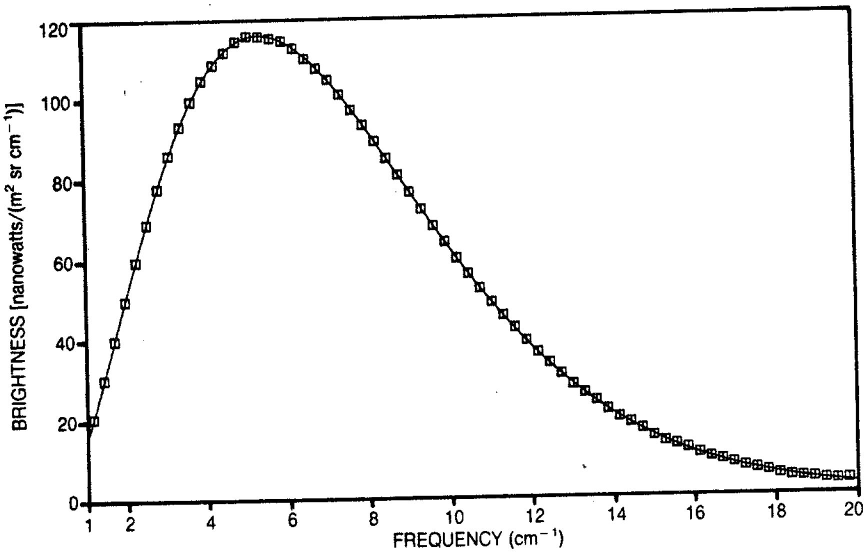
COBE SATELLITE FINDS NO HINT OF EXCESS IN THE COSMIC MICROWAVE SPECTRUM

For several years cosmologists have been kept busy puzzling over reports of a large excess in the cosmic microwave background spectrum at wavelengths shorter than 1 mm. Now they've been given a brief respite. At the January meeting of the American Astronomical Society in Washington, DC, John Mather of NASA's Goddard Space Flight Center presented the first spectral results[1] from COBE—the Cosmic Background Explorer—which had been launched into Earth orbit just eight weeks earlier. The moment Mather placed the COBE spectrum (reproduced on this page) on the overhead projector, the packed lecture hall burst into sustained applause. The contrast with all the earlier, fragmentary data was astonishing. The spectral measurements, from 1 cm down to 0.5 mm, fit perfectly to a Planck blackbody radiation curve for a temperature of 2.735 ± 0.06 K. At the 1% level one could see no deviation from an ideal blackbody spectrum. And it's not just a question of fitting a shape. With only one free parameter—temperature—the normalization also has to come out right. For a given temperature the absolute brightness of a blackbody spectrum is specified.



Cosmic microwave background spectrum measured by the Far Infrared Absolute Spectrometer[1] aboard the Cosmic Backgound Explorer. The COBE satellite was launched in November, and these data come from just 9 minutes of early observing near the Galactic north pole. The data points are shown here fitted to a Planck blackbody curve. This fit yields a temperature of 2.735 ± 0.06 K. At the level of 1% of peak brightness, these new observations show no deviation from a perfect blackbody spectrum.

These spectacular results come from just 9 minutes of observation near the north Galactic pole by the Far Infrared Absolute Spectrometer. FIRAS is one of the three observing instruments aboard COBE. The north pole of our Galaxy is relatively free of local microwave sources and these were 9 minutes of particularly good thermal stability for FIRAS, making it easy to analyze the data quickly. FIRAS will take data all over the sky for about a year, until COBE's liquid helium cryogen runs out. In the end it should be possible to detect departures from a blackbody spectrum as small as 0.1 % of the peak brightness.

The audience also heard reports of first results from the Differential Microwave Radiometers and the Diffuse Infrared Background Experiment, the other two instrument systems aboard COBE. But the DMR and DIRBE results were at even more preliminary stages than the FIRAS data. George Smoot (Lawrence Berkeley Laboratory) presented the preliminary sky maps shown on page 18, displaying the DMR's first measurements of the variation of radiation intensity from place to place at three microwave wavelengths. Thus far, Smoot told his audience, the sky maps give evidence of no large-scale background variation other than the "dipole moment attributed to the "peculiar" motion of our Galaxy toward the Virgo cluster. The DMR has a relatively wide angular resolution of 7°, designed for all-sky surveys and measurements of large-angular-scale cosmological variations. Apart from the well-known dipole variation, the early DMR measurements find that the microwave background is uniform across the sky to a part in 10^4.

The blackbody spectrum

Measuring the cosmic microwave spectrum is difficult. At wavelengths shorter than 1 cm, ground-based observers have to contend with molecular-absorption bands in the atmosphere. Rocket and balloon-borne observations are all too brief. COBE is the first orbiting observatory designed for this part of the spectrum. It cannot observe at wavelengths longer than 1 cm, simply because its apertures are too small. Ground-based observations at longer wave-