KH渦の2次的不安定による乱流発展：2次元性と3次元性の比較

松本 洋介 [1]; 関 華奈子 [2]
[1] 名大環境; [2] 名大 STE 研

Turbulent evolution of the KH instability: Comparison between 2-D and 3-D secondary instabilities

Yosuke Matsumoto[1]; Kanako Seki[2]
[1] SELIS, Nagoya Univ.; [2] STEL, Nagoya Univ.

High Reynolds number flow is always subject to generation of turbulence. In space plasma, the collision-less property indicates that plasma is a high Reynolds number medium, and understanding of its turbulent nature gives us a new idea of energy and mass transport in a collision-less plasma system. In fact, in-situ observations often revealed a turbulent nature in the plasma sheet [e.g., Borovsky and Funsten, 2003] and in the solar wind [e.g., Matthaeus and Goldstein, 1982]. Turbulence in the LLBL has also been discussed [Antonova, 2006], although the observational evidences still have been limited. Generation mechanism of the turbulence can be categorized in two ways: Alfven wave turbulence or a high Reynolds number flow turbulence. The latter was found out to be dominant mechanism in the plasma sheet and considered to be possibly important in the LLBL where the shear flow instability, i.e., the Kelvin-Helmholtz instability (KHI), may play a significant role [Borovsky and Funsten, 2003].

We have shown by simulation studies that the strong flow turbulence is a natural consequence of the nonlinear development of the KHI through the secondary Rayleigh-Taylor instability, if there is large density difference between the two media. The mechanism takes place in a 2-D plane and therefore we term it 2-D secondary instability. More recently, we have shown the three-dimensional nonlinear evolution of the KHI by performing MHD simulation. The KH vortex is also susceptible to the 3-D secondary instability which converts the rotating energy into the magnetic energy by generating large amplitude Alfvenic fluctuations. Following the previous 3-D simulation study, we have newly found that the nonlinear evolution of the large amplitude Alfvenic fluctuations are subject to the magnetic turbulence: Once the 3-D secondary instability is excited, the mode cascade starts after the amplitude of the fluctuation reaches about 3% of the background field. In particular, in a low beta condition, the secondary instability excites only a long wave mode and then it finally shows the energy cascade to the short wave mode. We examined some simulation runs under varying plasma beta and background flow speed conditions to understand this signature. Even though the time evolution of the secondary instability and its characteristic mode are different among the simulation runs, we obtained a similar result that the mode cascade starts at the time when the amplitude of the fluctuations reaches the same level. The present result implies that even in a strong magnetic field condition, generation of turbulence can be achieved by the 3-D secondary instability through the nonlinear development of the Alfvenic fluctuation in contrast to the 2-D secondary instability driven by the hydrodynamical instability. The detailed mechanism of the turbulence and the coupling between the 2-D and the 3-D secondary instability is discussed in this talk.