Quantum mechanics & the Creator

Physics points to a world in which relationships matter most

Catherine H. Crouch

Suppose you had to choose between two worlds. In one, reliable physical laws are the same everywhere, ensuring that the universe is consistent and predictable.

In the other world, while we can predict many things, the behavior of the most fundamental building blocks of reality is up for grabs. For example, atoms can seem to be in more than one place at the same time — and there's no way to find out where they really are.

Which world seems preferable? Which seems more likely to be a world created by God?

These two worlds are alternate descriptions of our universe. The first is the clockwork picture provided by classical physics — the foundations of Western science from the Renaissance to the beginning of the 20th century. The second description comes from the 80-year-old science of quantum mechanics. No less a scientist than Albert Einstein knew which he preferred. "God does not play dice with the universe," he famously said — rejecting QM's picture of an unsettling unpredictability at the heart of things.

But Einstein was almost certainly wrong. In recent years, experiments have confirmed some of QM's most astonishing predictions. And the strange world of QM could actually be remarkably compatible with Christian beliefs.

Classical physics was based on the work of Isaac Newton, whose theory of gravity explained the motion of objects, from falling apples to the orbits of the planets. According to Newton's theory, if we know an object's mass, starting velocity and starting position, a few simple laws allow us to calculate exactly how that object will move. His universe is orderly, rational and predictable.

The problem was that while Newton's laws worked extremely well for apples, they didn't do so well at explaining what 19th and 20th century scientists found as they probed the amazingly small spaces of atoms. In fact, once atoms were discovered to be made up of smaller particles (protons, neutrons and electrons), it was clear that something was catastrophically wrong with the classical picture. Under Newton's laws, atoms should self-destruct in a burst of radiation.

Enter quantum mechanics

In the 1920s, several physicists devised a theory — quantum mechanics — which solved some of the mysteries that had bedeviled Newton's theories. In the QM world, the properties of physical objects aren't well-defined but are described by probabilities. Take the location of any given particle: QM is stubbornly unwilling to tell you where each electron in your body's roughly billion billion billion (1027) atoms is right now. (In fact, there is a real, although extraordinarily small, chance that right now at least one of your electrons is outside your body.)

QM tells us only that at any given time, each electron has a certain probability of being somewhere within a range of locations. It's similar to flipping a coin. Before you flip it, you don't know whether it will land heads or tails, only that you have an equal chance of either heads or tails. This idea — that chance, rather than definite predictability, describes the behavior of the universe — prompted Einstein's uneasy comment about God playing dice.

But the trouble with QM goes well beyond randomness. In 1935, Einstein and others pointed out that if QM were true, it would actually fly in the face of conventional ideas about cause-and-effect.

A measurement made on one particle, they theorized, could instantly affect the properties of another particle, no matter how far apart the two are.

If the effect on the second particle was triggered by a signal coming from the first particle, as the classical picture of the universe required, that signal would have to travel from the first to the second in literally no time.

This seemed to either violate one of Einstein's most important ideas, namely that nothing can travel faster than the speed of light, or worse, demand that the effect on the second particle happens without an immediate cause. For Einstein, this was evidence that something was rotten in QM's picture of the universe.

But in the past 20 years, physicists have performed many experiments which indicate that, indeed, nature is as bizarre as QM tells us. The current debate is not whether QM is right, but what it means.

There is a big difference between the observable physical phenomena predicted by a scientific theory, such as the locations of particles, and the philosophical or theological meanings that can be ascribed to the theory.

While a scientific experiment can confirm or disprove the predictions of a theory, *interpretations* of the theory are rarely testable. Since QM's inception, physicists and philosophers of science have argued about how to understand QM's probabilistic description of reality. Some, like physicist Stephen Hawking of Cambridge [England] University, believe QM shows that if there is a God at all, this God can't be purposeful or act deliberately in the world. QM's randomness and irrationality make it impossible for even God to foresee or govern the future.

So it's not surprising that when they think about physics at all, Christians may wonder if cosmos is giving way to chaos. But often several different interpretations are consistent with the same evidence. Hawking takes the random nature of the QM universe as proof that the universe lacks purpose and design.

Yet others, such as British physicist and Anglican priest John Polkinghorne, see an opening for divine and human free will that had been excluded from previous models of the cosmos. Indeed, Polkinghorne points out that in certain kinds of complex physical systems, the behavior of the system as a whole proceeds within certain boundaries even though the behavior of its microscopic parts is governed by probability. Similarly, he suggests the cosmos as a whole could be working out God's purposes while permitting freedom of choice to individuals and even randomness at the level of atomic events.

