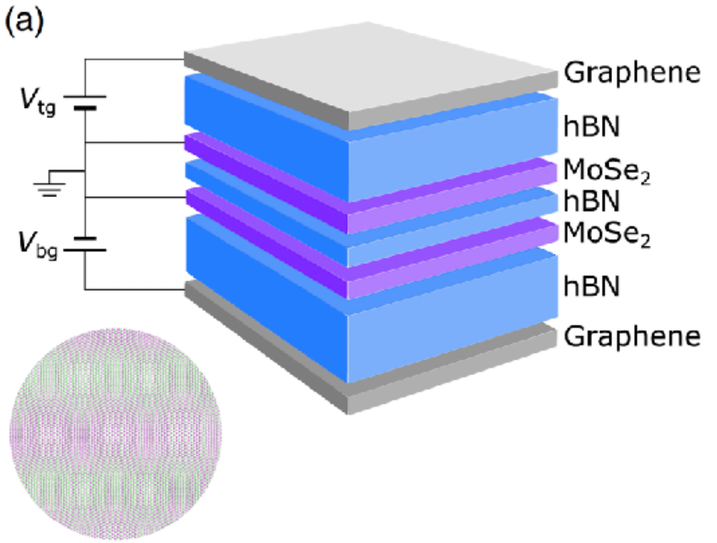
Homobilayers heterostructures:
exciton-polaron spectroscopy of incompressible electronic states

Giacomo Mazza - Unige -

Flat Club - Mar 2022 -

Optical Signatures of Periodic Charge Distribution in a Mott-like Correlated Insulator State

Yuya Shimazaki,[1*,‡,§] Clemens Kuhlenkamp,[1,2,3,‡] Ido Schwartz,[1,‡] Tomasz Smoleński,[1,‡] Kenji Watanabe,[4] Takashi Taniguchi,[5] Martin Kroner,[1] Richard Schmidt,[3,6] Michael Knap,[2,3] and Ataç Imamoğlu[1,†]



Article

Strongly correlated electrons and hybrid excitons in a moiré heterostructure

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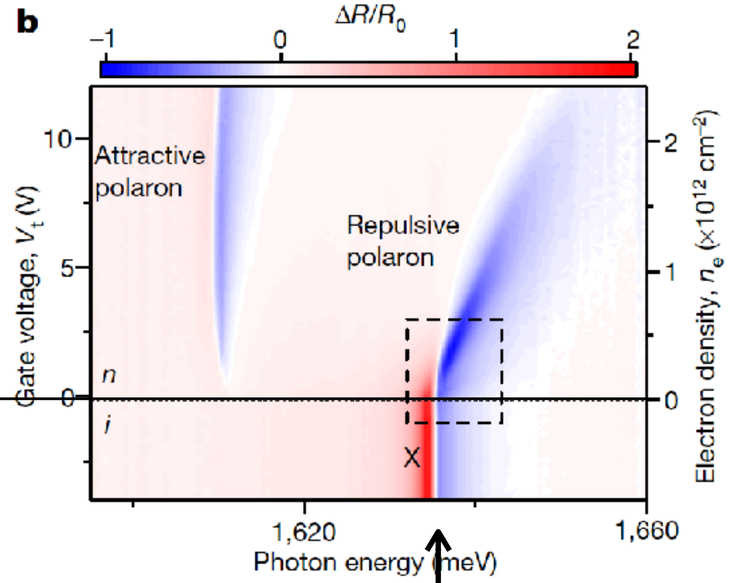
- Exciton-polaron spectroscopy on homobilyers heterostructure $MoSe_2$-hBN-$MoSe_2$
- Incompressible (Mott-like) electronic states

