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Gravitational instability by suppression of magnetic turbulence by electric-field heating

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Turbulence in protoplanetary disks is essential for disk evolution since the turbulence transport angular momentum outside and the gas falls into the central star. One of possible mechanism of generating the turbulence is magnetorotational instability (MRI; Balbus & Hawlley 1991). In a region far from the star where MRI fully develops, electric fields induced by MRI will heat up electrons (electric-field heating; Inutsuka & Sano, 2005). When the electric-field heating occurs, heated electrons tends to collide with and be captured by dust grains. Since number density of electrons decreases in the gas-phase, finally magnetic fields may disperse (Okuzumi & Inutsuka, 2015). For MRI, the dispersion of magnetic fields implies suppression of the magnetic turbulence. We have investigated where and how MRI turbulence is suppressed in protoplanetary disks so far. As a result, we have estimated the MRI turbulence is suppressed within approximately 100 AU on the mid-plane (electric-field heating region; the fall meeting of the Japanese Society for Planetary Sciences, 2014).

The purpose in this study is to investigate where the gas is accumulated in the disk considering electric-field heating.
In a vigorous turbulent region, the turbulence transports angular momentum of gas and the gas falls into the central star. On the other hand, in a weak turbulent region, accretion gas from outer disk is accumulated because of inefficiency of angular momentum transport. Therefore, the broad suppression of MRI turbulence will change the global disk structure of surface denaity(Mori & Okuzumi, in prep.). The fallen gas is accumulated in the inner region where MRI does not grow (dead zone; Gammie 1996), and the possibility is pointed out that gravitational instability occurs in the region. Considering the electric field heating of our study, the gas will be accumulated in broader region.

We calculated the relation between surface density and mass accretion rate at each place in disks. As our disk model, we set the disk containing 0.1 um-sized dust grain with dust-to-gas mass ratio of 0.01, and the gas pressure to the magnetic pressure on the mid-plane to be 10^4. As a result, with the mass accretion rate of $10^{-7} \mathrm{M}\odot/yr, thesurfacedensityrealizingthesteadyaccretiondoesnote$

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