g model'.

[구 GC-20] A Weak-lensing Study of the Double Radio Relic Galaxy Cluster Abell 1240

Hyejeon Cho (조혜전)[1], Myungkook James Jee (지명국)[1,2], Kyle Finner[1,3]
[1]Department of Astronomy & Institute of Earth·Atmosphere·Astronomy, Yonsei University, Korea, [2]Department of Physics, University of California, Davis, USA, [3]Harvard-Smithsonian Center for Astrophysics, USA

Abell 1240 is a merging galaxy cluster hosting prominent, symmetric double radio relics. To constrain its merging history, we provide the first weak-lensing analysis of the dark matter distribution of the Abell 1240 field with Subaru/Suprime-Cam observations after robustly addressing instrumental systematics. We also investigate the cluster galaxy distributions, combining our new MMT/Hectospec observations and the spectroscopic redshifts from the literature. Both weak-lensing mass reconstruction and galaxy distribution show that Abell 1240 consists of two subclusters stretched north to south between the double radio relics. We quantify the significance of the substructures and present their mass estimates. Finally, we discuss a merging stage of Abell 1240 with the current weak-lensing results and the radio relic priors.

[구 GC-21] Multi-wavelength view of SPT-CL J2106-5844: A massive galaxy cluster merger at z~1.13

Kim HyeongHan[1], Luca Di Mascolo[2,3,4,5], Tony Mroczkowski[6], Yvette Perrott[7], Lawrence Rudnick[8], M. James Jee[1,9], Eugene Churazov[2,10], Jordan D. Collier[11,12], Jose M. Diego[13], Andrew M. Hopkins[14], Jinhyub Kim[1], Bärbel S. Koribalski[12,15], Joshua D. Marvil[16], Remco van der Burg[6], Jennifer L. West[17]
[1]Department of Astronomy, Yonsei University [2]Max-Planck-Institu für Astrophysik (MPA) [3]Astronomy Unit, Department of Physics, University of Trieste [4]INAF – Osservatorio Astronomico di Trieste [5]IFPU – Institute for Fundamental Physics of the Universe [6]European Southern Observatory (ESO) [7]School of Chemical and Physical Sciences [8]Minnesota Institute for Astrophysics, School of Physics and Astronomy, University of Minnesota [9]Department of Physics, University of California, Davis [10]Space Research Institute [11]The Inter-University Institute for Data Intensive Astronomy (IDIA), Department of Astronomy, University of Cape Town [12]School of Science, Western Sydney University [13]Institute de Física de Cantabria (CSIC-UC) [14]Australian Astronomical Optics, Macquarie University [15]Australia Telescope National Facility, CSIRO Astronomy and Space Science [16]National Radio Astronomy Observatory [17]Dunlap Institute for Astronomy and Astrophysics University of Toronto

SPT-CL J2106-5844 is the most massive galaxy cluster at z>1 discovered to date. It has been known to be an isolated system with a singular, well-defined halo. However, recent studies provide lines of evidence for its merging state. We strengthen the case with the multi-wavelength observations from ALMA, ACA, ASKAP, ATCA, and Chandra. With the sensitive, high resolution ALMA+ACA observations, we reconstruct the ICM pressure map from the thermal SZ effect. It reveals two main gas components that are associated with the mass clumps inferred from the weak-lensing analysis. Furthermore, the X-ray hardness map supports the bimodal gas distribution. With these multi-wavelength data, we probe the merger phase in SPT-CL J2106-5844.

항성 및 항성계

[구 SA-01] Messier 3: An Extra-Galactic System with Two Globular Clusters

Jae-Woo Lee[1], Christopher Sneden[2]
[1]Department of Physics and Astronomy, Sejong University, [2]Department of Astronomy, The University of Texas at Austin

We present Ca-CN-CH-NH photometry for the globular cluster (GC) M3. Our new photometric system combined with robust and self-consistent theoretical fine model grids allows us to measure key elements in stellar populations, [Fe/H], [C/Fe], and [N/Fe], even in the extremely crowded fields. Our results show that M3 consists of two GCs with different chemical abundances, structural and kinematical properties. Furthermore, each GC has its own carbon-nitrogen anticorrelation with whose fractions of the CN-weak populations are consistent with those in the Magellanic Clouds. We suggest that M3 is a merger remnant of two GCs, most likely in a dwarf galaxy environment and accreted to our Milky Way Galaxy later in time.

