

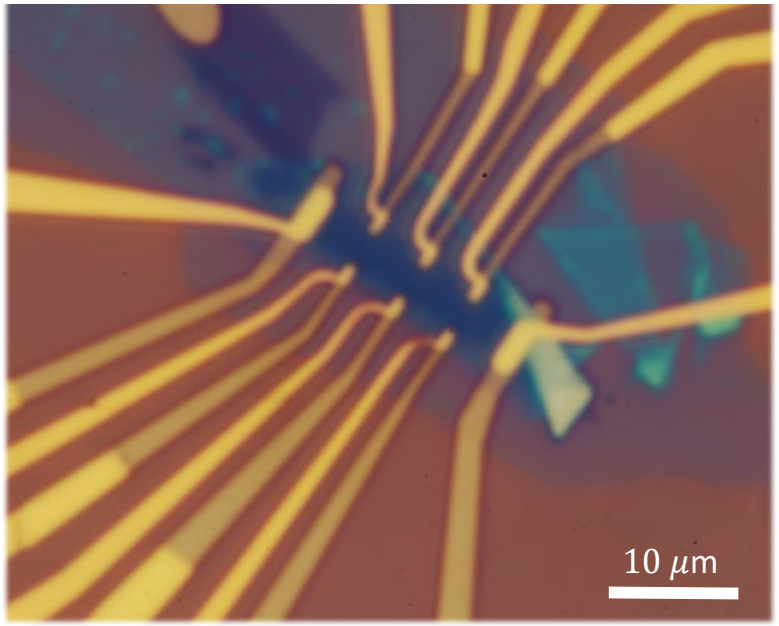
PQS2D Thrust 2: Gated Quantum Dots

Highlights of past year

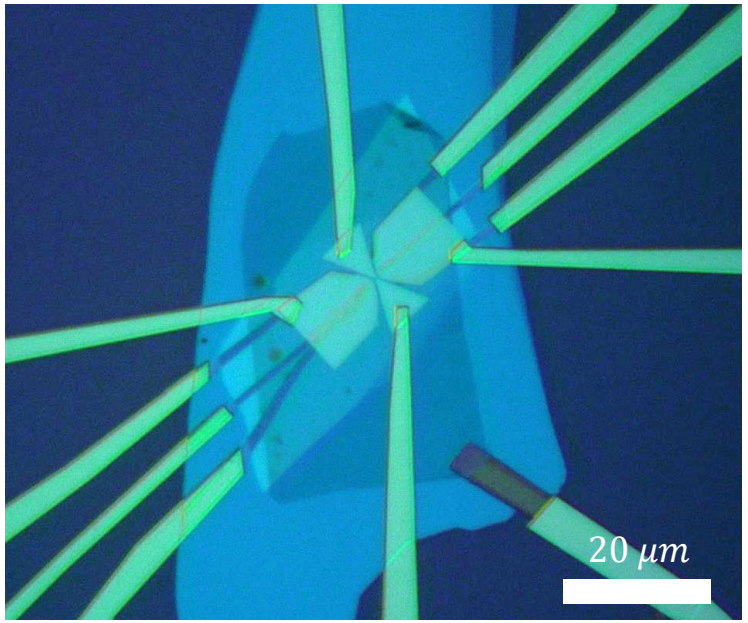
NRC·CNRC Canada

uOttawa

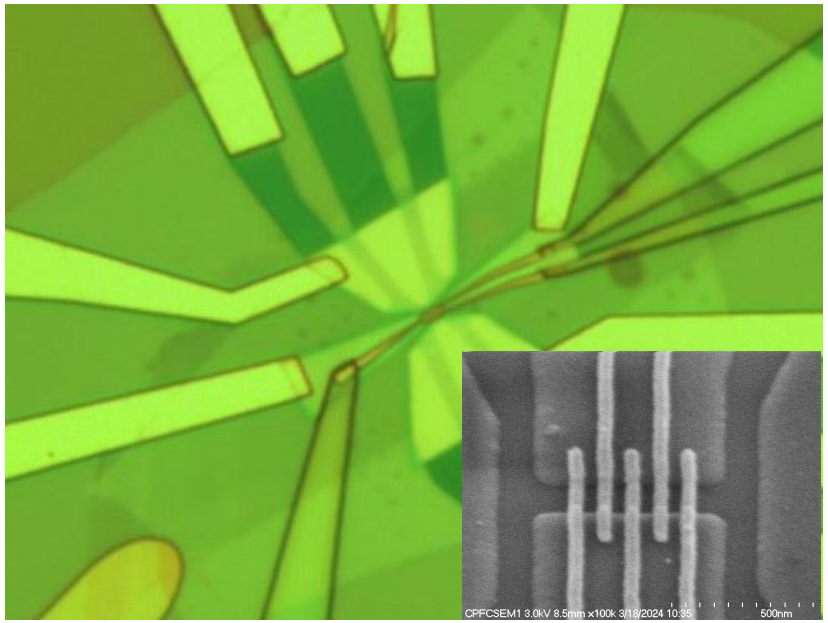
Quantum Hall (2D)



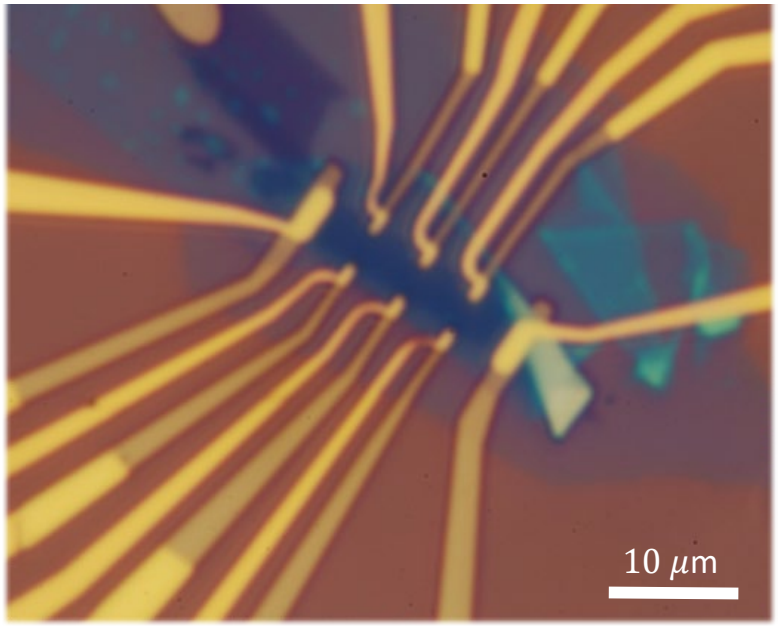
1D Channels



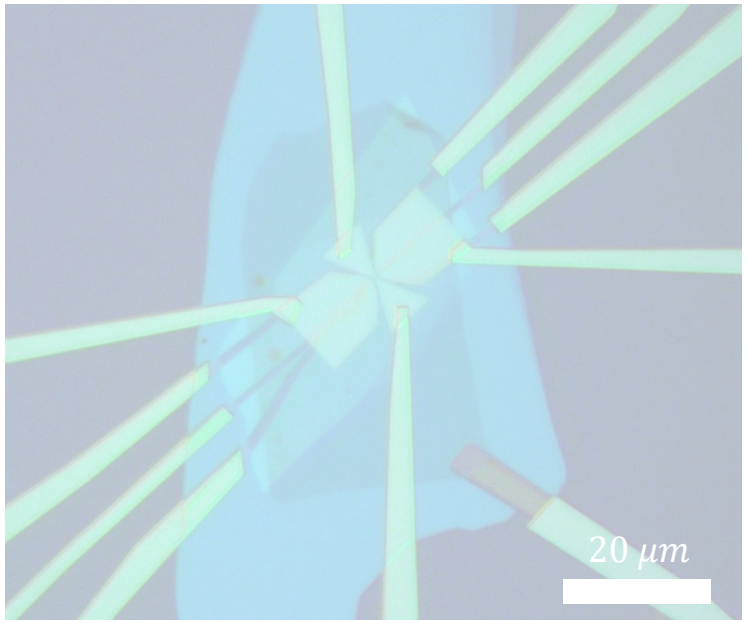
Quantum Dots (0D)



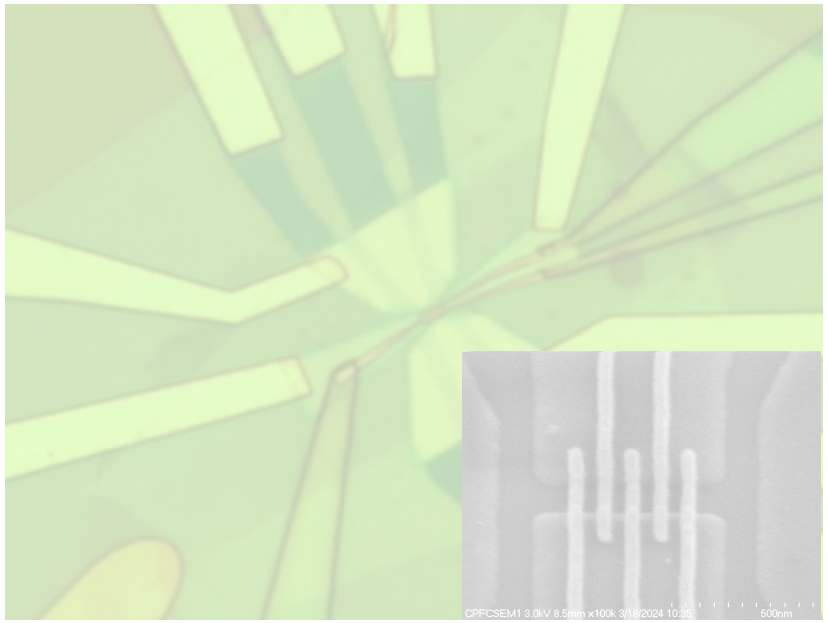
Quantum Hall (2D)



1D Channels



Quantum Dots (0D)



Dr. Justin Boddison-Chouinard Dr. Alina W. Rodrigues Dr. Marek Korkusinski







Magnetic Phase Transition in 2D WSe_2

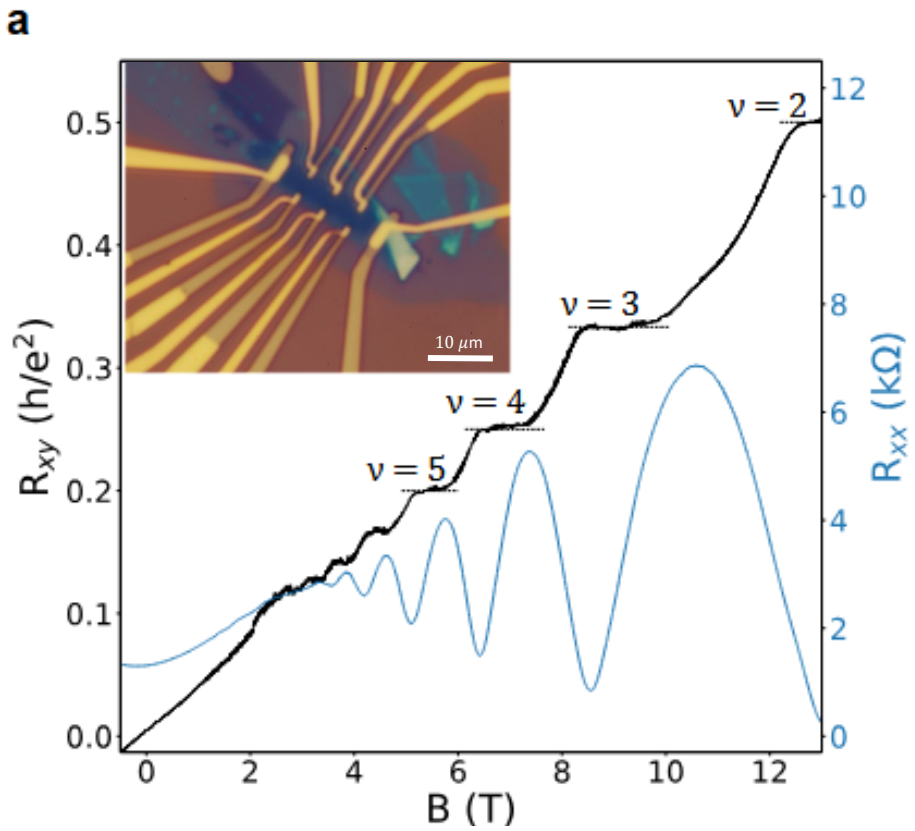
Dr. Justin Boddison-Chouinard Dr. Alina W. Rodrigues Dr. Marek Korkusinski







