Moiré phonons in twisted $MoSe_2$-WSe_2 heterobilayers and their correlation with interlayer excitons

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We report about the investigation of twisted $MoSe_2$–WSe_2 heterobilayers by means of low-frequency Raman spectroscopy (LFRS) and low-temperature micro photoluminescence (μPL) [1]. We identify moiré phonons of both constituting materials in heterobilayers, which enables us to determine the relative twist angles of the heterobilayers on a local scale with high precision. On the other hand, atomic reconstruction [2,3] at small twist angles can be probed by the observation of an interlayer shear mode (ISM) [4]. We apply this technique to a H-type heterobilayer (Figs. **(c)** and **(f)**): Atomically reconstructed regions, which are identified by the observation of an ISM in LFRS experiments (Figs. **(b)** and **(f)**), exhibit in μPL a strong, momentum-allowed interlayer-exciton signal (Fig. **(e)**). On the contrary, regions, where moiré phonons are observed (Figs. **(a)** and **(f)**), exhibit no significant interlayer-exciton signal (Fig. **(d)**).

References

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[3] Weston A *et al.*, Nat. Nanotechnology **15** (2020) 592
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Figures

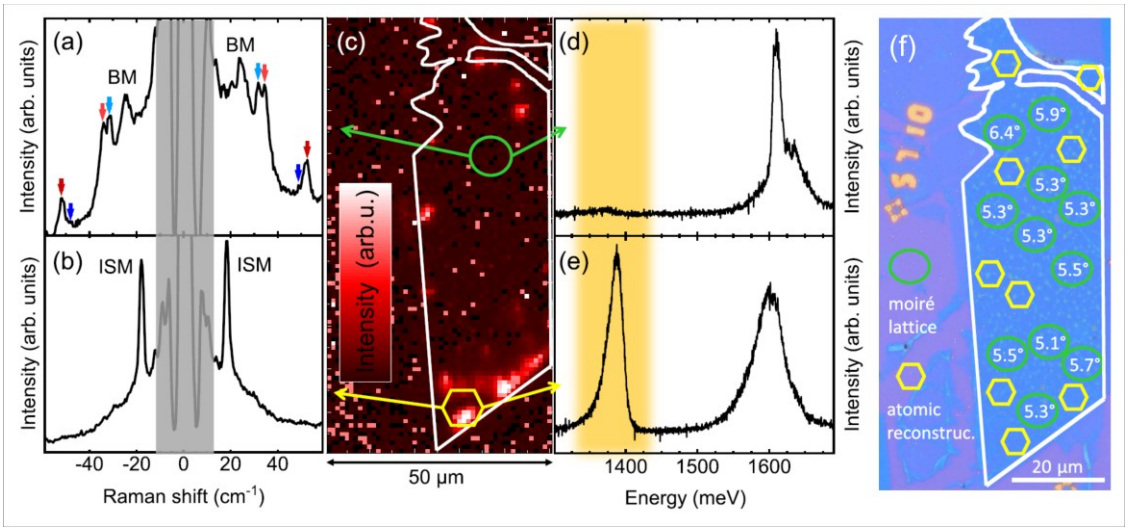

Figure: Local determination of the twist angle and identification of regions with atomic reconstruction in a twisted $MoSe_2$-WSe_2 heterobilayer ((c) and (f)) via LFRS of moiré phonons (a) and an interlayer shear mode (ISM) (b) as explained in the text. Regions with atomic reconstruction show a strong interlayer exciton (e), while regions with moiré lattice do not (d). LFRS allows us to identify regions of atomic reconstruction and such with a finite twist angle on a local scale (f).