used in this study had been observed with OASIS spectrometer at CFHT 3.6m telescope using O300 grism, MR1. The wavelength coverage is 4760Å -5558Å, which includes emission lines, Hβ4861Å, [OⅢ]4959Å, and [OⅢ]5007Å. We observe that forbidden lines have both narrow and broad components. Radial velocity of NGC 4051 is blue-shifted, perhaps due to the z value derived by the earlier studies, 0.002336. We use the revised z, 0.002099, according to the radial velocity of the central spectrum. NGC 4051 is face-on galaxy without rotation observed. Radial velocity of Mrk 79 shows a rotation characteristic in narrow components, relative to PA = 160°, red-shifted to north-west, and blue-shifted to south-east. In the [OⅢ] broad components, blue-shifted points are observed at the place at 2 arcsec apart from the center of Mrk 79 to north-west, which are likely to be gas outflow.

[구 GC-07] Spin evolution of Horizon-AGN early-type galaxies

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The differential rotational properties of early-type galaxies (ETGs) revealed by integral field spectroscopy surveys is arguably one of the most exciting findings in the galaxy evolution study during the past decade. Numerical studies have shown that galaxy mergers under various configurations can reproduce the observed distribution of ETG spin. However, we suggest an alternative scenario for the spin evolution of a large fraction of ETGs. Using the Horizon-AGN simulation, we follow the spin evolution of 10037 color-selected ETGs more massive than 1010 Msun that are divided into four groups: cluster centrals (3%), cluster satellites (33%), group centrals(5%), and field ETGs (59%). We find a strong mass dependence of the slow rotator fraction, fSR, and the mean spin of massive ETGs. Although the environmental dependence is not clear in the fSR, it is visible in the mean value of the spin parameter. The environmental dependence is driven by the satellite ETGs whose spin gradually decreases as their environment becomes denser. Galaxy mergers appear to be the main cause of total spin changes in 94% of central ETGs of halos with Mvir > 1012.5 Msun, but only 22% of satellite and field ETGs. We find that non-merger induced tidal perturbations better correlate with the galaxy spin-down in satellite ETGs than mergers. Given that the majority of ETGs are not central in dense environments, we conclude that non-merger tidal perturbation effects played a key role in the spin evolution of ETGs observed in the local (z < 1) universe.

[구 GC-08] On the origin of gas deficient galaxies in galaxy clusters: insights from cosmological hydrodynamic simulations

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Galaxies associated with massive groups/clusters are normally gas deficient in contrast to field galaxies. HI observations on such galaxies have revealed signs of violent gas stripping, the direct evidence of the environmental effect. At the same time, the notable number of passive galaxies at the cluster outskirts indicates the presence of pre-processing that makes galaxies gas-poor before entering clusters. We investigate the possible channels for the production of the gas deficient galaxies using the state-of-the-art cosmological hydrodynamic zoom-in simulations of 16 clusters (Choi&Yi). We find cluster effect and pre-processing together play an important role in producing the gas-poor galaxies and in both cases gas loss qualitatively agrees with the ram pressure stripping description. Among the currently gas-poor cluster galaxies, 34% are pre-processed before the cluster infall. They are mainly satellites that have undergone ram pressure stripping in group halos. 43% deplete quickly after arriving at cluster during their first approach to the center. Some of them are group halo satellites low in the gas at the infall compared to galaxies directly coming from the field. 24% retain gas even after their first pericentric pass mainly because they are falling into low mass clusters and/or they have a circular orbit that minimizes the ram pressure

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