

Activity Report for NAOJ Visiting Joint Research in FY(2019)

Date: 2019/07/15

Applicant (Host Researcher)	Name	Xing Lu
	Affiliation/ Title	ALMA Project, Specially Appointed Research Employee
Research Title	Kinematics and chemical properties of initial star formation toward Molecular Clouds in the Milky Way	
Work location	Mitaka campus	
Visiting Joint Researcher	Name	Siyi Feng
	Affiliation/ Title	National Astronomical Observatory of China, postdoc
1. Summary of research		
<p>The aim of this two-week's visit is to analyze the data from 5 ALMA projects conducted in ALMA Cycles 5 & 6. Two projects are led by S. Feng (2018.1.00101.S, 2018.1.00215), two projects are led by X. Lu (2017.1.00523.S, 2017.1.00526.S), and one project is led by P. Sanhueza.</p> <p>These projects are focusing on characterizing the kinematic and chemical properties of initial star-forming regions from 1 pc scale down to 100 AU scale at 1 mm, 2 mm, and 3 mm bands. The data of the Cycle 5 projects are delivered; the Cycle 6 projects has been partially executed (80%) and more data are expected.</p> <p>After two weeks' efficient collaboration, we have obtained very interesting results, by imaging a large number of molecular lines at high velocity resolution. In particular, our molecular line tracers clearly reveal signatures of gas flow (accretion), which indicate material transportation between the 70-micron-dark cold molecular clouds and the descendant dense cores. These results are planned to be written in manuscripts and to be submitted to journals.</p> <p>Furthermore, we discussed about future collaborations and follow-up studies in the next ALMA Cycles, in aims of giving constraints for the timelines of molecular line emission from the prestellar to protostellar stages, quantifying the chemical and kinematic properties of the under-explored star forming regions, and ultimately determining the molecular complexity and formation paths from the complex organics to the prebiotic species/precursors.</p>		

2. Research achievements *Please fill out the attachment if you have made presentations at academic conferences or if your research has been published in academic journals

During Dr. S. Feng's business trip in NAOJ from June 2 to June 15 2019,

(1) We found interesting results in each of the 5 ALMA projects. Specifically, we unveiled the perpendicular distribution between the outflow/jet (traced by SiO emissions) and the disk/torus structure (traced by DCO+ emissions) towards a 70-micron-dark core; we witnessed very narrow FWHM linewidth (<0.12 km/s) of DCO+ (2-1) towards the filament associated with an HII bubble rim; we detected a pc-scale ring-like structure in SiO with a narrow linewidth (1.4 km/s) in a region where neither 2mm/3mm continuum emission nor dense gas tracers such as H13CO+ (1-0) are detected. These results will refresh our understanding of initial conditions and feedback in high-mass star-formation.

(2) We made a detailed plan on how to run the radiation transfer code and chemical modeling, in order to give a feasible theoretical explanation for the physical-chemical features of the sources unveiled by ALMA.

(3) S. Feng gave a NAOJ-ALMA seminar on "What can chemistry tell us the initial condition and feedback of high-mass star-forming regions". This talk summarized the projects status of the multi-wavelength multi-scale observations towards a sample of low luminosity-to-mass ratio dense dark molecular clouds; the ALMA results deepen our understanding of this topic.

(4) Thanks to the sensitivity and angular/velocity resolution of ALMA, it brings us fruitful data of molecular emission lines towards every single source. To avoid getting lost in the data jungle, we discussed and made a clear and mutual agreeable plan on the focus and timeline for each manuscript writing as well as possible publications.

3. Any comments on this program 【From the applicant】

4. Any comments on this program 【From the visiting joint researcher】

5. Joint research period	
Name/Affiliation	Siyi Feng/National Astronomical Observatory of China
Period of stay	2019/06/02 ~ 2019/06/15 (14) days
Period of stay	YYYY/MM/DD ~ YYYY/MM/DD () days
Total	(14) days

(Notes)

- If additional space is required to complete any item within this form, please edit the size of the blank spaces as needed.
- For item 5, please include all period(s) of stay(s) of the joint researcher, adding extra lines as necessary. If you have invited more than one joint researcher, please copy and create a table for each invited person.
- If you have any concerns or difficulties with publicizing the items of this report, please identify the relevant items and the reasons for each.

(Request)

After a year following the completion of the joint research period, we will send you a request to submit a list of papers and other results that have been produced by this research collaboration. We appreciate your cooperation.