

The Nature of Contingency

Quantum Physics as Modal Realism

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To Miranda, with love and gratitude for making ours the only world I want to inhabit.

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Preface

This book explores how the conceptual foundations of contemporary physics bear on some traditional metaphysical questions about the nature and structure of objective reality. The specific target of investigation is the metaphysics of modality—contingency, necessity, actuality, chance, and cognate notions—and the specific physical theory that is brought to bear is *Everettian quantum mechanics* (EQM), also known as the *many worlds interpretation*.

EQM is one of the most popular approaches to quantum mechanics amongst theoretical physicists. It is effectively presupposed by a large body of work in quantum cosmology. Unmodified quantum mechanics has passed every empirical test we have been able to devise, and recent experiments have further restricted the range of viable alternative theories by closing loopholes in tests of Bell correlations between entangled quantum systems.¹ In light of progress over the last four decades on the theory of *decoherence*, and of progress over the last two decades in understanding probability in the Everettian setting, EQM—more than ever—appears to be the most natural way to understand contemporary quantum physics. Its potentially radical consequences for metaphysics accordingly deserve examination.

When setting out his metaphysical project of Humean Supervenience, David Lewis memorably rejected the use of arguments from quantum mechanics in metaphysics:

I am not ready to take lessons in ontology from quantum physics as it now is. First I must see how it looks when it is purified of instrumentalist frivolity, and dares to say something not just about pointer readings but about the constitution of the world; and when it is purified of doublethinking deviant logic; and—most of all—when it is purified of supernatural tales about the power of the observant mind to make things jump.

Lewis (1986a, p.ix)

EQM is how quantum physics looks once it has been purified in all of the ways Lewis demanded, without the addition of any superfluous theoretical structure. It is time to pay attention to its lessons in ontology.

¹ I have in mind the ‘loophole-free’ experiments of Hensen et al. (2015), Giustina et al. (2015), and Shalm et al. (2015).

Outside theoretical physics, EQM has hitherto featured mainly as a plot device for science fiction. What has not been appreciated—at least not beyond certain technical debates in philosophy of physics—is the potential of EQM to transform the foundations of metaphysics. In this book I will be posing some perennially difficult metaphysical questions in the Everettian context, and offering some provisional answers to them which make novel use of theoretical resources from quantum physics. The resulting framework—which I call *quantum modal realism*—has strong affinities with the modal realism of David Lewis (Lewis 1986b), but it also has some unique features that set it apart from all extant theories of modality.

The thought that quantum theory might be relevant to the metaphysics of modality is not a new one. ‘Quantum logic’ interpretations² involve profound changes to our understanding of logical consequence; a more radical project in the foundations of metaphysics is hard to imagine. The current project is more conservative: the goal is a minimally revisionary way of incorporating quantum theory into our worldview that leaves untouched our ordinary scientific theorizing about the actual world. In this respect, it is inspired by pioneering work by Simon Saunders (Saunders 1997, 1998) who was the first to make explicit the relevance of EQM to the questions asked by metaphysicians about contingency and necessity. Saunders’s own views have changed significantly over the two decades since those papers were written. He no longer places such an emphasis on relationality, and is more tolerant of the language of ‘many worlds’. In my view, these are steps in the right direction; in this book, I try to take a few more steps.

This idea of this book was conceived while an undergraduate in Oxford in 2002, prompted by tutorials on modality with Bill Newton-Smith and by classes on the philosophy of quantum mechanics with Jeremy Butterfield. I then worked on the project under the guidance of Oliver Pooley, David Wallace, John Hawthorne, Simon Saunders and Cian Dorr. Numerous friends and colleagues have provided feedback on these ideas along the way, too many to name; I am very grateful to them all. The following deserve special thanks for reading and commenting on substantial chunks of the manuscript: Adam Bales, Chloé de Canson, Christina Conroy, Nina Emery, Salvatore Florio, David Glick, Dana Goswick, Toby Handfield, Mario Hubert, Matthias Jenny, Nicholas Jones, Dan Marshall, Robert Michels, Kristie Miller, Martin Pickup, Mark Pinder, Michael Raven, Katie Robertson, Miranda Rose, Alex Silk, Jussi Suikkanen, Tuomas Tahko, Henry Taylor, Paul Tappenden, and two referees for Oxford University Press.

² The canonical proposal is by Putnam (1968).

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Some material from chapters 2 and 3, including figure 2, has been reproduced from my articles “Objective Probability in Everettian Quantum Mechanics”, “Everettian Confirmation and Sleeping Beauty”, and “The Quantum Doomsday Argument”, all of which were published in *The British Journal for the Philosophy of Science*.

Introduction

ABSTRACT

The first part of this introduction sketches the main project of the book, and the structure of the arguments for my proposed quantum modal realism. The second part describes the unsatisfying present state of the metaphysics of modality, setting out what I take to be the most serious objections facing the best extant proposals. A naturalistic approach to metaphysics promises to resolve these objections by providing an account of modality that draws only on scientifically respectable theoretical resources. In the third part, I distinguish two big-picture approaches to the metaphysics of modality, and argue for the viability of an unfamiliar approach that takes the nature of contingency as the core phenomenon that a theory of modality needs to explain. In the fourth part, I explain my methodology and briefly defend the general project of naturalistic metaphysics.

“[O]ur intuitions as to what is ‘unreasonable’ or ‘absurd’ were formed to aid our ancestors scratching a living on the savannahs of Africa, and the Universe is not obliged to conform to them.”

Wallace (2012, p.45)

0.1 Emergent Contingency

This book argues that quantum theories are best understood as theories about the space of possibilities rather than as theories solely about actuality. When quantum physics is taken seriously in the way first proposed by Hugh Everett III (Everett 1957a), it can offer us direct insight into the metaphysics of possibility, necessity, actuality, chance, and a host of related modal notions. As electromagnetism revealed the nature of light, as acoustics revealed the nature of sound, as statistical mechanics revealed the nature of heat, so quantum physics reveals the nature of contingency. Objective modality is quantum-mechanical.

According to Everettian quantum mechanics (EQM), there exists an enormous plurality of worlds. The entire universe that we see around us, with all its atoms and cities and galaxies, is just one among many universes. Indeed, any way that the laws of quantum physics permit a universe to be is a way in which some universe is. The collection of all of these universes is known as the *Everettian multiverse*. Each universe contained within the multiverse I will call an *Everett world*. You, and all the people you will ever meet, together inhabit just one single Everett world out of the multitude. Although each Everett world is already inconceivably vast, the Everett multiverse is inconceivably vaster.