【Science and Engineering（Mathematics/Physics）】

Title of Project	Anatomy of protosolar system
Principal Investigator Name	Hisayoshi Yurimoto, Hokkaido University, Department of Natural History Sciences, Professor
Abstract of Research Project Number of Researchers : 3 Term of Project: 2008–2012	Recently we developed a state-of-the-art instrument of isotope microscopy and applied to meteorite analyses. We discovered that circumstellar materials formed before solar system formation are embedded in meteorites. This discovery demonstrates that evolution from the circumstellar materials to solar system materials can be directly traced by isotope microscopy. In this project, we continue to develop the anatomy of meteorite by isotope microscopy more precisely. The new generation isotope microscopy will clarify material evolution during and before our solar system formation. Based on the results, we propose new scenario of origin of solar system including our specificity and universality. This is a challenge to universal theory of origin of planetary system in galaxy based on material evidence.

Title of Project	New Development of Neutrino Physics by Reactor Neutrinos
Principal Investigator Name	Fumihiko Suekane, Tohoku University, Graduate School of Science, Associate Professor
Abstract of Research Project Number of Researchers : 5 Term of Project: 2008–2012	The neutrino is an elementary particle which is not well understood yet. Knowing the properties of neutrino is important to deepen our understanding of the nature. There are 3 types of neutrinos. The type changes spontaneously during traveling due to neutrino oscillation. There are 3 kinds of neutrino oscillations. Two of them have already been measured. However, the 3rd oscillation has not been detected yet. The purpose of this experiment is to discover the last neutrino oscillation using reactor neutrinos. The experiment will be performed at Chooz nuclear power station in France. By comparing the data from 2 neutrino detectors which locate near and far from the reactors, the amplitude of the 3rd neutrino mixing will be precisely measured. This experiment completes the determination of amplitudes of all three neutrino oscillations and the neutrino physics will go into a new step.

Title of Project	A Study of the Evolution of Large Scale Structures Based on the Ultra Wide Band Millimeter And Submillimeter Observations
Principal Investigator Name	Kotaro Kohno, The University of Tokyo, School of Science, Associate Professor
Abstract of Research Project Number of Researchers : 8 Term of Project: 2008–2012	The goal of the project is to unveil the evolutions of the true star formation activities and large scale structures in the early universe. First, we will conduct unprecedented millimeter/submillimeter-wave surveys, which are very efficient to detect dusty starbursts in the early universe. A large numbers of dust enshrouded massive young starburst galaxies will be uncovered. Because they are often invisible in optical and infrared observations, it could be referred as "dark galaxies". The distances (or epochs) of them will then be determined based on our own methods. We will build a multi-color camera and ultra-wide-band spectrometers using superconducting devices, and they will be mounted on the new submillimeter telescope ASTE in Chile and other telescopes. From these results, we will unveil the true history of the cosmic star formation. The evolution of dark matter distributions will also be addressed through the analysis of clustering properties of galaxies.

【Science and Engineering（Mathematics/Physics）】

Title of Project	Behavior of Fe-bearing materials under very high pressure and mineralogy of the lowermost mantle and the inner core
Principal Investigator Name	Tetsuo Irifune, Ehime University, Geodynamics Research Center, Professor
Abstract of Research Project Number of Researchers : 5 Term of Project: 2008–2012	Application of nano-polycrystalline diamond and sintered-polycrystalline diamond to ultra high-pressure generation will be pursued using both diamond anvil cell and multianvil apparatus to realize static pressures equivalent to the central part of the Earth. Using these techniques, combined with synchrotron X-ray and ultrasonic measurements, we will particularly focus on the crystal structure of metallic iron, nature of electron spin transitions in Fe-bearing minerals, and chemical compositions of the lower mantle and the core. First-principles calculation will also be adopted to investigate these subjects at the P, T conditions where the experiments are difficult to cover.

Title of Project	Contribution to fundamental physical constants using exotic-atom spectroscopy
Principal Investigator Name	Ryugo Hayano, The University of Tokyo, Department of Physics, Professor
Abstract of Research Project Number of Researchers : 1 Term of Project: 2008–2012	Exotic atoms denote systems in which a heavy negatively-charged particle (e.g., antiproton) is bound by the Coulomb force to the nucleus. Precision spectroscopy of exotic atoms yields fundamental constants, such as the proton-to-electron mass ratio, which cannot be obtained in the studies of ordinary atoms. Since exotic atoms do not exist in nature, accelerators are necessary for their studies. This project emphasizes precision studies of two kinds of exotic helium atoms, 1) antiprotonic helium (at CERN's antiproton decelerator facility) and 2) kaonic helium (at the hadron-hall of J-PARC accelerator complex in Tokai, Japan). The laser spectroscopy of antiprotonic helium atoms, which has already contributed to the CODATA 2006 values, will improve the precision of the relative atomic mass of the electron, while the X-ray spectroscopy of kaonic helium atoms will experimentally pin down the kaon-nucleus strong-interaction strength, the subject of hot theoretical debate for the past 10 years.

Title of Project	New Quantum Phases of Matter in Multidimensional Environments
Principal Investigator Name	Yoshio Kitaoka, Osaka University, Graduate School of Engineering Science, Professor
Abstract of Research Project Number of Researchers : 7 Term of Project: 2008–2012	In order to create the basic science and engineering of twenty-first century, it is necessary to investigate the new quantum phases of matter in multidimensional environment, especially in the research field of strongly correlated matter. Through this specially promoted research project, we address intriguing properties in the new quantum phases of matter and their physical backgrounds. Main targets are fundamental research aiming at the creation of novel quantum materials exhibiting cooperative and competitive effects of the typical quantum functions of materials, such as superconductivity, magnetism, and ferroelectricity, and the establishment of heretofore unexplored fundamental principles of materials science through the elucidation of new quantum functions of these materials; these will be achieved by combining evolutional experimental techniques and theoretical analysis in an interdisciplinary approach .

