The Applicability of Mathematics as a Philosophical Problem

by Mark Steiner

CAMBRIDGE, MA. HARVARD UNIVERSITY PRESS, 1998. viii + 215 PP. US$xx.xx, ISBN 0-674-04097-X (alk. paper)

REVIEWED BY RICHARD CONN HENRY

How large and how significant a problem dare you tackle in your research?

Astronomers (such as myself) have it easy: there are lots of easily answerable questions to be asked, and, in addition, astronomy *has* produced some *big* answers. Having your cake and eating it too! However, the danger for astronomers is that it is all too easy to disappear into the endless small tractable publishable questions.

Some career choices are for bolder people: philosophers and theologians restrict themselves to big questions; questions so big, in fact, that they do not yield the same kind of progressive advance on which less ambitious investigators pride themselves. Or, at least, they have not *so far*.

Yet in this review, we find an astronomer commenting on a book by a philosopher. How can that be? It must be that the astronomer at some point gathered his courage, and went where astronomers are overwhelmingly too wise to go! Just so. In 1975, after a two-year stint as Deputy Director of the Astrophysics Division of NASA, I returned to The Johns Hopkins University, entirely cured of administritus, and ready to continue research in astronomy—and the teaching of physics.

Five years of teaching quantum mechanics—at the beginning, thinking (even as I "explained" it to the students), "What the hell am I talking about"; but at the end, wishing Feynman were alive and I could claim to him, "I understand quantum mechanics," and see what he said.

I felt like writing a book! However, not being that sure that I actually *did* understand quantum mechanics, I thought I'd better publish a *paper*, not a

book: "Quantum Mechanics Made Transparent," in the *American Journal of Physics*, November 1990. The paper was a joy to write (it was all in my head already), and a joy to work on, with the aid of four referees. Three referees dropped out early, but the final referee worked with me long and hard, for which I am very grateful.

Then I sat back, expecting and hoping to be punched in the nose. But nothing happened. Nine years passed. Then, just a few weeks ago, an agent walked into my office and asked if I wanted to write a book. In a few short weeks I was (and am) under contract, and in 2000 you will be able to read *The Universe Does Not Exist,* by Richard C. Henry.

Before signing the contract, I went to the Science Citation Index. Not a single citation of my paper in nine years. A few days after the contract was signed, an e-mail from Jet Wimp asking if I would write the present book review. Anything for a laugh: yes, of course! A few later, I looked in the book's index. My God! Turn to page 177: "...the following "derivation" of quantum mechanics, which was inspired by, and resembles, that of Henry 1990…!" Referred to at last and by a Professor of Philosophy at the Hebrew University of Jerusalem!

So, what is Mark Steiner's book about? "My claim is that an anthropocentric policy was a necessary factor in discovering today's fundamental physics … that ours appears to be an intellectually "user friendly" universe, a universe which allows our species to discover things about it—I mean this claim to stand as an empirical hypothesis, and as the conclusion of this book."

Steiner is practicing *metaphysics*, the investigation of what lies behind the so-called laws of physics. Well, to let the cat out of the bag, so am I practicing metaphysics. With reference to my paper on QM (the only substantial paper on the subject that I have ever published), Steiner says, "Henry's aim was completely different from mine. His treatment was meant for the classroom, to persuade students that QM is 'inevitable.' Needless to say, I dissociate myself from that goal." *AJP* is a pedagogical journal, and indeed, pedagogy was one of my aims. But in fact the paper is a perfect example of Steiner's own thesis, which he expresses thus: "my goal in this book is to show in what way scientists have—quite recently and quite successfully—adopted an anthropocentric point of view in applying mathematics."

The genesis of my QM paper was anthropocentric. (No, better to say *noöcentric*; I will come back to this in a moment.) Having taught special relativity, I was overwhelmed with its simple logic and its *inevitability*. So, I made my first sally at changing the world: "Special Relativity Made Transparent," (1985), in which I first made use of Galileo's gang of three (Sagredo, etc.). To me, now, SR was not the least bit mysterious, but instead was necessary and inevitable: if you want what we call time in your Universe, there is no other way. And so, reasoning by mathematical analogy, I deduced that, improbable as it seemed at first blush, *QM must be vastly simple, and must be inevitable*. I set out to show that it is. If I succeeded, it may reinforce Steiner's thesis.

