

dence of fighting viruses, such evidence is now being bolstered with new results. During the past five years, for instance, Thomas C. Merigan of Stanford University College of Medicine and his co-workers have treated 32 chronic hepatitis patients with interferon plus an antiviral drug because they had not been able to totally eradicate the condition with either one of them alone. They then followed the patients for a mean of 10 months and found that some patients showed a fall in the hepatitis virus antigen and felt better. One patient was cured. Others, however, were not helped.

New insights into interferon per se are also emerging. For instance, there is growing evidence for not only two major kinds of interferon—leukocyte and fibroblast—but for a third one, gamma. And now subforms of leukocyte and fibroblast interferons are also taking a bow. Weissmann

reports there are at least 10 different species of leukocyte interferon. Pravin-kumar Sehgal of Rockefeller University in New York City and colleagues have found two different types of fibroblast interferon, and one appears to be a more potent antiviral agent than the other.

More is also being learned about how interferon works as an antiviral or anti-cancer agent. For instance, B.Y. Rubin and S.L. Gupta of the Sloan-Kettering Cancer Center in New York City tested leukocyte, fibroblast and gamma interferons on various viruses. They report that the three major forms of interferon tended to inhibit the growth of specific viruses, indicating that the viruses differ in their sensitivity to different interferons, or that the interferons' antiviral actions may be different.

Many questions remain, but interferon research has come a long way in a short time. □

to Grieger and the series of stellarator experiments done at Garching in recent years under the name Wendelstein. (The name means "stone of transmutation" or philosophers' stone.) It turns out that the neutral beams will also heat the stellarators and the stellarators seem much more promising with better heating and their lack of the problems with magnetic field shapes that ohmic heating bequeathes to tokamaks. The audience seemed impressed by what they heard.

Another old idea that never worked very well is the magnetic mirror. The basic idea is to make a cylindrical magnetic field and to try to close it down at the ends so that the ends reflect the particles back toward the middle. In practice it proved impossible to close the ends very efficiently. Now the tandem mirror at Lawrence Livermore National Laboratory, the TMX as it is called, is showing how to do it. The ends are closed by other mirrors so that there are three in line. The end mirrors are what is called "baseball mirrors." They depend on the peculiarly twisted magnetic fields produced by coils shaped like the seams of a baseball. This field holds a dense plasma, which, being electrically charged, sets up an electrostatic field that helps confine the plasma in the central mirror. A year ago the Livermore group announced that they had evidence that plasma was being confined in the central portion of the TMX as though the end plugs were working. As one of them, Paul Drake, related to the meeting, they have examined and tested their evidence and are now convinced that the TMX does in fact have electrostatic plugging and not some other kind that might have happened unintentionally and that the plugging is as theory predicts.

Another way of confining plasma is the nonmagnetic or inertial means. A fuel pellet is crushed by being hit from all sides by beams of laser-like or energetic particles. Fusions take place during the implosion, releasing a small puff of energy.

Implosion fusion experiments began with laser light. Lasers are easily available and light is easy to transport from laser to target. But light does not deliver energy to the target very efficiently. Energetic particles—electrons, protons—would deliver energy better. Heavy ions—say ionized uranium—would be optimum. But there are difficulties in the production of such ions and in accelerating them to the energies necessary to induce a fusion implosion. Because of these and other problems, physicists weren't sure the task was practical, but now they think they can do it. The history of the subject has progressed from light to electrons to light ions and now to enthusiasm with heavy ions. A statement characterizing the progress went something like this: "We didn't think it would work but we tried it and it worked." It seems that plasma physicists are able to say that more than they used to. □

Plasma physicists have a lot to say

"Is plasma physics about fusion?" As he opened a morning of papers on astrophysical plasmas at the meeting in San Diego last week of the American Physical Society Division of Plasma Physics, Charles Kennel related that he had recently been asked that question. His reply—"Not entirely"—was appropriate for the morning's topic. Astrophysics contains many instances where plasmas—ionized gases—in which nuclear fusions neither happen nor are intended to happen, play an important role. They can even make a galaxy ripple like a flag in the wind. This is the analogy used by G. Bertin of Massachusetts Institute of Technology, L. Blitz and G. Lake of the University of California at Berkeley, J. W.-K. Mark of Lawrence Livermore National Laboratory and R. Sinha of the National Radio Astronomy Observatory at Socorro, N.M., in presenting a theory to explain how unstable warps in the flat plane of a galaxy can form as a result of differences in rotation rate between the slow moving central part (bulge and halo) and the slower outer part.

Nevertheless, the paper presented by Eugene N. Parker of the University of Chicago, whom Kennel was introducing, dwelt mainly on the physics of the sun, in which nuclear fusion is of central importance. This conjunction underlines also the Promethean quality of the science: If it succeeds, it will be to bring the energy source of the stars to earth to put it at the disposal of humanity. Plasma physics aims at a pure scientific understanding of the behavior of ionized gases, but even in developing that it will serve the practical task, which characterizes it in the eyes of the public and the world's legislators and which is the ground of enthusiasm for many of its practitioners.

The practical task of developing controlled thermonuclear fusion has an even higher profile in the appearance of the

science of plasma physics, because plasma physics has been a more empirical science than many. Theory has never had a good time in plasma physics. This is in contrast to the situation in, say, particle physics. In particle physics the theorists dominate, and they have already precisely predicted the outcomes of generations of experiments yet to be mounted. In plasma physics an experiment can still yield real surprises for all concerned.

These considerations mean that nobody is certain what will work. So a large variety of approaches are tried. Designs and concepts are mixed. Old approaches that have been dropped are picked up again, often with new twists determined by changed circumstances.

"Why build stellarators," asked P. Grieger of the Institute for Plasma Physics in Garching, West Germany. The idea of the stellarator is now 30 or 40 years old. It was the first approach to the confinement of a plasma in a magnetic field shaped like a torus or doughnut. (A plasma is electrically charged, and so it will fly apart if not contained by a counter force.) A plasma must also be heated to induce fusions. In this department stellarators were found wanting—at least relatively—and enthusiasm went to the later invented tokamak.

The tokamak has what is called ohmic heating: An electric current is induced to flow through the plasma itself, and the plasma heats up through its own electrical resistance. Ohmic heating works, but not as well as the inventors of the tokamak believed it would. Auxiliary heating methods have had to be devised for tokamaks. One of these is the injection of beams of neutral gas into the plasma. The neutral gas adds to the density of the plasma (also a desirable thing) and by the friction of collision heats it.

Neutral beam injection brings us back