Plasma instabilities and turbulence through a stellarator lens.

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Abstract

Having non-planar magnetic axis and rotating highly-shaped poloidal cross sections, stellarators are the most complex devices in the family of toroidal chambers used for magnetic confinement fusion. Their complexity, if not dealt with care, can lead to a string of undesirable transport properties such as unsustainable collisional heat losses, hollow density profiles, impurities accumulation, and lack of confinement of trapped and energetic particles.

The discovery of stellarator quasi-symmetries, however, opened the way to the solution of the many problems stellarators faced for decades. Today, the stellarator is a viable reactor concept whose potential is constantly reinvigorated by the results of the Wendelstein 7-X (W7-X) experiment, based at Greifswald, Germany.

In this talk, we will examine some questions that a modern experiment like W7-X is compelling us to reconsider, and propose the answers to them. Are heat losses turbulent? Which turbulence? How does complex geometry change turbulence? What suppresses or exacerbates this turbulence? How does it saturate? Do electromagnetic fluctuations affect the turbulence saturation process? Do impurities accumulate? Do we observe current-driven magnetic reconnection in a stellarator, even if it was designed to be virtually "current free"? We will close our discussion by summarising the key steps needed to be taken to address the problem of turbulence and stability in high-performance stellarator reactors.