

state devices—for example, stored energy densities and characteristic line widths. So pulse durations shorter than tens of nanoseconds have not been produced with gas lasers. Some experimenters think they may be able to overcome these limitations, though. —GBL

Does the Microwave Background Have a Hump in its Spectrum?

The three-degree blackbody radiation may have a hump in its spectrum at about 1 mm, just where it peaks. Whether or not it's there, and if so, how it got there, is an intriguing mystery.

At the Washington APS meeting James Houck (Cornell University) described in an invited paper two rocket observations that he, Kandiah Shivanandan (Naval Research Laboratory) and Martin Harwit (Cornell) made.^{1,2} With a broad-band spectrometer sensitive over 0.5–1.3 mm they found a flux 50 times higher than expected.

Houck says the extra signal "may have been due to instrumental effects, the thin atmosphere [in which the rockets flew—170 km above the earth], or some unexpected emission process in the solar system or our galaxy. There is also the possibility that the radiation is an unexpected feature of the 'Big Bang.'"

Subsequent balloon observations by Dirk Muehlner and Rainer Weiss³ of MIT also suggest too much flux in the 0.8–1.0 mm range.

Although the funding situation has limited the number of flights, groups at Cornell, NRL and Los Alamos are planning more rocket flights soon.

Last year Patrick Thaddeus (Institute for Space Studies), John Clauser and Victor Bortolot (Columbia University),⁴ by measuring interstellar optical absorption lines of CN, CH and CH⁺, established upper limits at three wavelengths on the intensity of background radiation in the interstellar medium. At 2.64 mm Thaddeus, Clauser and Bortolot measured a temperature of 2.8 K; they inferred upper limits to the background temperature of 4.7 K, 5.4 K and 8.1 K at 1.3 mm, 0.56 mm and 0.36 mm, respectively.

The limits are consistent with three-degree blackbody radiation. They imply a flux that cannot be reconciled with the rocket and balloon observations, say Thaddeus, Clauser and Bortolot, unless the flux being observed is concentrated into a sharp line that happens to avoid the molecular resonances, or unless the flux originates locally.

How could most of the radiant energy in the universe be produced in the form of lines? If the excess flux comes from quasars, distant galactic nuclei and the like, one would expect fairly broad-band radiation. The three-degree background radiation has 100 times the energy density of starlight throughout the universe. If the rocket and balloon observations are correct, the hypothesized line source would be 2000 times the energy density of starlight.

Recently Thaddeus and Philip Solomon (Institute for Space Studies) have been looking at interstellar formaldehyde, a very sensitive radiometer already located in outer space. The formaldehyde is cold—colder than 3 K, and it is apparently absorbing out the three-degree blackbody radiation. What could be pumping it down? Thaddeus and Solomon believe that the best explanation for the formaldehyde behavior is that there are small departures from the

blackbody spectrum, about a degree or even a tenth of a degree, in the vicinity of 2 mm or less. They are extremely skeptical, however, that the departures are anything like the magnitude observed in rocket and balloon flights.

An alternative mechanism for the cooling of the formaldehyde, involving collisions between formaldehyde and hydrogen atoms or molecules has been proposed by Charles Townes and Albert Cheung (University of California, Berkeley).⁵ —GBL

References

1. K. Shivanandan, J. R. Houck, M. Harwit, *Phys. Rev. Lett.* **21**, 1460 (1968).
2. J. R. Houck, M. Harwit, *Astrophys. J.* **157**, L245 (1969).
3. D. Muehlner, R. Weiss, *Phys. Rev. Lett.* **24**, 742 (1970).
4. V. J. Bortolot, Jr., J. F. Clauser, P. Thaddeus, *Phys. Rev. Lett.* **22**, 307 (1969).
5. C. H. Townes, A. C. Cheung, *Astrophys. J.* **157**, L103 (1969).

CERN Proposes Missing Magnets And 150 GeV for New Machine

The CERN 300-GeV project, plagued with foot-dragging, international intrigue, and tight money, and most recently confronted with Robert Wilson's announcement that the Batavia accelerator might yield a 500-GeV beam by 1 July 1971, has announced a new design approach that might salvage the project. In mid-April the new proposal was presented for discussion to European governments and European scientists; a decision is hoped for by October.

In the initial 300-GeV concept, conventional combined-function magnets were arranged in a 2.4-km-diameter ring. The new proposal is for a "missing-magnet" design, in which only half the magnets are installed originally in a 1.8-km-diameter ring. (The Batavia accelerator originally had a "missing-power" design, allowing for a larger power supply to be installed later, so that energy could then be raised from 200 to 400 GeV. It later proved possible to get all the power required for 500 GeV at a cost low enough to install from the start.)

The CERN machine would start out with a maximum energy of 150 GeV but could have its energy doubled by doubling the number of magnets. If pulsed superconducting magnets continue to look as promising as they do now, the spaces could be filled with superconducting magnets, allowing a maximum energy of about 400 GeV.

Then if the superconducting acceler-



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ator worked well, the whole ring could be filled with superconducting magnets, and the maximum energy could be about 800 GeV.

Because the new proposal calls for a smaller ring diameter the accelerator could be built across the road from the existing CERN-Meyrin site. The rock in which the machine tunnel would be bored is the same as has already proved satisfactory for the 28-GeV proton synchrotron and for the Intersecting Storage Rings, now nearing completion; CERN believes the site is suitable.

The advantages of the Meyrin site are at least twofold: The political de-