Sokal's Hoax

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Like many other scientists, I was amused by news of the prank played by the NYU mathematical physicist Alan Sokal. Late in 1994 he submitted a sham article to the cultural studies journal Social Text, in which he reviewed some current topics in physics and mathematics, and with tongue in cheek drew various cultural, philosophical and political morals that he felt would appeal to fashionable academic commentators on science who question the claims of science to objectivity.

The editors of Social Text did not detect that Sokal's article was a hoax, and they published it in the journal's Spring/Summer 1996 issue.1 The hoax was revealed by Sokal in an article for another journal, Lingua Franca;2 he explained that his Social Text article had been "liberally salted with nonsense," and in his opinion was accepted only because "(a) it sounded good and (b) it flattered the editors' ideological preconceptions." Newspapers and newsmagazines throughout the U.S. and Britain carried the story. Sokal's hoax may join the small company of legendary academic hoaxes, along with the pseudo-fossils of Piltdown man planted by Charles Dawson and the pseudo-Celtic epic Ossian written by James Macpherson. The difference is that Sokal's hoax served a public purpose, to attract attention to what Sokal saw as a decline of standards of rigor in the academic community, and for that reason it was unmasked immediately by the author himself.

The targets of Sokal's satire occupy a broad intellectual range. There are those "postmoderns" in the humanities who like to surf through avant garde fields like quantum mechanics or chaos theory to dress up their own arguments about the fragmentary and random nature of experience. There are those sociologists, historians, and philosophers who see the laws of nature as social constructions. There are cultural critics who find the taint of sexism, racism, colonialism, militarism, or capitalism not only in the practice of scientific research but even in its conclusions. Sokal did not satirize creationists or other religious enthusiasts who in many parts of the world are the most dangerous adversaries of science,3 but his targets were spread widely enough, and he was attacked or praised from all sides.

Entertaining as this episode was, from press reports I could not immediately judge what it proved. Suppose that, with tongue in cheek, an economist working for a labor union submitted an article to the National Review, giving what the author thought were false economic arguments against an increase in the statutory minimum wage. What would it prove if the article were accepted for publication? The economic arguments might still be cogent, even though the author did not believe in them.

I thought at first that Sokal's article in Social Text was intended to be an imitation of academic babble, which any editor should have recognized as such. But in reading the article I found that this is not the case. The article expresses views that I find surreal, but with a few exceptions Sokal at least makes it pretty clear what these views are. The article's title "Transgressing the Boundaries - Toward a Transformative Hermeneutics of Quantum Gravity," is more obscure than almost anything in his text. (A physicist friend of mine once said that in facing death, he drew some consolation from the reflection that he would never again have to look up the word "hermeneutic" in the dictionary.) I got the impression that Sokal finds it difficult to write unclearly.

Where the article does degenerate into babble, it is not in what Sokal himself has written, but in the writings of the genuine postmodern cultural critics quoted by Sokal. Here, for instance, is a quote that Sokal takes from the oracle of deconstructionism, Jacques Derrida:

> The Einsteinian constant is not a constant, is not a center. It is the very concept of variability -- it is, finally, the concept of the game. In other words, it is not the concept of something -- of a center starting from which an observer could master the field -- but the very concept of the game.

I have no idea what this is intended to mean.

I suppose that it might be argued that articles in physics journals are also incomprehensible to the uninitiated. But physicists are forced to use a technical language, the language of mathematics. Within this limitation, we try to be clear, and when we fail we do not expect our readers to confuse obscurity with profundity. It never was true that only a dozen people could understand Einstein's papers on general relativity, but if it had been true, it would have been a failure of Einstein's, not a mark of his brilliance. The papers of Edward Witten, which are today consistently among the most significant in the promising field of string theory, are notably easier for a physicist to read than most other work in string theory. In contrast, Derrida and other postmoderns do not seem to be saying anything that requires a special technical language, and they do not seem to be trying very hard to be clear. But those who admire such writings presumably would not have been embarrassed by Sokal's quotations from them.

