eigenvalue with the maximum growth rate is found to correspond to a thermal condensation mode, for which the density and temperature variations are anti-phased (of opposite signs). Only when the shear velocity in the k-direction is near zero, the eigenfunctions for the condensation mode are of smooth sinusoidal forms. Otherwise each eigenfunction for density and temperature is singular and of a discrete form like delta functions. Our results indicate that any non-uniform velocity field with a magnitude larger than a millionth of the Alfven velocity can generate discrete eigenfunctions of the condensation mode. We therefore suggest that condensation at discrete layers or threads should be quite a natural and universal process whenever a thermal instability arises in magnetized plasmas.

[구 HT-05] Electron Pre-acceleration in Weak Quasi-perpendicular Shocks in Clusters of Galaxies

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Giant radio relics in the outskirts of galaxy clusters have been observed and they are interpreted as synchrotron emission from relativistic electrons accelerated via diffusive shock acceleration (DSA) in weak shocks of Ms < 3.0. In the DSA theory, the particle momentum should be greater than a few times the momentum of thermal protons to cross the shock transition and participate in the Fermi acceleration process. In the equilibrium, the momentum of thermal electrons is much smaller than the momentum of thermal protons, so electrons need to be pre-accelerated before they can go through DSA. To investigate such electron injection process, we study the electron pre-acceleration in weak quasi-perpendicular shocks (Ms = 2.0 - 3.0) in an ICM plasma (kT = 8.6 keV, beta = 100) through 2D particle-in-cell simulations. It is known that in quasi-perpendicular shocks, a substantial fraction of electrons could be reflected upstream, gain energy via shock drift acceleration (SDA), and generate oblique waves via the electron firehose instability (EFI), leading the energization of electrons through wave-particle interactions. We find that such kinetic processes are effective only in supercritical shocks above a critical Mach number, Ms* ~ 2.3. In addition, even in shocks with Ms > 2.3, energized electrons may not reach high energies to be injected to DSA, because the oblique EFI alone fails to generate long-wavelength waves. Our results should have implications for the origin and nature of radio relics.

[구 HT-06] Radio relics in merging clusters of galaxies

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Clusters of galaxies shape up through a series of hierarchical mergers. It is believed that major mergers lead to cluster-wide shock waves, which are manifested as radio relics. The 1RXS J0603.0+4213 and CIZA J2242.8+5301 clusters, for instance, contain Mpc-size giant radio relics in the outskirts. Synchrotron emission from these radio relics reveals the presence of relativistic electrons and the magnetic fields of a few μG strength. The presence of such magnetic fields in the ICM has been explained by the so-called small-scale turbulent dynamo. To get quantitative measures for magnetic fields in clusters of galaxies, we investigate the development of turbulence and the follow-up amplification of magnetic fields through three-dimensional numerical magnetohydrodynamical (MHD) simulations. The turbulence is induced in highly stratified cluster media, and driven sporadically by major mergers. We here present the results, aiming to answer whether the turbulence dynamo scenario can explain the observed strength and scale of magnetic fields in clusters. Also, we discuss whether the observed properties of giant radio relics can be reproduced in our simulations.

태양/태양계

[구 SS-01] The wave nature of halo coronal mass ejections (파동으로서의 태양 코로나질량방출 현상 연구)

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햇무리(halo) 모양 코로나질량방출(coroanl mass ejection) 현상은 1970년대 후반 처음 발견된 이후, 그 물리적 본질에 대해 많은 논쟁이 있었다. 우주 망원경 SOHO LASCO의 고분해능 관측이후, 햇무리 모양은 시선방향에 나란한 방향으로 팽창하며 진행하는 고깔모양의 자기 구조(cone-shaped magnetic flux rope)가 2차원 관측이미지에 투영된 것으로 해석하는 것이 정설이다. 우