Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM30-P01 Room:Poster Time:April 30 18:15-19:30

Alfven wave resonance in density profile structure and the effect for nonlinear phenomenon

TSUTSUMI, Akihiro[1*] ; SUZUKI, Takeru[1]

[1]Nagoya University

Wave transport in plasma (e.g. Alfven wave) is a universal phenomenon for astrophysical fluid which is effected by electromagnetic force. Presence of

density structure in plasma causes these wave reflection, and prevents smooth transport for one direction. However, it is known that if the density structure is like square well form, Alfven wave is trapped in the structure and wave reflection does not occur. It seems that this wave trapping is a ordinary case and concerns with physical phenomenon, because density valley usual exist in plasma. For example, it is pointed out that Alfven wave energy is dissipated at low-density area which is located in surface of the sun, and this mechanism is relate to coronal heating.

At linear phase, we can understand analytically the property of Alfven wave transport on square well density profile. Therefore, we can also understand the condition that wave trapping and no reflection occurs. At this phase, the flow is well-regulated and steady state, and compressibility effect (e.g. pressure or density vary) doesn't appear because Alfven wave is essentially transverse wave. However, as the wave injection continues, the amplitude increases and nonlinear effect turns important. At this phase, the flow is complicated due to trapped wave's collision, and square well density profile can not keep the form. As a result, the resonance condition will change voluntarily. This density profile is universal in the plasma gas, so above physical mechanism is important for understanding plasma phenomenon.

In our numerical simulation, we pay attention voluntarily structural change due to linear phase shift to nonlinear phase. Consequently, the linear phase resonance condition directly affects the time evolution in nonlinear phase. We will introduce the result.

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The effect of the ion gyro motion to nonlinear processes of the Kelvin-Helmholtz instability

UENO, Satoshi[1*] ; UMEDA, Takayuki[1] ; NAKAMURA, Takuma[2] ; MACHIDA, Shinobu[1]

[1]Solar-Terrestrial Environment Laboratory, [2]Los Alamos National Laboratory

Nonlinear evolution of the Kelvin-Helmholtz instability (KHI) at a transverse velocity shear layer in an inhomogeneous space plasma is investigated by means of a four-dimensional (two spatial and two velocity dimensions) electromagnetic Vlasov simulation. When the rotation direction of the primary KH vortex and the direction of ion gyro motion are same, there exists a strong ion cyclotron damping. In this case, spatial inhomogeneity inside the primary KH vortex is smoothed and the secondary Rayleigh-Taylor instability is suppressed. The ion gyro motion also suppresses the formation of secondary vortices in the spatial scale smaller than the ion gyro radius, when the rotation direction of the vortex and the direction of ion gyro motion are same. As a result, the secondary instabilities take place at different locations in the primary KH vortex, where the rotation direction of the secondary vortex and the direction of ion gyro motion are opposite. These results indicate that secondary instabilities occurring in the nonlinear stage of the primary KHI at the Earth's magnetospheric boundaries might show dawn-dusk asymmetries.

Keywords: the Kelvin-Helmholtz instability, Vlasov simulation, space plasma, nonlinear processes, secondary instabilities

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Magnetohydrodynamic and Radiation Hydrodynamic Simulations of Tidal Disruption Events by a Supermassive Black Hole

KAWASHIMA, Tomohisa[1] ; OHSUGA, Ken[2] ; MATSUMOTO, Ryoji[3*]

[1]Shanghai Astronomical Observatory, [2]NAOJ, [3]Chiba University

Gas clouds or a star approaching a supermassive black hole can be disrupted by its tidal force. Such tidal disruption events enable us to observe the luminosity variations and state transitions triggered by the increase of the accretion rate, and give us hints to understand the transitions between different types of active galactic nuclei. Furthermore, the interval between the state transitions restricts the angular momentum transport rate, which determines the time scale of viscous evolution of an accretion disk. In 2014, tidal disruption flares are expected in two objects. One is the Galactic center supermassive black hole Sgr A∗. A gas cloud named G2, whose mass is three times of the Earth mass is now approaching Sgr A∗, and its pericenter passage will be in March, 2014. Since the distance from the black hole is well inside the radius of the accretion disk around Sgr A∗, the tidally disrupted gas cloud will interact with the accretion disk. We carried out three-dimensional magnetohydrodynamic simulations of this interaction by applying a MHD code CANS+ based on the HLLD scheme. We found that the accretion rate increases more than 10 times during this outburst, and that magnetically driven jets are ejected. Increase of the X-ray and radio luminosity takes place within 1 month after the passage. The second object we expect an outburst is Swift J1644+57, which showed extremely high energy outburst in March 2011. This object locates at the center of a galaxy at redshift z=0.35. The energy released in this outburst indicates that the outburst was triggered by a disruption of a star. The luminosity of this source exceeded the Eddington luminosity for a 1-million solar mass black hole for period longer than a year but the X-ray luminosity decreased 100 times in August 2012. This darkening can be interpreted as the transition from a supercritically accreting slim disk state to a sub-critically accreting standard disk state. We carried out radiation hydrodynamic simulations of this event and showed that mass of the stellar debris is accumulating in the outer disk. When the surface density of the outer disk exceeds the threshold for the transition from a standard disk to a slim disk, the disk mass will accrete supercritically onto the black hole. Numerical results indicate that the luminosity of Swift J1644+57 may exceed the Eddington luminosity again in 1-2 years from the darkening.

Keywords: accretion disk, MHD, radiation hydrodynamics, black hole, tidal disruption, state transition