Part of Sokal's hoax was in his description of developments in physics. Much of it was quite accurate, but it was heavily adulterated with howlers, most of which would have been detected by any undergraduate physics major. One of his running jokes had to do with the word "linear." This word has a precise mathematical meaning, arising from the fact that certain mathematical relationships are represented graphically by a straight line.4 But for some postmodern intellectuals, "linear" has come to mean unimaginative and old-fashioned, while "nonlinear" is understood to be somehow perceptive and avant garde. In arguing for the cultural importance of the quantum theory of gravitation, Sokal refers to the gravitational field in this theory as "a noncommuting (and hence nonlinear) operator."5 Here "hence" is ridiculous; "noncommuting" does not imply "nonlinear," and in fact quantum mechanics deals with things that are both noncommuting and linear.

Sokal also writes that "Einstein's equations [in the general theory of relativity] are highly nonlinear, which is why traditionally trained mathematicians find them so difficult to solve." The joke is in the words "traditionally trained;" Einstein's equations are nonlinear, and this does make them hard to solve, but they are hard for anyone to solve, especially someone who is not traditionally trained. Continuing with general relativity, after correctly remarking that its description of curved spacetime allows arbitrary changes in the spacetime coordinates that we use to describe nature, Sokal solemnly pronounces that "the pi of Euclid and the G of Newton, formerly thought to be constant and universal, are now perceived in their ineluctable historicity." This is absurd -- the meaning of a mathematically defined quantity like pi cannot be affected by discoveries in physics, and in any case both pi and G continue to appear as universal constants in the equations of general relativity.

In a different vein, Sokal gives serious consideration to a crackpot fantasy, known as the "morphogenetic field." He refers to complex number theory as a "new and still quite speculative branch of mathematical physics," while in fact it is nineteenth century mathematics and as well established as anything ever gets. He even complains (echoing the sociologist Stanley Aronowitz) that all of the graduate students in solid state physics will be able to get jobs in that field, which will be news to many of them.

Sokal's revelation of his intentional howlers drew the angry response that he had abused the trust of the editors of Social Text in his credentials as a physicist, a complaint made by both sociologist Steve Fuller and English professor Stanley Fish.6 (Fish is the executive director of the Duke University Press, which publishes Social Text, and is reputed to be the model for Morris Zapp, the master of the academia game in David Lodge's comic novels.) The editors of Social Text7 also offered the excuse that it is not a refereed journal, but a journal of opinion. Maybe under these circumstances Sokal was naughty in letting the editors rely on his sincerity, but the article would not have been very different if Sokal's account of physics and mathematics had been entirely accurate. What is more revealing is the variety of physics and mathematics bloopers in remarks of others that Sokal quotes with sly mock approval. Here is the philosopher Bruno Latour on special relativity:

> How can one decide whether an observation made in a train about the behavior of a falling stone can be made to coincide with the observation of the same falling stone from the embankment? If there are only one, or even two, frames of reference, no solution can be found ... Einstein's solution is to consider three actors...

This is wrong; in relativity theory there is no difficulty in comparing the results of two, three, or any number of observers. In other quotes Stanley Aronowitz misuses the term "unified field theory;" feminist theorist Luce Irigaray

deplores mathematicians' neglect of spaces with boundaries, though there is a huge literature on the subject; English professor Robert Markley calls quantum theory nonlinear, though it is the only known example of a precisely linear theory; and both philosopher Michael Serres (a member of the Academie Francaise) and arch-postmodern Jean-Fran^�ois Lyotard grossly misrepresent the view of time in modern physics. Such errors suggest a problem not just in the editing practices of Social Text, but in the standards of a larger intellectual community.

It seems to me though that Sokal's hoax is most effective in the way that it draws cultural or philosophical or political conclusions from developments in physics and mathematics. Again and again Sokal jumps from correct science to absurd implications, without the benefit of any intermediate reasoning. With a straight face, he leaps from Bohr's observation that in quantum mechanics "a complete elucidation of one and the same object may require diverse points of view which defy a unique description" to the conclusion that "postmodern science" refutes "the authoritarianism and elitism inherent in traditional science." He blithely points to catastrophe theory and chaos theory as the sort of mathematics that can lead to social and economic liberation. Sokal shows that people really do talk in this way by quoting work of others in the same vein, including applications of mathematical topology to psychiatry by Jacques Lacan and to film criticism by Jacques-Alain Miller.

