

## ASTRONOMY

### Pair showed Big Bang theory could stand up to cosmic tests

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Many people talk about the Big Bang, but hardly anybody does anything about it.

Last week, the Nobel Prize in physics went to John Mather and George Smoot, who really did do something. Let's have a look at how their work was important for our conception of the cosmos.

The essence of the Big Bang theory is that the universe has evolved from a hot, dense, early state where matter was spread very smoothly through space, to today's cool, thin state where matter is clumped into galaxies stars and planets.

In the 1950s, the Big Bang was by no means the front-running theory.

Most astronomers favored the Steady State model, which said that the universe, even though it was expanding, always had done so, and always would look pretty much the same.

But in 1964, research groups at Bell Labs and Princeton University, in New Jersey, recognized that a ubiquitous radio "static" could be explained by the Big Bang model

This cosmic background radiation was a natural relic of a hot, dense early universe.

That didn't mean the Big Bang was proved. Scientific theories have to be more than just reasonable-sounding explanations. They have to go out on a limb and make testable predictions. A theory that stands up to many tests is solid; one that doesn't is rejected.

In the Big Bang's case, the crucial observations had come in before anybody had had a chance to make the detailed predictions. The theory could explain them after the fact, but that's not the same thing.

Twenty-something years ago, as graduate students at Princeton, my classmates and I learned all about the cosmic background radiation, and why measuring its properties was fiendishly difficult. We also heard that a special-purpose satellite was being built that would put all previous measurements to shame.

The COBE satellite, built by Smoot, Mather and their team, flew a few years later. By then, we knew what to expect. According to Big Bang calculations, the spectrum of the cosmic background radiation should be very close to that of a perfect thermal radiator, or "blackbody." It should be slightly different in different directions, varying by no more than a few parts in 100,000.

The COBE results were jaw-droppingly awesome, confirming the Big Bang predictions to four decimal places and producing one of the few standing ovations that I have seen at a scientific meeting.

Since then, even more-detailed predictions have been computed from the Big Bang theory, and more-sophisticated equipment has been built to test them.

Every time, the theory has passed the test. The evidence is overwhelming that the Big Bang really did happen.

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