The Weekly Newsmagazine of Science

SCIENCE NEWS

April 16, 1994
Vol. 145, No. 16
Pages 241-256

Riding a plasma wave toward high energies

With the cancellation last fall of the Superconducting Super Collider, high-energy physicists are paying closer attention to alternative, potentially less costly schemes for accelerating electrons and other particles. One possibility involves the use of powerful electric fields generated by waves traveling through plasmas of charged particles at nearly the speed of light.

Last year, electrical engineer Chan Joshi and his team at the University of California, Los Angeles, demonstrated that they could boost the energy of electrons injected into waves in a laboratory plasma. Now, the same group has shown that a plasma wave can trap injected electrons, allowing the electrons to gain additional energy as they move along with the wave.

This is "a necessary condition for obtaining the maximum amount of energy theoretically possible for such schemes," the researchers report in the April 7 NATURE.

Although the idea of plasma-wave particle accelerators originated 15 years ago, researchers have only in recent years overcome tough technical problems and gained the expertise required to make plasma waves of sufficiently high quality for acceleration experiments.

Joshi and his coworkers focus a pair of beams from a carbon dioxide laser — operating at two slightly different frequencies — and a beam of electrons on the same point in a chamber filled with hydrogen. The hydrogen breaks down into a low-density plasma consisting of electrons and hydrogen nuclei, or protons.

The overlapping laser beams interfere with each other, creating a sequence of pulses of light. These pulses, in turn, exert a force on the electrons in the plasma, thus altering electron distribution. The result is a rapidly propagating plasma wave at a frequency equal to the difference of the two laser frequencies. Injected electrons race along with the plasma disturbance like surfers riding an ocean wave.

The researchers found that they could increase the energy of injected electrons from 2 million to 30 million electron-volts over a distance of about 1 centimeter. This represents "the largest coherent man-made accelerating field yet produced," Robert Bingham of the Rutherford Appleton Laboratory in Chilton, England, notes in the same issue of NATURE.

Joshi and his collaborators are now aiming for higher electron energies, while other groups continue to work on somewhat different strategies for plasma-wave acceleration. "It is . . . gratifying to see that some of the ideas on alternative acceleration schemes proposed more than a decade ago are coming to fruition," Bingham comments. *— I. Peterson*