CAVITY ELECTRO-OPTICS

Photon conversion integrated

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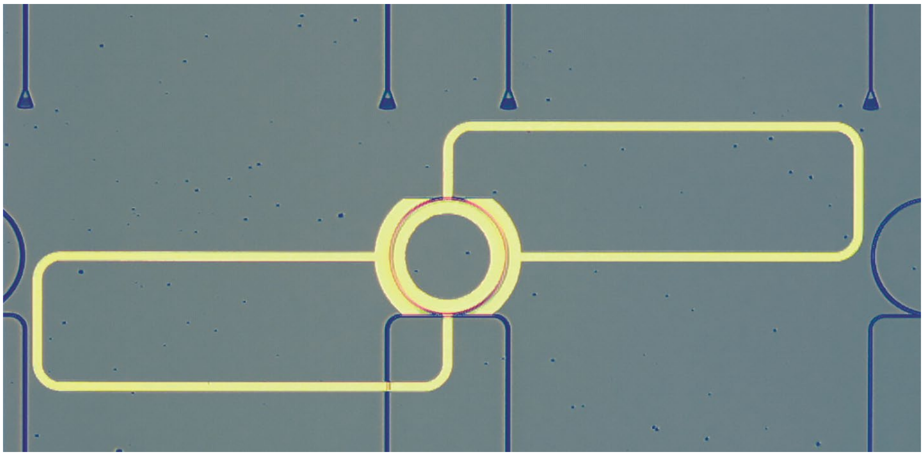

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Efficient conversion between microwave and optical photons is important for the development of hybrid quantum platforms in which quantum information is processed by superconducting circuits and transmitted with optical photons. A promising approach is to use electro-optic modulation with a microwave cavity coupled to an optical cavity, where microwave photons are up-converted to optical photons through sum frequency generation, and optical photons are converted to microwave photons through difference frequency generation. However, the frequency matching conditions in such set-ups usually require the size of the device to be large enough so that the optical frequencies of the pump and signal photons are supported. Hong Tang and colleagues have now fabricated a hybrid superconducting–photonic device that overcomes this limitation by using an integrated planar geometry to coherently convert between microwave and optical photons.

The researchers — who are based at Yale University and Yale Quantum Institute — developed a chip on which planar superconducting resonators are integrated with optical, microring cavities made of aluminium nitride. The planar geometry and optimized shape of the microwave resonator allow the transverse-electric and transverse-magnetic optical modes, which are allowed to propagate in the structure, to be used as pump and signal photons simultaneously. As a result, the frequency matching conditions can be met in a small structure. With the chip, Tang and colleagues demonstrated conversion between microwave and optical photons with an internal conversion efficiency of 25.9% and a total efficiency of 2.05%. Additionally, the frequency difference between pump and signal photons could be tuned precisely over a wide spectral range by applying a voltage.

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