UI black hole researcher keeps Einstein in mind

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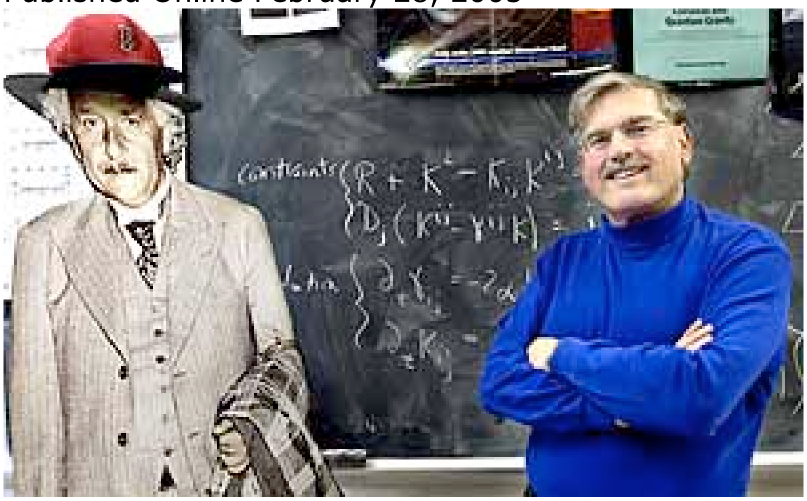

N-G photo by Robin Scholz

University of Illinois physicist Stuart Shapiro keeps a cutout of his 'friend," famed scientist and new Red Sox fan Albert Einstein, in his office at Loomis Lab on the UI campus in Urbana.

A hundred years ago, Albert Einstein had his "miraculous year," in which the great scientist outlined ideas still underlying much of modern physics.

Einstein's five papers covering special relativity, which revamped our conception of space and time, and the photoelectric effect and Brownian motion, which likewise changed the way we look at the nature of light and of atoms and molecules, is the impetus for the 2005 World Year of Physics. The international event is designed to capture the attention of the public and of a new generation of potential Einsteins.

That would make this a special time for University of Illinois physicist Stuart Shapiro even if the Connecticut native wasn't still basking in the World Series victory of his beloved Boston Red Sox.

Shapiro, whose work related to black holes was among the top science stories of 2004 cited in Discover magazine's January issue, sometimes hears Einstein speaking to him as he goes about his business.

Sometimes Einstein, who died in 1955, even looks over his shoulder.

Not to worry. It's only a cardboard cutout of Einstein's picture, albeit life-sized one, sporting a Red Sox cap these days.

And when Shapiro says he hears Einstein every day, he's just being metaphorical.

Shapiro tells people he builds black holes for a living, those mysterious regions of space thought to be created when stars more than 10 times as massive as our sun die, whose gravity is so strong not even light can escape from it.

"Of course, I don't do it in the conventional lab, I do it on the computer," the physics and astronomy professor said recently.

In fact, Shapiro, who's also a senior research scientist with the UI-based National Center for Supercomputing Applications, and colleagues build extremely complex, animated simulations – movies if you will – of black holes and related phenomena.

Underlying those simulations are Einstein's equations.

In particular, Shapiro works with the landmark theory Einstein laid out 10 years after his miraculous year in 1915, the general theory of relativity, which recast Newton's classic theory of gravity.

The term "black hole" was decades in the future when Einstein advanced his general theory and computers weren't something he and most scientists employed even at the time of his death.

But Einstein predicted the existence of black holes and his equations, with a lot of work, can be recast for the computer, a task on which Shapiro spends a good deal of his time.

This is more than an academic exercise. Shapiro and others now believe black holes may have begun forming early in the life of the universe and thus are part of its initial birth structure, as the UI scientist explained in Discover.

"It lies at fundamental questions of where we are in the universe and where we are going," Shapiro said of his research.

Moreover, modern galaxies, including our own Milky Way, appear to have black holes at their centers whose masses correlate with the properties of the galaxies themselves. It may be that black holes play some regulating role in the structure of a galaxy, Shapiro said.

In addition, besides the window they offer on the structure of the universe, the computational physics techniques developed by

Shapiro and colleagues may be useful in areas as diverse as aerodynamics and weather forecasting.

"Stu's just great to work with," said UI astronomy and physics Professor Charles Gammie, who collaborates with Shapiro. "He has an unerring sense of a good problem, what a good problem is. He knows what problem is the right problem to work on."

Lately, the problem Shapiro has been working on is "gravitational waves." It is a problem with a decided link to Einstein, whose theory has massive bodies like black holes radiating waves of gravity in much the same way vibrating electrons give off the electromagnetic radiation that we use for radio and TV signals.

But gravitational waves have never been captured, although there's strong indirect evidence of their existence. Scientists are now working on a new generation of Earth- and space-based detectors to capture them for the first time.

At stake not only is a better understanding of the universe but also, in essence, Einstein's general theory, which has survived a variety of other tests over the years. Confirm, deny or modify, it would be big news.

"You can put it this way," said Gammie of the impact finally capturing gravity waves could have. "Was Einstein right?"

The problem is that gravitational waves, after traversing long stretches of space and time and amid all the other "noise" of the cosmos, are extremely weak. Capturing them has been compared not to finding a needle in a haystack but to finding a certain stalk of hay.

"It's really the case that you cannot detect it without knowing what you're looking for," said UI physics Professor Fred Lamb.

That's where Shapiro comes into the picture. He's using his computational techniques, and Einstein's equations, to simulate what the gravitational waves we're likely to see will look like to give observers a basis for comparison.