【Science and Engineering (Chemistry)】

Title of Project	Physical chemistry of nanographene edges: edge states and their electronic and magnetic functions
Principal Investigator Name	Toshiaki Enoki, Tokyo Institute of Technology, Graduate School of Science and Engineering, Professor
Abstract of Research Project Number of Researchers : 4 Term of Project: 2008–2012	Nanographene, which is intermediate in size between graphene and polycyclic aromatic hydrocarbon molecules, has electronic structure that crucially depends on the geometry of its edge structure. Around zigzag edges are created unconventional edge states having localized spins. The edge states not only play important roles in electron reservoirs and active sites for chemical reactions, but also provide building blocks in designing molecular magnets. The present project aims at creating a new frontier of science on nanographene edges on the basis of atomic-resolution studies of the electronic structure of nanogaraphene edges. It also contributes to clarifying the mechanism of electron transfer and chemical reaction in nanographene, building a new class of carbon-based molecular magnets, and developing electronic/spintronic molecular devices.

Title of Project	Reversible Conversion between Electrical Energy and Chemical one Mediated with Coordination Complexes
Principal Investigator Name	Koji Tanaka, Institute for Molecular Science, Department of Life and Coordination-Complex Molecular Science, Professor
Abstract of Research Project Number of Researchers : 1 Term of Project: 2008–2011	Since James Watt's invention of steam engines about 250 years ago, our society has been heavily relying on thermal energy released by combustion of tremendous amounts of fossil fuel. Conversion of electrical energy to chemical one would provide the most reasonable methodology to fix non-steady natural energies and to store extra electricity generated by power plants at night. The aim of this study is to develop molecular catalysts that are able to catalyze conversion between carbon dioxide and methanol through six-electron redox reactions of those molecules.

Title of Project	Synthetic Studies on Biologically Functional Molecules
Principal Investigator Name	Tohru Fukuyama, The University of Tokyo, Graduate School of Pharmaceutical Sciences, Professor
Abstract of Research Project Number of Researchers : 3 Term of Project: 2008–2012	Overcoming the serious diseases such as cancers and Alzheimer's disease is one of the most important issues in the aging society. Accordingly, intensive efforts for developing new and effective medicines to cure these diseases are actively pursued. Natural products have recently drawn renewed interests and attentions as the seeds of novel medicines. However, availability of such natural products from nature tends to be severely limited. In order to develop novel medicines from natural products, sufficient amounts of compounds need to be provided for derivatization and biological testing. One of the goals of our research program is to establish practical synthetic routes for the natural products of medicinal importance. In addition, a variety of derivatives of the natural products will be synthesized for biological testing.

【Science and Engineering (Engineering)】

Title of Project	Study of Mechanisms of Cellular Mechanosensing
Principal Investigator Name	Masaaki SATO, Tohoku University, Graduate School of Biomedical Engineering, Professor
Abstract of Research Project Number of Researchers : 6 Term of Project: 2008–2012	The cells constituting tissues/organs can sense mechanical forces (termed as "mechanosensing"). Vascular endothelial cells, bone cells, and articular chondrocytes, which are the main focus of this study, are typical examples of cells with mechanosensors. These cells exhibit morphological and functional changes in response to external forces; however, the underlying sensing mechanisms are still unknown. The aim of this study is to elucidate the mechanisms by using a combination of cutting-edge bio-imaging and computer simulation techniques as well as novel experimental methods to specifically apply mechanical forces to local regions of the cells.

Title of Project	Identification of Epileptogenic Focus by Employing Softcomputing and Establishment of Minimally Invasive and Definitive Surgery
Principal Investigator Name	Takeshi Yamakawa, Kyushu Institute of Technology, Graduate School of Life Science and Systems Engineering, Professor
Abstract of Research Project Number of Researchers : 5 Term of Project: 2008–2011	Epilepsy is a chronic brain disorder characterized by recurrent seizures. The seizure is shot down by the surgical removal of the region which is so called "epileptogenic focus". However, the accuracy to detect the focus is not good (order of cm). Thus the extirpation of origin with significant margin causes the removal of healthy brain and leads to the severe aftereffects such as restricted vision, motor dysfunction, disorder of memory, and so on. To cope with this problem, we should develop the technology of (1) detecting the epileptogenic focus, and (2) necrotizing the epileptogenic focus excluding healthy brain by (a) colliquative necrosis with flash freezing or (b) cauterizing by focused laser beam.

Title of Project	Establishment of Electrochemical Device Engineering
Principal Investigator Name	Tetsuya Osaka, Waseda University, Faculty of Science and Engineering, Professor
Abstract of Research Project Number of Researchers : 4 Term of Project: 2008–2012	Electrochemistry deals with systems of interface between electrode and electrolyte, and it covers industrial products and processes including batteries, energy devices, chemical sensors, surface treatments, electronic devices, and chemical analysis. The objective of this research is to establish 'electrochemical device engineering' based on the design of electrode/electrolyte interface with a single-layer or multi-layers of atoms and/or molecules. The work will be focused on the development of energy devices and chemical sensors, and three- or two-dimensional designs of interface will be investigated to establish the basic concept for device fabrication processing. In addition, nano-particle systems of functional materials will be studied, which can be considered as zero dimensional material systems. The smart design concept based on 'electrochemical device engineering' will be established as this research makes a progress.