Session:	**[B3B-2] S2 : Interstellar Matter, Star Formation and the Milky Way**
Date:	August 20, 2014 (Wednesday)
Time:	14:00~15:25
Room:	Room B (Room 103)
Chair:	Hauyu Baobab Liu (Academia Sinica Institute of Astronomy and Astrophysics)

[B3B-2-1] **14:00~14:20**

[Invited] Dynamics of Filamentary Molecular Clouds: A Galactic View of Star Formation

Shu-ichiro Inutsuka (Nagoya University, Japan)

Recent observations of molecular clouds have revealed central roles of filamentary clouds in star formation processes. On the other hand, the formation and evolution of filamentary molecular clouds have been studied extensively in the past decades. This review explains the current understanding of the dynamics of filamentary molecular clouds and its implication to an overall picture of star formation in the Galaxy. The formation of filamentary molecular clouds can be understood in the context of cloud formation by external compression. Recent high-resolution magneto-hydrodynamical simulations of two-fluid dynamics with cooling/heating and thermal conduction have shown that the formation of molecular clouds requires multiple episodes of supersonic compression. This finding enables us to create a scenario of molecular cloud formation as the interacting shells or bubbles in the galactic scale. We can estimate the ensemble-averaged growth rate of the individual molecular cloud, and predict the mass function of molecular clouds. This picture naturally explains the accelerated star formation over many million years that was previously reported by stellar age determination in nearby star forming regions. Recent claim of cloud-cloud collision as a mechanism of forming massive stars and star clusters can be naturally expected in this scenario.

[B3B-2-2] **14:20~14:40**

[Invited] The Processing of the Clumpy Molecular Gas in the Galactic Center and the Star-Formation

Hauyu Baobab Liu (Academia Sinica, Taiwan), Young Chol Minh, and Elisabeth Mills

The universality of the star formation laws has been widely investigated in extragalactic studies. When taking a closer look, these star formation laws may represent merely the weighted media for the large number of observed molecular clouds. Ultimately, the high precision observations may allow us to parametrize the details about how the star formation rate and efficiency are deviated from the laws, because of the different physical conditions in the natal molecular clouds. Preliminary hints may first be provided by observing the environments with the extreme physical conditions. The ~200 pc Galactic Central Molecular Zone (CMZ) provides the unique laboratory to resolve the star-forming molecular clouds around the supermassive black hole with the sub-parsec scale resolutions, thanks to the proximity. The high molecular gas temperature and the largely non-virialized gas motions in these clouds present the most extreme environment for star formation. The previous observations on molecular cloud M0.25+0.01 in the CMZ have reported the ~2 orders of magnitude smaller star-forming efficiency than the molecular clouds in the rest of the Galactic disk. In my talk, I will review the recent state-of-the-art mapping observations on the central ~20 pc area in the Galactic Center, which are the star-forming regions nearest to the central supermassive black hole Sgr A*. These observations include the Green Bank 100m Telescope (GBT) observations of the CS/SiO 1-0 lines and several ammonia hyperfine line transitions, the Karl G. Jansky VLA (JVLA) mosaic of ammonia hyperfine line transitions, and the large Submillimeter Array (SMA) 157-pointings mosaic of the 0.86 mm dust continuum emission as well as several warm and dense molecular gas tracers. We have resolved several filamentary gas streams, which follow highly eccentric Keplerian orbits around the central supermassive black hole (SMBH) Sgr A*, and the 2-4 pc scale circumnuclear disk (CND). Some of these gas streams appear to be well connected with the CND. Rather than being a quasi-stationary structure, the CND may be dynamically evolving, incorporating the inflow via exterior gas streams, and feeding gas toward the center. Combining the

GBT data with data from the JVLA covering clouds in the central ten parsecs, we are able to construct new maps of their temperature structure on tenth of a parsec size scales. We also see for the first time evidence of cooler and less turbulent clumps of gas embedded within these clouds. In addition, the unprecedentedly large field-of-view and the high angular resolution of our SMA dust image allow the identification of abundant 0.1-0.2 pc scale dense gas clumps. Simple calculations suggest that the identified clumps can be possibly the pressurized gas reservoir feeding the formation of 1-10 solar-mass stars. We propose that these gas clumps are the most promising candidates for ALMA to resolve high-mass star-formation in the Galactic center.

[B3B-2-3] **14:40~14:55**

The Role of Ridges in High Mass Star Formation: Super Filaments Hosting Protostars

Tracey Hill (Joint ALMA Observatory, Chile), Frederique Motte, Pierre Didelon, Quang Ngyuen Luong, Philippe Andre, Martin Hennemann, and V. Minier

High mass star formation and evolution is still a process that is not well understood, which is largely attributed to the clustered and embedded nature in which high-mass stars form. The Herschel Imaging Survey of OB Young Stellar Objects (HOBYS; Motte, Bontemps and Zavagno), aims to study the earliest stages of high-mass star formation and evolution as well as the environments in which they form.

