UNIVERSIDAD AUTONOMA DE MADRID

NÉEL institut

MPI Stuttgart

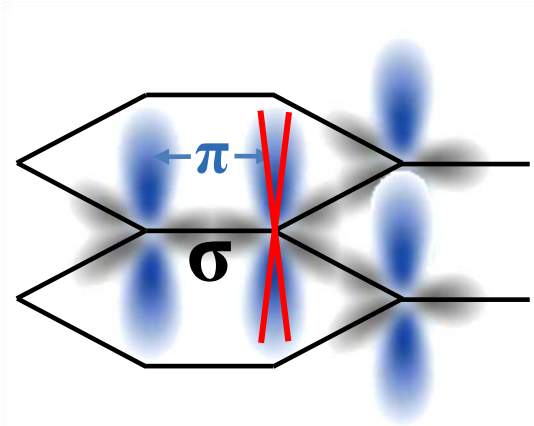
Atomic-scale control of graphene magnetism using hydrogen atoms

"HiMagGraphene"

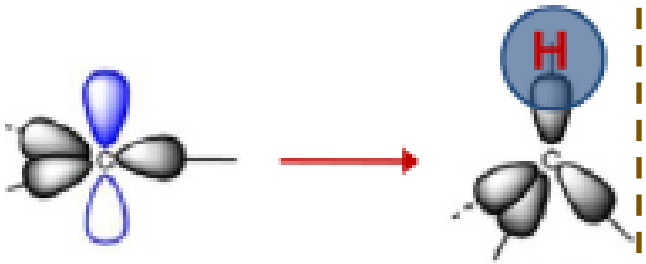
ivan.brihuega@uam.es
www.ivanbrihuega.com

Budapest, *April, 2016*

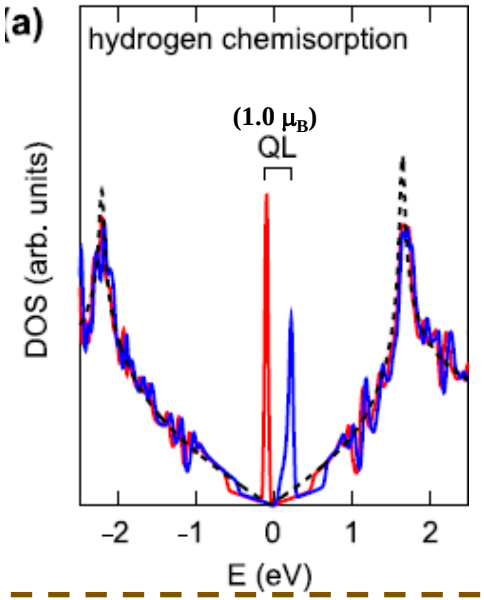
Magnetism in graphene: just remove a p_z orbital



Atomic Hydrogen



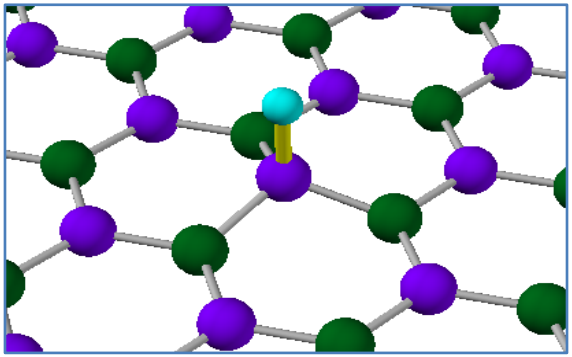
$m_T = m_\pi = 1\mu_B$



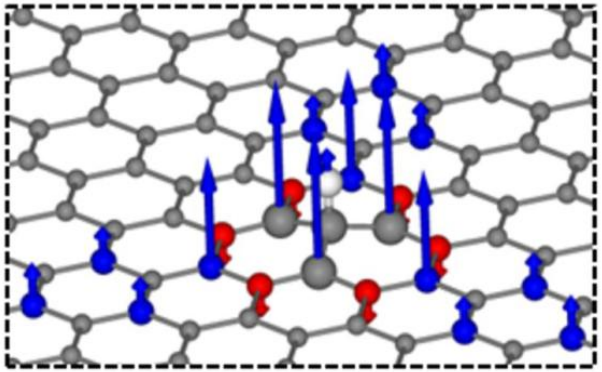
O. Yazyev, **Rep. Prog. Phys. 73** 056501 (2010)

Atomic Hydrogen on Monolayer Graphene

Relaxed Atomic structure

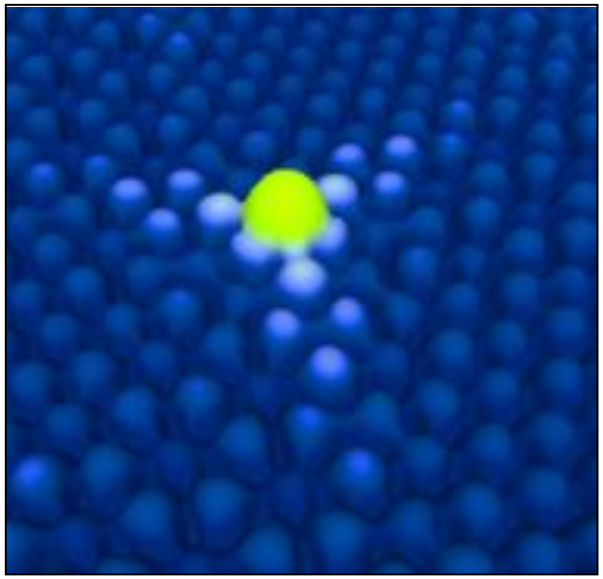


Calculated spin density

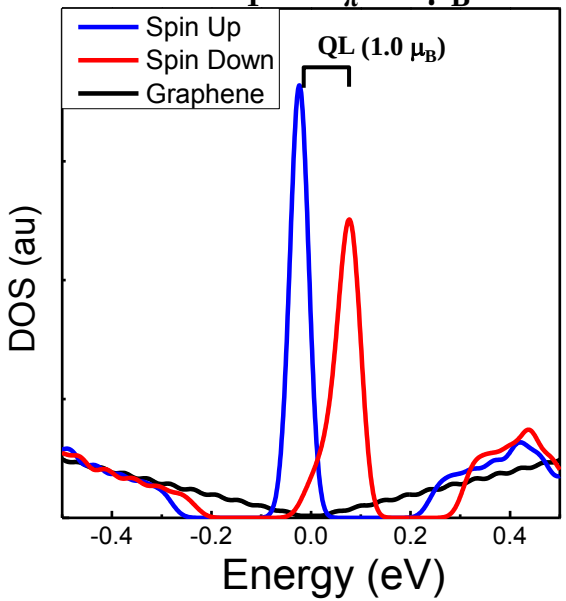


- Magnetic moment = $1\mu_B$
- spin density located on the opposite triangular sublattice.