Magnetic Phase Transition in 2D WSe_2



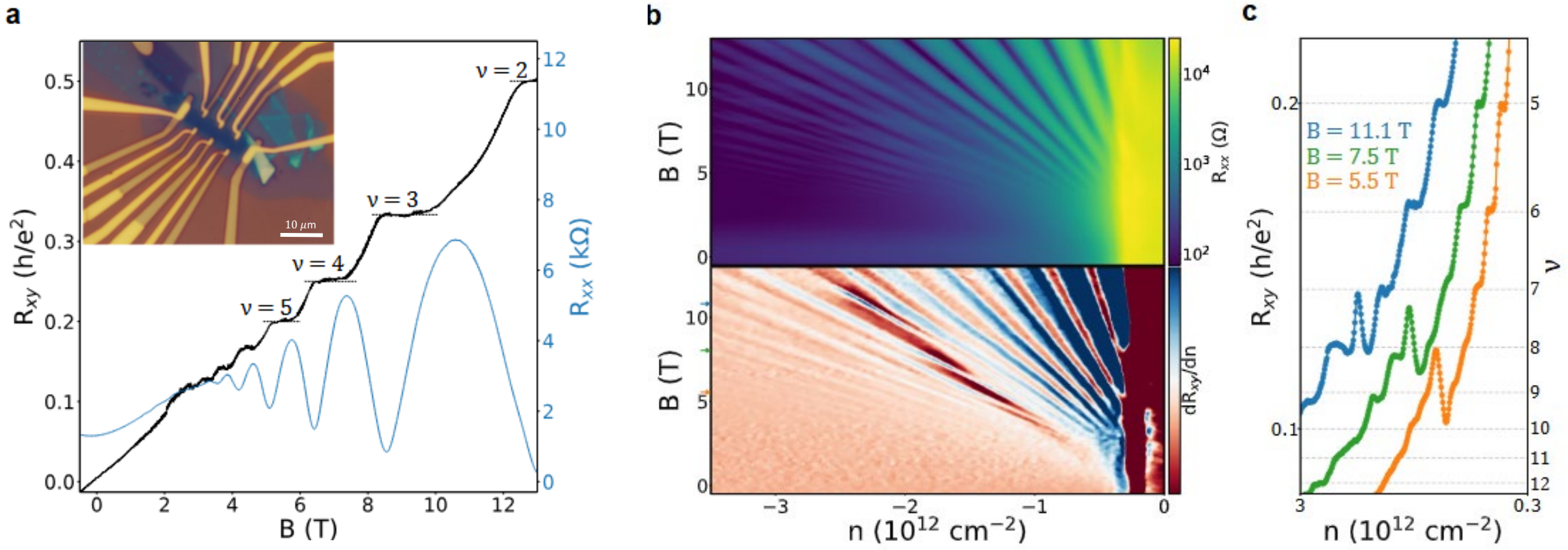
Dr. Justin Boddison-Chouinard Dr. Alina W. Rodrigues Dr. Marek Korkusinski







