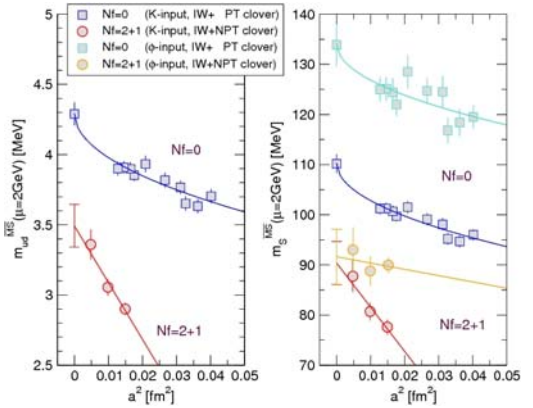
R&D field: Physics/astronomy

Study of elementary particle and nuclear physics based on Lattice QCD simulation

- Program name: LatticeQCD
- Developer
  - Tomoteru Yoshie, Associate Prof. of Univ. of Tsukuba and collaborators
  - Ken-ichi Ishikawa, Associate Prof. of Hiroshima Univ. and collaborators
- Abstract
  - First-principle calculation of strongly-interacting elementary particles based on QCD (fundamental theory for quarks and gluons) formulated on the four-dimensional space-time lattice.
- Algorithm
  - Monte-Carlo and CG methods.
  - Two- and three-dimensional decomposition of four-dimensional space-time lattice.
  - Fortran90 and MPI.
- Current computation size
  - Lattice points 28x28x28x56, total computation amount 1.7 TFlops･year, output data 4.1 TByte.
  - Sustained performance 412 GFlops and memory 7.5 GBytes (14 nodes of Earth Simulator).
- Future computation size in 2010
  - Wilson-clover quark action with lattice points 100x100x100x200 and chiral quark action with 50x50x50x100.

Average mass of u- and d-quarks (left) and of s-quark (right). The vertical axis is square of lattice spacing.



- Expected results
  - The standard theory for elementary particles will be established and fundamental interaction will be understood based on the degrees of freedom of quarks and leptons by investigating asymmetry between matter and anti-matter (violation of CP symmetry).
  - The state of matter just after Big Bang (birth of universe) will be understood by describing physical properties of quark-gluon plasma at extremely high temperature of more than 2 trillion degrees and high density.
  - Fundamental physics underlying the birth of the universe will be understood by describing the proton/neutron and nucleus based on quarks and gluons.
- Reference
  - http://pos.sissa.it//archive/conferences/032/181/LAT2006_181.pdf