REPORT IN BRIEF

December 2006

Scientific Opportunities with a Rare-Isotope Facility in the United States—*Report Brief*

BOARD ON PHYSICS AND ASTRONOMY

Background

Over ten years ago, U.S. nuclear scientists proposed construction of a new rare isotope accelerator in the United States. Such a facility would enable experiments to elucidate the structure of exotic, unstable nuclei and provide critical information needed to explain nuclear abundances in the universe. Studies by the NSF-DOE Nuclear Science Advisory Committee supported this proposal—initially termed the Rare Isotope Accelerator. In 2005, DOE and NSF, seeking an independent scientific assessment, asked the NRC to define the science agenda for a next-generation U.S. Facility for Rare Isotope Beams (FRIB). As the study began, DOE announced that the budget for what was then the RIA should be reduced about in half. The study focused on an evaluation of the science that could be accomplished with a facility reduced in scope. The revised charge also directed the NRC to evaluate the scientific impact of a FRIB in the overall context of the national and international nuclear physics programs. Finally, the NRC was not asked to give advice on whether such a facility should be constructed.

Findings and Conclusions

According to current DOE plans, a FRIB facility might not begin operations until 2016. Nevertheless, most of the major technical issues for building this facility appear to be well in hand. Further a next generation radioactive beam facility of the type embodied in the U.S. FRIB concept represents a unique opportunity to explore the nature of nuclei under extreme conditions and to develop a more quantitatively robust characterization of nuclear structure by exploring new forms of nuclear matter.

A FRIB could impact the study of the origin of the elements and the evolution of the cosmos. Several key science drivers are apparent:

- ***Nuclear structure***. A FRIB would offer a laboratory for exploring the limits of nuclear existence and identifying new phenomena, with the possibility that a more broadly applicable theory of nuclei will emerge.

- ***Nuclear astrophysics.*** A FRIB would lead to a better understanding of key issues by creating exotic nuclei that, until now, have existed only in nature's most spectacular explosion, the supernova. It would offer new glimpses into the origin of the elements.
- ***Fundamental symmetries of nature.*** Experiments addressing questions of the fundamental symmetries of nature will similarly be conducted at a FRIB through the creation and study of certain exotic isotopes.

Nuclear structure and nuclear astrophysics constitute a vital component of the nuclear science portfolio in the United States. Moreover, nuclear-structure-related research provides the scientific basis for important advances in medical research, national security, energy production, and industrial processing. Failure to pursue a U.S.-FRIB would likely lead to a forfeiture of U.S. leadership in nuclear-structure-related physics and would curtail the training of future U.S. nuclear scientists.

A U.S. facility for rare-isotope beams of the kind described to by DOE would be complementary to existing and planned international efforts, particularly if based on a heavy-ion linear accelerator. With such a facility, the United States would be a partner among equals in the exploration of the world-leading scientific thrusts listed above.

The science addressed by a rare-isotope facility, most likely based on a heavy-ion driver using a linear accelerator, should be a high priority for the United States. The facility for rare-isotope beams envisaged for the United States would provide capabilities unmatched elsewhere that would help to provide answers to the key science topics outlined above.

For further information

Copies of the complete report, *Scientific Opportunities with a Rare-Isotope Facility in the United States*, can be obtained on the National Academy Press Web site <www.nap.edu/catalog/ >**.**

Support for this project was provided by the Department of Energy and the National Science Foundation Any opinions, findings, conclusions, or recommendations expressed in this material are those of the National Academies and do not necessarily reflect the views of the sponsors. More information about the Board on Physics and Astronomy can be found at <http://www7.nationalacademies.org/bpa>.

RARE-ISOTOPE SCIENCE ASSESSMENT COMMITTEE