New Look At Microwave Background May Cast Doubts On Big Bang Theory

August 10 2005

A new analysis of 'cool' spots in the cosmic microwave background may cast new doubts on a key piece of evidence supporting the big bang theory of how the universe was formed.

Two scientists at The University of Alabama in Huntsville (UAH) looked for but couldn't find evidence of gravitational "lensing" where you might expect to find it, in the most distant light source in the universe - the cosmic microwave background.

Results of this research by Dr. Richard Lieu, a UAH physics professor, and Dr. Jonathan Mittaz, a UAH research associate, were published Monday in the "Astrophysical Journal."

In the same paper, Albert Einstein's 1917 theory that at a certain "critical" density the counteracting forces of gravity and expanding space can result in a "flat" universe no matter how irregular the distribution of matter might be, is proven mathematically for the first time.

Proving Einstein right might become a problem for the standard cosmological model of how the universe was formed because Einstein's theory also predicts that the cosmic microwave background shouldn't look the way it does, according to Lieu.

The problem, he says, is that cool spots in the microwave background are too uniform in size to have traveled across almost 14 billion light years from the edges of the universe to Earth.

"Einstein's theory of how gravity attracts light, coupled with the uneven distribution of matter in the near universe, says you should have a spread of sizes around the average, with some of these cool spots noticeably larger and others noticeably smaller," he said. "But this dispersion of sizes is not seen in the data. When we look at them, too many cool spots are the same size."

The cosmic microwave background is believed to be the afterglow of hot gases that filled the fledgling universe immediately following the big bang. These microwaves permeate the sky, coming to Earth from every direction in a nearly homogeneous blanket of weak radiation.

Nearly homogeneous because some spots are slightly cooler than the average "temperature" of less than three Kelvin - three degrees Celsius above absolute zero.

Cosmologists have theorized that these cool regions in the microwave blanket are the birthmarks of galaxies and clusters of galaxies that condensed out of the primordial plasma a few eons after the big bang.

Based on theories about disturbances in gases that existed for millennia after the big bang, cosmologists developed detailed estimates of how big these cool spots should have been when they emitted the radiation reaching us as microwaves today.

These cool spots were studied in detail by the Wilkinson Microwave Anisotropy Probe (WMAP), which found that the average spot is about the size that had been forecast for a flat, smooth universe.

The problem, says Lieu, is that not only is the average about right, but far too many of the spots themselves are "just right" with too little variation in sizes. Given the uneven distribution of matter in an expanding universe, he says, we should see a broader size distribution among the cool spots by the time that radiation reaches Earth.

The distribution of matter and the expanding universe are important because they have opposite effects on the "shape" of space and the paths taken by light, microwaves and other radiation as they zip through the cosmos.

An expanding universe would tend to "stretch" space, causing radiation to disperse as it flies through. That dispersion would make objects appear to an observer to be smaller than they really are, as if the light went through a concave lens.

"As far as we know," said Lieu, "the expansion takes place smoothly everywhere. When the universe reaches a certain age all points in space at this moment expand in the same way."

Matter - or more specifically gravity - tends to constrain space. And because matter is distributed unevenly across the universe, so are its gravitational effects.

If you have enough matter in one small place, such as a galaxy or cluster of galaxies, that super concentration of gravity can act like a convex lens, bending inward both space and any light traveling through it. When light from a distant galaxy is bent by gravity as it passes another galaxy or galaxy cluster, these distortions can appear as Einstein rings or weak lensing shear effects.

If the object emitting light is like a cool spot in the microwave background, the focusing effect of galaxy clusters or groups of galaxies between those spots and Earth might make the spots appear to be larger than they really were.

A large portion of the mass in the nearby universe is concentrated in small volumes of space. These are galaxies and massive galaxy clusters, which are surrounded by vast empty voids of intergalactic space.

If the standard big bang model is correct, that means the microwave radiation from some cool spots would travel through mostly empty space, would be dispersed by the expanding universe and would look small by the time that radiation reached Earth.

Radiation from other cool spots, however, would pass around or near massive gravity lenses. These focused spots would appear to be larger than the average cool spot.

"But you don't see this fluctuation," said Lieu. "There appear to be no lensing effects whatsoever. This lack of variation is a serious problem."

In his "Cosmological Considerations of the General Theory of Relativity," Einstein theorized that the net effect of the counteracting forces of expansion and gravity should remain the same if the amount of matter in the universe stays the same.

While Einstein developed this theorem based on a universe where the distribution of matter is "smooth," the UAH mathematical work shows for the first time that the net effect on the propagation of light doesn't change even if the universe is "clumpy."

If the cool spots are too uniform to have traveled to Earth from near the beginning of time, Lieu says cosmologists are left with several alternative explanations.

The first is that the cosmological parameters (including the Hubble constant, the amount of dark matter, etc.) used to predict the original, pre-lensed sizes of the cool and hot spots in the microwave background might be wrong. These parameters could be adjusted to predict a narrower range of sizes on either side of the "pre-lensed" average.

Then, after the effect of gravitational lensing is folded in, the resulting average size and size dispersion would agree with what WMAP actually saw, said Lieu. "This approach is the most conservative, but would still result in an overhaul of the standard model."

"Or, could it be that although the radiation itself is from far away, some of these cool spot structures are caused by nearby physical processes and aren't really remnants of the universe's creation?" Lieu asked. "Could they have been imprinted locally and aren't cosmological at all? Given that we find no lensing, that might be one possibility.

[3]Or is it possible that as light goes through the vast areas of space there is some other, unknown factor damping the effects of dispersion and focusing? There is certainly plenty of room for unknowns."

The most contentious possibility is that the background radiation itself isn't a remnant of the big bang but was created by a different process, a "local" process so close to Earth that the radiation wouldn't go near any gravitational lenses before reaching our telescopes.

Although widely accepted by astrophysicists and cosmologists as the best theory for the creation of the universe, the big bang model has come under increasingly vocal criticism from scientists concerned about inconsistencies between the theory and astronomical observations, or by concepts that have been used to "fix" the theory so it agrees with those observations.

These fixes include theories which say the nascent universe expanded at speeds faster than the speed of light for an unknown period of time after the big bang; dark matter, which was used to explain how galaxies and clusters of galaxies keep from flying apart even though there seems to be too little matter to provide the gravity needed to hold them together; and dark energy, an unseen, unmeasured and unexplained force that is apparently causing the universe not only to expand, but to accelerate as it goes.

In research published April 10 in the "Astrophysical Journal, Letters," Lieu and Mittaz found that evidence provided by WMAP point to a slightly "super critical" universe, where there is more matter (and gravity) than what the standard interpretation of the WMAP data says. This posed serious problems to the inflationary paradigm.

Recent observations by NASA's new Spitzer space telescope found "old" stars and galaxies so far away that the light we are seeing now left those stars when (according to big bang theory) the universe was between 600 million and one billion years old - much too young to have galaxies with red giant stars that have burned off all of their hydrogen.

Other observations found clusters and super clusters of galaxies at those great distances, when the universe was supposed to have been so young that there had not been enough time for those monstrous intergalactic structures to form.

Citation: New Look At Microwave Background May Cast Doubts On Big Bang Theory (2005, August 10) retrieved 24 July 2024 from https://phys.org/news/2005-08-microwave-background-big-theory.html