

Summary of Proposal

Host institution name	The University of Tokyo
Head of host institution	Hiroshi Komiyama, (President, The University of Tokyo)
Center Director	Hitoshi Murayama
Administrative director	Kenzo Nakamura
Title of center project	Institute for the Physics and Mathematics of the Universe
Center name	Institute for the Physics and Mathematics of the Universe
Project Summary	<p>This center aims at establishing a multi-disciplinary research institute with the unifying goal of understanding the universe from the synergistic perspectives of physics, cosmology and mathematics. The Institute will bring many of the world's leading theoretical physicists and mathematicians together to develop new formulations of the fundamental laws of nature, a crucial step toward solving the mysteries of the universe.</p> <p>We will study dark energy, dark matter, neutrinos, and physics beyond the Standard Model of elementary particles and will follow these closely related research threads toward a deeper and more comprehensive view of the cosmos. The Institute will utilize state-of-the-art facilities (Super-Kamiokande, KamLAND, Subaru telescope, and LHC accelerator) and will produce an unprecedented volume of precision data. We will invent new mathematical tools to analyze the data and develop new strategies for future experiments.</p> <p>This center is a unique research institute in the world on the forefront of physics, cosmology and mathematics. It will attract highly motivated young researchers, as well as established leading scientists from around the world and will greatly strengthen the foundation of mathematical and physical sciences in Japan.</p>
Research fields	<p>Physics and Mathematics</p> <p>Science's fundamental and historic search for the fundamental laws of Nature is built on the invention of new mathematics, and it has inspired many important developments in the field. Approximately 40% of Field Medalists in mathematics since 1990 have worked in areas closely related to quantum field theory or string theory. No other area of science has had such a great impact on mathematics in the past few decades, and the rate of progress in this area suggests that this trend will only accelerate in the future. Japan has long been strong in both physics and mathematics. The Institute will bring the world's leading physicists and mathematicians together, build a unified community, redefine the boundaries between them, and help nurture future generations of mathematical scientists.</p> <p>The Institute will also support and take advantage of superb experimental programs. Japan continues to lead the world in the field of underground physics including dark matter searches and the study of neutrinos by capitalizing on two major underground detectors (Super-Kamiokande and KamLAND). A new instrument that enables a</p>

	<p>wide-field, deep-sky survey of galaxies is being built for Japan's largest telescope, Subaru, which has a unique technical capability for such projects. The world highest energy accelerator LHC, to which Japan has made significant contributions for construction, will become operational by the end of this year, and the data on high energy collisions that mimic those which occurred during the Big Bang, the birth of the Universe, will be available to us.</p> <p>Thus, the Institute will be a globally unique research center that spans pure mathematics, theoretical physics, experimental physics, astronomy, and applied mathematics. Frontier research projects in each field will motivate efforts in the others in a way not possible within the usual structure of academic institutions.</p>
<p>Research objectives</p>	<p>We will address a set of basic and deep questions about the universe, its fundamental laws, its beginning, its fate and its mysterious components, especially Dark Matter and Dark Energy. For this purpose, we will create the new mathematics needed for a unified description of the universe. This mathematical foundation will allow the formulation of new physical theories with well-defined and testable predictions. Technological innovations will follow to make new experiments possible; the resulting data streams will stimulate further developments in mathematics.</p> <p>The ambitious ten-year goals of the Institute's activities are as follows:</p> <ul style="list-style-type: none"> • Using new data from underground (neutrino) and accelerator (high energy particle) experiments, we aim to unveil the nature of dark matter and develop a new paradigm in particle physics, based on a unified physical theory and founded upon new mathematical tools and insights. • The vast data volumes produced by next-generation galaxy surveys will motivate applied mathematicians and statisticians to develop the novel methods needed to extract subtle signals and maximal information, thus uncovering any unanticipated behavior of the universe's mysterious Dark Energy component. • We will enumerate and classify solutions of string theory that will lead to the development of new types of geometries. • Mathematical developments in integrable systems will allow string theorists to find new classes of solutions which determine the dynamical behavior of Dark Energy. <p>Taken together these goals will produce revolutionary and unifying advances in physics, mathematics and cosmology.</p>
<p>Outline of management</p>	<p>The Institute Directorate consisting of the Director, Deputy Directors and Administrative Director will have direct access to the Office of the President, will be able to consult with the President and his staff members and will thus share their management resources. Thanks to this arrangement, we envision our administrative organization to be <i>streamlined</i>, yet very <i>effective</i>. More than 50% of the staff members will be bilingual.</p> <p>Aside from the appointment of the Director and approval of PI selections, the Director will have the authority to make nearly all decisions on the Institute's composition, organization and operation. The Scientific Advisory Committee (SAC) to the Director consists of four to five PIs of his choice. It will advise the Director on planning and hiring staff members, as well as scientific directions, but the Director is solely responsible for the final decisions. The PIs will have great autonomy in the research they conduct and will be encouraged to fund their research through competitive grants. They can make proposals to the Director to hire postdocs and term professors. The Director's approval of such appointments will reflect the scientific vision and priorities set by the</p>