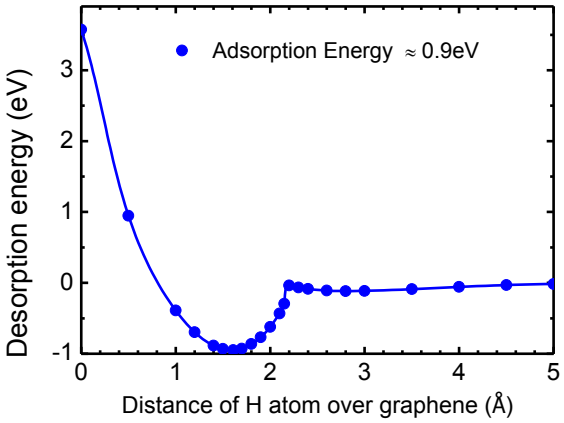
Simulated STM image (Tersoff-Hamann)



$m_T = m_\pi = 1\mu_B$



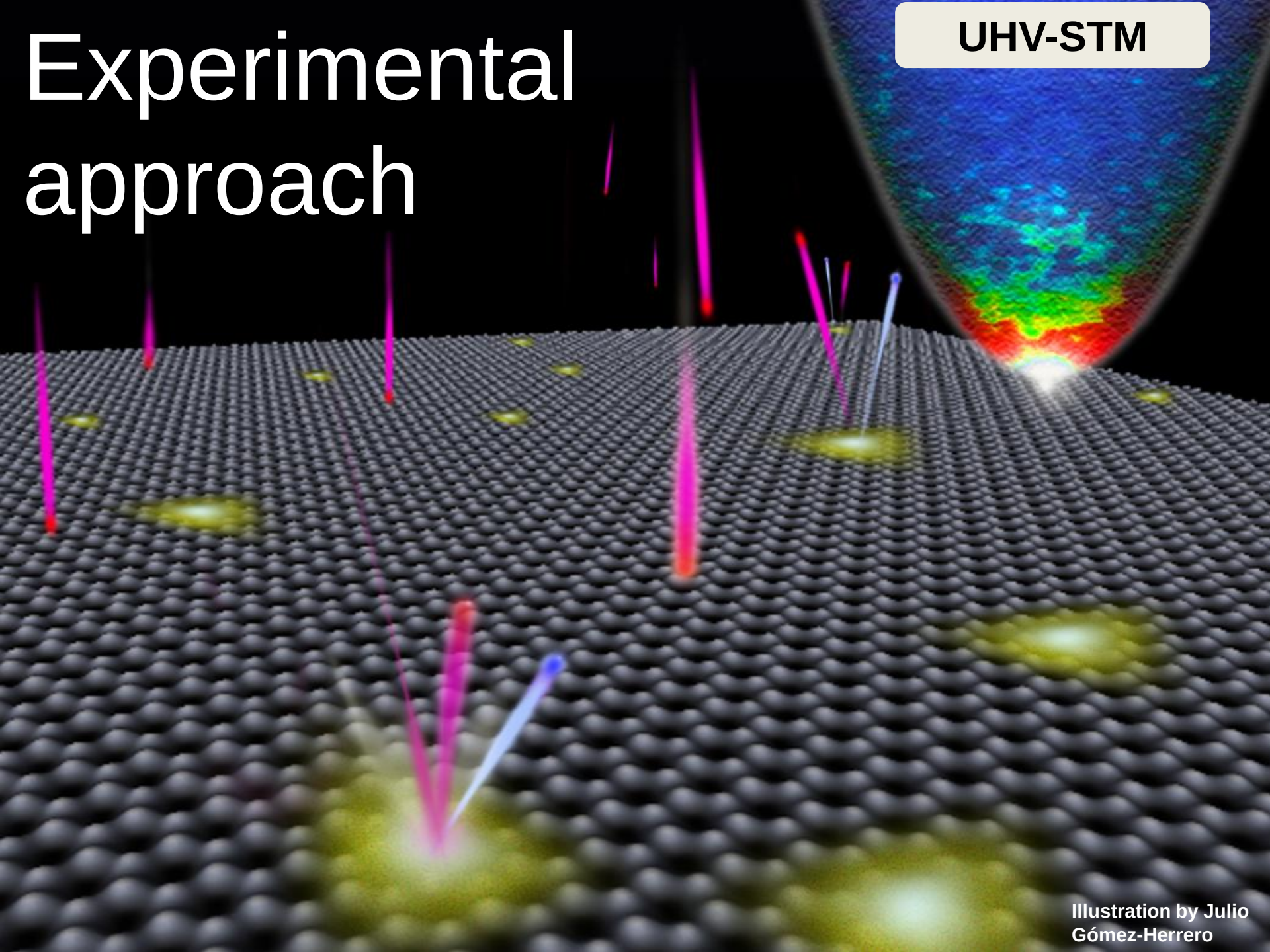
H chemisorbs on Graphene



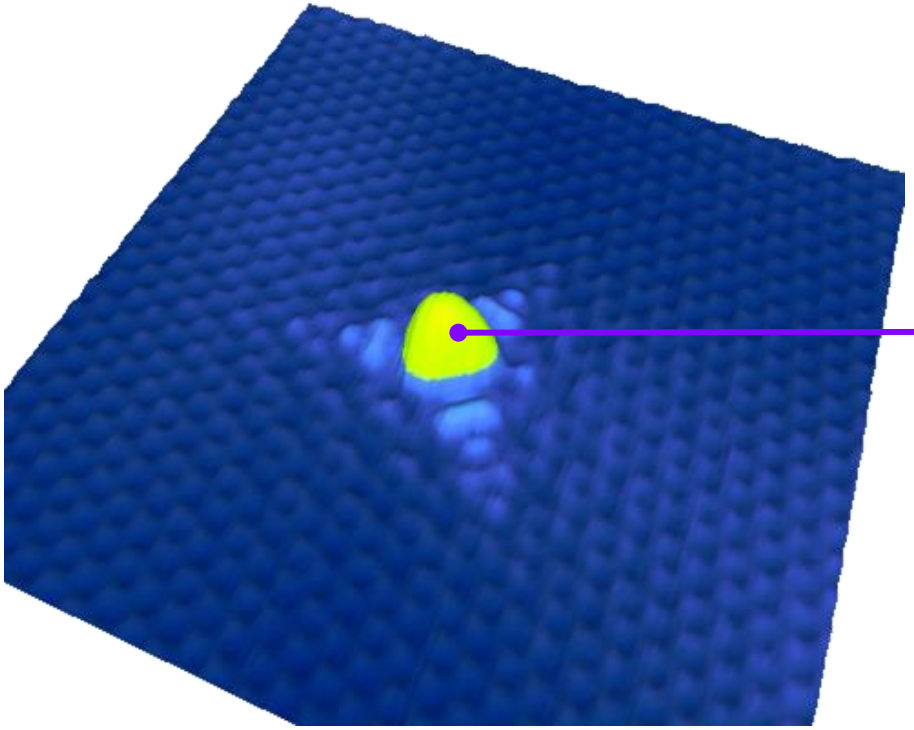
DFT calculations: M. Moaied, J.J Palacios, Felix Yndurain

- Spin Polarized – DFT SIESTA code // (DZP) basis set.

