The crystal symmetry dependence of high-harmonic generation in monolayer dichalcogenides

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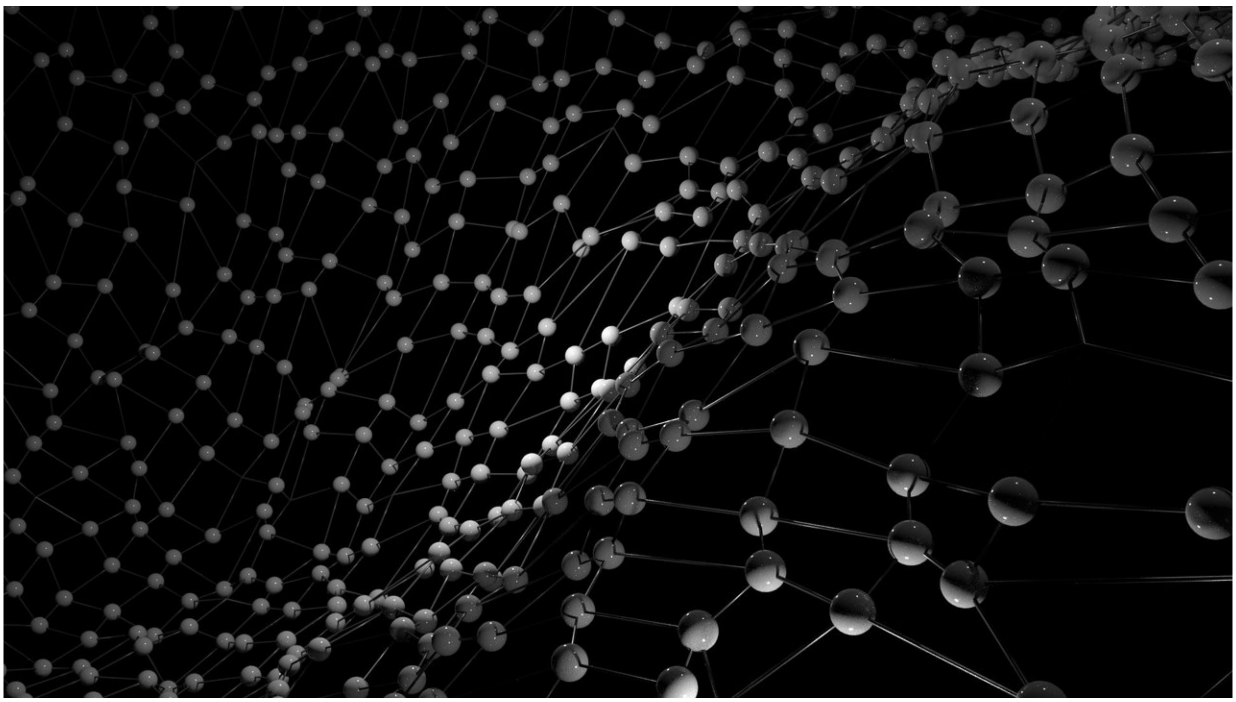

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The light-matter interaction has long been one of the most advanced areas in physics. Recently, it has attracted more attentions due to the rapid development of ultra-short lasers, and a variety of ultra-fast phenomena have been experimentally achieved, including band structure, transition dipole moments, and Berry curvature.

Solid-state high-harmonic generation (HHG), especially HHG from monolayer transition-metal dichalcogenides (TMDCs), has emerged as a novel spectroscopic tool for the ultrafast phenomena. However, many obstacles severely hinder the development of solid-state HHG.

Crystal symmetry, as one of the most important factors governing the process of solid-state HHG, is of urgently demands to be investigated because of the negative impact in the emission of HHG. Therefore, systematic analysis of the HHG from monolayer TMDCs can greatly help to complete the picture of the role of symmetry effects.

A research team led by Prof. Dr. Shamnhu Ghimire from Stanford University presented an investigation referring to the crystal-orientation dependence of HHG in monolayer transition-metal dichalcogenides, WS_2 and $MoSe_2$. The results were published in *Ultrafast Science*.

According the researchers, they used difference-frequency generation (DFG) system as an optical pump. The source of DFG system was a Ti: sapphire femtosecond midinfrared laser followed by optical parametric amplification.

The simulation based on semiconductor Bloch equations was also performed to verify the experimental results. Specifically, the smaller laser amplitude is selected for comparison, which is well agreement with the experimental results.

The results indicate that the polarization direction of odd-order harmonics in WS_2 smoothly follows that of the driving laser field irrespective of crystal orientation. Moreover, the polarization characteristics exhibit a flip during the crystal symmetry.

As for $MoSe_2$, exhibiting noticeable deviations of high-harmonic signals, was also investigated. The 10th harmonic is maximized for parallel excitation and its polarization demonstrates a clear contrast between the other even-order harmonics.

This work suggested the capabilities of the polarization-resolved HHG measurements to reveal the roles of the intra-band and inter-band contributions as well as the deflection of the electron-hole trajectories by non-parabolic bands in the crystal.

More information: Yuki Kobayashi et al, Polarization Flipping of Even-Order Harmonics in Monolayer Transition-Metal Dichalcogenides, *Ultrafast Science* (2021). DOI: 10.34133/2021/9820716

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