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Particle acceleration in helical magnetic fields in the corona

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Twisted magnetic fields should be ubiquitous in the solar corona. Emerging twisted ropes as well as complex photospheric motions provide continuous influx of the magnetic helicity. Twisted coronal fields, in turn, contain excess magnetic energy, which can be released, causing solar flares and other explosive phenomena. It has been shown recently, that reconnection in helical magnetic structures results in particle acceleration distributed within large volume, including the lower corona and chromosphere. Hence, the magnetic reconnection and particle acceleration scenario involving magnetic helicity can be a viable alternative to the standard flare model, where particles are accelerated in a small volume located in the upper corona.

We discuss our recent results on the energy release and particle acceleration during magnetic reconnection in twisted coronal loops. Evolution of various helical structures is described in terms of resistive MHD, including heat conduction and radiation. We consider the effects of field topology and photospheric motions on the energy accumulation and release. In particular, we focus on scenarios with continuous helicity injection, leading to recurrent explosive events.

Using the obtained MHD models, ion and electron acceleration is investigated, taking into account Coulomb collisions. We derive time-dependent energy spectra and spatial distribution for these species, and calculate resulting non-thermal radiation intensities. Based on the developed numerical models, we investigate observational implications of particle acceleration in helical magnetic structures. Thus, we compare temporal variations of thermal and non-thermal emission in different configurations. Furthermore, we consider spatial distributions of the thermal EUV and X-ray emission and non-thermal X-ray emission and compare them with observational data.