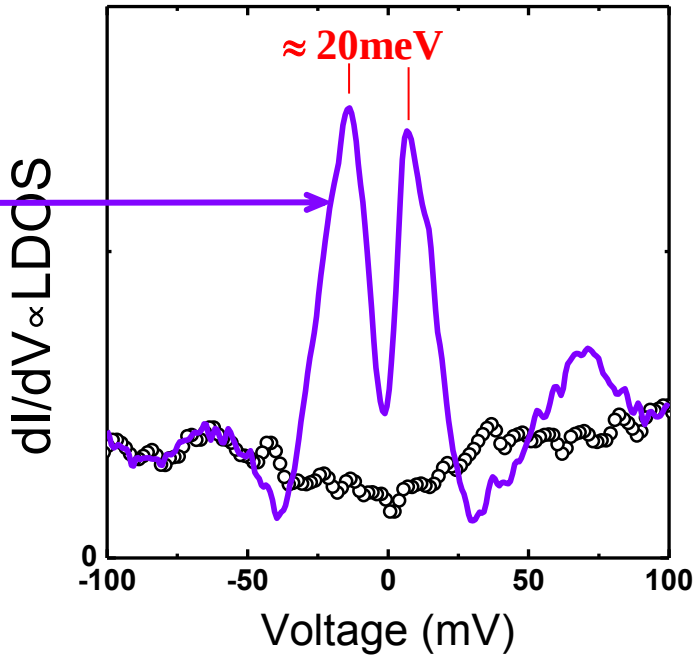
Experimental approach



Starting point of the project!

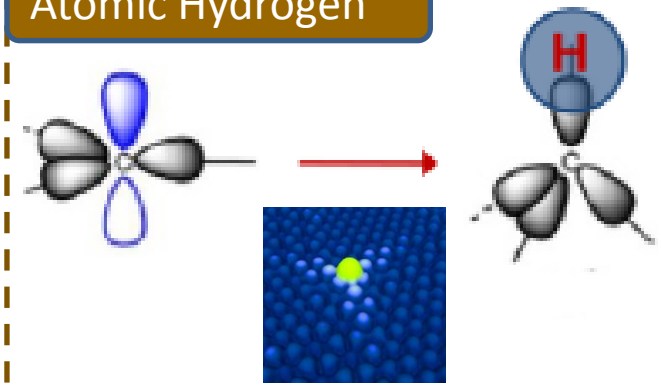


Spin-split peaks!!

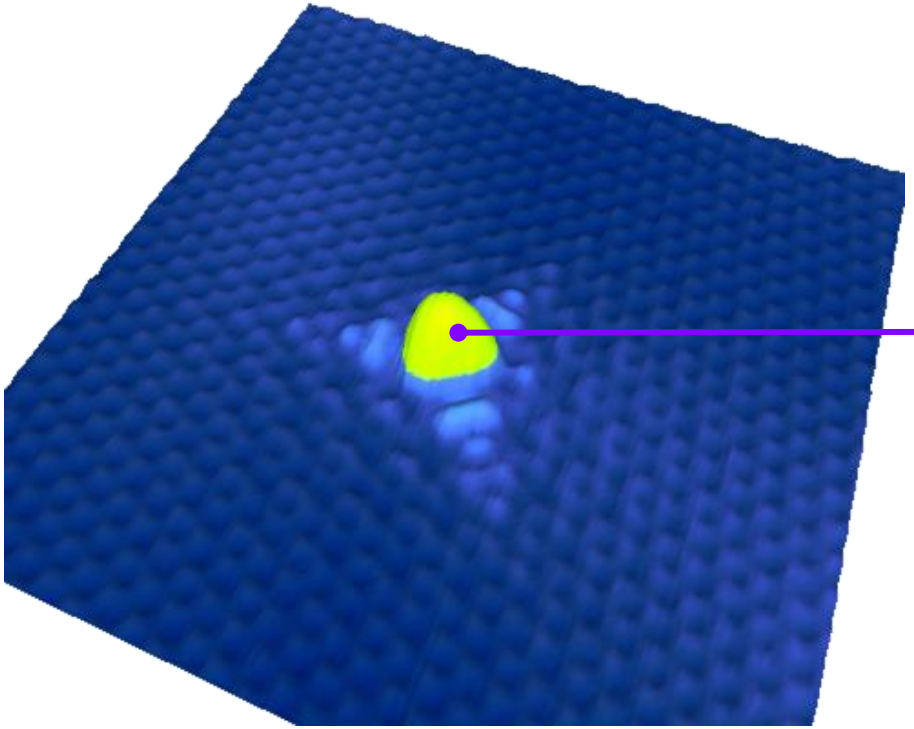


Theoretical prediction

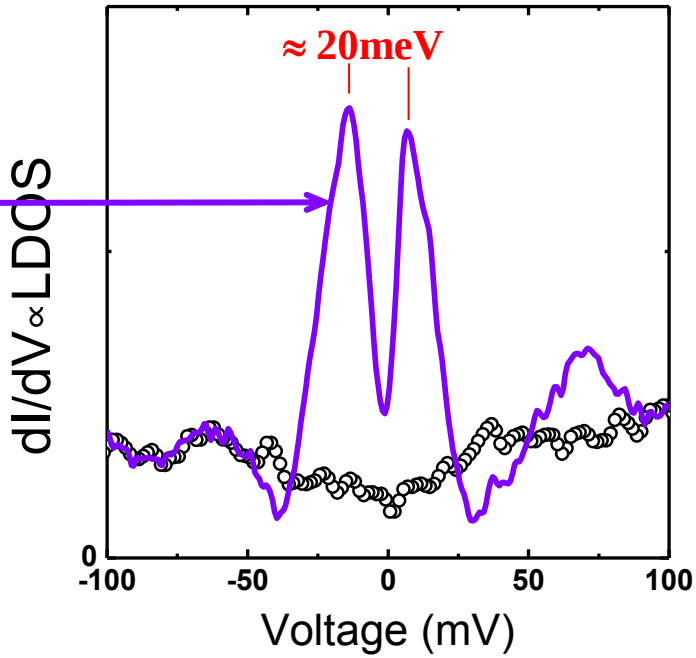
Atomic Hydrogen

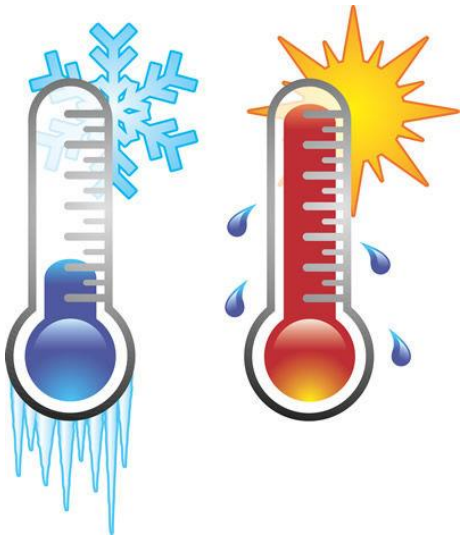


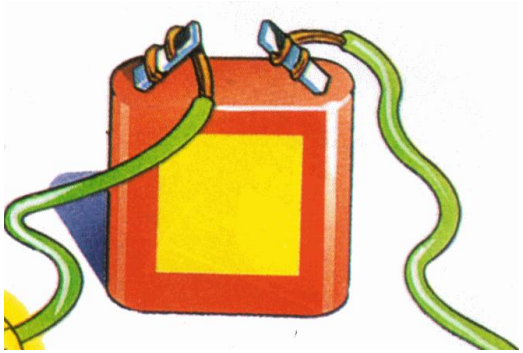
Proposed experiments



Spin-split peaks!!