I find it especially disturbing that the editors of Social Text thought it plausible that a sane working physicist would take the positions satirized by Sokal. In their defense of the decision to publish Sokal's article, the editors explain that they had judged that it was "the earnest attempt of a professional scientist to seek some sort of affirmation from postmodern philosophy for developments in his field."8 In an introduction to the issue of Social Text in which Sokal's article appears, one of the editors mentions that "many famous scientists, especially physicists, have been mystics."9 There may be some working physicists who are mystics, though I have never met any, and I can't imagine any who holds views as bizarre as those that Sokal satirized. The gulf of misunderstanding between scientists and other intellectuals seems to be at least as wide as when C. P. Snow worried about it three decades ago.

After Sokal exposed his hoax, one of the editors of Social Text even speculated that "Sokal's parody was nothing of the sort, and that his admission represented a change of heart, or a folding of his intellectual resolve."10 I am reminded of the case of the American spiritualist Margaret Fox. When she confessed in 1888 that her career of seances and spirit rappings had all been a hoax, other spiritualists claimed that it was her confession that was dishonest.

Those who seek extrascientific messages in what they think they understand about modern physics are digging dry wells. I think that, with two large exceptions, the results of research in physics (as opposed, say, to psychology) have no legitimate implications whatever for culture or politics or philosophy. (I am not talking here about the technological applications of physics, which of course do have a huge effect on our culture, or about its use as metaphor, but about the direct implications of purely scientific discoveries themselves.) The conclusions of physics may become relevant to philosophy and culture when we learn the origin of the universe or the final laws of nature, but not for the present.

The first of my exceptions to this statement is jurisdictional: discoveries in science sometimes reveal that topics (like matter, space and time) that had been thought to be proper subjects for philosophical argument actually belong in the province of ordinary science. The other, more important, exception to my statement is the profound cultural effect of the discovery, going back to the work of Newton, that nature is strictly governed by impersonal mathematical laws. Of course, it still remains for us to get the laws right, and to understand their range of validity; but as far as culture or philosophy are concerned the difference between Newton's or Einstein's theories of gravitation or between classical and quantum mechanics is immaterial.

There is a good deal of confusion about this, because quantum mechanics can seem pretty eerie if described in ordinary language. Electrons in atoms do not have definite velocities or positions until these properties are measured, and the measurement of an electron's velocity wipes out all knowledge of its position. This eeriness has led Andrew Ross, one of the editors of Social Text, to remark elsewhere that "Quantitative rationality -- the normative description of scientific materialism -- can no longer account for the behavior of matter at the level of quantum reality."11 This is simply wrong. By rational processes today we obtain a complete quantitative description of atoms in terms of what is called the wave function of the atom.12 Once one has calculated the wave function, it can be used to answer any question about the energy of the atom or its interaction with light. We have replaced the

precise Newtonian language of particle trajectories with the precise quantum language of wave functions, but as far as quantitative rationality is concerned, there is no difference between quantum mechanics and Newtonian mechanics.

I have to admit at this point that physicists share responsibility for the widespread confusion about such matters. Sokal quotes some dreadful examples of Werner Heisenberg's philosophical wanderings, as for instance: "Science no longer confronts nature as an objective observer, but sees itself as an actor in this interplay between man and nature." (Heisenberg was one of the great physicists of the twentieth century, but he could not always be counted on to think carefully, as shown by his technical mistakes in the German nuclear weapons program.13) More recently scientists like Ilya Prigogine have claimed14 a deep philosophical significance for work on nonlinear dynamics,15 a subject that is interesting enough without the hype.

So much for the cultural implications of discoveries in science. On the other side of the coin are the implications for science of its cultural and social context. Here scientists like Sokal find themselves in opposition to many sociologists, historians, and philosphers as well as postmodern literati. In this debate, the two sides often seem to be talking past each other. For instance, the sociologists and historians sometimes write as if scientists had not learned anything about the scientific method since the days of Francis Bacon, while of course we know very well how complicated the relation is between theory and experiment, and how much the enterprise of science depends on an appropriate social and economic setting. On the other hand, scientists sometimes accuse others of taking a completely relativist view, of not believing in objective reality. With dead seriousness, Sokal's hoax cites "revisionist studies in the history and philosophy of science" as casting doubt on the post-Enlightenment dogma that "there exists an external world, whose properties are independent of any individual human being and indeed of humanity as a whole." The trouble with this satire is that most of Sokal's targets deny that they have any doubt about the existence of an external world. Their belief in objective reality was reaffirmed in response to Sokal's hoax both in a letter to the New York Times by the editors of Social Text16 and in the op-ed article by Stanley Fish.

