Remnants of the primeval fireball believed aglow

Big Bang theorists take relic radiation as proof

by Dietrick E. Thomsen

For the last 50 years cosmologists have known that they have to deal with an expanding universe. Many theories of the universe's evolution and history have been proposed in the light of this fact, and controversy over them has been continuous.

Until recently observation—the basis of most sciences—has had little to contribute to the argument because the effects that would distinguish among the theories were unobservable. However, radio astronomers in the last few years appear to have hit on one of the few observables in the business. They have identified in space radiation of the sort that would be expected from a black body at temperatures three degrees above absolute zero.

This level of blackbody radiation is predicted by the so-called big bang theory of cosmology, which postulates a universe supposed to have expanded from a small, extremely dense beginning and to be getting thinner and thinner as it grows. Finding the radiation, supposed to be a relic of physical conditions at the time of the primordial fireball, has given proponents of the theory almost a certainty that they are right, but the proponents of a radically different set of theories—the steady-state models—are not ready to give up. They continue to try to shake the confidence of their opponents.

The expansion of the universe began as a theoretical prediction by Dr. Willem de Sitter, who found in 1917 that one of the possible solutions of Einstein's general relativity called for it. Observational evidence that there was indeed an expansion going on came in the next decade from studies of the velocities of distant galaxies by Dr. Edwin Hubble and others, but whether it fitted de Sitter's model was not determinable; the field was open for theorists.

This expansion, if it has always been going on, raises serious problems of beginning and end in cosmological theories. If one follows time backward, the universe gets smaller and smaller until in the beginning everything is concentrated in a geometrical point. Going toward the future the universe gets ever more attenuated.

These ideas, especially the problem of infinite density at one end and infinite expansion at the other, were difficult for many scientists to accept, and some tried to get around them by postulating various combinations of static and expanding or pulsating universes.

A more radical way of getting around the density difficulties was to throw away the notion, implicit or explicit in other models, that the amount of matter and energy in the universe was fixed and constant once and for all. Doing this led to the steady-state or continuous-creation theories associated with the names of Profs. Hermann Bondi, Thomas Gold and Fred Hoyle.

Though Profs. Gold and Bondi differ from Prof. Hoyle, both theories are based on the notion that as the universe expands, matter is continually created out of nothing. This notion is shocking to many people, but, Prof. Bondi asks in his book, Cosmology (Cambridge University Press, 1961):... why is it more of a hypothesis to say that creation is taking place now than that it took place in the past? The continuous creation maintains the density of the universe at a constant value. As the universe gets bigger, more matter appears; in the past when the universe was smaller, there was less matter.

At about the time — 1948 — that Profs. Bondi and Gold came up with their steady-state theory, Drs. George Gamow, R. A. Alpher and R. C. Herman took a close look at the physical conditions that would have existed if the universe began in a point or a very small volume. They evolved a theory that has since become known as the...
... blackbody and the fireball

big bang or cosmic fireball concept. They found that if the matter and energy now in the universe were concentrated into a very small volume it would have been very hot; 10 billion degrees C. is the figure usually given. At these temperatures unorganized matter would not exist; electromagnetic radiation would dominate the situation. They found further that this radiation would be thermal or blackbody radiation; that is, it would have the characteristics of the radiation that comes from a hypothetically perfect radiator when only thermal motions are contributing to its generation.

The spectrum of a blackbody shows a characteristic pattern of variation of brightness with wavelength. The shape of the pattern is the same no matter what the temperature of the emitter, but the wavelength band it covers shifts with temperature: When the body is cool, it emits in the radio range, shifting its emissions into the infrared, visible, ultraviolet and X-ray regions as it gets warmer.

As the universe expanded, it would have cooled. Most of the original radiation would have been converted to matter, but some of the radiation would have stayed as such, cooled by now to a temperature less than 10 degrees above absolute zero, at which it would appear roughly as centimeter-band radio waves.

The idea got a good deal of publicity when it was presented, but then it fell into a kind of limbo. Prof. Robert H. Dicke of Princeton University suggested a similar blackbody condition in a theoretical study of a pulsating universe, but he forgot that he had done so until some students and colleagues reminded him of it years later.

It was in 1964 that the reminder took place and Prof. Dicke suggested that the cooled-off blackbody radiation might be looked for. A group of Princeton physicists prepared to look, aided by a microwave radiometer that Prof. Dicke had invented in 1945—this he had not forgotten—which used a technique of switching back and forth between the signal and a supercooled reference to record faint signals that were in danger of being masked by receiver noise caused by heating in the circuits.

While the Princeton cosmologists were at this work, they received word that Drs. Arno A. Penzias and Robert W. Wilson of the Bell Telephone Laboratories in Holmdel, N.J., had found a signal at 7.3 centimeters wavelength that fit a blackbody spectrum of about three degrees above absolute zero.
HOT? COLD? THERMOMETERS EVERYONE!


Thermometer Roundup: 3 for $5.50 p.

Harry Ross
31 L. E. Boyd Ave., N.W., N.Y.

GRADWOHL
School of Laboratory Technique


SEE MIRACLE OF BIRTH

POST PAID WITH
SIX QUALITY BOGS
($3.25 Without Eggs)
You get the new clear plastic dome CHICK-SATOR with 6 Beautiful Quail Eggs (available in 3 colors) and Egg Hatchers Extra Large Book. Company of Poultry Breeders. Send check or Money Order Today.


WRITERS

Slosh Printing

Enrich your style through Herbert Spencer and Edgar Allan Poe's classic principles that have influenced many of the world's great authors. Indispensable for writers eager to get published: Send $1.00 to Slosh Press Dept. 941, 101 5th Ave., New York 3

MEET THE HEAVENS!

LUNAR MAP: 10" chart in 2 colors identifies 326 mountains, seas, craters. 25 cents

POPULAR STAR ATLAS: All stars to magnitude 5½ charted in book form. $2.50

Write for new free catalogue N. DePuy, Dept. N

SKY AND TELESCOPE Cambridge, Mass. 02138

TELLS HOW TO SELL YOUR INVENTION

If you have an invention that you believe has merit, write us at once for copy of copyrighted booklet "How to Go About Selling Your Invention," We work with inventors, write copy, and booklet manuscript, and booklet reveals, preparing for manufacture, research and negotiation of deals including terms for profit sharing, royalties, etc. "How to Go About Selling Your Invention" is offered to encourage new ideas we might submit to manufacturers. Just send name, address, and ideas to: Kessler Sales Corp., Dept. D-461, Fremont, Ohio 43420

Doctors Trim 2 Inches

Off Flabby Waists!

German doctors at the famous Max-Planck Institute have discovered an instant-workout method that can reduce waistlines in 30 days. Called "Isometric Contractions," one 90-second daily workout can reduce waistline fast, 10 simple exercises can put the whole family in shape fast. No sweat, strain or tiring repetitions. Acclaimed internationally by physiologists, coaches, athletes. Results guaranteed. Free illustrated information. Write AWARD-WINNING ISOMETRICS, 37 Centaur Street, Yonkers, N. Y. 10710.

SCIENCE NEWS BOOK ORDER SERVICE

As a service to our readers, Science News has expanded its Book Order Service. You may order any U.S. book in print, at the retail price. We pay postage. There is a 25¢ handling charge if the price is less than $2. Write, Book Order Service, Science News, 1719 N St., N.W., Washington, D.C. 20036. Include your zip.

15 june 1968/vol. 93/science news/577