SEMINAR NOTICE

Department of Physics and Engineering Physics
University of Saskatchewan

SPEAKER: Dr. Lenaic Couedel
Physics & Engineering Physics

TOPIC: ***Experimental Studies of Two-Dimensional complex plasma crystals: waves and instabilities***

DATE: September 25th , 2018

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

PLACE: Physics 103

ABSTRACT:

Complex plasmas consist of particles immersed in weakly ionized gases. Due to the absorption of ambient electrons and ions, microparticles acquire negative charges and can form strongly coupled systems. Microparticles injected in capacitively-coupled radio-frequency discharges levitate in the sheath region near the bottom electrode, where the electric field can balance gravity. Under certain conditions the particles can form a monolayer and arrange themselves into ordered structures: 2D plasma crystals. In such crystals, two in-plane wave modes with an acoustic dispersion can be sustained (longitudinal and transverse modes). Since the strength of the vertical confinement is finite, there is a third fundamental wave mode associated with the out-of- plane oscillations that has a negative optical dispersion . Due to the strong electric field in the sheath region, every particle is influenced by a strong ion flow. The ions tend to focus downstream of the particles making the system highly polarized (plasma wake). In 2D plasma crystals, wake-mediated interactions result in the coupling of the crystal in-plane and out-of-plane modes into a shear-free hybrid mode of the lattice layer and trigger the mode-coupling instability (MCI) which can melt the crystal . Localized ``hot spots'' in the lattice phonon spectra are a typical signature of this mode . MCI induced melting can only be triggered if (i) the modes intersect, and (ii) the neutral gas damping is sufficiently low.

In this seminar, a review of experimental studies on waves, phonon dispersion relations and mode coupling instability in two-dimensional complex plasma plasma crystals is presented. An improved imaging method allowing the simultaneous measurements of the three waves modes (compression in-plane, shear in-plane and out-of-plane modes) is exposed. This method is used to evidence the formation of hybrid modes and the triggering of the mode coupling instability due wake-mediated interactions. The main stages of the mode coupling instability are analyzed. In the early stage, synchronization of the microparticle motion at the hybrid mode frequency is reported. The spatial orientation of the observed synchronization pattern correlates well with the directions of the maximal increment of the shear-free hybrid mode. When the instability is fully developed, a melting front is formed. The propagation of the melting front has similarities with flame propagation
in ordinary reactive matter. Finally, it is experimentally demonstrated that an external mechanical excitation of a stable 2D complex plasma crystal can trigger the mode coupling instability and lead to the full melting of the two-dimensional complex plasma crystal.

Coffee and Cookies will be served in Physics lounge at 3:00 p.m. for those attending the seminar.