	<p>Director, advised by the SAC.</p> <p>An External Advisory Board (EAB) will review the Institute's activities annually and advise the Director on the effectiveness of its operational priorities and research activities with respect to the proposed science goals summarized above. At least half of the EAB's members will be scientists from outside the University of Tokyo.</p>
<p>Researchers and other center staffs</p>	<p>Initially the Institute will have 20 Principal Investigators and 3 administrative staff members. By March, 2011, the Institute will have grown to 22 PI's, 173 other researchers, 20 research support staff members and 10 administrative staff, totaling 225 core members of the Institute. The initial list of PI's is: H.Murayama, Y.Suzuki, T.Kajita, M.Nakahata, M.Fukugita, H. Aihara, K. Sato, K. Nomoto, T. Yanagida, M. Jimbo, T. Kohno, M. Sugiyama, A. Tsuchiya, K.Inoue, H. Ooguri, K.Saito, M.Nojiri, D.Spergel, S.Katsanevas, H.Sobel. A satellite activity center will be established at Kamioka. Department of Astrophysical Sciences of Princeton University, Department of Physics of University of California Berkeley, IHES in France, the Physics Department and the YITP at Kyoto University, NAOJ, KEK, and Tohoku University Research Center for Neutrino Science will be collaborating institutions.</p>
<p>Outline of research environment</p>	<p>The Director has extensive experience leading research groups at Berkeley and the Institute for Advanced Study and via service on numerous scientific-policy making committees in the US and Japan. The agreements with the University and the funds secured by the Director will enable Institute researchers to focus on their research and on scientific interactions with each other. The new Institute building, with a large open area and amenities, will provide an attractive and stimulating environment for scientists from around the world. International conferences and workshops held at the Institute will bring visitors to further stimulate the intellectual activities and to keep the Institute at the forefront of global science. The Institute will adopt a merit-based compensation system with salaries based on individual performance criteria.</p>
<p>Outline of indicators for evaluating a center's global standing</p>	<p>The number of refereed journal papers by Institute authors and their citation impact, plus the number of presentations the researchers deliver at major international conferences will be monitored. The number of visitors, and the number of foreign scientists among them, are other objective indicators of the Institute's contributions and visibility. We plan to monitor the number of publications co-authored by mathematicians and physicists as a measure of the synergy between the two disciplines.</p>
<p>Securing research funding</p>	<p>The initial Institute PIs received a total of approximately \$57M in competitive funding during the last five years, and they have already secured approximately the same amount for the future. We are, therefore, confident that they can maintain a similar funding profile in the era of this new Institute.</p>
<p>Summary of host institution's commitment</p>	<p>A world-class center of excellence for international research aligns with the University's medium-term objectives and plan extremely well; hence the Institute will be the most important and visible organizational unit and endeavor reporting to the President. It will thus receive university-wide support under the specified achievement targets. Top priority will be given to financing and appropriating land for the Institute's new research building. Until the new research building is constructed at the Kashiwa Campus, rooms and other space in the Kashiwa General Research Building will be provided for activities of the Institute on a priority basis.</p>