고에너지천문학/이론천문학

[구 HT-01] Morphology of radio relics in galaxy clusters

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Galaxy clusters host Mpc-scale diffuse radio emission giving us evidence of large-scale magnetic fields in the Universe. It is relevant to understand magnetic field amplification processes occurring at the center and outskirts of galaxy clusters. Each of these processes are believed to give rise to observed radio haloes and radio relics, respectively. In this work, we focus on studying the continuum and polarised emission in radio relics. We use threedimensional

magnetohydrodynamical simulations of merger shock waves propagating through a magnetized, turbulent intracluster medium. Our model includes the diffusive shock acceleration (DSA) of cosmic ray electrons, their spatial advection and energy losses at run-time. We discuss the relation between the mock observation features and the underlying morphology of the magnetic field.

[구 HT-02] A PIC Simulation Study for Electron Preacceleration at Weak Quasi-Perpendicular Galaxy Cluster Shocks

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In the outskirts of galaxy clusters, weak shocks with $M_s < \sim 3$ appear as radio relics where the synchrotron radiation is emitted from cosmic-ray (CR) electrons. To understand the production of CR electrons through the so-called diffusive shock acceleration (DSA), the electron injection into the DSA process at shocks in the hot intracluster medium (ICM) has to be described. However, the injection remains as an unsolved, outstanding problem. To explore this problem, 2D Particle-in-Cell (PIC) simulations were performed. In this talk, we present the electron preacceleration mechanism mediated by multi-scale plasma waves in the shock transition zone. In particular, we find that the electron preacceleration is effective only in the supercritical shocks, which have the sonic Mach number $M_s > M_{crit} \approx 2.3$ in the high-beta (β∼100) plasma of the ICM, because the Alfven ion cyclotron instability operates and hence multi-scale plasma waves are induced only in such supercritical shocks. Our findings will help to understand the nature of radio relics in galaxy clusters.

[구 HT-03] Structures and Energetics of Flows in Ultra-relativistic Jets

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We study ultra-relativistic jets on several tens kpc scales through three-dimensional relativistic hydrodynamic (RHD) simulations using a new RHD code based on the weighted essentially non-oscillatory (WENO) scheme. Utilizing the high-resolution and high-accuracy capabilities of the new code, we especially explore the structures and energetics of nonlinear flows, such as shocks, turbulence, velocity shear in different parts of jets. We find that the mildly relativistic shocks which form in the jet backflow are most effective for the shock dissipation of the jet energy, while the turbulent dissipation is largest either in the backflow or in the shocked ICM, depending on the jet parameter. The velocity shear is strongest across the jet flow to the cocoon boundary. Our results should have important implications for the studies of high-energy cosmic-ray production in radio galaxies.

[구 HT-04] Spectral variability of Blazar 3C 279 during 2009-2018

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블레이자는 제트가 관측자 시선방향과 나란하게 놓여있는 활동은하핵(AGN)으로 모든 파장대역에서 변광을 보이는 것이 주요 특징이다. 우리는 블레이자의 변광특성을 이해하기 위해 강한 변광을 보이는 천체인 3C 279를 연구대상으로 선정했고, 9년간의 X선 및 광학 데이터를 이용하여 이 천체의 광도와 스펙트럼 기울기 사이의 상관관계분석을 수행하였다. 이를 통하여, 시간에 따라 상관계수가 변한다는 것과 X선 변광이 광학변광보다 65일 앞선다는 것을 발견하였다. 이 발표에서는 one-zone SED 모형을 이용해 위의 현상들을 해석한 결과를 제시한다.

[석 HT-05] X-ray orbital light curve modelling of HESS J0632+057 using intrabinary shock model