Astronomy in Focus - XXX
Proceedings IAU Symposium No. XXX, 2018
M. T. Lago, ed.

doi:10.1017/S1743921319003892

3D simulations of accretion onto a star: Fast funnel-wall accretion

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Abstract. We show the results of global 3D magnetohydrodynamics simulations of an accretion disk with a rotating, weakly magnetized central star (Takasao *et al.* 2018). The disk is threaded by a weak large-scale poloidal magnetic field. The central star has no strong stellar magnetosphere initially and is only weakly magnetized. We investigate the structure of the accretion flows from a turbulent accretion disk onto the star. Our simulations reveal that fast accretion onto the star at high latitudes is established even without a stellar magnetosphere. We find that the failed disk wind becomes the fast, high-latitude accretion as a result of angular momentum exchange mediated by magnetic fields. The rapid angular momentum exchange occurs well above the disk, where the Lorentz force that decelerates the rotational motion of gas can be comparable to the centrifugal force. Unlike the classical magnetospheric accretion model, fast accretion streams are not guided by magnetic fields of the stellar magnetosphere. Nevertheless, the accretion velocity reaches the free-fall velocity at the stellar surface owing to the efficient angular momentum loss at a distant place from the star. Our model can be applied to Herbig Ae/Be stars whose magnetic fields are generally not strong enough to form magnetospheres, and also provides a possible explanation why Herbig Ae/Be stars show indications of fast accretion.

Reference

Takasao, S.,Tomida, K., Iwasaki, K., & Suzuki, K.T. 2018, *ApJ*, 857, 4