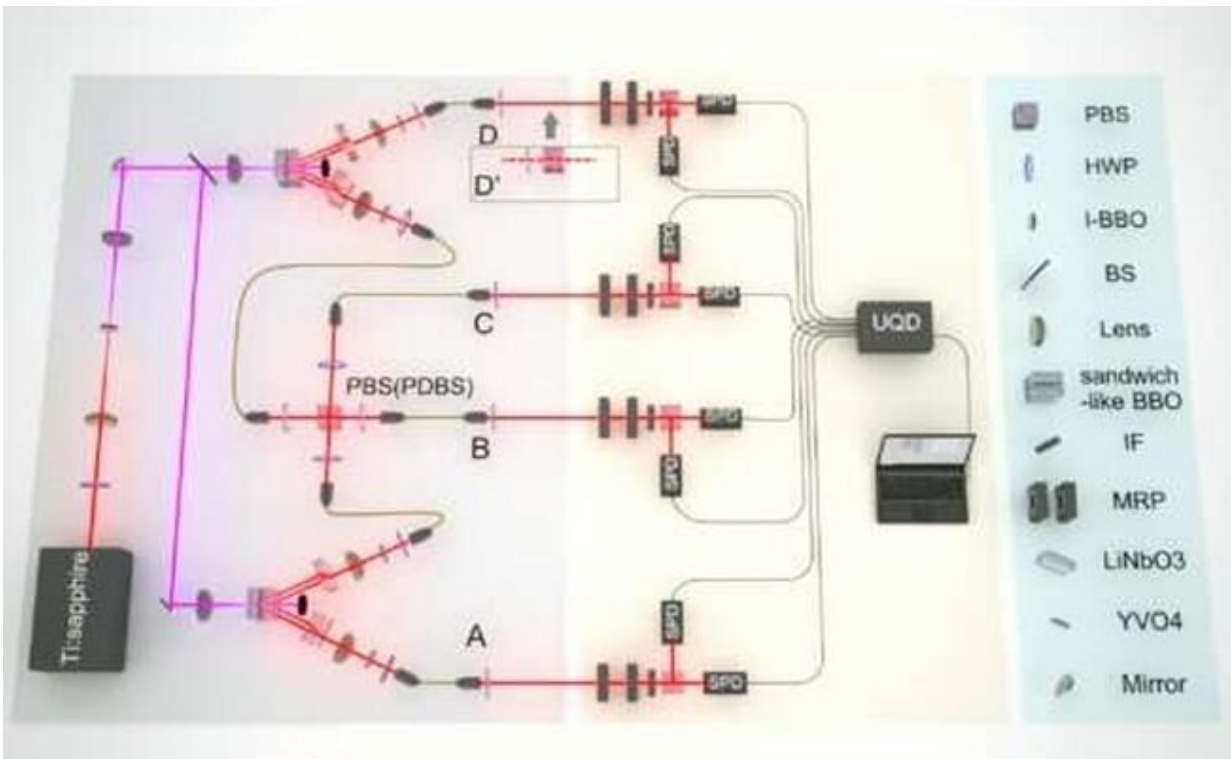


# Researchers certify device-independent genuine multipartite entanglement

November 28 2022, by Liu Jia



Experiment setup of certification of four-photon entanglement. Credit: Zhang Chao et al

Prof. Li Chuanfeng, Prof. Huang Yunfeng, Prof. Chen Geng, and their colleagues from Prof. Guo Guangcan's group at the University of Science and Technology of China (USTC) of the Chinese Academy of Sciences (CAS), collaborating with Swiss academicians, have certified

device-independent genuine multipartite entanglement for the first time and invented a new method to certify genuine multipartite entanglement without making any assumptions on the internal functioning of the measurement device. Their work was published in *Physical Review Letters*.

Genuine multipartite entanglement is considered the most potent form of entanglement and an essential resource for [quantum information processing](#). The full knowledge of the dimensions of the system and accurate calibrations of the measuring instruments that are needed for detecting genuine multipartite entanglement are usually challenging to acquire in an experiment.

In principle, the entanglement properties of a system can be tested by using device-independent measurements and analyzing the violation of Bell inequality in the measurement results without making any assumptions on the system. However, certifying device-independent genuine multipartite entanglement in an arbitrary finite dimension remains challenging due to the difficulty in identifying optimal multipartite Bell inequalities.

By decomposing the internal structure of the multipartite system, the researchers delineated the minimum covering sets and the full covering sets respectively. They then applied the bipartite Bell inequality to examine the multipartite entanglement system. This method could certify genuine multipartite entanglement in arbitrary sizes and forms by using only the Clauser-Horne-Shimony-Holt (CHSH) inequality. It could also measure the weight of genuine multipartite entanglement in multipartite entanglement.

The researchers experimented on four-photon entangled states, and the results showed that the full covering is very tolerant to noise and the minimum covering can achieve higher efficiency while being robust to

noise, that is, the number of the measurement devices does not scale exponentially with the system size. Several vital forms of multipartite entangled states were examined, and the measurements of both coverings proved the existence of genuine multipartite entanglement. The weights of genuine multipartite entanglement in different forms were also calculated.

More importantly, the researchers examined a weakly entangled state that has been proven unable to violate the standard multipartite Bell [inequality](#), which previously made it difficult to determine its genuine entanglement properties by device-independent methods. But in this work which used the new method of decomposing the structure, such weakly entangled states violated the local bound and were confirmed to be genuine multipartite [entanglement](#).

**More information:** Chao Zhang et al, Certification of Genuine Multipartite Entanglement with General and Robust Device-Independent Witnesses, *Physical Review Letters* (2022). [DOI: 10.1103/PhysRevLett.129.190503](#)

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