design together a very large (100-m^3) hydrogen-deuterium chamber.

Because NAL's actual mailing address is Batavia and the name Weston is now associated with civil-rights problems, the lab decided to emphasize its Batavia location.

Mid-1972 is the target date for finishing the accelerator, and the end of 1973 for the entire laboratory.

Lamb-Effect Sources Make Better Polarized Ion Beams

Spin dependence of nuclear forces is probably becoming more accessible to experiment as makers of polarized ion beams improve their sources. Two methods appear to be battling for the honor of producing the most intense and best polarized beams. The "conventional" one throws out ground-state atoms you don't want with inhomogeneous magnetic fields and keeps the ones you do want.

The other method starts by making metastable 2S atoms; then it quenches the unwanted ones by causing them to mix with the short-lived 2P state and drop through it into the ground state. With their own version of the quench method, which they call a "spin filter," Joseph L. McKibben and his colleagues at Los Alamos have been able to make 300 nanoamperes of 90%-polarized H^- ions and 600 nA of 78%-polarized D^-.[1]

At Lake Forest College, Bailey Donnally has developed the quench method, basing his work on observations of Willis E. Lamb Jr, R. Curtis Retherford and E. K. Zavoiskii.[2] Hydrogen (or deuterium or tritium) atoms with their electrons in the metastable $2^2S_{1/2}$ state differ in energy from the short-lived $2^2P_{1/2}$ atoms by the Lamb shift. In a 575-gauss field 2S atoms with electron spin opposite to the field ($M_J = -1/2$) have the same energy as 2P atoms with $M_J = +1/2$. A small electric field mixes the states, and the $M_J = -1/2$ atoms fall into the ground state leaving undisturbed those 2S atoms with $M_J = +1/2$.

Thus the beam becomes electronically polarized, and when it passes adiabatically into a weak magnetic field, electrons couple with nuclei producing 50% nuclear polarization. Then you can add or subtract an electron to make ions that you can send through an accelerator.

GROUNDBREAKING task is shared by Robert R. Wilson, (left) director of the National Accelerator Laboratory, and AEC chairman Glenn Seaborg at the Batavia, Ill. site. First permanent building will house the 200-MeV linac injector. The 200-GeV proton synchrotron is scheduled for completion in 1972.

Leon Madansky and George E. Owen[3] had shown earlier that the method was possible, but the experimenters had had difficulty making enough metastable atoms and ionizing them selectively. Too many ground-state atoms became ionized in collisions and contaminated the beam. But Donnally and coworkers solved both problems. They made metastables by allowing protons to pick up electrons in the 2S state from cesium atoms. The charge transfer is nearly resonant, and they managed 5% efficiency.[4] Then they found that with 500-keV kinetic energy a metastable atom would pick up an additional electron from argon atoms 300 times as readily as would a ground-state atom.[5]

The resulting negative ion is appropriate for a tandem Van de Graaff, and Willi Haeberli and colleagues have in-

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stalled this kind of source in their accelerator at Wisconsin.[6]

To make their spin filter the McKibben group adds an rf field at a frequency corresponding to the energy difference between 2S atoms with $M_J = +1/2$ and $-1/2$. An equilibrium mixture of these states in which all atoms have a particular nuclear-spin state remains in the emerging beam. Other metastables fall into the ground state. By varying the longitudinal magnetic field, they can unambiguously select the nuclear spin that remains in the beam.

In the race for the best beam, proponents of the Lamb-shift devices show some confidence that they will outdo the conventional scheme. On the other hand, their optimism is tempered by realization that the conventional system is improving too. Whichever wins, experimenters will have their probe for observing spin dependence.

Meanwhile Donnally is at work on an entertaining by-product. A polarized-electron source may be available by letting collisions detach electrons from the polarized metastables.[7]

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A Visit to the Semiconductor Institute in Leningrad

One of the leading Soviet centers for solid-state physics is the Semiconductor Institute in Leningrad, which has 170 scientists and 800 employees. When we visited the Institute shortly after attending the ninth International Conference on the Physics of Semiconductors, we talked with institute director A. R. Regel, one of the conference vice-chairmen. He told us of research and development activities and explained how the scientific soviet helps run the institute.

A. R. REGEL is director of the Semiconductor Institute in Leningrad.

Research. V. N. Bogomolov, D. N. Mirlin and I. I. Reshina reported at the conference that they had observed polaron absorption in rutile crystals. Although many-body theory predicts the existence of polarons, experiment had not conclusively identified them.

The Leningrad experimenters shine an infrared beam on the sample and observe the optical absorption as a function of frequency. Even though they varied number and types of donors by changing the doping (using lithium, phosphorus, chromium or niobium), the absorption spectra kept the same broad shape with a maximum at about 0.8 eV; so the group concludes that the spectra are due to the interaction of light with the current carriers.

According to polaron theory, if you apply light of the appropriate frequency, electrons are no longer free, but must interact with a lattice phonon at the lattice vibration frequency; hence absorption increases. One can think of a polaron as an electron with virtual phonons surrounding it. Bogomolov and his collaborators find their experiment agrees well with the theory of small-radius polarons (rather than that for large-radius polarons).

At the conference G. E. Pikus and A. G. Aronov discussed a theory of interband anisotropic electrooptical effects and of the Faraday effect in crossed electric and magnetic fields,