



# Programming the Universe: A Quantum Computer Scientist Takes on the Cosmos

By Seth Lloyd

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Is the universe actually a giant quantum computer? According to Seth Lloyd, the answer is yes.

All interactions between particles in the universe, Lloyd explains, convey not only energy but also information—in other words, particles not only collide, they compute. What is the entire universe computing, ultimately? “Its own dynamical evolution,” he says. “As the computation proceeds, reality unfolds.”

*Programming the Universe*, a wonderfully accessible book, presents an original and compelling vision of reality, revealing our world in an entirely new light.

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### Editorial Review

From Publishers Weekly

Lloyd, a professor at MIT, works in the vanguard of research in quantum computing: using the quantum mechanical properties of atoms as a computer. He contends that the universe itself is one big quantum computer producing what we see around us, and ourselves, as it runs a cosmic program. According to Lloyd, once we understand the laws of physics completely, we will be able to use small-scale quantum computing to understand the universe completely as well. In his scenario, the universe is processing information. The second law of thermodynamics (disorder increases) is all about information, and Lloyd spends much of the book explaining how quantum processes convey information. The creation of the universe itself involved information processing: random fluctuations in the quantum foam, like a random number generator in a computer program, produced higher-density areas, then matter, stars, galaxies and life. Lloyd's hypothesis bears important implications for the red-hot evolution-versus-intelligent design debate, since he argues that divine intervention isn't necessary to produce complexity and life. Unfortunately, he rushes through what should be the climax of his argument. Nevertheless, Lloyd throws out many fascinating ideas. (For another take on information theory, see *Decoding the Universe* on p.53.) 12 b&w illus.

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From [Booklist](#)

\*Starred Review\* Lloyd's specialty in physics is the hot topic of quantum information. And his book may do for quantum information what Brian Greene did for strings (*The Elegant Universe*, 1999) and Stephen Hawking did for spacetime (*A Brief History of Time*, 1988): popularize a far-out scientific frontier. Will Lloyd's listeners have the same head-scratching reactions as his MIT students do on their first encounter with the idea that information is a quantifiable physical value, as much as mass or motion? Or with the proposition that any physical system--a river, you, the universe--is a quantum mechanical computer? Not if they've read his book, which offers brilliantly clarifying explanations of the "bit," the smallest unit of information; how bits change their state; and how changes-of-state can be registered on atoms via quantum-mechanical qualities such as "spin" and "superposition." Putting readers in the know about quantum computation, Lloyd then informs them that it may well be the answer to physicists' search for a unified theory of everything. Exploring big questions in accessible, comprehensive fashion, Lloyd's work is of vital importance to the general-science audience. *Gilbert Taylor*

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Review

"Lloyd is one of the gurus of quantum and information theory, and in this accessible book he presents an insightful new perspective on the cosmos."—Sir Martin Rees, University of Cambridge "What an astonishing book! Lloyd is at the forefront of a revolution." —Kevin Kelly, Editor-at-Large, *Wired* "Lloyd thinks he has found a new way to explain one of the most basic questions in science: Why is the world so complex? . . . Fascinating and profoundly comforting. . . . Seth Lloyd certainly gives his readers a lot of bang for their buck."—*The New York Times Book Review* "Renowned for his innovative conflation of pure physics and computation, Lloyd is well positioned to hack his way into space-time and come back with answers." —*Seed*

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