[구 SA-02] Absolute Dimension and Pulsational Characteristics of the Eclipsing Binary EW Boo with a δ Sct Pulsator

Hye-Young Kim[1], Kyeongsoo Hong[1], Chun-Hwey

Kim[1], Jae Woo Lee[2], Min-Ji Jeong[1], Jang-Ho Park[2], Mi-Hwa Song[1]
[1]Chungbuk National University, [2]Korea Astronomy and Space Science Institute

We present the TESS photometry and our high-resolution spectra of the semi-detached Algol EW Boo. For an orbital period study, we collected all available times of minima including ours for the last 30 years. It is found that the eclipse timing variation of the system can be represented by a periodic oscillation of 18.5±1.0 yr plus a secular period increase with a rate of $[dP/dt]_{\rm orb}=-6(\pm3)\times10^{-8}$ d yr^{-1}. From our observed spectra, the effective temperature of the primary star was determined to be $T_{\rm eff,1}=8560\pm118$ K. From a simultaneous analysis of the TESS light and our double-lined radial velocity curves, the absolute masses, radii, and luminosities are $M_1=2.30\pm0.07\,{\rm M}_\odot$, $M_2=0.38\pm0.01\,{\rm M}_\odot$, $R_1=1.92\pm0.02\,{\rm R}_\odot$, $R_2=1.27\pm0.01\,{\rm R}_\odot$, $L_1=1.92\pm0.02\,{\rm L}_\odot$, and $L_2=0.752\pm0.007\,{\rm L}_\odot$, respectively. Multiple frequency analyses were carried out for the light residuals after subtracting the binary star model. We detected a total of 75 frequencies in the region of 16.50-104.8 day-1. Our results demonstrate that the more hotter primary star of EW Boo is a δ Sct pulsator by considering its position in the δ Scuti region of the Cepheid instability strip and pulsational characteristics.

[구 SA-03] *Absolute calibration of near-infrared Period-Luminosity-Metallicity relations for RR Lyrae variables using Gaia EDR3*

Anupam Bhardwaj[1], Marina Rejkuba[2], and Soung-Chul Yang[1]
[1]Center for Large Telescopes, Korea Astronomy and Space Science Institute, Daejeon, Korea
[2]European Southern Observatory, Garching bei München, Germany

RR Lyrae stars are sensitive probe for the precision stellar astrophysics and also for the cosmic distance scale thanks to their well-defined near-infrared Period-Luminosity relations (PLRs). These horizontal branch variables can be used for primary calibration of the first-rung of population II distance ladder providing an evaluation of the ongoing tension between Cepheid-Supernovae based Hubble constant and the Planck results. Therefore, absolute calibration of RR Lyrae PLRs is now crucial to complement or test the tip of the red giant branch based distances, and in turn, population II star based Hubble constant measurements. While the pulsation models of RR Lyrae can reproduce most observables, they predict a significant metallicity effect on their JHKs-band PLRs that is inconsistent with so-far limited observational studies. We remedy this inconsistency of metallicity dependence in RR Lyrae PLRs by combining their near-infrared observations in the globular clusters of different mean-metallicities with the new parallaxes from the Gaia early data release 3 (EDR3). Our empirical results on Period-Luminosity-Metallicity (PLZ)relations are consistent with theoretical predictions but the precision of absolute calibrations is still affected by the parallax uncertainties and the systematic zero-point offset present in the Gaia EDR3.

[구 SA-04] Variable Blue Stragglers in the Metal-Poor Globular Clusters in the Large Magellanic Cloud - Hodge 11 and NGC1466

Soung-Chul Yang and Anupam Bhardwaj
Center for Large Telescopes, Korea Astronomy and Space Science Institute

Blue straggler stars (BSs) are “rejuvenated” main sequence stars first recognized by Allan Sandage from his observation of the prominent northern globular cluster M3 in the year of 1953. BSs are now known to be present in diverse stellar environments including open clusters, globular clusters, dwarf galaxies, and even the field populations of the Milky Way. This makes them a very useful tool in a wide range of astrophysical applications: Particularly BSs are considered to have a crucial role in the evolution of stellar clusters because they affect on the dynamics, the binary population, and the history of the stellar evolution of the cluster they belong to. Here we report a part of the preliminary results from our ongoing research on the BSs in the two metal-poor globular clusters (GCs) in the Large Magellanic Cloud (LMC), Hodge 11 and NGC1466. Using the high precision multi-band images obtained with the Advanced Camera for Survey (ACS) onboard the Hubble Space Telescope (HST), we extract time-series photometry to search for the signal of periodic variations in the luminosity of the BSs. Our preliminary results confirm that several BSs are intrinsic “short period (0.05 < P < 0.25 days)” variable stars with either pulsating or eclipsing types. We will discuss our investigation on the properties of those variable BS candidates in the context of the formation channels of these exotic main sequence stars, and their roles in the dynamical evolution of the host star clusters.