A Powerful New Accelerator for Nuclear Research

The most powerful electrostatic accelerator to be used in Caltech's nuclear research laboratories will be delivered to the campus this spring. Construction is now being completed on a heavily shielded underground vault to house the machine in the new Alfred P. Sloan Laboratory of Mathematics and Physics. The 10,000,000 electron volt tandem accelerator, costing $1,151,400, is being financed by the Office of Naval Research. The new accelerator will be used for studies of nuclear reactions. Scientists study these reactions for clues to the mysteries which govern the structure of the nucleus of the atom.

The new machine joins a team of three lower energy electrostatic accelerators which are now in operation in Caltech's Kellogg Radiation Laboratory. The three existing machines have been used in studies of nuclear reactions in the ten lightest chemical elements (hydrogen, helium, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine and neon) and their isotopes.

Heavy nuclei

The new electrostatic accelerator, being more powerful than the other three, will make it possible to study the heavier nuclei, and will also be used for studies of higher energy levels of the light nuclei.

Physicists work with accelerators in order to examine the central core, or nucleus, of the atom. Around this core, electrons rotate like satellites about a planet. The nucleus usually has great stability because the forces binding its parts are the most powerful known. In the nucleus, matter and energy can be interchangeable.

When one nucleus is hit by another one, nuclear reactions result. Sometimes the reaction sparks a release of energy or radiation. Sometimes it results in the transformation of one chemical element into another. Often, both of these things occur.

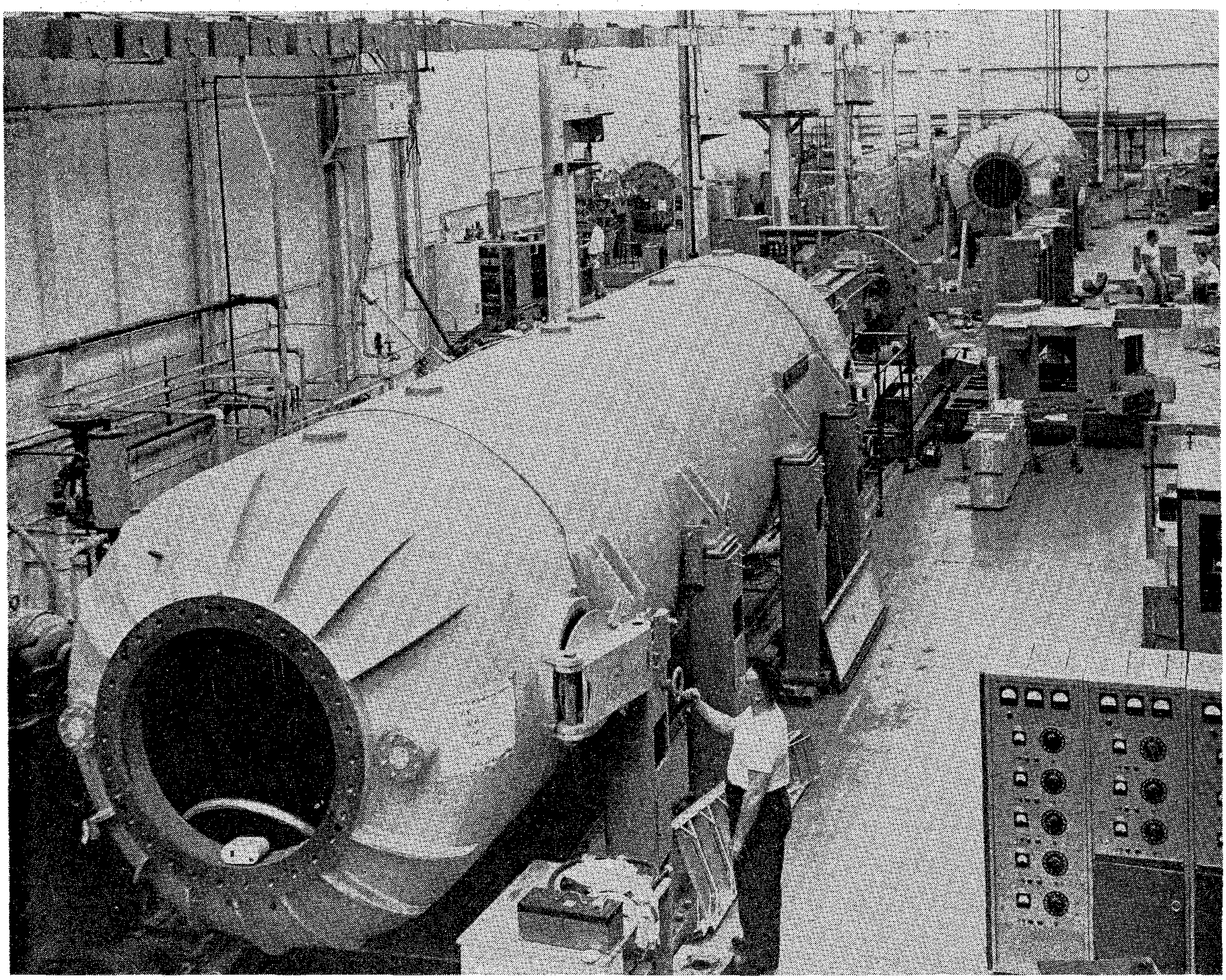
It isn't easy to get two nuclei to collide. Each nucleus carries a positive electrical charge, and because like electrical charges repel each other, nuclei have to be accelerated sufficiently to overcome this electrical barrier before they can run into each other.

