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Insights into Solar Flare Reconnection and Energetics from Novel Forms of High-resolution Observation and Modeling

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According to our current understanding, solar flares are driven by magnetic energy stored in the solar corona being rapidly released through a process involving magnetic reconnection. This scenario was originally proposed on the basis of classic observations including radio and hard X-ray emission from non-thermal electrons accompanying rising emission from hot thermal plasma. Over the past decade complementary observations have offered novel ways to constrain, quantify, and model, flare reconnection and the energy conversion it initiates. High-resolution studies of chromospheric flare ribbons, including their downward velocity (condensation), allow inference of the structure and evolution of coronal reconnection. Multi-band EUV imaging of the high-density, high-temperature plasma sheet formed around the current sheet shows the degree of heating and plasma compression which must accompany reconnection. Similar imaging shows flux tubes retracting through the sheets (SADs), pointing to the location and patchy nature of that reconnection. These myriad, novel observational constraints can be accommodated by a theoretical model in which magnetic energy is released as flux tubes retract through the current sheet following their creation by localized reconnection episodes. The measured, global rate of reconnection reflects their rate of production rather than the local electric field within one episode. Global flare properties, comparable to observation, can be reproduced by convolving the response to a single retraction with that production rate.

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