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The Scorpion's Strategy: "Catch and Subdue"

Scientists develop new technique to remove magnetic islands that drain power from plasma in the DIII-D tokamak fusion reactor.

PROVIDENCE—Adopting what they call "the scorpion's strategy," scientists at the DIII-D National Fusion Facility and colleagues at the Princeton Plasma Physics Laboratory have successfully applied state-of-the-art real-time control of microwave power from gyrotrons, along with mirror aiming of the power, to catch and subdue "tearing modes" that break up the magnetic surfaces of the magnetic bottle called a tokamak—a torus (or donut) shaped vacuum vessel where the plasma is contained by powerful magnetic fields.

Tearing modes in tokamak plasmas can form magnetic islands that destroy toroidal symmetry and leak the energy out of the magnetic bottle. The m=3, n=2 tearing mode, for example, has a magnetic field perturbation that wraps around three times poloidally for every two times toroidally. The resulting island can be removed ("subdued") by applying precisely aligned electron cyclotron current driven by high-power microwave sources (gyrotrons), as sketched in Figure 1.

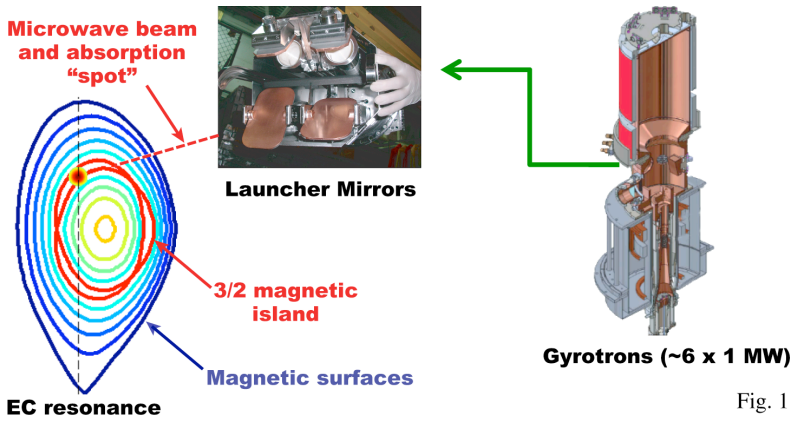

Fig. 1

The procedure resembles the way scorpions catch and subdue their prey, lying in ambush and waiting for the prey to approach and then seizing it with pincers. Small prey may be eaten without even being stung. Figure 2 shows how an initially growing 3/2 island is detected, the gyrotron power

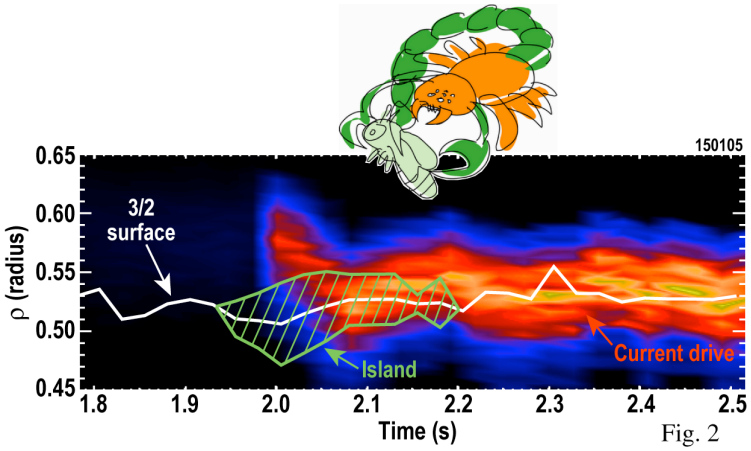

Fig. 2

(and thus current drive) is turned on and aligned, and the island promptly vanishes. The rapid "catch and subdue" method allows gyrotrons to be powered off when not needed, thus saving energy as well as maintaining the plasma in stable condition.

The DIII-D results show promise in solving a problem in the power-plant-scale tokamak called ITER now being constructed.

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Abstracts:

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