

symbiotic stars are known to exhibit broad wings around Balmer emission line. We show high resolution spectra of S-type symbiotic stars, Z Andromedae and AG Draconis, obtained with the ESPaDOnS and the 3.6 m Canada-France- Hawaii Telescope, in which we find prominent broad wings around Balmer lines. We adopt Monte-Carlo technique to consider two types of wing formation mechanisms, which are Thomson scattering by free electron in H II region and Raman scattering by atomic hydrogen in H I region. We find that Thomson wings of H α and H β have the same widths in the Doppler space due to the cross section independent of wavelength. In contrast, Raman H α wings are 3 times broader widths than H β counterparts, which is attributed to the different cross sections and branching ratios. Our CFHT data show that H α wings of Z Andromedae and AG Draconis are broader than H β wings, lending strong support to the Raman scattering origin of Balmer wings in these objects.

[포 SA-05] Chemical Abundance Analysis of Ultra Metal-Poor ([Fe/H] < -4.0) Stars

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We present preliminary results of elemental abundances of six ultra-metal poor (UMP; [Fe/H] < -4.0) stars derived from high-resolution spectra obtained by Gemini/GRACES. The UMP candidates were selected for the high-resolution follow-up from the low-resolution spectra of Sloan Digital Sky Survey (SDSS). We investigate possible progenitors of the UMP objects by comparing the measured abundance patterns with yields that various supernova models predict. Our results can provide stringent constraints on the mass range of the first generation of stars, which are the progenitors of the UMP objects.

[포 SA-06] Magellan High Resolution Spectroscopy of Raman-Scattered He II, C II and O VI Lines in the Symbiotic Nova RR Telescopii

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RR~Telescopii is a symbiotic nova exhibiting accretion activities through gravitational capture of the slow stellar wind from a Mira variable. We present high resolution spectra of RR~Tel obtained with MIKE and the 6.5 m Magellan-Clay telescope, in which we find broad features with FWHM exceeding 10 Å at 6545, 6825, 7082, 7023 and 7053 Å. They are formed through Raman-scattering with atomic hydrogen of far-UV He II 1025, O~VI 1032, 1038 Å and C II 1036 and 1037 Å. We compute the Raman conversion efficiencies using the case B recombination theory for He II emissions, which are used in turn to infer the intrinsic line luminosities of O VI and C II. The Raman O~VI features are characterized by double-peaked profiles with a peak separation ~ 60km/s, pointing out the presence of an accretion disk with a physical size of ~ sub AU. In contrast, Raman C II features exhibit profiles with a simple peak and a narrower width ~40 km/s, indicating that C II is formed in a much more extended region. The weak C II multiplet at 1335, 1336 Å found in the IUE spectral archive and the absence of C II 1036, 1037 Å in the FUSE archive show that far-UV C II lines suffer heavy interstellar extinction consistent with the distance of ~ 2.5 kpc to RR Tel.

천문우주관측기술

[포 AT-01] Flight model development of the NISS structure for NEXTSat-1 payload

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한국천문연구원은 차세대소형위성 1호의 근적외선 영상분광기 NISS (Near-infrared Imaging Spectrometer for Star formation history) 탑재체를 개발하여 2017년 6월 30일에 최종 비행모델을 납품하였고, 이 발표는 탑재체 NISS 구조체의 비행모델 개발 결과를 보고한다. NISS는 0.9 - 2.5 μ m (R~20) 근적외선 파장에서 관측을 해야 하기 때문에, 구조체의 배경잡음을 없애기 위해서 200K 까지 passive cooling으로 냉각되며, H2RG 검출기는 소형 냉동기에 의해 약 88K에서 운영된다. NISS 구조체의 passive cooling을 효율적으로 수행하기 위해서 방열판, Kevlar 지지대, MLI, 표면제어용 필름 등을 조립하였고, 실제 지상 시험을 통해서 그 성능을 확인하였다. NISS 구조체는 최종 시스템 조립 과정에서 전자부 하네스 조립을 함께 수행했으며, 온도 모니터링 센서를 부착하고 소형 냉동기 피드백 온도를 반복 시험을 통해서 결정하였다. NISS 구조체는 미러 및 렌즈를 지지하는 광기계부를 함께 포함하기 때문에 발사 및 우주환경에서 광학 성능을 유지하기 위한 설계를 거쳐서 제작 되었으며, 최종 시스템 검교정 시험, 진동 및 열진공 시험을 통해서 그 성능을 확인하였다. NISS를 탑재한 차세대소형위성 1호는 2018년 상반기에 미국의 Falcon 9 발사체에 실려서 발사될 예정이다.

[포 AT-02] Design of Linear Astigmatism Free Three Mirror System (LAF-TMS) for Sky Monitoring Programs

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We report a novel design of the "linear astigmatism-free" three mirror system (LAF-TMS). In general, the linear astigmatism is one of the most dominant aberration degrading image qualities in common off-axis systems. The proposed LAF-TMS is based on a confocal off-axis three mirror system, where higher order aberrations are minimized via our numerical optimization. The system comprises three pieces of aluminum-alloy freeform mirrors that are feasible to be fabricated with current single-point diamond turning (SPDT) machining technology. The surface figures, dimensions, and positions of mirrors are carefully optimized for a LAF performance. For

higher precision-positioning mechanism, we also included alignment parts: shims (for tilting) and L-brackets (for decentering). Any possible mechanical deformation due to assembly process as well as 1-G gravity, and its influence on optical performances of the system are investigated via the finite element (FE) analysis. The LAF-TMS has low f-number and a wide field of view, which is promising for sky monitoring programs such as supernova surveys.

[포 AT-03] Performance Evaluation of the Extended KVN (KVN 확장에 따른 예상성능 분석)

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한국우주전파관측망(KVN: Korean VLBI Network)은 서울, 울산, 제주에 직경 21m 전파망원경 3기로 이루어진 우리나라 최초의 초장기선 전파간섭계(VLBI: Very Long Baseline Interferometry)이다. KVN은 밀리미터 파장의 22, 43, 86, 129 GHz 대역을 동시에 관측할 수 있는 수신 시스템을 이용하여 독보적인 다파장 관측연구를 진행하고 있으며, 뛰어난 위상보정 성능을 바탕으로 기존의 밀리미터 대역에서 검출되지 않았던 많은 천체들을 검출하고 있다. 하지만, KVN 3기 VLBI 관측으로부터 얻어지는 천체의 합성영상(synthesized image)은 초미세구조에서 발생하는 물리 기작을 연구하기에는 큰 한계를 지닌다. KVN을 활용한 연구 성과를 극대화하기 위한 최적의 방안을 도출하기 위하여, KVN 확장 기획연구를 진행하고 있다. 본 연구는 KVN 확장시 예상되는 성능을 분석하고, 영상 성능을 극대화하기 위한 최적의 사이트 조건을 알아본다.

[포 AT-04] Applications of Open-source NoSQL Database Systems for Astronomical Spatial and Temporal Data

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We present our experiences with open-source NoSQL database systems in analyzing spatial and temporal astronomical data. We conduct experiments of using Redis in-memory NoSQL database system by modifying and exploiting its support of geohash for astronomical spatial data. Our experiment focuses on performance, cost, difficulty, and scalability of the database system. We also test OpenTSDB as a possible NoSQL