main-ring components were time-consuming major endeavors because over 1000 magnets were involved.

Problems. After the coils were installed in the main-ring magnets, they were tested at 2500 volts, considerably beyond the 1000-V potential required for 200-GeV operation. But the tests did not require submerging the magnets in water before voltage measurements were made. When summer brought high humidity to the magnets in the cold tunnel, they became saturated with moisture and any small cracks in the epoxy-impregnated fiberglass provided a conduction path to ground that could cause a serious spark discharge. To cure this ailment the Batavia workers started a program of heating and drying the tunnel, retesting the magnets in the tunnel at 500 and later 1000 volts, baking in a vacuum vessel those magnets that showed low resistance to ground, and eventually vacuum impregnating with epoxy all magnets that showed a low resistance to ground.

Another difficulty appeared in the power supplies when the magnets were operated at high field values, a difficulty apparently caused by occasional large voltage pulses that destroyed some of the components.

A further problem is that the main-ring beam decayed rapidly in only a few thousandths of a second, whereas normal operation would require the beam to last for about one second under coasting conditions. This beam loss suggested that there were obstructions in the vacuum chamber, possibly thin stainless-steel shavings left over from cutting operations. These shavings would stand up when the magnetic field was on and lie flat (and thus be difficult to see) when the field was off. Eventually the NAL workers built devices to sweep the vacuum chamber clean.

Agenda. Now that NAL has demonstrated operation at 200 GeV, the next thing on the agenda is to operate the machine with a normal acceleration cycle. As of the beginning of April the cooling system was installed and temporary modifications of the power supplies are being undone.

After that, according to Edwin L. Goldwasser, NAL deputy director, the highest priority is to extract the beam and then to steer it into the neutrino area, where it will go to the old Argonne 30-inch hydrogen bubble chamber. Extraction is expected to be somewhat easier than at other accelerators because of the long straight sections around the ring. Goldwasser believes that by summer most of the present NAL difficulties will be solved.

The intensity will be increased in part by injecting twelve pulses from the booster instead of one. Also, four linac pulses will be injected for each booster acceleration cycle. In addition to this 48-fold increase, it is hoped to diminish the losses now occurring in the early part of the main-ring cycle. An NAL spokesman said they believe this can be done by improving the so-called "20th harmonic tune" of the accelerator, by turning on sextupoles and by tuning the trim steering magnets at low momentum. He said there is no reason to believe that they will be unable to achieve the design intensity.

What about NAL's hopes of achieving 500 GeV? Goldwasser told us he does not anticipate any major difficulty getting to 400 GeV, but he will not venture a prediction as to when that will occur. He does believe that operating the accelerator at 500 GeV will be harder because it is difficult to extract a beam at that energy. —GBL

Alfvén on cosmic rays, sunspots, antimatter

Plasma-physics theories often have had little connection with reality, according to Hannes Alfvén. When we recently chatted with him in his office at the University of California in La Jolla (shortly before he left for his annual six-month stay at the Royal Institute of Technology in Stockholm) Alfvén pointed out that two major confrontations between theory and experiment have occurred. One took place when controlled thermonuclear experiments began. "The result was catastrophic," he said. The second confrontation came when space missions made the magnetosphere and interplanetary space accessible to physical instruments, and some cherished theories became ripe for revision. In the future, Alfvén believes, at least three "sacrosanct" astrophysics theories may be drastically revised.

It is generally believed that the intensity of the common cosmic rays (energy of 10^{10}–10^{11} eV) is essentially the same over the entire galaxy as it is measured near the earth, he noted. Alfvén suggests that there may very well be a magnetic field, for example in the heliosphere, that forms a screen between the solar system and the galaxy. Just as the van Allen radiation in the earth's magnetic field differs by orders of magnitude from the radiation outside, the cosmic-ray intensity between the planets may be orders of magnitude larger than the interstellar intensity. To test the opposing views, we will probably have to wait until spacecraft pass the outer shock front of the solar wind, when we could learn about the structure of magnetic fields in the surroundings of the solar system.

The sacrosanct belief about solar magnetic fields is that the sun's general magnetic field varies in strength and sign from day to day, and that sunspots are produced by mechanisms close to the surface of the sun. Alfvén points out that the readings of "solar magnetographs" do not give the actual magnetic field, but rather a complicated function of magnetic field, turbulence, temperature, and so on. Thus rapid changes in the "magnetograph" readings may be due to factors other than changes in magnetism. The sun may have a dipole field. Sunspots may be caused by disturbances occurring in the core, which travel upwards as hydromagnetic waves. Alfvén feels that new methods of measurement and theoretical analysis of magnetic fields in the solar atmosphere are necessary.

The popular view is that all celestial objects are made of koinomatter (ordinary matter). Alfvén's heretical belief is that some of these objects are made of antimatter (PHYSICS TODAY, February 1971, page 28). To find out whether a certain star is made of koinomatter or antimatter, we would probably have to send a spacecraft there.

Another somewhat heretical suggestion, made by Alfvén and Gustaf Arrhenius (Scripps Institution of Oceanography), is that we send a space mission to an asteroid. Alfvén eloquently argued to us the importance of such a mission, saying that there is no inherent reason why a 2-km-diameter body like Toro (PHYSICS TODAY, December 1971, page 17) should be any less interesting than a 7000-km-diameter body such as Mars. He notes that the stated goal of NASA is to clarify the origin and evolution of the solar system. Such a goal could just as well be served by studying asteroids.

It is a very natural but very regrettable fact in science that before a field is considered important, you have to know enough about it, Alfvén said. Those fields about which we know nothing are considered to be unimportant, and the reason lies in simple psychology, he explained. "If there are a hundred people working in a field, they will automatically constitute a very powerful pressure group. If a single man works on a problem it doesn't matter how important the problem is, he can exert very little pressure. Mars proponents can call a conference and discuss all the maps of Mars, and discuss how many craters there are—there are hundreds of things to discuss, and the more they discuss, the more there is." But an asteroid like Eros, for example, has never been seen. "No one has made a map of it yet. How could you discuss it? But Eros may be much more important." GBL