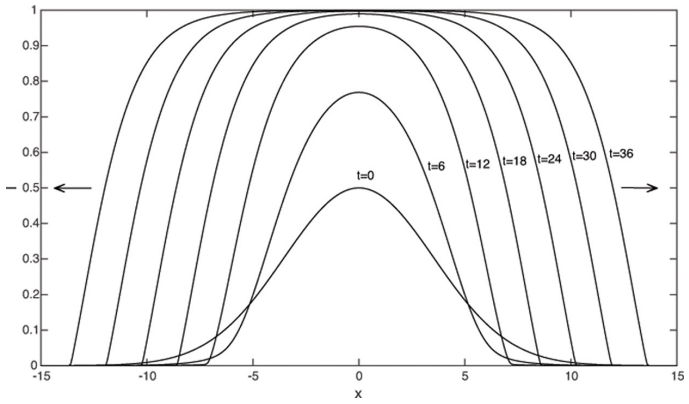
Scilight

7 March 2019

Uncovering what triggers avalanches in plasma

Chris Patrick

A new, unified model of turbulence spreading and avalanching is the first to propose a mechanism for plasma avalanches.



In plasma, turbulence spreading and avalanching are both processes that propagate turbulence and influence electron transport. Avalanches, however, are not well understood, despite playing an important role in magnetic fusion and accounting for a large percentage of total transport.

In turbulence spreading, localized turbulence spreads via nonlinear scattering. In an avalanche, localized turbulence spreads sequentially via gradient coupling. Due to this distinction, the plasma community often treats the two phenomena separately, but the new paper by Heinonen and Diamond argues that turbulence spreading and avalanching in plasma systems should be described with a single model because they share similar properties.

Heinonen and Diamond developed a unified model for turbulence spreading and avalanching, based on the Zel'dovich-Frank-Kamenetsky equation. Their model is the first to propose a possible mechanism for how avalanches are triggered, positing that when an initial seed of turbulence exceeds a threshold it then propagates and becomes an avalanche. Their model can be used to predict this threshold, or the minimum size and scale of seed needed to start an avalanche in a given plasma system.

The new model predicts stronger ballistic penetration, in contrast to the established model for turbulence spreading based on the Fisher equation, which predicts weak and evanescent turbulence penetration.

Subcritically unstable turbulence, or turbulence that can sustain itself below the threshold for linear instability, is another component of the new model. In the future, Heinonen and Diamond would like to investigate the origin of subcritical turbulence in plasma, which is not well understood. They also plan to study spreading in a more realistic model that includes zonal flows and profiles.

Source: "Subcritical turbulence spreading and avalanche birth," by Robin Heinonen and Patrick Diamond, *Physics of Plasmas* (2019). The article can be accessed at https://doi.org/10.1063/1.5083176.