Magnetorotational Instability in Accretion Disk Plasmas: Quantum Mechanical Approach

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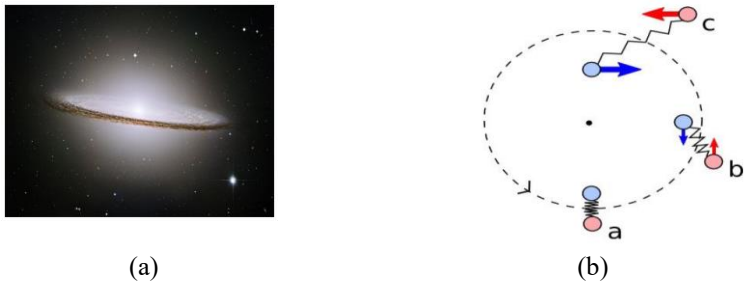
In rotating plasma when the angular velocity of a magnetized fluid changes with the distance from the center of rotation, a magnetic field destabilizes the rotating velocity field and fluid instability occurs, called magnetorotational instability (MRI). The MRI remains as the principal mechanism facilitating plasma turbulence, angular momentum transport, and consequently causes the materials in the accretion disks to fall inward to feed the stars or the black holes.

An accretion disk is a disklike flow of gas, plasma, dust, or particles around any astronomical object in which the material orbiting in the gravitational field of the object loses energy and angular momentum as it slowly spirals inward. We in this talk will focus on MRI in complex quantum plasma, in accretion disk around compact objects like Black hole or Neutron star, using multi fluid quantum hydrodynamic approach. Electrons are degenerate while ions and dust like other particles are considered as nondegenerate.

The general dispersion relation for MRI with the effect of spin magnetization is derived using local approximations. The instability criteria for spin quantum plasma are derived using low-frequency approximations. Due to the complex nature of the dispersion relation, MHD assumptions are used to define the instability criteria. The dust mass plays a significant role in both the dispersion and growth rate of the magnetorotational mode. The complex mass of dust modifies the instability criteria. It is found that spin magnetization influences the criteria for instability and hence the properties of MHD waves in the degenerate plasma.

References

[1] Balbus, S. A., & Hawley, J. F. 1991, ApJ, 376, 214
[2] Balbus, S. A., & Hawley, J. F. 1998, RvMP, 70, 1
[3] Zuckerman, B., Koester, D., Reid, I. N., & Hünsch, M. 2003, ApJ, 596, 477
[4] Omand, C. M., Kashiyama, K., & Murase, K. 2019, MNRAS, 484



(a) (b)

Figure 1. (a) The astrophysical accretion disk image and analogue of simple model of MRI