Proton research wins Jefferson Lab prize: Post-doctoral fellow takes 'polarized' measurements. By Tamara Dietrich tdietrich@dailypress.com

Priyashree Roy, UMich, won the 2016 Jefferson Science Associates Thesis Prize for her work on polarized proton research.

As a little girl in India, Priyashree Roy would get regular life lessons from her father, an electrical engineer, while on family outings.

But those lessons weren't what typical doting fathers provide their daughters.

"He was always talking about science," said Roy, now 30, in a phone interview Wednesday. "And, especially, always talking about atoms. He would ask me how is an atom made, and what are the components. How do they interact. He talked about many other things in physics, saying he was also interested, in general, in many other topics within physics — for example, the universe."

With a head start like this, it's hardly surprising that Roy is a physicist today, or a post-doctoral fellow at the University of Michigan in Ann Arbor.

Or that Roy's research into the proton and its spectrum of "excited" states is a fundamental attempt to crack the code of the very matter that makes up, for example, the universe.

From 2012 to 2016, Roy conducted that research using the particle beam accelerator at Jefferson Lab in Newport News. Now, her resulting thesis was just awarded the 2016 Jefferson Science Associates Thesis Prize.

The annual award recognizes the best Ph.D. student thesis related to Jefferson Lab science.

"We received a lot of excellent nominations," said Larry Weinstein in a statement announcing the prize. "It was a pleasure to read the different theses, and very challenging to select the winner."

Weinstein is 2016-17 chairman of the Users Group Board of Directors that oversees the selection process.

Winning the award, said Roy, was overwhelming at first.

"I was a little bit in shock — in a good way — when I saw I won," Roy said. "So it did take some time to sink in."

At Jefferson Lab, Roy was part of a collaboration called FroST — for Frozen-Spin Target.

Physicists shot a beam of photons at 6 GeV, or 6 gigaelectronvolts, at a target of frozen beads of butanol, a type of alcohol. Protons inside the target's hydrogen atoms were polarized, or forced to spin. Keeping the target cold allowed the protons to "freeze" in their spin for long periods of time so scientists could gather the data they need to identify the proton's excited states.

"We want to excite the proton," Roy explained. "We want to change it. And we want to increase its energy from the lowest energy state to a higher energy state."

Unlike an atom, for instance, whose excited states are "quite stable" and more defined before reverting to a stable, low-energy state again, a proton's excited states are ephemeral, broad and overlapping. This makes it harder to tease out the underlying mechanism inside the proton, or map out any potential pattern in the spectrum of excited states.

"How are the quarks and gluons, which are inside the proton, how are they interacting?" Roy explained. "Unless we find these excited states, we cannot really study the spectrum as a whole and then look for a pattern."

Polarized measurements have been taken at other laboratories in the world, Roy said, but the Jefferson Lab measurements are unique for the energy and type of beam that was used and the type of target polarization.

It's impossible to know how fundamental physics such as this could be applied in the real world over time, said Roy, much the way no one could imagine how the discovery of electricity would eventually change the way we live.

"Since the proton makes up the matter everywhere around us, understanding how the proton was made from quarks and gluons, that could really help us in material science in the future," Roy said.

"Another thing ... is, it will help us know how the universe was created. How were the first protons created. Because only a few fractions of a second after the Big Bang, we had a plasma of gluons and quarks. And then somehow these quarks and gluons combined to make the proton. And that's what we are trying to understand."

Roy's thesis is entitled "Measurement of Polarization Observables in Vector Meson Photoproduction Using a Transversely Polarized Frozen-Spin Target and Polarized Photons." According to Jefferson Lab, Roy completed her research while earning her doctorate at Florida State University in Tallahassee under associate professor and thesis adviser Volker Crede.

Honorees receive a $2,500 cash award and a commemorative plaque.

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