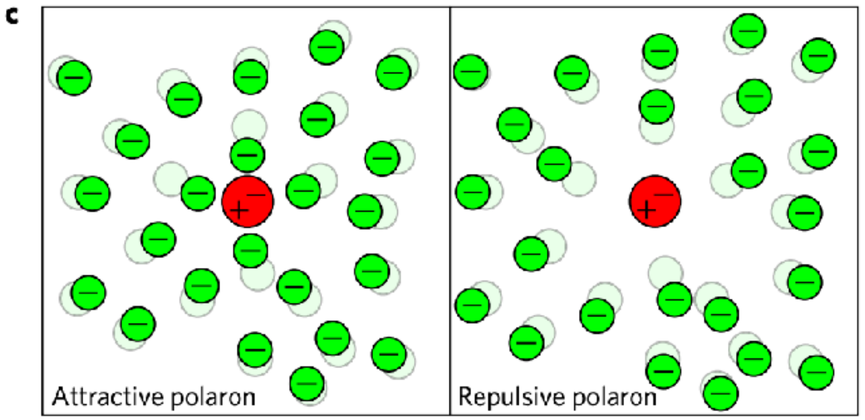
exciton polarons



electron doped

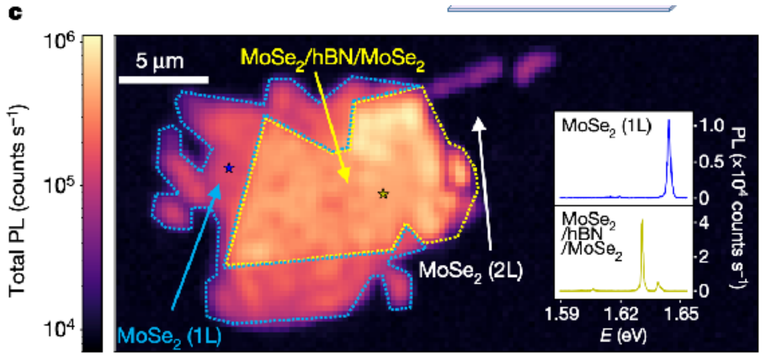
charge neutral

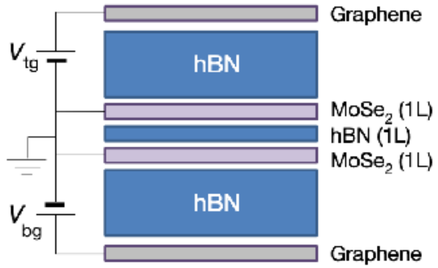
bare exciton



T. Smolensy *et al* Nature 595, 53–57 (2021)

M. Sidler *et al* Nature Physics 13, 255–261 (2017)

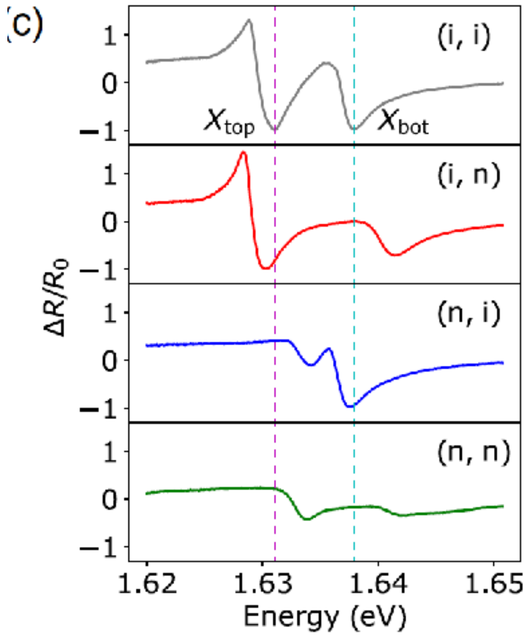


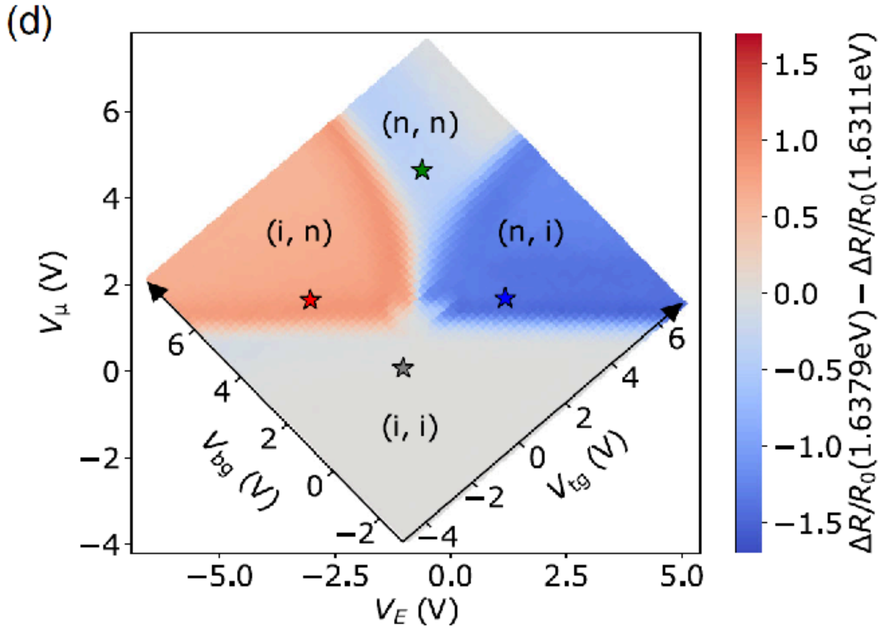


