Study on growth potential of magneto-rotational instability at an accretion discs

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The accretion disc observed around protoplanets, close binary systems and active galactic nuclei was composed of a gas and a dust. It's considered that these materials release the gravitational energy and fall in a central object by transporting the angular momentum from the inside region to the outside region of the disc. However, the mechanism for transporting the angular momentum has been an open question.

The candidate for this problem is the magnetic turbulence. At the first time, Lynden-bell(1969) pointed out the importance of the magnetic stress as the origin of great viscosity in the accretion disc. The MRI which has a much growth rate in the weakly magnetized disc is suggested by Balbus and Hawley(1991). MRI was found by Velikhov(1959) and Chandrasekhar(1961). On the one hand, Balbus and Hawley(1991) pointed out that this mechanism was efficient for the angular momentum transport in the accretion disc. Afterward, Stone et al.(1996) suggested that the turbulence cased by the MRI transported sufficiently a number of the angular momentum using by the three dimensional simulation under a specific physical condition in the accretion disc around a black hole. On the other hand, this mechanism is not effective for the protoplanetary discs due to its lower ionization degree[Nishimura, 2006].

In respect of the protoplanetary discs under the condition of the class 2 which is the most turbulent condition, Sano et al.(2000) showed that the presence of dust is interrupt this instability, and suggested that MRI is no effective till the beginning of the class 3 which the dust settled equatorial plane. Because the dust have a high proportion of the mass, the angular momentum distribution confirmed the current solar system has to been explained the angular momentum transport including the dust. Moreover, the accretion disc at the close binary system and the active galactic nuclei is as the fully ionized plasma without the anomalous resistance found the high energy condition.

In this study, we investigate the fundamental process for the MRI and the effect of the magnetic diffusion caused by the coulomb collision and the anomalous resistance under the condition of the fully ionized plasma. In addition, dependence of the mode instability is discussed here.

As a result, we confirmed that the growth rate of the MRI is the highest when both of the magnetic field and the wave vector are perpendicular for the accretion discs. This is due to the property of Alfven wave that disturbance growing up along the radial direction at accretion disc. Additionally, we estimate the effect of magnetic diffusion and viscosity of fully ionized plasma with magnetic Reynolds number and Reynolds number. When the magnetic diffusion or viscosity is distinguished, the peak of linear growth rate become small. And for this analytical result on linear analysis of MRI, we deliver that magneto field intensity and density must have some applicable domain. The result considered for anomalous resistance, it's showed this effect exceed coulomb collision effect. Although Anomalous resistance based on micro instabilities on accretion disc strongly depend on intensity and wave length of electrostatic plasma wave in excited plasma wave, it's showed the effect of anomalous resistance have a considerable impact.

thus, to resolve the problem that angular momentum transport supporting activity of accretion disc existing under various physical circumstance, it's considered necessary that investigating not only MRI but also an other MHD instability(Parker instability), an effect not described a single MHD(hall effect), an instability attributed a nonuniformity of disc(drift instability) and kinematic plasma instability.