Columbia Supercomputer Project Receives $5M From RIKEN of Japan, to Be Installed at Brookhaven Lab

By Suzanne Trelmel

Physicists from both Columbia and the Brookhaven National Laboratory plan to build a super-computer capable of 10 trillion arithmetic operations per second for explorations of sub-atomic particles. The project will be conducted with $5 million in funding from RIKEN (The Institute of Physical and Chemical Research) of Japan, a leader in the promotion of international research collaboration.

The computer will be installed at the RIKEN BNL Research Center (RC), located at the Brookhaven National Laboratory on Long Island, N.Y. T.D. Lee, the Nobel Prize winner theoretical physicist and Columbia professor, is RBC's director.

To be completed in 2003 and capable of 10 trillion arithmetic operations per second (10 Teraflops), the supercomputer will be used by physicists at the RIKEN Brookhaven facility and the Columbia Physics Department for investigations of quarks and gluons, the subatomic particles from which the atomic nucleus is constructed.

RIKEN's involvement in the project is a part of its broader support for basic elementary particle research, especially pertaining to nuclei and spin. RIken carries out a base accelerator-based research program in Japan and plays a role in the promotion of international research and collaboration.

"The supercomputer will be a world-leading facility which will drive major advances in our understanding of nature," said Lee, who played a critical role in the creation of the RBRC in 1997 and has been director since it was founded. Lee, who was instrumental in securing the funds for RIKEN, went on to say that "there is a remarkable opportunity for the physicists at Columbia and the RBRC to make new discoveries on the frontier of particle and nuclear physics.

The project builds on important work already underway at Columbia in the development of a highly cost-effective QCDOC supercomputer architecture and the collaborative research program at the RIKEN Laboratory and Columbia involving a previous generation of QCDSF supercomputers.

The same QCDOC derives from Quantum Chromodynamics On a Chip, where Quantum Chromodynamics is the underlying theory of the quark-gluon interaction. This computer design project has been under way at Columbia since the fall of 1999 and represents a close collaboration between Columbia's Physics Department and the Research Laboratory of IBM, RIKEN and a large collaboration in the United Kingdom known as UKQCD, centered at the University of Edinburgh.

There are currently two large Columbia-designed QCDSF (Quantum Chromodynamics on Digital Signal Processors) installations: a 400 Gflops (400 billion arithmetic operations per second) machine at Columbia and a second 600 Gflops computer at the RBRC.

Completed in 1998, these computers are among today's fastest computers being used for fundamental research in nuclear and particle physics.

Both theoretical and experimental research groups in the Columbia physics department are major participants in the RBRC research program. The computational field theory group at Columbia, headed by Professors Norman Christ and Robert Mawhinney, plays a leading role in both the design and construction of the QCDSF and QCDOC computers and the physics program supported by these machines.

This group explores the transition between normal nuclear matter and a new state of matter called the quark-gluon plasma, which is believed to have existed for a fleeting moment as the Universe cooled, for a few microseconds following the Big Bang. The properties of this phase of matter can be studied by both theoretical simulations with powerful supercomputers and actual collisions between heavy nuclei produced by the Relativistic Heavy Ion Collider (RHIC) recently commissioned at the Brookhaven Laboratory.

The group also studies the underlying quark properties. Of particular interest is a small parameter which spoils the triality of quarks and anti-quarks and which may explain why our present Universe is predominantly made of matter rather than anti-matter.

At an international meeting in Boston last fall, the Brookhaven-RIKEN collaboration announced the results of a close collaboration which determined two experimentally measured quantities in rare particle decays, their prediction for the mixing of the neutrino isometry are surprisingly different from experiments.

The question is whether this disagreement is caused by a flaw in the standard model of particles and the interactions or simply by a coincidence of the calculataion, "said Christ, adding that this crucial question is likely to be solved through calculations made possible by this new supercomputer.

On the experimental side, the Columbia physics department's experiment group, which was proposed by Professors Brian Cole, James Nagle and William Zajc, is attempting to create and detect the quark-gluon plasma in the laboratory, using RHIC. Brookhaven's newest particle accelerator, RHIC produces the world's highest energy nuclear collisions, which are then measured in the $100M PHENIX detector. Zajc is the spokesperson for this 400-member collaboration, which was formed by adapting an existing detector which began taking data with the PHENIX apparatus in the year 2000.

The PHENIX experiment is also designed to make fundamental measurements at a unique origin of the proton spin, using measurement which was also funded as part of the RIKEN program.