A simulation on protostar flare and the expected hard X-ray spectrum

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Many X-ray observations have revealed that protostars have strong flare activities. The released energy sometimes reaches 10^{36-37} erg. It is widely accepted that these flares are driven by magnetic reconnection like solar flares. Applying the solar flare mechanism to protostars, we performed hydrodynamic simulations and predicted the hard X-ray spectra. We assumed a magnetic loop of $14R_{\odot}$, in the halfway point of which an accretion disk exists. A flare energy of 10^{36} erg, which consists of thermal and non-thermal energies, is released in the half loop. We found that the evaporation flows from the star and the disk occured so that hot and dense flare loop was formed there. The conduction front was blocked by the disk, and hence the other half loop remained to be a pre-flare loop. However, non-thermal electrons having enough energy could penetrate the disk and released their energy beyond the disk. The expected hard X-ray spectra had a spectral break at about 100 keV, and the shapes were very similar to thouse of solar flares. We also found that the spectral energy distribution was different at some regions in the flare loop due to the collision by non-thermal electrons. This may provide a diagnostic tool to test the existence of the accretion disk in the flare loop.