High mass stars require a greater reservoir of material than their (better studied) lower mass equivalents. We have identified the best locations from which high-mass stars can form - super filaments which we called ridges. Ridges are supercritical high-column density (>10^23 cm^-2) filaments which dominate their environment and serve as the preferential sites of high-mass star formation. For the first time, ridges provide an excellent mechanism through which high mass stars can form. We have identified a number of ridges in high-mass star forming complexes from HOBYS. Our earlier work suggested that ridges form through dynamical means such as converging flows and turbulence (e.g. Hill et al., 2011, Nguyen Luong et al., 2011) or through mergers of smaller filaments (e.g. Hennemann at al., 2012).

Understanding how a ridge forms may allow prediction of how, where, and under what conditions high-mass stars form. It may be that high-mass stars are born as a result of the formation of the ridge itself, or that other factors, such as a bipolar nebula - as proposed by us (Minier et al. 2013) acts upon the ridge to trigger high-mass star formation. We present here the results of a census of ridges in HOBYS regions, which had the objective of identifying how a ridge forms from its natal molecular cloud and ultimately how they form young massive stars.

[B3B-2-4] **14:55~15:10**

UKIRT Widefield Infrared Survey for Fe+

Jae-Joon Lee (Korea Astronomy and Space Science Institute, Korea), Bon-Chul Koo, Yong-Hyun Lee, Ho-Gyu Lee, Jong-Ho Shinn, Hyun-Jeong Kim, Yesol Kim, Tae-Soo Pyo, Dae-Sik Moon, Sung-Chul Yoon, Moo-Young Chun, Dirk Froebrich, Chris J. Davis, Watson P. Varr

The United Kingdom Infrared Telescope (UKIRT) Widefield Infrared Survey for Fe+ (UWIFE) is a 180 deg2 imaging survey of the first Galactic quadrant ($7^\circ < l < 62^\circ$; $|b| < 1.5^\circ$) using a narrow–band filter centered on the [Fe II] 1.644 μm emission line. The [Fe II] 1.644 μm emission is a good tracer of dense, shock–excited gas, and the survey will probe violent environments around stars: star-forming regions, evolved stars, and supernova remnants, among others. The UWIFE survey is designed to complement the existing UKIRT Widefield Infrared Survey for H2 (UWISH2). The survey will also complement existing broad-band surveys. The observed images have a nominal detection limit of 18.7 mag for point sources, with the median seeing of 0.83″. For extended sources, we estimate surface brightness limit of 8.1×10^{-20} Wm^{-2} $arcsec^{-2}$. We will present the overview and preliminary results of this survey.

[B3B-2-5] **15:10~15:25**

[Fe II] 1.64 μm Outflow Features Around Ultracompact H II Regions in the 1st Galactic Quadrant

Jong-Ho Shinn (Korea Astronomy and Space Science Institute, Korea), Kee-Tae Kim, Jae-Joon Lee, Yong-Hyun Lee, Hyun-Jeong Kim, Tae-Soo Pyo, Bon-Chul Koo, Jaemann Kyeong, Narae Hwang, and Byeong-Gon Park

Outflows play an important role in the star formation, especially during the mass accretion process onto the central compact object, because they remove the angular momentum from the ambient material. This functionality enables us to study the accretion process and its history by studying outflow phenomena. We here present the outflow features around ultracompact H II regions (UCHIIs) found on a quest for the “footprint” outflow features of UCHIIs --- the features produced by the outflowing materials ejected during the earlier, active accretion phase of massive young stellar objects. We surveyed 237 UCHIIs in the 1st Galactic quadrant, employing the CORNISH UCHII catalog and UWIFE data. UWIFE is an imaging survey in [Fe II] 1.644 μm performed with UKIRT-WFCAM under ~ 0.8” seeing condition. The [Fe II] outflow features were found around five UCHIIs, one of which has a low plausibility. We interpret that the [Fe II] features are shock-excited, and estimate the outflow mass loss rates from the [Fe II] flux. The mass loss rate ranges ~ 1 x 10^{-6} – 4 x 10^{-5} Ms yr^{-1}. We propose that the [Fe II] features might be the “footprint” outflow features, but more studies are required to clarify it. This is based on the morphological relation between the [Fe II] and 5 GHz radio features, the outflow mass loss rate, the traveling time of the [Fe II] features, and the existence of several YSO candidates near the UCHIIs. The UCHIIs accompanying the [Fe II] features have a higher peak flux density. The outflow mass loss rate shows no significant correlation with the peak flux density, being limited by the small number of data. The fraction of UCHIIs accompanying the [Fe II] features, 5/237, is small when compared to the ~ 90 % detection rate of high-velocity CO gas around UCHIIs. We discuss some possible explanations on the low detection rate.