system to maintain low hydrogen temperature. These days it is cheaper to use liquid hydrogen directly from commercially supplied tanks.

A second chamber will be available later when the old 72-inch chamber from Lawrence Radiation Laboratory is modified; its effective length will be 2.08 meters. The chamber, piston operated with an omega bellows, will pulse twice a second, twelve times faster than the 72-inch. Testing should be finished by the end of the year; soon after the remodeled chamber should be ready for events.

1-GeV Protons Probe Motion of Nucleons in Nuclear Matter

The exceptional stability and high energy of the Cosmotron beam and recent improvements in wire spark-chamber techniques have been used to probe the distribution of matter in light nuclei. In a race to beat the final shutdown of the Cosmotron an 11-man team (Harry Palevsky, Joseph Friedes, Richard Sutter and Gerald Bennett of Brookhaven, George J. Igo of Los Alamos, Dwayne Simpson and Gerald Phillips of Rice University, Daniel Corley and Nathan S. Wall of the University of Maryland, Robert Stearns of Vassar College and Bernard Gottschalk of Northeastern University) used 1-GeV protons to probe the nucleus in much the same way as x rays probe condensed matter. Their first results were reported in *Phys. Rev. Letters* **18**, 1200 and **19**, 387.

Energy resolution was so good (roughly 3 MeV) that one could separate elastic from inelastic scattering for several light nuclei. Angular resolution was ±0.1 deg.

The beam itself was amazingly stable; over 24-hour periods its long-term stability was about 1.5 MeV. No one associated with the accelerator had realized how good it was. Before the Cosmotron closed permanently on 31 December the collaboration did experiments with hydrogen, deuterium, helium, lithium-6, carbon, oxygen and lead.

Although electrons have been used to probe the correlations of individual nucleons inside the nucleus, the Cosmotron collaboration is the first to do the same with protons. The proton scattering results suggest that nucleon-

nucleon correlations appear in the elastic scattering; this is unlike electron scattering, in which the correlations are expected in the inelastic scattering and are masked by bremsstrahlung.

Other groups are also interested in using high-energy protons to do nuclear physics. A CERN group (G. Bellettini, Guiseppe Cocconi, A.N. Diddens, E. Lillethun, J. Pahl, J.P. Scanlon, J. Walters, A.M. Wetherell and P. Zanella, *Phys. Letters* **14**, 164, 1965) used 20-GeV protons, but the energy resolution was not small enough to resolve excited states of the nuclei under investigation. In the Cosmotron collaboration separation was possible; so one could distinguish between elastic and inelastic contributions to the cross section.

Results. The 1-GeV proton elastic scattering from alpha particles gave surprising results. Proton scattering data at small angles are consistent with that previously found (by Robert Hofstadter and his collaborators) with electron scattering. But at 24 deg (center of mass) the proton data show a diffraction-like minimum that does not appear in the electron data.

A theoretical explanation was offered by Robert Bassel and Colin Wilkin (*Phys. Rev. Letters* **18**, 871) and independently by Wieslaw Czyz and L. Lesniak (*Phys. Letters* **24B**, 227). They argue that unlike elastic electron scattering, in which the electron in interacting with the nucleus is scattered once at most, the proton-proton interaction is so strong that multiple scatterings will occur before the nucleon leaves the nucleus; that is, the impulse (or Born) approximation breaks down. In addition to the Born term one sees double and triple scatterings that are sensitive to nucleon-nucleon correlations. The correlation effect is important, however, only at high momentum transfers.

The Cosmotron experiments could resolve the first excited state from the ground state for C^{12} and O^{16}. The group found both elastic and inelastic scattering in collisions that led to the low-lying levels of these nuclei.

Bassel and Wilkin find they can describe elastic scattering in O^{16} without any correlations. They explain that for heavier nuclei, nucleon-nucleon correlations become less important; the effect varies inversely as atomic mass. Correlations implied by the Pauli principle, however, are an important correction.

In proton-deuteron scattering the Cosmotron group finds some evidence that the ratio of real to imaginary part of the nucleon-nucleon scattering amplitude depends on the momentum transfer.

Future prospects. The Cosmotron collaboration will soon publish its results on knockout of deuterons from nuclei. They still have p,2p reaction data to analyze; Palevsky expects they will finish by the end of the year.

At the Saclay Saturne, which in principle should have energy resolution as good as the Cosmotron, similar experiments are being considered. The Cosmotron collaboration has some hope of using the Princeton-Pennsylvania accelerator, which will have a flat-topped external beam in a year or so. They might also use the Brookhaven Alternating-Gradient Synchrotron with pions instead of protons. Since pion-nucleon scattering is better known than proton-nucleon scattering, it is easier to interpret pion-nucleon data. At CERN there are proposals to do pion-helium and pion-deuterium scattering.

And about five years from now the newly authorized Los Alamos meson factory is expected to produce a beam with energy resolution comparable to the Cosmotron and with much greater intensity. —GBL

Buzzing in on the Earth and Its Environment

Only a tenth the size of a bee's eye, as seen in the accompanying photo, the tiny dark lens in the center of the white disk is believed to be the world's smallest germanium-immersed infrared detector. Developed by the Barnes Engineering Co., Stamford, Conn., these detectors are now being used in spacecraft instruments for analyzing radiation from the earth's horizon. When five of these units are mounted in a tightly spaced row one can examine the horizon in detail. Behind the 1-mm diameter lens a tiny