bounce back along the magnetic field lines.

After 3,000 nanoseconds, before the antiprotons can get back to the other end, the entrance-end cap is dropped to −3,000 volts, and the antiprotons are caught in the trap, bouncing back and forth. After some trapping period, which has ranged from 1 millisecond to 10 minutes, the exit-end cap is grounded, and the trapped antiprotons exit to an instrument that counts them. The whole thing is done at a temperature of 11°K for the ultrahigh vacuum the low temperature helps provide.

Antimatter is supposed to be the exact mirror image of matter, except that for properties that have polarity, the polarity is reversed. Thus an antiproton should be just like a proton except for having negative electric charge. Particularly the mass of one should exactly equal that of the other, or, to put it another way, the ratio of the mass of the proton to that of the antiproton should be 1.0000 . . . to an infinity of zeroes.

The experiment Gabrielse and his coworkers are now preparing is intended to measure that ratio by alternately trapping protons and antiprotons in the same trap with the same fields and the same ambient conditions. The size of the helix that a particle makes in the magnetic field depends on its mass, so a comparison of the paths of protons and antiprotons should get the mass ratio directly.

In the past, measurements of the mass ratio have been done by introducing antiprotons into atoms in place of electrons and measuring how the substitution changes the energy-level structure of the atoms. Gabrielse expects that the new method will increase the accuracy of the measurement by a factor of 100 or so. Up to now, nobody has found anything that could be called a deviation of the mass ratio from unity, but who knows what further refinement might turn up?

Other experiments that might now be possible with trapped antiprotons, and that have been suggested from time to time by a number of physicists, include the making of antihydrogen by mixing positrons with trapped antiprotons. Is the structure of antihydrogen the precise mirror image of that of hydrogen?

Another possibility is the making of protonium, a system in which a proton and an antiproton are bound together and orbit each other. The force that holds them is mainly electric, but the strong interaction, the force that holds atomic nuclei together, should contribute a part of it. The strong interaction exerts a powerful attraction between protons and protons, between protons and neutrons, and between neutrons and neutrons. Is it equally strong between proton and antiproton, and is it still attractive?

—D. E. Thomsen

Ecological energy: Bigger is better

A large bird like the wild turkey takes in more food than, say, a sparrow. Moreover, despite their typically smaller numbers, large birds as a group may use a disproportionately large share of the resources available within an ecological community, two ecologists now report. Although small birds tend to be much more numerous, this doesn't compensate for their lower food needs per individual.

The finding that larger animals seem to dominate an ecosystem may help answer some evolutionary questions and appears to contradict earlier studies concluding that species of small body size use at least as large a proportion of the resources within ecosystems as their larger relatives. "Our evidence suggests that this is not the case," says James H. Brown of the University of Arizona in Tucson. "On the average, the energy flow through the larger species outweighs that through the smaller species." He and Brian A. Maurer of Brigham Young University in Provo, Utah, report on their work in the Nov. 20 NATURE.

Brown and Maurer analyzed data covering the population density and individual body mass of related species within an ecosystem. They looked at birds in a variety of habitats across North America, rodents in a desert environment, marine fish in tidal pools and perennial plants in five different desert habitats. In all of these groups, the researchers say, species made up of large individuals account for most of the energy flow and resource use within local ecosystems.

What isn't clear is whether the results apply over the whole range of animals or plants within large areas. "I'm quite willing," says John Damuth of the Smithsonian Institution in Washington, D.C., "to accept the idea that within [groups of related species] in local communities, there might very well be an advantage to large size." Nevertheless, he says, according to his analyses, that advantage may disappear on larger scales across broader groups of animals.

Brown and Maurer say their results may help explain evolutionary patterns in which small organisms eventually give rise to gigantic forms that often become extinct. "There are certain roles in communities that can be filled efficiently only by these large species," says Brown, but population densities and sizes also go down. The evolutionary process pits the advantages of being an individual of large size (greater likelihood of survival, more mobility, etc.) against the greater probability of species-wide extinction because of smaller populations and slower growth.

—I. Peterson

Lasers advancing on heart problems

Lasers are making a rapid advance on heart disease. They have already reamed out clogged heart arteries during coronary bypass operations (SN: 11/23/85, p.327), and at the recent American Heart Association meeting in Dallas, researchers detailed initial human trials of lasers to treat erratically beating hearts as well as a simpler approach to atherosclerotic arteries.