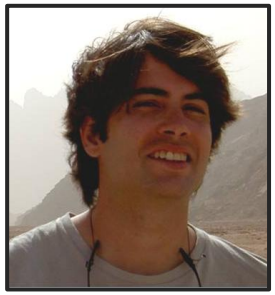


The consortium (who we are)

Coordinator (P1)

UAM UNIVERSIDAD AUTONOMA DE MADRID

P.I.



I. Brihuega

co-Investigator

J.M.Gómez-Rodríguez

Partner 2

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P.I.

J-Y Veuillen

co-Investigator

P. Mallet

Partner 3

MPI Stuttgart

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K. Kern

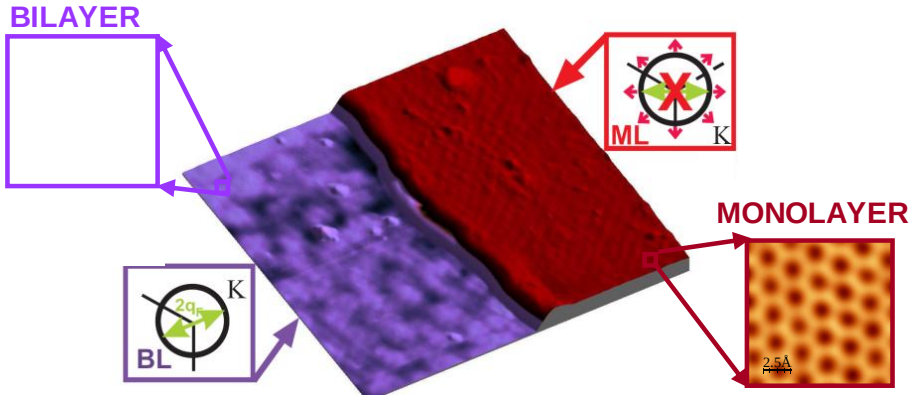
co-Investigator

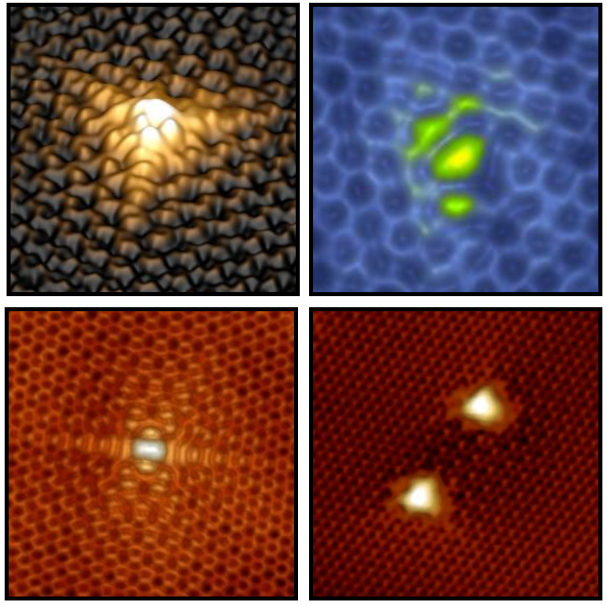
M.Ternes

Quasiparticle pseudospin

I Brihuega, P. Mallet, C. Bena, S. Bose, C. Michaelis, L. Vitali, F. Varchon, L.Magaud, K. Kern, J.Y. Veuillen

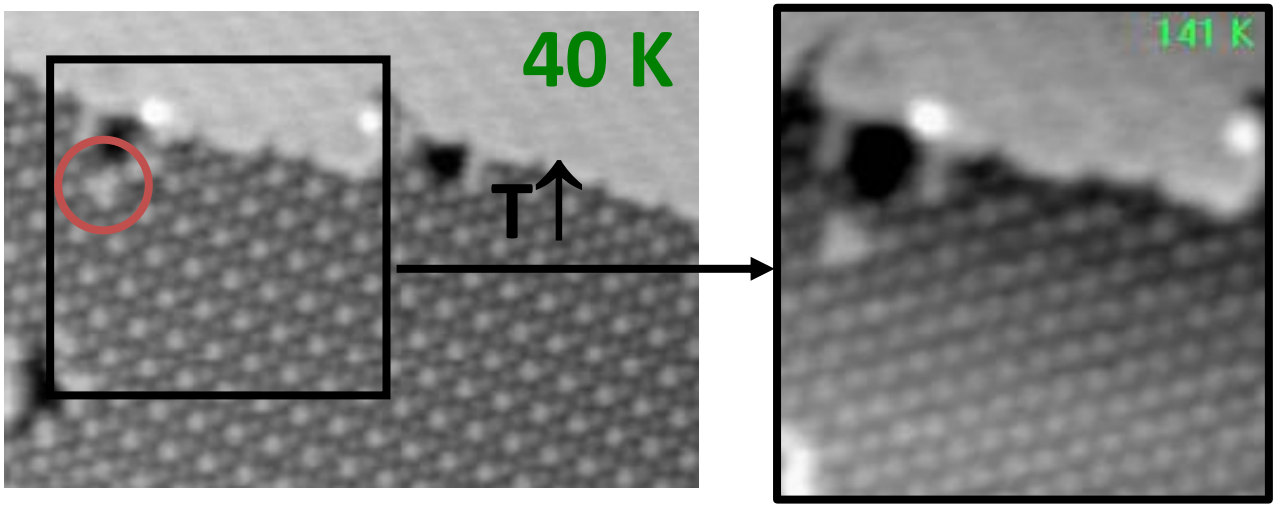
Phys Rev. Lett. 101, 206802 (2008)



