Big Bang's Afterglow Fails an Intergalactic Shadow Test

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The apparent absence of shadows where shadows were expected to be is raising new questions about the faint glow of microwave radiation once hailed as proof that the universe was created by a "Big Bang."

In a finding sure to cause controversy, scientists at The University of Alabama in Huntsville (UAH) found a lack of evidence of shadows from "nearby" clusters of galaxies using new, highly accurate measurements of the cosmic microwave background.

A team of UAH scientists led by Dr. Richard Lieu, a professor of physics, used data from NASA's Wilkinson Microwave Anisotropy Probe (WMAP) to scan the cosmic microwave background for shadows caused by 31 clusters of galaxies.

"These shadows are a well-known thing that has been predicted for years," said Lieu. "This is the only direct method of determining the distance to the origin of the cosmic microwave background. Up to now, all the evidence that it originated from as far back in time as the Big Bang fireball has been circumstantial.

"If you see a shadow, however, it means the radiation comes from behind the cluster. If you don't see a shadow, then you have something of a problem. Among the 31 clusters that we studied, some show a shadow effect and others do not."

Other groups have previously reported seeing this type of shadows in the

microwave background. Those studies, however, did not use data from WMAP, which was designed and built specifically to study the cosmic microwave background.

If the standard Big Bang theory of the universe is accurate and the background microwave radiation came to Earth from the furthest edges of the universe, then massive X-ray emitting clusters of galaxies nearest our own Milky Way galaxy should all cast shadows on the microwave background.

These findings are scheduled to be published in the Sept. 1, 2006, edition of the *Astrophysical Journal*.

Taken together, the data shows a shadow effect about one-fourth of what was predicted - an amount roughly equal in strength to natural variations previously seen in the microwave background across the entire sky.

"Either it (the microwave background) isn't coming from behind the clusters, which means the Big Bang is blown away, or ... there is something else going on," said Lieu. "One possibility is to say the clusters themselves are microwave emitting sources, either from an embedded point source or from a halo of microwave-emitting material that is part of the cluster environment.

"Based on all that we know about radiation sources and halos around clusters, however, you wouldn't expect to see this kind of emission. And it would be implausible to suggest that several clusters could all emit microwaves at just the right frequency and intensity to match the cosmic background radiation."

Predicted as early as 1948 and discovered in 1965, the cosmic microwave background is a faint glow of weak radiation that apparently permeates the universe. Because it is seen coming from every direction

in nearly uniform power and frequency, cosmologists theorized that the microwave background is afterglow radiation left over by the Big Bang that created the universe.

If that were the case, the background microwave radiation reaching Earth today would have traveled billions of light years through space from the furthest edges of the universe.

Galaxy clusters are the largest organized structures in the universe. Each cluster can contain hundreds of galaxies like the Milky Way, each with billions of stars. The gravity created at the center of some clusters traps gas that is hot enough to emit X-rays.

This gas is also hot enough to lose its electrons (or ionize), filling millions of cubic light years of space inside the galactic clusters with swarming clouds of free electrons. It is these free electrons which bump into and interact with individual photons of microwave radiation, deflecting them away from their original paths and creating the shadowing effect. This shadowing effect was first predicted in 1969 by the Russian scientists Rashid Sunyaev and Yakov Zel'dovich.

Like shadow puppets on a wall, however, these shadows would only form if all three ingredients (light, object and observer) are in the correct order. If an object casts no shadow, it might be because the light source is closer to the observer than the object. That might mean that the cosmic microwave background didn't originate at the far edges of the universe, although there are no obvious or popular alternative sources.

The WMAP dataset is available to the public and other scientists are already testing the UAH group's results, Lieu said, although no one has yet reported finding any flaws in their analysis.

Just over a year ago Lieu and Dr. Jonathan Mittaz, a UAH research

associate, published results of a study using WMAP data to look for evidence of "lensing" effects which should have been seen (but weren't) if the microwave background was a Big Bang remnant.

Lieu, Mittaz and Shuang-Nan Zhang, UAH, "The Sunyaev-Zel'dovich effect in a sample of 31 clusters: A comparison between the X-ray predicted and WMAP
observed decrement," *Astrophysical Journal*, Sept. 1, 2006, Vol. 648, No. 1, p. 176

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