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PHYSICS DIVISION ANNUAL REPORT 2003

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Director

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Preceding Annual Reports
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FOREWORD

This report highlights the research performed in 2003 in the Physics Division of Argonne National Laboratory. The Division's programs include operation of ATLAS as a national user facility, nuclear structure and reaction research, nuclear theory, medium energy nuclear research and accelerator research and development. The great progress that has been made in meeting the exciting intellectual challenges of modern nuclear physics reflects the talents and dedication of the Physics Division staff and the visitors, guests and students who bring so much to the research.

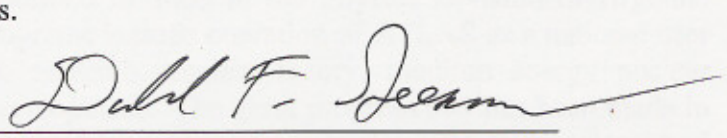
The focus of research in the Division is on understanding the structure of strongly interacting matter, hadrons and nuclei, and the role nuclear processes take in the cosmos in the energy generation in stars and the formation of the very elements of which we are made. A great strength of these efforts is the critical interplay of theory and experiment. Major strides have been made both in understanding the basis of the strong interaction from quantum chromodynamics, and in realizing how the resulting interactions between protons and neutrons lead directly to the properties of the world around us. These theoretical advances provide a firm foundation to move forward in the science agenda of our field and the Department of Energy as expressed in the Office of Science Strategic Plan.

Notable results in research at ATLAS include the exploration of how nuclear shell closures arise in neutron rich nuclei and the evolution of the basic nuclear spin-orbit force with changing neutron number. Gammasphere began a new epoch of exciting research including advances in nuclear structure and astrophysics. Unstable ^{6}He was trapped in an atom trap for the first time in preparation for a decisive measurement of its charge radius. ATLAS operated for 5490 hours of research in FY2003 while achieving 96% efficiency of beam delivery for experiments. The 2003 ATLAS Operations Review concluded that "The ATLAS facility has an outstanding broad-based program, aligned with, and in many areas driving forward, the present and future goals of the low energy nuclear physics field as expressed in the Nuclear Science Advisory Committee (NSAC) 2002 Long Range Plan."

In Medium Energy Physics new measurements of the proton's elastic form factors demonstrated that a major puzzle in understanding the distribution of charge and magnetization of the proton must involve a fundamental challenge in interpreting electron scattering data. Substantial progress was made on a long-term experiment to search for the violation of time-reversal invariance using trapped Ra atoms. As shown in our cover illustration, Atom Trap Trace analysis was successfully used to map the flow of million-year-old groundwater in the Sahara desert.

The DOE/NSF Nuclear Science Advisory Committee recommended that the Rare Isotope Accelerator is the highest priority of our field for major new construction. Argonne continues to lead in the development and exploitation of the new technical concepts that will truly make RIA, in the words of NSAC, "the world-leading facility for research in nuclear structure and nuclear astrophysics." New classes of superconducting cavities are being fabricated and the

beam dynamics of this high power accelerator have been extensively explored and optimized. Liquid-lithium targets were shown to successfully survive the full-power deposition of a RIA beam. Our science and our technology continue to point the way to this major advance. It is a tremendously exciting time in science for RIA holds the keys to unlocking important secrets of nature. The work described here shows how far we have come and makes it clear we know the path to meet these intellectual challenges.



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