Diagnosing the state of an unruly plasma

The narrow, high-voltage gap between the positive and negative electrodes in a pulsed-power diode is a hostile environment. Intense electric and magnetic fields, restricted to a small volume, tear matter apart to produce an extremely hot, unruly plasma of ions and electrons. Such extreme conditions make it difficult to monitor what's happening inside the diode – the kind of fundamental information needed for learning how to generate ion beams with the right characteristics to initiate and drive thermonuclear fusion in tiny fuel pellets.

Now researchers are starting to catch glimpses of the hitherto largely unseen world inside such diodes. Using sophisticated spectroscopic techniques developed by Yitzhak Maron of the Weizmann Institute of Science in Rehovot, Israel, they can measure the intensity and extent of the electric fields present, the location and geometry of the plasmas near the electrodes, and the velocities and numbers of particles at various points within the diode gap.

"Maron can be considered a pioneer in the diagnostics of what happens in a very complicated system – how ion beams are accelerated against a plasma background," says physicist Martin Reiser of the University of Maryland in College Park. Maron described his diagnostic techniques at last week's meeting on atomic processes in plasmas, held in Gaithersburg, Md.

Maron's scheme exploits the effects of strong electric and magnetic fields on light emitted by certain ions that have been excited to particular energy levels. By measuring the precise wavelengths of light emitted by magnesium, aluminum and other ions present in the diode gap and by unraveling the meaning of these signals, he can glean information about the behavior of the electric fields and plasmas in the gap.

The measurements are difficult to make because so little time is available and the space is so small, Maron says. Pulse-generated plasmas last only 100 nanoseconds, and the diode gap may be less than a centimeter wide. Nevertheless, Maron and his colleagues have managed in several tests to detect plasma and electric-field features as small as 200 microns and events as brief as 5 nanoseconds.

Until Maron's work, researchers had to calculate theoretically what happens inside a pulsed-power diode to predict the characteristics of the ion beam that emerges. "Maron's work has been instrumental in giving detailed measurements of important quantities inside a diode," says J. Pace VanDevender of the Sandia National Laboratories in Albuquerque, N.M.

Maron is now working with Sandia scientists to adapt his diagnostic methods for use in the powerful ion diode for Sandia's Particle Beam Fusion Accelerator II. Earlier this year, this giant accelerator produced an ion beam of record intensity, an important milestone on the road to inertial confinement fusion. In this scheme, beams of energetic ions would irradiate fuel pellets containing the hydrogen isotopes deuterium and tritium. Theoretically, depositing sufficiently large amounts of energy quickly should initiate nuclear fusion in the fuel pellet.

"The understanding that we get from the detailed behavior of the electrons and ions in the diode from the spectroscopic studies will help us do the job," VanDevender says. "The more sophisticated the diagnostics, the faster progress can be made." – *I. Peterson*

Eruption streaks Triton sky

Jet Propulsion Laboratory

After examining photos taken during Voyager 2's flight past Neptune, scientists last week announced the discovery of geyser-like eruptions towering above the surface of Triton, the planet's largest moon. Triton thus joins Earth and Jupiter's moon Io as the only known erupting bodies in orbit around the sun.

The picture above, taken Aug. 24, shows a dark vertical plume (arrow) rising to a height of nearly 8 kilometers before Triton's winds sweep it across the sky. Scientists say the wind-borne streak extends about 150 km.

Fascinated researchers are still trying to understand the eruption's cause. One theory suggests that a pressurized gas, probably nitrogen, has risen from beneath the surface, carrying up dark particles of presumably carbon-rich material.

Voyager scientists have identified two such plumes, each visible in four or five photos, reports Laurence A. Soderblom of the U.S. Geological Survey in Flagstaff, Ariz. "There's a lot of stuff that's aloft," he says, "but only a couple of cases where we can see its actual connection to the surface." Soderblom also notes that a possible, though less likely, source for the plume could be methane, which he says "would rise as a buoyant parcel in the nitrogen atmosphere." He suggests that a heat source such as the sun or buried radioactive elements may cause the gas to expand and burst forth from the surface.

In-school breakfasts improve test scores

Children from low-income families who participate in the federally funded School Breakfast Program improve more on annual achievement tests than do classmates who qualify for the program but skip the school breakfast, new research shows. Though other studies have identified nutritional benefits from the subsidized breakfasts, this is the first to demonstrate the program's statistically significant impact on academic achievement, its authors say.

Elementary schools in Lawrence, Mass., adopted the School Breakfast Program in January 1987. Researchers compared changes in achievement test scores between the spring semesters of 1986 and 1987 for 1,023 third- to sixth-graders in six of those schools. Though more than 90 percent of the students in the study qualified for free breakfasts – and the rest for heavily subsidized ones – only 33 percent ate the early meal. The researchers say they do not know why most children passed it up or how many ate breakfast at home.

While achievement gains showed up both in those who ate school breakfasts and in those who chose not to, the increases among children participating in the program were roughly 2 percent higher in math, 4 percent higher in reading and more than 6 percent higher in language skills. In schools basing promotion to the next grade level on standardized achievement test scores, "differences of this magnitude may mean the difference between promotion and retention," note Boston University pediatrician Alan F. Meyers and his colleagues in the October AMERICAN JOURNAL OF DISEASES OF CHILDREN.

Moreover, participating children had lower rates of absence and tardiness than did those who declined the meals. And this difference "may be as crucial as or more crucial than the one in achievement test scores," says coauthor Michael Weitzman. "Many studies have shown that absence rates – even as early as the third grade – help predict kids that will eventually drop out of school."

The size of the test gains "is exactly what I'd expect," says psychologist David Benton of University College in Swansea, Wales. Benton coauthored a study in the Jan. 23, 1988 LANCET showing a similar modest gain in nonverbal intelligence-test scores for Welsh children receiving vitamin and mineral supplements. He says data from his unpublished follow-up involving 169 Belgian students suggest that "what we're measuring are effects of poor diets on a child's ability to concentrate." – *J. Raloff*

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