# New method uses noise to make spectrometers more accurate

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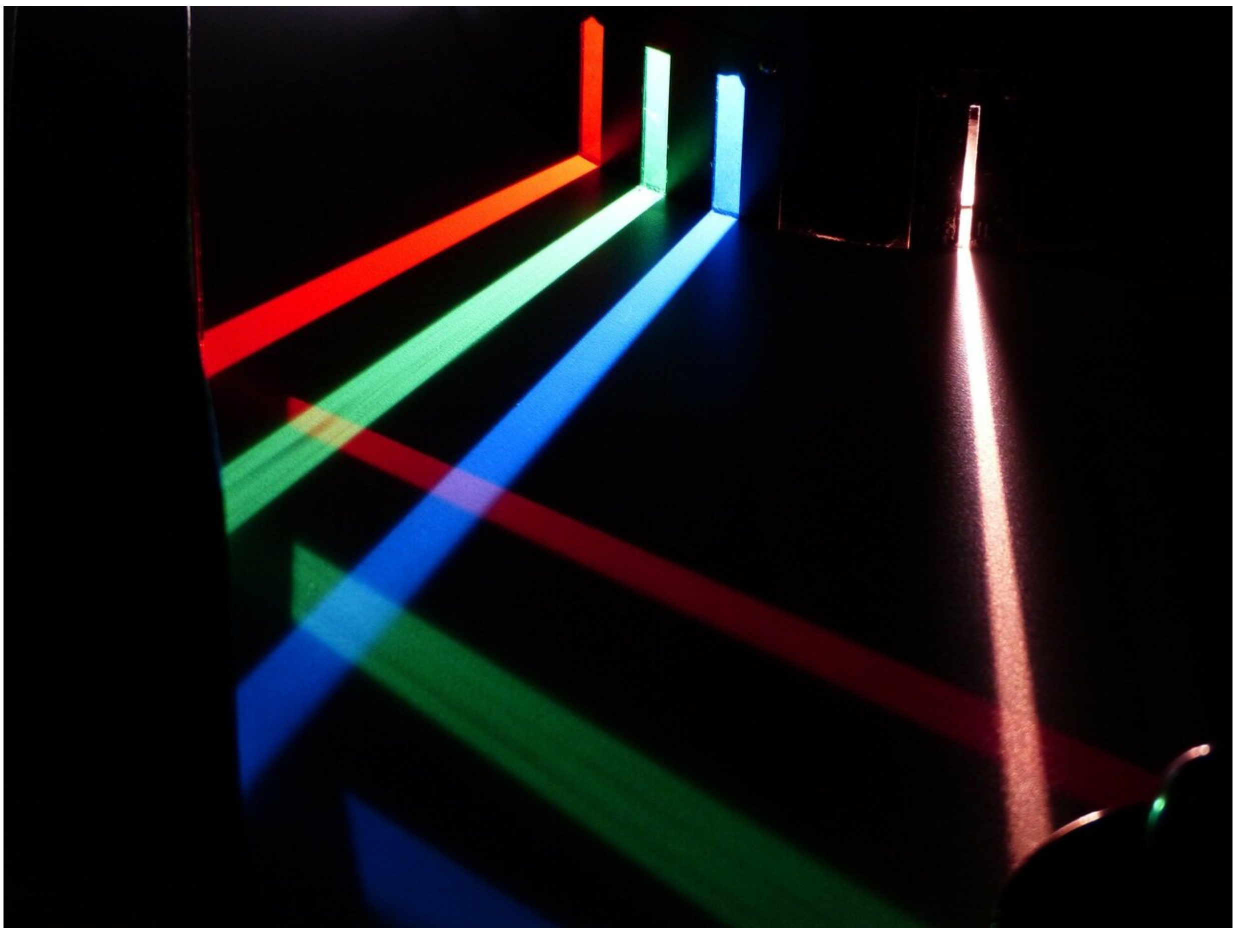

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Optical spectrometers are instruments with a wide variety of uses. By measuring the intensity of light across different wavelengths, they can be used to image tissues or measure the chemical composition of everything from a distant galaxy to a leaf. Now researchers at the UC Davis Department of Biomedical Engineering have come up a with a new, rapid method for characterizing and calibrating spectrometers, based on how they respond to "noise."

## Rendering of prism and spectrum

Spectral resolution measures how well a spectrometer can distinguish light of different wavelengths. It's also important to be able to calibrate the spectrometer so that different instruments will give reliably consistent results. Current methods for characterizing and calibrating spectrometers are relatively slow and cumbersome. For example, to measure how the spectrometer responds to different wavelengths, you would shine multiple lasers of different wavelengths on it.

Noise is usually seen as being a nuisance that confuses measurements. But graduate student Aaron Kho, working with Vivek Srinivasan, associate professor in biomedical engineering and ophthalmology, realized that the excess noise in broadband, multiwavelength light could also serve a useful purpose and replace all those individual lasers.

"The spectrometer's response to noise can be used to infer the spectrometer's response to a real signal," Srinivasan said. That's because the excess noise gives each channel of the spectrum a unique signature.

## Faster, more accurate calibration

Instead of using many single-wavelength lasers to measure the spectrometer's response at each wavelength, the new approach uses only the noise fluctuations that are naturally present in a light source with many wavelengths. In this way, it's possible to assess the spectrometer's performance in just a few seconds. The team also showed that they could use a similar approach to cross-calibrate two different spectrometers.

Kho and Srinivasan used the excess noise method in Optical Coherence Tomography (OCT), a technique for imaging living eye tissue. By increasing the resolution of OCT, they were able to discover a new layer in the mouse retina.

The excess noise technique has similarities to laser speckle, Kho said. Speckle—granular patterns formed when lasers are reflected off surfaces—was originally seen as a nuisance but turns out to be useful in imaging, by providing additional information such as blood flow.

"Similarly, we found that excess noise can be useful too," he said.

These new approaches for characterization and cross-calibration will improve the rigor and reproducibility of data in the many fields that use spectrometers, Srinivasan said, and the insight that excess noise can be useful could lead to the discovery of other applications.

The work was published Oct. 6 in *Light Science & Applications* .

**More information:** Aaron M. Kho et al, Incoherent excess noise spectrally encodes broadband light sources, *Light: Science & Applications* (2020). DOI: 10.1038/s41377-020-00404-6

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