I don't mean to say that this part of Sokal's satire was unjustified. His targets often take positions that seem to me (and I gather to Sokal) to make no sense if there is an objective reality. To put it simply, if scientists are talking about something real, then what they say is either true or false. If it is true, then how can it depend on the social context of the scientist? If it is false, how can it help to liberate us? The choice of scientific question and the method of approach may depend on all sorts of extrascientific influences, but the correct answer when we find it is what it is because that is the way the world is. Nevertheless, it does no good to satirize views that your opponent denies holding.

I have run into the same sort of stumbling block myself. In an early draft of my book Dreams of a Final Theory,17 I criticized the feminist philosopher of science, Sandra Harding (one of the contributors to Social Text), for taking a relativist position that denied the objective character of physical law. In evidence I quoted her as calling modern science (and especially physics) "not only sexist but also racist, classist, and culturally coercive," and arguing that "Physics and chemistry, mathematics and logic, bear the fingerprints of their distinctive cultural creators no less than do anthropology and history."18 It seemed to me that this statement could make sense only to a relativist; what is the good of wishing that the conclusions of scientific work were friendlier to multicultural or feminist concerns if these conclusions are to be an accurate account of objective reality? I sent a copy of this part of my draft to Harding, who pointed out to me various places in her writing where she had explicitly denied taking a relativist position. I took the easy way out; I dropped the accusation of relativism, and left it to the reader to judge the implications of her remarks.

Perhaps it would clarify what is at issue if we were to talk, not about whether nature is real, but about the more controversial question, whether scientific knowledge in general, and the laws of physics in particular, are real.

When I was an undergraduate at Cornell I heard a lecture by a professor of philosophy (probably Max Black) who explained that whenever anyone asked him whether something was real, he always gave the same answer. The answer was "Yes." The tooth fairy is real, the laws of physics are real, the rules of baseball are real, and the rocks in the fields are real. But they are real in different ways. What I mean when I say that the laws of physics are real is that they are real in pretty much the same sense (whatever that is) as the rocks in the fields, and not in the same sense (as implied by Fish19) as the rules of baseball -- we did not create the laws of physics or the rocks in the field,

and we sometimes unhappily find that we have been wrong about them, as when we stub our toe on an unnoticed rock, or when we find we have made a mistake (as most physicists have) about some physical law. But the languages in which we describe rocks or in which we state physical laws are certainly created socially, so I am making an implicit assumption (which in everyday life we all make about rocks) that our statements about the laws of physics are in a one- to-one correspondence with aspects of objective reality. To put it another way, if we ever discover intelligent creatures on some distant planet and translate their scientific works, we will find that we and they have discovered the same laws.

There is another complication here, that none of the laws of physics known today (with the possible exception of the general principles of quantum mechanics) are exactly and universally valid. Nevertheless, many of them have settled down to a final form, valid in certain known circumstances. The equations of electricity and magnetism that are today known as Maxwell's equations are not the equations originally written down by Maxwell; they are equations that physicists settled on after decades of subsequent work by other physicists, notably Oliver Heaviside. They are understood today to be an approximation that is valid in a limited context (that of weak slowly-varying electric and magnetic fields), but in this form and in this limited context they have survived for a century and may be expected to survive indefinitely. This is the sort of law of physics that I think corresponds to something as real as anything else we know. This appears to be a point where scientists like Sokal and myself are in clear disagreement with some of those that Sokal satirizes. The objective nature of scientific knowledge has been denied by Andrew Ross20 and Bruno Latour21 and (as I understand them) by the influential philosophers Richard Rorty and the late Thomas Kuhn,22 but it is taken for granted by most natural scientists.

I have come to think that the laws of physics are real because my experience with the laws of physics does not seem to me to be very different in any fundamental way from my experience with rocks. For those who have not lived with the laws of physics, I can offer the obvious argument that the laws of physics as we know them work, and there is no other known way of looking at nature that works in anything like the same sense. Sarah Franklin (in an article in the same issue of Social Text as Sokal's hoax) challenges an argument of Richard Dawkins, that in relying on the working of airplanes we show our acceptance of the working of the laws of nature, remarking that some airlines show prayer films during take-off to invoke the aid of Allah to remain safely airborne.23 Does Franklin think that Dawkin's argument does not apply to her? If so, would she be willing to give up the use of the laws of physics in designing aircraft, and rely on prayers instead?

