Non-linear interaction of relativistic current sheets: Particle-in-cell simulations

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Correlated X-ray and optical observations of 'synchrotron wisps' in the equatorial outflow of the Crab pulsar are accredited to the presence of a 'striped' pulsar wind (Kennel & Coroniti,1984). Force-free stability conditions imply that the 'stripes' of alternating magnetic polarity are separated by current sheets consisting of relativistically hot pair plasma (Coroniti, 1990; Lyubarski & Kirk, 2001; Kirk & Skjaeraasen, 2003). The non-linear interaction of such relativistic current sheets is crucial to the solution of the so-called 'Sigma-problem of the Crab pulsar wind', i.e. the conversion of the originally Poynting-flux dominated outflow towards a kinetically dominated state within the tight boundaries imposed by the surrounding X-ray torus. We study the non-linear evolution and interaction of relativistic current sheets in 2D and 3D simulations employing a relativistic, fully electromagnetic particle-in-cell (PIC) code. The simulations are a continuation of the previous studies of relativistic current sheets by Zenitani & Hoshino (2001), Jaroschek et al (2004), Zenitani & Hoshino (2005). The discussion includes the rate of magnetic dissipation, the efficiency of particle energization as function of the sigma-parameter, the ratio of non-thermal to thermal particle generation in correlation with magnetic topologies and associated synchrotron signatures.