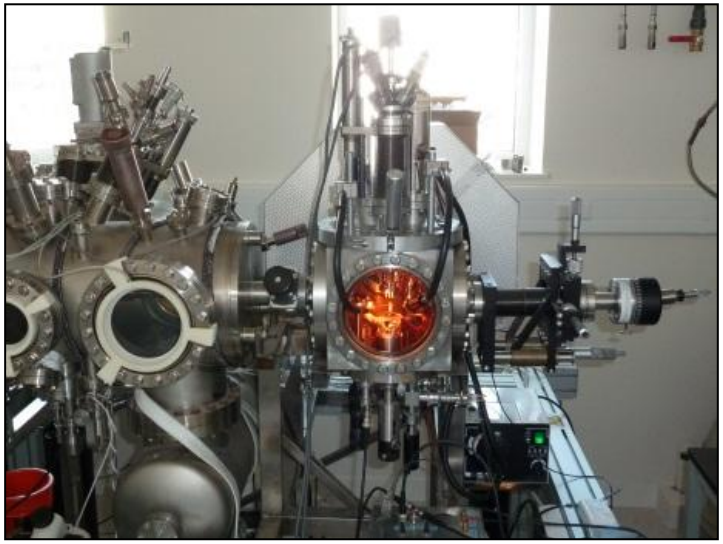


Point defects in graphene

True variable Temperature experiments

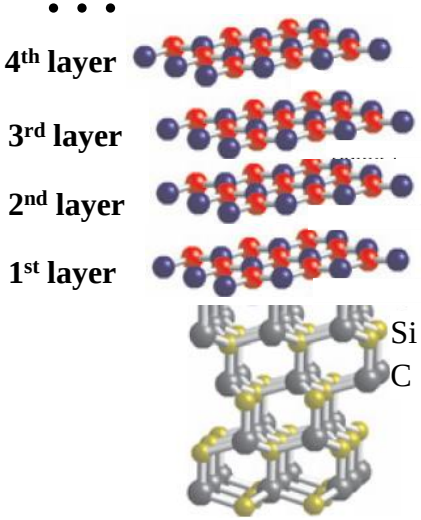


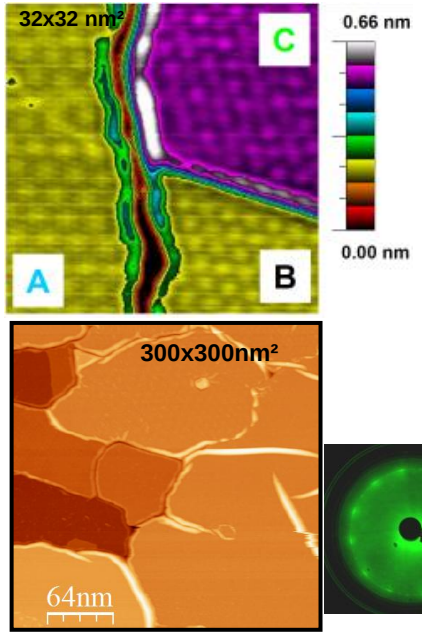
Preparation of graphene substrates



G/SiC-C

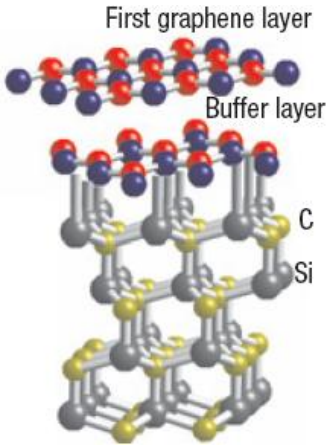
doped twisted bi(tri)layer Gr

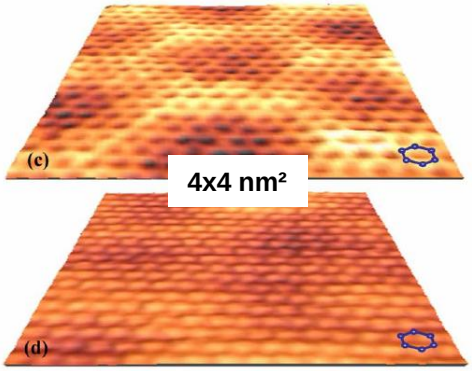




