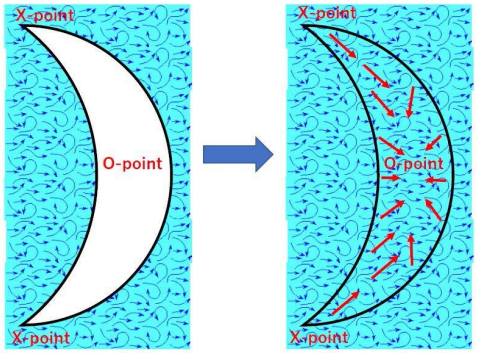
The first experimental proof of the propagation of plasma turbulence

20 June 2018

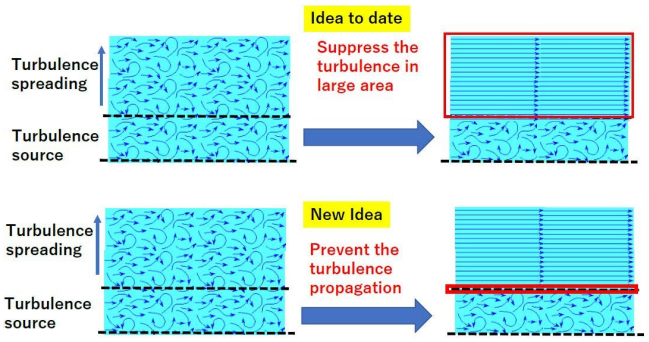


(left) There is no or small turbulence due to the almost zero temperature gradient inside the crescent-shaped magnetic island. (right) Turbulence propagates inside the magnetic island faster than the heat pulse. Credit: Dr. Katsumi Ida

In seeking to achieve fusion energy, research on magnetic field confinement of high-temperature plasma is being conducted around the world. In a high-temperature plasma, there is a temperature gradient. When the temperature gradient becomes steep, turbulence is generated. Because the high-temperature regions and the low temperature areas are mixed due to the turbulence, the core temperature cannot be effectively raised. Thus, research on the generation and suppression of turbulence is being performed around the world on experimental devices of magnetically confined plasma (tokamaks and helical devices). It has been very difficult to distinguish where and how turbulence propagates in a plasma. Researchers have predicted that turbulence expands into other regions, a phenomenon called "turbulence propagation," but this has not been observed experimentally.

The research group of Professor Katsumi Ida and Professor Tatsuya Kobayashi of the National Institutes of Natural Sciences (NINS) National Institute for Fusion Science (NIFS) and United States collaborators conducted research on turbulence propagation in the Doublet III-D tokamak of General Atomics, in the United States. They used the so-called "heat pulse modulation method" in the Large Helical Device (LHD) at NIFS to measure turbulence in a special region called the "magnetic island," where turbulence theoretically should not be generated because there is no temperature gradient. They discovered that the turbulence exists in the magnetic island, and propagates faster toward the center of the magnetic island, which is called the O-point, than the modulated temperature change. Thus, the researchers observed turbulence propagation for the first time.

The results have been published in *Physical Review Letters*. In the future, the researchers will continue to improve high-performance plasma through accumulating further knowledge on the suppression of turbulence.



(top) Idea to date: To suppress the turbulence in a high-temperature plasma region it was thought that the turbulence should be suppressed in a large area.(bottom) New idea: It is thought that the turbulence propagation is needed to suppress. Credit: Dr. Katsumi Ida

More information: K. Ida et al, Hysteresis Relation between Turbulence and Temperature Modulation during the Heat Pulse Propagation into a Magnetic Island in DIII-D, *Physical Review Letters* (2018). DOI: 10.1103/PhysRevLett.120.245001

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