- double gate structure
- twist angle $\theta \sim 0.8$

$a_M \sim 25$ nm

charging diagram





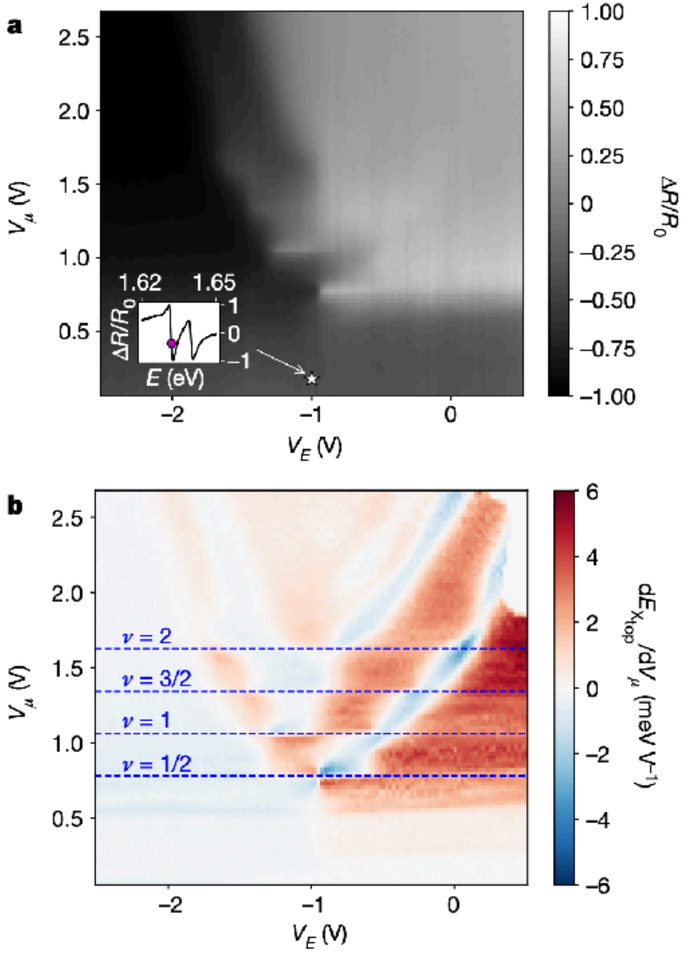
(i) = charge neutral

(n) = electron doped

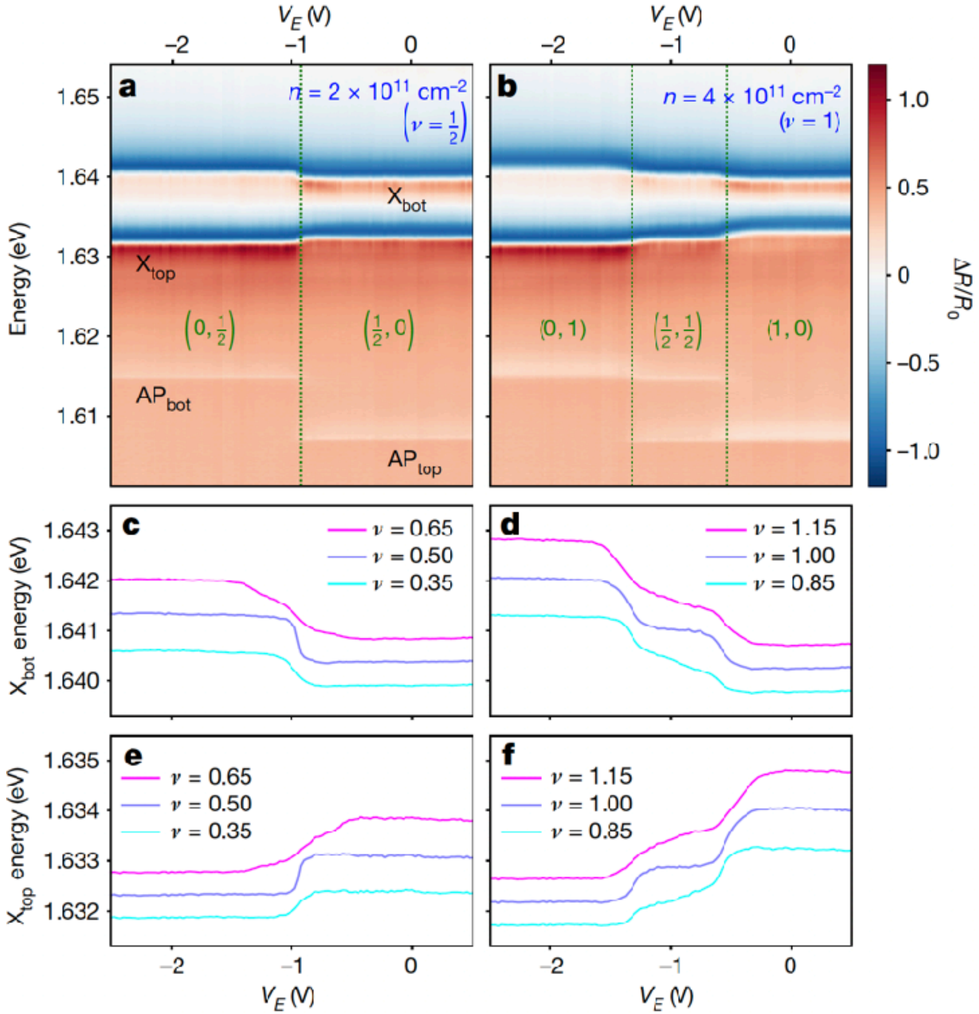
$$V_E = 0.5V_{\mathrm{tg}} - 0.5V_{\mathrm{bg}}$$

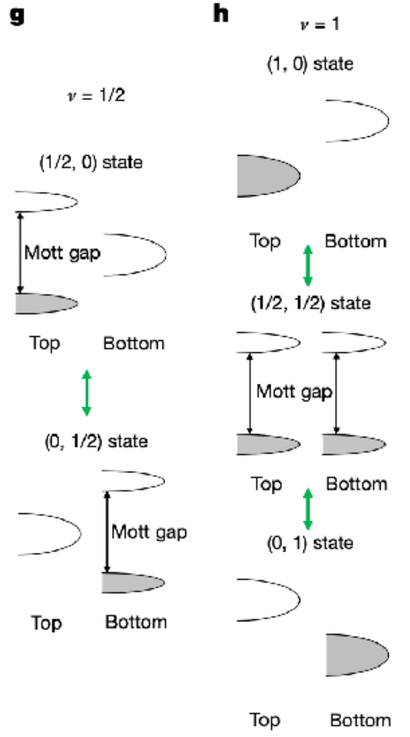
$$V_\mu = 0.45V_{\mathrm{tg}} + 0.55V_{\mathrm{bg}}$$

