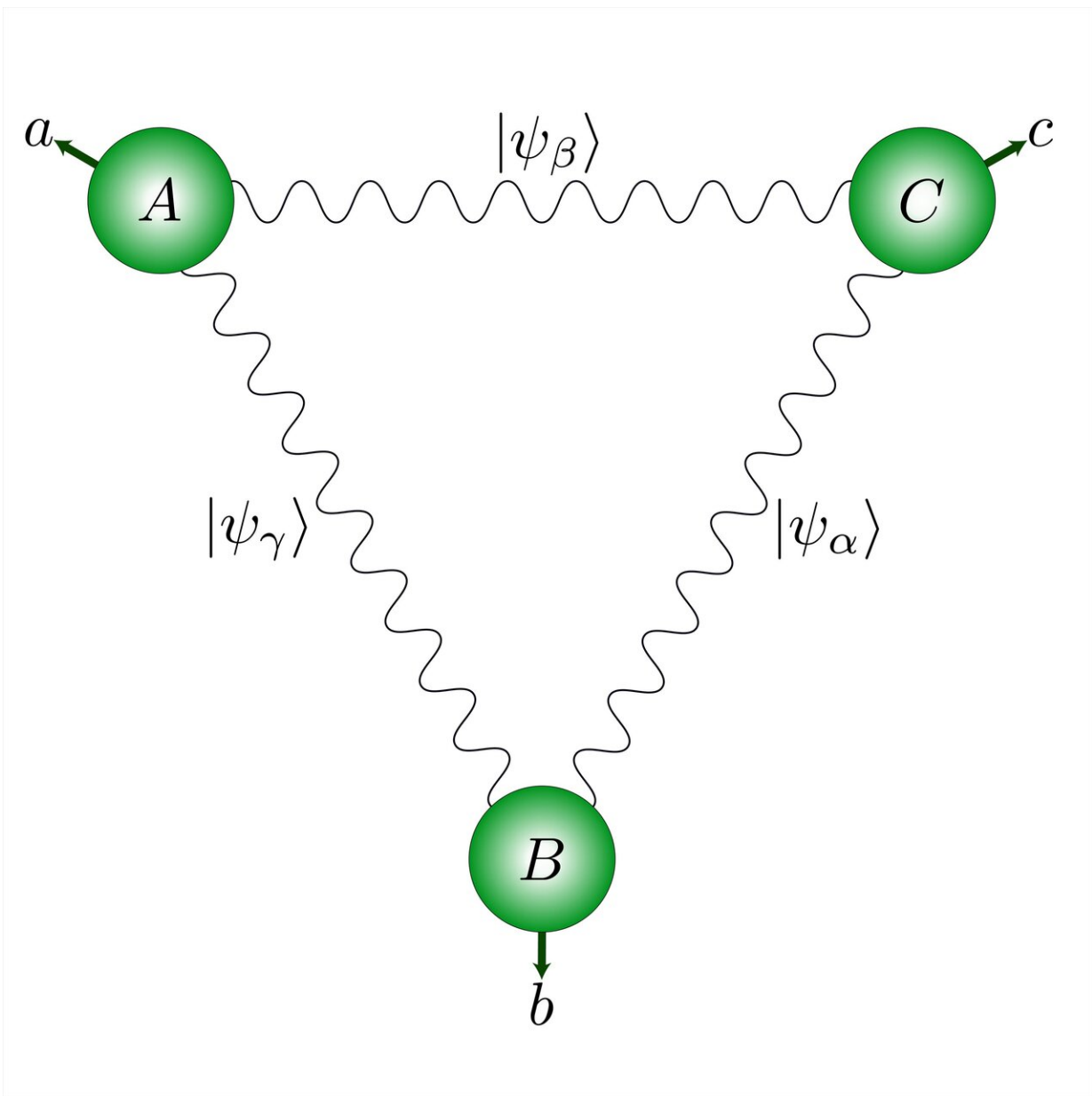


Quantum physics: Ménage à trois photon-style

October 16 2019



A quantum network with a triangular structure allows for a fundamentally novel type of quantum correlations. Credit: © UNIGE

Entanglement is one of the properties specific to quantum particles. When two photons become entangled, for instance, the quantum state of the first will correlate perfectly with the quantum state of the second, even if they are at a distance from one another. But what happens when three pairs of entangled photons are placed in a network? Researchers at the University of Geneva (UNIGE), Switzerland, working in partnership with Tehran's Institute for Research in Fundamental Sciences (IPM), have proved that this arrangement allows for a new form of quantum correlation in theory. When the scientists forced two photons from separate pairs to become entangled, the connection was also made with their twin photon present elsewhere in the network, forming a highly correlated triangle. These results, published in the journal *Physical Review Letters*, create the potential for new applications in cryptography.

Entanglement involves two [quantum particles](#)—photons, for example—forming a single physical system in spite of the distance between them. Every action performed on one of the two photons has an impact on its "twin" [photon](#). This principle of entanglement leads to quantum non-locality: The measurements and statistics of the properties observed on one of the photons are very closely correlated with those of the other photon. "Quantum non-locality was discovered theoretically by John Stewart Bell in 1964," says Nicolas Brunner, associate professor in the Department of Applied Physics in UNIGE's Faculty of Science. "This showed that photon correlations are exclusively quantum in nature, and so can't be explained by conventional physics. This principle could be used to generate ultra-secure encryption keys."

But what are the implications of this principle of quantum non-locality

when several pairs of photons are placed in a [network](#)? "To answer this question, we devised an experiment involving three pairs of photons that were then separated and dispersed to three points, forming a triangle," says Marc-Olivier Renou, who is also a researcher in the Department of Applied Physics. "At each vertex, two photons from a different pair are processed together."

The physicists subsequently forced the two photons at each vertex of the triangle to entangle by making them interact with each other, before measuring them. They finally showed that the statistics arising from these measurements cannot be explained by any local physical theory. In addition, these statistics are so strongly correlated that they could represent a new form of quantum correlations. "It could become a new version of Bell's theorem, specific to quantum networks," says Nicolas.

This important theoretical discovery underlines the power of quantum correlations in networks, which far exceeds what researchers had originally thought possible. The next step will be to observe these phenomena in the laboratory. "It's not going to be child's play, because conducting an experiment like this is still extremely difficult for the time being," concludes Nicolas Gisin, a professor in UNIGE's Department of Applied Physics.

More information: Marc-Olivier Renou et al, Genuine Quantum Nonlocality in the Triangle Network, *Physical Review Letters* (2019). [DOI: 10.1103/PhysRevLett.123.140401](https://doi.org/10.1103/PhysRevLett.123.140401)

Provided by University of Geneva

Citation: Quantum physics: Ménage à trois photon-style (2019, October 16) retrieved 17 April 2024 from <https://phys.org/news/2019-10-quantum-physics-mnage-trois-photon-style.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.