Neutral (thick) twisted multilayer

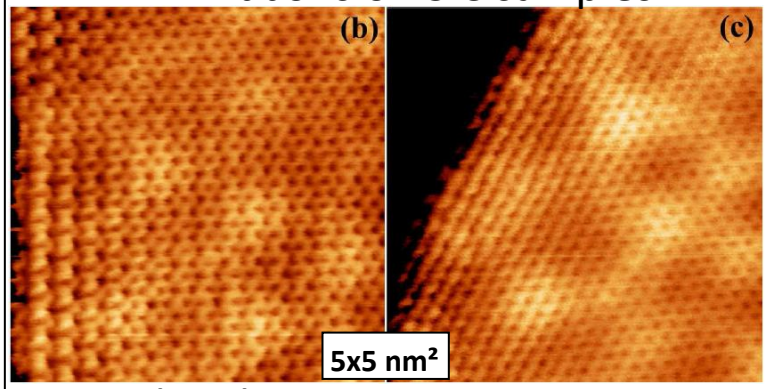
G/SiC-Si





Heavily doped ML and BL Gr

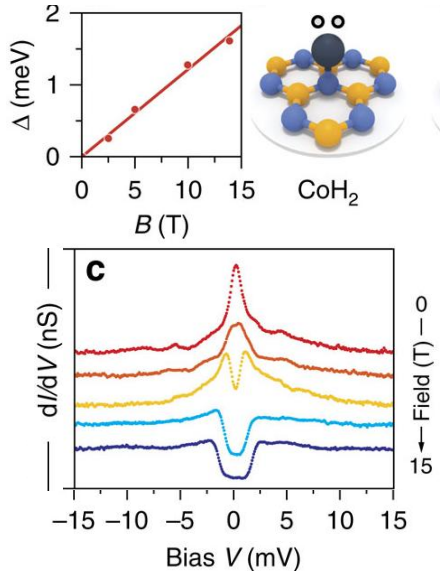
ribbons on SiC samples

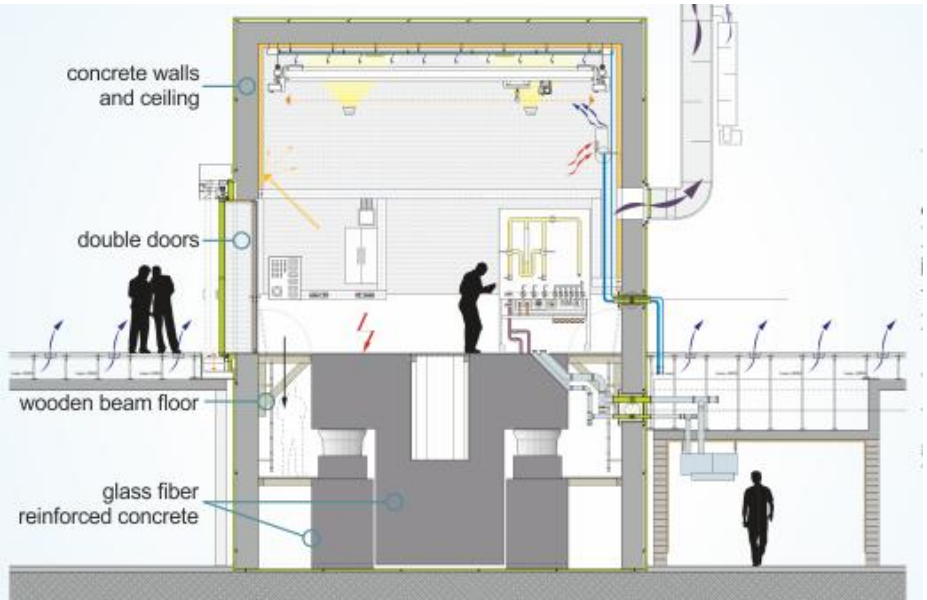


Max-Planck-Institute for Solid State Research

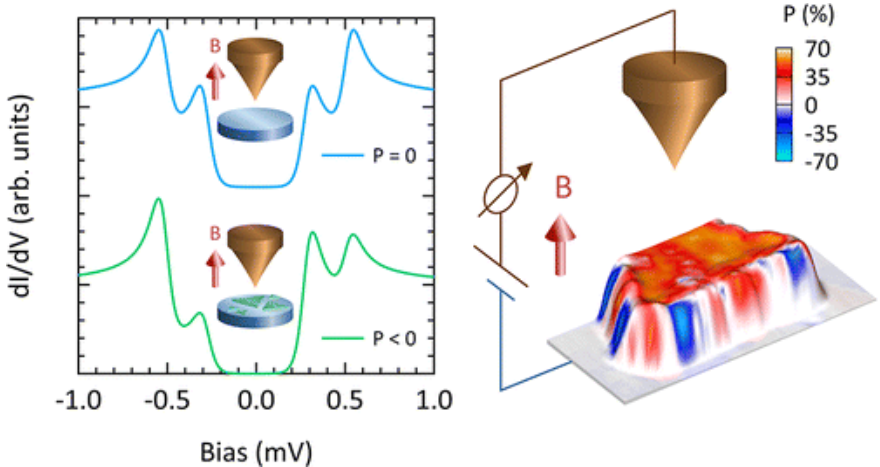
Nanoscale Science Department

