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Effects by the inhomogeneous MRI growth on the process of the planetesimal formation

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We take a magnetohydorodynamic approach to the planet formation. Planets are formed in a protoplanetary disk as planetesimals coagulate with each other. However, we have not known the exact scenario of the formation. For example, the formation of planetesimals is a long standing unsolved problem. Planetesimals supposed to be formed via gravitational instability of dust particles when their density is somehow made to exceed a threshold. In theory, however, dust particles in a protoplanetary disk fall quickly to the central star because of the drag from the disk gas that rotates slower than the dust particles (dust in-fall problem). Be this true, there is no material left in the disk to form planets. Then, in order to see if the dust in-fall problem can be rescued and if the planetesimal formation can be realized, we study the property of the Magneto Rotational Instability (MRI) in a protoplanetary disk and the dust motion affected by the MRI. Since a protoplanetary disk is weakly-ionized, linear analyses show that a region with small vertical magnetic field has a smaller MRI growth rate and vice versa (Gammie, 1996; Sano & Miyama, 1999). We ever have studied the flow patterns produced by the non-uniformly growing MRI by situating a MRI unstable and a MRI stable annulus in the simulation box of 3D resistive MHD simulation with the local approximation. Additionally, we have included dusts as test particles and followed their motion. As a result, we found that the gas rotates faster than the dust particles in some part of the disk. The particles could not only be prevented from the in-fall but also be concentrated at the outer edge of the gas super-rotating zone substantially, which is a crucial process for planetesimal formation. Then we perform a global 3D simulation to cross-examine the planetesimal formation.