

# Particle methods for the three dimensional Vlasov-Poisson system with a large magnetic field

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We propose a class of Particle-In-Cell (PIC) methods for the Vlasov-Poisson system with a strong and inhomogeneous external magnetic field with fixed direction. In this regime, the time step can be subject to stability constraints related to the smallness of Larmor radius and plasma frequency. To avoid this limitation, our approach is based on first and higher-order semi-implicit numerical schemes already validated on dissipative systems and for homogeneous magnetic fields. Thus, when the magnitude of the external magnetic field becomes large, this method provides a consistent PIC discretization of the guiding-center system taking into account variations of the magnetic field. We carry out some theoretical proofs and perform several numerical experiments that establish a solid validation of the method and its underlying concepts.