

globally synchronous extinction of so poorly distributed a fossil type as late Cretaceous dinosaurs has been proven (prediction 14) or that the dinosaurs' extinction can be precisely correlated with the much-better-defined marine extinctions. In fact one of the conclusions of the Os isotope study was that the marine and continental isotope signatures, if cosmic, would have to be derived from separate impact events.³ This finding, along with the recognition by impact proponents of the need for multiple events, would seem to make prediction 6, the synchronicity of plant and animal extinctions, a moot point.

In summary, 8 of the 15 tests offered in support of the impact extinction hypothesis seem either mutually contradictory or in conflict with the multiple-impact hypothesis, probably the only impact scenario consistent with the periodic extinction events alluded to in prediction 15. Other tests, such as the description of the K-T spherules as high-temperature artifacts of an impact event, appear to have been evaluated prematurely. Despite these inconsistencies, the impact hypothesis remains a stimulating and viable, although still unproven, theory.

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5/88

After reading the letters about the bolide impact at the Cretaceous-Tertiary boundary and Luis Alvarez's response in the January issue, I see no more urgent need than for a few complete scientists. Outside of their disciplines, most scientists are hopelessly lost. The case for the impact at the extinction boundary is well made, but the consequences for life on Earth

are not completely understood. Until and unless scientists show the proper respect for each other's disciplines, a more accurate understanding of the Earth's history will elude them.

I would say that the iridium layer is best explained by Alvarez's impact theory, but it does not follow that the extinction event is solely explained by the impact. Alvarez must be satisfied to offer the paleontologists his new evidence of major climatic upheaval and let them run with it for a while. The paleontologists must be willing to consider the impact along with the fossil record to come up with a clearer picture of what died when, and why.

Life on Earth has survived despite the Sun's gradual warming, despite the Earth's tectonic activity and despite occasional collisions with solar system debris. The true understanding of how this marvelous story unfolded will require much hard interdisciplinary study. Unfortunately there are too few scientists, paleontologists in this case, who can look at new evidence as a chance for increased understanding. Instead most scientists become overprotective of their pet theories. Yet Alvarez has made the mistake of treating the impact not merely as new evidence, but as the entire answer to a problem that is largely beyond his area of expertise.

Also, regarding Sanford Aranoff's letter and Alvarez's response, what could be more absurd than to plan to protect ourselves from a bolide impact, an event that occurs "only every 100 million years or so"? Instead of wasting their time on such an improbable extinction event, those "many scientists" who have studied it would be better put to studying the current mass extinction episode caused by *Homo sapiens*!

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2/88
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(Editor's note: Luis Alvarez died on 1 September. His illness prevented him from replying to these letters.)

Book Review Rebuttal

I am writing to correct certain misunderstandings and errors in the review by S. James Gates of my book *Introduction to Supersymmetry and Supergravity* (World Scientific, Singapore, 1986) in the November 1987 issue (page 92). The curious opening sentence, "Through the cooperation of a number of researchers . . .," is a result of Gates's confusing the book he

was reviewing with another book I have written with Peter van Nieuwenhuizen (to be published by Cambridge U.P.). The relation between these works is clearly stated on page 1 of the former book.

Midway through the third paragraph the review states, "Unfortunately, West's discussion of the superconformal algebra contains an error that causes a problem in a later 'proof' of the finiteness of $N=4$ Yang-Mills theory." Chapter 2 of my book gives the equations that make up the superconformal algebra. The two equations Gates is referring to are

$$[Q^{\alpha i}, A] = -i(\gamma_5)^{\alpha}_{\beta} c Q^{\beta i}$$

$$\{Q^{\alpha i}, S^{\beta j}\} = \dots + d 4i(\gamma_5 C^{-1})^{\alpha\beta} \delta^{ij} A$$

I give the values

$$c = -(N-4)/4N, \quad d = 1$$

while a book of which Gates is coauthor¹ gives

$$c = 1, \quad d = -(N-4)/4N$$

The reader will notice that these two choices are related, except for $N=4$, by a *redefinition* of the generator A . For $N=4$, the Jacobi identities imply that $cd=0$. The case $N=4$ is not discussed in chapter 2 of my book; however, clearly one can obtain either $c=0$ or $d=0$ by rescaling A before setting $N=4$. Gates and his coauthors insist in their book that $c=1$ and $d=0$. However, both choices lead to a consistent algebra. Following the method given in chapter 14 of my book, one easily finds that both possible algebras admit faithful superspace representations. In short, there is no error.

