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Injection of accelerated particles from a MHD approach

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We propose a model to explain how particles, accelerated at a given reconnection site not magnetically well connected to the Earth, can eventually propagate along the well-connected open flux tube. Our model is based on a low-β resistive MHD simulation of a line-tied 3D null-point topology, with an open outer spine embedded in a non-uniform open magnetic field. We form a current sheet at the null point through simple photospheric motion.

We find that field lines initially rooted below the fan surface, in the inner connectivity domain, reconnect at the null point and jump to the open magnetic domain, which is the standard interchange mode. After the interchange, reconnected field lines located around the open outer spine keep reconnecting, but now continuously across quasi-separatrix layers. This slip-running reconnection induces an apparent slipping motion of reconnected field lines, which doesn't correspond to mass motion.

Particles accelerated at the null point will normally propagate along reconnected field lines. But, because of the slip-running reconnection, accelerated particles are successively injected along newer and newer reconnected field lines which are connected further and further from the spine, due to their slipping motion. The speed and the distance travelled by these slip-running reconnected field lines are significant. The slipping motion implies the formation of an extended-narrow magnetic flux tube at high altitude. As accelerated particles propagate along the slip-running field lines, this leads to form an extended-narrow beam of accelerated particles.

This result suggests that particles accelerated at the null point can be injected in field lines slipping over large distances, and thus could reach the distant flux tube that is well connected to the Earth.