Magnetic Phase Transition in 2D WSe_2



Dr. Justin Boddison-Chouinard Dr. Alina W. Rodrigues Dr. Marek Korkusinski

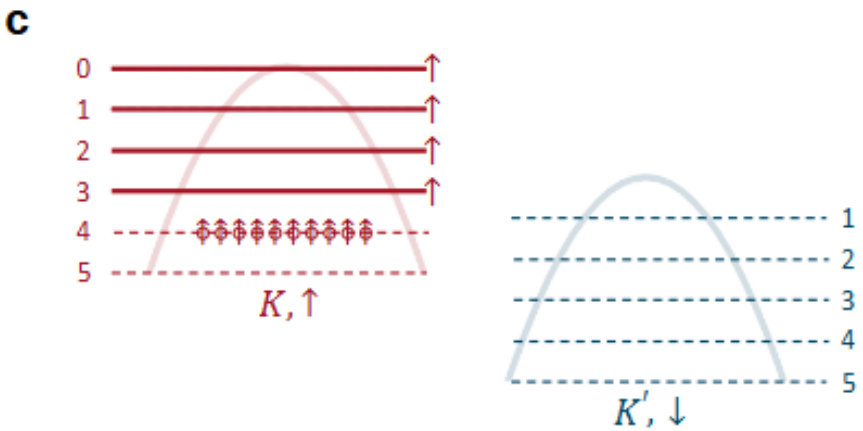






Polarized system

spin-valley locking



Dr. Justin Boddison-Chouinard Dr. Alina W. Rodrigues Dr. Marek Korkusinski





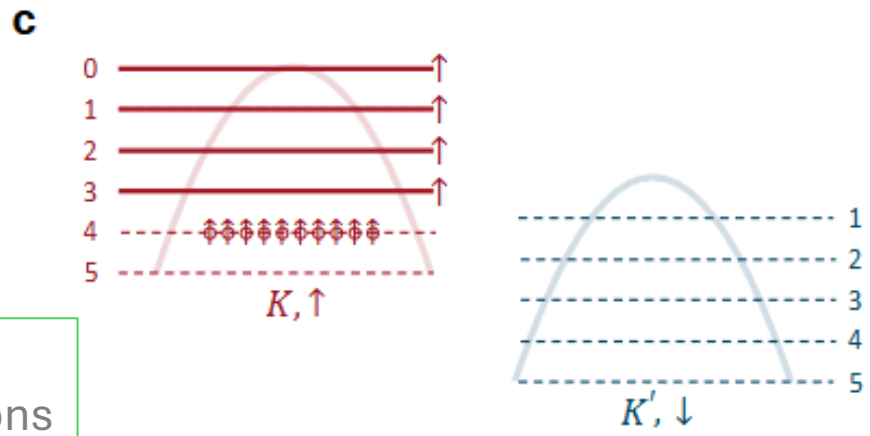


Polarized system

spin-valley locking

Phase Transition

Exchange interactions



Dr. Justin Boddison-Chouinard Dr. Alina W. Rodrigues Dr. Marek Korkusinski

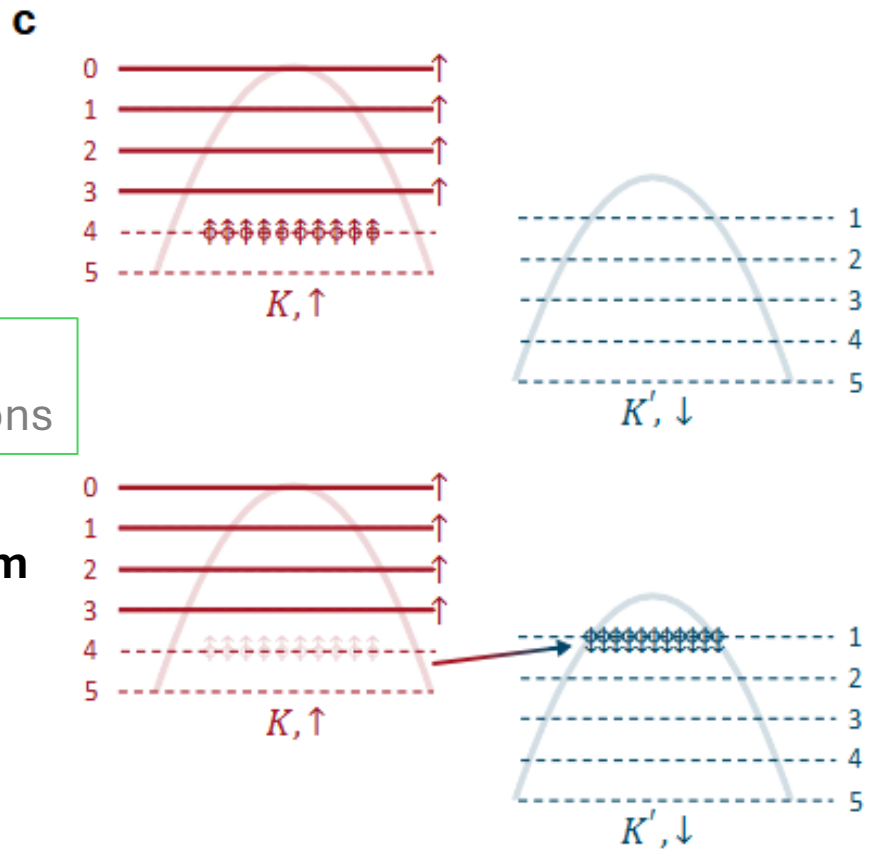




Polarized system
spin-valley locking

Phase Transition
Exchange interactions

Depolarized system
spin-valley locking



Dr. Justin Boddison-Chouinard Dr. Alina W. Rodrigues Dr. Marek Korkusinski



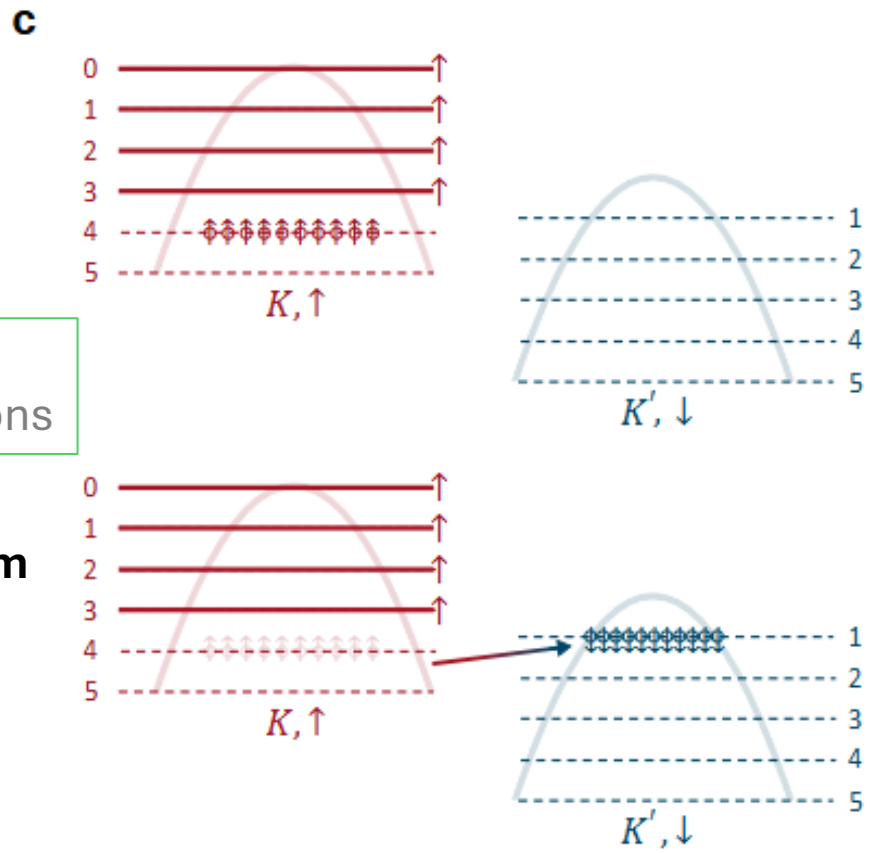


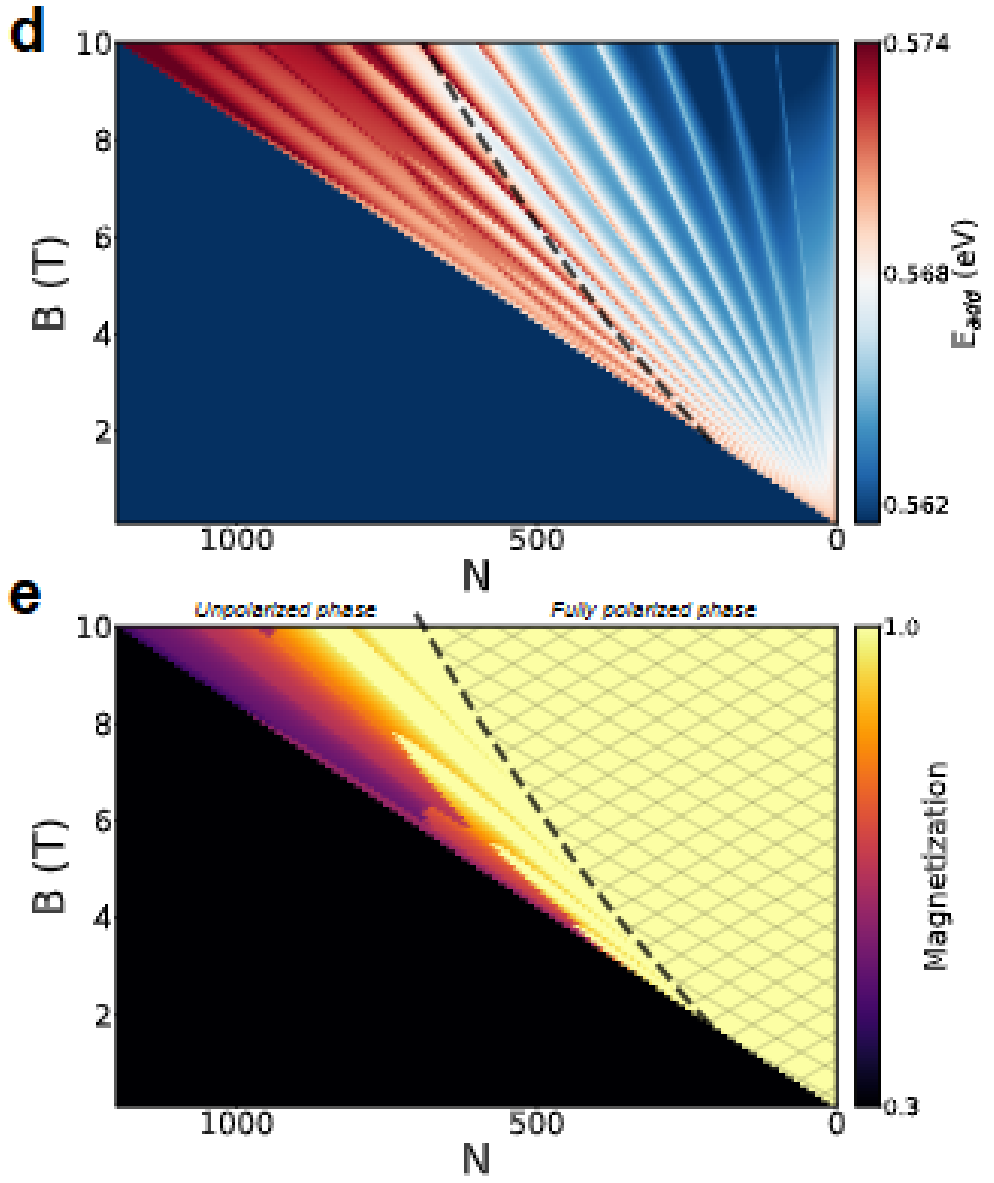


Polarized system
spin-valley locking

Phase Transition
Exchange interactions

Depolarized system
spin-valley locking

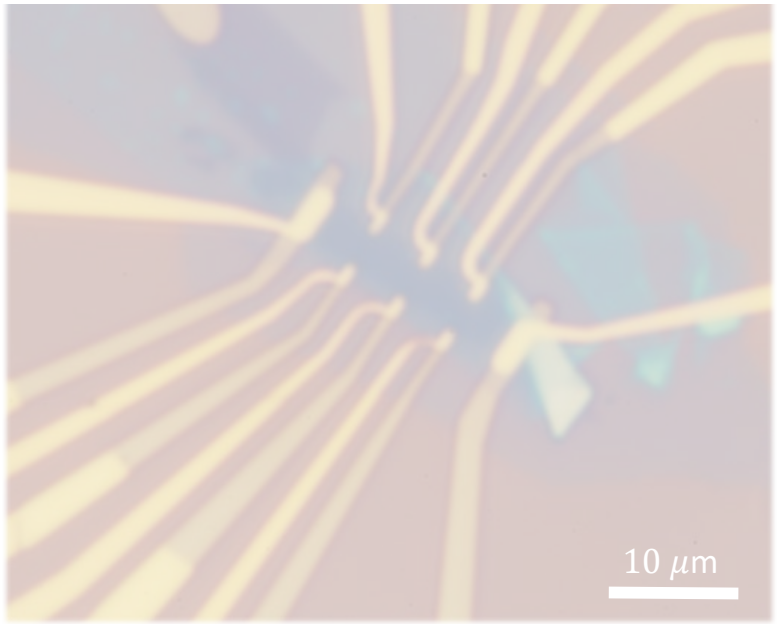


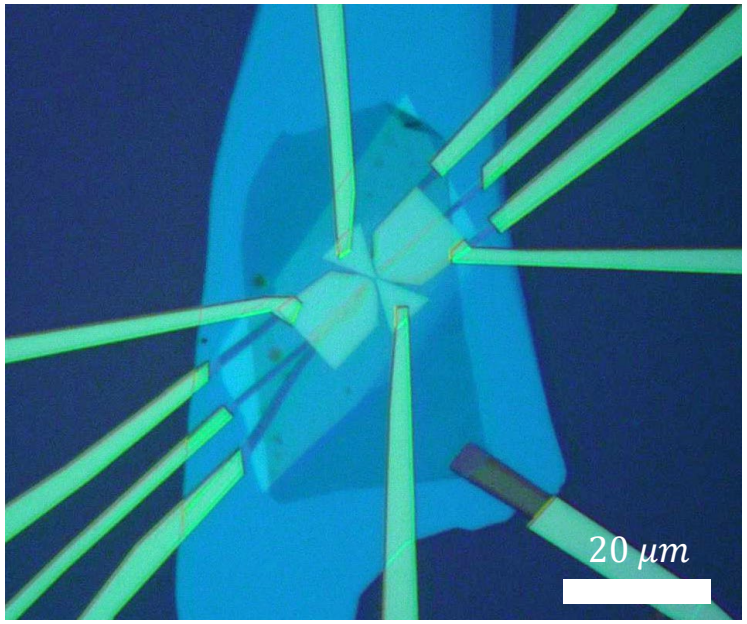


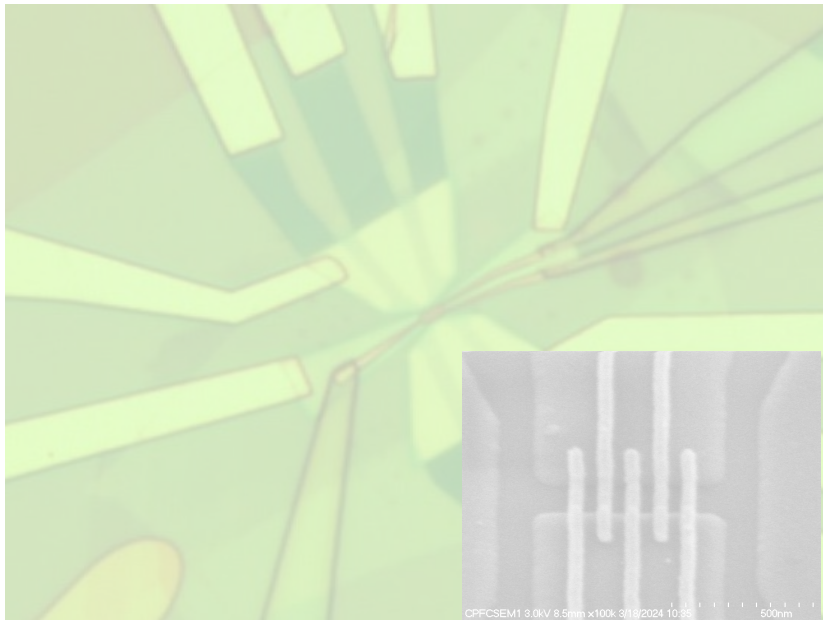
Quantum Hall (2D)

1D Channels

Quantum Dots (0D)







Dr. Justin Boddison-Chouinard Dr. Marek Korkusinski





SCIENCE ADVANCES | RESEARCH ARTICLE

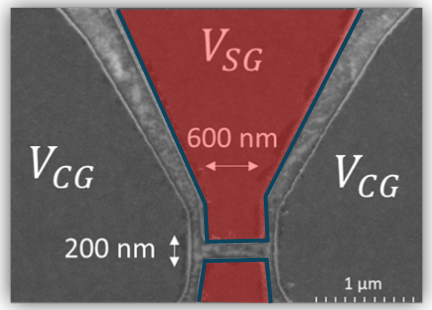
PHYSICS

Valley-spin polarization at zero magnetic field induced by strong hole-hole interactions in monolayer WSe_2

Dr. Justin Boddison-Chouinard Dr. Marek Korkusinski







SCIENCE ADVANCES | RESEARCH ARTICLE

PHYSICS

Valley-spin polarization at zero magnetic field induced by strong hole-hole interactions in monolayer WSe_2

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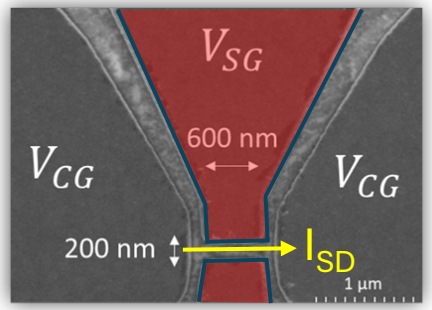




SCIENCE ADVANCES | RESEARCH ARTICLE

PHYSICS

Valley-spin polarization at zero magnetic field induced by strong hole-hole interactions in monolayer WSe_2



1D Channel:

