

SUPERPOSITION

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an imprint of Prometheus Books
Amherst, NY

Published 2015 by Pyr®, an imprint of Prometheus Books

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Cover design by Grace M. Conti-Zilsberger

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19 18 17 16 15 5 4 3 2 1

Library of Congress Cataloging-in-Publication Data

Walton, David, 1975-

Superposition / by David Walton.

pages ; cm

ISBN 978-1-63388-012-2 (paperback) — ISBN 978-1-63388-013-9 (e-book)

I. Title.

PS3623.A454S87 2015

813'.6—dc23

2014043772

Printed in the United States of America

To Miriam
because second is best

“Our imagination is stretched to the utmost, not, as in fiction, to imagine things which are not really there, but just to comprehend those things which are there.”

—Richard Feynman,
1965 Winner of the Nobel Prize in Physics

CHAPTER 1

UP-SPIN

I should have known better than to let him in. Brian Vanderhall showed up on my doorstep in the falling snow wearing flip-flops, track shorts, and an old MIT T-shirt, the breath steaming from his mouth in little white gusts. It would have saved me a lot of trouble if I had slammed the door in his face, never mind the cold. Instead, like a fool, I stepped aside.

I had been in the basement working the heavy bag when the doorbell rang. A vee of sweat darkened my gray, sleeveless shirt, and my arms were slick with sweat.

“Jacob Kelley,” he said. “Looking like a Neanderthal, as always.”

“And you’re as charming as ever,” I said. “Where’s your coat?”

He gave me a weak smile. “Close the door.”

I peered out and saw nothing but snow and darkness. “Everything okay?”

“Just close it, will you?”

Brian Vanderhall had been a friend since college, probably my best friend through graduate school and all the drama surrounding our careers at the New Jersey Super Collider. He hadn’t always been the most loyal of friends, and there were reasons I’d let him slide out of my life. Finding him unexpectedly at the door like that, I thought he would try to pull me into some kind of messy personal or financial problem, but I wasn’t expecting disaster. I guess we never do.

Brian stamped snow off his flip-flops and kicked them into a corner. A blast of frigid air invaded the room’s fireplace warmth as I pushed the door shut and relocked it. His face and hands were chapped red, and several days’ worth of stubble covered his face. It had been two years since I had seen him in person, and he looked different, though I wasn’t sure

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why. His hair was a bit longer, I thought, and the glasses might have been a new pair. Maybe he just looked older.

We climbed the three steps from the landing to the living room, where my daughter Claire sat curled by the fire doing her math homework, her blond hair spreading like a sunrise over her shoulders. I gave her a quick kiss on the forehead, and we rounded the corner into our kitchen.

The kitchen was the room that had sold Elena and me on this house. It was spacious and modern, with long countertops and a butcher-block island. Elena soon had us around the breakfast table with hot mugs: coffee for her and Brian and tea for me. I could hear Alessandra practicing her trumpet upstairs.

Brian cupped his hands around his mug and inhaled the steam. "Thank you," he said. "Really, I can't say how much."

Elena and I traded glances. She was small, athletic, and wore jeans and a health club sweatshirt. Her looks, as far as I was concerned, had only improved since she was twenty-two, when I'd spotted her running ahead of me in the Philadelphia marathon and I'd finished in record time just to keep her in sight.

"How are things at the NJSC?" she asked.

"Oh, you know, same old," Brian said distractedly. "Richardson is an ass, as always." He looked at me. "Things were never right after you left."

"Things were never right when I was there, either," I said. The New Jersey Super Collider was the largest particle accelerator in the world, built under the Pine Barrens at Lakehurst, not far from Princeton. Massively expensive, its construction far over budget, it had been condemned by many as the "Big Dig" of our generation, the protests compounded by the environmentalist outcry about long-term radioactive effects on the pine forest ecology. Despite all the objections, Richardson had managed to push it to completion. Once it was operational, the political feeding frenzy had increased, only instead of fighting about whether the accelerator should be built, they fought over who should be allowed to use

it. There were some aspects of working there that I dearly missed. There were others that I didn't miss at all.

"I don't understand why you left," Brian said. "Nobody does. You've got a PhD from Princeton. You're a published physicist, top of your game, the next Wheeler maybe. How could you give it up for . . ." He waved his hand vaguely around the kitchen.

"I'm teaching physics at Swarthmore College," I said. "I love it there. I have some bright kids. And there's no politics, no squabbling over experiment time, no need to prove to strangers that my work is worthwhile in order to keep doing it."

That had been the last straw for me, when the appearance of our research to the outside world overcame the commitment to genuine discovery. There was such a pressure for our multibillion-dollar investment to produce new results that the value of the science itself was jeopardized. For the first time since Congress had canceled the Superconducting Super Collider in Texas in 1993, the United States was on the leading edge of particle physics. We could have finally overcome the infamous American nearsightedness where science was concerned. Instead, we spent so much effort trying to prove the value of the NJSC to taxpayers that we hardly got any value from it at all.