There is also the related argument that, although we have not yet had a chance to compare notes with creatures on a distant planet, we can see that on Earth the laws of physics are understood in the same way by scientists of every nation, race, and -- yes -- gender. Some of the commentators on science quoted by Sokal hope that the participation of women or victims of imperialism will change the character of science, but as far as I can see, women and third-world physicists work in just the same way as Western white male physicists do. It might be argued that this is just a sign of the power of entrenched scientific authority or the pervasive influence of Western society, but these explanations seem unconvincing to me. Although natural science is intellectually hegemonic, in the sense that we have a clear idea of what it means for a theory to be true or false, its internal operation is not hegemonic -- authority counts for very little.

From time to time distinguished physicists who are past their best years, like Heisenberg in Germany in the 1950s or De Broglie in France, have tried to force physics in the direction of their own ideas; but where such mandarins succeed at all, it is only in one country, and only for a limited time. The direction of physics today is overwhelmingly set by young physicists, who are not yet weighed down with honors or authority, and whose influence - - the excitement they stir up -- stems from the objective progress that they are able to make. If our expression of the laws of nature is socially constructed, it is constructed in a society of scientists that evolves chiefly through grappling with nature's laws.

Some historians do not deny the reality of the laws of nature, but nevertheless refuse to take present scientific knowledge into account in describing the scientific work of the past.24 This is partly to avoid anachronisms, like supposing that scientists of the past ought to have seen things in the way we do, and partly out of a preoccupation with maintaining the intellectual independence of historians.25 Of course, in judging the work of past scientists, it is silly to suppose that they ought to have seen things the way we do. The problem is that if we try to avoid this sort of anachronism by ignoring present scientific knowledge, we give up clues to the past that cannot be obtained in any

other way. In the late 1890s J. J. Thomson carried out a celebrated series of measurements of the ratio of the electron's mass and charge, and though the values he found were spread over a wide range, he persistently emphasized measurements that gave results at the high end of the range. The historical record alone would not allow us to decide whether this was because these results tended to confirm his first measurement, or because these were actually more careful measurements. Why not use the clue that the second alternative is unlikely because the large value that was favored by Thomson is almost twice what we know today as the correct value?

A historian of science who ignores our present scientific knowledge seems to me like a historian of U.S. military intelligence in the Civil War, who tells the story of McClellan's retreat from the Virginia peninsula in the face of what McClellan thought were overwhelming Confederate forces, without taking into account our present knowledge that McClellan was wrong. Even the choice of topics that attract the interest of historians has to be affected by what we now know were the paths that led to success. What Herbert Butterfield called the Whig interpretation of history is legitimate in the history of science in a way that it is not in the history of politics or culture, because science is cumulative, and permits definite judgments of success or failure.

Sokal was not the first to visit these issues,26 but he has done a great service in raising them so dramatically. They are not entirely academic issues, in any sense of the word "academic." If we think that the discoveries of science are flexible enough to respond to the social context of their discovery, then we may be tempted to press scientists to see nature in a way that is more proletarian or feminine or American or religious or whatever else it is we want. This is a dangerous path, and more is at stake in the controversy over it than just the health of science. As I mentioned earlier, our civilization has been powerfully affected by the discovery that nature is strictly governed by impersonal laws. As an example I like to quote the remark of Hugh Trevor-Roper, that one of the early effects of this discovery was to reduce the enthusiasm for burning witches. We will need to confirm and strengthen the vision of a rationally understandable world to guard us from the irrationalities that still beset humanity.

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Footnotes

1 Alan D. Sokal, "Transgressing the Boundaries - Toward a Transformative Hermeneutics of Quantum Gravity," Social Text 46/47, 217-252 (1996).

2 Alan D. Sokal, "A Physicist Experiments with Cultural Studies," Lingua Franca May/June, 62-64 (1996).

3 In an afterword, "Transgressing the Boundaries," submitted to Social Text, Sokal explained that his goal was not so much to defend science, as to defend the Left from postmodernists, social constructivists, and other trendy leftists.

4 For instance, there is a linear relation between the number of calories in a cake and the amounts of each of the various ingredients: The graph of calories verses ounces of any one ingredient, holding the amounts of all the other ingredients fixed, is a straight line. In contrast, the relation between the diameter of a cake (of fixed height) and the amounts of its ingredients is not linear.