Ballistic Transport

Quantization of Conductance

Dr. Justin Boddison-Chouinard Dr. Marek Korkusinski

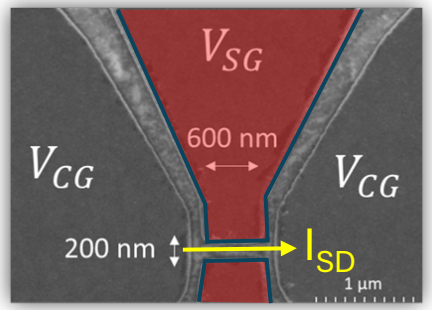




SCIENCE ADVANCES | RESEARCH ARTICLE

PHYSICS

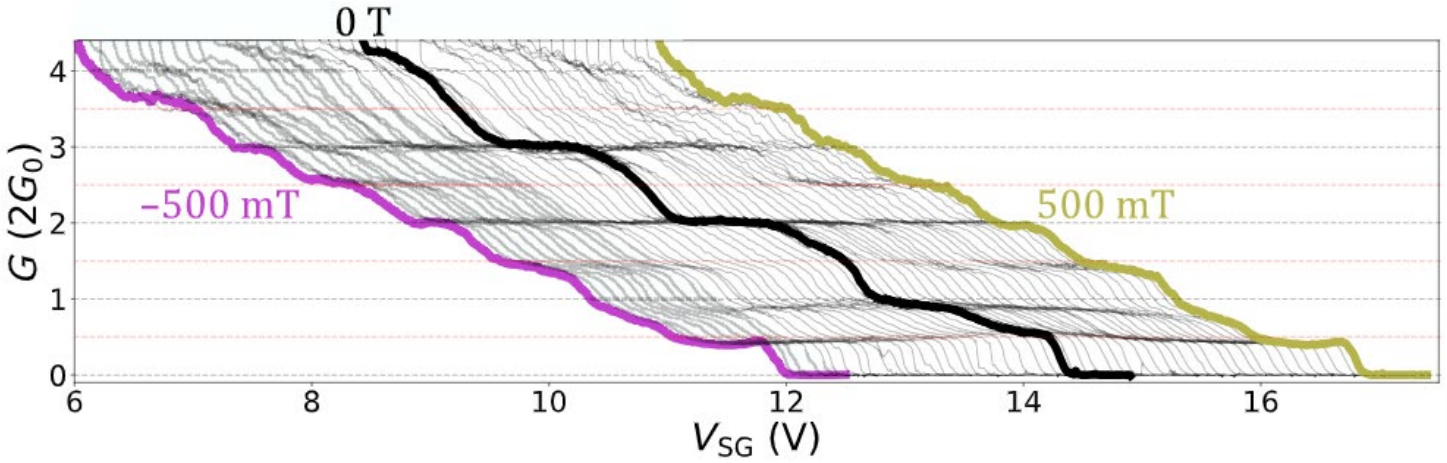
Valley-spin polarization at zero magnetic field induced by strong hole-hole interactions in monolayer WSe_2



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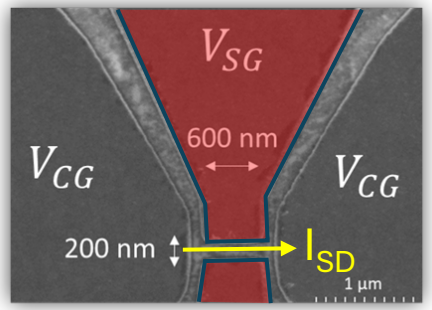




SCIENCE ADVANCES | RESEARCH ARTICLE

PHYSICS

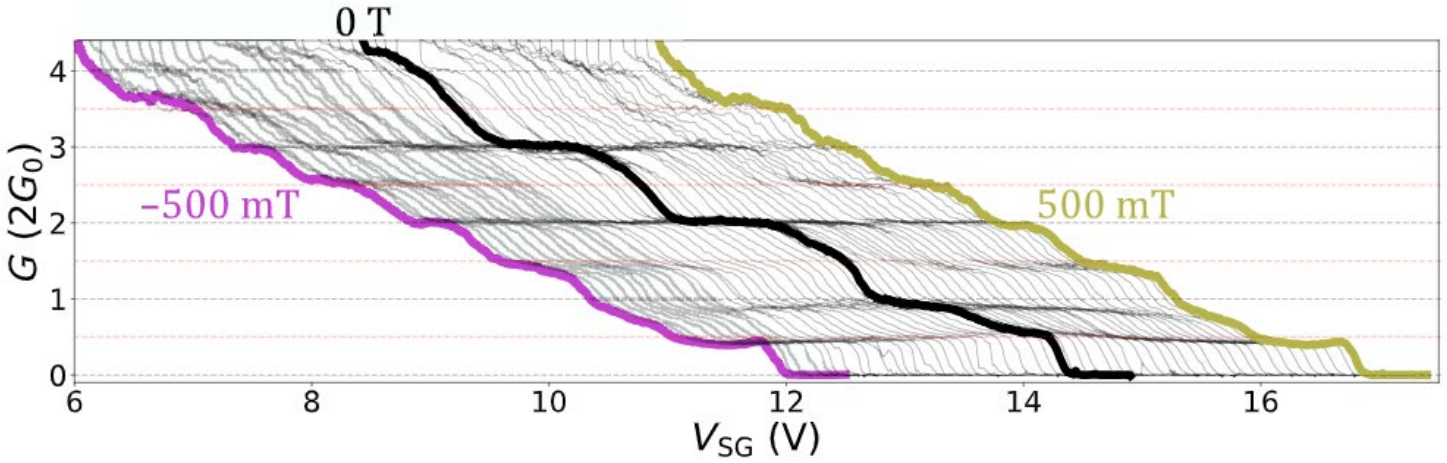
Valley-spin polarization at zero magnetic field induced by strong hole-hole interactions in monolayer WSe_2



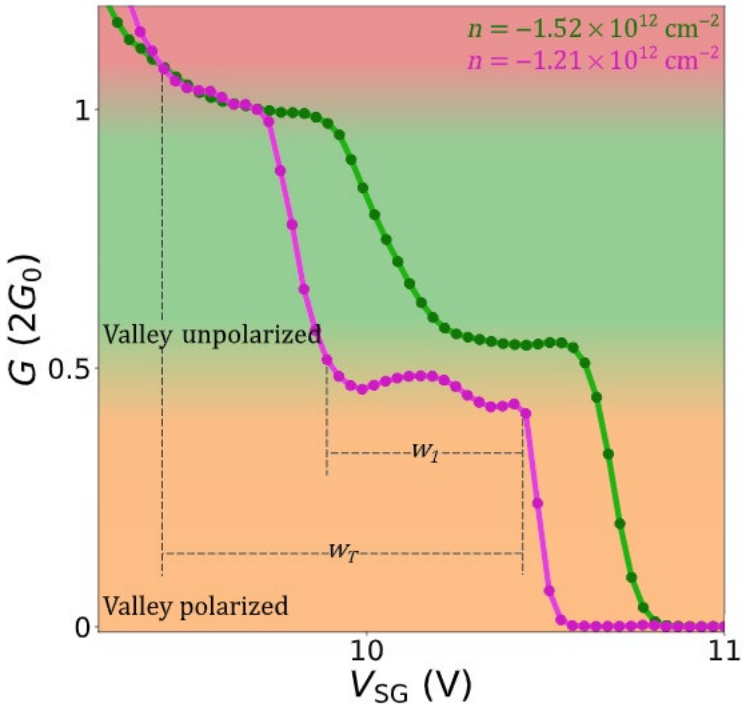
1D Channel:

Ballistic Transport

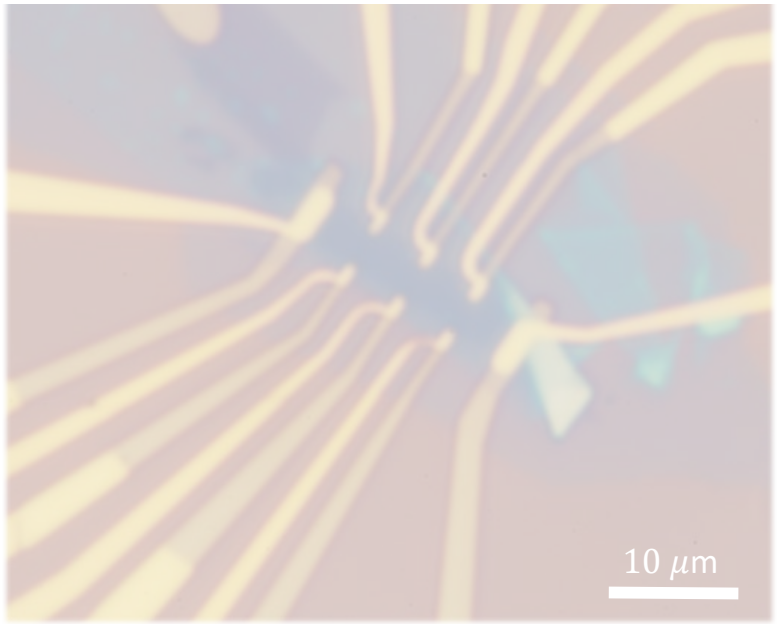
Quantization of Conductance



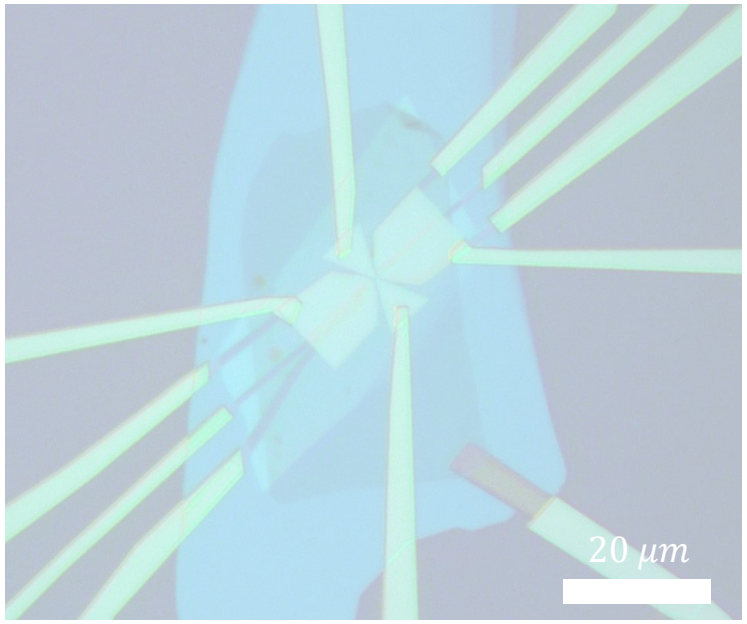
Spin Polarization at B = 0



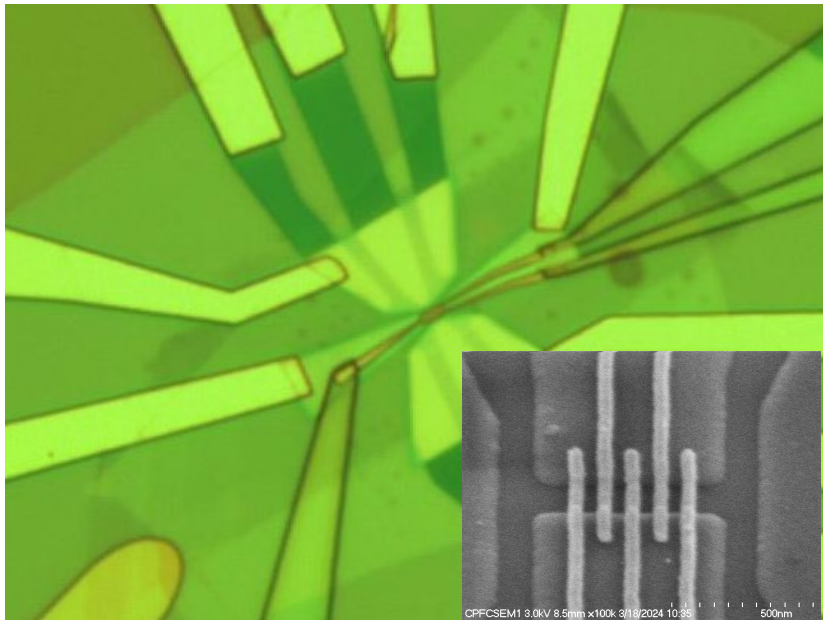
Quantum Hall (2D)



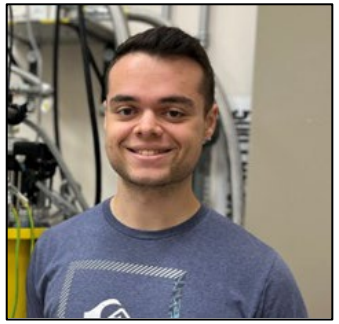
1D Channels



Quantum Dots (0D)



