외부은하 / 은하단

[구 GC-01] Satellites of Isolated Early-type Galaxies and the Missing Satellite Galaxy Problem

Changbom Park[1], Ho Seong Hwang[1], Hyunbae Park[2], Jong Chul Lee[2]
[1]Korea Institute for Advanced Study, [2]Korea Astronomy and Space Science Institute

The standard hierarchical galaxy formation scenario in the popular LCDM cosmogony has been very successful in explaining the large-scale distribution of galaxies. However, one of the failures of the theory is that it predicts too many satellite galaxies associated with massive galaxies compared to observations, which is called the missing satellite galaxy problem. Isolated groups of galaxies hosted by passively evolving massive early-type galaxies are ideal laboratories for finding the missing physics in the current theory. We discover through a deep spectroscopic survey of galactic satellite systems that bright isolated early-type galaxies have almost no satellite galaxies fainter than the r-band absolute magnitude of about Mr=-14. The cutoff is at somewhat brighter magnitude of about Mr=-15 when only early-type satellites are used. Such a cutoff is not observed in the luminosity function of galaxies in the field. Physical properties of the observed satellites depend sensitively on the host-centric distance. All these are strong evidence that galactic satellites can become invisible due to astrophysics of satellite-host galaxy interaction. A recent state-of-the-art hydrodynamic simulation of galaxy formation does not reproduce such a cutoff in the satellite galaxy luminosity function. But the past history of the simulated satellites shows that many satellite galaxies near or somewhat fainter than the cutoff magnitude have recently become extinct through fatal encounters with the host or other satellite galaxies. Our observation indicates that the missing satellite galaxy problem could be mitigated if the astrophysics of galaxy interaction is more elaborated in the theory.

[구 GC-02] A Hyper Suprime-Cam View of the Interacting Galaxies of the M81 Group - Structures and Stellar Populations

Nobuo Arimoto[1,3] and Sakurako Okamoto[2]
[1]Seoul National University
[2]Shanghai Astronomical Observatory
[3]Subaru Telescope, NAOJ

Over the last decade, deep studies of nearby galaxies have led to the discovery of vast stellar envelopes that are often rich in substructure. These components are naturally predicted in models of hierarchical galaxy assembly, and their observed properties place important constraints on the amount, nature, and history of satellite accretion. One of the most effective ways of mapping the peripheral regions of galaxies is through resolved star studies. Using wide-field cameras equipped to 8 m class telescopes, it has recently become possible to extend these studies to systems beyond the Local Group. Located at a distance of 3.6 Mpc, M81 is a prime target for wide-field mapping of its resolved stellar content.

In this talk, we present the detailed results from our deep wide-field imaging survey of the M81 group with the Hyper Suprime-Cam (HSC), on the Subaru Telescope. We report on the analysis of the structures, stellar populations, and metallicities of old dwarf galaxies such as NGC3077, IKN, KDG061, as well as young stellar systems such as Arp's Loop and Holmberg IX. Several candidates for yet-undiscovered faint dwarf galaxies and young stellar clumps in the M81 group will also be introduced. The peculiar galaxy NGC3077 has been classified as the irregular galaxy. Okamoto et al. (2015, ApJ 809, L1) discovered an extended halo structure with S-shape elongated tails, obvious feature of tidal interaction. With a help of numerical simulation by Penarrubia et al. (2009, ApJ 698, 222), we will demonstrate that this tidal feature was formed during the latest close encounters between M81, M82, and NGC 3077, which induced star formation in tidally stripped gas far from the main bodies of galaxies. It is not clear whether the latest tidal interaction was the first close encounters of three galaxies. If NGC3077 is still surrounded by the dark matter halo, it implies that NGC3077 has undergone the first tidal stripping by larger companions. Kinematic studies of inter galactic globular clusters and planetary nebulae would tell us the past history of tidal interaction in this group of galaxies.

[구 GC-03] Revealing Natures of Ultra-diffuse Galaxies: Failed Giant Galaxies or Dwarf Galaxies?

