"Entangled" particles could build wormhole

Dec. 6, 2013
Courtesy of the University of Washington
and World Science staff

A strange natural phenomenon that Albert Einstein once described as "spooky action at a distance" could be even spookier than he thought.

The phenomenon is quantum entanglement, a process in which two objects maintain related behaviors no matter how far apart they are—as if they were communicating instantaneously.

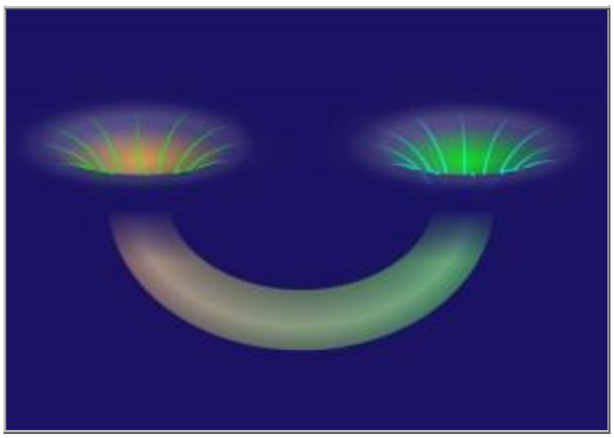

Illustration showing the concept of a wormhole connecting two black holes. (Alan Stonebraker/APS)

New research has persuaded some physicists that entanglement might be related to wormholes, hypothetic features of space and time that in science fiction can provide a much-faster-than-light shortcut between different parts of the universe.

But here's the catch: One couldn't actually travel, or even communicate, through these real wormholes, said University of Washington physicist and study collaborator Andreas Karch.

Quantum entanglement can be seen in laboratories when a pair or a group of particles interact in specific ways. In a pair of entangled particles, if one particle is measured to have a specific spin, for example, the other particle observed at the same time will have the opposite spin. The "spooky" part is that, as past research has confirmed, the relationship holds true no matter how far apart the particles are.

Recent studies indicate that a wormhole's properties are the same as if two black holes were en-

tangled, then pulled apart, Karch said. Even if the black holes were on opposite sides of the universe, the wormhole would link them. Black holes, which can be as small as an atom or many times larger than the sun, exist throughout the universe. They're objects whose gravitational pull is so strong that not even light can escape them.

If two of them were entangled, Karch said, a person outside the opening of one wouldn't be able to see or communicate with someone just outside the opening of the other. "The way you can communicate with each other is if you jump into your black hole, then the other person must jump into his," he said.

The work shows an equivalence between quantum mechanics, which deals with nature at very tiny scales, and classical geometry—"two different mathematical machineries to go after the same physical process," Karch said. The result is a tool scientists can use to develop broader understanding of entangled quantum systems, he added.

"We've just followed well-established rules people have known for 15 years and asked ourselves, 'What is the consequence of quantum entanglement?'" Karch is a co-author of a paper describing the research, published in November in the journal *Physical Review Letters*.

In a paper published alongside that of Karch's group, the Massachusetts Institute of Technology's Julian Sonner proposed that gravity itself might emerge from quantum entanglement. That's because as Einstein found, gravity is fundamentally a geometric phenomenon—a bending of space and time—and gravity holds together wormholes.