layer-by-layer filling



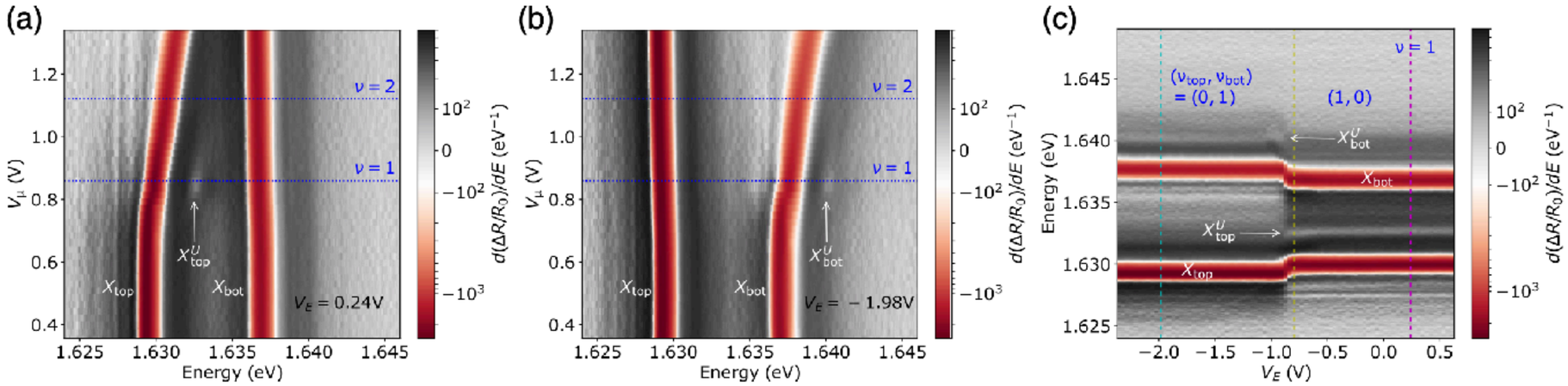
polarisation switching of incompressible electronic



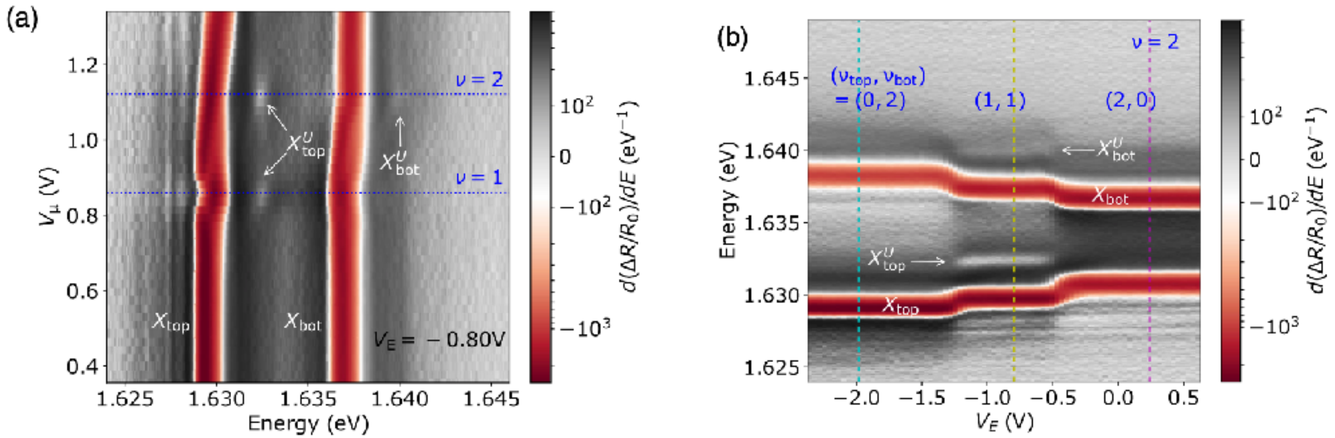


umklapp exciton-polaron peak

$V_E = 0.24$ V



$V_E = -0.80$ V



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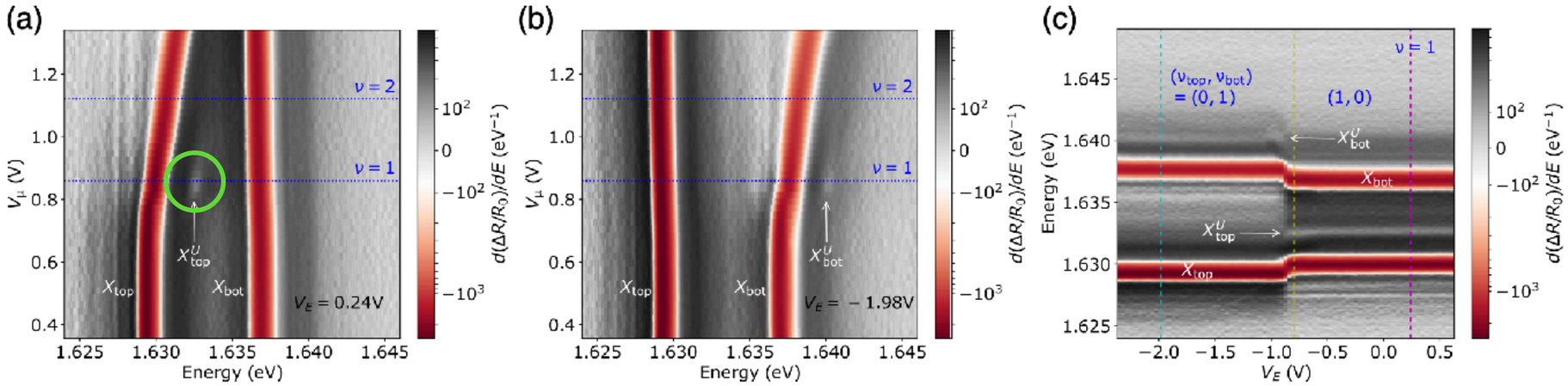

