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We investigate the long-period radial velocity (RV) variations for M giant HD 18438 and
K giant HD 158996 using the high-resolution Bohyunsan Observatory Echelle Spectrograph at the 1.8m telescope of Bohyunsan Optical Astronomy Observatory in Korea. These two target stars are important because HD 18438 is the largest star and HD 158996 is the brightest star for exoplantary system candidate so we can understarnd how evolved stars affect planets by researching these stars. We calculated precise RV measurements of 38 and 24 spectra from November 2010 to January 2017 and June 2010 to January 2017, respectively. We dreived the RV variation period for 719.0 days of HD 18438, 775.6 days for HD 158996. We conclude that the RV variation of HD 158996 is caused by planetary companion which has the mass of 14.7 MJup, semi-major axis of 2.2 AU, and eccentricity of 0.27 assuming the stellar mass of 2.34 M⊙. On the other hand, the origin of RV variation of HD 18438 with period of 719.0 days is still uncertain. It might be caused by stellar chromospheric activity or planetary companion, so more observations and tests are required.

### [구 SH-05] Black Hole Binaries Dynamically Formed in Globular Clusters

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We investigate properties of black hole (BH) binaries formed in globular clusters, by using direct N-body simulations. Comparing with previous studies which usually considered single BH masses, our models consist of two-component BH masses, or continuous BH mass function with single mass ordinary cluster stars. During the early stage of dynamical evolution, initially distributed BHs are move to the cluster center by dynamical friction, then BH-BH binaries start to be formed, and eventually be ejected from the cluster due to three body interaction. Finally we find the formation efficiency of high mass BHs are alwats larger than that of lower mass BHs, implying that a BH mass spectrum expected from GW observation should be biased to high mass. In addition, mass ratios of BHs in binaries prefer similar masses (ratio~1), while the most extreme case is less than 3. Expected merger rate from our models is about 7 BH-BH mergers per $Mpc^3$ per yr.

### [구 SH-06] The Constellation Maps in the Flags of Barracks in GANGJIN
(강진 병영 영기(令旗)에 그려진 별자리)

Hong-Jin Yang
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전라남도 강진에서 발견된 영기(令旗)라는 책에는 병영에서 사용된 별자리 깃발에 관한 기록이 남아있다. 영기는 군중에서 군령(軍令)을 전달하기 위해 사용한 것으로 고종대에 이르러 깃발에 28수(宿) 별자리를 처음으로 사용한 것으로 알려져 있다. 승정원일기와 일성록에 의하면 군영에서 사용한 28수 별자리 깃발은 1874년 중앙관 진무사(鎭撫使)의 수장이었던 김선필(金善弼)이 처음 만들어 사용한 것으로 기록되어 있다. 본 발표에서는 국내에 처음 보고된 28수(宿)가 그려진 영기를 소개하고 영기의 별그림을 한국과 중국의 전통 성도와 비교한 내용을 발표하고자 한다. 영기에는 28수 별자리 외에도 28 동물과 기하학적 문양이 그려져 있는데 이에 대해서도 간단히 소개하고자 한다. 영기 별그림은 실제 성도와 비교해 많은 오류가 확인되는데 이를 교정하여 새롭게 도안한 별자리 깃발도 함께 소개하고자 한다.

## KMTNet

### [구 KMT-01] Operation and System Upgrade of KMTNet

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We report the operational highlights of KMTNet in the point of observing rate, image pre-processing and data reduction, observing run for each science program, and scientific publications performed in 2016. Major system upgrade has been conducted in the CCD camera and the wide field telescope optics: the post amp and readout electronics of the 18k Mosaic CCD

camera at Siding Spring Observatory site has been fine tuned and the protected silver coat of the primary mirror has been replaced with the bare aluminium coat due to the degradation of reflectivity of the primary mirror surface. A plan of KMTNet observation system improvement for 2017 will be introduced in this talk.

### [구 KMT-02] OGLE-2015-BLG-1482L:The first isolated Galactic bulge microlens

Sun-Ju Chung[1,2], Wei Zhu[3], Andrzej Udalski[4], Chung-Uk Lee[1,2], Yoon-Hyun Ryu[1], Youn Kil Jung[5], In-Gu Shin[5], Jennifer C. Yee[5], Kyu-Ha Hwang[1], Andrew Gould[1,3,6], and KMTNet/OGLE/Spitzer collaborations
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The single lens event OGLE-2015-BLG-1482 has been simultaneously observed from two ground-based surveys and from Spitzer. The Spitzer data exhibit finite-source effects due to the passage of the lens close to or directly over the surface of the source star as seen from Spitzer. Thanks to measurements of the microns parallax and the finite-source effect, we find that the lens of OGLE-2015-BLG-1482 is a very low-mass star with the mass 0.10±0.02 M⊙ or a brown dwarf with the mass 55±9 MJ, which are respectively located at DLS = 0.80±0.19 kpc and DLS = 0.54±0.08 kpc, and thus it is the first isolated low-mass microlens that has been located in the Galactic bulge. The degeneracy between the two solutions is severe. The fundamental reason for the degeneracy is that the finite-source effect is seen only in a single data point from Spitzer and this single data point gives rise to two ρ solutions.

### [구 KMT-03] KMTNet time-series photometry of the doubly eclipsing candidate stars in the LMC

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Multiple stellar systems composed of triple, double+double or double+triple, etc. are very rare and interesting objects for understanding the star formation and dynamical evolution. However, only six systems have been found to be a doubly eclipsing quadruple, which consists of two eclipsing binaries, and four systems to be a triply eclipsing hierarchical triple. Recently, the 15 doubly eclipsing multiple candidates located in the Large Magellanic Cloud (LMC) have been reported by the OGLE project. In order to examine whether these candidates are real multiple systems with eclipsing features, we performed a high-cadence time-series photometry for the LMC using the KMTNet (Korea Microlensing Telescope Network) 1.6 m telescopes in three site (CTIO, SAAO, and SSO) during 2016-2017. The KMTNet data will help reveal the photometric properties of the multiple-star candidates. In this paper, we present the VI light curves and their preliminarily analyses for 12 of the 15 eclipsing systems in the LMC, based on our KMTNet observations and the OGLE-III survey data from 2001-2009.

### [구 KMT-04] Introduction to sample light curves of optical transients discovered by the KMTNet Supernova Program

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We introduce sample light curves of optical transients discovered by the KMTNet Supernoa Program, focusing on their early discoveries and rapid evolutions decoded in the high-cadence observations of the program. For some sources, we also show their spectra obtained either from rapid Target-of-Opportunity follow-up observations immediately after their discoveries or from regularly-scheduled observations. We expect the program to bring unprecedented insights into what is happening during early phases of various types of optical transients, centered on supernovae.

### [구 KMT-05] A KMTNet search for RR Lyrae Stars in the Crater II Ultra-Faint Dwarf Galaxy

Seok-Joo Joo, Eon-Chang Sung, Jaemann Kyeong,