

【Grant-in-Aid for Scientific Research on Innovative Areas (Research in a proposed research area)】
Science and Engineering



**Title of Project : A Paradigm Shift by a New Integrated Theory of
Star Formation: Expanding Frontier of Habitable
Planetary Systems in Our Galaxy**

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Research Project Number: 18H05436 Researcher Number: 80270453

【Purpose of the Research Project】

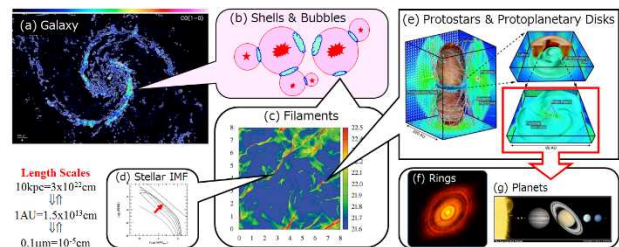
Stars are continuously created in our Milky Way Galaxy. Heavy atomic elements, such as metals, are created inside stars and blown out into the interstellar space of the Galaxy. This process provides atomic elements heavier than hydrogen and helium, such as carbon and oxygen, which is critically important for the existence of living creatures in the universe. In our Milky Way Galaxy, the enrichment of heavy elements starts in the inner Galactic regions and gradually expands toward the outer regions of the Galactic disk. This implies that the environment for creating habitable planets and biological entities are developed inside-out in the Galactic Disk over a timescale of the age of the universe. Understanding the origin and evolution of our solar system requires the comprehension of the environment of the birth place of the solar system about 4.6 billion years ago that is expected to be different from its current location in the Galaxy. This requires our understanding of the evolution of our Galaxy itself, over the timescale comparable to the age of the universe. We will try to understand this by extending the recently developed theory of star formation and describing the formation of star clusters. In addition, we will develop the planet formation theory and try to solve multiple puzzling questions regarding the origin of the solar system. This would be done by the collaboration of all the relevant researchers in Japan and this work is expected to lead a paradigm shift in the investigation of the origin of our solar system. We will also try to find possible siblings of the Sun that would have been born at the same time in the same star cluster, i.e., the expected birth place of the Sun. The results of our project are expected to provide a quantitative picture for the distribution of habitable planets in the Galaxy, and hence, provide a new strategy for future observations of exo-planets.

【Content of the Research Project】

- [A01] Theory for the Formation of Star Clusters and the Evolution of Our Galaxy
- [A02] Theory for the Formation of Planetary Systems from Diverse Protoplanetary Disks
- [A03] Theoretical and Observational Studies of the Formation and Evolution of Diverse

Planetary Atmospheres

- [B01] Observational Studies on the Formation of Star Clusters in Giant Molecular Clouds
- [B02] Observational Studies on the Evolution of Protoplanetary Disks in Diverse Environments
- [B03] Innovation of Infrared Observations of Young Planets and Habitable Planets



【Expected Research Achievements and Scientific Significance】

We will describe the time evolution of the formation rate and the mass function of star clusters and establish a quantitative picture of the Galactic chemical evolution. We will also investigate theoretically and observationally the existence of different types of exo-planets and understand the diversity of planet formation in our evolving Galaxy. These studies are expected to provide a deep understanding on the origin of our solar system.

【Key Words】

Galactic Chemical Evolution: The enrichment of heavy elements in the Galaxy.

Molecular Clouds: Low temperature (~10K) clouds in the interstellar space that are mostly composed of molecular hydrogen: The birthplace of stars.

Protoplanetary Disks: Rotating gaseous disks created around new-born stars: The birthplace of planets.

Exo-Planets: Planetary systems found outside of our solar system.

Habitable Planets: A certain type of planets that may possess liquid water on their surface, and hence, may potentially provide a chance to host biological entities.

【Term of Project】 FY2018-2022

【Budget Allocation】 1,109,800 Thousand Yen

【Homepage Address】

<http://www.ta.phys.nagoya-u.ac.jp/star/>