Description	Sample No.	Age (yr)
Hearth No. 8 is approximately 30 in. in diameter and 6 in. deep. It contained the charred remains of three small logs from which sample was taken. Associated with charcoal in hearth No. 8 were charred terrapin carapace fragments, small rodent bones, snail shells, and charred hackberry seeds. This sample has been classified by E. S. Barghoorn, curator of paleobotany, Harvard University, as wood charcoal. There was a sufficient number of large fragments to permit hand-picking of the sample for radiocarbon assay. Collected by W. W. Crook, Jr., R. K. Harris, and other members of the Dallas Archeological Society, May 1956. Submitted by W. W. Crook, Jr.		

News of Science

New Type Nuclear Reaction

The observation of a new kind of nuclear reaction that yields energy and is akin to thermonuclear reactions was reported recently to the American Physical Society by scientists in the University of California Radiation Laboratory. The scientists who participated in the research are Luis W. Alvarez, Hugh Bradner, Frank S. Crawford, Jr., John A. Crawford, Paul Falk-Vairant, Myron L. Good, J. Don Gow, Arthur H. Rosenfeld, Frank Solmitz, M. Lynn Stevenson, Harold K. Ticho, and Robert D. Tripp.

The new phenomenon is described as a "catalyzed nuclear reaction." This adds to those reactions already known to science a new and third way of making a nuclear reaction take place. The older ways are either to induce thermonuclear reactions, in which two light nuclei fuse into a heavier one when the temperature is raised to roughly 1 million degrees, or else to bombard nuclei with other nuclear particles from accelerators like cyclotrons or nuclear reactors.

In order to make a nuclear reaction take place, two nuclei must touch. The new discovery is a way of pulling two nuclei together so that a proton and a nucleus of heavy hydrogen (a deuteron) can combine to form helium-3 with the release of 5.4 million volts of energy. This pulling together takes place in a mesic molecule.

In a normal molecule the nuclei of the component atoms are pulled together weakly by electrons. But the electron can be replaced by a much heavier particle, the negative mu meson. Because the mu is 210 times heavier than an electron, it circles the nucleus at only 1/210th the distance of an electron, and thus binds the two nuclei correspondingly closer. The nuclei then have a good chance of touching, and the nuclear reaction can take place.

The reaction is termed a catalyzed reaction because the mu meson is not consumed by the reaction but may be ejected from the molecule by the energy released. The mu is then free to catalyze more reactions, in chain fashion.

The Berkeley group emphasized that at the present time the energy-producing chain of catalyzed reactions cannot continue long enough to generate commercially useful amounts of power, because mu mesons decay into other particles after two-millionths of a second. Unfortunately, from the point of view of thermonuclear power mu mesons can be made only in high-energy nuclear collisions of particles accelerated by cyclotrons and other expensive machines. However, the scientists described as "interesting" the possibilities if a much longer lived particle, with properties similar to that of the mu meson, is ever found. The Russian physicist Alikhanian has reported evidence for such a particle.

The observations were made in studies of photographs taken of tracks in the 10-inch hydrogen bubble chamber which is being used with the Berkeley bevatron, at present the most powerful such machine in the world (a larger one is about to go into operation in the Soviet Union).

The bubble chamber is filled with liquid hydrogen, which boils and forms tiny bubbles along the track of any charged particle that goes through it. Photographs can thus be made of the trail of a particle in much the same way that one can record the passage of an otherwise invisible jet plane by photographing its vapor trail. The bubble chamber was invented at the University of Michigan and has been highly developed at Berkeley. It is tending to replace an older but similar tool, the cloud chamber. This is because a greater number of interesting nuclear collisions and events occur in a given volume of liquid hydrogen than in the more rarified gas of a cloud chamber.

Scientists expected that all mu mesons that came to rest in hydrogen would simply decay. Consequently there was excitement in the Berkeley group when it was noticed that occasionally a particle that looked like a mu came to rest but, instead of decaying, flung out another particle that also looked like a mu, went a short distance, came to rest, and decayed. In some of the photographs there was a gap between the two mu-like tracks. At first there was speculation about a new particle, a "super-mu" which decayed into an ordinary mu.

The pictures are now understood as follows. When the negative mu comes to rest it becomes attached to a proton, forming a mu-mesic atom that is similar to an ordinary electronic atom but scaled down 200-fold in size. In natural hydrogen, one atomic nucleus in 5000 has a neutron stuck to its proton and is called a deuteron. It can be shown that a mu meson prefers to form an atom with a heavy particle at its center; so the mu will form an atom selectively with a deuteron, even though the protons are much more abundant. Any mu-mesic atom will eventually attach itself to another atom to form a molecule.

The gaps are explained as a drift of the tiny neutral mu mesic deutron atom as it dashes away from the proton from which it stole its mu meson. Any complete atom, regardless of its size, is a neutral system, and does not make a track. Being neutral, the mesic atom makes no track.

The result of all these processes is that shortly after a mu comes to rest in hydrogen it finds itself holding a deuteron and proton together in the form of a tiny molecule. The deuteron and the proton are bound so closely that soon

they fuse to form helium-3. The mass of helium-3 is less than the combined mass of a proton and a deuteron, and the difference—5.4 million electron volts—is available as energy. This energy of fusion is the same energy that is released by the sun or during thermonuclear reactions.

Another way of looking at the reaction was described as follows. The mu meson holds the deuteron and proton together as if in a tiny box until they fuse. Thus fusion does not take place in ordinary molecules because the volume of the box is 10 million times larger.

