

Preface

In a routine optical telescope scan of a distant galaxy, astronomer Alice saw nothing unusual. Her radio astronomer colleague Bob, however, reported intense radio activity in that galaxy. Who had the true view of the galaxy?

This is the sort of question discussed in this book. If you said that Bob had the “true” view of the galaxy, you would be quite normal. *Normal*, in the sense of *average*, or *typical*, or even *reasonable*. But if you went on to read the rest of this book and understand its main message, you might then give a different answer to that question.

It is not a trick question, however. The “correct” answer is **not** “*Alice has the true view of the galaxy.*” Neither is it “*Neither of them*” nor is it “*Both of them.*”

This preface is not the place to discuss possible alternative answers to the above question; you should be able to work one out based on the principles discussed in the main text of this book. Although the question is easy to state, the answer we give in the last chapter is simple neither to explain nor to justify. It is best discussed using a lot of words and rather sophisticated mathematical models and technologies. These are introduced, developed, and applied after intensive preliminary discussions of the issues concerned.

Our answer is intimately bound up with the *laws of observation* as they pertain to quantum processes, the subject matter of this book. These laws are the rules that underpin modern, empirically based perceptions of physical reality (our term for the world of experience).¹ It has taken over two thousand years of philosophical, natural philosophical, and empirical inquiry into the physical universe for some of these rules to be discovered, particularly the ones involving quantum processes. These latter have been understood for only the last hundred years or so, and what they mean is still an active subject of debate. The old question of how many angels can dance on the head of a pin is nothing compared with the question of what the wave function means in quantum mechanics.

The problem is that most rules of quantum mechanics are counter intuitive and may even appear wrong and unphysical to the person in the street. But then, quantum mechanics has appeared baffling ever since it was stumbled on by Planck in 1900. But as with Alice and Bob above, appearances can be deceptive:

¹ I don't imply there are other forms of reality. I can say nothing about that.

it is quantum mechanics that continues to give verified predictions, while our classical intuition, experience, and expectations all continue to be confounded.

It is my intention that this book be of value to a wide spectrum of readers: refined quantum theorists, philosophers of science, experimentalists, students, and the well-educated person in the street. If nothing else, I want to provoke readers in two ways: first, to question their own ingrained belief structures about the world they live in and second, to be alerted to the fact that there are a lot of speculative concepts and theories that are discussed by some scientists as if they were scientifically meaningful, when in reality they have no empirical basis whatsoever. I call these theories *vacuous* and they are dangerous, because they equate theory with empirical evidence. They lure the unsuspecting into unfounded quasi-religious modes of thinking that may be good science fiction but have no place in science proper. A sound interpretation of quantum mechanics really does matter, because that involves our perceptions of reality. After all is said and done, that is really what distinguishes us from other creatures and affects everything that we do.

This book is timely in two ways. First, after a century of attempts to understand quantum theory from a classical, noncontextual perspective, intense activity into the neurological basis of human psychology has started to reveal a starting truth: classical reality exists only in the mind. Every day, the results of new laboratory experiments demonstrate more and more convincingly just how misleading the classical perception of the world really is. We humans are now being shown up for what we are: we live in illusory worlds of our imaginations, constructed by our brains as they attempt to match the vast flood of sensory data streaming in through our senses with patterns of preconditioned rationalization.

Second, there is intense interest and work worldwide in the development of quantum computers. In this book I discuss the application of computer algebra to quantum registers containing many quantum bits (qubits). Although my focus in this book is on the description of quantum experiments, there will be a great overlap between quantum computation and that focus, so that I expect this book to be of some interest, and I hope value, to quantum computation theorists.

A preface is the place for an author to give their thanks and acknowledgment. Here are mine. First, I have been overawed by the fact that the underlying theme of this book, which is the debate about the nature of perception, has been going on for many centuries. Some of the views that I have read greatly impressed me and I realized that there were individuals who saw through the fog of conditioning that surrounds all of us. In particular, I greatly admire the works of David Hume, whose views about the nature of perception I found remarkably in tune with this book. As an undergraduate, I was greatly influenced by the lectures of Nicholas Kemmer. Later, I encountered the brilliant works of Julian Schwinger, and even had the great pleasure of meeting him and talking with him in 1993 in Nottingham and London, during the bicentenary celebrations of the

birth of George Green. These extraordinarily generous individuals in particular and many others influenced me in one way or another in the most significant of ways.

Finally, I express my gratitude to all members of my extended family, past and present. My parents gave me the opportunities to start writing and the arrival of my granddaughter Julia gave me the motivation to continue when that writing became tedious. Without them this book would not exist. In particular, my wife, Małgorzata, has been immensely supportive and helpful in all my efforts; I thank her for that and for her great patience.