

## NUCLEAR PHYSICS

# Neutron Becomes Proton

Reverse action is also found in atom nucleus showing how the nucleus is held together by a subnuclear force differing from any known forces.

## See Front Cover

► THE neutron (trigger of the atomic bomb and the proton (heart of the hydrogen atom), both fundamental particles in the nuclei of atoms, can turn one into the other.

This top discovery in man's invasion of the atomic nucleus was announced by Prof. Ernest O. Lawrence, Nobel physicist of the University of California, who delivered the first Silliman lecture of Yale's Centennial Celebration of the Sheffield Scientific School at New Haven, Conn.

This research done with the new giant cyclotron at Berkeley gives direct evidence on the nature of the force that holds the nucleus together. It confirms for the first time a basic theory of atomic forces proposed by the German Dr. Werner Heisenberg in the early 1930's. Dr. Heisenberg headed Nazi atomic energy research during the war.

A new monster atom-smashing "bevatron" to attain 10 billion electron volts was also shown in preliminary design by Prof. Lawrence.

This Heisenberg theory, now confirmed, explained an anomaly of the nucleus. The elementary particles of the nucleus are protons, with a positive electrical charge, and neutrons, with no charge. If electrical laws alone were considered, the nucleus could not exist because protons would repel each other so forcibly when packed together in the nucleus that the atom would disintegrate.

## Exchange Forces in Nucleus

Dr. Heisenberg proposed that, in addition to ordinary forces, there are "exchange forces" acting within the nucleus. For example, the charge on the proton, the theory holds, is tossed back and forth between the proton and neutrons, creating a subnuclear force differing from any known forces.

Prof. Lawrence said experiments at Berkeley proving this to be true were done by Drs. B. J. Moyer, J. Hadley, C. E. Leith, Harvey York and Wilson Powell. Interpretation of the results was done largely by Prof. Robert Serber and

the theoretical staff of the Radiation Laboratory.

Two types of experiments were done, using the 100-million electron volt neutrons which are emitted from a target of beryllium bombarded by 200-million electron volt deuterons, the nuclei of heavy hydrogen atoms.

In the first experiment, the high energy neutrons were turned on a target of paraffin, which contains many atoms of hydrogen, the simplest of all nuclei, consisting of one proton.

## Like Billiard Ball Collision

Prof. Lawrence likened this situation to a billiard ball collision. He said that the frequency with which the "cue ball" neutrons would strike the target protons a glancing blow and then continue at a slight angle in the same general direction can be calculated according to the laws of probability.

At varying angles away from the paraffin target a series of four radiation counters were placed, weak radiations being filtered out by the first three counters.

It was found that high energy protons were being emitted where ordinary mechanical laws would dictate that only neutrons could be.

The conclusion, Prof. Lawrence said, is that the neutrons, in the collisions, had picked up the charge of the protons. In Jekyll-and-Hyde fashion, the neutrons had become protons and the protons neutrons.

Cloud chamber photographs taken by Dr. Powell revealed the same thing. Neutrons cannot be photographed in a cloud chamber, but protons can. Protons suddenly starting up in the photographs took the same pattern of angles from the direction of neutron beam as they did in the other experiment. Thus it was concluded that the bombarding neutrons had been converted into protons in an exchange of charge.

The pictorial record of the latest advance in physics, appearing on this week's cover of the SCIENCE NEWS LETTER, is a cloud chamber photograph showing the disintegration of carbon and oxygen



**MELTED BY RADIO**—The investigator shown is measuring the temperature of thorium with a pyrometer while radio waves bombard it in a tubular high frequency melting chamber of the Westinghouse Lamp Research Laboratories. Thorium powder fuses at 3,600 degrees Fahrenheit.

nuclei and the conversion of neutrons into protons under bombardment of 100 million electron volt neutrons from the giant University of California cyclotron.

Direction of the neutron beam is indicated by the arrow. Four "stars," the disintegrations of nuclei similar to those found in cosmic rays, are lined up in a row from a point directly to the right of the arrow to the right of the picture. The heavy tracks are made by alpha particles and protons emitted from the disintegrations. The long curving track is a 1.8 million electron volt proton.

Conversion of a neutron into a proton, demonstrated for the first time, is seen in three short tracks: first just above the right of the arrow; second, halfway between the second and third "stars"; and third, just to the right of the third star and crossing one of the tracks of that star.

