[구IM-01] Tidal Disruption Flares from Stars on Bound Orbits

Kimitake Hayasaki[1,2] , Nicholas Stone[2] , Abraham Loeb[2]
[1]Korea Astronomy and Space Science Institute, [2]Institute for Theory and Computation, Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA02138, USA

We study tidal disruption and subsequent mass fallback process for stars approaching supermassive black holes on bound orbits, by performing three dimensional Smoothed Particle Hydrodynamics simulations with a pseudo-Newtonian potential. We find that the mass fallback rate decays with the expected −5/3 power of time for parabolic orbits, albeit with a slight deviation due to the self-gravity of the stellar debris. For eccentric orbits, however, there is a critical value of the orbital eccentricity, significantly below which all of the stellar debris is bound to the supermassive black hole. All the mass therefore falls back to the supermassive black hole in a much shorter time than in the standard, parabolic case. The resultant mass fallback rate considerably exceeds the Eddington accretion rate and substantially differs from the −5/3 power of time. We also show that general relativistic precession is crucial for accretion disk formation via circularization of stellar debris from stars on moderately eccentric orbits.

[구IM-02] INVERSE ENERGY CASCADE AND IMBALANCED ELECTRON MAGNETOHYDRODYNAMIC TURBULENCE

Hoonkyu Kim and Junhyeon Cho
Dept. of Astronomy and Space Science, Chunnam National Univ., Daejeon, Korea

Electron magnetohydrodynamic (EMHD) turbulence provides a fluid-like description of small-scale magnetized plasmas. Most EMHD turbulence studies consider “balanced” EMHD turbulence. However, imbalanced EMHD turbulence has never been studied. In this study, we numerically study “imbalanced” EMHD turbulence. Imbalanced turbulence means that wave packets moving in one direction have high amplitudes or strong perturbations than the others. In driven imbalanced EMHD turbulence, non-zero magnetic helicity is injected. When magnetic helicity is injected at a scale, we expect to have inverse cascade of magnetic helicity, as well as magnetic energy, in three-dimensional (3D) EMHD turbulence. For no helicity injection, we do not observe inverse energy cascade. However, when magnetic helicity is injected, inverse cascade of magnetic helicity is clearly observed . Magnetic energy also shows inverse cascade. In EMHD turbulence, it is well known that magnetic energy on scales smaller than the energy injection scale is forward-cascading quantity and the magnetic energy spectrum follows a k^{-7/3} one. On the other hand, the inverse-cascading entity on scales larger than the energy injection scale is uncertain. If the magnetic helicity is inverse-cascading quantity, we will obtain a k^{-5/3} magnetic energy spectrum. In our simulations, we do observe energy spectrum consistant with k^{-5/3} on large scales. Therefore, we confirm that magnetic helicity indeed is the inverse-cascading entity in 3D EMHD turbulence.