Impulsive Magnetic Reconnection Mechanism for Non-thermal Emission of Solar Flares

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Many violent physical processes in space and astrophysical plasmas involve impulsive magnetic reconnection. It has been observed that for most large solar flares non-thermal emissions in hard X-rays (HXR) and millimeter/submillimeter waves impulsively rise and decade during the soft X-ray (SXR) emission rise phase. We show that the impulsive non-thermal emissions correlate temporarily with the impulsive acceleration of CME (which resides in flux rope or plasmoid) upward motion via an impulsive magnetic reconnection process. To obtain the magnitude of the impulsive magnetic reconnection rate, the magnetic reconnection electric field at the reconnecting X-point (or X-line) can be computed from the rate of change in magnetic flux swept by the evolution of H-alpha ribbons or EUV ribbons or HXR footpoints. By averaging the magnetic flux change rate over the ribbons the peak reconnection electric field during impulsive phase is on the order of ~ 1 kV/m for X-class flares, which is consistent with the MHD simulation using a nonlinear anomalous resistivity model. Further studies show that the magnetic flux change rate varies along the ribbons and the peak value is located near the HXR footpoint and can be several times larger than the averaged value. Employing HXR footpoint motion observed by RHESSI the peak reconnection electric field is larger than that evaluated from H-alpha or EUV ribbons.