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Michigan Institute for Plasma Science and Engineering

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Physics of Partially Magnetized ExB Plasmas in the Laboratory and Space

Partially magnetized plasma is a regime where the electron dynamics across the magnetic field are controlled by the magnetic field. The electron Larmor radius is much smaller than the macroscale (e.g., geometric scale of the domain or device size), while the ion Larmor radius is much larger. Ions are weakly affected by the magnetic field. Such regimes occur in parts of Earths' ionosphere, the solar chromosphere, and collisionless shocks in space. In natural conditions, the electric field perpendicular to the magnetic field is often created due to the relative flow of the electrons and ions. In laboratory and technological plasmas, an external electric field perpendicular to the magnetic field is applied so that the ions can be extracted and accelerated by the electric field, while the electrons remain trapped by the magnetic field enhancing the discharge efficiency. Such cross-field (or ExB) discharges are widely used in magnetron sputtering devices for material processing and plasma electric propulsion such as Hall thrusters. Despite their long history, many aspects of ExB physics are only qualitatively understood precluding the predictive modeling of, for example, the next generation of Hall thruster for space propulsion or the theoretical prediction of ionosphere irregularities. Quantitative characteristics of nonlinear plasma instabilities, plasma turbulence, and associated anomalous transport remain poorly understood. Physics of instabilities and transport in partially magnetized ExB plasmas will be discussed, presenting recent advances in analytical theory and numerical approaches, and highlighting critical questions and problems.

About the Speaker: Andrei Smolyakov is a Professor in the Department of Physics and Engineering Physics at the University of Saskatchewan, Canada. He received his MSc. (Diploma of Engineer-Physicist) and Ph.D. (Candidate of Physical and Mathematical Sciences) degrees in 1983 and 1986, respectively, both from Moscow Institute of Physics and Technology, Russia. His research interests include basic plasma physics with applications to magnetic fusion, laboratory plasmas, and plasma for electric propulsion. He is a Fellow of American Physical Society, Senior Member of the Institute of Electrical and Electronics Engineers, and a Professional Engineer registered in the Province of Saskatchewan. He is a member of the editorial boards for several plasma physics journals and is an Associate Editor for *Physics of Plasmas* of AIP.