Jungha Kim[1], Jeong-Eun Lee[1], Minho Choi[2], Tyler L. Bourke[3], Neal J. Evans II[4], James Di Francesco[5], Lucas A. Cieza[6,7], & Michael M. Dunham[8]
[1]*School of Space Research, Kyung Hee University, Yongin-Si, Gyeonggi-Do 446-701, Republic of Korea*
[2]*Korea Astronomy and Space Science Institute, 776 Daedeokdaero, Yuseong, Daejeon 305-348, Korea*
[3]*Square Kilometre Array Organisation, Jodrell Bank Observatory, Lower Withington, Cheshre SK11 9DL, UK*
[4]*Department of Astronomy, University of Texas at Austin, 2515 Speedway, Stop C1400, Austin, TX 78712-1205, USA*
[5]*National Research Council Canada, Herzberg Institute of Astrophysics, Victoria, BC, Canada*
[6]*Institute for Astronomy, University of Hawaii at Manoa, Honolulu, HI 96822, USA*
[7]*Universidad Diego Portales, Facultad de Ingeniera, Av. Ej_ercito 441, Santiago, Chile*
[8]*Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA*

We present a multi-wavelength observational study of a low-mass star-forming region, L1251-C, with observational results at wavelengths from the near-infrared to the millimeter. Spitzer Space Telescope observations confirmed that IRAS 22343+7501 is a small group of protostellar objects. The extended emission to east-west direction with its intensity peak at the center of L1251A has been detected at 350 and 850 Ꝋm with the CSO and JCMT telescopes, tracing dense envelope materials around L1251A. The single-dish data from the KVN and TRAO telescopes show inconsistencies between the intensity peaks of several molecular line emission and that of the continuum emission, suggesting complex distributions of molecular abundances around L1251A. The SMA interferometer data, however, show intensity peaks of CO 2-1 and ^{13}CO 2-1 located at the position of IRS 1, which is both the brightest source in IRAC image and the weakest source in the 1.3 mm dust continuum map. IRS 1 is the strongest candidate for being the driving source of a newly detected the compact CO 2-1 outflow. Over the whole region (14′x14′) of L125l-C, 3 Class I and 16 Class II sources have been detected, including three YSOs in L1251A. A comparison with the average projected distance among 19 YSOs in L1251-C and that among 3 YSOs in L1251A suggests L1251-C is an example of low-mass cluster formation, where protostellar objects are forming in a small group.

[구 SF-04] Blue profile in different evolutionary stages of massive star forming regions

Mihwa Jin[1] Jeong-Eun Lee[1], Kee-Tae Kim[2]
[1]*Kyunghee University, Korea*
[2]*Korea Astronomy and Space Institute, Korea*

Gravitational collapse is a dynamical process associated with star formation. One observational evidence of such infall motion is so called "blue asymmetry" profile, which is the optically thick line profile with the intensity peak skewed blueward relative to the intensity peak of optically thin lines. We analyzed both HCN J=1-0 and HNC J=1-0 line profiles to study the inflow motion in different evolutionary stages of massive star formation; Infrared dark clouds (IRDCs), High-mass protostellar object (HMPOs), and Ultra-compact HII regions (UCHIIs). The infall asymmetry in the HCN spectra seems to be more prevalent than the HNC spectra throughout all the three evolutionary phases. The prevalence of the blue profile in the HCN spectra is found in every evolutionary stage, with IRDCs showing the largest blue excess. In the case of the HNC spectra, only IRDCs show the blue excess statistically significant. These results suggest that HCN may be a better infall tracer in massive star forming region. In addition, even though the characteristics of the blue profile largely depend on the suitable combination of optical depth and critical density, our analyses also indicate that IRDCs may have the most active infall process compared to other evolutionary phases.

[구 SF-05] [Fe II] 1.64 µm Outflow Features around Ultracompact H II Regions in the First Galactic Quadrant

Jong-Ho Shinn[1], Kee-Tae Kim[1], Jae-Joon Lee[1], Yong-Hyun Lee[2], Hyun-Jeong Kim[2], Tae-Soo Pyo[3], Bon-Chul Koo[2], Jaemann Kyeong[1], Narae Hwang[1], Byeong-Gon Park[1]
[1]*Korea Astronomy and Space Science Institute,*
[2]*Seoul National University,* [3]*National Astronomical Observatory of Japan*

We present [Fe II] 1.644 µm features around ultracompact H II regions (UCHIIs) found on a quest for the "footprint" outflow features of UCHIIs —the features produced by outflowing materials ejected during an earlier, active accretion phase of massive young stellar objects (MYSOs). We surveyed 237 UCHIIs in the first Galactic quadrant, employing the CORNISH UCHII catalog and UWIFE data, which is an imaging survey in [Fe II] 1.644 µ m performed with UKIRT-WFCAM under ~0.''8

seeing conditions. The [Fe II] features were found around five UCHIIs. We interpret the [Fe II] features to be shock-excited by outflows from YSOs and estimate the outflow mass-loss rates from the [Fe II] flux which are ~1×10^{-6}–4×10^{-5} $M_\odot$ yr^{-1}. We propose that the [Fe II] features might be the "footprint" outflow features, but more studies are required to clarify whether or not this is the case. This is based on the morphological relation between the [Fe II] and 5 GHz radio features, the outflow mass-loss rate, the travel time of the [Fe II] features, and the existence of several YSO candidates near the UCHIIs.

