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Physical constraints on energy release and heating in solar flares

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According to our current understanding, solar flares occur when magnetic energy stored in the solar corona is rapidly converted into other forms. This process appears to be initiated by, if not fully explained by, fast magnetic reconnection occurring somewhere in the corona. I will describe some physical constraints on the process of energy release and conversion. First, magnetic energy stored throughout a large coronal volume must be released by a process, magnetic reconnection, currently believed to operate on very small length scales. This length-scale discrepancy suggest energy conversion occurring outside the reconnection site proper. In his seminal work, Petschek invoked slow-mode shocks as a means of converting energy mostly into heat and bulk kinetic energy. These shocks extended well away from the reconnection site. I will show that an updated generalization of this model is capable of generating temperatures and densities consistent with those observed in solar flare plasmas. Those observations show density enhancement, by up to an order of magnitude or more, within a high-temperature plasma sheet surrounding the most likely site of reconnection. This large density enhancement, coinciding with substantial heating, would be a natural consequence of slow mode shocks and would be hard to explain in any other way. I show how a simple model of magnetic energy release and conversion, initiated by reconnection at the observed rate, produces temperatures, densities, emission measures, and even hard X-ray spectra matching those actually observed in particular flares.

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