Antoine Labbé Dr. Justin Boddison-Chouinard Dr. Marek Korkusinski

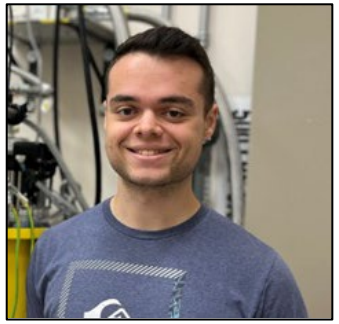






Magneto-spectroscopy of WSe_2 QDs

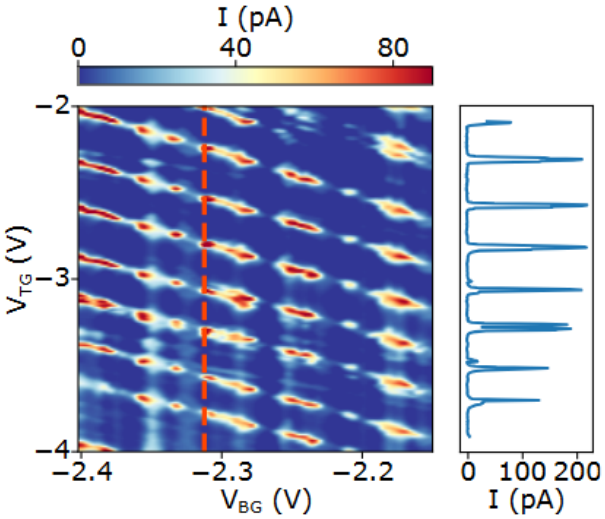
Antoine Labbé Dr. Justin Boddison-Chouinard Dr. Marek Korkusinski





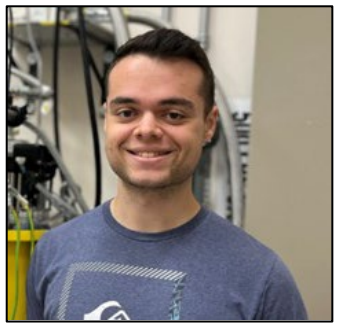


Magneto-spectroscopy of WSe_2 QDs



0D Transport:
Coulomb Blockade

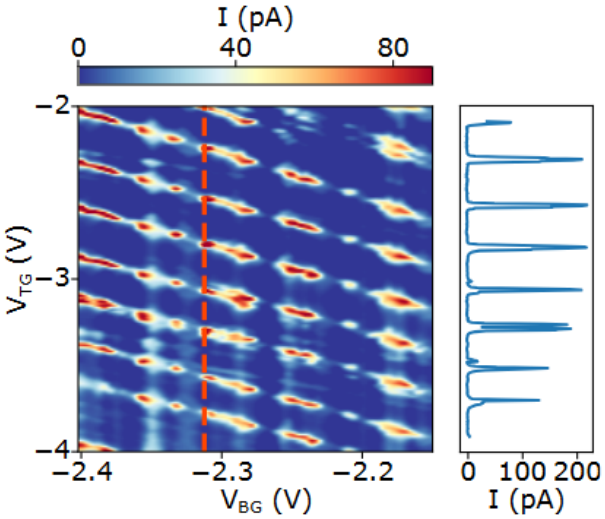
Antoine Labbé Dr. Justin Boddison-Chouinard Dr. Marek Korkusinski



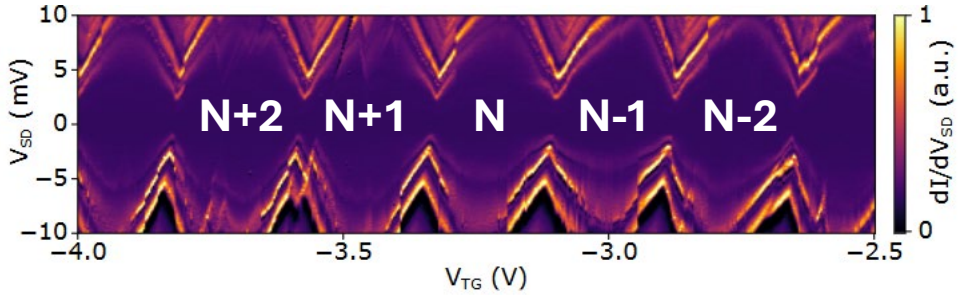




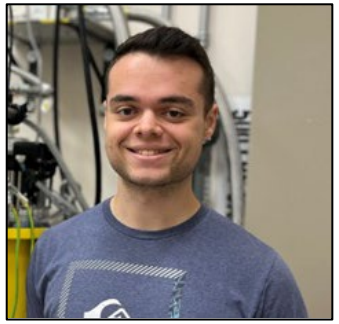
Magneto-spectroscopy of WSe_2 QDs



0D Transport:
Coulomb Blockade



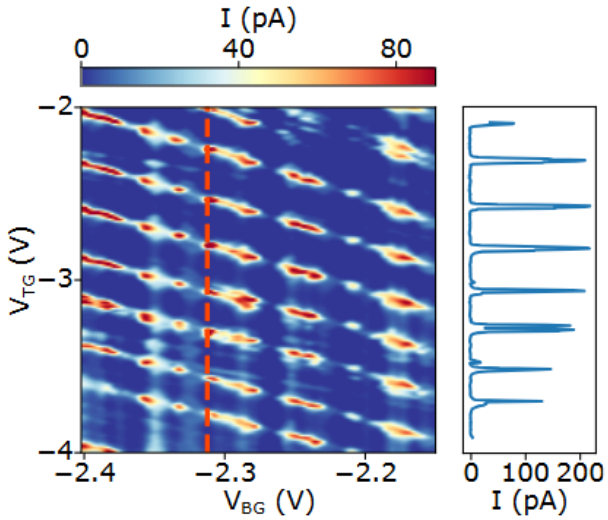
Antoine Labbé Dr. Justin Boddison-Chouinard Dr. Marek Korkusinski



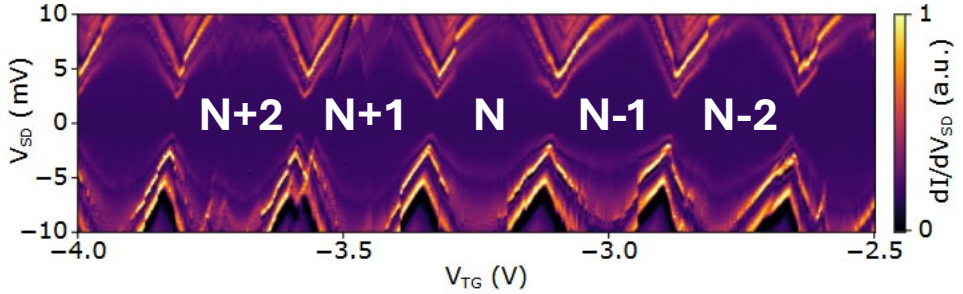


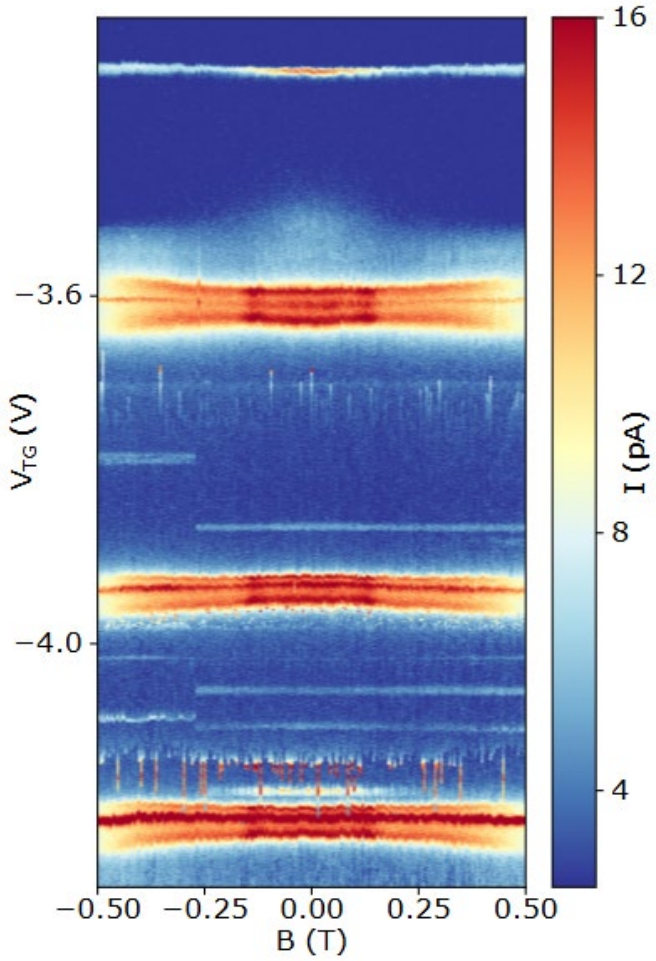


Magneto-spectroscopy of WSe_2 QDs



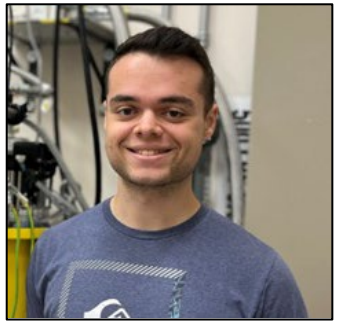
0D Transport:
Coulomb Blockade





Excited state spectroscopy
Spin filling sequence
QD structure

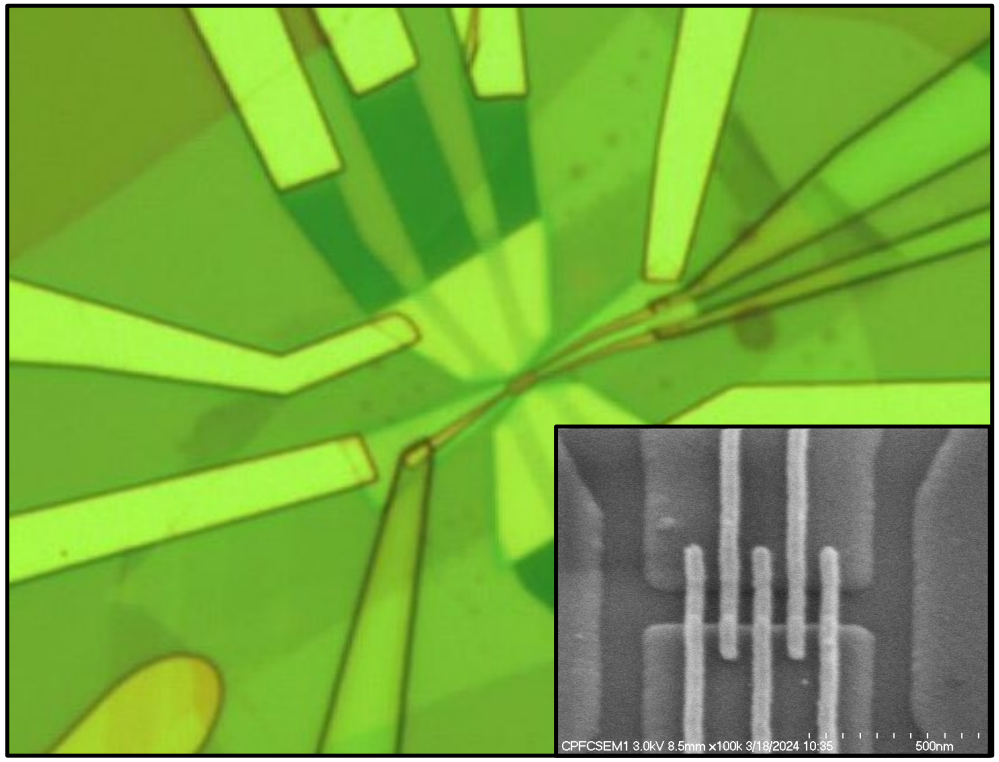
Antoine Labbé Dr. Justin Boddison-Chouinard Dr. Marek Korkusinski







