A relativistic Petschek-type model of magnetic reconnection

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A model of time-dependent Petschek-type reconnection of arbitrary strong magnetic fields where all necessary relativistic effects are taken into account is presented. The reconnection is supposed to be initiated due to a local decrease of the plasma conductivity inside the diffusion region, which results in the appearance of an electric field along the X-line. This electric field is considered as a given arbitrary function of time. Then all MHD parameters as well as the shape of the moving Petschek-type shocks are obtained from the ideal relativistic MHD equations written in terms of 4-magnetic field and 4-velocity vectors suggested by Lichnerowicz. The analysis is restricted to a symmetric current sheet geometry and to the case of weak reconnection, where the reconnection rate is supposed to be a small parameter. The solution obtained extends the Petschek model for the steady-state case to incorporate relativistic effects of impulsive reconnection. It is shown that plasma is accelerated at the slow shocks to ultrarelativistic velocities with high Lorentz-factors only for current layers embedded into strong magnetic fields and a low-density plasma. In this case the plasma is strongly compressed and heated while the normal size of the outflow region with the accelerated plasma becomes very small.