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Time-dependent PIC - Monte Carlo modeling of electron-positron cascade in the polar cap of pulsar

Many previously proposed models for polar cap cascades (and almost all quantitative models) assumed stationary particle outflow. Predictions of such models disagree with both observational data (e.g. the number of electron-positron pairs in the Crab nebula is ~100 higher than predicted) and results of numerical models of force-free pulsar magnetosphere (the current density required to support force-free magnetosphere differs substantially from what stationary model for PC cascade predicts). On the other hand, the stability of stationary models has not been quantitatively studied. We decided to study the problem from the first principles, namely to model the accelerating electric field, particle acceleration and pair production simultaneously. We developed a hybrid Particle-In-Cell-Monte Carlo code for direct self-consistent time-dependent modeling of polar cap cascades. Here we report the first results of cascade modeling using the current 1D version of the code.

Michael Watson
Fisk University
GRPIC modeling of jets from accretion disks

An algorithm is presented that incorporates the tensor form of Maxwell\'s equations in an electromagnetic particle-in-cell algorithm. The code simplifies to Schwartzschild space-time for the absence of a spinning central mass and to Minkowski space-time if no central mass is present. The current density is calculated using the curved space-time of the metric. The algorithm described here is part of a core software engine developed for plasma simulation in an environment around a spinning central mass. The versatility of the algorithm allows for calculations without spin. Because the algorithm uses a general metric explicitly for the description of the space-time, this algorithm can be used as a general relativistic particle-in-cell (GRPIC) code. We have studied the particle dynamics within the negative energy region of the ergosphere.

Seiji Zenitani
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Relativistic current sheets in electron-positron plasmas

The current sheet structure with magnetic field reversal is one of the fundamental structure in space and astrophysical plasmas. It draws recent attention in high-energy astrophysical settings, where relativistic electron-positron plasmas are considered. In this talk we will review the recent progress of the physical processes in the relativistic current sheet. The kinetic stability of a single current sheet, the nonlinear behavior of these instabilities, and recent challenges on the multi current sheet systems are introduced. We will also introduce some problems of magnetic reconnection in these relativistic environments.