NEWS | AUGUST 07 2017

# Demonstrating collisionless fluid models of reconnection in the magnetosphere FREE

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*Scilight* 2017, 070004 (2017)
https://doi.org/10.1063/1.4997931

**Sci**light

**8 August 2017**

# Demonstrating collisionless fluid models of reconnection in the magnetosphere

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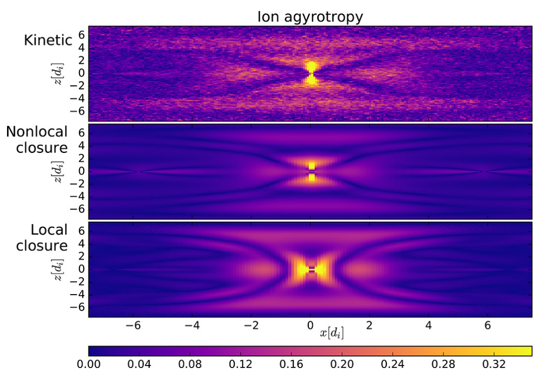
**Researchers show how high-order moments of kinetic equations allow simulations of critical reconnection events in the magnetosphere.**




Spurred on by the interest in space weather and by the success of collisionless fluid closures developed for magnetically confined fusion, researchers from Los Alamos National Laboratory and Princeton Plasma Physics Laboratory have demonstrated a much-improved method to capture nonlocal particle heating in simulations of the Earth's magnetosphere. As reported in *Physics of Plasmas*, the energy transferred from the magnetic field to the ionized plasma during reconnection depends critically on complex ion motion and the evolution of the ion pressure tensor.

According to lead author Jonathan Ng, magnetohydrodynamics modelling fits well for the large-scale modelling of the magnetosphere, but for the smaller and important subfocus of magnetic reconnection, kinetic modelling is necessary to capture the local physics and particle acceleration.

The researchers modelled nonlocal and collisionless damping of fluctuations by particles by truncating a hierarchy of fluid equations with a complex closure. For the first time, they applied a ten-moment system to simulations of collisionless magnetic reconnection by modifying the Hammett-Perkins closure used for collisionless models of plasma turbulence, whereby they captured collisionless ion damping and the anisotropic ion pressure tensor needed for accurate magnetic reconnection simulation.

The researchers successfully demonstrated the new model with idealized examples, and additionally with larger magnetic reconnection simulations, which similarly worked well, but not perfectly, according to Ng. While the adapted ten-moment fluid system provided better simulation of the ion pressure tensor and of the rate of plasma island convergence as compared with fully kinetic simulations, additional ion dynamics (like meandering ion orbits caused by the complex electric and magnetic fields in the reconnection region) are not included by the model and further developments are needed to fully simulate global reconnection phenomena in space weather.

**Source**: "Simulations of anti-parallel reconnection using a nonlocal heat flux closure," by Jonathan Ng, Ammar Hakim, A. Bhattacharjee, Adam Stanier, and W. Daughton, *Physics of Plasmas* (2017). The article can be accessed at https://doi.org/10.1063/1.4993195.