James Jee[1]
[1]*Astronomy Dept, Yonsei University*

The current 'standard model' of cosmology provides a minimal theoretical framework that can explain the gaussian, nearly scale-invariant density perturbations observed in the CMB to the late time clustering of galaxies. However accepting this framework, requires that we include within our cosmic inventory a vacuum energy that is ~122 orders of magnitude lower than Quantum Mechanical predictions, or alternatively a new scalar field (dark energy) that has negative pressure.

An alternative approach to adding extra components to the Universe would be to modify the equations of Gravity. Although GR is supported by many current observations there are still alternative models that can be considered. Recently there have been many works attempting to test for modified gravity using the large scale clustering of galaxies, ISW, cluster abundance, RSD, 21cm observations, and weak lensing.

In this work, we compare various modified gravity models using cosmic shear data from the Deep Lens Survey as well as data from CMB, SNe Ia, and BAO. We use the Bayesian Evidence to quantify the comparison robustly, which naturally penalizes complex models with weak data support. In this talk we present our methodology and preliminary results that show f(R) gravity is mildly disfavoured by the data.

[구 CD-03] Constraints on cosmology and baryonic feedback by the combined analysis of weak lensing and galaxy clustering with the Deep Lens Survey

Mijin Yoon[1], M. James Jee[1], Tony Tyson[2], and DLS Collaboration
[1]*Department of Astronomy, Yonsei University, Republic of Korea*
[2]*Department of Physics, UC Davis, United States of America*

We constrain cosmological parameters by combining three different power spectra measured from galaxy clustering, galaxy-galaxy lensing, and cosmic shear using the Deep Lens Survey (DLS). Two lens bins (centered at z~0.27 and 0.54) and two source bins (centered at z~0.64, and 1.1) containing more than one million galaxies are selected to measure the power spectra.

We re-calibrate the initial photo-z estimation of the lens bins by matching with SHELS and PRIMUS and confirm its fidelity by measuring a cross-correlation between the bins. We also check the reliability of the lensing signals through the null tests, lens-source flipping and cross shear measurement. Residual systematic errors from photometric redshift and shear calibration uncertainties are marginalized over in the nested sampling during our parameter constraint process.

For the flat LCDM model, we determine S_8=sigma_8(Omega_m/0.3)^0.5=0.832+-0.028, which is in great agreement with the Planck data. We also verify that the two independent constraints from the cosmic shear and the galaxy clustering +galaxy-galaxy lensing measurements are consistent with each other.

To address baryonic feedback effects on small scales, we marginalize over a baryonic feedback parameter, which we are able to constrain with the DLS data alone and more tightly when combined with Planck data. The constrained value hints at the possibility that the AGN feedback in the current OWLS simulations might not be strong enough.

[구 CD-04] Using the Topology of Large Scale Structure for Cosmological Parameter Estimation

Stephen Appleby
School of Physics, Korea Institute for Advanced Study, 85 Hoegiro, Dongdaemun-gu, Seoul 02455, Korea

The Minkowski Functionals of the matter density eld, as traced by galaxies, contain information

regarding the nature of dark energy and the fraction of dark matter in the Universe. In particular, the genus is a statistic that provides a clean measurement of the shape of the linear matter power spectrum. As the genus is a topological quantity, it is insensitive to galaxy bias and gravitational collapse. Furthermore, as it traces the linear matter power spectrum, it is a conserved quantity with redshift. Hence the genus amplitude is a standard population that can be used to test the distance-redshift relation. In this talk, I show how we can extract the genus from galaxy catalogs, and how we can use its properties to constrain the equation of state of dark energy and the energy content of the Universe.

[구 CD-05] Cosmological Information from the Small-scale Redshift Space Distortions

Motonari Tonegawa[1], Changbom Park[1], Yi Zheng[1],

Hyunbae Park[2] and Sungwook Hong[2]
[1]Korea Institute for Advanced Study
[2]Korea Astronomy and Space Science Institute

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

Hyesung Kang[1], Dongsu Ryu[2], Ji-Hoon Ha[2]
[1]Pusan National University, [2]Ulsan Institute of Science and Technology

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

Allard Jan van Marle[1], Dongsu Ryu[1], Hyesung Kang[2], Ji-Hoon Ha[1]
[1]Department of Physics, School of natural Sciences, UNIST (Ulsan National Institute of Science and Technology)
[2]Department of Earth Sciences, Pusan National University

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