But *was* I successful? I am still by no means sure! I found no new physics (not that I was trying to, or expected to), and I knew the answer (QM) before I started. Now, when I am setting a physics test for students, I avoid questions of the type "given that …blah, blah, blah… show that $A = B$," because it is such hard work to grade: every student will write some stuff, followed by "therefore, A = B." I've done it myself, as an undergraduate. What I am worried about still, with my derivation of QM from scratch, is that knowing the answer, I of course darn well got there.

The reader is invited to check my story. The test is the following: if you could time-travel, and could visit with Newton in his old age, could you, guided by the strategy of my paper, induce Newton, by means of the Socratic method, to derive QM? My claim is that you could (although you would have to teach Ike matrices first.)

While I am worried that my approach may contain circular reasoning or worse, I am *not* worried about the fundamental idea. Someone of a more rigorous cast of mind is invited to re-do my work better. But that it can be done, I have no shard of doubt. My introductory material is right (I will not recapitulate it here), and QM itself is surely inevitable, independent of my paper. Steven Weinberg himself, it seems to me, established that fact by attempting to show that QM as we know it was *not* inevitable (Weinberg 1989), and failing (Weinberg 1992).

I have more than once read remarks (e.g., Weinberg 1992) about how the world could have been classical, but is not. That seems to me to be *not so*; the world surely *could not* have been classical. QM is the inevitable result

of simple symmetries. While the existence of the Universe is deeply mysterious, QM itself is not the least bit mysterious (Henry 1989).

My *quarrel* with Steiner is on two counts, on one of which I am much less radical than he is, and on one of which I am much more radical. It is clear, if somewhat puzzling (given his emphasis on anthropocentricism), that Steiner rejects what he calls "metaphysical Pythagoreanism, which simply identifies the Universe … with mathematical objects or structures." In these terms, I am a metaphysical Pythagorean. Indeed, I regard the case for this as overwhelming, and I regard society as being in a metastable situation with regard to accepting the fact. That is where I am (at the moment) more radical than Steiner. I am much more conservative than Steiner in that I see no evidence for a special role for the human species, just for life. Steiner himself refers to "minds like the human mind, if there are any." He is clearly referring to other worlds, but if he looks about, he will find elephants and cats. Their mathematics is rudimentary, but the differences between their minds and ours are small.

Steiner argues for the criterion of beauty in mathematics as anthropomorphic. But there is ugly mathematics (four-color theorem) that is correct. One can argue that a powerful selection effect is at work; mathematicians find it much easier to find the beautiful (typically, symmetric) theorems, than to find the ugly-but-true theorems. Also, to suggest that appreciation of what we call beauty is specifically human seems to me to be wrong; for example, we humans are at one with both the bees and the butterflies with regard to the beauty of the flowers.

Steiner shows how correct physics follows even from our *notation*, e.g. from Taylor series. Indeed, I was much struck, at first, how the Gaussian distribution arises so directly from a Taylor series expansion of ln(P). Why ln, I thought? Why not something else? But of course you can expand $P^{1/10}$ if you like; you will just have to include more terms to get as good an approximation to the Binomial Distribution, which is all that the Gaussian is, as you got with ln(P).

Steiner's book is very scholarly, but I am pleased to see joy and excitement leak in: "the consequences are startling … in order for angular momentum to be in the same Hilbert space as the other quantities, it must be quantized!" This is one of the most glorious things that I know. I think we need a more Hasidic physics: Sing the Torah of physics! Dance to express your joy!

Steiner quotes Pierce extensively; Pierce clearly felt the vibes of the Universe in his bones. Physics needs a Blake, someone who can fill our children with the power and the *beauty* of mathematical physics.

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