

of a levitron or spherator, with sheared magnetic field. Experiments on a small-scale supported ring began in February. With two rings one has a quadrupole geometry and the magnetic-field lines can be made either closed or sheared without making the plasma unstable against the interchange (flute) instability, Yoshikawa said.

The rings, together with their liquid-helium jackets, are levitated in equilibrium by a feedback-controlled magnetic field. The ion lifetime in this machine should be longer than previously obtained, since there will be no mechanical supports, which have adversely affected other toroidal-geometry devices (PHYSICS TODAY, December, page 49).

Magnetic elements called "divertors" sweep up plasma that leaves the region of confinement, thus preventing bombardment of the walls of the main chambers; the divertor surface is covered with a getter to absorb neutrals formed by ion recombination. In this way the neutral background, and hence the charge-exchange limitation on confinement time, is lower than it would be if the neutrals were

allowed to go back into the plasma.

When the Controlled Thermonuclear Research Standing Committee recommended last September that the Princeton multipole be built, it noted: "Considerable encouragement for improved containment in toroidal devices has been gained from experience with smaller scale experiments, thus opening the possibility that the limitations of anomalous diffusion losses can now be overcome. This machine is the next logical step in a systematic program to exploit these results. It has the further virtue of a simple and symmetric configuration well suited to critical tests of theoretical principles under conditions sufficiently flexible to provide several possible magnetic-field geometries."

Yoshikawa commented that, "With the present concept of floating multipole devices, they will probably never be economically used as controlled-fusion reactors. By using such devices we should be able to define the conditions necessary for plasma confinement. Ultimately we'll probably have to go back to externally supported toroidal devices, such as the stellarator."

Chalk River Plans for Intense, Continuous Neutron Source

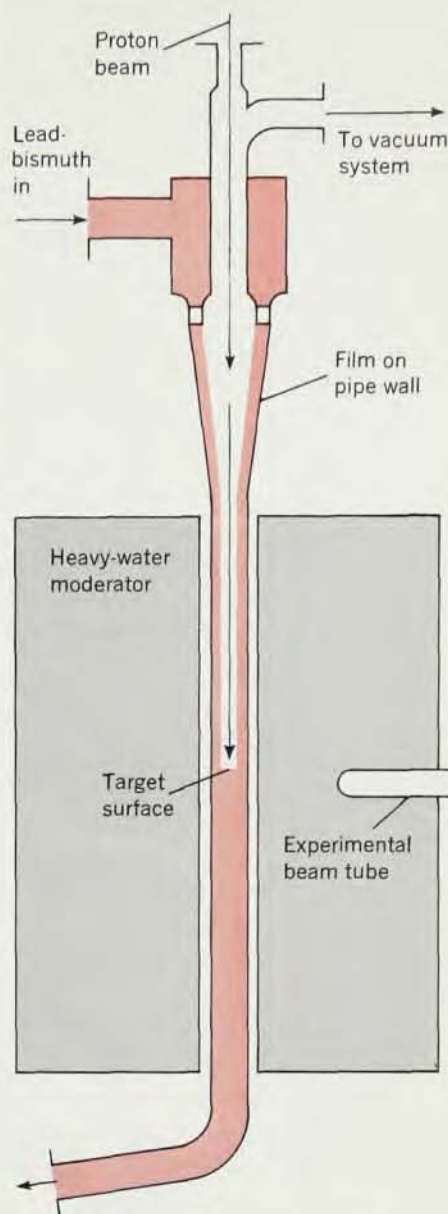
Chalk River Nuclear Laboratories of Atomic Energy of Canada, Ltd. hopes to build a device called the "Intense Neutron Generator" that will produce 10^{16} thermal neutrons/cm²/sec continuously. In the design a linear accelerator produces a 65-milliampere continuous beam of 1-GeV protons that strikes a target of liquid lead-bismuth eutectic; neutrons come off through spallation reactions.

Construction of the device, expected to cost about \$150 million, has not yet been authorized. Meanwhile design work continues. W. Bennett Lewis, senior vice president of AECL, talked to PHYSICS TODAY about the future of factory-type accelerators, which he defines as those that deliver currents from milliamperes to hundreds of thousands of amperes and find applications for their secondary and tertiary products. "In the long-term future," he said, "when such accelerators have been developed to high efficiency, their use to produce neutrons on a large scale could compete or share with nuclear fission. It is possible to devise nuclear fuel cycles that could by these

means deliver abundant nuclear energy independent of the existence or availability of U²³⁵, and these may some day compete with cycles employing only breeder or converter reactors."

Although present accelerator technology offers only poor efficiency and high capital cost, he noted that the stage has now been reached where if one wants thermal-neutron intensities of 10^{16} n/cm²/sec or more, "it promises to be economically competitive to produce neutrons by the spallation reactions of heavy nuclei (in particular lead and bismuth) excited to high energies by protons or other light ions of 500 to 1000 MeV."