5 Operations are said to be noncommuting if the result when you perform several of them depends on the order in which they are performed. For instance, rotating your body by, say, thirty degrees around the vertical axis and then rotating it by thirty degrees around the north-south direction leaves you in a different position than these

operations would if they were carried out in the opposite order. Try it and see.

6 Steve Fuller, letter to The New York Times, May 23, 1996, page 28, and Stanley Fish, "Professor Sokal's Bad Joke," Op-Ed article in The New York Times, May 21, 1996, page 23..

7 Bruce Robbins and Andrew Ross, "Mystery Science Theater," Lingua Franca (July/August 1996).

8 Bruce Robbins and Andrew Ross, "Mystery Science Theater."

9 Andrew Ross, "Introduction," Social Text 46/47, 1-13 (1996).

10 Quoted by Bruce Robbins and Andrew Ross in "Mystery Science Theater."

11 Andrew Ross, Strange Weather (Verso, London, 1991), p. 42.

12 In general, the wave function of any system is a list of numbers, one number for every possible configuration of the system. For a single electron in an atom, the list includes a different number for each possible position of the electron. These numbers give a complete description of the state of the system. One complication is that the possible configurations of any system can be described in different ways; for instance, an electron could be described in terms of its possible velocities, rather than its possible positions (but not by both at the same time). There are well-understood rules for calculating the numbers making up the wave function in one description if we know what these numbers are in any other description. Another complication is that these numbers are complex, in the sense that they generally involve the quantity known as i, equal to the square root of minus one, as well as ordinary real numbers.

13 See Jeremy Bernstein, Hitler's Uranium Club (American Institute of Physics, Woodbury, NY, 1995).

14 For quotes and comments, see Jean Bricmont, "Science of Chaos or Chaos in Science?" Physicalia Magazine 17, 159-208 (1995), reprinted in The Flight from Science and Reason (New York Academy of Sciences, New York, (1996). A rejoinder and response are given by Ilya Prigogine and I. Antoniou, "Science of Chaos or Chaos in Science: A Rearguard Battle," Physicalia Magazine 17, 213-218 (1995); Jean Bricmont, "The Last Word from the Rearguard," ibid., 219-221.

15 Nonlinear dynamics deals with cases in which the rates of change of various quantities depend nonlinearly on these quantities. For instance, the rates of change of the pressures, temperatures, and velocities at various points in a fluid like the atmosphere depend nonlinearly on these pressures, temperatures, and velocities. It has been known for almost a century that the long-term behavior of such systems often exhibits chaos, an exquisite sensitivity to the initial condition of the system. (The classic example is the way that the flapping of a butterfly's wings can change the weather weeks later throughout the world.) For physicists, the current interest in nonlinear dynamical systems stems from the discovery of general features of chaotic behavior that can be precisely predicted.

16 Bruce Robbins and Andrew Ross, letter to The New York Times, May 23, 1996, page 28.

17 Pantheon, 1993.

18 Sandra Harding, The Science Question in Feminism, (Cornell University Press, Ithaca, 1986), pp. 9, 250.

19 Fish, "Professor Sokal's Bad Joke."

20 Andrew Ross was quoted by the New York Times on May 18, 1996, to the effect that "scientific knowledge is affected by social and cultural conditions and is not a version of some universal truth that is the same in all times and places."

21 Bruno Latour, Science in Action (Harvard Press, Cambridge, 1987).

22 For instance, see Thomas Kuhn, "The Road Since Structure," in PSA 1990 (Philosophy of Science Association, 1991), and "The Trouble with the Historical Philosophy of Science," (1991 lecture published by the Department of the History of Science, Harvard University, 1992).

23 Sarah Franklin, "Making Transparencies -- Seeing Through the Science Wars," Social Text 46/47, 141-155 (1996).

24 This point of view was expressed to me by the historian Harry Collins, then at the Science Studies Centre of the University of Bath.

25 In "Independence, Not Transcendence, for the Historian of Science," ISIS 82, 71 (1991), Paul Forman called for historians to exercise an independent judgement not just of how scientific progress is made, but even of what constitutes scientific progress.

26 See especially Gerald Holton, Science and Anti-Science (Harvard University Press, Cambridge, 1993), and Paul R. Gross and Norman Levitt, Higher Superstition (Johns Hopkins Press, Baltimore, 1994). The issue of Social Text in which Sokal's hoax appeared was intended as a response to Gross and Levitt's book, which also according to Sokal inspired his hoax.