Statistical Analysis of Solar Hard X-ray Flares -Verification of Sakao-type Flare and Parameter Dependence of Hard X-ray Emission-

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From the observations of YOHKOH/HXT, it is found that hard X-ray sources in a solar flare mainly show double-source structure. T. Sakao analyzed seven events of this type flare in detail (Sakao 1994), and he found four tendencies: 1) Double sources are located on both sides of the magnetic neutral line. 2) Brighter source is located in a weaker photospheric magnetic field region. 3) Brighter source have harder energy spectra. 4) Temporal simultaneity of intensities of hard X-ray from double sources is quite high. These results suggest a solar hard X-ray flare model that accelerated electrons are injected in a single magnetic loop and emit hard X-ray with losing energy at both footpoints (Sakao-type).

However, the number of events used for the analysis was limited in Sakao (1994), so we first try to verify the result of Sakao (1994) by using more number of events. We use YOHKOH/HXT and SOHO/MDI data from April 1996 to December 2001, having simultaneous observation for both instruments. Among flare events occurred in this period, we select 24 events in which hard X-ray sources show double-source structure and they are located on both sides of the magnetic neutral line. We examine intensity of hard X-ray, intensity of magnetic field and hard X-ray spectrum of each hard X-ray source. The result is almost consistent with the result of Sakao (1994) when the ratio of intensity of hard X-ray from double sources is less than two.

Then, we are trying to examine parameter dependence of hard X-ray emission. If solar hard X-ray flare could be explained by the magnetic reconnection model, intensity of hard X-ray (I_HXR) would depend on intensity of magnetic field (B) in a flare region. In a B vs I_HXR plane, the scatter plot concentrate in the region below I_HXR proportional to B^(2~3), namely there is an upper bound of I_HXR for a given B. Also this upper-bound line breaks down above ~700 Gauss where no strong hard X-ray flare exists. These results suggest that the B vs I_HXR relation is not straightforward and that other parameters are necessary to determine the I_HXR in a flare.