

Letters

Tritium Production

I hope that readers of Mark Crawford's article "Accelerator eyed for warhead tritium" (News & Comment, 27 Jan., p. 469) will not be misled by the lack of hard analysis therein. For example, an installation of five passive, inherently safe, modular high-temperature gas-cooled reactors (MHTGRs), a type proposed by Senator James McClure (R-ID), could produce 750 megawatts of electrical energy and, at the same time, more tritium than the proposed Accelerator-Tritium Producer, which would require 750 megawatts of electrical energy. The revenues from the sale of the electrical energy from the MHTGRs would pay for the annual operating costs of the complex, and over the lifetime of the installation pay for the initial construction costs.

Why even consider an installation whose technical feasibility is highly questionable, when one could choose a proven technology that would pay for itself and provide the tritium at no cost? In these times of budget deficits, one needs to make rational choices.

In addition, the introduction of the MHTGR could bring in a new era of clean energy sources for the generation of electricity and industrial process heat, thereby reducing the growing acid rain and greenhouse effects.

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Cardiac Chaos

Robert Pool's excellent article "Is it healthy to be chaotic?" (Research News, 3 Feb., p. 604) nicely summarizes a complex new area of investigation. However, contrary to the impression left by the discussion, we did not make any connection between the fractal structure of the heart's electrical conduction system (the His-Purkinje network) and the apparently chaotic nature of normal heart rate variability. Indeed, as we have previously emphasized (1), there is an important distinction between the generation of a single ventricular depolarization waveform (QRS complex) by the fractal His-Purkinje system, on the one hand, and the organization of sinus rhythm heart rate variability, on the other. In the first case, that of the single QRS complex, a

direct link can be made between the fractal structure (the His-Purkinje conduction tree) and fractal function (depolarization pulses on the electrocardiogram with a 1/f-like spectrum). In the second case, that of heart rate variations, there is no evident physical structure that underlies the healthy variability of sinus rhythm, which is also characterized by a 1/f-like spectrum (with superimposed peaks due to respiration, baroreflex, and so forth). Two-dimensional phase space plots of interbeat interval trajectories in healthy subjects suggest the presence of a strange attractor.

We have proposed, therefore, that physiological heart rate variability is governed by a fractal regulatory process leading to self-similar fluctuations in heart rate across multiple scales of time. These fractal dynamics involve the complex, nonlinear interaction of the parasympathetic and sympathetic branches of the autonomic nervous system.

According to this formulation, therefore, there is chaos both *within* the heart (fractal conduction system) and, on a larger scale, *outside* the heart that tethers the tempo of the heartbeat to the fractal dynamics of the nervous system. But there is no direct link between the two types of fluctuations.

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REFERENCE

1. A. L. Goldberger, V. Bhargava, B. J. West, A. J. Mandell, *Biophys. J.* **48**, 524 (1985); B. J. West and A. L. Goldberger, *Am. Sci.* **75**, 354 (1987); A. L. Goldberger and B. J. West, *Yale J. Biol. Med.* **60**, 421 (1987); A. L. Goldberger and D. R. Rigney, in *Dynamic Patterns in Complex Systems*, J. A. S. Kelso, A. J. Mandell, M. F. Shlesinger, Eds. (World Scientific, Singapore, 1988), pp. 248–264; A. L. Goldberger, D. R. Rigney, J. Mietus, E. M. Antman, S. Greenwald, *Experientia* **44**, 983 (1988).

Response: Besides the technical error that Goldberger explains above, my article may have given the wrong impression about how the work of Goldberger and co-workers has been received by the medical community. Although the work has its detractors, it is generally recognized as original, carefully performed, thought-provoking, and important.—ROBERT POOL

PNAS Reviewing Procedures

We wish to clarify a statement made by William Booth in the News & Comment item "AIDS paper raises red flag at PNAS" (10 Feb., p. 733). Booth writes, "Most of the 2000 articles printed in *Proceedings* each year slip quietly through without any-

mous and vigorous peer review. The authors simply agree to pass their papers by a knowledgeable colleague for an informal look-see." This statement describes the procedure applied to research articles contributed by members of the National Academy of Sciences to the *Proceedings*. Papers communicated on behalf of nonmembers, accounting for 75% of all papers published, are reviewed by two anonymous referees chosen by the communicating member. The reviews, authors' responses, and communicating member's comments are submitted with the manuscript to the editorial office for consideration. Review articles fall under a special category: such articles are published at the discretion of the editorial board, being either solicited or offered by the author(s) and judged acceptable by the board after appropriate review. Thus, a majority of articles published in the *Proceedings* has been subjected to anonymous review.

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Animal Activism

Constance Holden reports that "One of the more startling developments in this decade is the degree to which extremists have succeeded in taking over previously moderate groups" in the animal protection community (News & Comment, 6 Jan., p. 19). Her lead example is the Humane Society of the United States (HSUS), which is "seen as having gotten radicalized." This may indeed be the scientific community's impression, but it is mistaken. It apparently stems largely from an August 1986 article that appeared in the *Washingtonian* magazine, and the ensuing correspondence. The author of that piece relied heavily on statements made by a few staff members that were atypical and reflected personal opinions, not organizational policy. The resulting misunderstanding is regrettable. Our policy on animal research has remained essentially the same for over a decade. The HSUS is not an antivivisection society. We accept as inevitable some laboratory use of animals, given science's historical reliance on animals and

its current state of knowledge. At the same time, we believe that the scientific community should vigorously pursue the 3Rs of the alternatives approach, namely, reduction, refinement, and replacement, as well as carefully evaluate proposed animal research for consistency with society's increasing ethical concern for animals and science's highest standards.

Regardless of our policy, we object to characterizations of animal activists as anti-science, anti-intellectual, and anti-rational. Demands for animal protection are grounded in well-established, rational, philosophical debate. Scientists themselves have participated in this debate and should realize that differences in moral judgment occur and do not imply that the other side has abandoned rational argument. Nor is it appropriate to state that protestors' rationality is compromised by their emotional investment in the issues.

Holden suggests that a fundamental fear is that critics aim to limit scientific freedom and progress. Yet other attempts to regulate scientists, such as efforts to control research fraud, are not labeled as "anti-science" or "anti-intellectual." Scientists accept some

limits to their freedom, as do all humans, when they recognize the need to weigh freedom of inquiry against other values held by society. Emotions can run high when attempting to balance contrasting values, but neither side gains by hurling invectives.

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Erratum: Table 1 of the report "Reversible cleavage and ligation of hepatitis delta virus RNA" by H.-N. Wu and M. M. C. Lai (3 Feb., p. 652) contained an error. The religation percentage when the concentration of Mg^{2+} in the cleavage reaction was 2.4 mM and the concentration of EDTA was 3.0 mM should have been 10. The correct table is printed below.

EDTA (mM)	Religation (%) when Mg^{2+} in cleavage reaction is		
	7.2 mM	4.8 mM	2.4 mM
0	0	0	0
1.5	0	0	0
3.0	0	0	10
6.0	0	14	10
12.0	13	13	11
24.0	15	15	13
60.0	16	14	16

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