계를 이해하기에는 적합하지 않다. 본 연구에서는 최소한의 배플 만을 사용하여 경통이 없는 구조의 개방형 망원경을 설계 및 제작하였다. 개발된 변환식 반사망원경 키트(TRT Kit, Transformable Reflecting Telescope Kit)는 부경 모듈을 교체하는 방식만으로 뉴턴식 망원경(Newtonian Telescope), 카세그레인식 망원경(Cassegrain Telescope), 그리고 그레고리식 망원경(Gregorian Telescope)으로 변형하는 것이 가능하다. 주경, 부경을 비롯한 망원경의 모든 부분은 사용자가 직접 조립할 수 있도록 모듈화(Modularization) 하였다. 또한 부경에 부착된 슬라이딩 장치 및 리니어 스테이지(Linear Stage)는 망원경의 초점을 정밀하게 맞출 수 있도록 설계하였다. TRT Kit를 이용하여 학생들은 세 가지 형태의 망원경 광학계를 직접 조립하고 그 구조 및 성능을 비교해 볼 수 있으며, 광축 정렬, 정밀 초점 조절 과정을 통해 기본적인 광학계의 원리를 이해 할 수 있다.

[포 AE-02] The Development and Installation of the DNSM 1meter Telescope

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국립대구과학관 천체 관측 핵심시설인 1m 반사망원경을 개발하고 설치 완료하였다. 본 발표에서는 국립대구과학관 1m 망원경의 시스템 사양과 개발 및 설치과정을 전반적으로 기술하고 앞으로의 활용계획에 대해 소개하고자 한다. 이번에 도입된 주망원경은 지난 2014년 11월부터 광학계 및 마운트 설계를 시작으로 2016년 5월까지 약 1년 6개월의 개발기간을 거쳐 설치 완료되었다. 순수 국내 기술로 개발된 주망원경은 주경 1,000mm(부경 300mm)의 유효구경을 가지며 후방초점거리가 700mm인 초점비 F/8의 리치-크레티앙 방식의 광학계로 설계되었다. 레이저 간섭계를 이용하여 거울면 전체의 형상 오차를 정밀하게 측정한 결과 주경면 PV < λ/4, RMS < λ/20, 부경면 PV < λ/10, RMS < λ/50의 형상 정밀도를 가진다. 포크 형태의 경위대식 마운트 구조로 방위각, 고도 양축과 디로테이터에 각각 모터가 장착되어 움직이는 다이렉트 드라이브 방식으로 구동된다. 최대 구동속도는 2°/s이상, 포인팅 정밀도는 2′이하, 10분간 추적 정밀도는 3″이하(10분간 오토가이더 추적 정밀도는 1″이하)의 구동 성능을 가진다. 제어용 컨트롤 시스템은 JTCS(Justek Telescope Control System)를 사용한다. 성능 평가를 위해 시험 관측된 10~13등급 사이 10개의 별들에 대한 FWHM 측정결과는 4~5″ 범위에 있다. 앞으로 지속적인 성능 평가와 업그레이드를 통해 향후 정밀도를 높여 학술 연구용으로 공개할 예정이다. 이번 국립대구과학관 1m 주망원경의 도입으로 지역 천문교육 프로그램이 한 단계 더 도약할 수 있을 것으로 기대한다.

이 사업은 2013년 미래창조과학부 국립대구과학관 전시관운영사업의 지원을 받아 이루어졌다.

[포 AE-03] Applications of Open-source Spatio-Temporal Database Systems in Wide-field Time-domain Astronomy

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We present our experiences with open-source spatio-temporal database systems for managing and analyzing big astronomical data acquired by wide-field time-domain sky surveys. Considering performance, cost, difficulty, and scalability of the database systems, we conduct comparison studies of open-source spatio-temporal databases such as GeoMesa and PostGIS that are already being used for handling big geographical data. Our experiments include ingesting, indexing, and querying millions or billions of astronomical spatio-temporal data. We choose the public VVV (VISTA Variables in the Via Lactea) catalogs of billions measurements for hundreds of millions objects as the test data. We discuss issues of how these spatio-temporal database systems can be adopted in the astronomy community.

