Exciton-driven Floquet-Bloch States in 2D Semiconductors

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1. Introduction

Floquet engineering, in which a temporal periodic drive breaks the continuous temporal symmetry and dynamically engineers the electronic structure, has attracted enormous attention in condensed matter physics. However, only a handful of studies have experimentally demonstrated Floquet effects driven by optical fields [1-4], which are limited by weak light-matter interactions. Meanwhile, theoretically it is predicted that an internal oscillating field, such as phonons and excitons, could also drive giant Floquet effects without the undesirable aspects of the optical case [5,6]. In this talk, we will discuss the experimental observation of the Floquet-Bloch states induced by the excitons in 2D semiconductors.

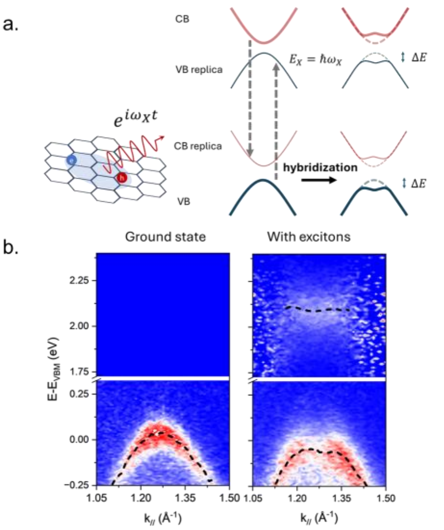

Figure 1. a. Schematics of Floquet effects driven by excitons**.** The bands are replicated by energy of exciton. The original valence band hybridize with the conduction band replica, transforming to Mexican-hat dispersion. b. ARPES spectrum of (left) ground state of valence band, (right) the valence band and its replica with excitons ($N_X = 3\times10^{12}$ cm^{-2}).

2. Experiment

We perform experiments on monolayer WS_2 using time-and angle-resolved photoemission spectroscopy (Tr-ARPES). The experimental setup, as employed in our previous studies [7,8], consists of a home-built table-top beamline generating 21.7-eV XUV probe to photoemit the electrons from the sample. The electrons are further analyzed by a momentum microscope to map the 3D band-structure of the material (E, kx, ky).

To study Floquet effects driven by excitons, a pump pulse resonant with the WS_2 A exciton (2.1eV) is used to excite the sample. As shown in figure 1(b), we observe the striking change of dispersion around the center of valence band top, transforming from ground-state parabolic dispersion to Mexican-hat dispersion. This change results from the hybridization of the valence band and the conduction band replica dressed by excitons. Similar change is also observed in the replica of valence band at 2.1eV.

3. Conclusions

Using Tr-ARPES, we studied the Floquet-Bloch states in 2D semiconductors, driven by the excitonic field internally.

Acknowledgements

This work was supported in part by JSPS Kakenhi grant number 21H01020. Funding was also provided in part by the Femtosecond Spectroscopy Unit of the Okinawa Institute of Science and Technology Graduate University. We thank the OIST engineering support section for their support.

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