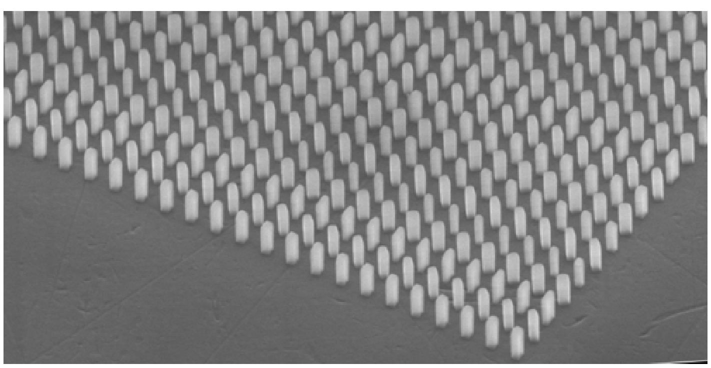
Metasurface Entangles and Distributes Photons

Photons passing through a specially engineered wafer emerge entangled and spread among multiple output channels.

By **Charles Day**

Before photon pairs can serve as conveyors of quantum information, they must be generated, entangled, and distributed. Each of those steps typically entails using at least one bulky, carefully aligned optical component. Mu Wang of Nanjing University in China and his collaborators have now shown that they can realize both entanglement and distribution with a single, passive metasurface [**1**]. The feat, which relies on tailoring quantum interference, boosts prospects that photon-based quantum technologies could be miniaturized.

The metasurface, only a few tenths of a millimeter wide, consists of a wafer of glass topped with two interleaved groups of amorphous silicon nanocuboids. Thanks to the distinct sizes and orientations of the nanocuboids, the two groups can route photons into odd and even diffraction orders—the output channels—while imposing specific polarizations. When two orthogonally polarized photons traverse the metasurface, they interfere, become entangled through their polarization, and appear at each pair of output channels. According to the team's measurements, with seven output channels, all of the 21 possible pairs exhibit entanglement, forming a fully connected distribution network.



Credit: M. Wang/Nanjing University

To confirm that the channels are distinct, Wang and his collaborators measured the transmission of single polarized photons as a function of incidence angle. Each of the seven output channels had a characteristic dependence. The researchers used a technique called quantum state tomography to confirm that emerging photon pairs were entangled. Wang anticipates that the metasurface could be engineered to have as many as 13 output channels, which may generate 78 entangled photon pairs. This is far beyond what is practical with conventional bulk optics.

Charles Day is a Senior Editor for ***Physics Magazine***.

REFERENCES

1. Y. Gao *et al.*, "Interference-induced entanglement engineering on a metasurface," **Phys. Rev. Lett. 136, 023601 (2026).**