Magneto-spectroscopy of WSe_2 QDs



Coupled QDs:
Sliced 1D channel

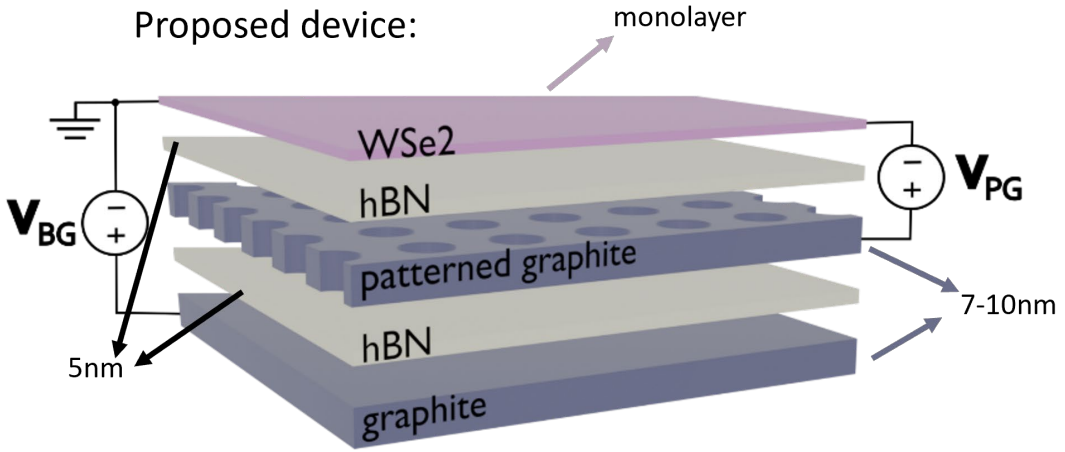
Superlattices

Dr. Melis Aygar



Patterned graphite gate generates
moiré-like potential

Proposed device:



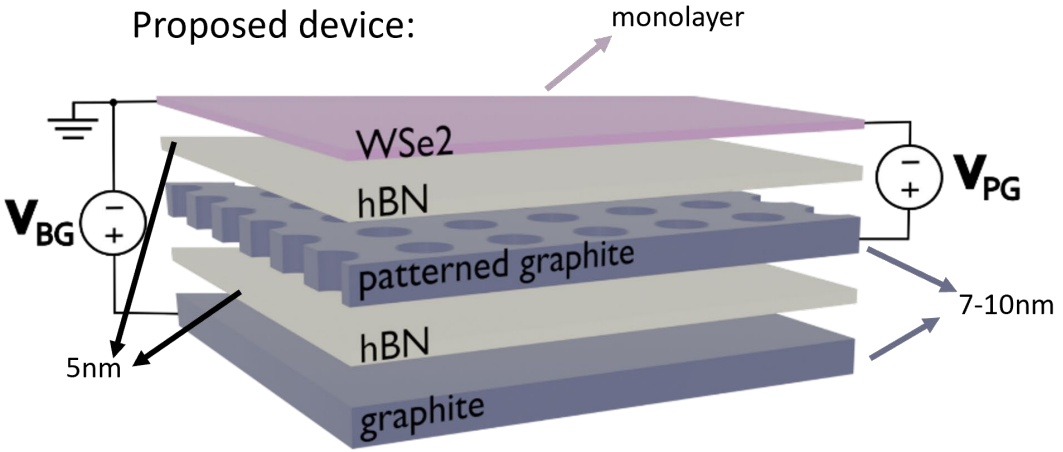
Superlattices

Dr. Melis Aygar



Patterned graphite gate generates **moiré-like** potential

Proposed device:

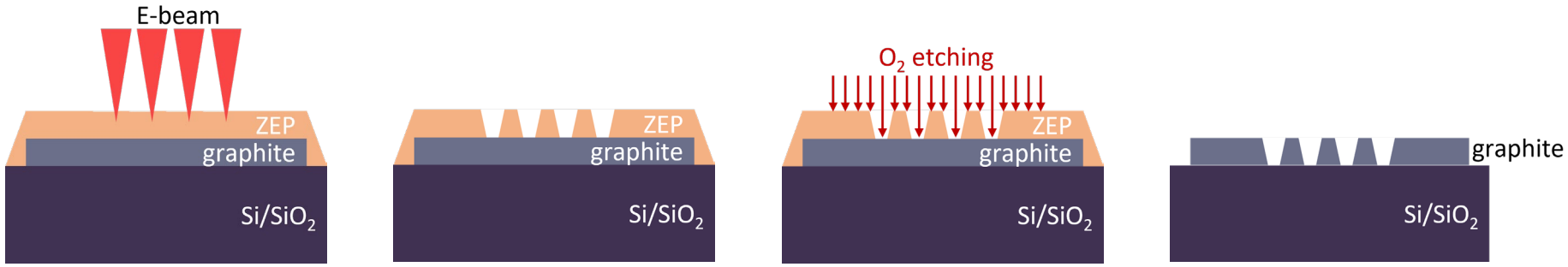


Dr. A. Position

?

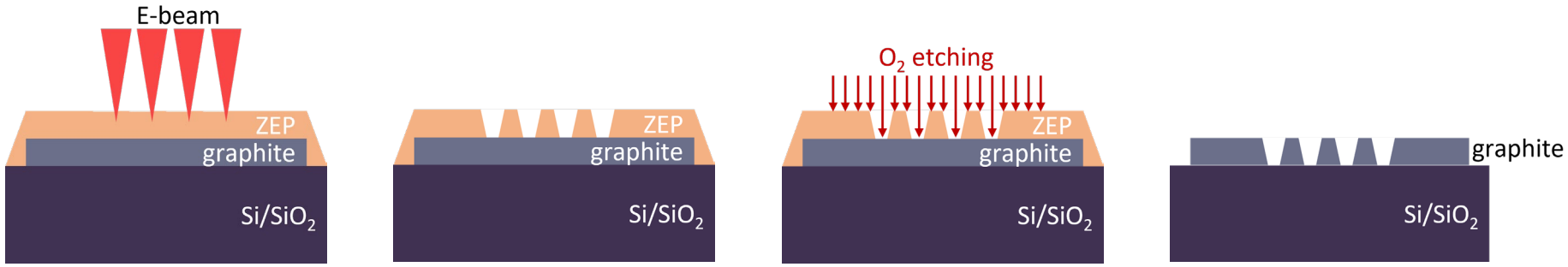
Superlattices and 2D Quantum Simulators

Nano-fabrication of the graphite gate

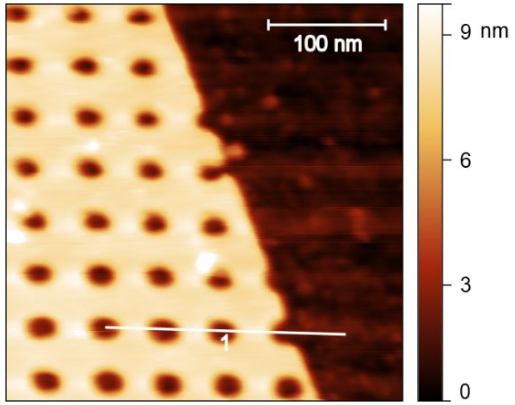


Superlattices and 2D Quantum Simulators

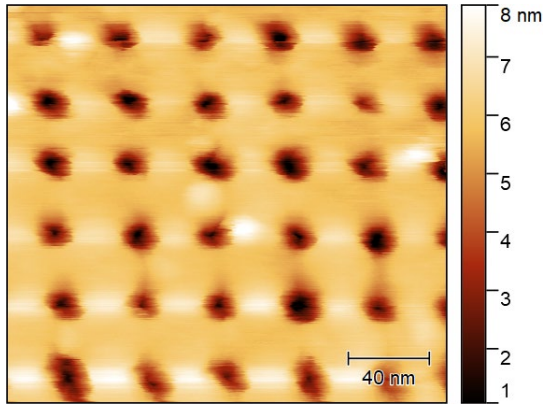
Nano-fabrication of the graphite gate



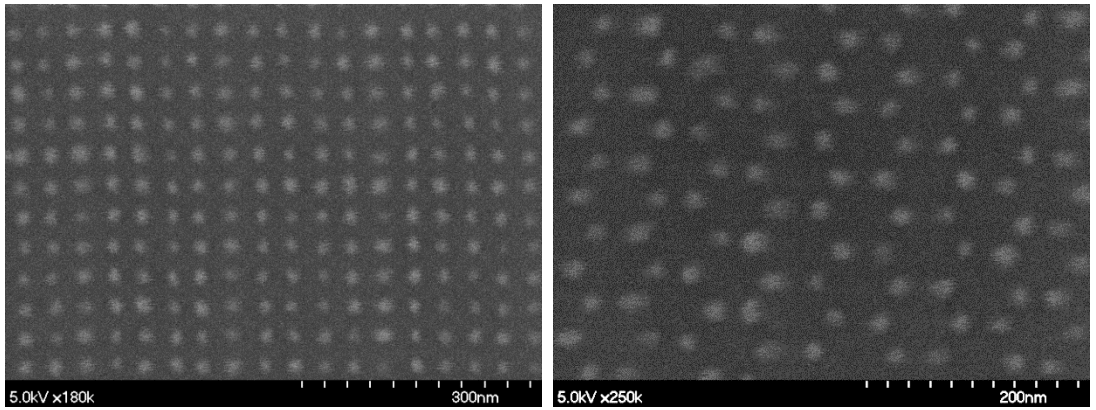
Holes in graphite, d=18nm, p=50nm



Holes in graphite, d=14nm, p=40nm



Gold discs, p=30nm, d=10nm

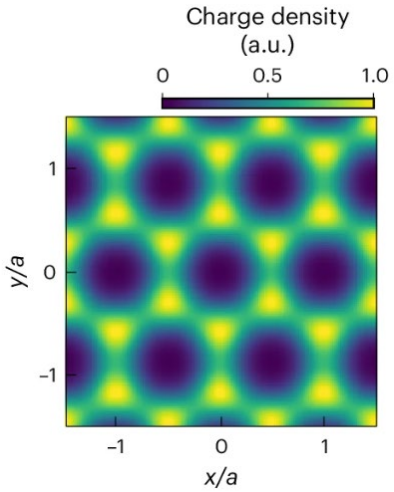


Theory

Dr. Alina W. Rodrigues Dr. Marek Korkusinski





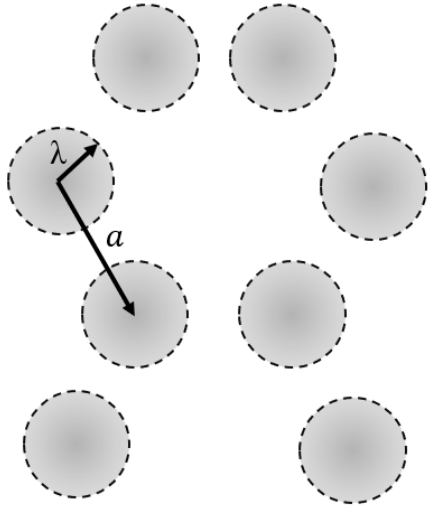


We can use anti-dots to obtain an effective smaller pitch

Nature Physics, **22**, (2026)

MODEL

Hexagonal patterned-hole lattice



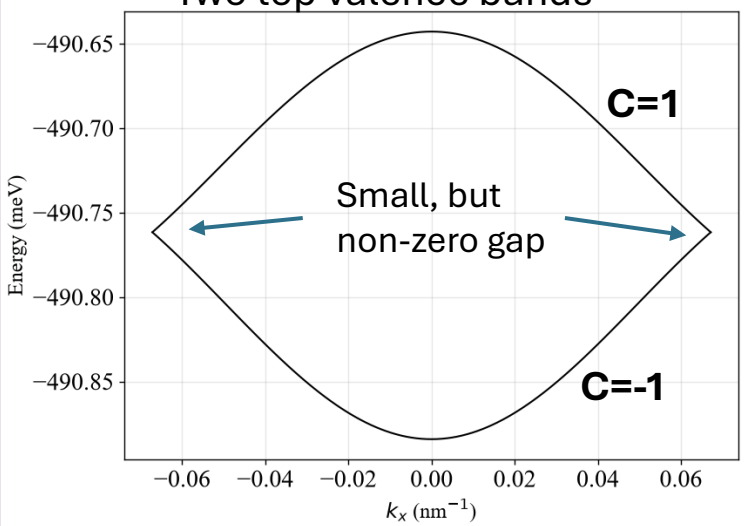
Hole pattern →periodic **gaussian potential**.