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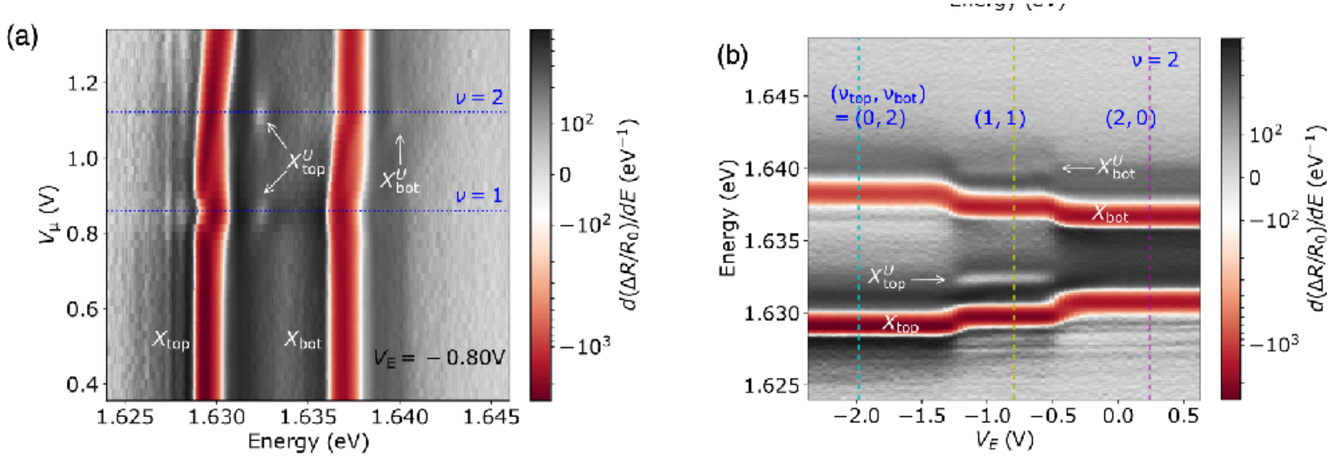

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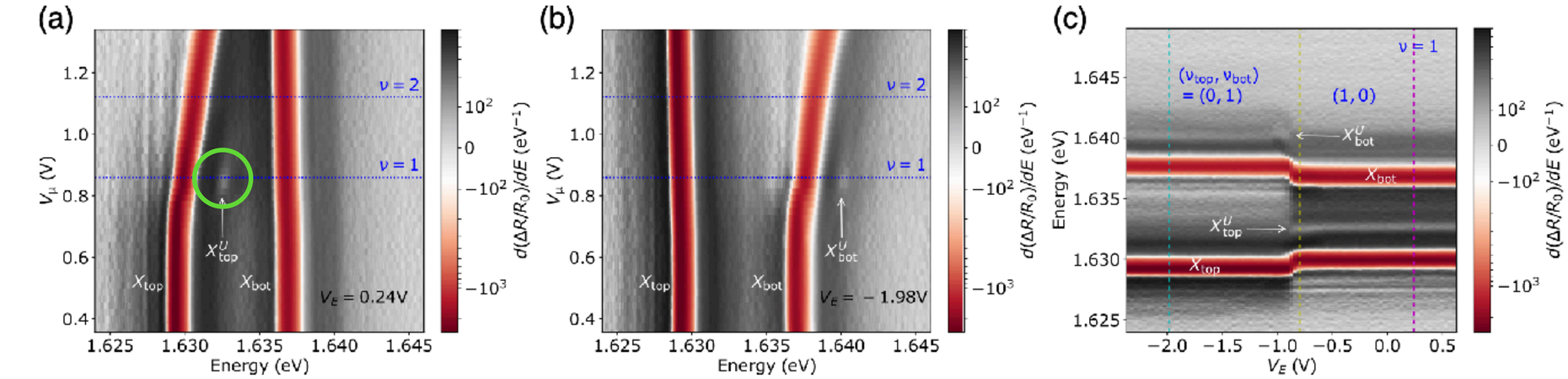

