We investigate the properties of galaxies belonging to the filaments in cosmic void regions, using the void catalogue constructed by Pan et al. (2012) from the SDSS DR7. To identify galaxy filaments within a void, voids with 30 or more galaxies are selected as a sample. We identify 3067 filaments in 1050 voids by applying the filament finding algorithm based on minimal spanning tree and reducing processes to spatial distribution of the void galaxies. We study the correlations between galaxy properties and the specific size of filament which quantifies the degree of the filament straightness. For example, the average magnitude and the magnitude of the faintest galaxy in filament decrease as the straightness of the filament increases. We also find that the correlations become stronger in rich filaments than in poor ones with fewer member galaxies. We discuss a physical explanation to our findings and their cosmological implications.

## [구 GC-11] Spectroscopic Confirmation of Galaxy Clusters at z~0.92

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Galaxy clusters have provided important information to understand the evolution of the universe, since the number density and mass of clusters are tightly related to the cosmological parameters. In addition, galaxy clusters are an excellent laboratory to investigate the galaxy evolution in dense environments. However, finding galaxy clusters at high redshift ($z \gtrsim 1$) still remains as a main subject in astronomy due to their rareness and difficulty in identifying such objects from optical imaging data alone.

Here, we report a spectroscopic follow-up observation of distant galaxy cluster candidates identified by a deep optical-NIR dataset of Infrared Medium-deep Survey. Through the galaxy spectra taken with the IMACS instrument on the Magellan telescope, we confirm at least 3 massive clusters at $z \sim 0.92$. Interestingly, the maximum spatial separation between these clusters is ~8Mpc, which implies that this system is a new supercluster in the distant universe. We also discuss properties of galaxies in these clusters based on multi-wavelength photometric data.

## [초 GC-12] 오스터호프 이분법의 규명과 우리은하 벌지의 기원에 대한 새로운 해석

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우리는 최근 현대천문학의 가장 오래된 난제로 우리은하 헤일로의 형성과 깊은 관련이 있는 구상성단계의 오스터호프 이분법이 다중항성종족 패러다임 하에서 76년 만에 완벽히 규명되는 것을 발견하였다. 또한 이 연구의 기본 개념을 우리은하 벌지에 적용한 결과, 기존 국제학계의 이론과 완전히 다른 벌지의 형성기원에 대한 새로운 해석에 도달하였다. 우리은하의 벌지에 대한 대규모 측광 서베이 분석으로부터 double red clumps가 있다는 것이 2010년에 발견되었고, 이는 디스크와 바 불안정에 기인하는 은하중심부 X-shape 구조의 증거로 널리 받아들여지고 있다. 그러나 우리는 이와 같은 국제학계의 해석이 수평계열성의 항성진화이론을 간과한데서 비롯된 허구일 가능성을 제시하고자 한다. 우리의 모델에 의하면 관측된 double red clumps는 Omega Cen을 포함하는 대다수의 구상성단에서 발견되는 것과 동일한 헬륨함량이 증가된 2세대 별들(G2)에 의한 효과이다. 우리은하 벌지에 위치한 Terzan 5 구상성단처럼, 중원소함량이 높은 벌지에서는 G2에 해당하는 수평계열성들이 광도가 약 0.5등급 더 밝은 red clump 위치에 놓이게 되어 자연스럽게 double red clumps를 형성하게 된다. 앞으로 우리의 새로운 해석이 Gaia에 의한 삼각시차 거리결정으로 확인된다면, 이는 우리은하 벌지를 이루는 대부분의 별들이 Terzan 5와 같은 원시 빌딩블럭들의 합병과 붕괴에 의해 형성되었다는 것을 암시하여, 우리은하는 물론, 조기형은하의 형성기원 연구에 큰 전환점이 될 것으로 기대한다.

## [구 GC-13] An MMT/Hectospec spectroscopic study of globular clusters in the M81 group

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We present a spectroscopic study of globular clusters in the M81 group that is one of the ideal laboratories for understanding mass assembly and evolution of galaxies, such as M81, the twin galaxy of the Milky Way, and the starburst galaxy M82, in the group environments. Spectra of about 800 globular cluster candidates are obtained using MMT/Hectospec, and about one hundred globular clusters are confirmed by their radial velocities.

Based on the kinematics derived from the spectra, we have found that most globular clusters rotate around M81. We have also discovered more than ten globular clusters belonging to M82, and that their kinematics is different from that of young star clusters in the disk of M82. There are few candidates of intra-group globular clusters. We will discuss the implications of these results.

## [구 GC- 14] How did the peculiar S0 galaxy M85 form?

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M85 is a merger remnant galaxy in the Virgo Cluster, showing complex merging features. Globular clusters in M85 are a good tracer of its merging history. To investigate globular cluster system of M85, we obtain deep and wide field images of M85 in *ugi* filters covering one square degree using CFHT/MegaCam. We discover about 1,000 globular cluster candidates in these images. The color distribution of the globular cluster candidates within $r < 5'$ from M85 does not show a clear bimodality and blue globular cluster candidates are more than red ones. These features are different from those in massive early-type galaxies. The spatial distribution of the globular cluster candidates is elongated along the faint stellar light of M85. We also investigate the spatial distribution of sub-populations of the globular cluster candidates with different color and brightness and estimate their ages based on their color. We discuss these results in relation with the formation history of M85.

## [구 GC-15] Progress Report of the Hubble Constant Determination based on the TRGB Method

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Modern methods in determining the value of the Hubble constant are divided into two main ways: the classical distance ladder method and the inverse distance ladder method. The classical distance ladder method is based on Cepheid calibrated Type Ia supernovae (SNe Ia), which are known as powerful distance indicator. The inverse distance ladder method uses cosmic microwave background radiation, which emitted from the high-z universe, and the cosmological model. Recent estimations of the Hubble constant based on these two methods show a 2~3σ difference, which called the "Hubble tension". It is currently an issue in the modern cosmology. We have been working on the luminosity calibration of SNe Ia based on the Tip of the Red Giant Branch (TRGB), which is a precise population I distance indicator. We present the TRGB distance estimates of 5 SNe Ia host galaxies with the archival Hubble Space Telescope image data. We derive the mean absolute maximum magnitude of 5 SNe Ia and the value of the Hubble constant. Cosmological implications of our estimate will be discussed.

## [구 GC-16] The significance of galaxy mergers in stellar mass growth as a function of galaxy and halo mass

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As theoretical and empirical studies have pointed out, galaxy mergers play a pivotal role in galaxy mass assembly histories. Its contribution is considered to be more significant in more massive galaxies. In order to quantitatively understand the origin of stellar components in galaxies, we investigated stellar mass assembly histories as a function of galaxy and halo mass using semi-analytic approaches. In this study, we found that the most massive galaxies ($\log M/\mathbf{M}_{\odot} \sim 11.75$ at $z = 0$), which are mostly the brightest cluster galaxies, obtain roughly 70% of their stellar components via mergers. The role of mergers monotonically declines with galaxy mass: less than 20% for $\log M/\mathbf{M}_{\odot} = 10.75$ at $z = 0$. The contribution of galaxy mergers to stellar mass growth decays more slowly than that of in-situ star formation. Therefore, merger accretion becomes a dominant channel for stellar mass growth of the most massive group since z~2. However, when it comes to central galaxies in haloes less massive than $\mathbf{10^{13}M_{\odot}}$, star formation is always dominant.

## [초 GC-17] Carnegie Hubble Program II : Overview and Research Status

Soung-Chul Yang