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MHD Simulations of Star-Disk Interaction I – Code Development and Initial Results

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In the final phase of the star formation processes, gas accretes through circumstellar disks onto protostars, and the disk and the protostar interact each other via magnetic fields in the innermost region. The structure of the accretion flow in this region is determined by the strength of the stellar magnetic fields and the accretion rate, which depends on angular momentum transport by turbulence driven by the Magneto-Rotational Instability (MRI). Therefore, high resolution MHD simulations are required to study the structure of the accretion flow.

For this purpose, we have extended Athena MHD simulation code (Stone et al. 2008) by implementing a new MHD solver for spherical polar coordinates. Our new solver is consistent with the concept of the finite volume method. The new code has an excellent parallel performance, which scales very well with more than 10,000 CPU cores. With this code, we performed MHD simulations similar to Romanova et al. (2012) with sufficient resolution to resolve MRI within the disk. We successfully simulated the accretion flow which is driven by MRI and flows along the stellar field lines (so-called funnel flow) in the vicinity of the central star.