While showing promise on two of the major problems of cardiology, lasers have their limitations. Using them to bust the clots involved in heart attacks, for instance, "would be like trying to burn Jell-O," one researcher says.

Several groups have used lasers to treat ventricular tachycardia, a condition in which part of the heart does not properly conduct the electrical signals that trigger beating. The heart contracts erratically, and death can result.

The condition is conventionally treated by drugs; for people who don't respond, operations to freeze or surgically remove the problem area are sometimes done. The laser treatment, say its developers, can benefit people whose arrhythmic areas are difficult to reach with scalpels or freezing devices, and once it is developed it may prove simpler and safer than either cutting or freezing.

Laser destruction of arrhythmias was first done a couple of years ago in France. At the Dallas meeting, Robert H. Svenson and his colleagues at the Sanger Clinic in Charlotte, N.C., described their use of the procedure in 21 patients, and Sanjeev Saksena of Newark (N.J.) Beth Israel Medical Center described its use in 12 patients. In both trials the patients had not responded to drug therapy.

In the Beth Israel procedure, worked out after years of animal trials, surgeons put patients on a bypass machine. With the hearts still beating but not pumping blood, the surgeons cut into the hearts with scalpels or lasers. They checked the heart's conduction patterns by applying electrical current and vaporized problem spots on the inner wall with lasers.

Eleven of the 12 people treated had no more tachycardia; the twelfth responded to drug therapy, says Saksena. About half of them would have been dead within a year, he estimates.

The Charlotte group used a laser tuned to kill but not vaporize the erratically firing cells. One patient died during the procedure and one shortly after; of the remaining 15, all but one appeared to be free of tachycardia, Svenson reported at the meeting.

Lasers have also been used on a more common problem, clogging of the arteries that feed the heart muscle itself. While lasers have been used point-blank during bypass surgery, the work presented at the meeting concerned laser energy delivered via fiber optics threaded through the patient's leg and up to the narrowed heart vessel.

The treatments began just a few months ago at Boston University and Northern Hospital in Sheffield, England, following use on clogged leg arteries in people. Timothy Sanborn, who heads the Boston project, says surgeons there have used a 1.7-millimeter-diameter metal tip heated to 400°C by laser light to treat seven people with coronary arteries that were 90 to 95 percent narrowed.

The device decreased the narrowing in four of the seven – from 95 percent blocked to 20 to 30 percent. A balloon inflated in the artery pushed back the arterial walls a little more. Perforations and blood clots, which have occurred in animal trials and with human leg arteries, were not a problem, says Sanborn. "Laser thermal angioplasty in the coronary system is in its early stages," he says. "The initial results are very encouraging."

The laser, he says, may someday be used to clear out the blockage completely without the balloon follow-up; the process could prove more resistant to the reblocking that often occurs after balloon use. The advantage of lasers over balloons, says Sanborn, "is that you leave behind a very smooth arterial surface. [Plaque] is removed rather than stressed or fractured."

"The preliminary experience has indicated [lasers] can be used successfully in the human [heart]," says laser researcher Jeffrey M. Isner of Tufts University-New England Medical Center in Boston. "As recently as a year and a half ago, some people believed it couldn't be done."

When will lasers move from an experimental process to conventional therapy? "For the past six years we've been saying in two years," says George S. Abela of the University of Florida in Gainesville, who is credited with much of the research that laid the groundwork for human trials. "So I'll say in two years." *– J. Silberner*

Voyager: Setting safe sights for Neptune

Late in August of 1989, the Voyager 2 spacecraft will hurtle past the planet Neptune, the probe's last scheduled encounter in what by then will have been a 12-year, four-planet grand tour of the solar system. Last week, members of the project's Science Steering Group met at Jet Propulsion Laboratory (JPL) in Pasadena, Calif., to discuss the specific route through the Neptunian system. The crux of the matter is a firing of Voyager 2's rocket engine, at present planned for next March 13, to fine-tune the encounter trajectory and determine how close the craft will pass to its never-before-visited objectives.

