A radio problem that may have a ten-billion-year-old solution

Activities in technology sometimes have surprising implications. For example, recent antenna tests conducted by Bell Telephone Laboratories at Holmdel, New Jersey, have apparently produced evidence about the early history of the universe.

In their radio communications studies, Bell Laboratories scientists had been using a horn-reflector antenna (employed on Project Echo and Telstar experiments) to measure the radio noise emitted by Cassiopeia A, an exploded star now surrounded by fiery gas. This and other similar measurements require accurate knowledge about or elimination of noise produced by the atmosphere, the ground, and the components of the antenna system itself. Now, noise from the Earth's atmosphere can be accurately measured and the antenna is so directional that ground noise is negligible (verified through a series of tests with a mobile transmitter). The electrical joints in the antenna system and waveguide were reworked and sealed to eliminate any possible noise due to leakage. And, an extremely accurate noise-level reference source—the best produced so far—was designed and built especially for this project.

But there was some noise which could not be explained. It was stronger than that radiated by the distant fixed stars. It showed none of the patterns typical of man-made interference. Drs. A. A. Penzias and R. W. Wilson were frankly puzzled. Strangely enough, similar unexplained noise, of the same order of magnitude, had been suspected by Bell scientists during the Project Echo and Telstar experiments. At that time, though, measurement techniques were not sufficiently perfected to allow them to be certain of their suspicions.

Not far away, however, at Princeton University, an explanation was being devised without knowledge of the Bell experiments. A group under Prof. R. H. Dicke was seeking information about the relationship between gravity and the recession of distant galaxies from us and from each other. The original composition of our galaxy (inferred from spectral lines of "old" stars) and the belief—held by many astronomers—that all matter was once compressed into a vastly smaller volume than at present suggested to the group that the universe was at that time much hotter—a veritable fireball. Such a fireball would emit a characteristic "black-body" radiation which—after cooling through billions of years of expansion—would have fallen in frequency from about 10^20 cps. to about 10^10 cps. It would thus lie in the radio spectrum, at wavelengths of a few centimeters. This was very much like the noise which was puzzling the men at Bell Laboratories.

A mutual acquaintance saw a possible connection and put Bell in touch with Princeton. Result: the signal received at Bell Laboratories has enabled Prof. P. J. Peebles of Princeton to draw the hypothetical radiation spectrum shown in the figure. Future measurements at other wavelengths within this spectrum are planned at both Bell and Princeton to determine whether there was a primordial fireball. If so, it will be the first reliable view man has had of events 10 billion years ago.
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only nine lines. Much of the literature published today is obscure and ungrammatical, and these faults will only be corrected when the rules of grammar are applied and clarity of expression is set high on the list of standards by which a manuscript is judged.

Forscher omits to mention that the referee has a responsibility to the author, who is entitled in this highly competitive age to prompt consideration of his manuscript. If a referee is too busy or too lazy to fulfill his obligations within a reasonable time, he should not be entrusted with the responsibility.

If it is the editor's responsibility to make the final decision about publication, it should also be his responsibility to weigh the advice of his referees. He need transmit to the author only those comments that he deems necessary for the improvement of the manuscript or for justifying its rejection; this he can do without disclosing the referees' names.

PETER H. WRIGHT
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Forscher's suggestion that verbatim comments from the referee be accompanied by his name appears to offer one way to curb the tendency of some referees to make unsupported judgments such as "naive," "superficial," or, in an extreme case, "stupid."

Moreover, communication of the author with the referee could in some instances prove to be mutually beneficial.

BARBARA J. POWELL
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Competence in the Universities

With regard to the Reuss subcommittee's inquiry into the relation between federal support for basic research and the quality of university science teaching (News and Comment, 22 Oct., p. 464), I offer the following observation: Having completed some 20-odd undergraduate and graduate courses in botany and genetics at four institutions (Washington University, the University of Michigan, Claremont Graduate School, and the University of California at Berkeley) during the pre- and post-Sputnik era, I have encountered teaching ranging from excellent to very poor. In every case the good-to-excellent teachers were those who were actively engaged in significant basic research, whereas the poor teachers were also inefficient as researchers. Thus my experience does not bear out the assumption that teaching and basic research are antagonistic duties of the university scientist. One might better regard poor teaching as simply one more aspect of professional incompetence.

KAREN A. GRANT
135 East Seventh Street,
Claremont, California

Antiunion

In the issue of 15 October (p. 292) there is a letter headed "No antineoplastic effects." Now, what can un-lun'g-g-plas'tuk mean? I get it! It means anti-neoplastic.

Why is the hyphen so avoided? The dashed little dash makes for clarity. How can one pronounce and divine the meaning of picornaviruses without hyphens? It's easy when you write it right: pico-RNA-viruses. That does for many another inelegant formulation born out of the modern, hasty need for neologisms and nonce words.

There ought to be a law: Dash it! As for acronyms: To hell with them.

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Erratum

The 22 October issue presents the wildly improbable coincidence of containing both a letter about parapsychology and "spontaneous cases" (p. 436) and a "spontaneous case." For on page 463, as part of my comments on the 1965 Nobel Laureates in Medicine or Physiology, there appears the phrase "The operator 'loses' . . . ," though what I had actually written was "The operator 'loses' . . . ." Now since I happen to have some doubts about the validity of the operator concept, doubts that I certainly would not consciously have wished to introduce on this happy occasion [though I did voice them earlier in Science 144, 816 (1964)], this strange error can be explained only as a Freudian slip by a member of the editorial staff of Science acting under the telekinetic influence of an author's psyche.

