

JOCELYN MONROE | MEETING THE MINDS



Basic theory of matter is tried, tested, and...

By Peter Dizikes, Globe Correspondent | May 28, 2007

For the young post doctoral physicist, it was a moment of high drama.

Jocelyn Monroe, just eight years out of college, stood in a lecture hall in MIT's Building 35 before more than 50 people in her field. Those scientists, who had anticipated the results for a decade, were waiting to hear whether she and her colleagues had punched a hole in the basic theory of the universe's ingredients.

If Monroe announced that the research team she'd worked on had confirmed the existence of a tiny piece of matter known as a sterile neutrino, scientists might be compelled to re-think the standard model of physics, a deeply logical arrangement of the 12 known sub atomic particles (including neutrinos) and the forces governing them. What had been clear and orderly about the universe could become more hazy and messy.

If no evidence for the sterile neutrino existed, however, scientists could continue their work without having to account for any strange, new paradigm-disturbing particle.

"Remember this moment," MIT physicist Peter Fisher told Monroe, "because you may only have one chance in your career to tear down the standard model."

To arrive in that classroom near the end of MIT's endless corridor, Monroe spent the last few years working on the so-called MiniBooNE experiment, studying neutrinos at Fermi National Accelerator Laboratory in Illinois. Some of her 76 Fermi colleagues were also standing up in front of university classrooms elsewhere in the country that same day, disclosing their results.

MiniBooNE researchers had worked since 2002 to detect these elusive "ghost particles," as some call them, which are released in nuclear reactions like those powering our sun. Neutrinos move rapidly and are so tiny they can zip through earth-size objects. (The atoms that compose matter are mostly empty space.) Billions of neutrinos are streaming through your body right now.

"Neutrinos are the wild west of particle physics, the frontier where it's very much uncharted territory," says Max Tegmark, an MIT physicist. Still, scientists have identified three types of neutrinos -- the electron neutrino, and the muon and tau neutrinos -- and know that neutrinos can change from one kind to another.

Therein lies the problem. The energies associated with all the neutrino transformations should add up -- a bit like the way money should, when changed from dollars into yen, then euros, then back to dollars. But in the 1990s, a Los Alamos experiment known as LSND suggested that those numbers don't compute. Searching for an explanation, physicists postulated the existence of a fourth type of neutrino, "sterile" because it would only interact with other neutrinos, to complete the circuit of neutrino transformations.

Such scientific intrigue can capture the imagination of a curious physicist. Monroe grew up in Chicago and took to science, she says, because "I had a high school physics teacher who would answer any question."

She attended college at Columbia University, earned her doctorate there, and now is a Pappalardo Fellow at MIT, a prestigious post doctorate position. Along the way, Monroe signed on to the MiniBooNE project, where she analyzed the stream of data as the team fired neutrinos into a giant tank of mineral oil, in the process double-checking LSND's results and hunting for the mysterious sterile neutrino.

Building anticipation during her 45-minute talk last month, and with the stage to herself, Monroe saved the results for the end. "We waited five years," Monroe says. "They waited just a little bit longer."

The verdict?

No evidence for a sterile neutrino -- thus reaffirming the standard model. "A very important result," says Fisher.

"I thought I could hear the collective sigh of relief from all the theorists," Monroe says.

After all, confirming science's sturdiness is a good thing, right? Yet Tegmark, in attendance, says he heard one researcher groan: "The standard model wins again."

As physicist Ed Kearns of Boston University, a leading neutrino researcher, puts it: "Physicists don't get up in the morning to confirm the standard model."

Monroe says she was "depressed for a couple of days" after first learning the result, but then settled into "a feeling of relief. We did a good job."

Still, she notes, "In physics the conversation is always: 'When are we going to find the cracks in the standard model?' We know it only works at low energy, so there has to be something more." Ultimately, young scientists study things like neutrinos not just to answer existing questions, but to create new ones. As Monroe says: "I want to hit the home run."

FACT SHEET

What's next for Monroe: With MIT colleagues, she's examining neutrinos generated by the sun and starting a study probing another deep cosmic unknown, dark matter.

Favorite science books: "Subtle is the Lord: The Science and the Life of Albert Einstein," by Abraham Pais. "Chaos: Making a New Science," by James Gleick.

Favorite authors: P.D. James, Graham Greene, Leo Tolstoy.

Problems with the standard model: Among other issues, it does not incorporate gravity, one of nature's four fundamental forces, and physicists believe it does not describe the behavior of matter at energy levels much higher than the ones we commonly observe. ■

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