NUCLEAR PHYSICS

How Mesons Were Made

Their creation may open up unprecedented opportunities for understanding mysterious sub-nuclear processes, cyclotron inventor believes.

See Front Cover

➤ CREATION of mesons artificially in the giant Berkeley cyclotron is called "the most significant event in fundamental nuclear studies since the discovery of uranium fission." (*See SNL*, March 13).

Tracks of the mesons were observed on photographic emulsion plates placed adjacent to targets of carbon, beryllium or other materials against which the great cyclotron hurls 380,000,000 electron-volt alpha particles, the nuclei of helium atoms.

Dr. Ernest O. Lawrence, inventor of the cyclotron, Nobelist, and director of the University of California radiation laboratory, believes that the development opens up unprecedented opportunities for understanding mysterious sub-nuclear processes, particularly the nature of the force which holds the nucleus together and subtle influences of atomic particles on each other. The meson is the best tool ever obtained for examining these forces. Because the largest cyclotron possesses just barely enough power to produce low energy mesons, super atom-smashers must be built.

Men Who Did Experiments

The two men who did the experiments, Dr. Eugene Gardner, research physicist in the Radiation Laboratory, and Dr. C. M. G. Lattes, a Brazilian scientist from the University of Sao Paulo, who came to Berkeley recently on a Rockefeller Foundation Fellowship, are shown on the cover of this week's SCIENCE NEWS LETTER.

In the photograph, Dr. Gardner is holding an experimental assembly of meson apparatus which Dr. Lattes is about to help put in the cyclotron chamber.

Dr. Lattes for the past two years worked with a group of scientists at the University of Bristol, Bristol, England. Dr. Lattes, Dr. C. F. Powell, and Dr. G. P. S. Occhialini, working at Bristol, have led in the application of specialized techniques for studying cosmic rays by means of photographic emulsions. Drs. Gardner and Lattes and Prof. Robert R. Serber, nuclear physicist in charge of the theoretical work in the Radiation Laboratory, joined with Drs. Gardner and Lattes in explaining how the mesons were observed.

Before the Bristol findings were revealed, it was generally believed that only one kind of meson existed. This particle was suggested in the 1930's by a Japanese scientist, Dr. Hideki Yukawa, to explain a gap in the atomic theory of that day; such a particle was later found in cloud chamber experiments by Dr. Carl D. Anderson, of California Institute of Technology, and he called it a mesotron. The names meson and mesotron have been used interchangeably.

Meson Found at Sea Level

Dr. Anderson's meson was found to have a mass of about 200 times that of the electron and either a positive or negative charge of electricity. Found at sea level, this meson has a life time of two millionths of a second and energies up to billions of electron volts. It is a secondary cosmic ray particle, and scientists considered that it was made as a result of the bombardment by heavy, energetic primary cosmic rays entering the earth's atmosphere from outer space and colliding with nuclei of the atmosphere.

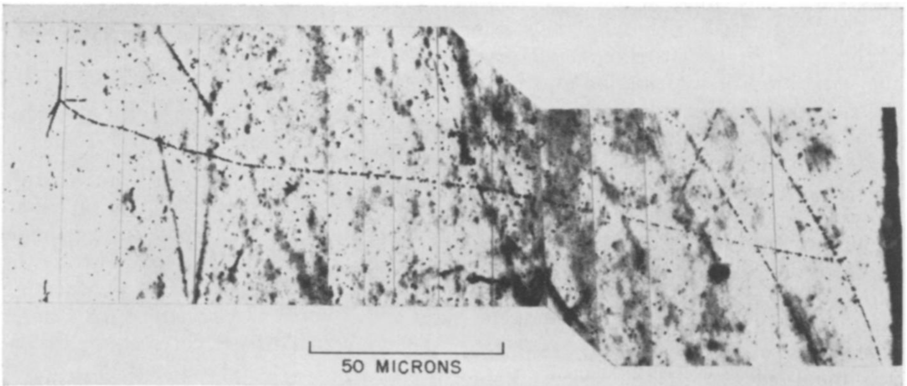
Scientists tried to tailor their theories to fit the idea that only this one kind of meson existed. One of their great difficulties was that this meson did not interact with atomic nuclei. Its birth could not be explained adequately, and its brief existence was climaxed by oblivion. But it was obvious that these light mesons were the product of nuclear particle collisions.

Years of Careful Study

During years of careful study and development of special techniques, the scientists at Bristol, taking their emulsions to mountain tops in the Andes and Pyrenees, were able to explain how the light meson often originated from a heavier meson.

They found on their photographic emulsions, mesons of a mass of about 320 times that of the electron. They found that these heavy mesons were both positively and negatively charged, and there was some evidence that neutral mesons also existed.

