2.Summary of Proposal

(Compile in English within 3 pages.)

Host institution	The University of Tokyo
Head of host institution	Junichi Hamada,（President, The University of Tokyo）
Research center	Institute for the Physics and Mathematics of the Universe
Center director	Hitoshi Murayama
Chief center-project officer (in October 2007)	Yoichiro Suzuki, Director and Professor, Institute for Cosmic Ray Research, The University of Tokyo
Project summary	We establish a multi-disciplinary research center with the unifying goal of understanding the universe from the synergistic perspectives of physics, cosmology and mathematics. The Center brings 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. We study dark energy, dark matter, neutrinos, and physics beyond the Standard Model of elementary particles and follow these closely related research threads toward a deeper and more comprehensive view of the cosmos. The Center utilizes state-of-the-art facilities (Super-Kamiokande, KamLAND, XMASS, Subaru telescope, and SuperKEKB accelerator) and produces an unprecedented volume of precision data. We invent new mathematical tools to analyze the data and develop new strategies for future experiments. This center is a unique research institute in the world on the forefront of physics, cosmology and mathematics. It attracts highly motivated young researchers, as well as established leading scientists from around the world and greatly strengthens the foundation of mathematical and physical sciences in Japan.
Mission statement and/or center's identity	We address big questions about the universe, its fundamental laws, its beginning, its fate, and its mysterious components. For this purpose, we create this center and bring mathematicians, physicists and astronomers into one place. We make experimental explorations from underground, into sky, and at the accelerator. We tie them together using common threads of theoretical physics that is closely tied with highly advanced mathematics and of highly sophisticated technologies in detectors and data handlings. Our goals are improved understanding on dark energy and dark matter, improved understanding on physics beyond the standard model, exploring new astrophysical phenomena, deeper understanding on string theory, further developments in geometry and algebra. These are all important ingredients for addressing the fundamental questions of the universe.
Research fields	Physics and Mathematics 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. This center brings the world's leading physicists and mathematicians together, builds a unified community, redefines the boundaries between them, and helps nurture future generations of mathematical scientists. The center also supports and takes 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 three major underground detectors (Super-Kamiokande, XMASS and KamLAND). A new instrument that enables a 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, became operational, and the data on high energy collisions that mimic those which occurred during the Big Bang, the birth of the Universe, are now available to us. The Center plans to participate in both detector construction and physics analysis at the world highest luminosity electron-positron collider SuperKEKB and push the study of supersymmetry and other new physics possibilities. Thus, the Center is a globally unique research center that spans pure mathematics, theoretical physics, experimental physics, astronomy, and applied mathematics. Frontier research projects in each field motivate efforts in the others in a way not possible within the usual structure of academic institutions.
Research objectives	We 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 create the new mathematics needed for a unified description of the universe. This mathematical foundation allows the formulation of new physical theories with well-defined and testable predictions. Technological innovations follow to make new experiments possible; the resulting data streams stimulate further developments in mathematics. The ambitious ten-year goals of the Center's activities are as follows: • Using new data from underground (neutrino) and accelerator (high energy particle) experiments, we 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 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 enumerate and classify solutions of string theory that lead to the development of new types of geometries. • Mathematical developments in integrable systems allow string theorists to find new classes of solutions which determine the dynamical behavior of Dark Energy. Taken together these goals produce revolutionary and unifying advances in physics, mathematics and cosmology.
Outline of management	The Center Directorate consisting of the Director, Deputy Directors and Administrative Director has direct access to the Office of the President, is able to consult with the President and his staff members and thus shares their management resources. Thanks to this arrangement, our administrative organization is *streamlined,* yet very *effective*. More than 50% of the staff members are bilingual. Aside from the appointment of the Director and approval of PI selections, the Director has the authority to make nearly all decisions on the Center's composition, organization and operation. The Scientific Advisory Committee (SAC) to the Director consists of four to five PIs of his choice. It advises 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 have great autonomy in the research they conduct and are encouraged to fund their research through competitive grants. They can make proposals to the Director to hire postdocs and termed professors. The Director's approval of such

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<tr><td></td><td>appointments reflects the scientific vision and priorities set by the Director, advised by the SAC.
The External Advisory Committee (EAC) reviews the Center's activities annually and advises 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 EAC's members are scientists from outside the University of Tokyo.</td></tr>
<tr><td>Researchers and other center staffs, satellites, partner institutions</td><td>Initially the Center had 18 Principal Investigators and 3 administrative staff members. By April, 2012, the Center has grown to 19 PIs, 66 other full-time researchers, 28 research support staff members and 10 administrative staff, totaling 123 core members. The initial list of PIs 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, D.Spergel. S.Katsanevas, H.Sobel. Satellite activity centers are established at Kamioka and University of California Berkeley campus (Kamioka satellite is now referred to Kamioka Branch since it turned not to qualify a strict definition of satellite); the Astrophysical Sciences Department of Princeton University; IHES in France; the Physics Department and the YITP at Kyoto University. NAOJ, Research Center for Neutrino Science at Tohoku University and KEK are the collaborating institutions.</td></tr>
<tr><td>Administrative director</td><td>Kenzo Nakamura, Professor,
Institute of Particle and Nuclear Studies, KEK (in October 2007)</td></tr>
<tr><td>Outline of research environment</td><td>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 enable the Center researchers to focus on their research and on scientific interactions with each other. The new Center building, with a large open area and amenities, provides an attractive and stimulating environment for scientists from around the world. International conferences and workshops held at the Center bring visitors to further stimulate the intellectual activities and to keep the Center at the forefront of global science. The Center adopts a merit-based compensation system with salaries based on individual performance criteria.</td></tr>
<tr><td>Outline of indicators for evaluating a center's global standing</td><td>The number of refereed journal papers by the Center authors and their citation impact, plus the number of presentations the researchers deliver at major international conferences are monitored. The number of visitors and the number of foreign scientists among them are other objective indicators of the Center's contributions and visibility. To evaluate research activities in mathematics and synergies between physics and mathematics, a periodic peer review is adopted.</td></tr>
<tr><td>Securing research funding</td><td>The initial Center PIs received a total of approximately $53M 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 center.</td></tr>
<tr><td>Appropriations plan

(Exchange Rate: JPY/USD=80)</td><td>
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<tr><td>FY</td><td>2012</td><td>2013</td><td>2014</td><td>2015</td><td>2016</td><td>Total</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cost
($ millions)</td><td>16.68</td><td>16.68</td><td>16.68</td><td>16.68</td><td>16.68</td><td>172.628</td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Summary of host institution's commitment</td><td>A world-class center of excellence for international research aligns with the University's medium-term objectives and plan extremely well; hence the Center is the most important and visible organizational unit and endeavor reporting to the President. It thus receives university-wide support under the specified achievement targets. Top priority was given to financing and appropriating land for the Center's new research building.</td></tr>
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