Magnetohydrodynamic simulations of high temperature plasma flows in protostellar system

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We propose a model of hard X-ray flares in protostars observed by the ASCA satellite. We assumed that the dipole magnetic field of the protostar threads the protostellar disk and carriedout magnetohydrodynamic (MHD) simulations of the disk-star interaction. Outgoing magnetic island and postflare loops are formed as a result of the reconnection. The released magnetic energy partly goes into the thermal energy and heats up the flaring plasma up to 100 million K. The speed of the hot plasmoid ejected by the reconnection is 200-400 km/s. The hot plasma outflow can explain the speed and mass flow rate of optical jets. The formation of chondrules can also be explained by our model.

We propose a model of hard X-ray flares in protostars observed by the ASCA satellite. We assumed that the dipole magnetic field of the protostar threads the protostellar disk and carried out magnetohydrodynamic (MHD) simulations of the disk-star interaction. The closed magnetic loops connecting the central star and the disk are twisted by the rotation of the disk. As the twist accumulates, magnetic loops expand and finally approach the open field configuration. A current sheet is formed inside the expanding loops. In the presence of resistivity, magnetic reconnection takes place in the current sheet. Outgoing magnetic island and postflare loops are formed as a result of the reconnection. The timescale of this flare is the order of the rotation period of the disk. The released magnetic energy partly goes into the thermal energy and heats up the flaring plasma up to 100 million K. The length of the flaring loop is several times the radius of the central star, consistent with observations. The speed of the hot plasmoid ejected by the reconnection is 200-400 km/s when the footpoint of the loop is at 0.03 AU from 1 Solar-Mass protostar. The hot plasma outflow can explain the speed and mass flow rate of optical jets. Dense, cold, magnetically accelerated wind (v=150-250 km/s) emanates from the surface of the disk along the partially open magnetic field lines threading the disk. This dense, cold wind may correspond to high-velocity neutral winds. The formation of chondrules can also be explained by our model.