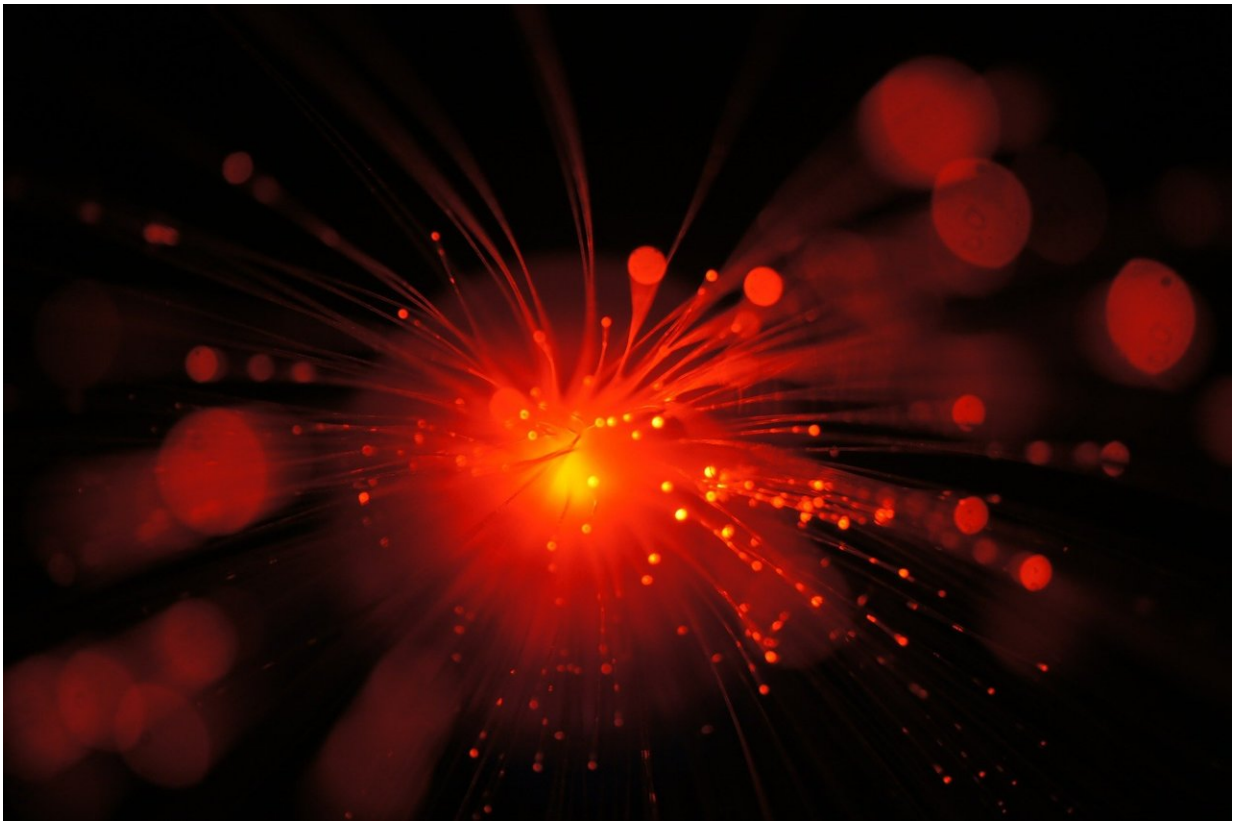


Using a crystal to link visible light to infrared opens a window on infrared sensing

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A cheap, compact technique for analyzing samples at infrared wavelengths using visible-wavelength components could revolutionize medical and material testing.

Infrared spectroscopy is used for material analysis, in forensics and in the identification of historical artifacts, for example,—but scanners are bulky and expensive. Visible-[wavelength](#) technology is cheap and accessible in items such as smartphone cameras and laser pointers.

This led Leonid Krivitsky and colleagues at the A*STAR Data Storage Institute to develop a method in which a laser beam was converted into two linked lower energy beams: The link between the two beams allowed experiments using one beam at [infrared wavelengths](#) to be detected in the second beam, at [visible wavelengths](#).

"It's a very simple setup, uses simple components, and is very compact, and we've hit a resolution comparable with conventional infrared systems," Krivitsky said.

The team fed laser light into a lithium niobate crystal that split some of the laser photons into two quantum-linked photons of lower energies, one in the infrared, and one in the visible parts of the spectrum, through a nonlinear process known as parametric down-conversion.

In a setup similar to a Michelson interferometer, the three beams were separated and were sent to mirrors that reflected them back into the crystal.

When the original [laser](#) beam re-entered the crystal, it created a new pair of down-converted beams that interfered with the light created in the first pass.

It was this interference that the team exploited: a sample placed in the infrared beam affected the interference between first-pass and second-pass beams, which could be detected in both the infrared and visible beams, because they are quantum linked.

Not only does the method allow changes in the infrared beam to be analyzed via the visible beam, it provides more information than conventional spectroscopy. "Because this is an interferometric scheme, you can independently measure absorption and refractive index, which you cannot measure in conventional [infrared spectroscopy](#)," Krivitsky said.

The team were able to gain more information about the sample by systematically changing its position in the [beam](#). With these measurements they were able to construct a three-dimensional image using a technique known as optical coherence tomography.

"It's a very powerful concept. It's a nice combination of spectroscopy, imaging and the ability to widely tune the wavelength," said Krivitsky.

The team analyzed samples at four wavelengths between 1.5 microns and 3 microns, wavelengths that previously required sophisticated lasers and detectors.

The range of the technique can be extended to the near and far infrared by judicious choice of components.

"To the best of our knowledge there is no commercially-available [optical coherence tomography](#) system that operates beyond 1.5 microns," Krivitsky said.

More information: Anna Paterova et al. Measurement of infrared optical constants with visible photons, *New Journal of Physics* (2018). [DOI: 10.1088/1367-2630/aab5ce](https://doi.org/10.1088/1367-2630/aab5ce)

Anna V Paterova et al. Tunable optical coherence tomography in the infrared range using visible photons, *Quantum Science and Technology* (2018). [DOI: 10.1088/2058-9565/aab567](https://doi.org/10.1088/2058-9565/aab567)

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