Magnetic Field dependence

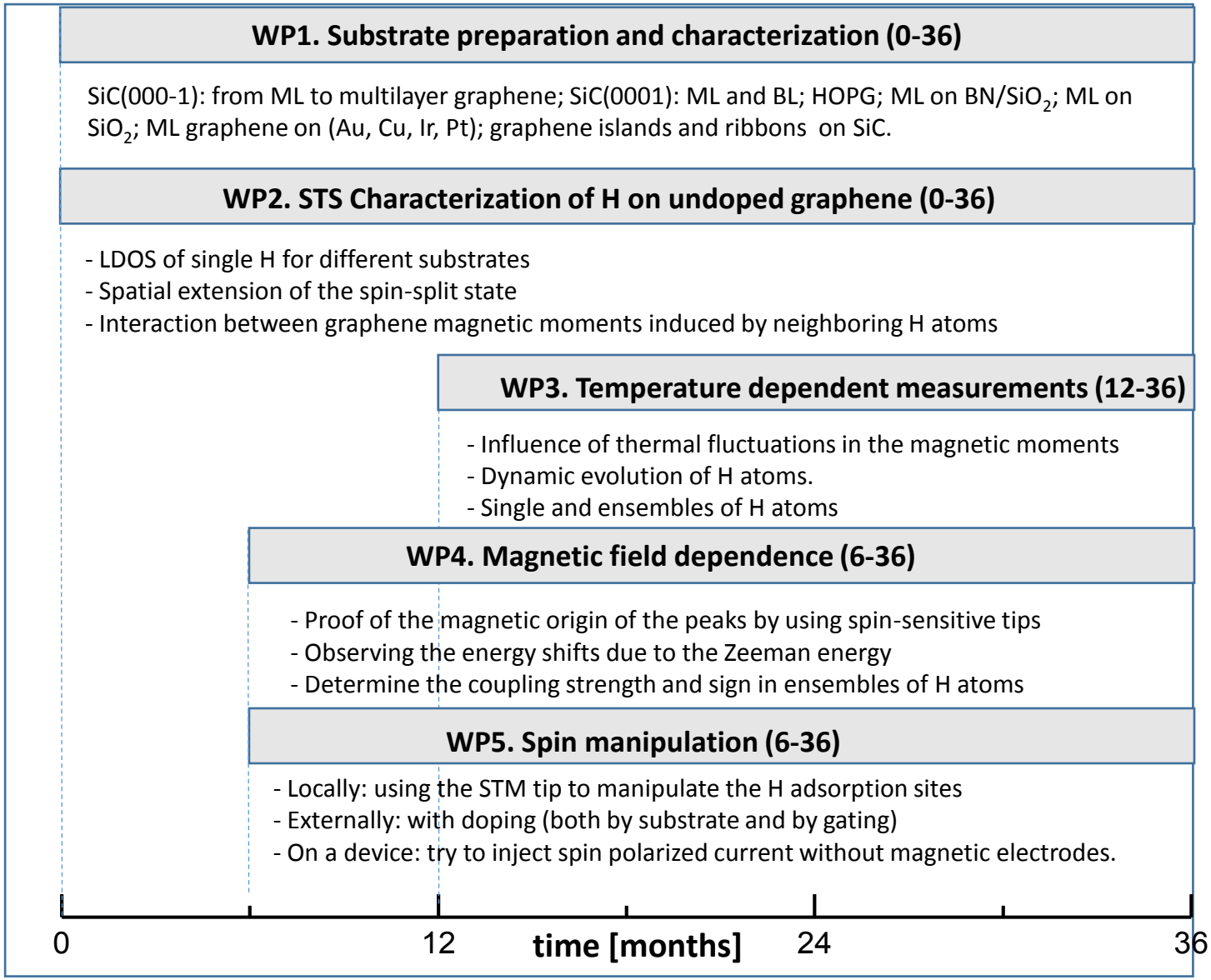




Spin polatization

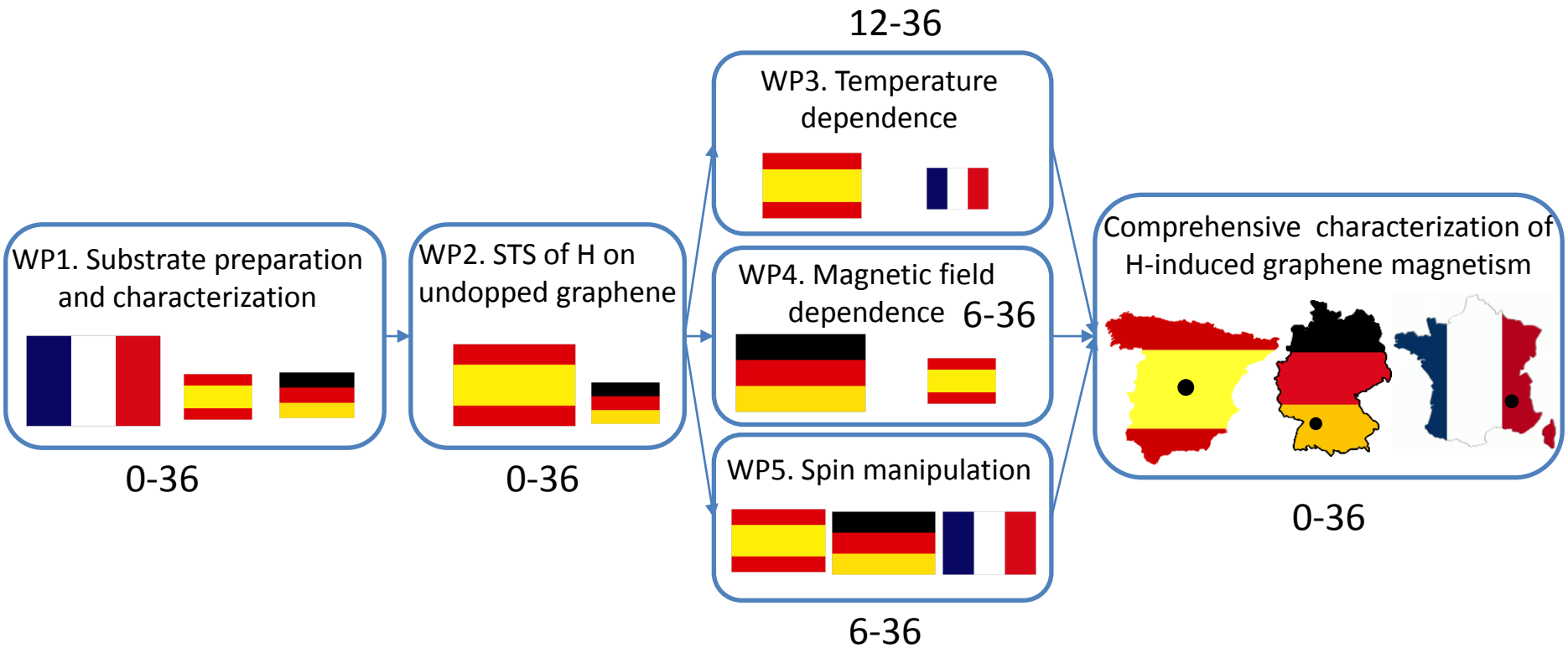


Chronogram of activities:



Role of the partners

(who does what)



GRAPHENE FLAGSHIP

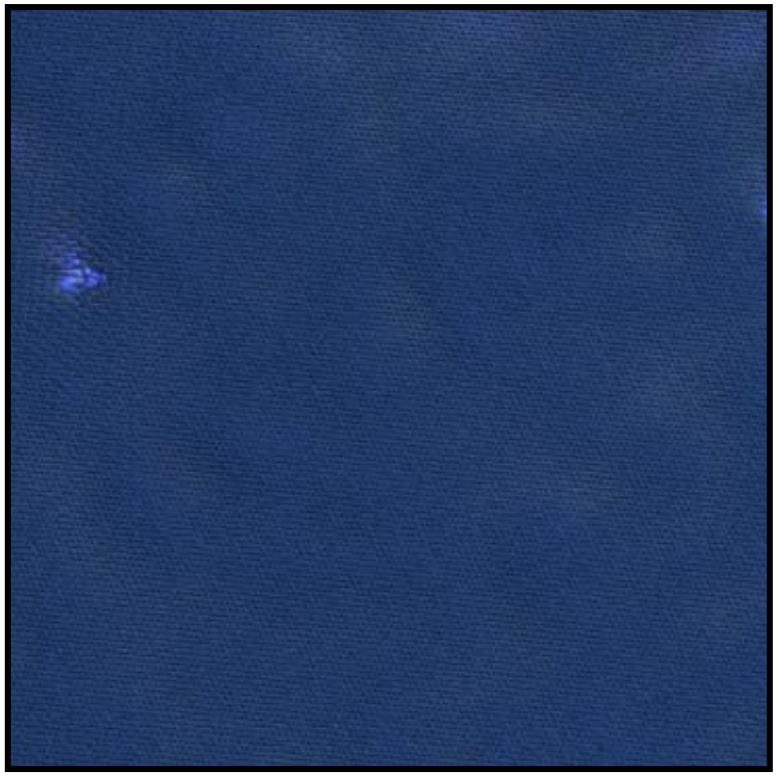
WP1: Enabling Research

WP2: Spintronics

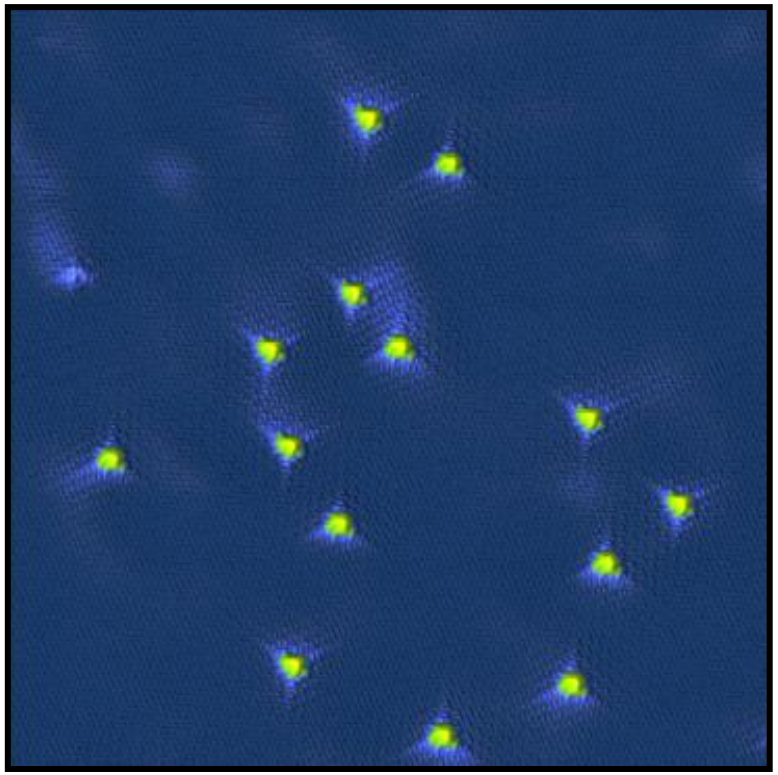
"HiMagGraphene"

