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**Rotating structures and vortices in low temperature plasmas**

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Rotating structures are present in a number of low temperature EXB devices such as Hall thrusters, magnetrons, Penning discharges etc... Some aspects of the physics of these rotating instabilities are specific to low temperature plasmas because of the relatively large collisionality, the role of ionization, and the fact that ions are often non-magnetized. On the basis of fully kinetic simulations (Particle-In-Cell Monte Carlo Collisions) we describe the formation of a rotating instability associated with an ionization front ("rotating spoke") [1] and driven by a cross-field current in a self-sustained cylindrical magnetron discharge at gas pressure on the order of 1 Pa. The rotating spoke is a strong double layer (electrostatic sheath) moving towards the higher potential region at a velocity close to the critical ionization velocity, a concept proposed by Alfvén in the context of the formation of the solar system. The mechanisms of cross-field electron transport induced by this instability are analyzed. At lower pressure (<0.01 Pa) the plasma of a magnetron discharge is non-neutral and the simulations predict the formation of electron vortices rotating in the azimuthal direction and resulting from the diocotron instability. The properties of these vortices are specific since they form in a self-sustained discharge where ionization (and losses at the ends of the plasma column) play an essential role in contrast with the electron vortices in pure electron plasmas [2]. We discuss and analyze the mechanisms leading to the generation, dynamics and merging of these self-sustained electron vortices, and to the periodic ejection of fast electrons at the column ends (consistent with previous experimental observations).

[1] J.P. Boeuf and B, Chaudhury, Phys. Rev. Lett. 111, 155005 (2013)
[2] K.S. Fine, C.F. Driscoll, J.H. Malmberg, T.B. Mitchell, Phys. Rev. Lett. 67, 588 (1991)