New experimental results from the largest and most sophisticated stellerator

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An international team of scientists is running tests on the largest and most sophisticated stellerator, the Wendelstein 7-X fusion experiment. This complex machine is housed at the Max-Planck-Institute of Plasma Physics in Greifswald, Germany. Besides preparing for new experiments, researchers are analyzing data from the first experiment campaign that took place in 2016, hoping to understand the science of fusion reactors. In a new report in *Physics of Plasmas*, Shaocheng Liu and his collaborators recount the first detailed characterization of plasma turbulence at the outer edge of the stellerator.

In Wendelstein 7-X, helium is ionized and heated to 50 million degrees Celsius where it is confined by strong superconducting magnets, which are cooled to minus 270 degrees Celsius. The superconducting magnets create helical magnetic field lines that have been carefully optimized so that fast-moving charged particles remain trapped on a toroidal surface. Like other magnetic confinement devices, turbulence appears in the heated plasma that causes heat and particles to wander across these surfaces and ultimately come into contact with the first wall surrounding the plasma. The characteristics of this turbulence are critical to understanding how to build energy-producing reactors in the future.

"Particles need to be transported to the target, to the outside, and this edge region is very important for particle confinement," said Shaocheng Liu, an author on the paper.

Their paper reports the first measurements of the plasma turbulence at

the edge of Wendelstein 7-X. Using a multi-tipped probe, the turbulence is seen to propagate in the direction of ion flow, have a broadband spectrum and change character upon changes in the magnetic topology at the edge.

"At the beginning we knew nothing about turbulence behaviors in the Wendelstein 7-X because it's a completely new device," Liu said. "Initially we didn't consider all the factors, like the angle and alignment of the local flux surfaces, but we [found] that we must consider these things because of the three-dimensional structures in the stellerator, so we changed the design of the new probes."

More information: "Characteristics of the SOL turbulence structure in the first experimental campaign on W7-X with limiter configuration," *Physics of Plasmas* (2018). DOI: 10.1063/1.5033353

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