Fokker-Planck treatment of the non-thermal electrons in a solar flare

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To study the dynamics of solar flares is essential for understanding the whole Sun-Earth system and predicting space weather. The impulsive non-thermal emission such as hard X-ray (HXR) is one of the important aspects in the flare. This reflects rapid and intense energy release in the flare, which mechanism should be understood. Non-thremal emissions reflect the information on the electrons at the emissions site(s) which is not necessarily same as the acceleration site(s). This means that the distribution of the electrons (for example, the energy spectrum) derived from these observations can be modified from that at the acceleration site through the transport effects such as the Coulomb collision, the magnetic field convergence, and the wave-particle interactions. The transport effects should be included to retrieve the initial information on the electrons at the (unknown) acceleration site from the observations.

Here we study the trap-plus-precipitation (Melrose and Brown 1976) as the electron transport mechanism, by treating the gyro-averaged Fokker-Planck equation. This equation can describe the time evolution of the spatial (along the magnetic field line), spectral, and pitch angle distributions of the electrons in given conditions such as the magnetic field geometry, the ambient (rest) plasma distribution, the electron injection from an unspecified site, and so on. We perform the calculations which include the effects of the Coulomb collision, the magnetic field convergence (geometry of the flare loop), the electron injection and precipitation into the loop.

We will examine the differences of the behavior of the trapped and precipitating electrons especially due to the difference of the pitch angle distribution of the injected electrons. At this time, the results in our model suggest that the pancake pitch angle distribution of the injected electrons rather than the isotropic distribution is qualitatively somewhat favorable to meet the observed characteristics of the non-thermal emissions.