

Nanoscale up-conversion

Photons in the mid-IR range of the electromagnetic spectrum have one-tenth the energy of those in the visible domain. Specialized detectors are capable of measuring those more feeble photons, but thermal noise and other engineering challenges limit the number of environments in which those detectors may be applied. One solution, up-conversion, pairs mid-IR photons with near-IR ones produced from a pump laser. The newly emitted IR photon has a higher frequency and thus a higher energy. The catch is that researchers must find suitable nonlinear crystals that are transparent at all of the involved frequencies and then carefully and painstakingly match the propagation phase of the two sets of photons. This artistic picture shows the polygonal crystalline surface of a new, alternative device for up-converting IR light and then detecting it with more cost-effective, off-the-shelf devices.

In the device shown, spherical gold nanoparticles, about 150 nm in diameter, reside in a similarly sized groove etched into a gold nanofilm. The mid-IR photons are resonantly captured in the groove, which acts as a slot antenna, and meet near-IR photons coming from an overhead pump laser. Those near-IR photons resonantly excite the nanoparticle-groove assembly. The confined, nanometer-wide channels house a monolayer of small organic molecules, which lie well below the diffraction limit of the setup's focusing microscope lens, so no matching of the propagation phase is necessary. The internal vibrations of the molecules in the channel mediate a nonlinear optical interaction that results in coherent up-conversion of mid-IR photons to visible ones. Those photons are then measurable with a conventional detector at ambient conditions. (W. Chen et al., *Science* **374**, 1264, 2021; image courtesy of Nicolas Antille, www.nicolasantille.com.) —AL

TO SUBMIT CANDIDATE IMAGES FOR **BACK SCATTER** VISIT <https://contact.physicstoday.org>.