"You could at least have taught at Princeton," Brian said. "They would have found a place for you."

"I left to *avoid* politics," I said.

Brian shook his head. "You would have been something special. Remembered by the history books. And you threw it all away."

I sipped at my tea to mask the bunching in my muscles. "Just because a man is a talented pianist doesn't mean he has to choose music as his career," I said. "Just because a girl is a talented ice skater doesn't force her to choose the life of an Olympian." It felt like we were picking up the conversation right where we'd left it two years before. I was tired of it already.

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He sipped his coffee, made a face. “That brilliant mind of yours is squandered helping mediocre students get a few science credits.”

I half stood, my hands flat on the table, scraping the chair against the tile floor. Elena put a quick hand on my arm. “Look,” I said. “Did you come here just to insult me, or did you have some other purpose?”

“Sorry, sorry,” he said. “I know. Old habits and all that.” He lifted the mug back to his mouth, but his hand shook, and some of the hot coffee spilled over the edge. He slammed the mug down, slopping more on the table, shouted a garbled expletive, and sucked at his hand.

“Here,” Elena said. She ran a dish towel under cool water and handed it to him. He wrapped it around his hand, while I used another cloth to wipe away the coffee mess.

I realized then why Brian looked so different. He was scared. Not stressed—I had seen that before, when he had money problems or feared that one of the women in his life would find out what he was doing with the other. This was different. He was stealing glances at the windows and startling at sudden noises. He was like a squirrel on the road, poised to bolt to safety the moment he was sure which way the danger was coming from.

“Spit it out,” I said. “What’s wrong?”

“What do you mean?”

“You’ve never made a social call in your life. What do you want from us?”

He brushed a stray lock of hair out of his eyes, which promptly fell back down again. “I’m in a bit of trouble,” he said.

“There’s a shock. Is it the work or the women?”

Brian gave a bitter laugh. “I guess you could say both.”

I drank the last of my tea and brought the mug over to the sink, where I washed it and set it on the drying rack. A holiday candle burning on the counter gave a sharp wintergreen smell to the air. “Keep talking.”

“Have you kept up with the literature?” Brian asked, but we were interrupted by a wailing cry before I could answer. Sean, my son, cata-

pulted into the room and crashed into me. At five years old, his only speed setting was full acceleration, and his only means of stopping was collision.

“Slow down,” I said. “What’s wrong?”

“Alessandra won’t let me play,” he said, still crying.

“She’s practicing. Why don’t you find your bugle?”

“It’s broke. And she hit me!”

“Alessandra hit you?”

“In the head! With her trumpet!”

I looked at the spot and, sure enough, a small half-moon cut was swelling, clearly visible through his blond, short-cropped hair. I sighed. Another chapter in the ongoing drama of the Kelley children.

Alessandra flew around the corner a moment later. She was dark-haired, like her mother, but without Elena’s easy-going patience. “It wasn’t my fault,” she said.

“Not your fault?” I said. “Look at that cut! You’re fourteen, Alessandra, not seven. You have to find a better way of dealing with him than violence.”

“I was just playing. He ran into it.”

“You’re seriously going to tell me he got that cut just running into you? That you were practicing, minding your own business, and he just crashed into your trumpet hard enough to leave that mark?”

She crossed her arms and gave me one of her ferocious, sullen glares.

“Don’t look at me that way,” I said. “You have to learn to keep that temper of yours under control.”

“You mean like you did with that guy at the gym who insulted Mom?” Alessandra asked.

I felt my blood rising. “Don’t push me, young lady. Fix your attitude right now and apologize to your brother.”

Elena put a hand on my arm again. “We have a guest,” she said. “You stay and talk; I’ll bring the kids upstairs and deal with this.” She

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rummaged in the freezer and pulled out a teddy bear icepack, which she pressed to Sean's head. "Upstairs for your pajamas," she said. She rotated Sean by his shoulders and pointed him in the right direction.

"Give me a moment to get the kids to bed, and then I'll be back," Elena said to Brian. "Help yourself to coffee; there should be another cup's worth in the pot."

I caught Brian staring at Sean's short arm, though he didn't say anything about it. It's what most adults did: they stole glances, with varying degrees of subtlety, but didn't ask. Sean had been born that way, his left arm half the normal length, with a tiny hand at the end of it that couldn't grasp anything very well.

I heard Alessandra still protesting her innocence as they climbed the stairs. Brian snickered. "Always the domestic, weren't you?" he said. "Diapers and runny noses." We'd been out of diapers for several years, but I didn't bother to point this out. I couldn't believe that even when he showed up at my house shaking in fear and asking for help, he could still manage to look down his nose at my family.

