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Redshift space distortion (RSD) is known as a powerful cosmological probe. The large-scale RSD has been detected by various redshift surveys and continues to be a major target of ongoing surveys. On the other hand, the small-scale RSD, called finger-of-god (FoG) effect, also has cosmological information, because different cosmological parameters cause different halo mass functions and viriarized velocities. We define the "length" of FoG and examine its dependence on cosmological parameters using the Multiverse simulation. We also use the SDSS DR7 data to see how strong constraints current data sets could provide. It is found that the volume-limited subsample D5, consisting of ~100,000 galaxies at z~0.08, yields $\Delta \Omega_m ~ 0.02$.

고에너지/이론천문

[구 HT-01] Proton Acceleration in Weak Quasi-parallel Intracluster Shocks: Injection and Early Acceleration

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Collisionless shocks with low sonic Mach numbers, $M < 4$, are expected to accelerate cosmic ray (CR) protons via diffusive shock acceleration (DSA) in the intracluster medium (ICM). However, observational evidence for CR protons in the ICM has yet to be established. Performing particle-in-cell simulations, we study the injection of protons into DSA and the early development of a nonthermal particle population in weak shocks in high β plasmas. Reflection of incident protons, self-excitation of plasma waves via CR-driven instabilities, and multiple cycles of shock drift acceleration are essential to the early acceleration of CR protons in supercritical quasi-parallel shocks. We find that only in ICM shocks with $M \geq 2.3$, a sufficient fraction of incoming protons are reflected by the overshoot in the shock electric potential and magnetic mirror at locally perpendicular magnetic fields, leading to efficient excitation of magnetic waves via CR streaming instabilities and the injection into the DSA process. Since a significant fraction of ICM shocks have $M < 2.3$ CR proton acceleration in the ICM might be less efficient than previously expected. This may explain why the diffuse gamma-ray emission from galaxy clusters due to proton-proton collisions has not been detected so far.

[구 HT-02] Evolution of particle acceleration and instabilities in galaxy cluster shocks

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When galaxy clusters interact, the intergalactic gas collides, forming shocks that are characterized by a low sonic Mach number (~3) but a comparatively high Alfvenic Mach number (~30). Such shocks behave differently from the more common astrophysical shocks, which tend to have higher sonic Mach numbers.

We wish to determine whether these shocks, despite their low sonic Mach number, are capable of accelerating particles and thereby contributing to the cosmic ray spectrum.

Using the PIC-MHD method, which separates the gas into a thermal and a non-thermal component to increase computational efficiency, and relying on existing PIC simulations to determine the rate at which non-thermal particles are injected in the shock, we investigate the evolution of galaxy cluster shocks and their ability to accelerate particles.

Depending on the chosen injection fraction of non-thermal particles into the shock, we find that even low-Mach shocks are capable of accelerating particles. However, the interaction between supra-thermal particles and the local magnetic field triggers instabilities and turbulence in the magnetic field. This causes the shock to weaken, which in turn reduces the effectiveness of the supra-thermal particle injection. We investigate how this influences the shock evolution by reducing the particle injection rate and energy and find that a reduction of the particle injection fraction at this stage causes an immediate reduction of both upstream and downstream instabilities. This inhibits particle acceleration. Over time, as the instabilities fade, the shock surface straightens, allowing the shock to recover. Eventually, we would expect this to increase the efficiency of the particle injection and acceleration to previous levels, starting the same series of events in an ongoing cycle of increasing and decreasing particle acceleration.

[구 HT-03] X-ray properties of PWNe measured with the NuSTAR telescopes

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Young pulsar wind nebulae, powered by energetic central pulsars, are often observed as bright extended sources in the X-ray band. They are believed to accelerate electrons and positrons to very high energy and can possibly explain the positron excess observed by Fermi and AMS. The electron distribution in these PWNe can be best studied by X-ray satellites because emission in the X-ray band is produced by direct synchrotron radiation of the electrons and positrons. We present NuSTAR studies of PWNe and discuss the implication. Future studies to help further our understanding of particle acceleration will be briefly discussed.

[구 HT-04] Pair-wise peculiar velocity and the redshift space distortion

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The line-of-sight component in the relative motion of galaxy pairs sources the redshift space distortion (RSD) in galaxy surveys. By knowing the probability density function (PDF) of pair-wise motions and projecting it to the line-of-sight direction, one can compute the RSD effect precisely. I present the pair-velocity PDF of dark matter and galaxies in the Horizon-run 4 simulation. I also derive a model motivated by the perturbation theory which fits the results fairly well. I also discuss the application of the model in constraining the cosmology.

[석 HT-05] PWN SED modeling: stationary and time-dependent leptonic scenarios

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We develop a model for broadband spectral energy distribution (SED) of Pulsar Wind Nebulae (PWNe). The model assumes that electrons/positrons in the pulsar wind are injected into and stochastically accelerated in the pulsar termination shock. We consider two scenarios: a stationary one-zone case and a time-evolving multi-zone case. In the latter scenario, flow properties in the PWNe (magnetic field, bulk speed) are modeled to vary in time and space. We apply the model to the broadband SED of the pulsar wind nebula 3C 58. From the modeling, we find that a broken power-law injection is required with the maximum electron energy of ~200 TeV.

천문우주관측기술

[구 AI-01] Korean 8m Class Optical Facility: Gemini Observatory

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As of July 24th 208, Korea Astronomy and Space Science Institute (KASI) has entered into a formal partnership with the Gemini Observatory. The Gemini Observatory has been operated by Association of Universities for Research in Astronomy (AURA) on behalf of the International Partnership that includes Argentina, Brazil, Canada, Chile, United States, and Korea as the new partner country. Effective from the 209A Call for Proposals (CfP), any researchers affiliated with Korean institutes are eligible to apply for various observing opportunities in both hemispheres covered by Gemini North in Hawaii and by Gemini South in Chile. We are going to share the importance and long-term perspectives of the KASI-Gemini Partnership in the context of the next decade of Korean optical astronomy researches.

[구 AI-02] Development Plan for Immersion Grating High-Dispersion Infrared Spectrographs (담금격자 적외선 고분산 분광기 개발 계획)

Sungho Lee, Chan Park, Narae Hwang, Sanghyuk Kim, Jae-Joon Lee, Ueejeong Jeong, In-Soo Yuk, Byeong-Gon Park