Superconductivity spreads

Low-power, high-efficiency machine for nuclear structure studies to be built at University of Illinois

by Dietrick E. Thomsen

Superconducting wave guides have two big advantages over the ordinary kind: They convert electric power to particle energy with almost 100 percent efficiency, and they don't give off much heat (SN: 6/22, p. 599).

In particle accelerators, this means a saving in power and the ability to produce a steady stream of particles without having the machine burn up.

One five-foot prototype accelerator, built by Prof. William Fairbank of Standford University, has already led to a beginning on a 500-foot model designed for actual experimentation.

Now, the University of Illinois says that a group led by Professors Peter Axel and Alfred O. Hanson will build a superconducting electron accelerator.

Although only three times as long as Prof. Fairbank's prototype, the new machine promises to provide new possibilities in the study of nuclear structure. The National Science Foundation likes the idea so well that it found $500,000 to finance the work in spite of the budget beating it is taking on Capitol Hill.

According to Prof. Hanson, the 15-foot Illinois machine will use waveguides of either niobium or lead to accelerate electrons to 30 million electron volts. Prof. Fairbanks expects about a billion electron volts from his 500-foot model.

The Illinois set-up, however, will eventually make the 15 feet of accelerating length do multiple duty. Two bending magnets will be placed at either end of the accelerator. The beam coming out will be bent 180 degrees and sent back to the bending magnet at the other end. The second magnet will reverse the beam's direction again and send it back through the accelerator for a further increment of energy. Twenty times around this so-called microtron will yield electrons at 600 MeV. By comparison, the 100-foot conventional accelerator at the National Bureau of Standards has a top energy of about 100 MeV.

The steady electron stream will provide an especial bonus for nuclear structure experiments. When the electrons are bounced off nuclei—a favorite type of such experiment—experimenters expect to be able to measure the energy of both the recoiled nuclei and the bounced electrons and make precise calculations of the structure of the electron's target. With the bursts of electrons delivered by conventional accelerators physicists find themselves unable to separate the events.

Construction is expected to begin immediately. Preliminary operation of the accelerator is expected in a year, full operation by 1970. Then construction of the microtron, with its magnets and oval orbits, will begin. Its cost is estimated at $1,250,000, and it will take two years to build after the linear accelerator is finished. The Linac and the microtron will replace machines that have been in use for two or three decades.

Microtron specifications

Maximum energy	600MeV
Energy gain per traversal	30 MeV
Number of traversals	20
Orbit spacing	14.7 cm
Magnetic field	13.67 kilogauss
Duty factor (Percent of operating time in which particles are actually accelerated)	100
Current	100 microamperes
End magnets (for each of two)	
weight—iron	234 tons
copper	1.33 tons
power	5.4 kilowatts
Orbiting time	
First orbit	42.3 billionths of a second
Last orbit	71.5
Total	1138
Superconducting Linac	
Nominal Energy gain per traversal	30 MeV
Length of Accelerating Linac	15 ft
Current	10 microamperes
Beam power	6 kilowatts
Operating frequency	1.3 billion cycles per second
Required radiofrequency power	10 kilowatts
Input power for radiofrequency	30 kilowatts
Refrigerator	
Cooling capacity (at 1.8 degrees Kelvin)	100 watts
Input power	200 kilowatts