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The impact of non-ideal effects on the circumstellar disk evolution and their observational signatures

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Abstract. It has been recognized that non-ideal MHD effects (Ohmic diffusion, Hall effect, ambipolar diffusion) play crucial roles for the circumstellar disk formation and evolution. Ohmic and ambipolar diffusion decouple the gas and the magnetic field, and significantly reduces the magnetic torque in the disk, which enables the formation of the circumstellar disk (e.g., Tsukamoto *et al.* 2015b). They set an upper limit to the magnetic field strength of ~ 0.1 G around the disk (Masson *et al.* 2016). The Hall effect notably changes the magnetic torques in the envelope around the disk, and strengthens or weakens the magnetic braking depending on the relative orientation of magnetic field and angular momentum. This suggests that the bimodal evolution of the disk size possibly occurs in the early disk evolutionary phase (Tsukamoto *et al.* 2015a, Tsukamoto *et al.* 2017). Hall effect and ambipolar diffusion imprint the possibly observable characteristic velocity structures in the envelope of Class 0/I YSOs. Hall effect forms a counter-rotating envelope around the disk. Our simulations show that counter rotating envelope has the size of 100–1000 au and a recent observation actually infers such a structure (Takakuwa*et al.* 2018). Ambipolar diffusion causes the significant ion-neutral drift in the envelopes. Our simulations show that the drift velocity of ion could become 100-1000 m s^{-1}.

Keywords. stars: formation, protoplanetary disks, magnetic fields

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