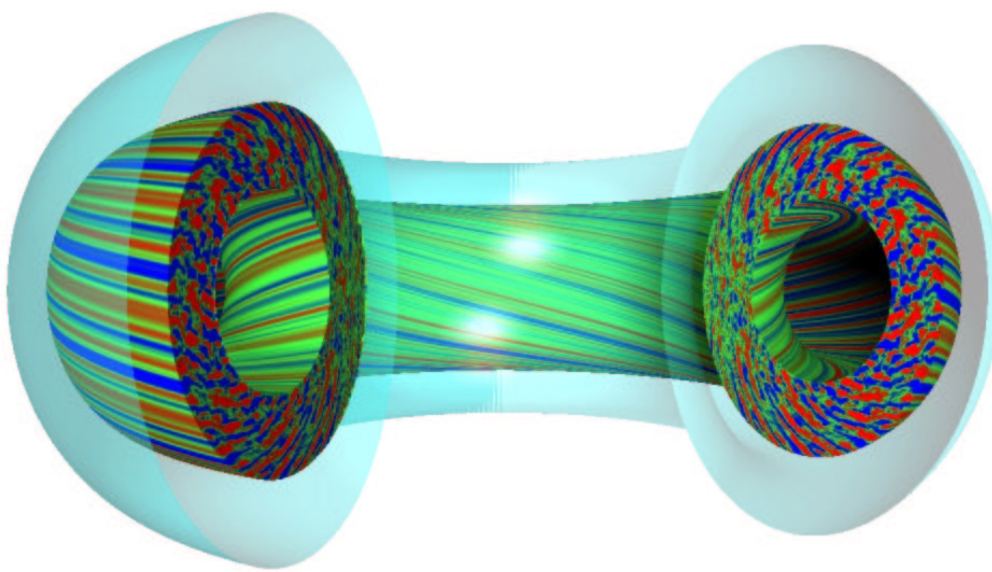
Turbulent Transport in the DIII-D Tokamak Matched by Supercomputer Simulation

Comprehensive computer simulations of turbulence in the DIII-D tokamak achieve an exciting new level of reality.

Computational physicists have been wrestling for years with the complexities of turbulence in tokamaks (donut-shaped plasma confinement machines). Until recently, no physically comprehensive computer simulations of heat and particle transport due to tokamak turbulence had ever been accomplished. This year, scientists at General Atomics (GA) in San Diego finally managed to merge two of the most elusive physics phenomena into one complete computer model. By combining (1) the strong destabilizing tendency of super-fast (kinetic) electrons with (2) the strong calming effects of plasma rotation and temperature variation, direct comparison of simulations with experiments has become possible. In their simulations, code authors Ronald Waltz and Jeff Candy have reproduced both the turbulent "Bohm" transport scaling and levels of heat loss that are characteristic of certain (L-mode) experiments at the DIII-D National Fusion Facility. The new comprehensive computer code was the result of an intensive three-year effort to combine various modern computational methods with insight from other GA physicists. Collaboration with senior theorists Marshall Rosenbluth and Fred Hinton (discoverers of "residual axisymmetric flows") was especially helpful in achieving exceptional simulation precision. The lengthy computer program uses the full power of the world's largest supercomputers. Present calculations are done on the 3328 processor IBM SP at the National Energy Research Supercomputer Center (NERSC) in Berkeley, CA. Work is in progress to compare computer simulation results with DIII-D "H-mode" discharges, and to make predictive calculations for future reactor-scale devices.



Computer simulation of turbulence in the DIII-D tokamak shows Bohm scaling and heat flow in accord with recent experiments. Color contours illustrate the highly elongated structure of turbulence in the electron density.

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