

The COBE Satellite (Explorer 66)

COsmic Background Explorer

The Satellite That Confirmed the Big Bang and Led to the Nobel Prize

By Barry Davidoff

The COBE program began in 1974 with an announcement by NASA that it was interested in future projects in astronomy that would utilize a small to medium size spacecraft.

George Smoot submitted a proposal to measure the Cosmic Microwave Background radiation (CMB) that would be important for proving the Big Bang theory. A satellite was necessary since the microwave wave lengths of CMB are obscured by the earth's atmosphere.

NASA's Goddard Space flight Center in Maryland developed the COBE satellite to verify many of the aspects of the Big Bang and to explore the heavens in microwave band widths. The satellite developed a map of the heavens in 10 different wave lengths.

The COBE satellite originally was designed to fly aboard the space shuttle in 1988. However the Challenger disaster forced COBE to be redesigned and made smaller so that it could be launched by a Delta 2 rocket.

When the satellite was originally proposed the cost was intended to be under \$30 million and the redesign escalated costs substantially. The final cost of the sophisticated satellite was in excess of \$600 million.

COBE was finally launched by a Delta II (5920) rocket on Nov. 18, 1989 into a 887 x 898 km. orbit. The orbit was inclined 99° to the earth's orbit so it would be synchronous with the sun to allow the satellite to take a scan of the entire heavens over a six month period.

COBE is also called Explorer 66, so it is a part of a long series of American satellites launched by NASA to study the earth and the universe.

COBE is 5.49 meters long and 2.44 meters in diameter, excluding its two large solar panels which provided 1050 watts of power, and weighed 2270 kg. In order to cool the far infrared spectrophotometer, the satellite carried 650 liters (95.7 kg.) of liquid helium contained in a specially designed dewar.



The COBE satellite

COBE carried three major instruments:

1. The Far Infrared Absolute Spectrophotometer (FIRAS)
2. The Differential Microwave Radiometer (DMR)
3. The Diffuse InfaRed Background Experiment (DIRBE)

FIRAS

The principal investigator of FIRAS was Dr. John Mather of the Goddard Space Flight Center who also was responsible for the integration of the entire spacecraft.

According to the Big Bang theory when the universe exploded the Cosmic Background radiation was 3000° C.

In the succeeding 14 billion years the background radiation cooled to only 2.7° K. and shifted to the microwave region.

The infrared spectrophotometer was cooled by liquid helium in order to record the ultra low temperature of the CMB.

Although FIRAS operated only for one year of the launch since the supply of liquid helium was exhausted, it confirmed that the CMB was exactly 2.725 +/- .001°K. This precisely matched the predictive models of the Big Bang theory.

The FIRAS findings are only one of the astounding proofs that the universe commenced with the massive explosion of the cosmic yelm.

Dr. Mather's role in calculating the temperature of the CMB and in developing FIRAS were the major reasons for him being selected as a

co-winner of this year's Nobel Prize in Physics.

DMR

The Differential Microwave Radiometer mapped every region of the universe in 10 different microwave frequencies.

In essence, the maps produced by DMR are a snapshot of the universe when it was only 300,000 years old. Before that the universe was too opaque for light to be transmitted.

The primary goal of DMR was to find fluctuations in the CMB. These fluctuations, however, are very hard to detect since they comprise only part in 1/100,000 of the 2.7° K temperature of the CMB. Nevertheless this sensitive instrument did find fluctuations of temperatures in the CMB proving that it was anisotropic.

The fluctuations were predicted by Big Bang theory and show ripples and waves being formed. Matter coalesced along the troughs of the ripples forming stars and later galaxies.

For his role as principal investigator of the DMR and mapping the anisotropic properties of the CMB, Dr. George Smoot was a co-winner of this year's Nobel Prize in Physics.

DIRBE

The Diffuse InfraRed Background Experiment mapped the sky in the infrared region and detected the Cosmic Infrared Background (CIB) which had been predicted.

DIRBE also discovered 10 new galaxies which were emitting in the far infrared region and nine other potential galaxies.

DIRBE studied interplanetary dust within the solar system. It found that most of the dust originated from asteroids and comets. It discovered that the center of solar system's cloud of interplanetary dust actually was not centered on the sun, but a few million kilometers away due to the influence of Jupiter and Saturn.

