Fast magnetic reconnection in an electron-positron plasma: a return to the Petschek model?

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In this poster, we will present simulation results of magnetic reconnection in an electron-positron (or pair) plasma with no guide field, using a 2-dimensional, electromagnetic, particle-in-cell code. In an electron-ion plasma, the generalized Ohm's law contains the Hall term, which introduces a dispersive whistler wave, which has been considered to play an important role in realizing fast magnetic reconnection. In an electron-positron plasma, on the other hand, the Hall term in the generalized Ohm's law is absent, because the mass of the positron is the same as the electron so that there is no scale separation between the electron and the positron in the diffusion region. We will demonstrate that fast reconnection can be realized without the intervention of the Hall current and the associated dispersive waves. We will also show that the quadrupolar structure in the out-of-plane magnetic field is absent in a pair plasma. Instead, the off-diagonal components in pressure tensors for both the electron and the positron become large in the diffusion region, and play the role of an effective collisionless resistivity. The localization of the effective resistivity is the key to the formation of the X-point and fast reconnection, as in the Petschek model.