Two methods

There are two ways to accelerate nuclei to sufficient speed to overcome their repulsive forces. One way is by heat. The tremendous heat inside stars excites the nuclei and causes them to lose their satellite electrons and dart about at tremendous speeds. Some of them collide and interact.

Another way to accelerate particles is by a machine like an electrostatic accelerator. In this case the target nuclei are held stationary. Nuclei of hydrogen or helium atoms are then accelerated by electric forces and hurled at the stationary target nuclei.

Each nucleus behaves as if it were tuned to a certain pattern of frequencies. It is possible to excite these resonant frequencies by bombarding the nucleus with particles of a certain energy, a different bombarding energy corresponding to each different frequency. By using the electrostatic accelerator, with its beam of variable energy, physicists can excite one after another of the natural frequencies of the target nucleus. Though electrostatic accelerators are not as powerful as cyclotrons or bevatrons, they have a dis-



Caltech's new electrostatic accelerator is now being assembled at the High Voltage Engineering Corporation in Burlington, Mass. It will arrive on campus this spring to be installed in a 120-foot underground vault.

tinct advantage over them because of this beam of continuously variable energy.

Each variety of nucleus has its own characteristic pattern of energy levels. It is important to know these patterns because it is only at their resonance levels that nuclei will interact readily. These interactions include absorbing or giving off energy and combining to form new chemical elements. Determining the pattern of energy levels is a vital part of the work.

Caltech's Kellogg Radiation Laboratory, which has been supported by the Office of Naval Research and the Atomic Energy Commission since 1946, has studied nuclear reactions for a quarter of a century. The earliest work was done with high energy x-rays, and the first electrostatic accelerator was placed in operation in 1939.

In 1942 the laboratory joined the Navy in its war work by designing and developing rockets. Through this work, the China Lake Naval Test Station was located and developed.

Much of the work with electrostatic accelerators has been concerned with the investigation of how stars are born, grow, wane and sometimes explode; how the sun's nuclear fires keep burning; how the nuclei of atoms behave and interact – including how the heavier chemical elements are synthesized from light elements like hydrogen. Findings from these studies are used by nuclear physicists, astronomers, and cosmologists.

Caltech physicists working on these studies include C. C. Lauritsen, one of the nation's pioneer physicists, who started nuclear physics research at Caltech in 1932; his son, Thomas, professor of physics; C. A. Barnes, associate professor of physics; William A. Fowler, professor of physics; R. W. Kavanagh, senior research fellow in physics; Ward Whaling, associate professor of physics; and R. F. Christy, professor of theoretical physics. Some 25 graduate students, working for their PhDs, also join in this research, as do three or four visiting physicists from Europe and Australia.