Spatial modulations of the density of states due to atomic defects in bulk ZrSe$_2$

Andreas Ørsted, Alessandro Scarfato, Enrico Giannini, and Christoph Renner

University of Geneva

ZrSe$_2$ is a transition metal dichalcogenide (TMD), isoelectronic with TiSe$_2$. Yet, the two materials are strikingly different. TiSe$_2$ is a semi-metal hosting a 2x2 charge density wave (CDW) phase, while ZrSe$_2$ in its pristine bulk form is an insulator and does not support a CDW phase. However, a recent study of mono- and few-layer ZrSe$_2$ on graphene reports the observation of a 2x2 CDW driven by charge transfer from the substrate. [1] Here we use low-temperature scanning tunnelling microscopy (STM) and spectroscopy (STS) to study in-situ (UHV) cleaved bulk ZrSe$_2$ crystals. We present a spectroscopic investigation of various native defects and the spatial extent of their influence on the electronic structure of ZrSe$_2$. Our study finds spatial modulations in the LDOS consistent with the previously reported results. These observations suggest that a similar CDW phase in bulk ZrSe$_2$ may be driven by native atomic defects.