Curvature of the tracks was produced by a magnetic field of 13,000 gauss.

For 15 years scientists have been trying unsuccessfully to prove Heisenberg's hypothesis. Low-energy cyclotrons did not give collision phenomena of sharp enough definition for conclusive proof.

## Billions of Electron Volts

Prof. Lawrence said that the "bevatron" would have a magnet weighing 13,000 tons, and that its source of protons would be a Van de Graaff generator.

"Developments in atomic physics have been and are continuing to be so rapid and so fundamental in character as to

constitute truly a revolution in our understanding of the properties of matter," Prof. Lawrence said.

"We see that the production in the laboratory of accelerated particles in the 100 million electron volt range has opened up a rich domain for investigation. Perhaps, therefore, we should now be content to devote all our attention to the experimental attack on the problems in this field. But the very richness of the atomic phenomena already apparent in the 100 million electron volt level surely beckons us on to green pastures—the domain of billions of electron volts.

"It is, therefore, understandable that as soon as the synchrocyclotron was well

launched on its operating career, W. M. Brobeck, who was chiefly responsible for the engineering design of the great machine, should give some thought to the next step up the energy scale.

"It did not take him long to reach the conclusion that it was well within the realm of practical feasibility to construct a great proton accelerator for the 10 billion electron volt level. Indeed, he has already completed preliminary engineering designs."

Prof. Lawrence did not indicate any immediate plans for the machine's construction.

*Science News Letter, October 25, 1947*

*For other news from the Sheffield Centennial see pages 261, 262, 264.*

#### PUBLIC HEALTH

## War on Cholera Mapped

Quarantine experts, who just met in Geneva, planned strategy to stop cholera in Egypt and wipe out this disease, if possible, to prevent future outbreaks.

► IMMEDIATELY needed in Egypt's fight against cholera are 100 more ambulances to transport patients and suspected cholera victims to hospitals, Dr. Mohamed Nasib Bey, undersecretary of state for quarantine, Ministry of Health, Alexandria, reported to the World Health Organization's special committee on quarantine which met in Geneva.

The cholera epidemic in Egypt is essentially limited to rural areas, and rigorous control measures are being taken to prevent its further spread, Dr. Bey reported.

Measures to prevent importation of cholera into countries connected with Egypt by land, sea and air already taken by those countries are more rigorous, the WHO committee found to its surprise, than those recommended by international sanitary conventions and even more rigorous than the situation apparently calls for.

With hospitals in Egypt under virtual military control and travel there limited to official business, the world's chiefs of staff for epidemic control met to map further strategy in the war on this disease.

They had really two fights to plan. One is the immediate battle to stop cholera in Egypt and keep it from spreading to other parts of the world. The other is the war to wipe out this enemy, if possible, so there will be no future outbreaks to endanger world health. This

war will be a long one, since it must involve improvements in sanitation in many parts of the world.

The possibility of cholera spreading to Palestine to add to that land's troubles is believed remote. So far, no cholera has been reported to the World Health Organization from either Palestine or Saudi Arabia.

Reason for Egypt's military control over hospitals is to keep patients from leaving while they may still be discharging cholera germs in their body wastes. Steps must also be taken to find cholera carriers outside of hospitals and bring them under control.

Guards have been posted, as well as placards, to keep people from using water supplies that have been found contaminated with cholera germs.

Part of the million units of cholera vaccine being made available by China will be flown to Saudi Arabia. It will be used to vaccinate the local population in and near Jidda, seaport where thousands of Moslem pilgrims converge during their trips to Mecca and other Holy cities in Arabia. The pilgrims are required to take cholera vaccination and other health safeguards before they are permitted to leave their homelands on these pilgrimages.

U. S. foreign quarantine regulations to prevent cholera getting into this country from abroad require that boats and planes take certain precautions before

departure and while en route from regions where cholera exists. Not only must passengers be vaccinated, but luggage and any other articles shipped on the boat or plane must be inspected to make sure they are not contaminated. Sterilization of such articles may be required. Food and water supplies for the trip must be safe and food handlers must be instructed in proper precautions to avoid contamination. In case of doubt, water must be boiled and all food cooked. On arrival in this country, Public Health Service officers take over. They make sure that no case of cholera is aboard and that all have been vaccinated. If there is a case aboard, passengers and crew are held in quarantine for five days. This is the time it takes for cholera to develop.

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