In chapter 18 of my book, one of the arguments for the finiteness of $N=4$ Yang-Mills theories uses the well-known fact that the maximal symmetry this theory can admit is $SU(4)$ and not $U(4)$. Clearly, because the ± 1 helicity states are in the same supermultiplet, the case $c \neq 0$ is precluded. If one takes $c=0$, then, as discussed in my book, A must be trivially realized. There is no problem here either. In fact, recent work has established the anomalies argument for finiteness as perhaps the most rigorous one.

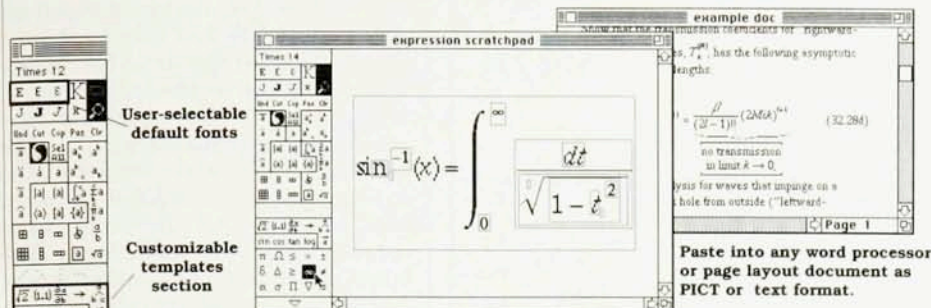
Let us now turn to Gates's reference in the review to my "discussion of the patently false notion of a finite set of auxiliary fields." This comment relates to my chapter 22, which discusses the now widely used result^{2,3} for the free gauge covariant bosonic string action, namely QXX. In reference 2 this result was found by

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$$= A_{|\alpha_1 \dots \alpha_p|} \delta_{\gamma_1 \dots \gamma_p \beta_1 \dots \beta_q}$$

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va-de me-cum (vā'dē mē'kəm, vā'dē mā'-) *n., pl. vade mecums.* 1. A useful thing that a person constantly carries with him. 2. A book, such as a guidebook, for ready reference. [Lat., go with me.]*

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*Source: *The American Heritage Dictionary*, 2nd ed. (Boston: Houghton Mifflin Company, 1982), p. 1134.

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working systematically from the Virasoro constraints, one step on the way being a formulation involving a finite number of fields. It was by using this method that the analogous result for superstrings was first found.⁴ It is not known whether the finite set correctly describes the on-shell states of string theory. However, the mismatch in supplementary fields with the XQX formulation begins at the fourth mass level, while it is known that the count of the finite set is correct up to the tenth level. The counting procedure is rather subtle: It involves hidden symmetries, which appear to arise from gauge fixing, and corresponding ghosts for ghosts; above the tenth level it may require Nielson-Kallosh ghosts. It is far from a trivial matter, and in my opinion there does not exist a convincing argument one way or the other.

The other criticisms Gates makes involve presentation and content and are somewhat subjective. He is of course entitled to his opinion, which is reflected in the differences in the way our two books are written. However, I would thank him for some of the agreeable statements he makes.

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2/88

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Corrections

September, page 37—The table should have included the following source note: "The first three questions are from a survey of 1273 adult Americans that Louis Harris and Associates conducted in October and November 1986 for the US Office of Technology Assessment, published as 'Public Attitudes Toward Science, Biotechnology and Genetic Engineering,' 9 January 1987. The second three questions are from a poll done by Jon D. Miller, director of the Public Opinion Laboratory at Northern Illinois University, for the National Science Board, published in *Science and Engineering Indicators—1987*, Washington, DC, 1987."

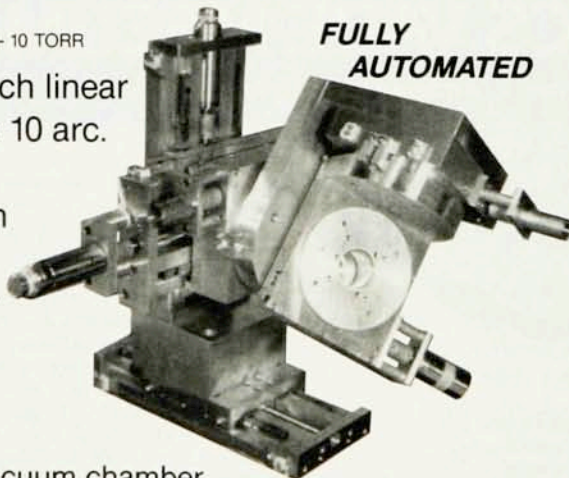
August, part 1, page 31—The second sentence of the figure caption should have read, "The expansion of the universe was taken into account." ■

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