PPPL PRINCETON PLASMA PHYSICS LABORATORY news release
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Powerful Computers Advance Fusion Research at PPPL

Plainsboro, New Jersey -- Scientists at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) report a major advance in the computer modeling of fusion plasmas in the September 18 edition of *Science*. The new results were obtained utilizing the Massively Parallel Processing (MPP) capabilities of the DOE's National Energy Research Scientific Computing Center (NERSC) at the Lawrence Berkeley National Laboratory (LBNL) in Berkeley, California.

In general, the formation of stars results from the dynamic behavior of hot ionized gases known as plasmas. Fusion researchers use magnetic fields to confine such hot gaseous fuel at the temperature, density, and duration required for the controlled production of significant amounts of fusion energy. However, turbulence can spoil the efficiency of this approach by causing accelerated loss of particles and energy from the plasma. As pointed out in a Perspectives article in the same issue of *Science*, good news from toroidal confinement experiments indicates that the suppression of turbulence can enable transitions to newly discovered enhanced confinement regimes.

In the work reported in *Science* this week, PPPL scientists have used the full power of the SGI/Cray T3E supercomputer at NERSC to create three-dimensional nonlinear particle simulations of microturbulence in the plasma. The use of NERSC's massively parallel processor (MPP) capabilities enabled scientists to perform calculations involving 400 million plasma particles (i.e., 100 million guiding centers) in 5,000 time-steps -- an achievement impossible without the use of powerful MPP computers.

"The information obtained from these advanced computer simulations is providing valuable new physics insights and correlates well with trends observed in experiments. This work builds on the excellent knowledge base developed internationally and complements related research efforts at other national laboratories such as Lawrence Livermore National Laboratory and General Atomics [both in California], as well as at universities such as UCLA and the University of Colorado," noted PPPL's Chief Scientist, William M. Tang. "The results in our *Science* article help support the increasingly accepted position that high performance scientific computing has

matured to a level where it can be considered a new tool for discovery complementing traditional theory and experiment. It is evident that plasma science, along with many other fields, will benefit greatly from the development of the advanced computational capabilities envisaged and strongly encouraged at the DOE/National Science Foundation Workshop on Advanced Scientific Computing held this July at the National Academy of Sciences."

NERSC was originally established in 1974 to support fusion energy research programs sponsored by the DOE. The center, one of the nation's most powerful unclassified supercomputing centers, provides both computational resources and technical support to researchers at PPPL, as well as a wide range of research efforts in various scientific disciplines at other DOE sites.

"These results are exciting in that they again demonstrate the value of computational science as a complement to experimental science. It's particularly exciting that this significant fusion result was achieved using a highly parallel computing system," said William Kramer, Deputy Director of NERSC. "We're also pleased to see that NERSC continues to play a critical role in helping plasma physics scientists make new advances in the field. Collaborations such as this really are the future of large-scale scientific research."

NERSC (www.nersc.gov) provides high performance computing services to DOE's Energy Research programs at national laboratories, universities, and industry. The DOE's LBNL (www.lbl.gov) conducts unclassified research and is managed by the University of California. PPPL (www.pppl.gov) , which is funded by DOE (www.doe.gov) and managed by Princeton University, is a collaborative national center for science and innovation leading to an attractive fusion energy source.

Editor's Note: The citation for the PPPL *Science* article is: "Turbulent Transport Reduction by Zonal Flows: Massively Parallel Simulations," Z. Lin, T.S. Hahm, W.W. Lee, W.M. Tang, and R.B. White, *Science* **281** (1998) 1835. There is also a Perspective article by Keith Burrell of General Atomics Corporation and a highlight of the article in the same issue of *Science*.

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