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ethane as his counting gas in order to introduce twice the amount of carbon into a liter-atmosphere of sample gas; counting 24 liter-atmospheres of ethane for 6 days allows him to measure, without isotopic enrichment, samples 60,000 years old. Unfortunately a very small amount of sample contamination is very significant in this range and may make statistical calculations of range purely academic. Badly needed for evaluating contamination is a series of samples extending from around 20,000 years, where C$^{14}$ ages should be reliable, back to 75,000 years or beyond.

Finally, Oeschger (Bern) described a very small gas counter having a volume of 40 cm$^3$, designed to analyze CO$_2$ extracted from glacial ice. Even with so small a detector almost one ton of ice must be melted to yield sufficient CO$_2$ for radiocarbon measurement.

In the field of natural tritium measurement, it is often necessary to enrich the H$^3$ prior to counting in order to attain adequate sensitivity. Customarily this has been done by water electrolysis, one installation of which was described by Cameron and Payne (International Atomic Energy Agency, Vienna). Enrichment using thermal diffusion has lately been considered; the conference heard reports on this technique from Sellschop (South Africa) and von Buttlar and Wiik (Darmstadt). Enrichment by use of a gas chromatographic column was described by Smith and Akhtar (Tennessee) but is not as yet applicable to natural levels.

Isotopic enrichment is often unnecessary where bomb-produced tritium is sufficiently abundant. In this case proportional counting has been used without enrichment. Von Buttlar, Wohlfahrt, and Farzine (Darmstadt) generate hydrogen from natural waters and use it to hydrogenate inactive ethylene to ethane, which they count. Lal (Bombay) described a process to produce tritiated methane from water in one stage. His reactor is loaded with sample water, zinc metal, and inactive CO$_2$ gas; the net reaction is CO$_2$ + 2H$_2$O + 42Zn $\rightarrow$ 4ZnO + CH$_4$. This same reaction can be used for C$^{14}$ measurements, in which case the CO$_2$ is sample-derived and the water is inactive.

The conferees considered the question of the best half-life to use in reporting C$^{14}$ ages to the journal Ra-

diocarbon. A similar discussion was held during the 1962 Cambridge Conference as a result of three new measurements of half-life (I) that showed the accepted value of 5568 years to be low by 3 percent. Majority opinion in both the Cambridge (2) and Pullman (3) conferences was for retaining the old value for the sake of uniformity in publication while at the same time suggesting a correction factor of 1.03 to be applied for greater accuracy.

One of the highlights for many was the all-day field trip which provided a change of pace in the middle of the conference week. The itinerary included the Palouse hills of Pleistocene loess deposits, the channeled scablands where Pleistocene flood waters have exposed and scoured Tertiary basalt flows of the Columbia Plateau, and the Marmes Rock Shelter at the confluence of the Palouse and Snake Rivers. The latter has been excavated by Washington State University archeologists who have exhumed several human skeletons antedating the Mazama ash fall of 6500 years ago. Guides for the field trip were Richard Daugherty, in archeology, Roald Fryxell in geology, and James Crosby in geohydrology.

EDWIN A. OLSON
Whitworth College, Spokane, Washington

R. M. CHATTERS
Washington State University, Pullman

References


Forthcoming Events

December

20–21. Molecular Transport and Rate Phenomena, 32nd annual chemical engineering symp., Stanford Univ., Stanford, Calif. (A. Acivos, Dept. of Chemical Engineering, Stanford Univ., Stanford, Calif.)
20–21. Nuclear Medicine, 2nd natl. cong., Tel Aviv, Israel. (P. Czernia) Israel Atomic Commission, Soreq Nuclear Research Center, Doar Yavne
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**Mathematics**
- American Mathematical Soc. (R. S. Pierce, Univ. of Washington, Seattle)
- Association for Computing Machinery. (H. D. Huskey, Univ. of California, Berkeley)
- National Council of Teachers of Mathematics. (J. D. Gates, 1201 16 St., NW, Washington, D.C.)
- Society for Industrial and Applied Mathematics. (J. H. Griesmer, IBM, Yorktown Heights, N.Y.)

**Physics**
- American Astronautical Soc. (P. B. Richards, General Precision, Little Falls, N.J.)

**Chemistry**
- American Chemical Soc., California Section. (R. L. LeTourneau, Chevron Research Co., Richmond, Calif.)

**Astronomy**
- American Astronomical Soc. (G. C. McVittie, Univ. of Illinois, Urbana)

**Geology and Geography**
- Association of American Geographers. (M. Mikesell, Univ. of Chicago, Chicago, III.)

**Zoological Sciences**
- American Fisheries Soc. (H. K. Chadwick, California Dept. of Fish and Game, Sacramento)
- American Soc. of Zoologists. (A. G. Richards, Univ. of Minnesota, St. Paul)
- Animal Behavior Soc. (E. M. Banks, Univ. of Illinois, Urbana)
- Herpetologists' League. (F. B. Turner, Univ. of California, Los Angeles)

**Zoological and Botanical Sciences**
- American Soc. of Naturalists. (C. H. Hubbs, Scripps Inst. of Oceanography, La Jolla, Calif.)
- Ecological Soc. of America. (G. M. Woodwell, Brookhaven Natl. Laboratory, Upton, L.I., N.Y.)
- Western Soc. of Naturalists. (J. M. Craig, San Jose State College, San Jose, Calif.)

**Psychology**
- Western Psychological Assoc. (G. A. Mendelsohn, Univ. of California, Berkeley)

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