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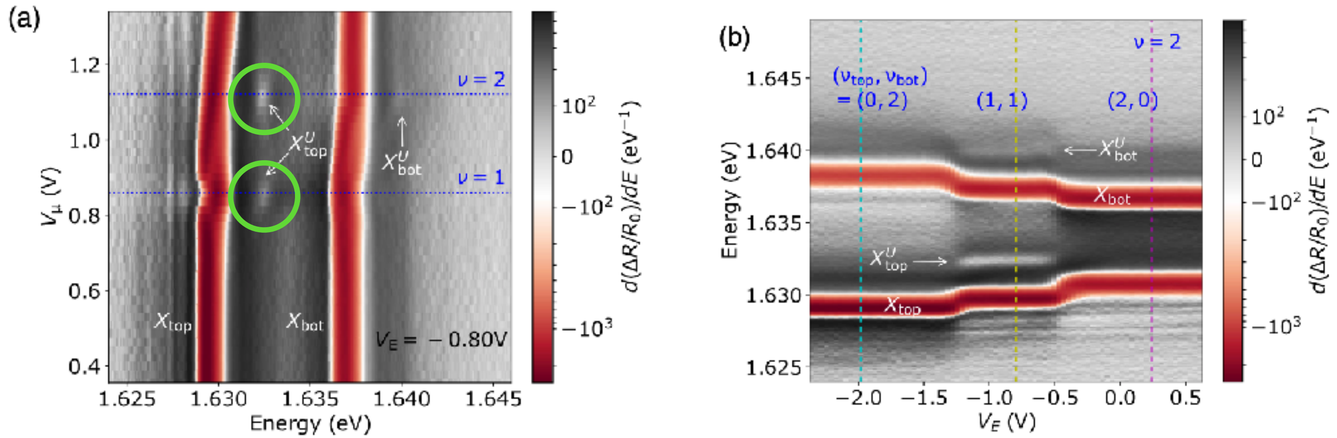
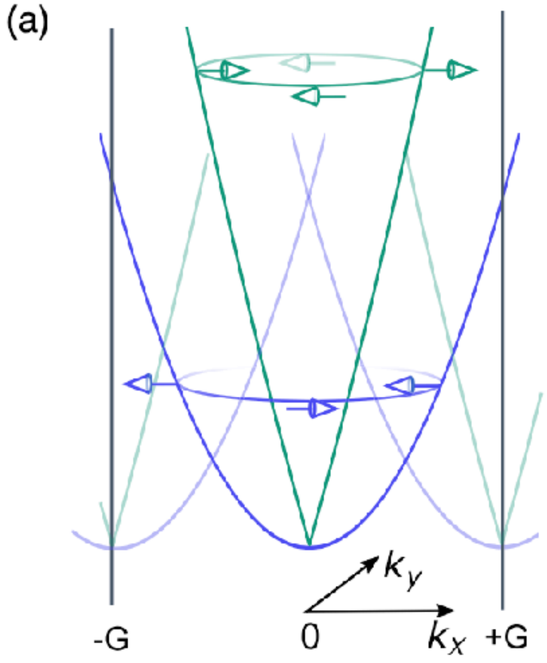
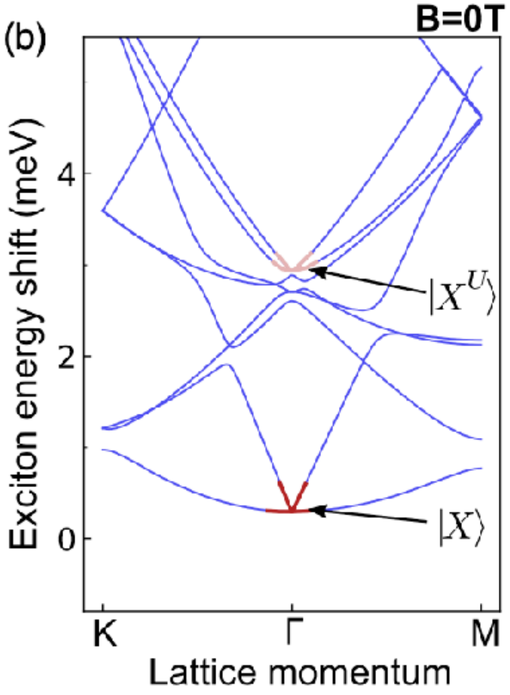
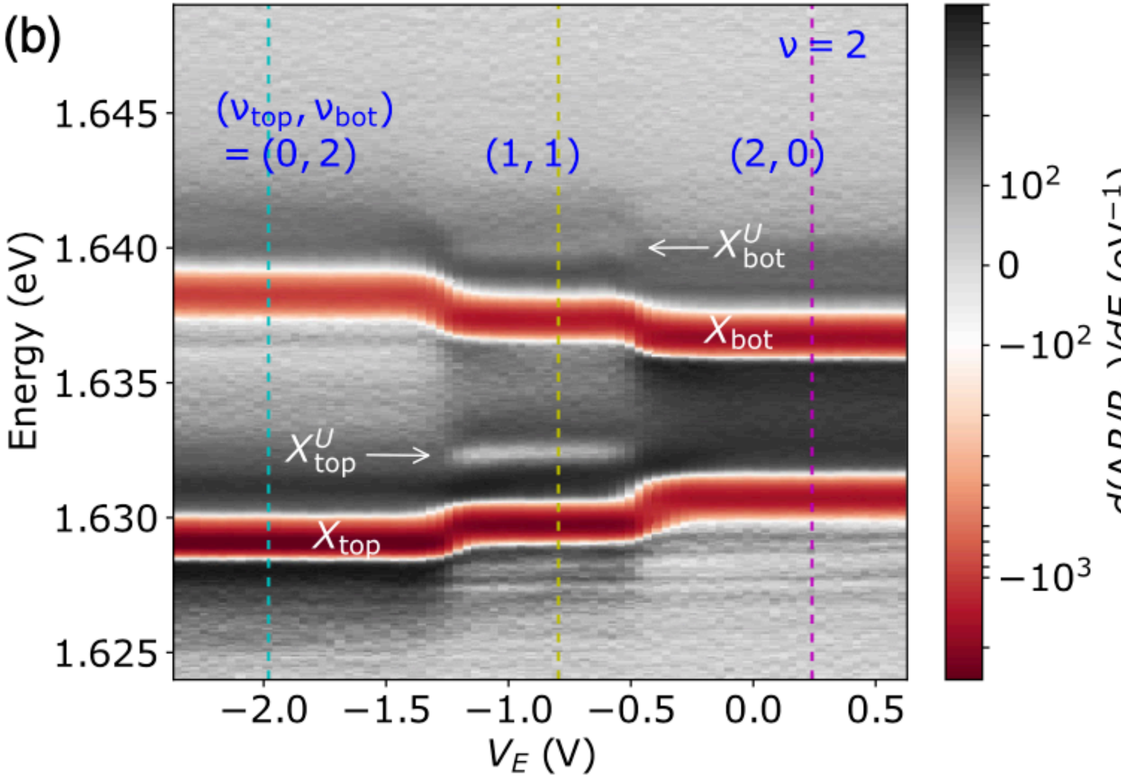


