Earthquake Light

I enjoyed Deborah Shapley's account "Chinese earthquakes, The Maoist approach to seismology" (News and Comment, 20 Aug., p. 656), but I am bemused by her report that a trained (Chinese) seismologist gave the Americans a "convincing" account of an "earthquake light" which illuminated the night sky during one quake. I also have some epistemological difficulties with C. Barry Raleigh's reported explanation that "the electrical discharge represented by an earthquake light may build up before the quake."

Perhaps, under these circumstances, we should reexamine the communication (*1*) directed to the president of the Royal Society by William Stukeley on 26 March 1750. In it he points out that

> In an age when electricity has been so much our entertainment, and our amazement; when we are become so well acquainted with its stupendous powers and properties, its velocity, and instantaneous operation through any given distance; when we see, upon a touch, or an approach, between a non-electric and an electrified body, what a wonderful vibration is produced! what a snap it gives! how an innocuous flame breaks forth! how violent a shock! Is it to be wonder'd at, that hither we turn our thoughts, for the solution of the prodigious appearance of an earthquake?

And again,

> We had lately read at the Royal Society, a very curious discourse, from Mr. Franklin of Philadelphia, concerning thundergusts, lightning, the northern lights, and like meteors. All which he rightly solves from the doctrine of electricity. . . . From the same principle I infer, that, if a non-electric cloud discharges its contents upon any part of the earth, when in a high electrified state, an earthquake must necessarily ensue. The snap made upon the contact of many miles compass of solid earth, is that horrible uncouth noise, which we hear upon an earthquake; and the shock is the earthquake itself.

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Ion Beam Analysis

The article by Arthur L. Robinson "Nuclear science: X-ray evidence for superheavy elements" (Research News, 16 July, p. 219) gives a misleading impression of one aspect of analysis using ion beams. This involves the statement that "the researchers had to focus the ion beam on the inclusions, which have diameters of 50 to 100 micrometers, for long periods of time (an hour), a never-before-achieved accomplishment in itself."

In fact, beams of protons and other ions focused to spots of less than 4 μm in diameter have been in use in this laboratory for about 7 years. Positional stability to a few micrometers is normally possible for periods of several hours. A description of the system was first published in 1972 (*1*), and much analytical work using the system has since been reported (*2*). Several copies of the system have been built in other laboratories, although not always successfully.

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2. T. B. Pierce, J. W. McMillan, P. F. Peck, I. G. Jones, *Nucl. Instrum. Methods* **118**, 115 (1974); J. A. Cookson and F. D. Pilling, *Phys. Med. Biol.* **20**, 1015 (1975).

Cookson is indeed correct. In fact, because of the long-term stability of the accelerator beam there, researchers who were involved in the superheavy element discovery will soon be journeying to Harwell to repeat their experiment. The lower beam energy available from the English accelerator will mean that it may take six or seven times as long to accumulate a given amount of data as with the Florida State University machine, thus requiring a length of time which will severely test the former's stability. Nonetheless, Neil Fletcher at Florida State University believes the experiment will be an important one in increasing the credibility of the x-ray evidence for the existence of superheavy elements.

—A.L.R.

Food, Energy, and Population

The studies on agriculture and energy by David Pimentel's team at Cornell provide a great deal of useful information on this important relationship, especially as it applies to American practice. But conclusions based on their extrapolations to a worldwide scale can be seriously misleading. That was the case with the much-quoted article of 1973 (2 Nov., p. 443) and is also true of the sequel (21 Nov. 1975, p. 754).

In the 1973 article, Pimentel *et al.* estimated "the fuel energy needs to feed 4 billion humans," extrapolating from energy inputs for corn in the United States (roughly 1 gallon of gasoline per bushel of corn). Nitrogen fertilizer accounted for one-third of that total, applied at 112 pounds per acre. But total U.S. nitrogen fertilizer consumption in 1970 was 7.46 million short tons (*1*), an average of only 45 pounds per acre of cropland. Pimentel's calculation therefore overstated this part of the energy budget by 2.5 times. Moreover, in attributing energy use on a U.S. scale to "green revolution agriculture," Pimentel *et al.* did not distinguish between energy required for high yields per acre and energy which merely replaces high-cost human labor—not a necessary aspect of the green revolution. Almost half of the total energy budget for corn falls in the latter category. Finally, the authors compared energy used in all forms with estimated reserves of petroleum alone, an inherently misleading comparison.

The 1975 article compounds some of these errors. One can heartily endorse the conclusion that population control in densely populated, low-income regions is of the highest priority without supporting that conclusion with dubious calculations based on the questionable assumption that "most people of the world desire to eat and live as we do in the United States." Taken literally, that assumption would require both global population-land ratios and global incomes at American levels. The first would be physically impossible without an enormous reduction of population elsewhere—in the case of South Asia, by 86 percent from present levels and even more from population levels in the future. Income equality might be physically possible at some time, but it is practically inconceivable for any visible future. Starting at 1972 nominal levels (*2*), if per capita output increased in India by 3 percent per year and in the United States by only 1 percent per year, it would take over 200 years to achieve equality.

Even if we assume that most people in the world would like a U.S.-style *diet*, Pimentel *et al.* incorrectly assume that this goal would require "the use of U.S. agricultural technology," which would be impossible because of insufficiencies of both land and energy. They neglect the fact that U.S. yields per hectare are far lower than European or Japanese yields, a natural result of differing constellations of availability and costs of land, labor, energy, and other inputs. For all cereal grains (*3*), U.S. yields in 1973 were 3680 kilograms per hectare; Japanese yields were 5755 kg; those of

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