Neutron physics instrument may unlock mysteries of universe

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Fundamental questions that particle physicists have pondered for decades might be answered when a $9.2 million **neutron** physics **beam line** is built at the Department of Energy's Spallation Neutron Source on Chestnut Ridge.

At the core of physicists' excitement is the fact that the SNS will produce up to 100 times more neutrons than are produced by any comparable source in the world. Tapping in to those neutrons will be the Fundamental Neutron Physics beam line, which will help physicists exploit neutrons to learn more about the Big Bang, left-right symmetry of the universe and the amount of energy produced in the sun. Recently, the beam line project passed a milestone with the approval of the performance baseline -- known as Critical Decision 2.

"This is, in a sense, the formal definition of the scope of the project and represents a detailed agreement between DOE and Oak Ridge National Laboratory as to what will be built, when it will be built, how much it will cost and how the project will be managed," said Geoff Greene, a professor at the University of Tennessee and researcher in the Physics Division at ORNL.

Greene noted that much work lies ahead, but the benefits of having extremely intense beams of neutrons at their disposal should be phenomenal.

"To scientists studying materials -- the main focus of SNS research -- the

neutron is merely a tool that helps them probe the structure of condensed matter," Greene said. "But to particle physicists, the neutron holds the key to understanding many of the mysteries of the universe."

The fact physicists will have many more neutrons available to them greatly increases the accuracy of their experiments, one of which is aimed at pinpointing the lifetime of a free neutron. Obtaining a precise answer could help physicists better understand the origin of matter and may help explain the "left-handedness" of the universe at the subatomic level.

A system is said to be "handed," Greene said, when its mirror image differs from its appearance looking at it directly. For example, a sphere is not handed, but a corkscrew is because its image in a mirror is reversed. The sphere viewed in a mirror looks the same.

Greene and others have long been puzzled by the fact that, in an otherwise symmetric universe, radioactivity viewed at the elementary particle level is left-handed. In the world of physics, the phenomenon is known as parity violation.

"So, is the left-handedness of the universe just an accident, a ‘broken symmetry,' or is it a manifestation of a fundamental characteristic of the cosmos?" Greene asked.

Indeed, to have an instrument like the Fundamental Neutron Physics beam line has been the dream of physicists for years, said Greene, who noted that 65 participants from 20 institutions participated in an organizational meeting of the development team at ORNL in 2001.

Greene led the proposal team, which was made up of Vince Cianciolo of ORNL, David Bowman and Martin Cooper of Los Alamos National Laboratory, John Doyle of Harvard University, Christopher Gould of

North Carolina State University, Paul Huffman of the National Institute of Standards and Technology and Mike Snow of Indiana University.

The beam line will consist of neutron guides, choppers, secondary shutters and shielding, along with the necessary utilities and safety and radiation protection equipment. The facility will be capable of accommodating a wide variety of experiments, each of which typically takes years to develop and occupies the beam line continuously for many months.

The Fundamental Neutron Physics beam line will be operated as a user facility with all beam time allocated on the basis of independent peer reviews, Greene said. The beam line should be commissioned in mid-2008, about two years after the $1.4 billion SNS comes on line.

Funding for the project is being provided by DOE's Office of Nuclear Physics within the Office of Science. ORNL, which is managed by UT-Battelle, employs 1,500 scientists and engineers and is DOE's largest multipurpose science and energy laboratory.

Source: Oak Ridge National Laboratory