Flare Ribbon Signatures of Reconnection Plasmoids

J. T. Dahlin (UMCP)
S. K. Antiochos (UMCP)
C. R. DeVore (NASA GSFC)
J. Qiu (MSU)
P. F. Wyper (DU)

Solar flares are explosive space weather events that rapidly convert stored magnetic energy into bulk motion, plasma heating, and particle acceleration. Understanding the structure and dynamics of the magnetic reconnection that powers flares is critical for predicting the energy release. In particular, the amount of energy transferred to energetic particles is thought to be highly dependent on whether the reconnection is primarily turbulent (e.g., plasmoid dominated) or instead laminar. We present high-resolution MHD simulations of three-dimensional reconnection in an eruptive flare and compare the results to recent data. Although flare reconnection is challenging to observe directly in the corona, highly detailed constraints on its dynamics can be obtained from observations of flare ribbons that track the chromospheric footpoints of newly reconnected field lines. The analogues of flare ribbons in our simulations are identified by tracking discontinuous changes in field-line magnetic connectivity due to the reconnection. In our highest-resolution calculations, we find that these ribbon analogues are highly structured and exhibit many 'whorl' patterns that are linked to turbulent plasmoids in the reconnecting current sheet. Flare ribbon fine structure therefore reveals crucial information about the fundamental turbulent vs. laminar nature of the reconnection. We discuss the implications of these results for understanding reconnection-driven energy release throughout the heliosphere.

Abstract of a contributed presentation to be given at the 2022 Fall Meeting of the American Geophysical Union, Chicago IL, 12-16 December 2022.