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Accessing a new regime of reconnection FREE

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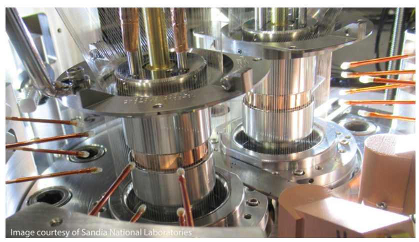
Experiments characterize strongly radiatively cooled magnetic reconnection, a process that occurs in the plasma of many astrophysical objects.



Magnetic reconnection occurs in plasmas when their magnetic field topology is abruptly rearranged, converting magnetic energy to kinetic and thermal energy. This process powers many intensely energetic astrophysical events, including solar flares.

Often, plasma in such astrophysical systems cools via the emission of thermal radiation. However, strongly radiatively cooled magnetic reconnection remains largely unexplored experimentally because it has been difficult to achieve the necessary cooling rates in the lab.

Datta et al. obtained detailed measurements of the reconnection process in this regime with the Magnetic Reconnection on Z (MARZ) experimental platform, a dual exploding wire array driven by the Z machine at Sandia National Laboratories. As the world's largest pulsed power machine, the Z machine delivered a current 10 times larger than previous experiments to yield stronger radiative emission.

Measuring the X-ray emission of the system spatially and temporally, the authors detected a rapid decline in emission generated from the reconnection layer, providing evidence of strong cooling. They also observed fast-moving hotspots of strong X-ray emission corresponding to plasmoids, an instability in the reconnection layer and a hallmark of reconnection in most astrophysical plasmas.

"Previous experiments have not simultaneously demonstrated the formation of plasmoids and strong cooling in the reconnection layer in this regime," said author Rishabh Datta. "These results not only enhance our knowledge of reconnection in a previously unexplored regime relevant to many extreme astrophysical objects, but also provide data for benchmarking numerical and theoretical models of such high energy density plasma systems."

MARZ experiments offer a new avenue for studying magnetic reconnection. Next, the authors will investigate how the interplay of radiative cooling and plasma instabilities affect reconnection properties.

Source: "Radiatively cooled magnetic reconnection experiments driven by pulsed power," by R. Datta, K. Chandler, C. E. Myers, J. P. Chittenden, A. J. Crilly, C. Aragon, D. J. Ampleford, J. T. Banasek, A. Edens, W. R. Fox, S. B. Hansen, E. C. Harding, C. A. Jennings, H. Ji, C. C. Kuranz, S. V. Lebedev, Q. Looker, S. G. Patel, A. Porwitzky, G. A. Shipley, D. A. Uzdensky, D. A. Yager-Elorriaga, and J. D. Hare, *Physics of Plasmas* (2024). The article can be accessed at https://doi.org/10.1063/5.0201683.

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