Magnetic Energy Storage, Release and Conversion in Solar Flares

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Energy release by magnetic reconnection has been hypothesized to drive numerous energetic phenomena in the Sun's corona including flares, coronal mass ejections and bright points. Prior to its release, energy is stored in the magnetic field as it slowly evolves subject to constraints on the topology of magnetic field lines. While this energy is stored in the large-scale coronal field, its release can be initiated by an electric field localized to very small scales provided it eliminates one of the topological constraints. Energy release initiated through local topological change is the essence of magnetic reconnection. It will be shown how observations of large-scale evolution of the Sun's photospheric field can be used to estimate the magnetic energy stored in the coronal field. It is then demonstrated how magnetic energy is converted into heat following small scale topological change. This is a transient, three-dimensional variant of the classic Petschek model whereby rotational discontinuities convert magnetic energy into kinetic energy of bulk flows whose collision creates slow magnetosonic shocks converting bulk kinetic energy into heat. The release of stored magnetic energy also reduces and redistributed large-scale coronal currents. This sudden change in current is accommodated in the global field by a fast magnetosonic front initiated at the reconnection site. We use a simple model to determine what fraction of the released energy takes this form.