

SEMINAR NOTICE

*Department of Physics and Engineering Physics
University of Saskatchewan*

SPEAKER: Andy Sabo, PhD Candidate,
Physics and Engineering Physics

TOPIC: *Thermal and Electromagnetic Effects on Plasma
Acceleration in the Magnetic Nozzle*

DATE: Tuesday February 25th, 2025

TIME: 3:30-4:30 p.m.

PLACE: *Physics 103*

Abstract:

Plasma is becoming an essential component of novel technologies, ranging from electric propulsion to nuclear fusion of hydrogen to the microfabrication of nano-scale devices. Advancements in these technologies require an understanding of plasma dynamics and how to confine and direct the flow of plasma. The confinement and acceleration of a plasma can be achieved through the use of an inhomogenous magnetic field. In most application such a magnetic field has the geometry of a converging-diverging nozzle also known as a Laval nozzle and is colloquially referred to as a magnetic nozzle. While the main mechanism of plasma acceleration in the magnetic nozzle, namely the creation of the ambipolar potential due to charge separation, is well understood, new mechanisms of plasma acceleration are being discovered, whose physics have yet to be elucidated.

This seminar will present the physics of ion acceleration in a magnetic nozzle. Starting from a quasi-two dimensional paraxial model, the dynamics of plasma flow in a magnetic nozzle will be simulated by solving numerically the equations of ideal magnetohydrodynamics, a set of coupled, non-linear, partial differential equations with the aim of arriving at stationary state solutions and analyzing their properties. Trans-sonic and trans-Alfvénic solutions and their uniqueness will be presented, as well as the conditions required for the existence of such solutions. The acceleration of ions in a cold plasma will be discussed for the case of isothermal electrons and also for a simple model of electron cooling involving polytropic electrons. Thermal effects from pressure anisotropy will be analyzed using the Chew-Goldberger-Low (CGL) model. The effects of heat fluxes will be presented for both collisionless plasma and also for the case involving ion-ion collisions. Rotational and electromagnetic effects on plasma dynamics will be presented for both a cold plasma and a plasma with isotropically hot ions. Lastly, dissipative effects such as ionization and charge-exchange between a plasma and neutral gas atoms and their effects on plasma acceleration will be discussed.

Coffee and Cookies available in Physics 177 lounge at 3:00pm to those attending the seminar.