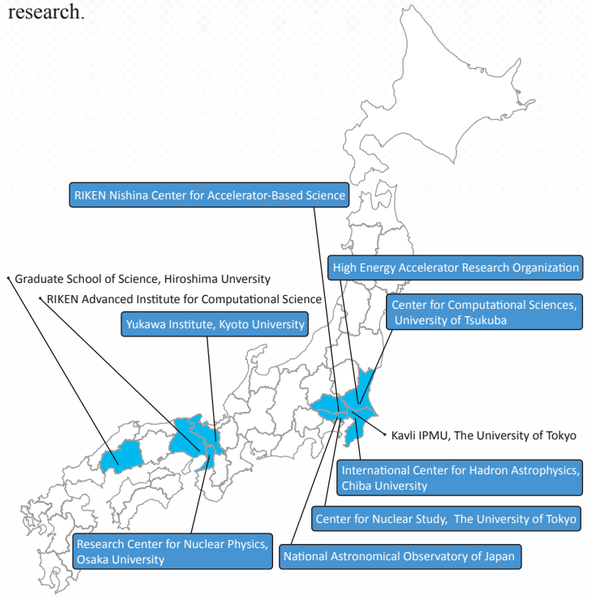
Science is the branch of study engaged in uncovering laws hidden in nature and in understanding, predicting, and reproducing phenomena. Over time, humankind has learned to express these laws in the form of equations through the use of two basic scientific methods - theory and experiment (observation). But the nature of elementary particles and the phenomena involved in the evolution of the universe involve complexities that cannot be resolved through an analytical approach starting from the basic equations. The supercomputers have emerged as essential tools for their investigation and resolution, and computational science using the supercomputers has now joined theory and experiment as the third scientific method.

Credit:
T. Ishiyama(Univ. of Tsukuba), T. Saito(Tokyo Tech.), T. Takeda(NAOJ), J. Baba(Tokyo Tech.)

Joint Institute for Computational Fundamental Science

Joint Institute for Computational Fundamental Science (JICFuS) is a collaborative effort eight institutions. We had conducted nuclear calculations using quantum chromodynamics, simulations of neutron star mergers, and research on the generation of density fluctuations in dark matter, under MEXT SPIRE Field 5 “The origin of matter and the universe” implemented in fiscal 2015. JICFuS had gained some noteworthy research results, winning the ACM Gordon Bell Prize.

MEXT as “Priority Issue on Post-K computer” (Elucidation of the Fundamental Laws and Evolution of the Universe) starts from fiscal 2016, we aim to create further research results. JICFuS dedicated to enhancement of the computational science research and development through (1) strong, fine-grained support of fundamental computational scientists, (2) provision of a venue for cooperation between fundamental computational scientists and computer scientists, and (3) creation of new fields of research.



JICFuS Joint Institute for Computational Fundamental Science | http://www.jicfus.jp/

Joint Institute for Computational Fundamental Sciences

JICFuS
Joint Institute for Computational Fundamental Science

RIKEN NiSHiNA CENTER
RCNP Osaka University
International Center for Hadron Astrophysics, Chiba University

Computational science

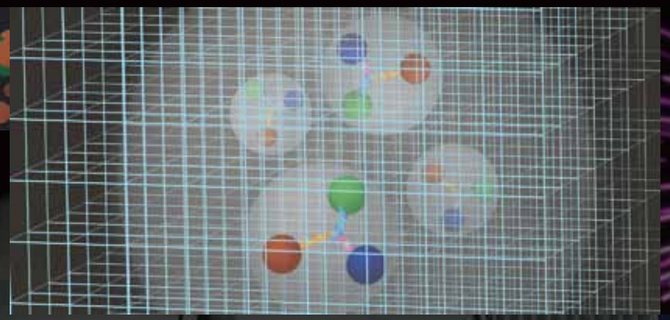
- the third scientific method

Elucidation of the Fundamental Laws and Evolution of the Universe

The ultimate purpose of computational science in the fields of particle physics, nuclear physics, and astrophysics is to elucidate the history of the creation of matter, in a manner that bridges the three fields. Our aim is to conduct precise large-scale calculations using a supercomputer in order to investigate phenomena on scales ranging from that of elementary particles to the universe itself. We will combine the results obtained with those of large-scale experiments and observational data, in an effort to elucidate the history of the creation of matter.

To realize these aims, MEXT as “Priority Issue on Post-K computer” (Elucidation of the Fundamental Laws and Evolution of the Universe), which will begin operation in fiscal about 2020, will develop simulation code to verify the Standard Model of particle physics, and investigate superstring theory, particle interactions, the structure of heavy nuclei, and stellar explosions, and so unlock the mysteries of the evolution of the universe.

Quest for the Ultimate Laws and the Birth of the Universe

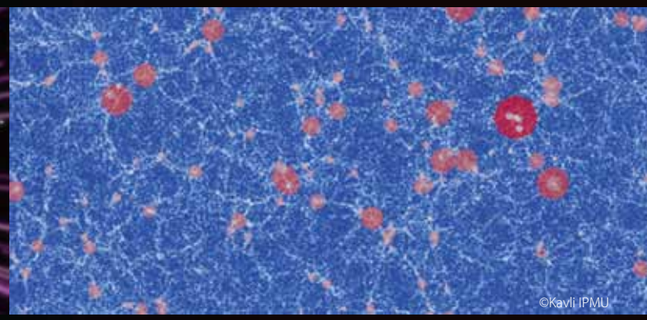


We plan to perform large-scale simulations of lattice quantum chromodynamics (QCD) in order to calculate the physical quantities needed to interpret the experimental results obtained at large particle accelerators such as SuperKEKB and J-PARC.

Exploring the Origin and Evolution of Matter

The purpose of this project is to explore the unsolved issues in microscopic physics by larger-scale numerical computation. Specifically, the issues are to accurately determine the baryon-baryon interactions, nuclear structure and many-body reactions between nuclei, and the equation of state for high-density nuclear matter.

Large-Scale Simulations and Astronomical Big Data



In the next ten years, a variety of large observational programs will be conducted. We will push the frontier of big data cosmology that combines observational data and large-scale simulations to elucidate the evolution of the universe and the formation of galaxies.

Promotion of Computational Fundamental Science

In order to accelerate the research and development of computational fundamental science, we promote user support, exploratory research support, and human network construction. To learn fundamental physics, we have developed “Quark Card Dealer” the Quantum Chromodynamics collectible card game.