

Dean's Colloquium

Dr. Shibabrat Naik, Assistant Professor

Department of Mathematics and Center for Fusion Research and Training



When: Wednesday, November 1st, 2023

Where: Turner 129

Time: 3:00 – 3:20 pm, Q&A: 10 min

Title: Nonlinear dynamics of magnetic confinement of plasma

Abstract: To achieve sustainable power output from a toroidal fusion device, one must confine the plasma using a magnetic field that is axisymmetric with an axial current (as in tokamaks) or is quasisymmetric but without the axial current (as in stellarators). In a magnetic field, transitions between classes of guiding-center motion (center of the helical path of a charged particle along the magnetic field line) can lead to cross-field diffusion and escape. In this talk, I will present a recently developed theory of *isodrastic magnetic fields* for plasma confinement based on nonlinear dynamics of guiding-center motion. First, we offer a weak formulation based on the longitudinal adiabatic invariant, generalizing omnigenity (a type of hidden symmetry of fields required for confining plasma). To demonstrate that isodrasticity is strictly more general than omnigenity, we construct weakly isodrastic mirror fields that are not omnigenous. Then, we present a strong formulation that is exact for guiding-center motion. The theory provides quantification of deviations from isodrasticity that can be used as objective functions in optimal design. We illustrate the theory with some simple examples.

Bio: Dr. Shibabrat Naik joined Hampton University in September 2023 as a faculty member in the Department of Mathematics and as a member of the Center for Fusion Training and Research to build the lab-scale stellarator, STAR_Lite, for training fusion scientists and answering novel questions related to stellarator research. His research interests are in theory and applications of nonlinear dynamics, chaos, computational science and engineering, and magnetic confinement of plasma. He obtained his Ph.D. in Engineering Mechanics from Virginia Tech and trained as a postdoctoral researcher in engineering at Drexel University and University of Pennsylvania, applied mathematics at University of Bristol and University of Warwick. His interdisciplinary research articles on nonlinear dynamical systems and computational science have appeared in *Physical Review E*, *Nonlinearity*, *Royal Society's PCCP*, *Chaos*, *Commun. Nonlinear Sci Numer. Simul.*