Researchers propose new physics to explain decay of subatomic particle

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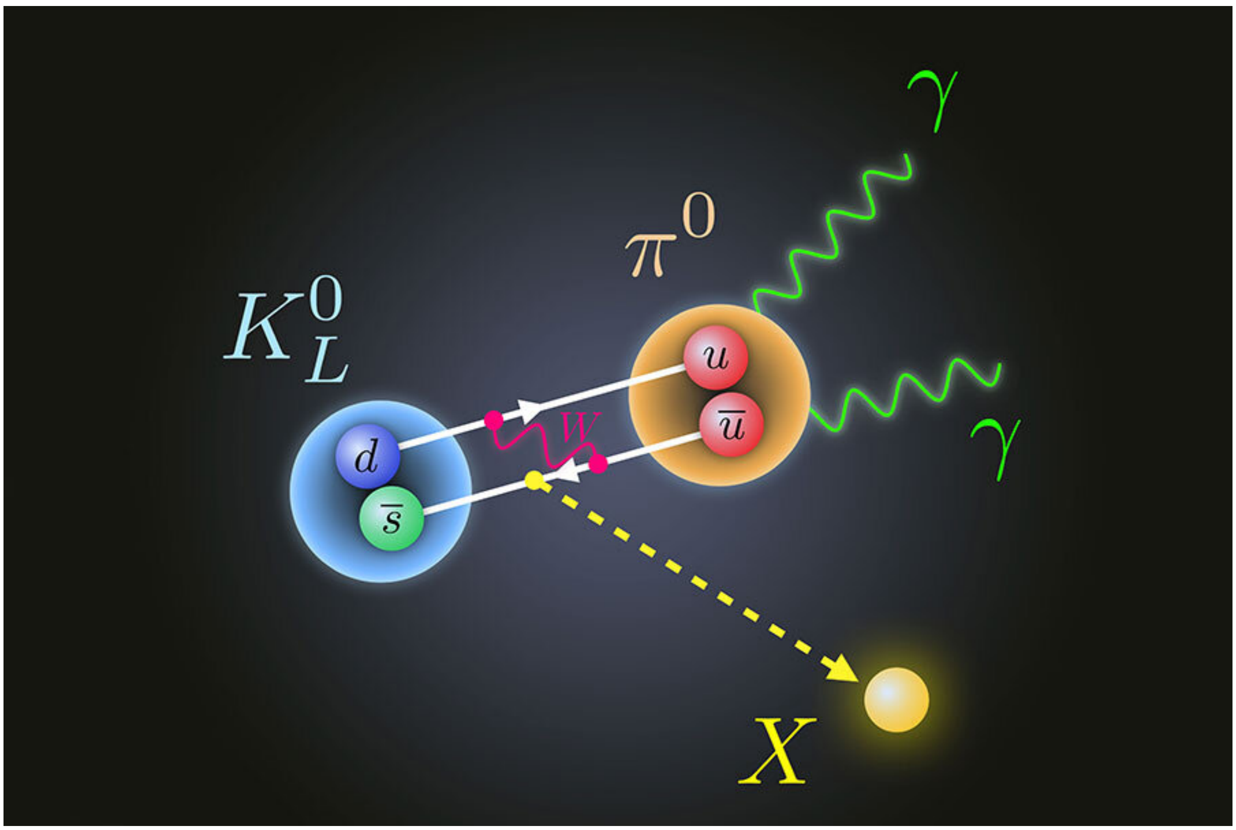

FSU physicists proposed a new particle (yellow) to explain recently reported rare kaon (blue) decays to neutral pions (orange). Credit: Florida State University

Florida State University physicists believe they have an answer to unusual incidents of rare decay of a subatomic particle called a Kaon that were reported last year by scientists in the KOTO experiment at the Japan Proton Accelerator Research Complex.

FSU Associate Professor of Physics Takemichi Okui and Assistant Professor of Physics Kohsaku Tobioka published a new paper in the journal *Physical Review Letters* that proposes that this decay is actually a new, short-lived particle that has avoided detection in similar experiments.

"This is such a rare disintegration," Okui said. "It's so rare, that they should not have seen any. But if this is correct, how do we explain it? We think this is one possibility."

Kaons are particles made of one quark and one antiquark. Researchers study how they function—which includes their decay—as a way to better understand how the world works. But last year, researchers in the KOTO experiment reported four instances of a particular rare decay that should have been too rare to be detected yet.

This observation violates the standard model of physics that explains the basic fundamental forces of the universe and classifies all known elementary particles.

According to their calculations, there could be two possibilities for new particles. In one scenario, they suggest that the Kaon might decay into a pion—a subatomic particle with a mass about 270 times that of an electron—and some sort of invisible particle. Or, the researchers in the KOTO experiment could have witnessed the production and decay of something completely unknown to physicists.

Researchers in Japan are conducting a special data run to confirm whether the previous observations were true detections of new particles or simply noise.

"If it's confirmed, it's very exciting because it's completely unexpected," Tobioka said. "It might be noise, but it might not be. In this case, expectation of noise is very low, so even one event or observation is very striking. And in this case there were four."

Okui and Tobioka's co-authors on this study were Teppei Kitahara and Yotam Soreg from the Israel Institute of Technology and Gilad Perez from the Weizmann Institute of Science in Israel.

More information: Teppei Kitahara et al. New Physics Implications of Recent Search for $K_L \to \pi^0 \nu \bar{\nu}$ at KOTO, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.124.071801

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