Session:	**[B5A-2] S2 : Interstellar Matter, Star Formation and the Milky Way**
Date:	August 22, 2014 (Friday)
Time:	09:00~10:25
Room:	Room B (Room 103)
Chair:	Sun Kwok (The University of Hong Kong)

[B5A-2-1] **09:00~09:20**

[Invited] Chemical Evolution in Star Formation

Jeong-Eun Lee (Kyung Hee University, Korea)

Although a detailed understanding of the process of star formation is fundamental for studies of planet formation and galaxy formation/evolution, the actual accretion process is not yet well understood. The standard model for low mass star formation predicted a constant (~2 x 10-6 Msun yr-1) steady accretion process. However, this accretion rate gives rise to the classic "luminosity problem" whereby accretion at such a rate produces accretion luminosities higher than typically observed in embedded protostars, exceeding the predictions by a factor of 10 to 100. The discovery of the Very Low Luminosity Objects (VeLLOs), which are in the embedded stage and have luminosity < 0.1 Lsun, by the Spitzer Space Telescope aggravated the luminosity problem. Episodic accretion has been suggested as one possible resolution to the luminosity problem. In the episodic accretion model, a protostar stays in the prolonged quiescent phase interrupted by short burst accretions. These two different accretion models (constant steady accretion and episodic accretion) are possibly discriminated by the chemical distributions in the envelopes and disks of protostars. Chemical evolution is the most sensitive to the temperature variation, which is affected directly by the accretion process. In constant steady accretion, the temperature in the envelope will increase gradually, while in episodic accretion, the envelope will remain cold most of time, punctuated by short hot phases. As a result, the two accretion processes should leave different chemical distributions in the envelope. In order to study the dynamical (i.e., accretion) process of star formation, therefore, the understanding of chemical evolution in the envelope is very important. We will present our model that has been developed to combine self-consistently the chemical and dynamical evolution in low mass star formation, and discuss the observational strategy to discriminate between different accretion models.

[B5A-2-2] **09:20~09:40**

[Invited] Chemical Evolution of N-bearing Organic Molecules Leading to Glycine

Masatoshi Ohishi (National Astronomical Observatory of Japan, Japan)

It is widely accepted that prebiotic chemical evolution from small to large and complex molecules would have resulted in the Origin of Life. On the other hand there are two conflicting views where inorganic formation of complex organic molecules (hereafter COMs) occurred in the early Earth, on the Earth or out of the Earth. Ehrenfreund et al. (2002) indicated that exogenous delivery of COMs by comets and/or asteroids to the early Earth could be larger than their terrestrial formation by three orders of magnitude. If amino acids are formed in interstellar clouds, significant amount of them may be delivered to planets. Detection of amino acids would accelerate the discussion concerning the universality of “life”.
So far, many trials to detect the simplest amino acid, glycine (NH2CH2COOH), were made towards Sgr B2 and other high-mass forming regions, but none of them were successful. One idea to overcome this situation would be to search for precursors to glycine. Although the chemical evolution of interstellar N-bearing COMs is poorly known, methylamine (CH3NH2) is proposed as one precursor to glycine. CH3NH2 can be formed from abundant species, CH4 and NH3, on icy dust surface. Further methyleneimine (CH2NH) would be related to CH3NH2. Another possible route to form CH3NH2 is hydrogenation (addition of hydrogen) to HCN on dust surface (Dickens et al., 1997; Kim & Kaiser et al. 2011; Theule et al. 2011): HCN → CH2NH→ CH3NH2. Figure 1 shows a possible formation route to glycine, which is based on the laboratory studies

mentioned above.

In the past CH_2NH was reported only in Sgr B2, W51, Orion KL, and G34.3+0.15 (Dickens et al.1997). In April 2013, we extended this survey by using the Nobeyama 45 m radio telescope towards CH_3OH-rich sources. We succeeded to detect four new CH_2NH sources. The derived fractional abundances of CH_2NH relative to H_2 are as high as 10^{-7}, implying that CH_2NH may exist widely in the ISM.

If this is the case, further hydrogenation would efficiently produce CH_3NH_2. Based on this idea we conducted a survey of CH_3NH_2 towards CH_2NH-rich sources in the spring of 2014, and succeeded to detect CH_3NH_2 towards a few sources. Further we discovered three absorption features of CH_3NH_2 towards Sgr B2(M) (see Figure 2). These facts would imply that CH_3NH_2 may widely exist in the ISM.

Since it is well known that CO_2 exists in most of molecular clouds, CH_3NH_2 could be a direct precursor candidate to glycine – the simplest amino acid— , CH_3NH_2-rich sources would turn into promising glycine targets by ALMA. Such studies would also accelerate discussion regarding the exogenous delivery of prebiotic species to planets and connection between the Universe and life.

