A turbulent solution to a growing problem

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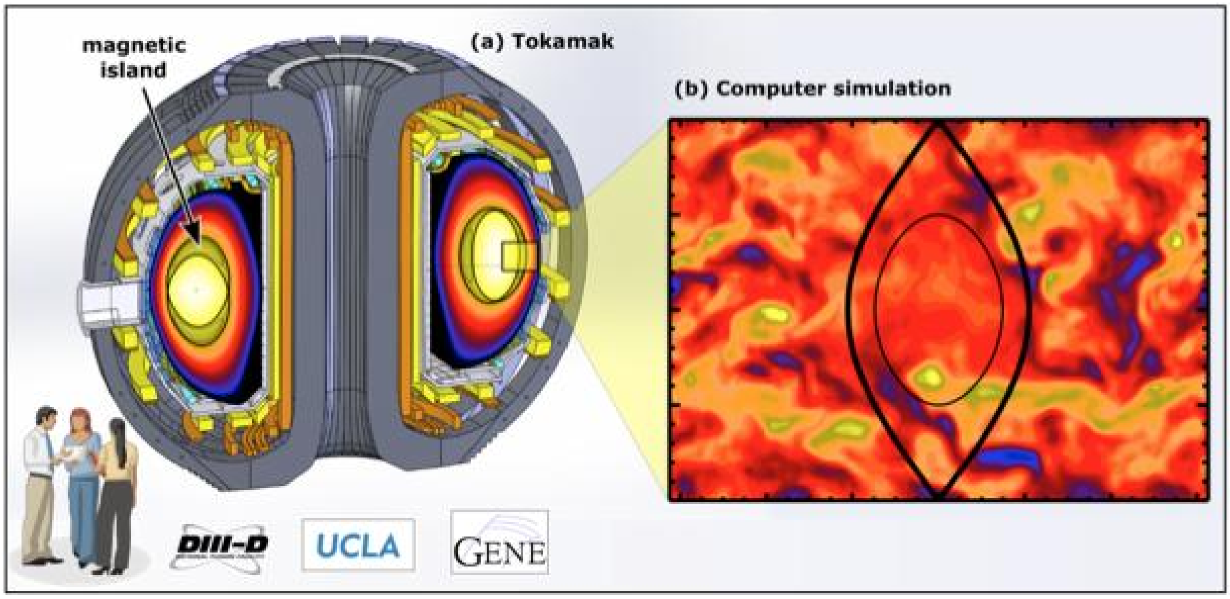

A schematic view of the DIII-D tokamak shows magnetic islands, along side computer simulations of a magnetic island and turbulence. Credit: DIII-D National Fusion Facility

A recent experiment lead by University of California, Los Angeles (UCLA), researchers on the DIII-D tokamak suggests that plasma turbulence can prevent filamentary structures called magnetic islands from growing so large that they cool off the 100 million degree plasma. This plasma needs to be as hot as possible so that individual nuclei collide with sufficient force to fuse together, thereby releasing energy. The magnetic fields of the DIII-D tokamak (Figure 1) confine the plasma while it is heated, but the plasma can also affect this field and manipulate it into undesirable island shapes that cause the plasma to expel much if its energy into the surrounding walls.

Plasma turbulence, the wildly fluctuating pattern of particle motion, is a concern for fusion energy devices because it allows heat to escape the plasma. However, an even more serious concern is posed by naturally growing magnetic islands that tear the magnetic fabric of the plasma (Figure 1a).

The research team performed experiments at the DIII-D National Fusion Facility, operated by General Atomics in cooperation with the U.S. Department of Energy, to study the mutual effect of plasma turbulence and magnetic islands.

"Our team has discovered plasma turbulence gets weaker inside large magnetic islands," explained graduate student and leader of the experiments Laszlo Bardoczi of UCLA. "This leads to islands becoming even larger, which is bad for fusion. However, turbulence can also prevent small islands from growing large. This suggests that we can avoid the growth of harmful magnetic islands by driving turbulence while islands are still small."

The researchers also conducted state-of-the-art computer simulations of the process (Figure 1b) that replicated the experimental findings. Demonstrating that simulation codes accurately calculate the plasma transport from such processes is vital to developing the ability to predict how fusion plasmas will behave in future experiments.

In future applications, plasma turbulence could be used to prevent small islands from growing and becoming harmful. This will potentially lead to improved control of the islands and therefore efficient operation of fusion devices like ITER, now being built in France as the world's largest tokamak by an unprecedented consortium of 35 nations including the United States. ITER is designed to produce more energy from fusion than it uses to heat the plasma, so understanding how to reduce, or possibly prevent, detrimental island growth could be an important capability.

More information: meetings.aps.org/Meeting/DPP16/Session/PI3.3

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