What about the ways that QM appears to undermine the need for cause-and-effect? Here again there are multiple interpretations. One interpretation of QM, devised by N. David Mermin of Cornell University, Ithaca, N.Y., not only makes sense of otherwise baffling data but also makes surprising (and most likely unintentional on Mermin's part) contact with some of the most fundamental Christian beliefs about God and creation.

It's the relationships

Mermin's central idea is simple: The basic elements of physical reality aren't individual objects but relationships between individual objects. Individual objects do certainly exist. But if we insist on knowing the properties of individual objects rather than the properties of relationships between objects, our efforts are doomed to appear paradoxical and incoherent.

Physics, it turns out, is not about smaller and smaller billiard balls — electrons, quarks or neutrinos. It's about the relations between those objects, which derive their very identity from their relations. The primacy of objects gives way to the primacy of relationships.

Mermin's approach, it turns out, eliminates QM's apparent violations of cause-and-effect. If the *relationship* between two objects is fundamental, rather than the objects themselves, then it isn't surprising that a change in that *relationship* can affect both objects at once, even at a great distance. The universe is *rational*, Mermin suggests, because it is *relational.*

Christian readers of Mermin suddenly find themselves in familiar territory. For any deeply Christian account of the creation seems bound to have a relational quality. From the enigmatic "us" in Genesis 1:26 to the fully formed descriptions of the Trinity in the creeds, Christian thought suggests a relationality in God. And the universe exists, Jewish and Christian theologians have long asserted, in continuous, dynamic, loving relation to God.

Under Mermin's and Polkinghorne's interpretations, QM turns out to be as much an ally as a foe to the Christian understanding of the world, and some of its most "irrational" elements actually compel a more relational rationality.

Indeed, the world that Mermin and Polkinghorne perceive in QM's looking glass is actually more consistent with a relational, free Creator and creation than the old billiard-ball world of Newton and Einstein. And we shouldn't expect any theory of physics to lead directly to the Christian picture of a God who is Creator, Redeemer and Sustainer of creation.

The Bible says, after all: "No one has ever seen God. It is God the only Son, who is close to the Father's heart, who has made him known" (John 1:18). Scripture shows that God's character is only made fully clear through God's interactions (relations) with human beings, especially Israel and the church. God made the world and it reflects some of God's qualities, just as a sculpture tells us something about the sculptor. But reading the sculptor's letters, meeting her children and especially meeting her, tell much more.

So, like all scientific discoveries, QM tells us something about God, but not enough. At the very least, QM makes a relational God who values freedom in the universe more plausible than ever. Certainly some present-day scientists are convinced that God is a cosmic gambler. But many of us find that far from playing dice, God is more intimately involved in the world than classical physics ever imagined.

For futher reading and reflection
Here is a selection of books from the authors and scientist profiled in this section.

Recommended by Catherine H. Crouch:

- *Albert Einstein, Philosopher-Scientist* by Paul A. Schilp (Open Court, 1949).

- *The Open Mind and Other Essays: A Scientist in God's World* by Donald M. MacKay (Intervarsity Press, 1991).

- *Science and Providence: God's Interaction with the World* by John C. Polkinghorne (Shambhala Publications, 1989), and other works. (Fortress Press published four: The Faith of a Physicist: Reflections of a Bottom-Up Thinker, 1996; Science and Theology, 1998; Faith in the Living God [with Michael Welker], 2001; and Traffic in Truth: Exchanges between Science and Theology, 2002.)

Recommended by James Houck:

- *Brother Astronomer: Adventures of a Vatican Scientist* by Guy Consolmagno (McGraw Hill, 2001).

- *The Character of Physical Law* (Modern Library, 1994) and *Meaning of It All: Thoughts of a Citizen Scientist* by Richard Feynman (Helix Books, 1999).

- *The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory* by Brian Greene (Vintage Books, 2000).

• *God and the Astronomers, 2nd ed.,* by Robert Jastrow (W.W. Norton & Co., 2000).

• *The Sun in the Church: Cathedrals and Solar Observatories* by J.L. Heilbron (Harvard University Press, 2001).

• *The Very First Light: The True Inside Story of the Scientific Journey Back to the Dawn of the Universe* by John C. Mather and John Boslough (Basic Books, 1998).

• *Wrinkles in Time* by George Smoot and Keay Davidson (Avon Books, 1994).

Recommended by William R. Matthews:

• *A Brief History of Time* by Stephen Hawking (Bantam, 1988).

• *The Dragons of Eden: Speculations on the Evolution of Human Intelligence* by Carl Sagan (Random House, 1977).

• *How We Believe: The Search for God in an Age of Science* by Michael Shermer (Freeman, 2000).

• *Why Religion Matters: The Father of the Human Spirit in an Age of Disbelief* by Huston Smith (HarperSanFrancisco, 2001).

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