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Spacetime: A smoother brew than we knew

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Spacetime may be less like foamy quantum beer and more like smooth Einsteinian whiskey, according to research led by physicist Robert Nemiroff of Michigan Technological University being presented today at the 221st American Astronomical Society meeting in Long Beach, Calif.

Or so an intergalactic photo finish would suggest.

Nemiroff and his team reached this heady conclusion after studying the tracings of three photons of differing wavelengths recorded by NASA's Fermi Gamma-ray Space Telescope in May 2009.

The photons originated about 7 billion light-years away from Earth from a gamma-ray burst and arrived at the orbiting telescope a mere millisecond apart.

"Gamma-ray bursts can tell us some very interesting things about the universe," Nemiroff says. In this case, those three photons recorded by the Fermi telescope may be validating Albert Einstein's view of smooth spacetime into the realm of quantum mechanics. In other words, spacetime may not be not as foamy as some scientists think.

In his General Theory of Relativity, Einstein described space and time as smooth, deforming only under the weight of matter and energy. But according to some theories of quantum gravity, which deal with matter and energy at the smallest scale, spacetime is made up of a froth of particles and possibly even black holes that pop in and out of existence over infinitesimally small moments at the so-called Planck-length scale, which is less than a trillionth of a trillionth the diameter of a hydrogen atom.

The "bubbles" in this foam—should they exist—are so small as to be almost undetectable. However, scientists have theorized that photons from gamma-ray bursts should be able to track down the bubbles' signature.

Here's why. The wavelengths of gamma-ray burst photons are some of the shortest distances known to science—so short they should interact with the even smaller bubbles of quantum foam. And if they interact, the photons should be dispersed—scattered—on their trek through frothy spacetime.

In particular, they should disperse in different ways if their wavelengths differ, as in the case of Nemiroff's three photons. Imagine a Ping Pong ball, a bowling ball, and a softball taking alternate paths down a gravely hillside.

Furthermore, few things can delay gamma-ray photons like these, so they might travel for unimaginably long distances unimpeded. You wouldn't notice the scattering over short distances, but across 7 billion light-years, the quantum foam might knock the light around enough to notice. And three photons from the same gamma-ray burst might not have crashed through the Fermi telescope in a dead heat.

Bolstered by the evidence garnered from the three photons, Nemiroff's analysis supports earlier indications but takes them clearly below the Planck length: "If foaminess exists at all, we think it must be at a scale far smaller than the Planck length, indicating that other physics might be involved," he says.

"There is a possibility of a statistical fluke, or that spacetime foam interacts with light differently than we imagined," Nemiroff said.

"If future gamma-ray bursts confirm this, we will have learned something very fundamental about our universe," says Bradley E. Schaefer, professor of physics and astronomy at Louisiana State University.

For now, at least, this looks like another win for Einstein. Perhaps it calls for a toast.

Provided by Michigan Technological University