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Solar-Stellar-Protostellar connection

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Magnetic field plays many important roles in the entire life of stars. Powerful outflows in star forming regions are believed to be driven magnetically and carry angular momentum to drive accretion. The protostars and pre-main-sequence stars are magnetized and interact with the inner disk edge with their magnetic fields. Particularly, classical T-Tauri stars are considered to have magnetospheres that interact with the inner disks. The star-disk interaction via the magnetospheric accretion is expected to play essential roles in the angular momentum evolution of the central stars and the mass ejection (winds/outflows). Solar-type main-sequence stars including the Sun show various magnetic activities such as stellar flares. The impact of stellar flares on the planetary atmospheres has attracted significant attention recently.

The Sun has been showing us how solar flares occur and how the solar atmosphere is heated. Similar magnetic activities are known to occur in other solar-like stars and protostars, but the situations are often very different from the Sun. A fraction of solar-like stars shows a much stronger steady X-ray luminosity (~10^30 erg/s) than the Sun (~10^27 erg/s), which suggests a significant coronal heating even without prominent flare heating. The energy of the largest solar flares on record is estimated to be 10^32 erg, but protostars produce X-ray flares with the energy of 10^37 erg or larger. We have been applying our understanding of solar magnetic activities to these systems to reveal violent stellar activities. We will discuss similarities and differences between the Sun and other stellar and protostellar systems, on the basis of MHD simulations and observations.

References

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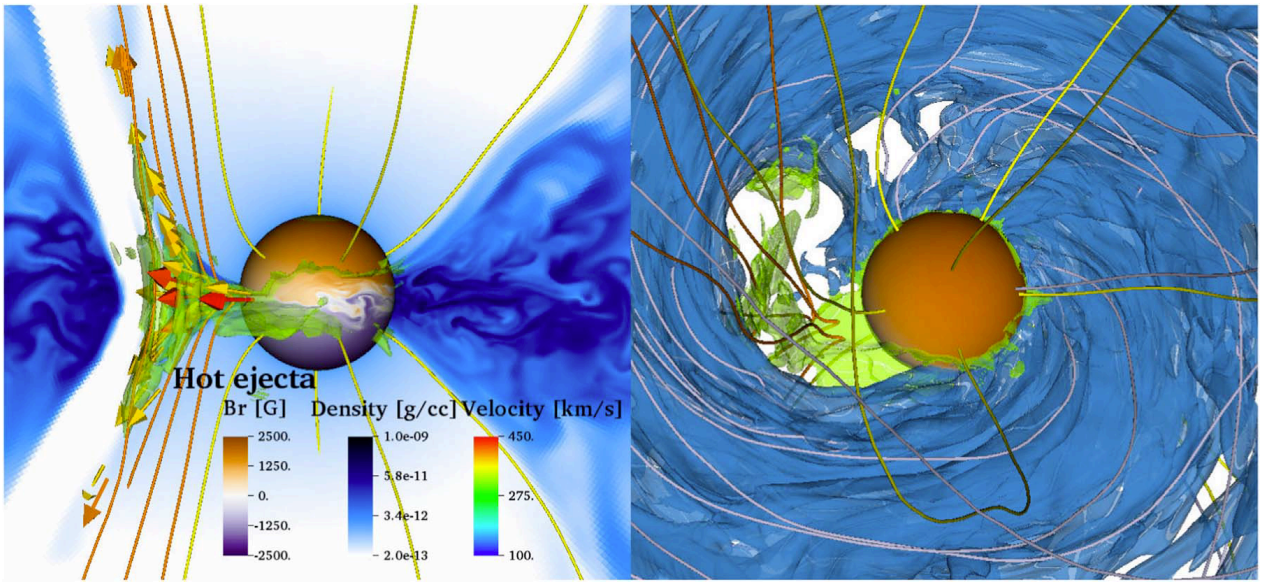

Figure 1 An example of protostellar flare found in the 3D MHD simulation of Takasao et al. (2019). Left: a side view. The density is displayed by the poloidal slice. Right: a top view. The blue isosurface denotes the density of 3 x 10^-11 g/cm^3. In the both panels, the hot plasma ejection is colored in yellow.