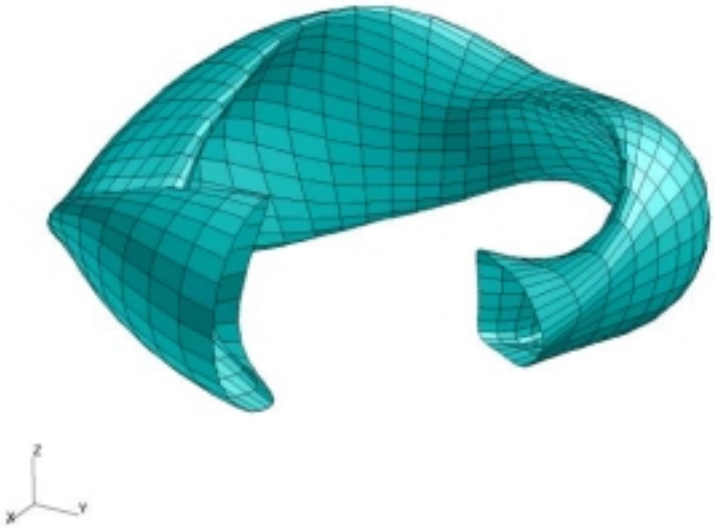
Compact Stellarators — The Best Features Combined

Using advanced plasma physics models and powerful computers, a team of magnetic fusion researchers has discovered a family of passively-stable plasma configurations that can be sustained continuously. In a fusion power plant, these plasmas could be maintained without having to use much of the plant's output power for driving active plasma control systems.

The crucial advance was learning how to combine the key features of two successful magnetic configurations, the "tokamak" and the "stellarator," to form a hybrid concept, known as the "Compact Stellarator."

During the 1990s, using the doughnut-shaped tokamak configuration, scientists demonstrated the production of record amounts of fusion power from high-temperature plasmas of short duration. Tokamaks exhibit a self-generated "bootstrap current," which helps sustain the confining magnetic field. The cross-sectional shape of a tokamak plasma is independent of location around the doughnut, or torus. Stellarators use three-dimensional shaping to stabilize the plasma. This means that the cross-sectional shape of the torus depends on where it is sliced (see figure).



Compact Stellarator researchers have discovered how to combine the bootstrap current with three-dimensional plasma shaping to obtain a theoretically sustainable configuration that combines the high performance of tokamaks with the passive stability of stellarators. The new design was subjected to a battery of computational evaluations to solidify theoretical predictions of good confinement and stability, and to demonstrate its practicality for construction.

The Compact Stellarator design will be presented in an invited paper by Dr. Allan Reiman of the U.S. Department of Energy's Princeton Plasma Physics Laboratory, a plasma physicist and leader of the configuration design team. The team includes U.S. researchers from Oak Ridge National Laboratory, University of Texas at Austin, Auburn University, Columbia University, New York University, the University of Wisconsin, and collaborators from Switzerland, Germany, Russia, and Japan. The team is now designing experiments for a Compact Stellarator they are proposing to build.

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