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Michigan Institute for Plasma Science and Engineering

Wednesday
September 16, 2015
3:30 pm
Room 1005 EECS

Prof. Uri Shumlak

University of Washington

Compact Approach to Fusion Energy with the Sheared Flow Stabilized Z-Pinch

Controlled nuclear fusion holds great promise for addressing Earth's growing energy demands and dwindling natural resources. Magnetic plasma confinement is a path to the nuclear fusion conditions of high temperature, high density, and long lifetime. Magnetic fields compress the plasma and provide stability, but often drive the design to a toroidal geometry, lower energy density, and larger size and cost. Early on, the Z-pinch was identified for fusion for its appealing simple geometry. The Z-pinch is a plasma column with an axial current that creates an azimuthal magnetic field, which radially compresses the plasma. Fusion reaction rates increase with decreasing Z-pinch plasma radius, providing an attractive scaling to a fusion reactor. Traditional Z-pinch plasmas suffer from large-scale instabilities that terminate plasma lifetime within tens of nanoseconds. Recent advances indicate that sheared plasma flows can mitigate these instabilities. Sheared flow stabilization may offer the missing ingredient to advance the Z-pinch as a viable fusion concept. The ZaP Flow Z-pinch group at the U. Washington has been investigating the connections between flow shear and plasma stability. The resulting Z-pinch plasma can be 50-130 cm long with 0.5-1.5 cm radius and confined for 20-40 μs with low magnetic activity, stationary plasma structures, and large flow shear. An overview of the experimental program, results, and comparison to theory and simulations will be presented. The Z-pinches have additional applications such as an EUV light source for next generation lithography and lab astrophysics.

About the Speaker: Prof. Uri Shumlak received his BS from Texas A & M University in 1987 and the PhD in Nuclear Engineering from the Univ. of California at Berkeley in 1992. He was then a National Research Council Postdoctoral Associate at the Air Force Phillips Laboratory at Kirtland AFB. In 1994, he joined the U. of Washington, where he is Professor & Associate Chair for Research in the Department of Aeronautics & Astronautics. Prof. Shumlak's research areas are plasma physics, innovative magnetic plasma confinement for fusion energy, electric propulsion, and theoretical and computational plasma modeling. His work includes theoretical and experimental investigation of the stabilizing effect of sheared flows in magnetically confined plasmas for fusion, high energy density physics, propulsion, and EUV light source applications. He studies high-fidelity plasma models, such as two-fluid and multi fluid, and develops high-order accurate numerical methods for plasma applications. In 2015-2016, Prof. Shumlak will serve as President of UFA (University Fusion Association), a non-profit organization that advocates for university fusion energy and plasma science research and education.