Design. According to a Chalk River design study, the accelerator for the Intense Neutron Generator would be very similar to that for the Los Alamos Meson Factory (LAMPF), with a peak current only about twice that of LAMPF. However, the rf power is continuous instead of being restricted to pulses with a duty cycle of about 4%. Lewis noted that "because of the high continuous beam power, 65 MW, it is very important to achieve high effi-



TARGET ZONE for proposed Intense Neutron Generator. A continuous 1-GeV proton beam strikes surface of rapidly flowing lead-bismuth eutectic that serves as target and heat-transport medium. Device is expected to produce 10^{16} thermal neutrons/cm²/sec continuously.

ciency. Special attention is being given to the development of high-power magnetron amplifiers because of the high efficiency ideally obtainable from such crossed-field rf power sources."

Besides producing a 65-mA positive-ion beam the accelerator will have an auxiliary 0.5-mA negative-ion beam that can be separated by magnetic deflection and directed to targets that would either be destroyed by the full beam or take too much energy from it. These targets will produce meson intensities that will rival LAMPF.

The proton beam will pass directly from a high vacuum vertically down into the surface of rapidly downward



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flowing eutectic (see figure), which will serve both as target and heat-transport medium. The lead-bismuth flows down a thin-walled tube 20 cm in diameter made of a zirconium alloy to have a low absorption for thermal neutrons. Surrounding the tube is a large volume of heavy water to slow down the neutrons and build up a high flux at thermal velocities.

Once authorized the facility will take eight years to build and commission, Lewis noted, so it is early to say what experiments with the Intense Neutron Generator will be most inter-

esting. Lewis feels that probably the device will be most widely used for inelastic scattering from solids. Studies on magnetic interactions, phonons, etc, Lewis said, "are limited by the long time necessary for a sufficient exploration through all directions relative to crystal and magnetic axes over ranges of temperature where characteristic transitions occur. Even higher neutron intensities may be required to make any rapid advance concerning the structure of complex organic molecules such as proteins, but the interaction of neutrons with deuterium atoms in such materials seems likely in time to become very revealing."

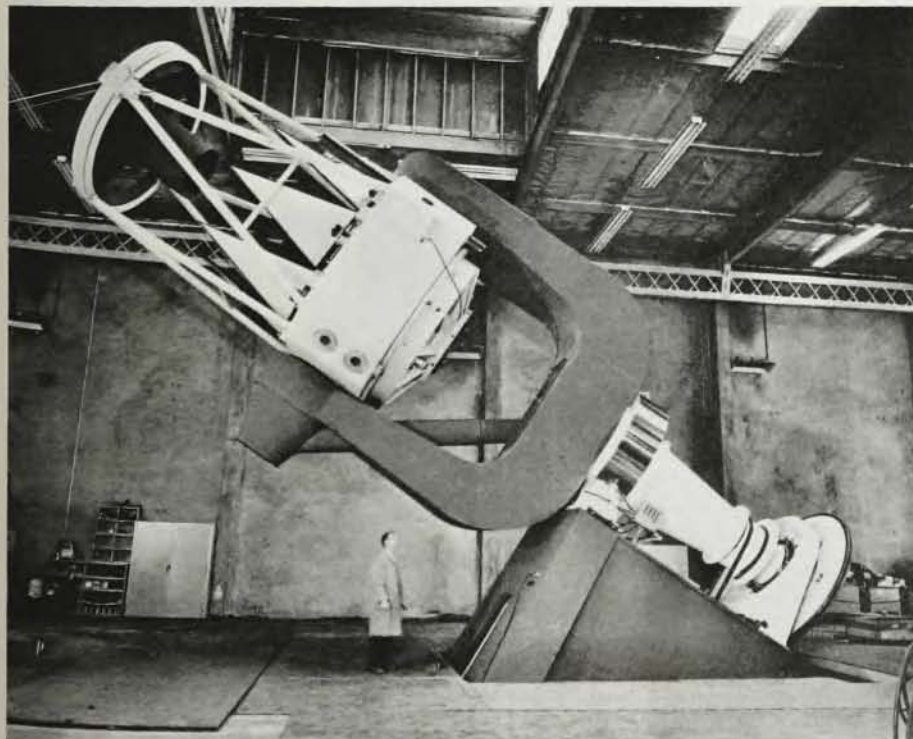
Electric Fields May Bedevil Falling-Electron Experiment

In an evacuated field-free space pennies, feathers and electrons should all fall with the same acceleration according to all the standard theories of gravitation. At the Washington meeting of the American Physical Society Fred C. Witteborn reported on an experiment he and William M. Fairbank have been doing at Stanford.¹ It seems to confirm this expectation for individual electrons although not everyone is convinced of its results.

While theorists are mulling over

what some of them think are inconsistencies in the experiment, the experimenters are turning to the same measurements on freely falling positrons. John Madey (also at Stanford) is working on a source that will produce slow ones, and he and his colleagues hope to find out whether antimatter falls up or down.

To do the experiment, one causes emission of a burst of electrons from a cold cathode along the axis of a long vertical copper cylinder. As the



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