

# Universal understanding

Married physicists Samir and Smita Mathur have their differences—especially when it comes to black holes. By **PAM FROST GORDER**.

Samir and Smita Mathur met as students in the same graduate program. Still, even after 20 years of marriage, neither of them completely understands the other's research.

He describes himself as a particle physicist. She says she is an astrophysicist. Both do research that concerns black holes.

And both have made their mark on their respective disciplines: he, by challenging Stephen Hawking's views on the nature of black holes; and she, by using a particular kind of black hole as a tool for finding the missing mass of the universe.

"We can't understand each other's research to the point that we could contribute to it," Samir said. "But if I am writing a paper that I would like a broader audience of physicists to understand, she reads it for me and makes suggestions, and I try to do the same thing for her."

Their story begins at the Tata Institute of Fundamental Research in Mumbai, India, where they both joined the Department of Astronomy and Astrophysics. As at Ohio State and other universities, the graduate students shared a common study space. "We couldn't not meet," Smita said with a laugh.

They worked on one project together: a research paper on black holes. Then she decided she wanted to study a special class of black holes—those located in the heart of very bright and distant galaxies—that offer clues to what the universe was like billions of years ago. And he decided he wanted to understand the universe in a completely different way, by uncovering the relationship between black holes and particle physics.

Today, Samir Mathur is a professor of physics at Ohio State and an expert in string theory, which holds that all the fundamental particles in the universe—protons, neutrons, and electrons—are made of tiny vibrating strings. His work came

full circle in 2004 when he derived equations to explain what happens to strings that get sucked into a black hole. He found that the strings become entangled in a giant "fuzzball."

Samir's work caught the attention of the media, and now even colleagues are using his term in their research papers. "Just search the technical journals for 'fuzzballs' and you'll find our theory," he said.

The notion that strings can survive inside a black hole counters Hawking's theories, which held that all objects that fall into a black hole instantly become homogenized. If that were true, all black holes would be the same, regardless of what kind of materials made them.

Hawking's ideas conflicted with quantum mechanics and created a contradiction that scientists call the "information paradox." Samir's work is helping to eliminate the paradox by showing that every black hole is unique.

Meanwhile, Smita Mathur, an associate professor of astronomy at Ohio State, published not one but two papers in the prestigious journal *Nature* when she found a cache of particles that had been hiding on the outskirts of our galaxy for the last 10 billion years.

The particles are called baryons, and they're made up of protons and neutrons—normal subatomic "stuff" as we know it. Scientists don't yet know why, but half the

Samir and Smita Mathur at the planetarium in Smith Lab



Photo by RICK HARRISON

baryons that formed at the beginning of the universe became stars and galaxies and lit up the sky, right about the time that the other half seemed to just disappear.

Smita discovered that the missing baryons are still out there, floating in rivers of gas that are too hot to see with optical telescopes. She used quasars—very bright galaxies with powerful black holes at the center—as light sources to record X-ray images of the gas. One gas cloud, more than 150 times hotter and one trillion times more massive than our sun, surrounds our local group of galaxies. Smita believes these hot baryons trace the location of another kind of missing matter: the universe’s dark matter.

The Mathurs say people they meet don’t seem surprised that they both are scientists, although they get very different reactions when it comes to interest in their specialties.

“It never fails,” Samir said. “I tell people I’m a particle physicist, and they say something like, ‘Oh, that’s nice.’ And then Smita tells them she’s an astrophysicist, and they say, ‘Wow! Astrophysics!’”

“I could tell people that I’m a string theorist, because that sounds more exciting, but until recently I don’t think many people would have known what that is.”

That may be changing. On a recent airline flight, an elderly lady sitting next to

Samir asked him the usual question about his work. “Particle physics,” he answered.

“Oh, okay,” she said—then added, “I wish you did something like string theory. That’s just fascinating!” ■

#### Learn more:

Read about Samir and Smita Mathur’s work as reported by Ohio State’s Office of Research Communications:

[researchnews.osu.edu/archive/fuzzball.htm](http://researchnews.osu.edu/archive/fuzzball.htm)  
[researchnews.osu.edu/archive/baryons.htm](http://researchnews.osu.edu/archive/baryons.htm)  
[researchnews.osu.edu/archive/foundmat.htm](http://researchnews.osu.edu/archive/foundmat.htm)

#### See also:

“Cosmic Quest,” page 4