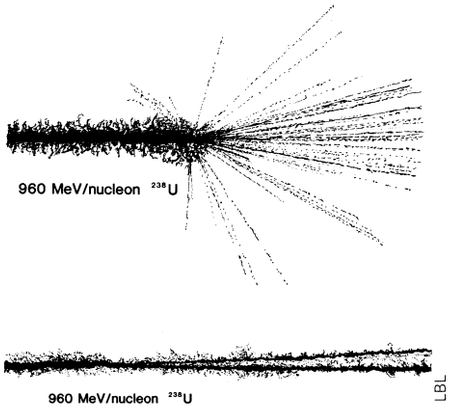
Uranium at a Quarter-Trillion Volts



Multiple fragmentation (top) and binary fission of high-energy uranium nuclei.

For decades physicists have studied atomic nuclei with very low energy. Now with the development of techniques for accelerating ions, nuclear physics is entering the domain of what physicists consider high energies. There they expect to find both exotic behavior and strange new states of matter.

At the moment the leading apparatus for accelerating ions of the heaviest elements to the highest energies is the Bevalac at the Lawrence Berkeley Laboratory in Berkeley, Calif. (SN: 8/14/82, p. 106). On the night of Sept. 25 the Bevalac beat its own record, by making what its managers call a full-energy run and accelerating uranium ions to almost a billion (10^9) electron-volts per nucleon (that is, per neutron or proton). Since there are 238 neutrons and protons in this particular isotope of uranium, the total energy of each nucleus was just about a quarter of a trillion electron-volts. The achievement and the first observations of what nuclei of this energy can do were described three nights later by Howel Pugh, scientific director for the Bevalac, in a special session of the International Conference on Nucleus-Nucleus Collisions, at Michigan State University in East Lansing.

The Bevalac is a coupling of two accelerators, the SuperHILAC (HILAC stands for Heavy Ion Linear Accelerator) and the Bevatron. The Bevatron was built about 30 years ago and was one of the first accelerators to bring protons to energies of a billion electron-volts. Now it does the same for heavy ions. Its vacuum system had to be rebuilt and a technique for using lighter ions as pilots to tune the guiding and focusing system for the heavy ions had to be developed (SN: 8/14/82, p. 106). Uranium is the heaviest natural element, so achieving the maximum Bevatron energy for it means the same feat is possible for any other element.

The process starts with uranium ions that are passed through metal foils to strip away their electrons. It is not practical to strip them completely at this point, so they enter the accelerator with a positive charge of 68, having lost 24 of their 92 electrons. After acceleration they are put through more stripping foils, and it is believed, though not known for certain, that the ions in this first run may have been fully stripped (positive charge 91 or 92) when they entered the detectors. Because of the final stripping the ions enter the detector with slightly less than the billion volt maximum energy of the accelerator. In the actual case it was 960 million electron-volts per nucleon.

The tracks the ions made in the detectors were analyzed by Harry H. Heckman, E. M. Friedlander and Y. J. Karant, all of LBL. The tracks of interest are cases where the incoming uranium nucleus strikes some nucleus in the detector material and thereby undergoes a change. One hundred and fifty-two such interactions had been analyzed at the time of the presentation. Half of them show fission into two more or less equal parts; half show fragmentation into several or many pieces. Most interesting of these are the 18 percent that represent a complete blow-up of the projectile nucleus into a large number of very light fragments. These events seem to represent a new kind of nuclear behavior that has physicists very interested. There are indications that these complete blow-ups are more likely to happen the higher the energy of the projectile. Thus, there is already an indication of exotic behavior at high energy.

LBL physicists are already making plans to use the Bevalac as a feeder for a large apparatus called Venus, the first phase of which is planned to bring heavy ions to 10 times the Bevalac maximum energy and strike them against fixed targets. The second phase of Venus would provide colliding beams of ions. —*D. E. Thomsen*

Earliest 'humans' may have inhabited ancient Israel

A California paleontologist has reported evidence that the species *Homo erectus* — immediate ancestor to *Homo sapiens* — was living in what is now Israel approximately 2 million years ago, raising the possibility that man evolved into a toolmaker in the Middle East or Asia rather than in the African savannas. Coupled with the fossil evidence of *H. erectus* from sites in Tanzania and Kenya, the new research suggests that ancient humans left the Middle East (perhaps driven south by a cold spell) to "invade" and colonize eastern Africa.

The oldest known *H. erectus* fossils — characterized by a thick cranium and robust skull features — are from the Olduvai Gorge in Tanzania and the Koobi Fora in Kenya, sites that have been worked by Mary Leakey and Richard Leakey, respectively. Both have been dated at about 1.5 million years. But according to Charles A. Repenning of the U.S. Geological Survey in Menlo Park, recent research indicates that the Ubeidiya site near the Sea of Galilee, which has yielded sophisticated stone tools, should be redated from 700,000 years old to anywhere from 1.9 million to 2.6 million years old. The presence of the tools in Ubeidiya indicates that the Jordan River valley was inhabited by *H. erectus,* Repenning told SCIENCE NEWS, and as a result the redating of the site provides the earliest known evidence of the species' existence.

Repenning, working with Oldrich Fejfar of the Geological Survey of Czechoslovakia and writing in the Sept. 23 NATURE, says that Ubeidiya cannot be reliably dated with traditional geological methods; the 700,000 year date has been assigned to the site because it has been assumed that humans dispersed from Africa, migrating north through the Middle East into Europe and Asia. What Repenning and Fejfar have done is examine the record of mammal fossils in Ubeidiya, and they have found that several animals thought to be extinct by 2 million years ago — including a sabre-toothed tiger — co-existed with the tool-bearing humans. Either the well-established evolutionary records of these mammals must be reconsidered, they say, or it must be granted that the human species immigrated from the Middle East to Africa between 1.5 and 2 million years ago.

Anthropologist F. Clark Howell of the University of California at Berkeley agrees with Repenning's findings although not necessarily with his speculations. "He's right, in essence, though I don't think it [Ubeidiya] is quite as old as 2 million. But it doesn't matter; it's twice as old as anybody thought before." And although Howell says that the data provide the earliest record of humanity outside Africa, he says that many different evolutionary scenarios could still be constructed.

Anthropologist Adrienne L. Zihlman of the University of California at Santa Cruz is more skeptical. It is reasonable to ex-