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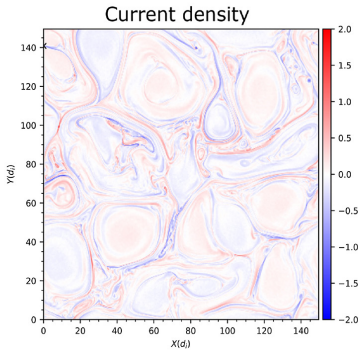
The finding suggests a flaw in accepted understandings of plasma dynamics.



For collisional plasmas, in which collisions between particles are frequent, simple functions can be used to describe the energy dissipation in terms of viscosity and resistivity. However, many plasmas found in space are weakly collisional, including solar winds and those in magnetospheres and stellar coronae. These so-called collisionless plasmas also exhibit physical effects that lead to dissipation, but because this process is more complicated in these plasmas, simple approximations cannot describe its relationships.

Bandyopadhyay et al. investigated the relationships between viscosity, resistivity, and dissipation in collisionless plasmas. They analyzed plasma simulations as well as in-situ satellite observations of plasmas in space to assess the viscous-like and resistive-like scaling in these plasmas.

They were surprised to find that the statistical averages of dissipation functions in the collisionless plasmas were comparable to those of collisional plasmas, suggesting the dissipation behavior of these two types of plasmas is actually very similar.

“This work suggests that there is a major component missing in our understanding of dissipation in collisionless plasmas,” said author Riddhi Bandyopadhyay. “Also, the scaling relations can be used to extract the effective values of viscosity and resistivity in collisionless plasmas in space and astrophysical systems, which will greatly help in modeling these systems.”

Next, the authors will use in-situ satellite observations to carry out a statistical survey of the effective viscosity and resistivities of plasmas in space, such as solar wind. They also plan to explore theoretically how collision-like dissipation emerges in collisionless plasma.

“This would require theoretical investigation of plasma physics in the weakly collisional regime,” Bandyopadhyay said.

Source: “Collisional-like dissipation in collisionless plasmas,” by Riddhi Bandyopadhyay, Yan Yang, William H. Matthaeus, Tulasi N. Parashar, Vadim Roytershteyn, Alexandros Chasapis, D. J. Gershman, B. L. Giles, and J. L. Burch, *Physics of Plasmas* (2023). The article can be accessed at https://doi.org/10.1063/5.0146986.