moment is known.

MISSISSIPPI FLOODS A LAWN

Here is the turbulent Father of Waters at flood stage, in miniature, from below Greenville, Miss., to the mouth of Old river. This reproduction of the Mississippi in reduced size at the U. S. Waterways Experiment Station, Vicksburg, Miss., has been called the largest river model ever built. It is used under the direction of Lieut. Herbert D. Vogel, of the Corps of Engineers of the U. S. Army to study the effect of structures designed to improve the river channel. The model is approximately 400 feet wide at the lower end and 120 feet wide at the upper end in the foreground. Twenty-four hundred feet of horizontal distance have been reduced to one foot and 120 feet of vertical distance to one foot. Notice the men in the background.

tion of one or the other. None of the recent work here or abroad shows a considerable effect of this character. Dr. Millikan has a great deal of data on this point. There are small and irregular variations but not of the sort which would result if the sun were the origin of the rays. Since they are, moreover, not produced on the earth they must come from the space outside.

The situation is in a very desirable state, Dr. Millikan pointed out. The leading experimenters everywhere are practically in complete accord as to the direct facts of observation. There are differences of opinion with regard to the interpretations to be applied to these facts. But in this matter of interpretation all physicists can join in the discussion. It will not be long before a generally acceptable conclusion will be reached as to the fundamental nature of the cosmic rays. The result will have consequences of most intense significance to theoretical physicists as well as to our notions of the structure of the universe.

Science News Letter, December 17, 1932

GEOGRAPHY

Heat Wave Aids Small Boat to Sail "Impossible" Arctic Seas

THE "IMPOSSIBLE" feat of sailing around Franz Josef Land, in the North Polar regions, has been achieved by Russian explorers. They were aided by a heat wave from Florida which started in the Gulf Stream four years ago and moving slowly northward warmed the Polar Sea this year.

Experienced navigators have thought it impossible to sail a ship safely through the fickle seas north of Franz Josef Land, which lies far up toward the Pole. The leader of the Russian expedition, Prof. N. N. Subov, believed this uncharted polar region should be visited, and oceanographic data gathered.

The voyage was made in a small motor sailing craft of only 100 tons displacement and 125 horsepower.

"It was not luck but careful planning that made our success possible," said Prof. Subov, telling of the difficulties and how they were met.

So closely was the trip planned, that the little boat was loaded with only 30 days' fuel and 40 days' provisions, and no winter equipment. Prof. Subov had prepared maps, and had surveyed the temperature conditions of the region for past years. He predicted that the seas northeast of Franz Josef Land and towards Novaya Zemlya would be found free of ice, owing to the fact that a large volume of warm water from the Gulf Stream has been moving for four years slowly northward, and has had a marked effect on icebergs and sea temperatures along its route.

So strong was Prof. Subov's confidence that he could travel around Franz Josef Land on the crest of this warm wave this year, that he refused to turn back when confronted by a great ice-pack blockade east of Graham Bell Island. Warmer water must be present farther to the northeast, he was convinced. And moving in that direction, 25 miles, a passage to the south was found. The boat had a narrow escape on one occasion, being caught in an ice pack which nearly closed upon it.

September 20, thirty-four days after the little boat sailed from its starting point, Murmansk, it was back there again. Its fuel supply was down to a mere two-hour reserve. The food stores had been eked out by two white bears, shot toward the latter part of the voyage.

One discovery announced by Prof. Subov is that the islands which Nansen named Eva and Liv after his wife and his daughter are in reality a single piece of land. The two ends are joined by a low stretch of land, the Russian explorers found.

"We charted it," said Prof. Subov, "and changed the name to Evaliv."

Describing the scientific observations made, Prof. Subov said:

"During our expedition we made 400 wire soundings at five-mile intervals. We made 38 full oceanographic stations at which temperature, salinity, oxygen, hydrogen ion concentration, phosphates, and nitrates were determined. We also investigated the distribution of plankton and benthos—forms of animal life at the sea bottom—and made the usual meteorological observations."

One practical application of the Arctic oceanographic studies is in the fishing industry of northern countries, which is directly affected by temperatures and other conditions of the Polar seas.

The most important results of the expedition, however, in Prof. Subov's opinion, is that it proved his ideas of forecasting Polar climatic conditions to be workable. The expedition also showed, he pointed out, that small boats can be very useful for oceanographic work in the high latitudes if climatic conditions are known beforehand.

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PHYSICS

Conservation of Energy Law Declared Unnecessary

THE LAW of conservation of energy which has been the cornerstone of physical theories for several generations may have to be discarded when dealing with certain atomic transformations. The conservation of energy is now doubted because identical radioactive atoms give off electrons of different energy and apparently continue to be identical so far as their energy is concerned.

Dr. Niels Bohr, the (*Turn Page*)