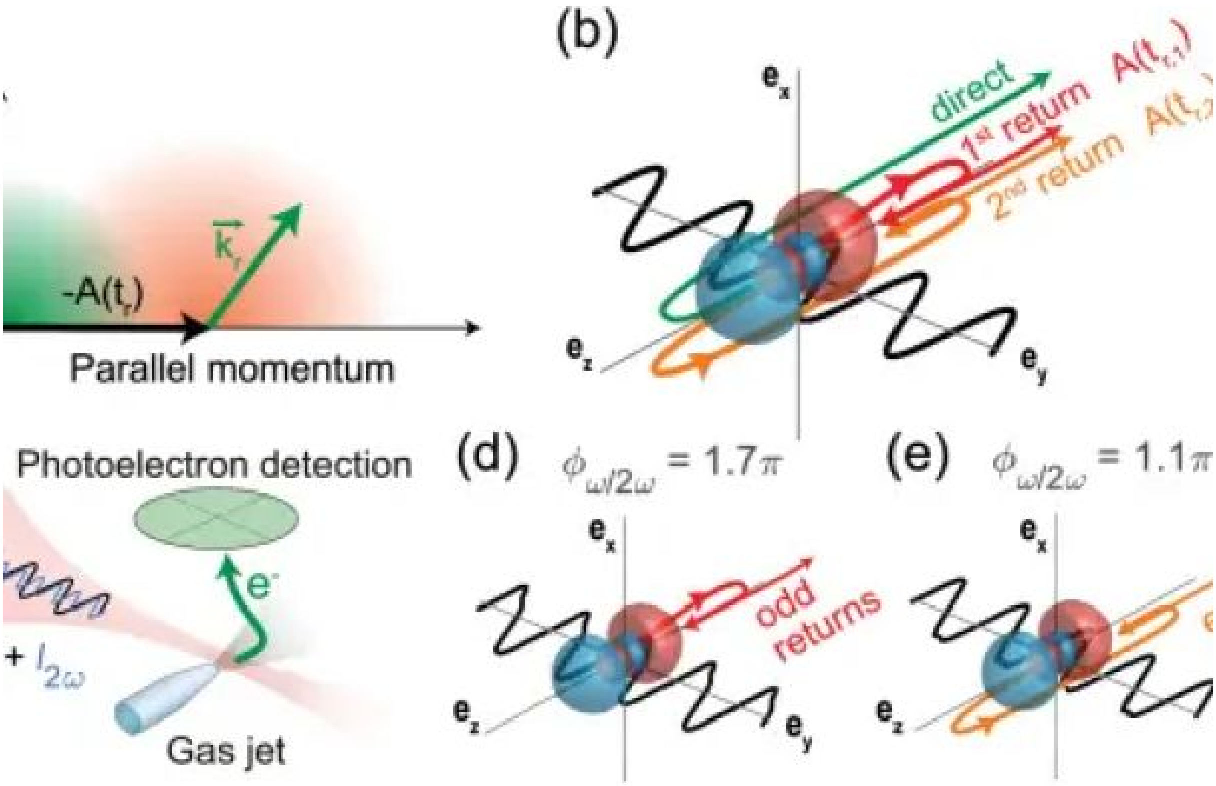

A tailored laser field to manipulate quantum pathways

A team of researchers published an experiment in Optica that enables the manipulation of electrons' different quantum trajectories using a phase-controlled and tailored two-color lase field.

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Have you ever asked yourself what is the ultimate limit to image a molecule? To i¿½seei ?½ where all the atoms of one molecule are located in space, one needs picometer s ace resolution. To also i¿½watchi¿½ how the molecule starts undergoing a chemical react on, one needs attosecond temporal resolution as well. Laser-induced electron diffraction (LIED is the only technique that combines picometer with sub-cycle resolution, and it can i age one isolated molecule with only one of its own electrons. Quantum mechanically, ven one electron can be at different locations at the same time. Thus, to achieve the ultimat limit, one would need to eliminate the electron's different quantum paths to achieve the hysica

Manipulating the photoelectron quantum trajectories

This is exactly what was achieved in the experiment, published in Optica, by ICFO researchers **Aurelien Sanchez**, **Kasra Amini** and **Tobias Steinle**, led by **ICREA Prof. at ICFO Jens Biegert**, in collaboration with researchers at the University of Rostock in Germany, the Weizmann Institute of Science and Technion in Israel

In the article, the team uses a phase-controlled and tailored two-color laser field t manipulate the rescattering pathways, enabling, on one hand, the selection of specifi quantum pathways and on the other hand, the precise mapping of the electron momentu to rescattering time

Researchers first conducted near-infrared (NIR) and mid-infrared (MIR) experiments usin two-color laser fields and manipulated the laser parameters to control the relative phases an intensities. The wavelengths used were 788 nm in NIR and 3.2 m in MIR, with a pul e duration of 30 fs and 50 fs respectivel . Then, they detected and measured the emitted photoelectrons by usi g velocity-map-imaging (VMI) and reaction microscopes, and saw that in the MIR experiment , there was a clear separation between the trajectories. To be able to further understand t e underlying quantum dynamics, they analyzed the time-resolved spectra using theoretic l simulations, differentiating between the even- and odd-order rescattering return . Finally, they could isolate the single electron trajectories removing the unwant d interferences, and were able to unambiguously map the energy and the rescattering time. y tuning the different parameters - such as the relative intensity ratio two-color field or t e phase difference-, researchers were able to control the contributions of long and sho t electron trajectorie . By combining experimental approaches and theoretical simulations (time-depende t Schrodinger equation), the article demonstrates that a phase-controlled two-color laser fie d can shape quantum trajectories in LIED measurements. Being able to control and sele t specific ionizing quantum trajectories can impact several applications in ultrafast physics a d imaging space and time.