천문화학/천연생물학

[포 AA-01] Evolution of Galaxy Habitability

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We combine a semi-analytic model of galaxy evolution with constraints on circumstellar habitable zones and the distribution of terrestrial planets in order to probe the suitability of galaxies of different mass and type to host habitable planets, and how it evolves with time. We find that the fraction of stars with terrestrial planets in their habitable zone (known as habitability) depends only weakly on galaxy mass, with a maximum around $4\times10^{10}M_{\odot}$. We estimate that 0.7% of all stars in Milky Way-type galaxies to host a terrestrial planet within their habitable zone, consistent with the value derived from Kepler observations. On the other hand, the habitability of passive galaxies is slightly but systematically higher, unless we assume an unrealistically high sensitivity of planets to supernovae. We find that the overall habitability of galaxies has not changed significantly in the last ~8 Gyr, with most of the habitable planets in local

disk galaxies having formed ~1.5 Gyr before our own solar system. Finally, we expect that ~ 1.4×10^9 planets similar to present-day Earth have existed so far in our galaxy.

성간물질

[포 IM-01] Looking for Direct Evidence of Triggered Star Formation: Gas Kinematics

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Stellar wind and radiation pressure from massive stars can trigger the formation of new generation of stars. The sequential age distribution of stars, the morphology of cometary globules, and bright-rimmed clouds have been accepted as evidence of triggered star formation. However, these characteristics do not necessarily suggest that new generation of stars are formed by the feedback of massive stars. In order to search for any physical connection between star forming events, we have initiated a study of gas and stellar kinematics in NGC 1893, where two prominent cometary nebulae are facing toward O-type stars. The spectra of gas and stars in optical and near-infrared (NIR) wavelength are obtained with Hectochelle on the 6.5m MMT and Immersion GRating INfrared Spectrograph on the 2.7m Harlan J. Smith Telescope at McDonald observatory. In this study, the radial velocity field of gas across the cluster is investigated using Hα and [N II] λ 6584 emission lines, and that of the cometary nebula Sim 130 is also probed using 1-0 S(1) transition line of H_2. We report a distinctive velocity field of the cometary nebulae and many ro-vibrational transitions of H_2 even at high energy levels in the NIR spectra. These properties indicate the interaction between the cometary nebulae and O-type stars, and this fact can be a clue to triggered star formation in NGC 1893.

[포 IM-02] Machine Learning Approach to Estimation of Stellar Atmospheric Parameters

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We present a machine learning approach to estimating stellar atmospheric parameters, effective temperature (Teff), surface gravity (log g), and metallicity ([Fe/H]) for stars observed during the course of the Sloan Digital Sky Survey (SDSS). For training a neural network, we randomly sampled the SDSS data with stellar parameters available from SEGUE Stellar Parameter Pipeline (SSPP) to cover the parameter space as wide as possible. We selected stars that are not included in the training sample as validation sample to determine the accuracy and precision of each parameter. We also divided the training and validation samples into four groups that cover signal-to-noise ratio (S/N) of 10-20, 20-30, 30-50, and over 50 to assess the effect of S/N on the parameter estimation. We find from the comparison of the network-driven parameters with the SSPP ones the range of the uncertainties of 73~123 K in Teff, 0.18~0.42 dex in log g, and 0.12~0.25 dex in [Fe/H], respectively, depending on the S/N range adopted. We conclude that these precisions are high enough to study the chemical and kinematic properties of the Galactic disk and halo stars, and we will attempt to apply this technique to Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST), which plans to obtain about 8 million stellar spectra, in order to estimate stellar parameters.

[포 IM-03] SED modeling of the Class 0 protostar L1527 IRS

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We model the spectral energy distribution (SED) of the Class 0 protostar L1527 IRS using a dust continuum radiative transfer code RADMC-3D to study the initial condition of gravitational collapse. To constrain the envelope structure, we use the data obtained by Herschel /PACS, which covers the far-infrared regime (55 – 190 μm) where the SED of L1527 IRS peaks. According to our modeling, a more flattened density profile fits the far-infrared SED of L1527 IRS better than the density profile of a rotating and infalling envelope. Thus, we employ the density structure of a Bonnor-Ebert sphere, which consists of the inner flat-topped and the outer power-law regions and is