[B5A-2-3] **09:40~09:55**

The Physical Condition of Gas and Origin of [CII] in NGC 3184

A. S. Abdullah (Leiden Observatory, Netherlands), B. R. Brandl, A. G. G. M Tielens, B. Groves, and M. Wolfire

[CII] 158 μm is one of the brightest cooling lines in the Interstellar Medium (ISM). The brightness of [CII] makes this line a promising candidate for a tracer of star formation rate, ISM heating and cooling, and gas physics diagnostic. It has been argued that [CII] mainly comes from Photo Dissociation/Dominated Region (PDR) where photoelectric heating is the main mechanism to heat the gas. Although the general picture is well understood, the details of heating and cooling process of ISM are not well understood. The low excitation potential of C allows different physical mechanism to excite [CII]. Different studies have shown that [CII] can also come from ionized region, cold neutral medium, and molecular clouds with different gas physical condition.

We present a case study of NGC 3184, a face-on spiral galaxy. NGC 3184 has been observed by Spitzer and Herschel as part of SINGS and KINGFISH programs. We present the gas physical condition in four regions of NGC 3184. The main goal of our study is to derive the gas condition in NGC 3184 and the fraction of [CII] from each of the multi-phase ISM components. We use several diagnostic lines to determine the gas properties. We define three distinguished ISM components namely : 1. Dense HII region, 2. Dense PDR, and 3. Diffuse Neutral Medium. We use MAPPINGS and dense PDR model to estimate the [CII] emission based on the gas properties from each of the components. Except for the nucleus, we find that diffuse neutral medium is the dominating contributor to the total [CII] emission. For nuclear region, the ionized gas contributes more than 40% of the [CII] emission. Surprisingly in this study we find that dense PDR contributes less than 10% to the total [CII] emission.

[B5A-2-4] **09:55~10:10**

The Carbon Inventory in a Quiescent, Filamentary Molecular Cloud in G328

Catherine Braiding (University of New South Wales, Australia) and Michael Burton

We present observations of [CI] 809 GHz, CO J=1–0 115 GHz and HI 1.4 GHz spectral line emission, and calculate the corresponding C, CO and H column densities, for a sinuous, quiescent Giant Molecular Cloud about 5kpc distant along the l = 328 sightline (hereafter G328) in our Galaxy. The [CI] data comes from the High Elevation Antarctic Terahertz (HEAT) telescope, a new facility near the summit of the Antarctic plateau at Ridge A, where the atmospheric precipitable water vapour content falls to the lowest values found on the surface of the Earth. The CO dataset comes from the Mopra Southern Galactic Plane CO Survey, and the HI data from the Parkes and ATCA telescopes. The morphology and kinematics of the G328 filamentary molecular cloud are similar in [CI], CO, and HI, though the latter appears as self-absorption. The filament is ~75x5 pc long, with mass ~ 4×10^4 solar masses and a narrow velocity emission range of 4 km/s. The line fluxes and column densities we calculate for the three emitting species are broadly consistent with a PDR model for a giant molecular cloud exposed to the average interstellar radiation field, and the [C/CO] abundance ratio averaged through the filament is found to be approximately unity. The G328 filament is constrained to be cold (T_D < 20K) by the lack of far–IR emission, shows no clear signs of star formation, from the narrow line width appears to only be mildly turbulent. We suggest that it may represent a GMC shortly after formation, or perhaps still be in the process of formation.

[B5A-2-5] **10:10~10:25**

Unraveling the Physical and Chemical Properties of Planck Cold Clumps

Tie Liu (Korea Astronomy and Space Science Institute, Korea), Yuefang Wu, Kee-Tae Kim, Diego Mardones, Arnaud Belloche, Di Li, Friedrich Wyrowski, Guido Garay, Isabelle Ristorcelli, Jeong-Eun Lee, Karl M. Menten, Ken Tatematsu, Ke Wang, Leonardo Bronfman,

Stars form in dense regions within molecular clouds, called pre-stellar cores (PSCs), which provide information on the initial conditions in the process of star formation. The low dust temperature (<14 K) of Planck cold clumps/cores makes them likely to be pre-stellar objects or at the very initial stage of protostellar collapse. We have proposed follow-up observations towards these sources with ground-based telescopes (IRAM, PMO 14m, APEX, Mopra, Effelsberg 100 m and CSO). We will identify and characterize starless cores, prestellar cores and preclusters, and determine the evolutionary sequence for these cores and study their physical and chemical properties. We will also study the fragmentation of these starless Planck cold clumps to see whether the fragmentation in the earliest phase of star formation is determined by turbulence or not. This study will greatly improve our understanding of the initial conditions for star formation and core evolution. I will discuss the progress and the plans of this internationally collaborating project.