Planck Mission: Space Probe Peers Into Dark Cosmos

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An artist's impression depicts the Planck telescope against a background image of the large-scale structure in the Milky Way. Photo copyright European Space Agency.

(PhysOrg.com) -- Imagine watching the birth of the universe -- the Big Bang -- from the outside. What would you have seen?

At that moment and for the next 380,000 years, a Big Nothing, as photons and particles clung to each other in a high-energy dance that kept any light from escaping.

USC College’s Elena Pierpaoli and 200 other physicists are trying to find out what went on during those dark days with the Planck mission — the most advanced space-based telescope designed to study the early universe.

Named after the founder of quantum theory and launched last year by the European Space Agency, Planck in coming years will map the weak background radiation pervading the universe with far greater accuracy than two previous missions.

“The [cosmic background radiation] is a gold mine to test various theories regarding the early universe,” Pierpaoli said. “It’s a section of the history of the cosmos that we don’t know much about and it’s incredibly important.”

Planck also could become the first telescope to prove the existence of gravity waves: ripples in space-time caused by the extreme phenomena of the birthing universe. If they exist, gravity waves would have left a unique signature on the cosmic background radiation (CMB).

The discovery of gravity waves would lift the darkness and help cosmologists — physicists who study the origins of the cosmos — to decide between several theories of the early universe.

While the discovery of gravitational waves may not occur even with Planck, there is no doubt about the probe’s main capability: mapping the cosmic background radiation with unparalleled accuracy.

The radiation was the first light released after the decoupling of photons and particles. So while it is not as old as gravity waves, it can still provide new information about the cosmos. And it may carry the imprint of a very fast expansion, known as inflation, theorized to have occurred a millionth of a second after the Big Bang.

As the graduate student of one of the mission’s first proponents in the early 1990s, Pierpaoli was grandfathered into the worldwide community behind the telescope. She joined USC College in 2006, becoming associate professor of physics the following year.

Pierpaoli and her postdoctoral researcher Loris Colombo, also on the Planck team, hope to use the data to sharpen estimates of some fundamental numbers: the total mass of the universe; the amount of mysterious "dark energy" driving the expansion of the universe; the speed of expansion; and several numbers relating to inflation.

Planck should improve the accuracy of existing estimates by three to four times, Pierpaoli said. That in turn could be used to confirm or rule out competing theories of the universe.

Pierpaoli and Colombo also hope to find signatures in the cosmic background radiation from the period after decoupling, when matter started forming into atoms and emitting radiation.

Finally, Planck is expected to provide valuable data on galaxy clusters, the largest objects bound by gravity in the known universe.

"There's much more science contained in the Planck measurements than just the CMB data. By observing the entire sky at nine different frequencies, ranging from the radio to the infrared, we'll be able to learn more about distant galaxies, other galaxy clusters and our own galaxy," Pierpaoli said while the Planck mission was in the planning stage.

Galaxy clusters are supposed to be spread over the cosmos more or less randomly. If unexpected variations were to turn up, they might indicate that something was not quite random during inflation — the way an unusual scatter pattern from shotgun pellets might indicate a burr in the barrel.

Pierpaoli and graduate student Thad Szabo are about to publish the newest and biggest survey of galaxy clusters as seen in the visible light in the Sloan Digital Sky Survey, containing 72,000 objects — five times more than previously surveyed.

New data expected from Planck will further improve scientists' understanding of clusters, along with the other phenomena related to the birth of the universe.
It's not as good as a front row seat to the Big Bang, but it's a start.

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