Joint Postdoctoral Fellow

Field: Multi-wavelength Surveys of Massive Star Formation
Advisor: Diego Mardones (U. of Chile)
Co-Advisor Di Li （NAOC）

1) Scientific Motivation

Star formation is a key process in making visible structures on all spatial scales in the universe. Stars form in dense, largely molecular interstellar medium (ISM) comprised of gas and dust. Due to the development of large format imaging arrays, particularly in infrared, millimeter, and radio bands, we are seeing a rapid growth of large maps of star forming regions from survey instruments, such as Spitzer, Herschel, SMA, VLA，and etc. These surveys form the foundation for studying the detailed physics and chemistry in star formation with newer instrument and at better resolution, such as ALMA and APEX. The key questions are

A. **the time scale and efficiency of star formation,**
B. **and the origin and the universality of the initial stellar mass function (IMF).**

The answers to these questions will alter our understanding of evolution of the galaxies, evolution of the Milky Way ISM, and ultimately, the origin of life.

Science Plan and Output

We plan to organize our efforts revolving the two key science questions.

A. The time scale and efficiency of star formation.

We propose to conduct continuum and spectroscopic surveys of dense cores, which are direct precursors to star formation. There are different proposed modes of star formation, through e.g. self-similar collapse, supercritical collapse, competitive accretion, converging flows, and etc. These modes result in vastly different star formation efficiency and time scales. We have tried to obtain an accurate physical picture of dense cores using interferometers including VLA (e.g. Li et al. 2013 ApJL 768) with different degrees of success in terms of separating the critical state of cores. Better and faster mapping is clearly needed.

Collaboratively, we will utilize high resolution and high sensitivity continuum mapping instruments, such as ALMA, to resolve a series of long-standing problems, e.g., different collapsing modes are associated with different density profile of dense cores. A multi-band dust continuum survey with spatial resolving power may hold the potential to finally reveal, with certainty, the true collapsing state of cores.

B. The origin and the universality of the initial stellar mass function (IMF).

Many galaxy simulations rely on the universality of the IMF, which has been widely demonstrated in the Milky Way. There are, however, critical exceptions toward the Galactic center. Is the IMF truly independent of the physical and chemical star forming environments? We propose to tackle this problem from two sides.

Using the NACO AO system on VLT, we aim to survey the stellar population in extreme environments. Although only feasible to completeness down to about a solar mass, such surveys should help test the universality of IMF.

It has often been suggested that there is a direct resemblance between core mass function (CMF) and IMF. That origin, however, has been challenged (Munoz et al. 2007 ApJ 668; Li et al. 2007 ApJ 655). The resolving power and mapping speed of ALMA will help provide a systematic look into to the origin of IMF.

2) China-Chile Connection

Drs. Di Li and Diego Mardones initiated the research efforts described separately and started collaborating since the first China-Chile meeting on radio astronomy and instrumentation held in Beijing in July 2013. The initial

collaboration was focused on the OMC 2 & OMC3 clouds in Orion, where they succeeded in obtaining ALMA band 3 time for a preliminary survey with 3" angular resolution. The reduction and analysis of the ALMA data in being carried out in Chile and China with the help of the postdoctoral fellows Jeremy (China) and Lei Zhu (Chile) and two papers are in preparation. The proposed research is a natural followup to that first project.

3. Implementation.

1st Year: Submit nir and alma proposals**;** Develop 3d radiation transfer models based on radmc3d or Lime**;** Prepare statistical analysis tools for IMF/CMF sampling and spatial distribution functions.

2nd. Year**:** nir observations, reduction,; IMF and protostellar spatial distribution analysis, publication**;** Joint working meeting of the full team in China/Chile

3rd Year**: A**lma observations & reduction **;** radiative transfer and spatial distribution modeling and publication;international conference presentation