Research Outline of Research Areas

Multi-messenger Atrophysics : From a Static Universe to a Dynamic Universe
http://multimessenger.jp

Number of Research Area	:	9	Term of Project :	FY2025-2029
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1. Details of Research Area

The gravitational energy produced by the mighty gravity of black holes has been the primary energy source of the universe since the Big Bang, and is the source of the diversity of the universe, driving the growth of black holes, the synthesis of elements that are the origin of matter, and the creation of ultra-high energy cosmic ray nuclei with enormous energy that has never been explored by humans. However, the origin of these extreme cosmic phenomena is a great mystery, as the sites are hidden by the surrounding high-density matter. In this research area, we will promote multi-messenger observations that combine neutrino and gravitational wave cosmology observations with traditional electromagnetic wave observations, which have made overwhelming progress in recent years, in order to unify our understanding of the final fate of gravitational energy, from the growth process of ultra-dense fireball plasma produced by the strong gravitational field to elemental synthesis and high-energy radiation. The final fate of gravitational energy, from the growth process of ultra-dense fireball plasma produced by a strong gravitational field to elemental synthesis and high-energy radiation, will be understood in a unified manner. The new research field by a diverse group of researchers with different professional backgrounds will reveal why the universe is so diverse and dynamic.

This research area consists of three research groups: Group A, which is a planned research group to dramatically advance observational research in multi-messenger astrophysics by strengthening the observational experiments and facilities currently in operation; Group B, which conducts future-oriented development research; and Group C, which promotes theoretical research. Each of these research groups is as follows Cosmic neutrinos (IceCube - A01), gravitational waves (LIGO - A02), visible, near-infrared and radio waves (A03), X-rays (A04), gamma rays (CTA - A05), multi-particle space observation technology (B01), multi–Messenger Observation Satellite (B02), Neutrino Astrophysical Theory (C01), and Strong Gravity Research (C02). Five fusion research themes with neutrino, gravitational wave, and electromagnetic wave observations designed to make the most of the observational experiments and projects participating in the area have been established, and each planned research in group A will be promoted in cooperation with each other. The mission of the group C project is to provide guidance for this fusion research and to decipher the observational data to understand in a unified manner the processes leading to the emission of neutrinos, gravitational waves, and electromagnetic waves, starting from the accumulation and release of gravitational energy. In order to sustainably develop this fusion research in the future, B01, which focuses on the development of detectors, especially in the wavelength and energy bands for which advanced observation sensitivity is required, and B02 , which conducts the basic design and development of the HiZ-GUNDAM satellite led by Japan, will play the role of sowing seeds of growth.

Multi-messenger astrophysics is a nascent interdisciplinary field that requires the formation of a new community of researchers with expertise in different space observation techniques. The ultimate goal of this research area is to create a multi-messenger astrophysics expert group consisting of a diverse group of researchers, with Japan leading the way in the fierce international competition.

2. Call for Proposals and Expectations for Publicly Offered Research, etc.

Multimessenger astrophysics, by its very nature, is related to a wide range of astronomical, space, and particle physics research fields. Although each planned research item in the field integrates various specialized research fields by setting up top-down issues, there are many research themes and projects that cannot be covered by this approach. We expect bottom-up research proposals that broaden the base of interdisciplinary research in the open call for research. We welcome observation research proposals that are not part of the top-down fusion research agenda, such as observation research using balloons and other flying objects, survey observation specializing in a certain wavelength band, and cosmic particle observation research using ground-based detectors, as well as proposals for detector development based on novel ideas. We also expect seed research proposals that will develop fusion research, such as research on methods for integrating and analyzing data of different quality, and theoretical research proposals on cosmology, particle theory, gravity theory, etc., which will form the basis of the framework of multi-messenger astrophysics.

In addition, in order to promote relatively large-scale observation and development research, we invite truly pioneering research with a maximum application amount of 5 million yen per single year .

3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)		Number of research projects

				scheduled to be selected
E01	Multi-messenger Astrophysics Observation and Development Large scale Research	5		2
E02	Multi-messenger astrophysics observation, numerical simulation and development research	3		8
E03	Multi-messenger astrophysics theory research	1		8