[구 SF-06] Optical Long-slit Spectroscopy of Parsec-scale Jets from DG Tauri

Heeyoung Oh[1,2], Tae-Soo Pyo[3], In-Soo Yuk[2], Byeong-Gon Park[1,2]
[1]*University of Science & Technology,*
[2]*Korea Astronomy & Space Science Institute,*
[3]*National Astronomical Observatory of Japan*

Classical T Tauri star DG Tau is suggested as the driving source of parsec-scale jet which expands up to 650″ (0.4 pc). To investigate the kinematics and physical properties of the jet, we have obtained the optical emission lines of Hα, [O I] λλ6300, 6363, [N II] λλ6548,6584, and [S II] λλ6716, 6731 from HH 158 ad HH 702. The radial velocity of HH 158 is in the range of -50 to -250 km s^{-1}. For HH 702, located at 650″ from the source, it shows ~ -80 km s^{-1}. In HH 158, the electron density (n_e) close to the star is ~$10^4 cm^{-3}$ and it decreases to ~$10^2 cm^{-3}$ at 14″ away from the star. Electron temperature (T_e) is decreasing from >15,000 K to ~5,000 K with distance. Ionization fraction (x_e) is increasing from almost zero to > 0.4 along the distance. In HH 702, the values of n_e, T_e, and x_e are similar to those estimated at 14″ from source, where knot C of HH 158 is located. This may imply that the physical properties of the knot could persist through such a long distance in the space, and the gas could be re-excited by the shock during propagation of the jet. On the other hand, we cannot avoid the possibility that HH 702 is driven by another source rather than DG Tau because HH 158 and HH 702 show somewhat large difference in their inclination angles
(Δ i = 21 - 35°).

고천문학 / 기타

[구 HA-01] Restoration Model Research and Modern Application of Astronomical Clock, Heum-gyeong-gak-nu in King Sejong Era

Sang Hyuk Kim[1,2], Seon Young Ham[1,3], Yong Sam Lee[3]
[1]*Korea Astronomy and Space Science Institute,*
[2]*Korea University of Science and Technology,*
[3]*Chungbuk National University*

세종시대의 장영실(蔣英實)은 두 가지의 자동 물시계를 제작했다. 이미 잘 알려진 보루각루(報漏閣漏, '자격루'로 불림)는 1434년에 완성되어 국가 표준시계로서의 역할을 수행했고, 이어서 만들어진 흠경각루(欽敬閣漏, 1438년 제작)는 세종을 위한 특별한 시계였다. 이 연구는 흠경각(欽敬閣)에 설치한 물시계에 대한 것이다. 당시 흠경각은 세종의 정치적 구상을 위한 장소로 사용됐다. 이는 흠경각루를 이루고 있는 외형 부분인 가산(假山)에 빈풍사시(豳風四時)의 풍경을 그린 점과 의기(倚器)를 설치한 정황에서 알 수 있다. 빈풍사시의 그림은 당시에 유행하던 그림화법으로 계절에 따른 농사일이 그려져 있어 농사짓는 백성들의 어려움을 살필 수 있었다. 또한 물시계와 함께 작동되는 의기(倚器)는 누수(漏水)에 의해서 그릇에 물이 담겨져 균형을 이루거나 기울어지는 것을 권력의 모습으로 비유하여 보여주었다. 우리는 흠경각루의 문헌내용을 분석하여 먼저 외형모습, 내부의 구성요소에 대한 것을 연구했다. 이러한 연구 성과를 확장하여 내부의 작동메커니즘의 기초설계를 실시했다. 흠경각루의 시간을 유지하는 중요한 요소는 물시계, 수차, 천형시스템의 유기적인 운영이다. 물시계의 유량실험을 통해 수압과 유량의 관계를 분석하고, 수차의 회전과 제어를 담당하는 천형시스템의 모델을 제시했다. 또한 연구과정에서 얻어진 자료의 일부를 전통천문학 교육에 활용하기 위한 웹페이지(history.kasi.re.kr)를 한국천문연구원 서버를 통해 구축중에 있다.

[구 HA-02] Bocheongа with new charts and Xieji bianfangshu (신도 步天歌와 協紀辨方書)

Sang-Hyeon Ahn
Korea Astronomy and Space Science Institute

조선 후기의 천문학자 김영(金泳)이 편집하여 1792년에 관상감에서 출간한 신도(新圖) 『보천가(步天歌)』는 조선 초기의 『보천가』에서 왕희명(王希明)의 가결을 가져오고, 성도와 주석은 페르디난드 페르비스트의 영향을 받았다고 알려져 있다. 본 논문에서는 1741년에 청(淸)에서 출간된 『협기변방서(協紀辨方書)』에 들어있는 「성도보천가(星圖步天歌)」의 내용과 신도 『보천가』의 내용을 서로 비교하였다. 또한 『협기변방서』의 조선 전래에 관한 역사적 상황을 정리하였다. 이러한 논의를 통해, 김영의 『보천가』는 1741년에 청에서 출간되어 1742년에 조선으로 수입된 『협기변방서』의 「성도보천가」에서 주석과 성도를 취하고, 조선 초기에 간행된 『보천가』에서 가결을 취하여 이룩된 것이라는 결론을 얻었다.