

understanding the structure of atomic nuclei from first principles.

Program Contact: (301) 903–3904.

(b) Heavy Ion Nuclear Physics

This subprogram supports experimental research primarily at the Relativistic Heavy Ion Collider (RHIC) directed at answering the second question: What are the properties of hot nuclear matter? At extremely high temperatures, such as those that existed in the early universe immediately after the “Big Bang,” normal nuclear matter is believed to revert to its primeval state called the quark-gluon plasma. This research program aims to recreate extremely small and brief samples of this high energy density phase of matter in the laboratory by colliding heavy nuclei at relativistic energies. At much lower temperatures, nuclear matter passes through another phase transition from a Fermi liquid to a Fermi gas of free roaming nucleons; understanding this phase transition is also a goal of the subprogram.

Program Contact: (301) 903–4702.

(c) Low Energy Nuclear Physics

This subprogram supports experimental research directed at understanding the remaining three questions: What is the structure of nucleonic matter? Forefront nuclear structure research lies in studies of nuclei at the limits of excitation energy, deformation, angular momentum, and isotopic stability. The properties of nuclei at these extremes are not known and such knowledge is needed to test and drive improvement in nuclear models and theories about the nuclear many-body system. What is the nuclear microphysics of the universe? Knowledge of the detailed nuclear structure, nuclear reaction rates, half-lives of specific nuclei, and the limits of nuclear existence at both the proton and neutron drip lines is crucial for understanding the nuclear astrophysics processes responsible for the production of the chemical elements in the universe, and the explosive dynamics of supernovae. Is there new physics beyond the Standard Model? Studies of fundamental interactions and symmetries, including those of neutrino oscillations, are indicating that our current “Standard Model” theory which explains what the universe is and what holds it together is incomplete, opening up possibilities for new discoveries by precision experiments.

Program Contact: (301) 903–6093.

(d) Nuclear Theory (Including the Nuclear Data Subprogram)

Progress in nuclear physics, as in any science, depends critically on improvements in the theoretical techniques and on new insights that will lead to new models and theories that can be applied to interpret experimental data and predict new behavior. The Nuclear Theory program supports theoretical research directed at understanding all five of the central questions identified in the NSAC 2002 Long Range Plan.

Included in the theory program are the activities that are aimed at providing information services on critical nuclear data and have as a goal the compilation and dissemination of an accurate and complete nuclear data information base that is readily accessible and user oriented.

Program Contact: (301) 903–7878.

4. Advanced Scientific Computing Research (ASCR)

The mission of the Advanced Scientific Computing Research Program is to deliver forefront computational and networking capabilities to scientists nationwide that enable them to extend the frontiers of science, answering critical questions that range from the function of living cells to the power of fusion energy.

In order to accomplish this mission, this program fosters and supports fundamental research in advanced computing research (applied mathematics, computer science and networking), and operates supercomputer, networking, and related facilities to enable the analysis, modeling, simulation, and prediction of complex phenomena important to the Department of Energy.

The following long-term goals will be indicators of ASCR’s success in meeting its mission.

- Develop mathematics, algorithms, and software that enable effective models of complex systems, including highly nonlinear or uncertain phenomena, or processes that interact on vastly different scales or contain both discrete and continuous elements.
- Develop, through the GTL partnership with BER, the computational science capability to model a complete microbe and a simple microbial community.

Mathematical, Information, and Computational Sciences Subprogram

This subprogram is responsible for carrying out the primary mission of the ASCR program: discovering, developing, and deploying advanced scientific

computing and communications tools and operating the high performance computing and network facilities that researchers need to analyze, model, simulate, and—most importantly—predict the behavior of complex natural and engineered systems of importance to the Office of Science and to the Department of Energy.

The computing, networking middleware required to meet Office of Science needs exceed the state-of-the-art by a wide margin. Furthermore, the algorithms, software tools, the software libraries and the distributed software environments needed to accelerate scientific discovery through modeling and simulation are beyond the realm of commercial interest. To establish and maintain DOE’s modeling and simulation leadership in scientific areas that are important to its mission, the MICS subprogram employs a broad, but integrated research strategy. The basic research portfolio in applied mathematics and computer science provides the foundation for enabling research activities, which includes efforts to advance high-performance networking, to develop software tools, software libraries and software environments. Results from enabling research supported by the MICS subprogram are used by computational scientists supported by other Office of Science and other DOE programs. Research areas include:

(a) Applied Mathematics

Research on the underlying mathematical understanding and numerical algorithms to enable effective description and prediction of physical systems, such as fluids, magnetized plasmas, or protein molecules. This includes, for example, methods for solving large systems of partial differential equations on parallel computers, techniques for choosing optimal values for parameters in large systems with hundreds to hundreds of thousands of parameters, improving our understanding of fluid turbulence, and developing techniques for reliably estimating the errors in simulations of complex physical phenomena.

(b) Computer Science

Research in computer science to enable large scientific applications through advances in massively parallel computing such as scalable and fault tolerant operating systems for parallel computers, programming models such as development of the Message Passing Interface (MPI) model that has become an industry standard, performance modeling and assessment tools, interoperability and infrastructure