

# Cosmic Blackbody: Adding Another Twist

Fourteen years ago a discovery was made that revolutionized astronomy. A cosmic background radiation (CBR) was found to permeate the entire universe.

Why the excitement? The spectrum of the radiation had the look of a blackbody emitting at about 3° K. This was just the type of radiation predicted to be a remnant of the big bang. Astronomers quickly adopted the finding as clear evidence that our universe began with the explosion of a primordial egg about 20 billion years ago. The CBR, they said, was the last echo of that cosmic cataclysm.

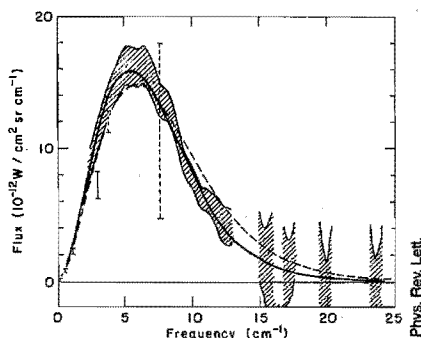
Ripples of concern went through the scientific community, however, when the most recent measurements of the background radiation did not totally conform to the spectrum of a 3° blackbody (SN: 4/21/79, p. 260). With the use of a balloon, David P. Woody, now with Caltech's Owens Valley Radio Observatory, and P. L. Richards of the Lawrence Berkeley Laboratory in California obtained the most accurate spectrum of the CBR to date—a spectrum with deviations. Their radiation measurements fell off the perfect blackbody curve in several places.

But now, three mathematicians from Massachusetts believe they have an explanation for the deviations. Ironically, their solution does not come out of the big bang theory but rather out of an opposing (and controversial) view of the origin of our universe—chronometric cosmology.

In the June 25 PHYSICAL REVIEW LETTERS, H. P. Jakobsen of Brandeis University, Mark Kon of Tufts University and I. E. Segal of MIT suggest that the photons that make up the background radiation have a total angular momentum large enough to produce an observable effect on the CBR. Such a "twist" is not incorporated into present theories and would have an appreciable effect only when applied on a cosmic scale.

With that in mind, the mathematicians modified Planck's law (the law that predicts the shape of a blackbody spectrum) to take this angular momentum into account. It became an added variable in determining the CBR's distribution of energy. They report that their adjusted law now provides a good fit to the spectrum observed by Woody and Richards.

The possibility that angular momentum might produce deviations in the CBR was actually brought out in Segal's chronometric cosmology several years ago. "I mentioned [angular momentum] to the big bang supporters years ago, but they didn't know how to work with it," Segal told SCIENCE NEWS. "The Woody-Richards experiments finally gave me a chance to bring it in. Until now, the deviations were not seen."



Shaded area is the CBR measured by Woody and Richards. Dashed line is pure blackbody curve. Solid line is blackbody spectrum modified by angular momentum.

This brings up a new question. How could an opponent of the big bang theory work on a problem that is considered to be the theory's greatest proof? "The cosmic background radiation is not uniquely indicative of a big bang," says Segal. "I don't believe the big bang has been substantiated. It requires many assumptions on how it began and how it cooled."

In place of the big bang, Segal envisions a closed, spherical universe that is both homogeneous and continuous in time. This means it is a nonexpanding, steady-state universe, a disturbing element to his critics.

An expanding universe is at the very crux of the big bang theory. Its supporters point to the shifting of spectral lines from distant galaxies toward the red end of the spectrum as proof that celestial objects are receding from us (just as a train whistle sounds lower as it moves away). Segal has another interpretation.

"In expanding universe theories, the photon is idealized as a plane wave. But this says its energy is infinite. It's unrigorous." To account for the redshift, Segal has developed alternative definitions for energy and time (hence the label chronometric) in a highly mathematical cosmology. As a photon travels from the far reaches of Segal's closed universe, it gets "delocalized." In other words, the photon spreads out to longer wavelengths. While the photon's apparent energy diminishes here in our local space-time, its total energy is conserved within the entire universe. We end up seeing a redshifted photon from a source that hasn't moved away due to an expansion.

To Segal, these "tired photons" (as they have been called) are the source of the cosmic background radiation. According to his theory, photons that have traveled around the universe several thousand times have completely redshifted and

have now achieved an equilibrium that follows Planck's law for a 3° blackbody (with angular momentum included).

It is conjectured that this angular momentum might explain how galaxies and solar systems get their spin as they evolve. The angular momentum would be imparted to the galaxies as they absorbed the photons.

The paper by Jakobsen, Kon and Segal was the first published attempt to explain the Woody-Richards deviations. Woody believes it is an unconventional approach. "My feeling is that people will be coming up with various ways to fit the data which are more conventional." Some theorists, for instance, believe there may have been physical processes going on in the early universe that degraded the blackbody from perfection. Only time will tell. □

## Busy last week for FDA Commissioner

The first scientist-commissioner of the Food and Drug Administration left the agency June 29. Donald Kennedy is returning to Stanford University after two years of FDA service, including a final, particularly busy, last week. The FDA made several important decisions during Kennedy's last days as its director:

- The synthetic sex hormone DES was banned as a growth stimulating feed additive for cattle and sheep because residues left in the meat may cause cancer in consumers. Kennedy said that DES has been shown to cause cancer both in animals and in humans and that there is currently no way to detect the smallest, but possibly still cancer-causing, residues in meat. Although the FDA is not charged with considering economic effects, Kennedy said the ban's opponents have not demonstrated that it will have significant economic impact. A report of the Congressional Office of Technology Assessment recently estimated that the drug increased beef production by 3 percent (SN: 6/30/79, p. 422). The FDA says other drugs may be substituted for DES.

- The FDA first issued a DES ban in 1972, but livestock and drug industries blocked it with court suits. Last September an FDA administrative law judge upheld the ban. The new FDA order states that DES use for animal growth promotion must stop by July 20. The hormone's use as a prescription drug is not affected.

- The limits on PCB's were tightened in fish, poultry and dairy products (see page 2).

- The FDA decided to prohibit sale of nonprescription drugs labeled as daytime