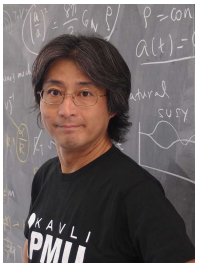
【Grant - in - Aid for Scientific Research on Innovative Areas(Research in a proposed research area)】
Science and Engineering



Title of Project : Why does the Universe accelerate? -Exhaustive study and challenge for the future-

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Research Project Number : 15H05887 Researcher Number : 20222341

【Purpose of the Research Project】

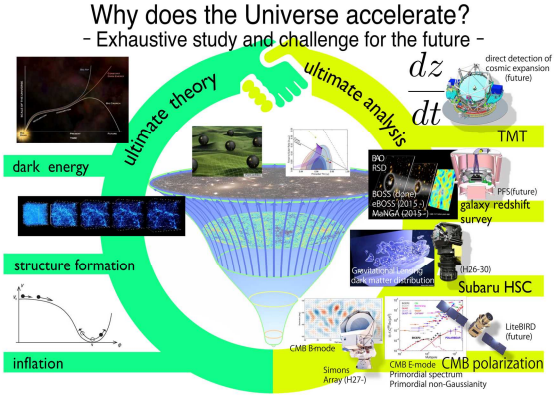
There are observational evidences for two periods of accelerated cosmic expansion, at the very beginning and the present. Since Newton and Einstein, gravity is known as an attractive force, hence can only "pull" the expansion to slow it down. What is "pushing" the Universe to speed it up? We often invoke "inflation" and Einstein's "cosmological constant" as its *theory*, but they have many unnatural features and are far from satisfying explanations. The accelerated cosmic expansion is the mystery that goes to the basic foundation of physics.

The purpose of this research area is to understand the origin of the accelerated cosmic expansion, as well as its interplay with dark matter that competes with the acceleration to build galaxies and clusters of galaxies. To address this problem never encountered before, we propose to conduct research based on a comprehensive approach, ranging from the superstring theory to observation, experiments, and statistical analyses, and realize a quantum leap in this research area based on unprecedented data sets from the Subaru Telescope and others combined with novel data analyses and innovative theoretical ideas.

【Content of the Research Project】

To achieve the purpose, we organized theory units (A01-A03), observation units (B01-B04), and ultimate research units (C01, D01).

- A01 studies physical mechanism behind inflation based on gravity and particle theories as well as their testability.
- A02 studies mechanism for creating unknown particles including dark matter after inflation, characteristics and evolution of primordial fluctuations, and the structure formation as their consequences.
- A03 studies the origin of the current accelerated expansion, building the physical models of dark energy, possibilities of modified gravity, and their testability.
- B01–B04 take data at Simons Array CMB experiment (starting in 2017 with three telescopes), HSC imaging survey on Subaru (2014–19), and large-scale galaxy redshift surveys (BOSS/eBOSS), to constrain inflation and dark energy models with a ten-fold higher precision. In addition, we develop instruments, methodology, and software for future LiteBIRD CMB satellite, multi-object Prime Focus Spectrograph on Subaru, and direct measurement of cosmic acceleration on 30m TMT all led by Japan.
- C01 seeks ultimate theory of accelerated cosmic expansion from the superstring theory with top-down perspective.
- D01 develops ultimate tools of analyzing physical data to constrain physics behind accelerated cosmic expansion in a unified fashion exploiting multi-wavelength data.



【Expected Research Achievements and Scientific Significance】

During the proposed period, we will improve constraints on the energy scale of inflation with a search for primordial B-mode polarization in CMB, on time-variation of dark energy with a deep imaging survey, and on modified gravity and dark energy theories using the galaxy redshift surveys. We will maximize science by a synergistic development of theory and analyses of multi-wavelength data sets. We will thus create a new research area and aim for a full resolution of the mystery of accelerated cosmic expansion. It addresses age-old basic questions by humankind on the creation, fate, structure, and laws of the Universe.

【Key Words】
Accelerated cosmic expansion, quantum gravity, general relativity, inflation, dark matter, dark energy, neutrino, structure formation, cosmic microwave background, Subaru Telescope, Thirty Meter Telescope (TMT), LiteBIRD
【Term of Project】 FY 2015–2019
【Budget Allocation】 1,106,000 Thousand Yen
【Homepage Address and Other Contact Information】 http://acceleration.ipmu.jp