EARTH SCIENCES

Brontides: The sound and the fury

Researchers recently stormed each other's theories about the natural explosive, booming noises of unknown origin called "brontides" (from *brontidi*, which means "like thunder"). The brontide bandy—published in the June 12 SCIENCE—is between Donald J. Stierman of the University of California at Riverside and Thomas Gold and Steven Soter of Cornell University in Ithaca, N.Y.

Gold and Soter theorize that explosive, booming noises can be caused by gas escaping from fractures in the earth. While conventional petroleum wisdom holds that most naturally occurring gas is organic in origin—formed when the complex mixture of subsurface organic matter called kerogen decomposes first to heavy oil then to light oil and finally to gas—Gold theorizes that this escaping gas is inorganic in origin, having been trapped deep within the earth at its birth 4.5 billion years ago (SN: 4/25/80, p. 267; 6/6/81, p. 359). The release of such gas, report Gold and Soter, may have caused the booming or rumbling noises that reportedly preceded major earthquakes — the Charleston, S.C., earthquake of 1886 and the April 18, 1906, San Francisco earthquake, for example.

Stierman, on the other hand, says, "Direct transmission of seismic energy from ground to air, sometimes by earthquakes too small to be felt, is clearly adequate to explain booming noises." He insists, "There is no need to invoke different physical processes for a single phenomenon."

But Gold and Soter say brontide researchers may not be dealing with a single phenomenon. While faint audible booming sounds indeed may be produced by direct ground-to-air transmission of energy from unfelt earthquakes, they explain, their brontide theory addresses sounds from waves in the 20 to 100 Hertz range. This is "much above the range used normally in seismology, since waves of such frequencies are rapidly attenuated in the ground," Gold and Soter report. "It thus appears that an additional mechanism, perhaps involving high-pressure gas, may be required to explain some of the brontides."

Still, Stierman maintains that "a number of the sources cited by Gold and Soter as evidence for gas eruptions leave something to be desired." Two of the events cited, for example, may have been legendary, Stierman says; for a third event cited, an explosive gas hypothesis long ago was rejected as "too vague."

Gold and Soter counter: "Stierman examines three of the particular brontide episodes for which he is able to find circumstances admitting doubt, ignoring the other 15 mentioned in our article. Almost any individual description of an anomalous phenomenon...can be picked apart; it is the similarity among a large number of independent accounts that must be considered in judging the probability that the general phenomenon is real. If we had to rely on only a few accounts, we too might doubt that gas emission is the cause of any brontides." Moreover, the Cornell researchers report, the gas hypothesis is based not only on earthquake-related booming noises, but also on reports of sulfurous smell, "dry" fogs, bubbling rivers and flames from the ground.

Nonetheless, Stierman concludes, "Virtually every episode of precursory brontide activity cited by Gold and Soter is more easily explained by unfelt foreshocks than by gas eruptions."

Last winter: How dry it was

The winter of 1980-81 was a record-breaker, according to recently released National Oceanic and Atmospheric Administration figures. January was the driest year-starter since 1895 and the fourth driest month since 1894, the first year national figures were collected. Also, the period December through February was the second driest in record-keeping history.

PHYSICAL SCIENCES

Michael A. Guillen reports from New Orleans at a research symposium in honor of P. A. M. Dirac

Coulomb's Law: At home in theory

Typically, each law of physics has been born in either of two places: the mind of a theorist or the lab of an experimentalist. Perhaps the most famous example of the latter sort is a set of four laws that pertain to all electrical and magnetic phenomena and which is obligingly named after 19th century experimentalist James Clerk Maxwell.

At the Dirac symposium, Bill J. Dalton of Iowa State University claimed to have found at long last a place in the modern theoretical language for Coulomb's Law, one of Maxwell's equations that specifically involves electrical charge. Dalton's work is based on "non-linear realizations of the space-time symmetry."—a mathematically complicated extension of its simpler "linear" cousin, which is a basis for today's theoretical discussions. The nonlinear physics extends the vocabulary of the linear physics.

The idea of charge, Dalton told SCIENCE NEWS, now seems to take its natural place beside that of another fundamental physical quantity, intrinsic spin. Spin is an inherent property of all elementary particles, and our current understanding of it is owed to the "linear" theoretical language. As Dalton puts it: "[My] result places charge on an equal footing with intrinsic spin, both being consequences of our space-time symmetry; charge is cast as a nonlinear counterpart of intrinsic spin."

There's more, because the cherished empirical principle of charge conservation could now be attributable to a (hitherto overlooked) symmetry of our universe, says Dalton, just as conservation principles for other physical quantities, such as angular momentum, are already known to correspond to other such symmetries.

Hole-ly large accelerations

The four laws of thermodynamics are a solid cornerstone of modern physics, an example of such rare fundamental veracity that they even managed to survive without significant emendation the changes that rocked physics over six decades ago. Of the four, the second is probably the most profound, certainly the most apocalyptic. It states in essence that the content of the universe is steadily becoming more chaotically distributed, less well-organized.

One of the few things that might threaten our interpretation of this long-standing law, or worse, threaten the law itself, is the black hole. This monstrosity of general relativity has ascribed to it such outlandish properties, it is understandable why Jesse Unruh of the University of British Columbia posed this question at the Dirac symposium: "Is the second law of thermodynamics valid in a universe populated by black holes?"

Previous attempts at this question have recently led to arguments that the second law would remain valid only through the saving existence of a complementary fifth law of thermodynamics, the experimental evidence for which is, to say the least, currently inconclusive (though, some would argue, not entirely absent).

Unruh offered his argument, however, that whether such a fifth law exists or not, the second law is in fact still true, black holes notwithstanding. Furthermore, he argued, there is an interesting spinoff to his analysis: a possible way of tapping black holes for energy.

In carrying out his calculations, Unruh imagines a rocket accelerating toward the surface of a black hole. He finds that this motion of the rocket through the black hole's gravitational field induces the hole to give up energy.

There is one rub to this scenario, though. The requisite acceleration to extract even a small bit of this radiative energy would be equivalent to going from zero to 10,000,000,000,000,000,000,000 miles per hour in 10 seconds flat!