umklapp scattering from a periodic arrangement of charges (~ Mott localised)

$$n_{el}(\mathbf{x}) \sim \sum_{\mathbf{R}\in\text{triangular lattice}} e^{-\frac{(\mathbf{x}-\mathbf{R})^2}{\xi^2}}$$







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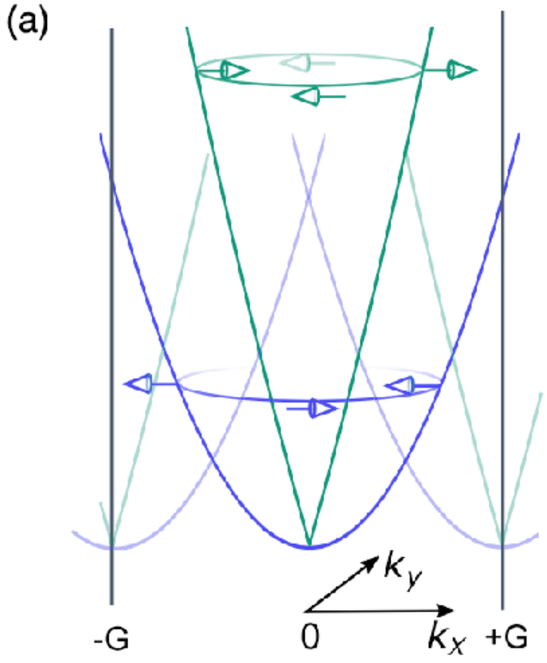
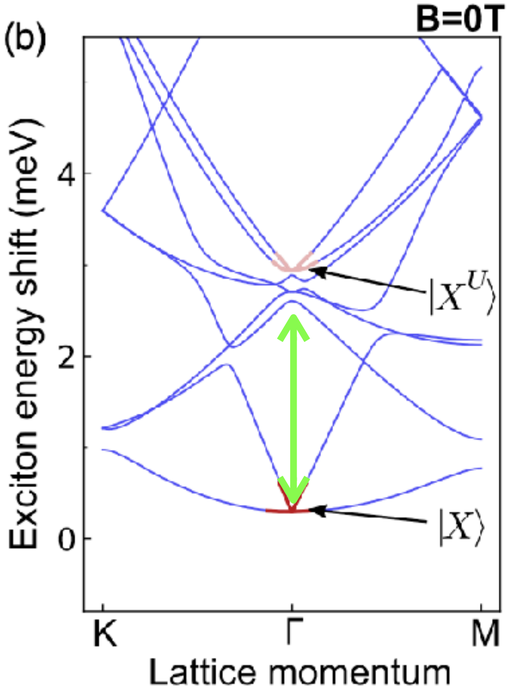
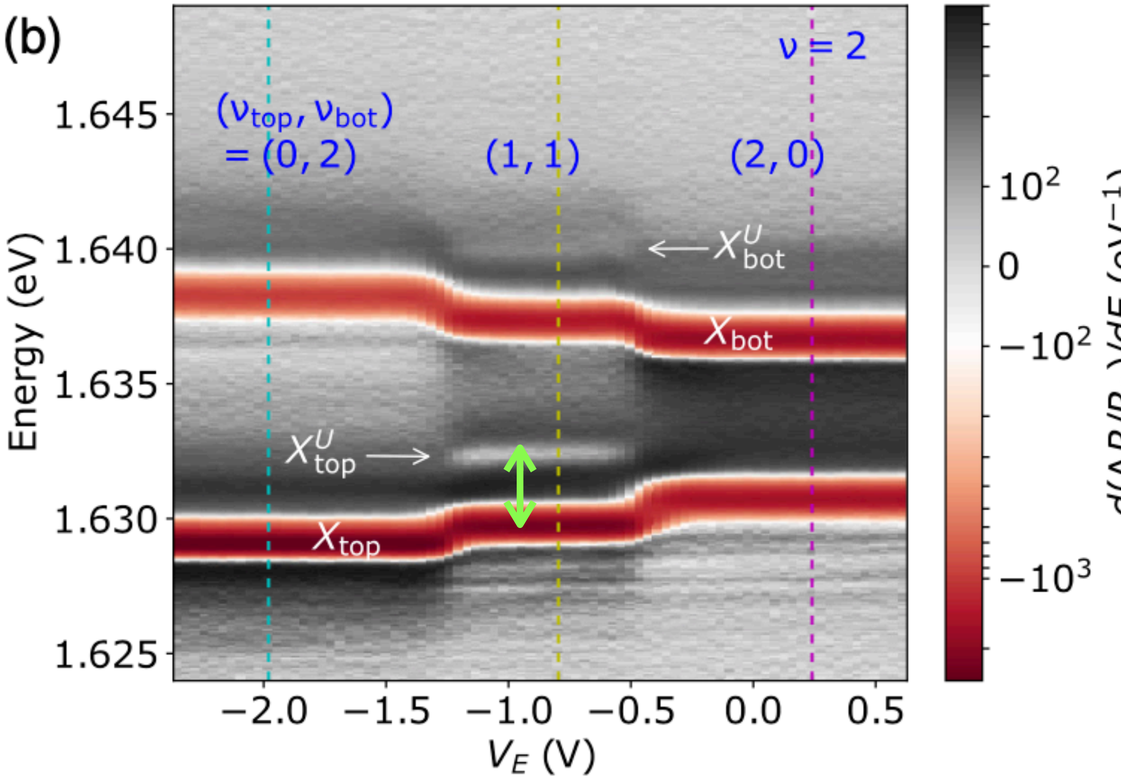
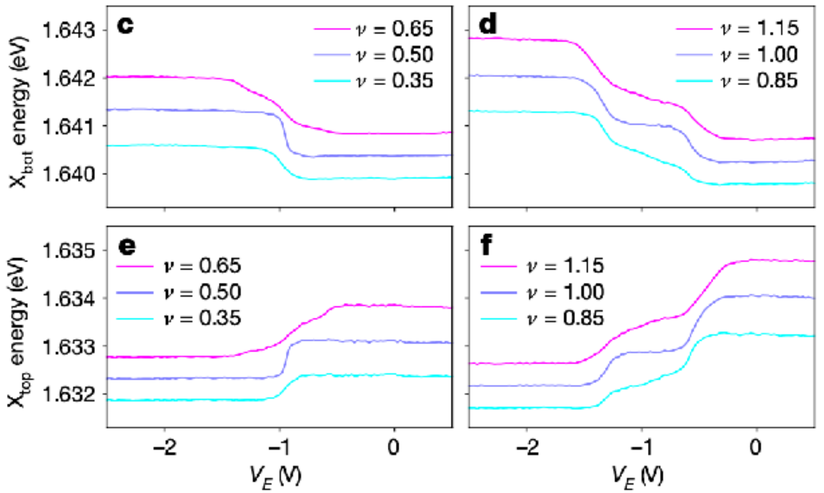


