effect. This study highlights the importance of the past history of galaxies, especially in group halos, before joining the current cluster when understanding the excess of passive galaxies in clusters.

[구 GC-09] Statistical Properties of Flyby Encounters of Galaxies in Cosmological N-body Simulations

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Using cosmological N-body simulations we investigate statistical properties of flyby encounters between halos in comparison with mergers. We classify halo pairs into two groups based on the total energy (E12); flybys (E12 > 0) and mergers (E12 < 0). By measuring the flyby and merger fractions, we assess their dependencies on redshift (0 < z < 4), halo mass (10.8 < log Mhalo/Msun < 13.0), and large-scale environment (from field to cluster). We find that the flyby and merger fractions similarly increase with redshift until z = 1, and that the flyby fraction at higher redshift (1 < z < 4) slightly decreases in contrast to the continuously increasing merger fraction. While the merger fraction has little or no dependence on the mass and environment, the flyby fraction correlates negatively with mass and positively with environment. The flyby fraction exceeds the merger fraction in filaments and clusters; even 10 times greater in the densest environment. Our results suggest that the flyby makes a substantial contribution to the observed pair fraction, thus heavily influencing galactic evolution across the cosmic time.

[박 GC-10] A Multi-Wavelength Study of Galaxy Transition in Different Environments (다파장 관측 자료를 이용한 다양한 환경에서의 은하 진화 연구)

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Galaxy transition from star-forming to quiescent, accompanied with morphology transformation, is one of the key unresolved issues in extragalactic astronomy. Although several environmental mechanisms have been proposed, a deeper understanding of the impact of environment on galaxy transition still requires much exploration. My Ph.D. thesis focuses on which environmental mechanisms are primarily responsible for galaxy transition in different environments and looks at what happens during the transition phase using multi-wavelength photometric/spectroscopic data, from UV to mid-infrared (MIR), derived from several large surveys (GALEX, SDSS, and WISE) and our GMOS-North IFU observations. Our multi-wavelength approach provides new insights into the *late* stages of galaxy transition with a definition of the MIR green valley different from the optical green valley. I will present highlights from three areas in my thesis.

First, through an in-depth study of environmental dependence of various properties of galaxies in a nearby supercluster A2199 (Lee et al. 2015), we found that the star formation of galaxies is quenched before the galaxies enter the MIR green valley, which is driven mainly by strangulation. Then, the morphological transformation from late- to early-type galaxies occurs in the MIR green valley. The main environmental mechanisms for the morphological transformation are galaxy-galaxy mergers and interactions that are likely to happen in high-density regions such as galaxy groups/clusters. After the transformation, early-type MIR green valley galaxies keep the memory of their last star formation for several Gyr until they move on to the next stage for completely quiescent galaxies.

Second, compact groups (CGs) of galaxies are the most favorable environments for galaxy interactions. We studied MIR properties of galaxies in CGs and their environmental dependence (Lee et al. 2017), using a sample of 670 CGs identified using a friends-of-friends algorithms. We found that MIR [3.4]-[12] colors of CG galaxies are, on average, bluer than those of cluster galaxies. As CGs are located in denser regions, they tend to have larger early-type galaxy fractions and bluer MIR color galaxies. These trends can also be seen for neighboring galaxies around CGs. However, CG members always have larger early-type fractions and bluer MIR colors than their neighboring galaxies. These results suggest that galaxy evolution is faster in CGs than in other environments and that CGs are likely to be the best place for pre-processing.

Third, post-starburst galaxies (PSBs) are an ideal laboratory to investigate the details of the transition phase. Their spectra reveal a phase of vigorous star formation activity, which is abruptly ended within the last 1 Gyr. Numerical simulations predict that the starburst, and thus the current A-type stellar population, should be localized within the galaxy's center (< kpc). Yet our GMOS IFU observations show otherwise; all five PSBs in

our sample have Hdelta absorption line profiles that extend well beyond the central kpc. Most interestingly, we found a negative correlation between the Hdelta gradient slopes and the fractions of the stellar mass produced during the starburst, suggesting that stronger starbursts are more centrally-concentrated. I will discuss the results in relation with the origin of PSBs.

[석 GC-11] Properties of Merger-Driven Shocks in Clusters of Galaxies

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Shock waves have been observed in the outskirts of galaxy clusters. They are commonly interpreted as being driven by mergers of sub-clumps, so are called "merger shocks". We here report a study of the properties of merger shocks in merging galaxy clusters with cosmological hydrodynamic simulations. As a representative case, we describe the case where sub-clusters with mass ratio ~ 2 go through an almost head-on, binary-like merger. Because of the turbulent nature of hierarchical clustering, shock surfaces are not uniform, but composed of parts with different Mach numbers. As merger shocks expand from the core to the outskirts, the average Mach number, $< M_s >$, increases. The shocks propagating along the merger axis could be observed as X-ray shocks and/or radio relics. The kinetic energy through the shocks peaks at ~ 1 Gyr after shock launching, or at ~ 1 - 2 Mpc from the core. The most energetic shocks are found to have the kinetic-energy weighted Mach number, $< M_s >_{\phi} \simeq 2-3$, and the CR-energy weighted Mach number, $< M_s >_{CR} \simeq 3-4$. We then discuss the observational implications of our results.

[구 GC-12] Magnetic fields in clusters of galaxies

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Magnetic fields in clusters of galaxies play a critical role in shaping up the intracluster medium. Their existence has been established through observations of synchrotron emission, especially from radio relics and halos, as well as observations of rotation measure. In the so-called Sausage relic, which is one of Mpc-size giant radio relics detected in the outskirts of merging clusters, for instance, the magnetic fields are believed to have a few μG strength and a Mpc scale. The observed magnetic fields are conjectured to be produced by the process of small-scale turbulence dynamo. To investigate the dynamo origin, we simulate the development of turbulence and the follow-up amplification of magnetic fields in galaxy clusters using a three-dimensional magnetohydrodynamical(MHD) code. Turbulence is induced in highly stratified backgrounds expected in clusters, and driven sporadically mimicking major mergers. We here present preliminary results, aiming to answer whether the turbulence dynamo scenario can explain observed magnetic fields in clusters of galaxies.

[구 GC-13] Statistical Moment Analysis of the Strong DLA Profiles

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Incorporating the fully quantum mechanical computation of scattering cross-section and statistical moment analysis of absorption profiles, we investigate the Lyman line asymmetry of extremely high column density systems. Recent high redshift observations detected strong damped Lyman alpha systems (DLAs) whose column density is larger than N_HI ~ 〚10〛^21.3 cm^(-2). Absorption profiles of these DLAs are characterized by the broad and asymmetric damping wing. For accurate description of radiation damping, the second-order time-dependent perturbation theory is adopted. To quantitatively address line asymmetry, we define a distribution function for each Lyman line, and compute statistical moments (mean, standard deviation, skewness and kurtosis) regarding column densities N_HI > 〚10〛^18 cm^(-2). In this work, we present statistical properties of the intrinsic line profiles, and compare them with the Lorentzian cases.

[구 GC-14] Revealing the Powering Mechanism of Lyman Alpha Blob via Polarization

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