Title of Project : Exploring Chemical Evolution from Star Forming Cores to Protoplanetary Disks by Multi-Wavelength Line Survey

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Research Area : Astronomy

Keyword : Radio Astronomy

【Purpose and Background of the Research】

Star and planet formation is a major target in modern astronomy. It is not only a structure formation process, but a chemical evolutionary process from interstellar matter to planetary systems, which would be related to an origin of the earth and an origin of life.

So far the chemical evolution from starless cores to star forming cores has been established by radioastronomical observations, whereas that from star forming cores to protoplanetary disks has scarcely been studied. However interesting chemical features of low mass star forming cores are now being unveiled owing to increasing sensitivity of radio telescopes. For instance, a French group discovered complex organic molecules in some low mass star forming cores, while our group found various long carbon-chain molecules in other low mass star forming cores. Chemical compositions of star forming cores are thus found to have significant variation. Hence, further chemical evolution toward protoplanetary disks is now becoming an important and urgent target.

With this in mind, we will conduct spectral line survey observations toward protostars with various evolutionary stages to grasp the characteristics of their chemical compositions.

【Research Methods】

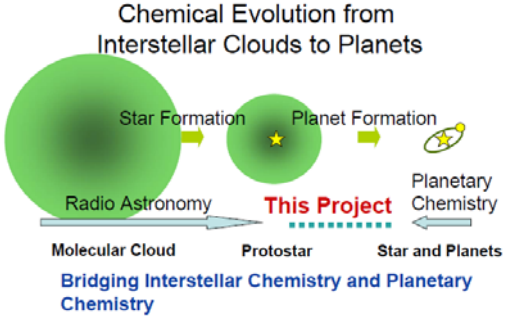
Our spectral line survey covers the mm-wave region, the submm-wave region, and the THz region. In the mm-wave region, we observe various organic molecules including carbon-chain molecule, whereas we concentrate on detection of high excitation lines of simple molecules in the sub-mm observations. In the THz region, spectral lines of simple hydrides can be observed. Combining all the results, we can explore the chemical evolution and its drivers.

For this purpose, we develop a new 70 GHz receiver for the Nobeyama 45 m telescope and a new THz receiver (0.9 – 1.5 THz) for the ASTE 10 m telescope. Here, we use Hot Electron Bolometer (HEB) mixer elements for the THz receiver, which are developed in our laboratory. Since we have already succeeded in fabricating the NbTiN HEB mixer receiver having the noise temperature of 1700 K at 1.5 THz, we will improve it down to 1000 K by using a better quality NbTiN film developed recently.

【Expected Research Achievements and Scientific Significance】

Our line survey will deliver detailed chemical compositions of five protostars with various evolutionary stages, including novel information on abundances of the fundamental molecules such as CH, CH_2, NH, and H_2D^+. From these data, we will draw an outline of the chemical evolution from star forming cores to protoplanetary disks. We can also answer how chemical variation seen in star forming cores propagates into protoplanetary disks.

At present, there is a missing link between interstellar chemistry and planetary chemistry. It is a chemical evolution from star forming cores and protoplanetary disks, which is what we would like to explore in our project. We therefore believe that an outcome of this project would be of fundamental importance both in astronomy and planetary science.



【Publications Relevant to the Project】

Sakai, N., Sakai, T., Hirota, T., and Yamamoto, S., "Abundant carbon-chain molecules toward the low-mass protostar IRAS 04368 +2557 in L1527", Astrophys. J. **672**, 371 (2008).

【Term of Project】 FY2009-FY2013

【Budget Allocation】 131,200 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.resceu.s.u-tokyo.ac.jp/~submm/Welcome.html