

Cambridge Elements

Elements in the Philosophy of Physics

edited by

James Owen Weatherall

University of California, Irvine

PHYSICS AND COMPUTATION

Armond Duwell

University of Montana



CAMBRIDGE
UNIVERSITY PRESS

Cambridge University Press
978-1-009-10855-3 — Physics and Computation
Armond Duwell
Frontmatter
[More Information](#)

CAMBRIDGE
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom
One Liberty Plaza, 20th Floor, New York, NY 10006, USA
477 Williamstown Road, Port Melbourne, VIC 3207, Australia
314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre,
New Delhi – 110025, India
103 Penang Road, #05–06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press is part of the University of Cambridge.
It furthers the University's mission by disseminating knowledge in the pursuit of
education, learning, and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781009108553
DOI: 10.1017/9781009104975

© Armond Duwell 2021

This publication is in copyright. Subject to statutory exception
and to the provisions of relevant collective licensing agreements,
no reproduction of any part may take place without the written
permission of Cambridge University Press.

First published 2021

A catalogue record for this publication is available from the British Library.

ISBN 978-1-009-10855-3 Paperback

ISSN 2632-413X (online)
ISSN 2632-4121 (print)

Cambridge University Press has no responsibility for the persistence or accuracy of
URLs for external or third-party internet websites referred to in this publication
and does not guarantee that any content on such websites is, or will remain,
accurate or appropriate.

Physics and Computation

Elements in the Philosophy of Physics

DOI: 10.1017/9781009104975
First published online: August 2021

Armond Duwell
University of Montana

Author for correspondence: Armond Duwell, armond.duwell@umontana.edu

Abstract: This Element has three main aims. First, it aims to help the reader understand the concept of computation that Turing developed, his corresponding results, and what those results indicate about the limits of computational possibility. Second, it aims to bring the reader up to speed on analyses of computation in physical systems that provide the most general characterizations of what it takes for a physical system to be a computational system. Third, it aims to introduce the reader to some different kinds of quantum computers, describe quantum speedup, and present some explanation sketches of quantum speedup. If successful, this Element will equip the reader with a basic knowledge necessary for pursuing these topics in more detail.

Keywords: quantum computation, quantum speedup, physical Church–Turing thesis, account of computation, quantum computers

© Armond Duwell 2021

ISBNs: 9781009108553 (PB), 9781009104975 (OC)
ISSNs: 2632-413X (online), 2632-4121 (print)

Contents

1	Introduction	1
2	Turing's 1936 Paper	1
3	The Church–Turing Thesis and the Physical Church–Turing Thesis	5
4	Accounts of Computational Implementation	17
5	Quantum Computers	42
6	Quantum Speedup	51
	References	66