Scilight

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Entangled photon pairs lead to optimized quantum spectroscopy

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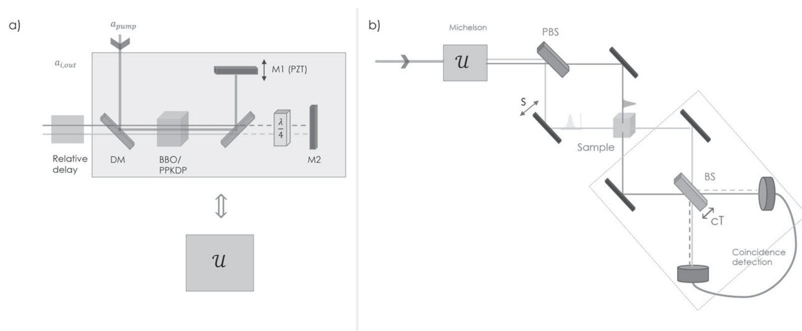
Quantum dynamics of molecules and photons used to explore nonlinear interferometric spectroscopy



Quantum information and computing applications make use of the quantum nature of light. Asban et al. demonstrated how to use a new source of quantum light, entangled photons, to further enhance the qualities of quantum spectroscopy.

"Connecting the two fields of quantum information and spectroscopy poses an exciting and promising challenge," said co-author Shaul Mukamel.

Spectroscopy typically uses classical light by varying frequencies or delaying the timing of optical pulses. However, high spectral, temporal, and spatial resolutions are not always attainable through these means.

Quantum spectroscopy combines state-of-the-art quantum optics technology with molecular science. Interferometric setups utilize the quantum inference of matter by mixing matter and light variables.

Using time-resolved photon counting signals induced by an entangled photon pair, the researchers developed a modular framework that simplifies the interferometric setup. A complete protocol for the interpretation of quantum spectroscopy is provided.

"This paper lays the foundations for the design and interpretation of brand new classes of measurements where the joint quantum dynamics of molecules and photons are utilized to explore new aspects of electron and nuclear dynamics," said Mukamel.

Future research will focus on nonlinear ultrafast spectroscopy allowing for further studies, such as the electron and energy transfer processes in photosynthesis without damaging the biological samples with strong light sources.

"These processes will be studied and optimized to reach desired goals, including directing electrons into specific sites, selecting and imaging desired pathways, and optimizing light harvesting in photosynthetic and artificial devices," said Mukamel.

Source: "Nonlinear quantum interferometric spectroscopy with entangled photon pairs," by Shahaf Asban, Vladimir Y. Chernyak, and Shaul Mukamel, *Journal of Chemical Physics* (2022). The article can be accessed at https://doi.org/10.1063/5.0079049.