

# Ellipticity Dependence of High Harmonic Generation in MoS<sub>2</sub> Monolayer

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In this contribution we experimentally demonstrate that the polarization dependence of high order harmonic generation (HHG) in single layer transition metal dichalcogenides (TMD's) materials strongly depends on the orientation of the polarization ellipse in respect to the symmetry axes of the crystal and distinctly different for even and odd orders of harmonic. The Harmonics were generated by 120 fs, 3.5  $\mu\text{m}$  wavelength laser pulses with the intensity up to 1.3 TW/cm<sup>2</sup> in a monolayer of MoS<sub>2</sub>. The laser polarization was controlled by broadband  $\lambda/4$  and  $\lambda/2$  waveplates, allowing for orientation of the polarization ellipse in respect to the crystal axes. The polarization components of the harmonic emission, parallel and orthogonal to the major axis of the laser polarization, were analysed using a wire grid polarizer placed in front of the spectrometer. We investigate the dependence of the polarization components

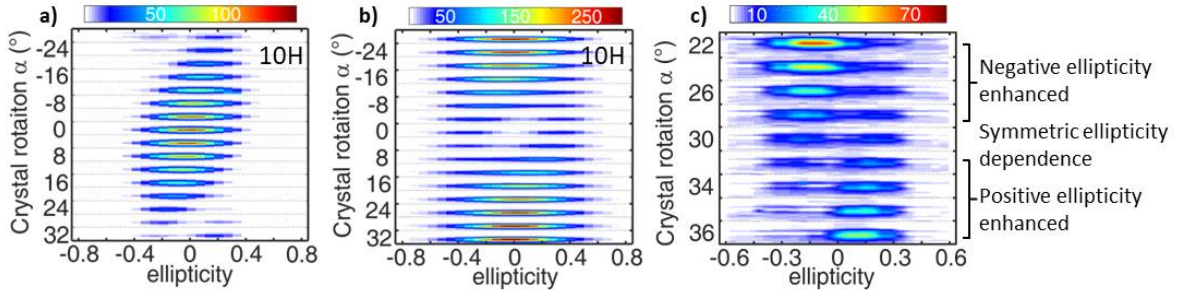


Figure 1: Ellipticity and orientation dependent intensity of 10<sup>th</sup> harmonic in the component, polarised a) parallel and b) orthogonal to the laser polarization. c) Zoomed region from a) around 30° crystal orientation angle (zigzag direction), showing transition from symmetric to strongly asymmetric ellipticity dependence

in harmonics emission parallel and orthogonal to the pump polarization for different orientations of the polarization ellipse in respect to the symmetry axes of the crystal. The exemplary results for 10<sup>th</sup> order harmonic are shown in Fig.1. For even harmonics (6<sup>th</sup>, 8<sup>th</sup> and 10<sup>th</sup>) we observe that the parallel component of the harmonic field shows helicity independent intensity enhancement for the pump ellipticity  $\pm 0.2$  along the zigzag symmetry direction of the crystal (30° rotation angle in Fig.1a). Rotation of the crystal towards armchair direction results in helicity dependent enhancement with the maximum of the asymmetry between the negative and positive ellipticities for the crystal orientation  $\approx 8^\circ$  from the zigzag direction (Fig.1c). The orthogonal component of the harmonic field shows similar behaviour but with the symmetric enhancement for the armchair crystal orientation and maximum of the asymmetry  $\approx 8^\circ$  from the armchair direction. Also, we observe that the helicity dependence in 8<sup>th</sup> harmonic has opposite sign to the helicity dependence of the 10<sup>th</sup> harmonic. Finally, odd order harmonics show no ellipticity enhancement for any orientation of the polarization ellipse in respect to the crystal symmetry axes.