



Magnetic reconnection in 3D

Earth's intrinsic magnetic field deflects the solar wind—and the interplanetary magnetic field it carries—and protects us from the wind's plasma of ions and electrons. But magnetic reconnection, in which oppositely directed field lines in the two fields break and reconfigure, can rupture that shield. Such explosively energetic events can accelerate particles to relativistic speeds and produce geomagnetic storms capable not only of generating spectacular aurorae but also of damaging satellites, disrupting communication networks, and overloading electric grids. (See the article by Forrest Mozer and Philip Pritchett in *PHYSICS TODAY*, June 2010, page 34.) During reconnection, ions, electrons, and fields interact turbulently across many spatial and temporal scales, and only in the past few years have detailed three-dimensional, kinetic simulations for studying the process become feasible.

Shown here is a visualization from a recent 3D global hybrid simulation by Homa Karimabadi (University of California, San Diego) and his team. Exploiting the petascale speed of today's supercomputers, such reconnection simulations can track the motion of more than a trillion ions; the electrons are modeled as a fluid. The 3D simulations reveal behavior not possible in 2D—in particular, the dominant role of helical magnetic structures known as flux ropes. With their customized visualization techniques, the researchers could color-code the field lines from the solar wind (here, red) and different parts of Earth's dipole field (green, yellow, pink) to better study the complex entanglement and mixing that ensue. (Image by Homa Karimabadi and Buren Loring. See also H. Karimabadi et al., *Astron. Soc. Pac. Conf. Ser.* **444**, 281, 2011.)

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