Electron Acceleration in Solar-Flare Magnetic Traps: Model Properties and Their Observational Confirmations

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Using an analytical solution of the kinetic equation, we have investigated the model properties of the coronal and chromospheric hard X-ray sources in the limb flare of July 19, 2012. We calculated the emission spectrum at the flare loop footpoints in the thick-target approximation with a reverse current and showed it to be consistent with the observed one. The spectrum of the coronal source located above the flare loop was calculated in the thin-target approximation. In this case, the slope of the hard X-ray spectrum is reproduced very accurately, but the intensity of the coronal emission is lower than the observed one by several times. Previously, we showed that this contradiction is completely removed if the additional (relative to the primary acceleration in the reconnecting current layer) electron acceleration in the coronal magnetic trap that contracts in the transverse direction and decreases in length during the impulsive flare phase is taken into account. In this paper we study in detail this effect in the context of a more realistic flare scenario, where a whole ensemble of traps existed in the hard X-ray burst time, each of which was at different stages of its evolution: formation, collapse, destruction. Our results point not only to the existence of first-order Fermi acceleration and betatron electron heating in solar flares but also to their high efficiency. Highly accurate observations of a specific flare are used as an example to show that the previously predicted theoretical features of the model find convincing confirmations.