In order to test their hypothesis, the physicists added artificially concentrated deuterium to the naturally occurring deuterium already in the bubble chamber. As was expected, there was an increase in the fraction of photographs in which there was an ejected mu or a gap at the end of a mu. Two pictures out of 10,000 showed a chain reaction two links long—where a single mu catalyzed two nuclear reactions before decaying.

After the experiments were completed, a colleague pointed out that in the 1954 *Proceedings of the Academy of Sciences of the U.S.S.R.* a theoretical physicist, Ya. B. Zel'dovitch, had already predicted a similar, though somewhat simpler, reaction.

The term *catalyzed nuclear reaction* was selected because of the comparison with what happens in chemistry, where a catalyst is used to speed up a reaction but is not itself used up in the reaction. A catalyzed nuclear reaction is similar to a thermonuclear reaction in that the same nuclear fusion reactions are common to both, but the conditions of the surroundings are quite different. Thermonuclear reactions take place only at extremely high temperature—in stars or hydrogen bombs—between nuclei propelled together by the great heat; a mu meson can pull nuclei together and catalyze a nuclear reaction at any temperature.

One of the great problems of controlled thermonuclear reactions lies in the need to maintain enormous heat in a confined system. Known materials melt at such temperatures, and investigations are under way to make "pinch containers" in which the hot materials do not touch the sides of the container. The difficulty is that the present containers leak.

National Health Survey

The U.S. Public Health Service has announced that a pilot test study under the new National Health Survey program will begin on 28 Jan. in Charlotte, N.C. The National Health Survey is being undertaken under legislation enacted by Congress last summer. The new law authorizes the Surgeon General of the Public Health Service to make continuing annual surveys and special studies of this country's population to determine the extent of illness and disability and gather related information. The last previous such federal survey was conducted 20 years ago.

The initial action in Charlotte will test a number of aspects of a questionnaire that is being developed for national use at a later date. Interviewing will be conducted by the Bureau of the Census, which is to perform this advance test and other field work on the survey. Data to be collected will include statistics on the number, age, sex, and occupation of persons suffering from diseases, injuries, or handicapping conditions; medical care received; the length of time that these people have been prevented from carrying on their usual occupations or activities; and the economic and other impacts of such conditions.

Sesquicentennial of Geodetic Survey

The Coast and Geodetic Survey plans a series of public events this year to celebrate its 150th anniversary. The survey was established in February 1807 under President Jefferson as the Government's first technical bureau. It has grown to the point where it now conducts official basic surveys of land areas and coastal waters of the United States and its possessions.

Its common services include tide tables for navigators, bathers, and fishermen; aeronautical charts for fliers; nautical charts for mariners; and starting points for surveyors. Admiral H. Arnold Karo is the director.

The anniversary program will be marked by the issuance of a special postage stamp. Plans are underway for sesquicentennial dinners, open house celebrations at survey headquarters, field offices and aboard ships, and for meetings of scientific and professional societies.

Teller on the Use of Nuclear Weapons

Edward Teller, nuclear physicist, discussed the moral issue involved in the use of nuclear weapons in a recent issue of the Air Force Association's monthly magazine *Air Force*. Teller stated that it would be "a considerable mistake for us to accept the idea that nuclear weapons are, on a moral plane, of a different nature from conventional weapons."

He noted that the U.S.S.R. had been exploiting the fact that the only use of atomic weapons in war so far had been against the civilian populations of Hiroshima and Nagasaki, Japan. He commented that "Russian propaganda has exploited this theme and has made it difficult, perhaps for the time being impossible, to make use of nuclear weapons, even in situations where such use would be logical and justified."

Rabies Treatment

The effectiveness of serum plus vaccine in preventing rabies in a group of persons who were severely bitten by a rabid wolf in Iran last year, and in similar less extensive experiences, was accepted as clear demonstration of the usefulness of the method by the Third World Health Organization Expert Committee on Rabies which recently met at the Pasteur Institute in Paris.

The meeting had historic interest inasmuch as it was at the institute that Pasteur introduced rabies vaccination for human beings more than 70 years ago.

This important step forward resulted from international collaboration, coordinated by WHO. The committee members, whose laboratories are situated in India, Iran, Israel, Spain, France, and the United States, have been working together on problems of rabies control since 1950.

The new approach involves providing basic protection by giving very small doses of chicken embryo vaccine, or a few doses of ordinary nervous tissue vaccine, followed by a single booster dose of vaccine rather than by the long schedule (14 to 21 days) of inoculations now performed.

Recently developed vaccines prepared from chicken embryos were found to confer long-term protection on dogs by only a single inoculation and were demonstrated to be useful also for cattle. It was stressed by the committeee that it is not only necessary to vaccinate dogs but also to control stray animals.

Rabies in wildlife, particularly in foxes, jackals, and wolves, is a problem in many countries. It also exists in insectivorous bats in areas of North America, and it has long been established that rabies is transmitted to men and animals in Latin America by blood-sucking bats. The finding of rabies in insectivorous bats in Yugoslavia indicates that this problem is not confined to the Western Hemisphere. Wild animal reservoirs present special difficulties, and it was agreed that extraordinary measures must be evolved to combat them.

The committee also suggested the establishment and use of an international standard reference serum and vaccine for countries throughout the world, so that procedures will be more uniform, and the potency of antirabic substances will be assured at time of use.

It also outlined forms for case reporting and case histories, to improve statis-