All of these heavy mesons were studied at very low energies, of a few million electron-volts, when they were close to or undergoing disintegration. At these energies, the positively charged heavy mesons, being unable to penetrate the electrical barriers of positively charged nuclei, simply wandered through the photographic emulsion until they



MESON TRACK—is shown in this photomicrograph. The edge of the emulsion plate is at right. In the beginning, with an energy of 4 million electron volts, the track of the meson is light, becoming heavier as it reaches the point of capture by a nucleus. It explodes the capturing nucleus, resulting in a "star". The reason for lightness of track at right, heaviness near star, is that a charged particle will affect more electrons of atoms through which it is passing as it loses energy. Dark parallel lines on the right hand edge show the edge of the photographic plate. The scale gives some idea of the length of the track—about four one-hundredths of an inch long.

disintegrated, giving birth to light mesons.

However, the negatively charged heavy mesons were greedily swallowed by nuclei, resulting in the detonation of the capturing nuclei into showers of particles called "stars". At the end of their course, when nearing capture, the mesons made a wavy track. The wavy track is made because the particle is relatively light, and, at the extremely low energies involved, it takes a severe buffeting from nuclei in the emulsion.

The negative heavy mesons are the type which have been produced in the giant Berkeley cyclotron. The Berkeley research shows they have a mass of 313. The characteristic wavy track and the "stars" resulting from the detonation of nuclei are also observed. About half the meson tracks observed end in "stars".

Theoretical calculations indicate that mesons were being made from the beginning of the operation of the giant cyclotron over a year ago. The first plate exposed on Feb. 21 of this year for 30 seconds yielded 100 times as many mesons per plate as were obtained in the Andes from cosmic rays in 45 days. This is 10,000,000 times as many mesons per second in the cyclotron as on a mountain top. On the first night one track in 10,000 was a meson, while now the method has been improved so that one track in 10 is a meson.

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PHYSIOLOGY

Sex Affects Skin's Color

Spectrophotometric studies show that a woman's skin is paler in color than a man's. Sex glands produce hormones which regulate the skin color.

➤ SEX differences and variations in sex gland activity are reflected in skin color. Spectrophotometric studies showing these were reported by Dr. Edward A. Edwards of Harvard Medical School and Tufts College Medical School at the meeting of the Optical Society of America in New York.

The spectrophotometer is an instrument used to analyze colors in a substance from the light it gives off. Doctors every day look at the skin color of their patients for clues to their state of health. The spectrophotometer gives the same kind of information and much more. It detects not only the quantity of blood present in the skin but also how well it is supplied with oxygen.

With the aid of this instrument, Dr. Edwards and Dr. S. Q. Duntley of Massachusetts Institute of Technology have made an optical reconstruction of human skin. This was done by stripping a piece of skin off a cadaver. After the blood was washed out of it, the skin was mounted against the spectrophotometer window. Backing it was a parallel-sided glass cell filled with oxyhemoglobin solution. Behind this was a second glass cell filled with reduced hemoglobin solution, that is, blood's red color chemical minus oxygen. The "skin" was completed with a block of fat. By varying the concentrations of the two hemoglobin solutions, curves simulating various body areas were obtained by this method.

The studies with the optically reconstructed skin were confirmed by studying the palm of a normal young man whose arm was bound by a tourniquet.

A woman's skin differs from a man's by being paler in color, showing less blood and less melanin, Dr. Edwards reported.

Melanin is a brown pigment found in large quantities in the dark races and is a prominent factor in sun tanning. The female skin, though having less of this pigment than the male skin, has more of another pigment, carotene. This is the chemical that gives carrots their color, and that in human skin is derived from vegetables, egg yolk and a few other sources of carotene.

The hormones produced by the sex glands regulate the skin color. Male castrates showed a sallow color, due mainly to lack of blood supply. This could easily be corrected by doses of synthetic male hormone. These patients also had skin that did not tan as much as normal male skin, and which contained more carotene than normal male skin. Their skin was more like that of a woman's in these respects. These differences were also corrected by male hormone treatment.

The effect of hormones on female skin color was found in studies of women whose ovaries had been removed and also in periodic changes in skin color corresponding to stages of the menstrual cycle.

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MEDICINE

Chemical Stops Hormone

A new principle in the treatment of cancer may result from the discovery that an anti-vitamin can interfere with the action of a female sex hormone.

➤ DISCOVERY that an anti-vitamin can interfere with the activity of a hormone, specifically a female sex hormone, was announced by Dr. Roy Hertz of the National Cancer Institute at the meeting of the American Association for Cancer Research in Atlantic City.

A new principle in treatment of disease may result. This new principle could apply not only to treatment of cancer but also treatment of many other diseases in which glands and their hormones are involved.

Dr. Hertz worked with chickens and monkeys. He gave the animals doses of a chemical called aminopterin. This is an antagonist, or anti-vitamin, to folic acid. This anti-vitamin stopped the growth response of chick tissues to the female hormone, estrogen.

The effect of hormones on the growth of tissues has recently been considered important in connection with cancer, which is a problem of abnormal growth. A relation between sex hormones and cancer of the breast is also known to exist and a number of scientists are working on this phase of the cancer problem. Some of them have been discussing their work at this meeting.

Cancers of the breast and uterus are known to have a certain dependence on stimulation by estrogens. In breast cancer it has been common practice to remove the patient's ovaries, or destroy them by X-ray or radium treatment.