26

Conclusions

In the Preface to this book, we started with Alice and Bob having very different views of their observations. Alice used an optical telescope and reported nothing unusual about a distant galaxy that she could see. Bob, on the other hand, detected intense radio activity in that galaxy. Our question was: *who has the true view of that galaxy?*

We advised the reader that the answer is not *Alice*. Neither is it *Bob*. The answer is not *both of them*, nor is it *neither of them*. It is not a trick question either. So what is the answer that this book would supply?

Our answer will come presently.

While this book has set forth a definite mathematical perspective on empirical physics, it has contained quite a lot of commentary that might be disparaged as metaphysics or philosophy. Such commentary is generally frowned on in science, because it has no empirical content. It is vacuous.

In our defense, we point out the obvious: science is not a robotic activity; it is carried out by humans and these *are* driven by their metaphysical, philosophical, and emotional imperatives. For instance, the hard-core scientific view that quantum theory needs no interpretation but only application is itself a philosophy. It is no more than a conditioned response, based on opinion and subscription to current scientific norms. It is, indeed, a philosophy of how to do quantum mechanics. So we all do it, in one way or another. Our concern in this book is that the way that we do it should be based soundly on scientific principles. The quantized detector approach that we describe and use in this book is our attempt to do just that.

There is an excellent paper on all of this that has the provocative title "Quantum Theory Needs No Interpretation," by Fuchs and Peres (2000). It seems on the face of it to dismiss any sort of "interpretation" of quantum mechanics. In fact, close reading of it confirms (to us at least) the agenda that we have set out in this book. Yes, quantum mechanics needs no interpretation, *when it is being applied to processes that take place in the information void.*

https://doi.org/10.1017/9781009401432.027 Published online by Cambridge University Press

But in our view, that is only half the story. We cannot exclude the observer and what they are doing. The information void is contextual: it is defined by whatever observer is involved, and by the apparatus that they are using. Schwinger said just that (see his quote on this in Chapter 24). It has long seemed obvious to us that the idea expressed by Schwinger really points to an extension of what physics means. Physics cannot be just the study of systems under observation (SUOs). The relationship of observers to those SUOs and to the Universe in which both observers and SUOs are embedded should surely be just as important an issue in physics as the perceived properties of SUOs.

That naturally leads to the realization that the physics of *emergence* should be at least as important in physics as the reductionist agenda is currently. Our explanation as to why it is not so regarded currently is that it is *hard*, much harder than standard reductionist approaches to physics, which absolutely rely on and utilize emergent concepts, but place them firmly outside the scope of investigation.

Fortunately, human opinions on what is significant carry no weight in real science: nature has a tendency to tell us when we are being complacent. Markers of this are evident throughout quantum mechanics: the randomness of quantum outcomes, the nonlocality of quantum correlations, the violations of Bell and Leggett–Garg inequalities, quantum interference, state reduction, the Kochen–Specker theorem (Kochen and Specker, 1967), entanglement, and more.

That brings us back to Alice and Bob. It was not a trick question: it was not a proper question in the first place, because it is contextually incomplete.

As given, there was no indication for whom this question could have a truth value. If you say that it is you, the reader, then our response is: what sort of "truth" is it that deals with an invented scenario? Alice and Bob don't exist. They were invented in the Preface for the purposes of demonstrating a fundamental point.

It may seem a glib, cheap point, but it is not. It points to the fact that "truth" does not exist in a vacuum. It requires an observer for whom that "truth" is empirically meaningful.

Contextual incompleteness is invariably the main ingredient in a number of theoretical disciplines that purport to "explain" reality, but in fact are as fictional in their scientific content as our image of Alice and Bob is. That is the essential point behind the article of Fuchs and Peres, mentioned above. If we could, we would retitle their paper: *quantum theory needs no interpretation, it needs to be extended to cover the observer*. That is what this book is all about.

A final comment about Alice and Bob. Our answer is that each of them is stating the truth, but only relative to their individual contexts. In that sense they are both making contextually true statements. But that is not the same as saying they both have the "true" view of the galaxy they are observing: there is no "true" view of that galaxy in an absolute sense. Reality is far too deep for that.