But how close is too close? The spacecraft is due to go nearer to Neptune than it did to any of its past goals of Jupiter, Saturn or Uranus. The general plan calls for Voyager to approach from the south, pass up through the planet's equatorial plane and swoop close over the north pole before angling back down toward Neptune's big moon Triton, believed from earth-based observations to have a significant atmosphere as well as possible "lakes" of liquid nitrogen. To many of the Voyager scientists, says Charles Kohlhase of JPL, the "polar crown" part of the flight is the mission's "holy grail." But in getting safely through it all, he says, there are three principal concerns:

- *The atmosphere:* The warmer its outermost reaches, or thermosphere, the farther it will extend from the planet's surface. Though extremely thin in its distant fringes, it could conceivably affect the fast-moving probe's orientation or radio transmissions. Fortunately, measurements from the earth-orbiting International Ultraviolet Explorer satellite suggest a relatively low temperature (about 227°C, compared with 477°C actually measured at Uranus). The Voyager team anticipates no difficulty.
- *The rings:* Detected only by their brief blockages, or occultations, of starlight seen from earth, the rings seem to be not continuous bands but only a few segments, possibly because the ring particles in many places are not closely packed enough to block the starlight. The concern, however, is not the "ring arcs" themselves, which are only about 8 to 20 kilometers wide and easy to miss. The issue, says Kohlhase, is the possibility of much finer material, virtually undetectable from earth but perhaps diffusing inward from the visible arcs in concentrations sufficient to damage Voyager 2.

The task of avoiding such material is presumably linked to the distance from Neptune at which the craft penetrates the equatorial plane, in which the rings are thought to lie. This distance also determines the closest approaches to Neptune and Triton, which in turn are linked to other factors. A likely version of the encounter would pierce the plane about 45,800 kilometers from Neptune's surface (just outside the outermost ring arc and allowing 4,000 km for the uncertainty of the arc's position), carrying Voyager about 4,300 km from the north pole and about 38,000 km from Triton. It also positions the craft to study Triton's atmosphere by looking at sunlight through it, and by sending radio signals through it to earth. There has been one report, disputed by some, that the ring arcs may lie in the plane of Neptune's rotation axis. If so, says Kohlhase, missing the arcs would be easy, though there might then be a choice between flying through the diffuse material or displacing the polar crossing and flying much farther from Triton.

- *Trapped radiation:* This is "our major concern," says Kohlhase, in part because it is the least-known item on the list. No signs have been detected yet of auroras or other clues to a magnetic field that could help scientists estimate the possible radiation hazard facing the spacecraft (signs of the Uranian field were not detected until the craft was five days out), which could cause false instrument readings or even damage some parts. Theoretical predictions range from benign to a peak radiation level higher than that at Jupiter, where a few components did fail. Specialists in the field will gather for a one-day meeting in January in hopes of narrowing the uncertainty. *– J. Eberhart*

Leech swimming: The neural story

Contrary to modern popular understanding, leeches give as well as take. They can suck up a blood meal nine times their weight, but they offer a variety of research services as well. Using leeches in the lab, scientists at the University of Virginia in Charlottesville have discovered a cellular link in a neural chain that enables them to explain the animal's rhythmic swimming movements in terms of neural mechanisms. Because such movements have features that are common to all rhythmic motor behaviors, including chewing, walking and breathing, the scientists say their findings extend far beyond the leech.

Whereas the human nervous system is woven from billions of cells, the nervous system of the leech species *Hirudo medicinalis* has about 13,000 cells, all of which scientists suspect are hard-wired to the point where any neuron can be labeled and identified from leech to leech. The leech has two ganglia, or discrete collections of nerve cells, in the head region and one in the tail region. In addition, there are 21 nearly identical segmental ganglia along the animal's axis. It is the exceptional regularity in its neural architecture that makes the leech especially suitable for detailed neuroethological studies, says W. Otto Friesen, who reports on the work in the Nov. 21 SCIENCE with Peter D. Brodfuehrer, now at Cornell University. Neuroethology is the study of animal behavior in terms of the underlying neural mechanisms.

By removing nearly the entire nervous system of the leech, the scientists were able to eavesdrop on individual neurons in different parts of the nervous system. Using two microelectrodes, they stimulated either of two brain neurons called Tr1 cells and observed electrical activity downstream in the segmental ganglia, in neurons already known to be involved in swimming. To determine that Tr1 cells