

PSSI lecture series

By

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Title: Physics of improved confinement in negative triangularity tokamaks

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Abstract: Gyrokinetic simulations reveal new insights into the collisionless saturation of zonal flows in ITG turbulence while illuminating the dynamics of the Dimits shift and improved confinement in negative triangularity (NT) tokamaks. Time series of the zonal free energy transfer function exhibits intermittent bursts of back-transfer from zonal modes to turbulence. These zonal back-transfer events limit the lifetime of zonal ExB shear. Increased back-transfer leads to shorter zonal shear lifetimes at higher temperature gradients. Near marginality, a reduction in back-transfer drastically enhances zonal flow shear coherence. We find that negative triangularity (NT) plasmas exhibit significantly reduced back-transfer compared to positive triangularity (PT). This suppression of back-transfer increases the shear auto-coherence time and the shearing Kubo number leading to more resilient shearing and effective turbulence regulation despite lower absolute zonal kinetic energy. Consequently, turbulent heat diffusivity is lower for NT than for PT, though their difference diminishes approaching marginality.

The speaker: Dr. Rameswar Singh received his M.Sc. in Physics from Gauhati University in 2007 and completed his Ph.D. at the Institute for Plasma Research in 2013, where he studied intrinsic rotation and zonal flows in microturbulence in tokamaks. He subsequently held research positions at École Polytechnique (2013–2015), at the Institute for Plasma Research (2016–2017), and at the University of California, San Diego (2018–2020) with Prof. Patrick Diamond. He is currently an Associate Project Scientist in Prof. Diamond's group at UC San Diego. Dr. Singh's research focuses on plasma turbulence, transport theory, intrinsic rotation, and nonlinear dynamics in magnetic confinement fusion. He is the recipient of **PSSI-JS Sodha** award in 2025.



About PSSI: The Plasma Science Society of India (PSSI) was established in 1978 with the vision of fostering excellence in plasma research, education, and application. PSSI represents a gathering of minds dedicated to unraveling the complexities of plasma phenomena and harnessing its transformative power. With a diverse membership drawn from academia, industry, and government institutions, it serves as a vibrant hub for interdisciplinary exchange and synergistic partnerships. PSSI is committed to nurturing the next generation of plasma scientists and engineers. Through various programs, educational outreach initiatives, national symposiums, and colloquium the society cultivates a vibrant ecosystem in the field of plasma science and technology. By empowering young minds with the tools and inspiration to pursue careers in plasma science, PSSI ensures a legacy of innovation that will endure for generations to come.