Jeong Hwan Lee[1], Jisu Kang[1], Myung Gyoon Lee[1], and In Sung Jang[2]
[1]Department of Physics and Astronomy, Seoul

National University, Republic of Korea
[2]AIP, Potsdam, Germany

Ultra-diffuse galaxies (UDGs) are an unusual galaxy population. They are ghostlike galaxies with fainter surface brightness than normal dwarf galaxies, but they are as large as MW-like galaxies. The key question on UDGs is whether they are 'failed' giant galaxies or 'extended' dwarf galaxies. To answer this question, we study UDGs in massive galaxy clusters. We find an amount of UDGs in deep HST images of three Hubble Frontier Fields clusters, Abell 2744 (z=0.308), Abell S1063 (z=0.347), and Abell 370 (z=0.374). These clusters are the farthest and most massive galaxy clusters in which UDGs have been discovered until now. The color-magnitude relations show that most UDGs have old stellar population with red colors, while a few of them show bluer colors implying the existence of young stars. The stellar masses of UDGs show that they have less massive stellar components than the bright red sequence galaxies. The radial number density profiles of UDGs exhibit a drop in the central region of clusters, suggesting some of them were disrupted by strong gravitational potential. Their spatial distributions are not homogeneous, which implies UDGs are not virialized enough in the clusters. With virial masses of UDGs estimated from the fundamental manifold, most UDGs have M_200 = 10^10 - 10^11 M_Sun indicating that they are dwarf galaxies. However, a few of UDGs more massive than 10^11 M_Sun indicate that they are close to failed giant galaxies.

[구 GC-04] Star formation in high redshift early-type galaxies

Raphael Gobat[1], Emanuele Daddi[2], Georgios Magdis[3], Frederic Bournaud[2], Mark Sargent[4], Marie Martig[2], Shuowen Jin[2], Ho Seong Hwang[1]
[1]KIAS (Korea), [2]CEA Saclay (France), [3]Dark Cosmology Centre (Denmark), [4]University of Sussex

Massive early-type galaxies (ETG) have been spectroscopically confirmed up to z>3 which, together with their ages and abundances at z>1.5, implies that their progenitors must have converted gas into stars on short timescales. The termination of star formation in these galaxies can occur through several channels, but they remain largely conjectural, in part due to the current lack of direct measurements of the amount of residual gas in high redshift ETGs. Here I will present constraints on the star formation rate and dust/gas content of z=1.4-2.5 ETGs. These galaxies, close to their epoch of quenching, contained more than 2 orders of magnitude more dust than their local counterparts, which suggests the presence of substantial amounts of gas and a low star formation efficiency.

[구 GC-05] Star-formation Properties of High-redshift (z~1) Galaxy Clusters Connected to the Large-scale Structure

Seong-Kook Lee[1], Myungshin Im1, Minhee Hyun[1], Bomi Park[2], Jae-woo Kim[3], Dohyung Kim[1], Yongjung Kim[1]
[1]Center for the Exploration of the Origin of the Universe, Department of Physics and Astronomy, Seoul National University,
[2]Department of Astronomy and Space Science, Kyung Hee University,
[3]Korea Astronomy and Space Science Institute

At local, majority of galaxies in the dense environment, such as galaxy cluster, are red and quiescent with little star-formation (SF) activity.

However, a different picture emerges as we go to high redshift: (1) there exist non-negligible fraction of galaxies still forming stars actively even in dense environment, and (2) there is a significant cluster-by-cluster variation in the SF properties, such as quiescent galaxy fraction.

In this presentation, we show the results of our study about the variation of quiescent galaxy fraction among high-redshift (z~1) galaxy clusters, based on the multi-object spectroscopic (MOS) observation with IMACS on the Magellan telescope.

Our main result is that galaxy clusters which are connected with significant large-scale structure (LSS), well beyond the cluster scale, are more active in their SF activity, i.e., the quiescent galaxy fraction for these clusters is lower compared to the clusters which are detached from LSS.

~~[구 GC-06] Discovery of a Protocluster associated with a Lyα Blob Pair at z=2.3~~

~~Yujin Yang[1], Toma Bădescu[2], Frank Bertoldi[2], Ann Zabludoff[3], Alexander Karim[2], Benjamin Magnelli[2]~~
~~*[1]KASI, [2]Affiliation Argelander Institut für Astronomie, Universität Bonn, [3]Steward Observatory, University of Arizona*~~

~~Bright Lyα blobs often reside in overdensities of compact Lyα emitters (LAEs) that may be galaxy protoclusters. The number density, variance, and internal kinematics of LABs suggest that they~~