Subject: JLab News: Research Planned for Unique Spinning Nuclei Nets Prize
From: "Kandice Carter" <kcarter@jlab.org>
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To: elawson@sura.org

For Immediate Release

Contact: Kandice Carter, kcarter@jlab.org

757-269-7263

Research Planned for Unique Spinning Nuclei Nets Prize

NEWPORT NEWS, VA, November 29, 2016 – Elena Long is all spun up over the new target she's planning for research at the Thomas Jefferson National Accelerator Facility. Now, she's gotten others spun over the idea, as well, and she's been awarded the 2016 Jefferson Science Associates Postdoctoral Research Prize to make her research plans a reality.

"I'm very excited: This award is going to help us build the target that we need for doing the program that I want to build," Long said. "It's a fantastic stepping stone. I'm very happy to receive this award and hopefully use it to advance our understanding of fundamental nuclear physics."

"Similar to the previous eight postdoctoral prizes that have been awarded, this award will continue to help promote the career development of young researchers in our field," said Haiyan Gao, 2015-2016 chair of the Jefferson Lab Users Group Board of Directors and Henry Newson Professor at Duke University, as well as Vice Chancellor for Academic Affairs at Duke Kunshan University in China. "We were delighted with the high-quality applications we had this year, and it was never an easier job to select the final winner."

Long, a postdoctoral research associate at the University of New Hampshire, was awarded $10,000 for her plans to build and test a new kind of target that will allow scientists to explore the physics of spinning nuclei. The target will be primarily composed of a special type of ammonia. The most familiar form of ammonia, found in household cleaners, is made of one atom of nitrogen for every three atoms of hydrogen, which has a single proton in its nucleus.

The form of ammonia that Long will be using is deuterated ammonia, which means that the hydrogen atoms are replaced with deuterium, an isotope of hydrogen whose nucleus contains both a proton and a neutron. The nucleus of the deuterium atom is called the deuteron.

"The deuteron is the simplest composite nucleus, so the simplest nucleus made up of more than one thing. We, as physicists, have spent a very long time trying to understand it, because if we can understand everything going on in the deuteron, we can build upon that for a better understanding of more complex nuclei," Long explained.

For instance, one long-known fact about deuterons is that their shape changes when they have been made to spin in a certain way. Non-spinning deuterons are shaped like donuts, while spinning deuterons are shaped like peanuts. (Caveat for physicists: we're referring to "non-spinning" as the case in which the z-axis component of the spin vector is zero).

This means that the deuteron's underlying structure, the proton and the neutron, changes dramatically when it's spinning. And, going a level deeper, it means that the three quarks inside the proton and the three quarks inside the neutron are interacting in different ways when the deuteron is spinning versus when it's not.

Quarks and their interactions build the nuclei of all of the atoms in the universe, so by comparing the features of spinning and non-spinning deuterons, scientists can get insight into the structure of all matter.

In particular, Long and her colleagues will be studying how the six quarks in the deuteron give rise to the force that binds the nucleus together (in a measurement of a quantity they refer to as b_1). They will also explore the features of that force, such as how it mediates the interaction between the proton and neutron inside the deuteron.

To enable the research, Long will need to build a target that can provide spinning deuterons for study. The target that she's building will feature a small sample of deuterated ammonia that will be cooled to just above absolute zero. A magnet will apply a strong magnetic field of 5-7 Tesla, about three times stronger than the magnets used for a medical MRI machine. Then, the deuterons will be zapped with microwaves and radiofrequency waves. A nuclear magnetic resonance system will measure the polarization, the number of spinning deuterons in the target, to ensure that the target reaches the goal of about 30 percent polarization.

Long said the award money will be spent buying materials for the refrigerator that will be used to cool the sample and for tests confirming that the target is able to achieve 30 percent polarization.

"There's so much that we can do if we can build this target," Long said. "Taking this research and moving it forward will keep me busy for quite some time to come."

The JSA Postdoctoral Research Grant has been awarded annually since 2008 by the Users Group Board of Directors. In making the award, the board judged each applicant on his or her record of accomplishment in physics, proposed use of the research grant and the likelihood of further accomplishments in the Jefferson Lab research fields. The research grant is one of the funded projects of the JSA Initiatives Fund program, provided by Jefferson Science Associates to support programs, initiatives, and activities that further the scientific outreach, and promote the science, education and technology missions of Jefferson Lab and benefit the Lab user community.

You can read more about the research that may be carried out with the new target in the following research proposals: Measurements of the Quasi-Elastic and Elastic Deuteron Tensor Asymmetries and The Deuteron Tensor Structure Function b1.

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