3D simulations improve understanding of energetic-particle radiation and help protect space assets

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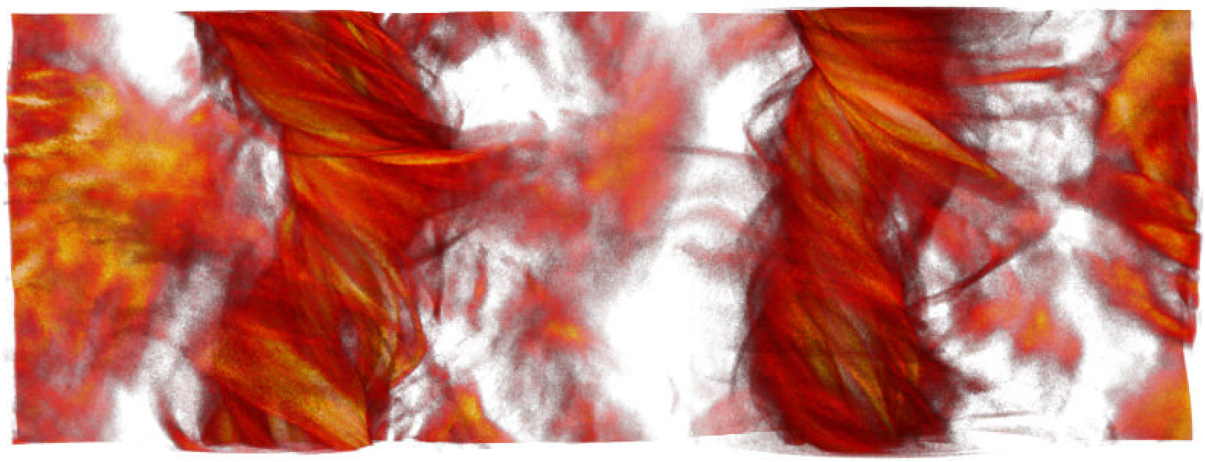

3D simulations based on fundamental physics principles model the production of energetic ions and electrons. Credit: Los Alamos National Laboratory

A team of researchers used 3D particle simulations to model the acceleration of ions and electrons in a physical process called magnetic reconnection. The results could contribute to the understanding and forecasting of energetic particles released during magnetic reconnection, which could help protect space assets and advance space exploration.

"For the first time ever, we can use 3D simulations from fundamental physics principles to model the production of energetic ions and electrons in those magnetic explosions in space," said paper author Qile Zhang, of the Nuclear and Particle Physics, Astrophysics and Cosmology group at Los Alamos National Laboratory.

The research was published in *Physical Review Letters*.

Magnetic reconnection can cause magnetic explosions, which result in events such as solar flares and geomagnetic storms near Earth; these explosions produce energetic-particle radiation that is harmful to spacecraft and humans. The research team discovered the underlying mechanisms controlling particle acceleration enabled by the 3D kink motions of plasmas—the collection of charged particles—and magnetic fields.

They also revealed the processes governing the key properties of the energetic-particle energy distributions. The team's predicted distributions agreed with observations from solar flares and Earth's magnetic fields.

More information: Qile Zhang et al, Efficient Nonthermal Ion and Electron Acceleration Enabled by the Flux-Rope Kink Instability in 3D Nonrelativistic Magnetic Reconnection, *Physical Review Letters* (2021). DOI: 10.1103/PhysRevLett.127.185101

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