Tuning parameters:

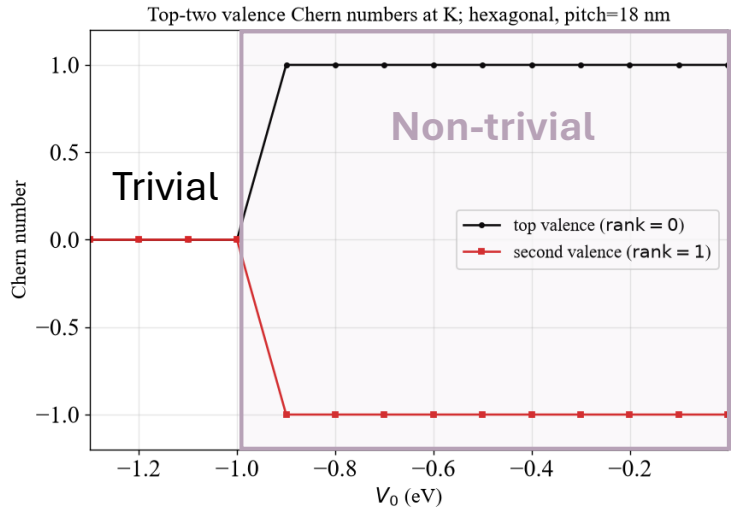
- Theory: Gaussian depth
- Experiment: applied electric field

TOPOLOGY

Two top valence bands



Applied electric field **controls topology**



Amine Kabraoui



Dr. Angela Gamouras



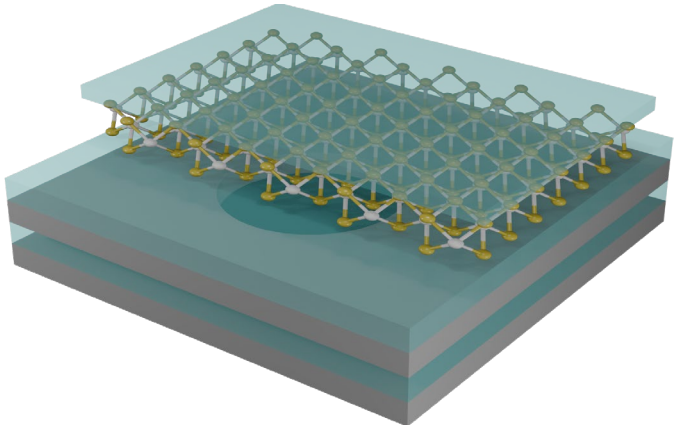
Electrostatically Controlled WSe_2 Single Photon Emitters

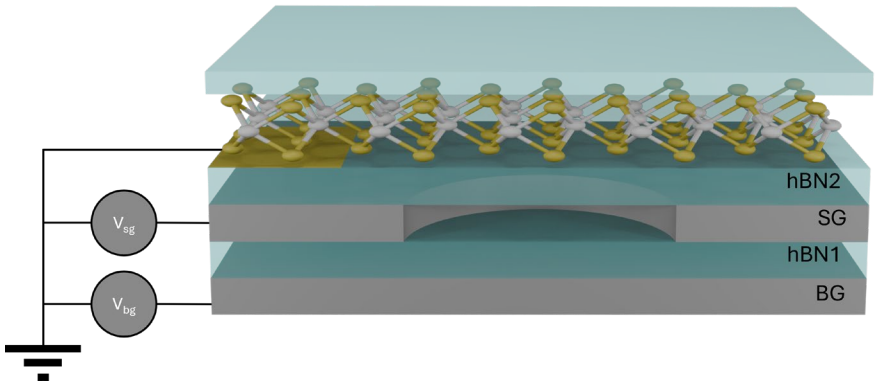
Amine Kabraoui Dr. Angela Gamouras





Electrostatically Controlled WSe_2 Single Photon Emitters



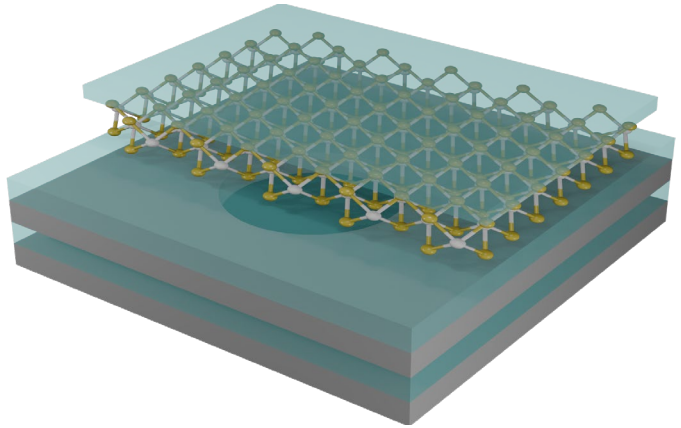


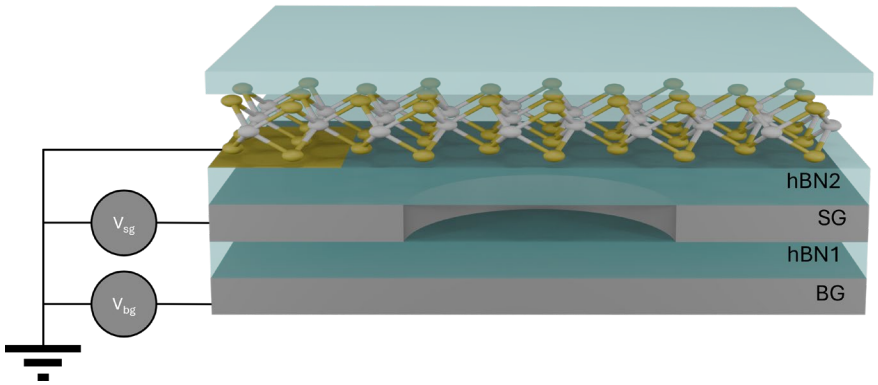
Amine Kabraoui Dr. Angela Gamouras

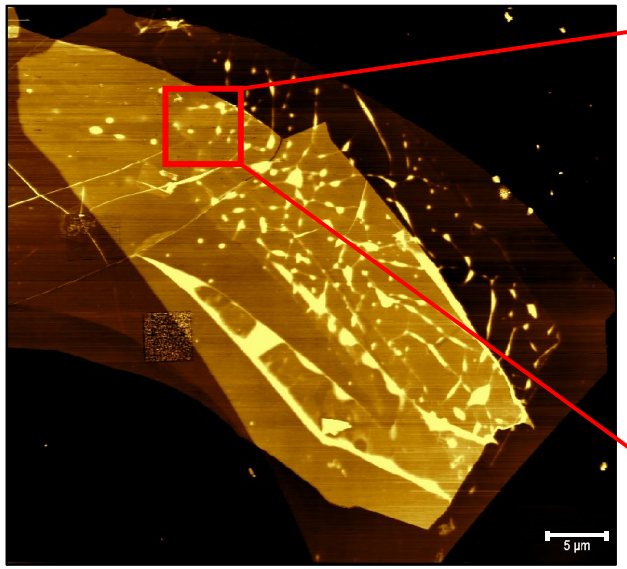


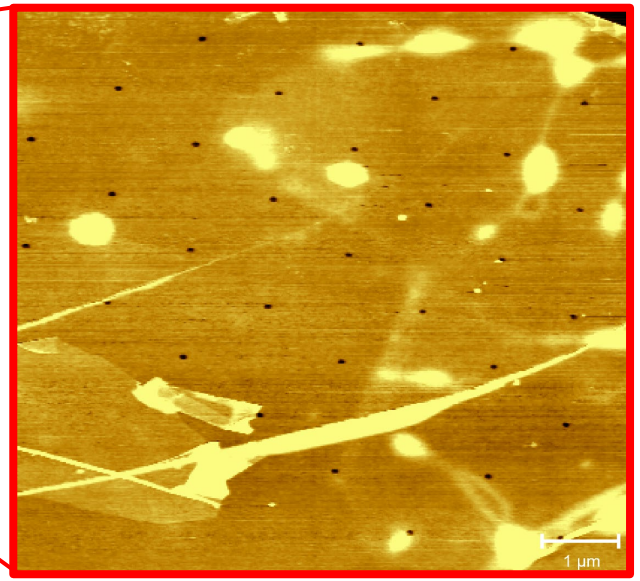


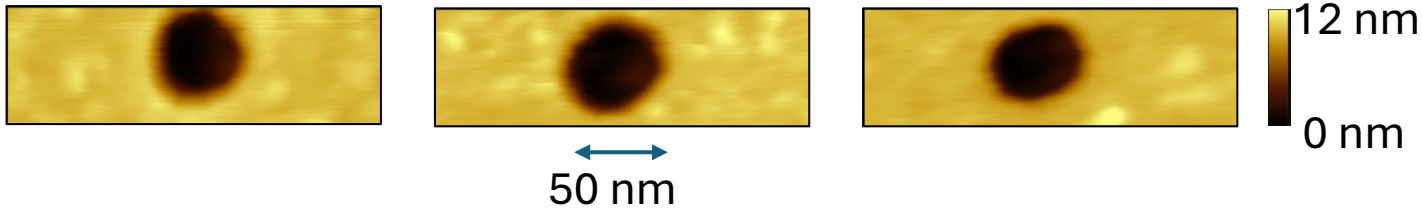
Electrostatically Controlled WSe_2 Single Photon Emitters











Isaac Lagaud Dr. Justin Boddison-Chouinard





Alternative vdW dielectrics for better electronic performance

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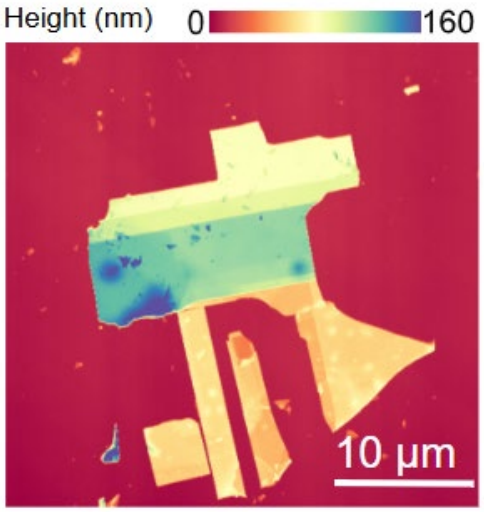