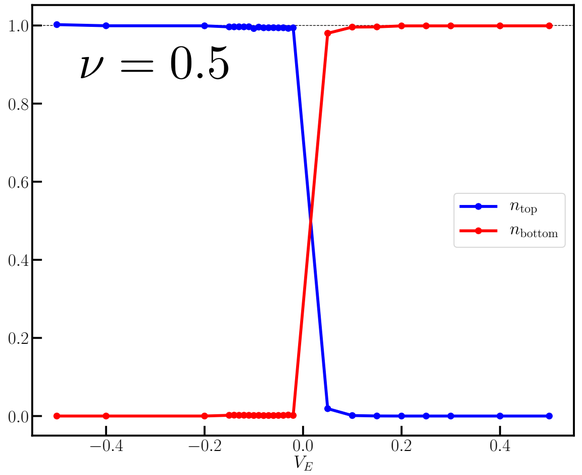


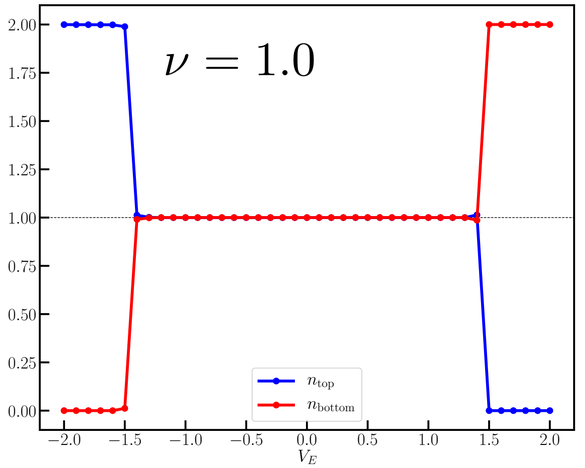


What can we say about the Mott localised phase?



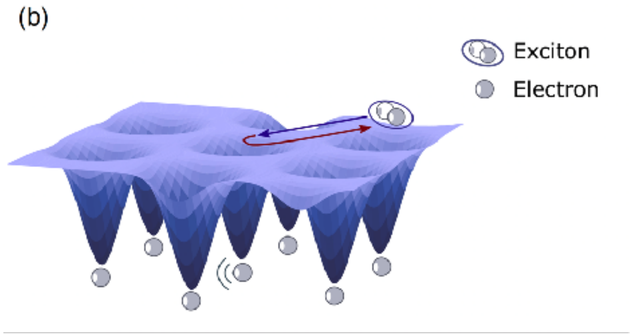
phenomenology of an effective “two-orbitals” Mott transition

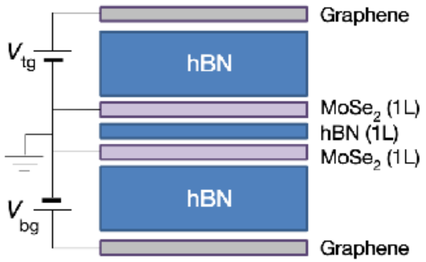




GM et al (in prep)

role of the moire potential?





~weak moire potential due to hBN layer ?

~periodicity in the non-Mott localised phase?