CSU PHYSICS COLLOQUIUM

"Dynamics of strongly kinked, low edge safety factor tokamak plasmas in the Madison Symmetric Torus"

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Virtual via Zoom (https://zoom.us/j/94863851739)

Abstract

Current-carrying toroidal fusion plasma devices can be characterized by the edge safety factor q(a), which is proportional to the ratio of toroidal field to plasma current. Tokamaks typically suffer "disruptions" or terminations due to the kink instability when q(a) < 2. Presented here are experiments in the Madison Symmetric Torus (MST) at the Wisconsin Plasma Physics Laboratory (WiPPL) in which tokamak discharges are sustained with q(a) < 2, thus filling the gap between reversed-field pinch and tokamak operation. The lack of disruptivity is thought to be due mostly to a thick conductive vacuum shell which passively stabilizes external kink modes, as well as a novel feedback-controlled power supply system that drives plasma current. This low-q(a) regime is interesting due to strong nonlinear dynamical self-organization behavior, the relationship with certain kinked astrophysical plasmas, and the possibility of higher-current tokamak operation for fusion research. First, previous work with low-q(a) tokamak plasmas is reviewed, then details of MST and WiPPL are given. Finally, using a range of internal and external diagnostics, the properties of low-q(a) plasmas are studied over the range 0.8 < q(a) < 3. It is found that the current and temperature profiles broaden as q(a) decreases toward 1. A transition is observed from the standard tokamak sawtooth cycle toward irregular fluctuation activity as q(a) decreases. For q(a) near and below 1, strong, saturated kink modes are observed. The experimental data are compared with preliminary nonlinear magnetohydrodynamic simulations using the NIMROD code.

Biography

Dr. Hurst received his Ph.D. in Physics at UC San Diego for his work with Prof. Cliff Surko on antimatter technology, non-neutral plasma physics, and electron ExB vortex dynamics. At UCSD, he developed an experimental technique to study vortex dynamics in applied, time-dependent strain flows using the ExB drift motion in pure electron plasmas, for which he was awarded the 2019 Marshall N. Rosenbluth Outstanding Doctoral Thesis Award. He continued to work on this project at UCSD as a postdoc under the DOE Fusion Energy Sciences Postdoctoral Research Fellowship, before accepting a postdoc position at UW – Madison studying tokamak disruption physics on the Madison Symmetric Torus (MST). Now, he is an Assistant Scientist at the Wisconsin Plasma Physics Laboratory studying disruptions, low-safety-factor tokamak plasmas, and runaway electron physics on MST.