ICFO

Simpler, yet just as precise: the new spectromicroscopy technique proposed at ICFO

Materials do not interact with light in the same way across different frequencies. Understanding how light is absorbed, scattered, or emitted in each case is essential to uncovering a material's optical properties and exploiting them in areas such as optoelectronics or device engineering. However, the external components typically required to capture this spectral information add cost and complexity to experimental setups, limiting their broader use.

Now, researchers at ICFO have proposed a new spectroscopic method that achieves spectral resolution comparable to other state-of-the-art approaches, without the need for such additional elements. The technique, described in ACS Nano, could bring high quality together with greater accessibility and simplicity to this kind of research.

ICFO

November 04, 2025

Conventional electron microscopes, which use electron beams to probe samples, need highly sophisticated and expensive components to gather **spectral information**. For instance, monochromators or electron spectrometers, which control and analyze how the beam's energy changes as it passes through the material.

Although these components can achieve excellent resolution (on the order of millielectronvolts), they considerably increase both the cost and complexity of the overall system. In their ACS Nano paper, ICFO researchers **Prof. ICREA Javier Garcia de Abajo** and **Cruz I. Velasco** present a new spectroscopy method that **delivers comparable spectral and spatial resolution to state-of-the-art approaches without using monochromators or electron spectrometers**. Known as Spectrometer-Free Electron Spectromicroscopy (SFES), the technique seeks to make advanced microscopy **simpler and more accessible without compromising performance**.

The method relies on the interference principle: when an electron beam splits into multiple paths that later recombine, the transmitted current follows an interference pattern. The researchers propose irradiating the sample with a laser and placing it along one of these paths so that only that beam interacts with the light scattered by the sample. This interaction changes the energy of the affected electrons, altering the interference pattern. In turn, it reveals how the material responds to the light's frequency at the point where the electron beam hits the sample.

They also suggest incorporating special ï¿½masksï¿½ that act as electron gates. These w uld be designed to completely block the electron beams and their interference pattern in the absence of a sample and illumination; the gates would remain closed. Once a sampl is introduced and the interference pattern shifts due to interactions between electrons and the optical fields generated by the illuminated material, the masks would no longer fully b ock the current; the gates would o en. The researchers further demonstrated that the transmitted current is directly related to the sample's optical properties. By adjusting the laser frequency and the position of the elec ron beam, one could measure changes in the transmitted electrical current and, from them, i fer the material's optical response at each point and for each freque cy. SFES can therefore retrieve spectral information without directly measuring the electr ns' energy, eliminating the need for monochromators and spectrometers, which gre tly simplifies the setup. The authors now hope that an experimental team will soon put t eir proposal to the t

Reference:

F. Javier Garcia de Abajo and Cruz I. Velasco, Spectrometer-Free Electron

Spectromicroscopy, ACS Nano 2025 19 (40), 35770-35776.
DOI: 10.1021/acsnano.5c12286

Acknowledgements:
This work was supported by the European Research Council (Grant No. 101141220-QUEFES).