Alternative vdW dielectrics for better electronic performance

LaOBr:

5.3 eV gap, $\varepsilon \sim 12.5$



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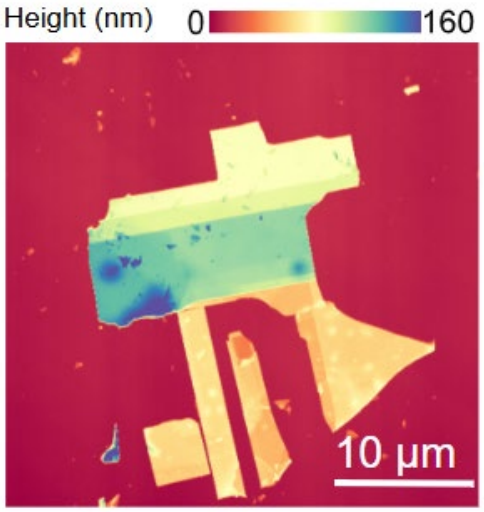


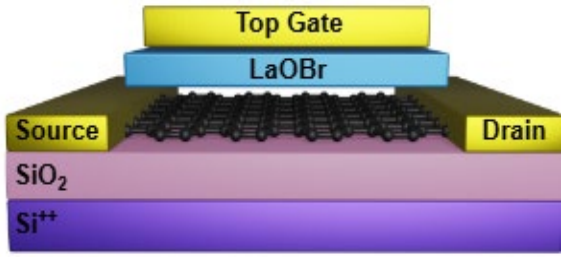


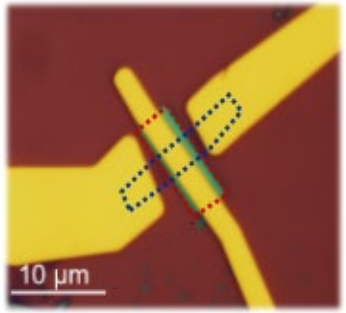
Alternative vdW dielectrics for better electronic performance

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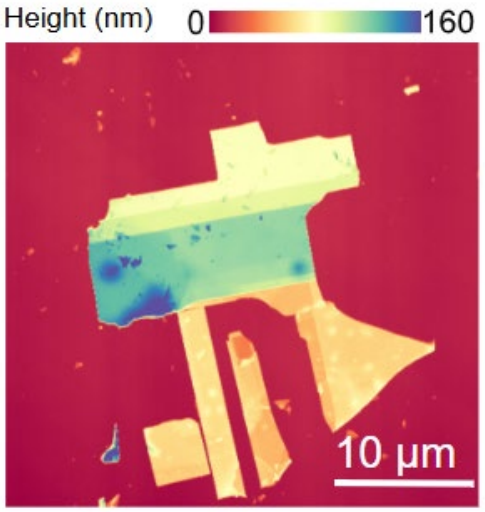


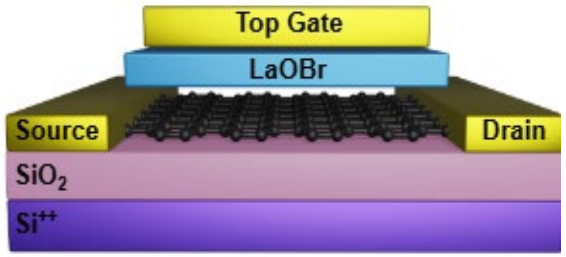


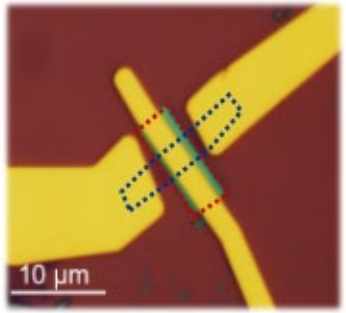
Alternative vdW dielectrics for better electronic performance

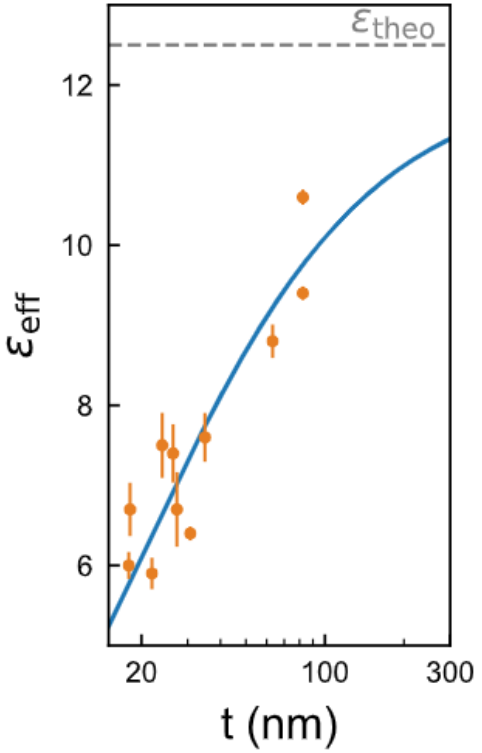
LaOBr:

5.3 eV gap, ε ~ 12.5









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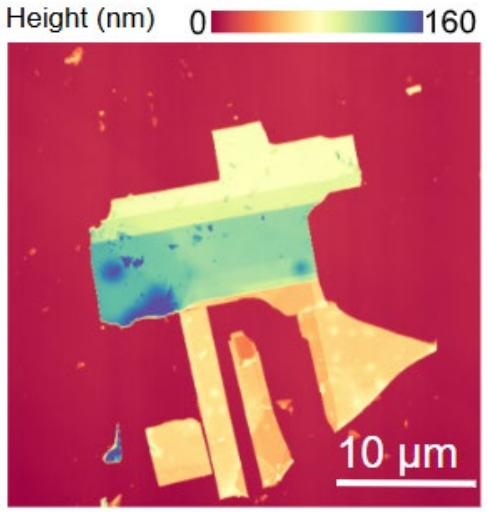


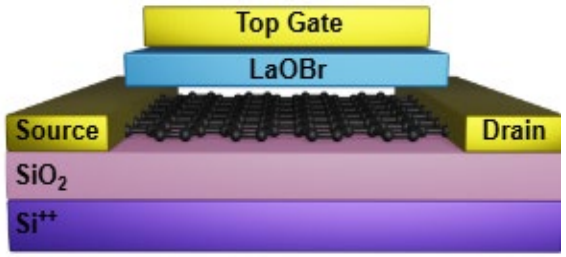


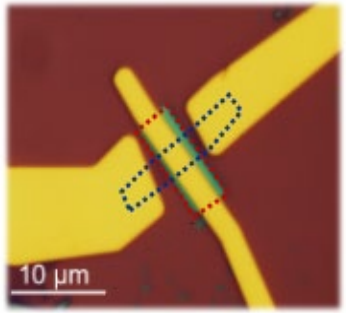
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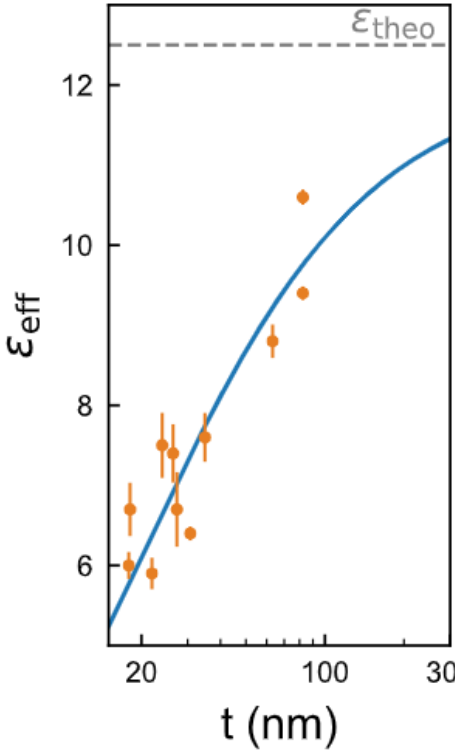
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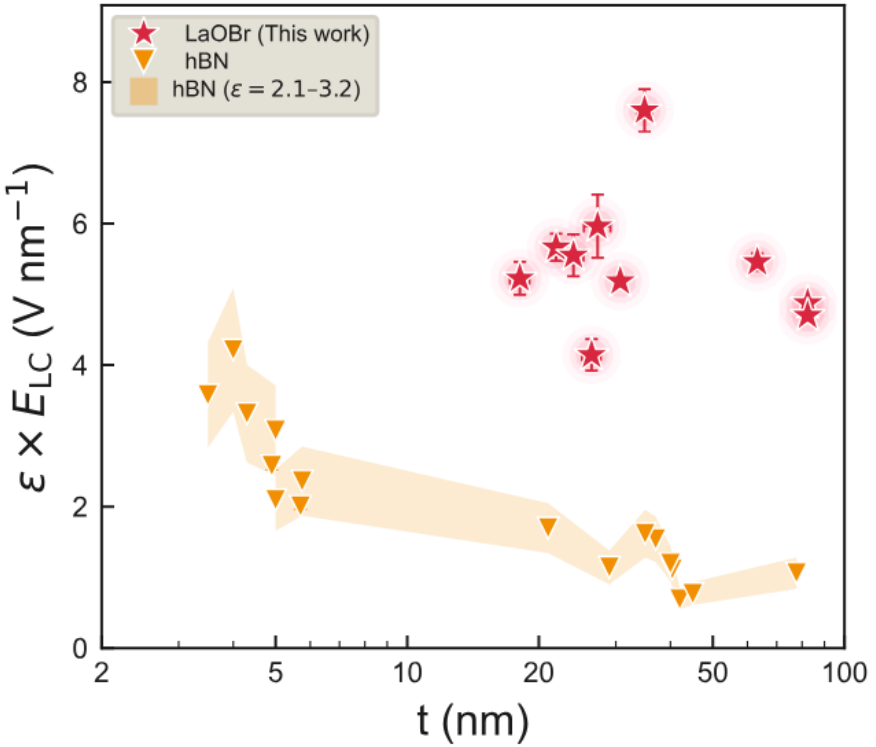
5.3 eV gap, ε ~ 12.5





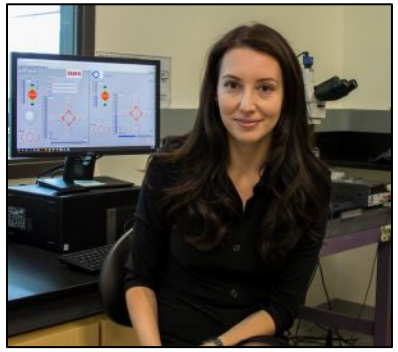




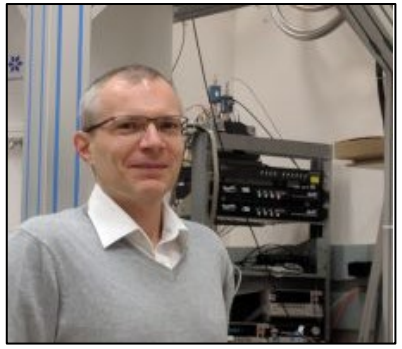


Many thanks to our close PI collaborators from PQS2D

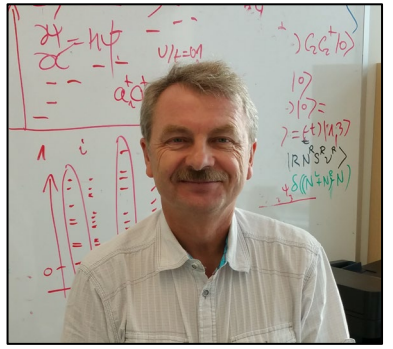
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~~uOttawa~~ UIC



Marek Korkusinski
NRC



Pawel Hawrylak
uOttawa



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HTSN

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