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Kinematics of neutral and ionzied gas in the candidate protostar with efficient magnetic braking B335

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Abstract. Ambipolar diffusion can cause a velocity drift between ions and neutrals. This is one of the non-ideal MHD effects proposed to enable the formation of large Keplerian disks with sizes of tens of au (Zhao *et al.* 2018). To observationally study ambipolar diffusion in collapsing protostellar envelopes, we analyzed the ALMA $H^{13}CO^+$ (3–2) and $C^{18}O$ (2–1) data of the protostar B335, which is a candidate source with efficient magnetic braking (Yen *et al.* 2015). We constructed kinematical models to fit the velocity structures observed in $H^{13}CO^+$ and $C^{18}O$. With our kinematical models, the infalling velocities in $H^{13}CO^+$ and $C^{18}O$ are both measured to be 0.85 ± 0.2 km s^{-1} at a radius of 100 au, suggesting that the velocity drift between the ionized and neutral gas is at most 0.3 km s^{-1} at a radius of 100 au in B335. The Hall parameter for $H^{13}CO^+$ is estimated to be $\gg 1$ on a 100 au scale in B335, so that $H^{13}CO^+$ is expected to be attached to the magnetic field. Our non-detection or upper limit of the velocity drift between the ionized and neutral gas could suggest that the magnetic field remains rather well coupled to the bulk neutral material on a 100 au scale in B335, and that any significant field-matter decoupling, if present, likely occurs only on a smaller scale, leading to an accumulation of magnetic flux and thus efficient magnetic braking in the inner envelope in B335.

References

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