

galaxies then consume their gas faster than those in low-density regions through frequent interactions with other galaxies, ending up being quiescent in the local universe.

## 천문우주관측기술

### [포 AT-01] Development of public release system of science mission data from KPLO and future space explorations

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우리나라는 최초의 우주탐사선이자 달탐사선인 KPLO를 2022년 8월에 발사할 예정이다. KPLO에는 6기의 임무 탑재체가 실리게 되며, 이중 4개의 탑재체는 국내의 대학과 정부출연연구소에서 개발하여 달 표면과 주변 우주환경에 대한 과학임무를 수행하게 된다.

이들 국내에서 개발된 과학탑재체가 달 궤도에서 획득한 Data, 즉 과학자료는 지상국에서 수신하여 이를 처리하여 과학연구 혹은 교육 목적으로 활용될 것으로 예상된다. 이러한 태양계 탐사 과학임무로부터 획득된 과학자료는 과학의 공익성과 연구교류 활성화를 위해서 국제적으로 대중에게 공개하고 있다. 이에 KPDS도 일반 사용자들이 인터넷으로 이들 과학자료를 쉽게 검색하고 다운로드 받을 수 있도록 한국항공우주연구원에서는 KARI Planetary Data System(KPDS)를 구축하고 있으며, 일반에게 공개할 예정이다.

KPDS는 단순히 과학자료를 제공하는 것에서 그치지 않고, 이들 과학자료가 NASA에서 개발한 PDS4 표준을 준수하고 있는지 검증함으로써 세계 각국의 타 우주관련 기관과 상호활용이 용이하도록 하여 활용성을 높은 과학자료로 관리하게 된다. 또한 이러한 PDS4 표준 준수여부를 검증함으로써 KPLO 이후 우리나라에서 수행하게 될 미래의 우주탐사 과학임무로부터 획득될 과학자료도 저장, 공개할 수 있도록 KPDS는 범용성을 고려하여 개발하고 있다.

### [포 AT-02] Deep Learning Study of the 21cm Differential Brightness Temperature During the Epoch of Reionization

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We propose a deep learning analysis technique with a convolutional neural network (CNN) to predict the evolutionary track of the Epoch of Reionization (EoR) from the 21-cm differential brightness temperature tomography images. We use 21cmFAST, a fast semi-numerical cosmological

21-cm signal simulator, to produce mock 21-cm maps between  $z = 6 \sim 13$ . We then apply two observational effects, such as instrumental noise and limit of (spatial and depth) resolution somewhat suitable for realistic choices of the Square Kilometre Array (SKA), into the 21-cm maps. We design our deep learning model with CNN to predict the sliced-averaged neutral hydrogen fraction from the given 21-cm map. The estimated neutral fraction from our CNN model has great agreement with the true value even after coarsely smoothing with broad beam size and frequency bandwidth and heavily covered by noise with narrow beam size and frequency bandwidth. Our results show that the deep learning analyzing method has the potential to reconstruct the EoR history efficiently from the 21-cm tomography surveys in future.

### [포 AT-03] Optical Design for UVOMPIS and Design Concept of the Mirror Holder

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We present the optical design of Linear Astigmatism Free - Three Mirror System (LAF-TMS) D200 for UVO-Multiband Polarizing Imager System (UVOMPIS). LAF-TMS D200 is the off-axis wide-field telescope with EPD = 200 mm, F/2, and Field of View (FoV) =  $2^\circ \times 4^\circ$ . Its optical mirrors are optimized to freeform surfaces for high-quality optical performance over a wide FoV. The proposed mirror holder consists of four aluminum optomechanical modules that have applied for LAF-TMS D150 which is a prototype of the LAF-TMS system. It can accurately mount mirrors and also can sustain from vibration environments. As a feasibility study, quasi-static, modal, harmonic, and random vibration analyses have been performed to LAF-TMS D150 optomechanical structure under the qualification level of the Soyuz-2/Fregat launch system. We evaluate the vibration analysis results in terms of von Mises stress and Margin of Safety.

### [포 AT-04] Johnson BV standardization of 60cm telescope at Gyeonggi Science High School for the Gifted

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Gyeonggi science high school for the gifted (GSHS) installed 60cm telescope, which is waiting for student observers. It is essential to understand the characteristics of the photometric system, consisting of telescope, filter, and CCD, to get reliable data. CCD images of SA98 Landolt standard field and M67 were obtained on 19th March 2020. The images of each field were combined by filters, i.e., we ignored the monochromatic atmospheric extinction since the photometric objects themselves are standard stars. 24 standard stars in SA98 field and 12 standard stars in M67 were used to derive the tentative transformation equation between our bv photometric system and Johnson BV photometric system. In this poster, we present the preliminary standardization result for Johnson BV photometric system in GSHS 60cm telescope. The reproductivity is discussed by comparing color coefficients of two fields. We plan to extend this process to Johnsons-Cousins BVRI photometric system and narrow-band filters for flux calibration.

#### [포 AT-05] Development of adaptive optics system for SNUO 1m telescope

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Adaptive Optics (AO) is the technology for ground-based telescopes to overcome the interference caused by atmospheric turbulence. We are developing an AO system for the 1-m telescope at Seoul National University Observatory (SNUO). The seeing size of the SNUO is 2 arcseconds on average, and 0.85 arcseconds at best condition. Our system is based on MEMS deformable mirror and Shack-Hartmann wavefront sensor. We developed the wavefront sensor using a cheap CMOS camera, and measured phase disturbance at SNUO. To verify the performance of the AO system, we designed an artificial phase disturber that produces similar scale phase error, measured at SNUO. We carried out laboratory tests in which the AO system measures and corrects the wavefront using the phase disturber and an F/6 light source, the same as that of SNUO telescope. The control system was developed in C++. The system performs closed-loop PI correction up to 100 Hz at a consumer-grade PC.

#### [포 AT-06] Surface Error Generation of Freeform Mirror Based on Zernike

#### Polynomial for Optical Performance Prediction

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Not only the magnitude of the mirror surface error, the pattern matters as it produces certain aberrations. In particular, the surface error of the freeform mirrors, which are optimized to eliminate specific aberrations, might show much higher sensitivity in optical performance. Therefore, we analyze the mirror surface error with Zernike polynomials with the goal of generating a realistic error surface. We investigate the surface error of the freeform mirror fabricated by diamond turning machine to analyze the realistic tendency of the error. The surface error with 0.22  $\mu\text{m}$  root-mean-square value is fitted to the Zernike terms using the incremental fitting method, which increases the number of the fitting coefficients through steps. Furthermore, optical performance via surface error pattern based on Zernike terms is studied to see the influences of each term. With this study, realistic error surface generation may allow higher accuracy not only for the feasibility test but also for all tests and predictions using optical simulations.

#### [포 AT-07] Design of the Filter Exchange Mechanism for Schmidt Telescope

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A prime focus telescope, e.g., Schmidt telescope, has advantages especially for a wide field of view survey in astronomy. In this optical configuration, the camera is placed in front of the primary mirror. Since the installation of a typical filter wheel to the prime focus telescope causes serious obscuration of the incoming light, a customized filter device is required for high sensitivity images. In this poster, we present a new filter exchange mechanism, which can host four filters moving along quadrant directions. We plan to install this on the Celestron 36 cm Rowe-Ackermann Schmidt