"Okay," I said. "Let's hear it."

Brian held my gaze for a beat. "You remember the nature-as-computer argument?"

"Sure. The idea that the whole universe is just one big quantum computer."

"All the information in the universe can be represented by a vast but finite number of bits, just a few for each particle: its type, its spin, its momentum, like that," Brian said.

"It always sounded like doublespeak to me," I said. "The universe is the universe. Calling it a computer doesn't provide any scientific insight."

Brian looked a little offended. "Yes, it does. You can simulate any real set of particle interactions with a quantum computer made up of the same number of particles, no matter how many particles and how complex the interaction."

So far, this didn't sound like anything to make anyone run out into the snow in flip-flops. It just sounded like wonky metaphysics. "Yeah? And I can simulate an apple with an apple. So what?"

"So, if you can simulate the universe with a quantum computer the same size as the universe, that means that the universe is indistinguishable from a quantum computer. For all practical purposes, it *is* a quantum computer."

"Which means . . ." I was starting to get it.

"Which means it's a computational device with a complexity factor far in excess of Pronsky's Threshold."

"Sufficient to generate consciousness," I said, letting my incredulity show in my voice.

"Right."

I couldn't help it. I laughed. "You're telling me, what? The universe is sentient?"

"Pieces of it."

"You're serious?"

Brian sat rigid in his chair, darting glances at the windows. He didn't have to answer. I knew he was serious. I just didn't know if he was crazy or not.

Just then, Claire came in and helped herself to Oreo cookies and a glass of milk. At sixteen, Claire generally chose her own bedtime. She sat down at the table, unscrewed a cookie, and dunked half of it.

I welcomed the distraction. "Claire, you remember Mr. Vanderhall?" I said.

"Sure, a little," she said. "Glad to meet you."

Brian's eyes focused, and he shook her hand. "My pleasure." He studied her face. "You've really grown up since I saw you last."

He was right—in the last few years, Claire's freckles had faded, and she'd traded girlish cuteness for a real beauty. Given Brian's reputation with women, though, I didn't like him noticing it. Besides, it wasn't just Claire's beauty that made her an impressive young woman.

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“Claire’s at the top of her class,” I said. “National Merit semifinalist, too.”

Claire rolled her eyes. “Dad.”

Elena came back into the room. “Head upstairs, please,” she said to Claire.

“I haven’t finished my cookies.”

“Take them upstairs with you. We need to speak with Mr. Vanderhall privately.”

“Can I watch the stream before bed?”

“Fine. Just go upstairs.”

She gave me a kiss, murmured a “G’night, Daddy,” and went up.

Elena settled into the chair next to me with her mug of coffee, probably cold by now. “So, what’s this all about?”

I rolled my eyes. “Brian was telling me how there are invisible fairies in the spaces between the atoms,” I said.

He leaned forward. “They’re real, Jacob.”

“What are? The fairies?”

“Consciousnesses. Beings. Artificial intelligences, like in a computer, only the computer in this case is the whole universe.”

“And you’ve seen them?”

“A lot more than that. They’ve talked to me. Taught me things.” His expression was cryptic, a smile laced with uneasy fear. “It’s probably easier if I show you.” He leaned over and picked a gyroscope up off the floor. Sean must have left it there—he was forever leaving his toys about. The gyroscope had been a gift from me, like the microscope and chemistry set and electricity kit—all attempts to interest Sean in science. He had paid little attention to my explanations of angular momentum, but he did like to watch the gyroscope spin at odd angles, balanced on a wire or a pencil point. For the first day, at least. Ultimately it was no more to him than a glorified top. He had lost the string and moved on to other toys.

Brian held the gyroscope up like a magician displaying a coin that was about to disappear. I felt a strange internal tugging sensation and wondered what it meant. Nervousness? Did I really care that much about what this was all about?

He held the gyroscope upright on the tabletop. Without the string, there was no way to set the gyroscope spinning. When Brian let go of the wheel, however, it started spinning on its own. He removed his hand, and it kept going, precessing with a slight wobble, but otherwise stable. My practical mind looked immediately for the power source, thinking that he might have switched the gyroscope for one with an ingeniously hidden battery and motor, but as far as I could tell, it was the same steel and plastic model, simple and cheaply made. There was no room for a power source. Despite this, the gyroscope kept spinning.

Elena started to say something, but Brian held up his hand, and we kept watching. Two minutes went by, and it didn't slow down. Not even a string-pulled gyroscope went on for that long without losing momentum. Three minutes went by. Four.

Finally, Elena reached out and snatched the gyroscope, her fingers stopping the spinning wheel. Her breathing was hard, and her eyes bored into Brian's.

"Maybe it's better if you tell us," she said.