

and Peter D. Blair ignore a critical factor in the energy equation: the US population. Energy impact equals total population times energy impact per person. In a nine-page article there is not a single sentence that even mentions exponential population growth (currently 1% a year in the US and nearly 2% a year worldwide). In California, for example, the population doubling time is only 30 years. At such a pace, by the end of the 21st century California's population will equal the present population of the entire US. In the face of such growth, even the most enlightened energy policies will fail.

To requote the ancient Chinese saying quoted by Gibbons and Blair: "If you do not change your direction, you are very likely to end up where you are heading."

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## Has Psychokinesis Met Science's Measure?

Philip Anderson (October 1991, page 146) says, "[W]ithin my competence as a theorist . . . physics as it is practiced, and specifically precise mensuration, is not compatible with [Robert G.] Jahn's claims" (that is, claims of the existence of psychokinesis). Anderson's idea is, no doubt, that if mind affected matter, this would disturb the results of laboratory experiments. An equivalent argument applied to chemistry would lead to the following: "Chemistry as it is practiced rests on the principle of the invariance of atoms, and so is incompatible with the idea that elements can be transmuted." The latter conclusion is not, I suspect, one whose truth Anderson would be as eager to assert in the columns of *PHYSICS TODAY* as the one quoted above.

Equally suspect is Anderson's second argument designed to persuade his readers to disregard Jahn's results, that is, Anderson's reference to the use of Bayesian statistical methods. I am willing to accept his claim that the use of such methods would make Jahn's numbers less favorable. But unfortunately the argument stops short at that point; Anderson does not inform us what the result would be if Bayesian methods were applied, and especially does not tell us the answer to the crucial question, Do Jahn's results remain significant if this analysis is done, or not? Why this reticence?

For Anderson and for other skeptics,

belief in the paranormal is irrational. But very often skeptics, in their uncritical attempts to persuade others of their point of view, fall back on inadequate arguments themselves. Those examined above provide clear illustrations.

What, then, about irrationality? Is it irrational to assert that under special conditions psychokinesis can occur, although most of the time it does not? No more irrational, I think, than to assert that while for most people walking on a tightrope across a ravine is an impossible task, it may nevertheless be possible under sufficiently favorable conditions (for example, with suitable dedication, training and concentration); again, I suggest, no more irrational than to assert that while an amount of uranium of mass on the order of a kilogram generates spontaneously an amount of heat requiring sensitive instruments to detect at all, a suitably larger amount can generate enough energy to provide power for a large city. (Further, as one of my collaborators, social anthropologist and parapsychologist Marilyn Schlitz, of the Mind Science Foundation, San Antonio, Texas, has noted, there exist analogies that may be more directly relevant in the field of social systems, an example being the way under special conditions in a society particular ideas that individuals have may spread widely, although in the vast majority of cases the effects of individuals' ideas remain localized close to their sources.) Finally, is it really irrational or unscientific, as some skeptics seem to think, to suggest that a relationship may exist between John Bell's nonlocal connections and telepathy? In this regard, I wish to draw attention to the publication in a reputable physics journal of a paper<sup>1</sup> that gives a rational account of how the two could be related and of why the latter kind of coupling should be possible in biosystems but not under the conditions of the normal physics experiment.

I hope that some readers may by now have picked up a message that skeptics might prefer they did not pick up: that psychic phenomena may be both consistent with physics and conceivable in rational terms; and, as a corollary, that many of the experiments on the paranormal may be measuring genuine phenomena that it should be the goal of science to try to understand.

Finally, I should like to recommend to readers not wanting to be caught in a paradigm that may be outliving its relevance to our understanding of the natural world that they read David

Bohm's elegant discussion of his concept "soma-significance."<sup>2</sup>

## References

1. B. D. Josephson, F. Pallikari-Viras, *Found. Phys.* **21**, 197 (1991).
2. D. Bohm, in *The Search for Meaning*, P. Pylkkänen, ed., Crucible, Wellingborough, Northants, England (1989), p. 43.

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ANDERSON REPLIES: The non sequitur in Brian's first paragraph gives us an object lesson in the scientific method. Artificial transmutation of elements was accepted almost instantly after the first observation, as the history of science goes, because the effects were reliably predictable and totally reproducible. I am not aware of any psychokinetic effects that have been reliably predicted in advance as to nature, sign and magnitude.

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## How Tiny Bubbles Can Cause Big Booms

I read with interest the news story "Light Comes from Ultrasonic Cavitation in Picosecond Pulses," by Barbara Goss Levi (November 1991, page 17), which describes, among other things, the generation of high temperatures during the collapse of cavitation bubbles and how these high temperatures have been thought to produce metallic glass when iron pentacarbonyl is irradiated with ultrasound. One area of considerable practical interest not mentioned in the story or in the references is the sensitization of explosives by microscopic bubbles.<sup>1</sup> Over two decades ago, Frank Philip Bowden and I showed, using high-speed photography, that when a microscopic bubble is rapidly compressed onto an explosive crystal, it can cause the initiation of an explosion in less than a microsecond.<sup>2</sup> The crystal acts as a fast-response thermometer: As soon as its temperature is high enough, an explosion results. Some scientists working in the field of explosives have argued, however, that not enough heat transfer can occur from the compressed gas to an adjacent surface in such a short time.<sup>3</sup> In view of the formation of metallic glass by cavitation, the work mentioned above and some other work on the sensitivity of explosives,<sup>4</sup> it appears quite clear that the heat

*continued on page 91*