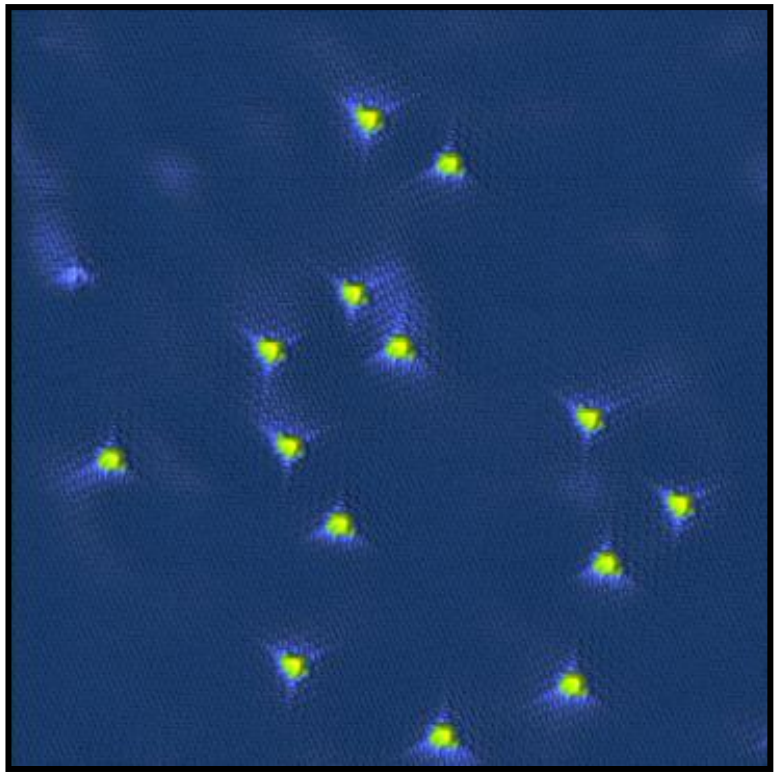
Progress so far…

Manipulating H magnetism



Manipulating H magnetism

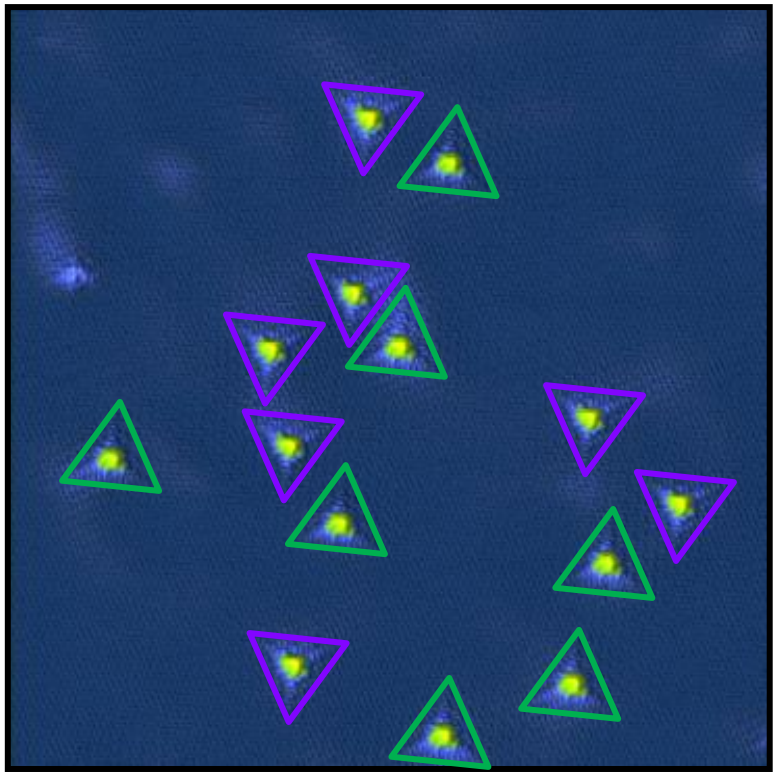




Manipulating H magnetism

7 H atoms “up”

7 H atoms “down”



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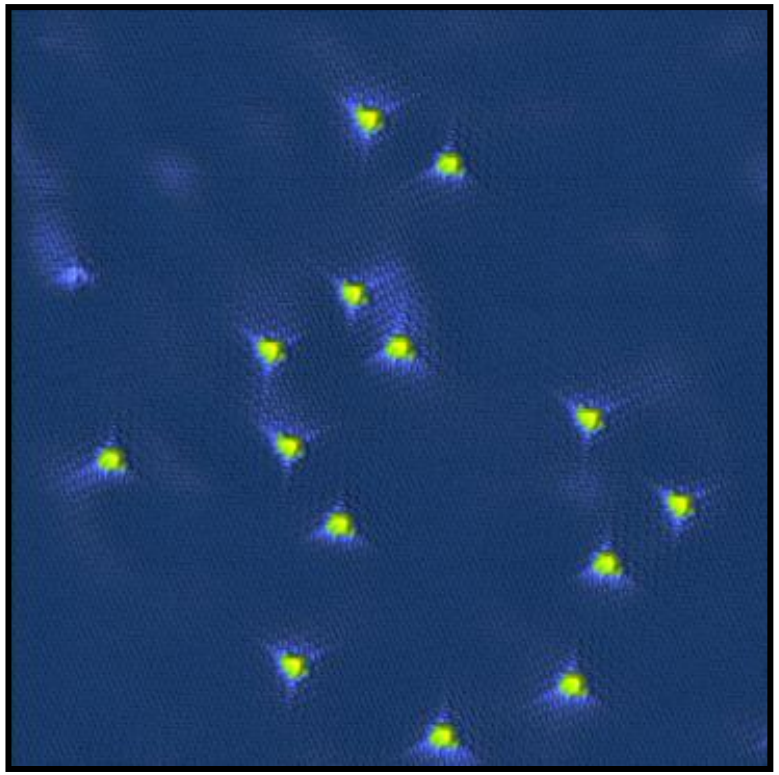

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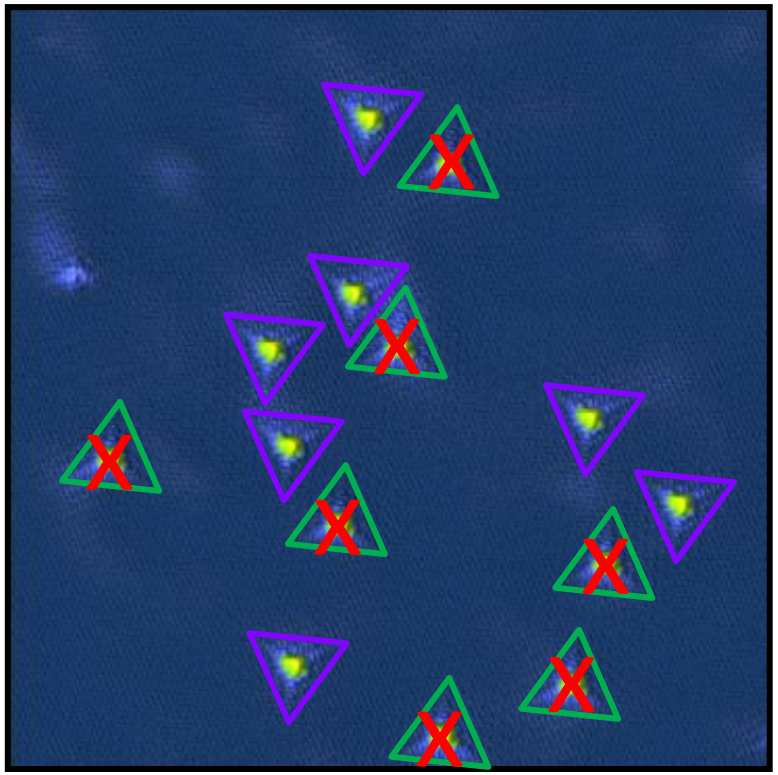

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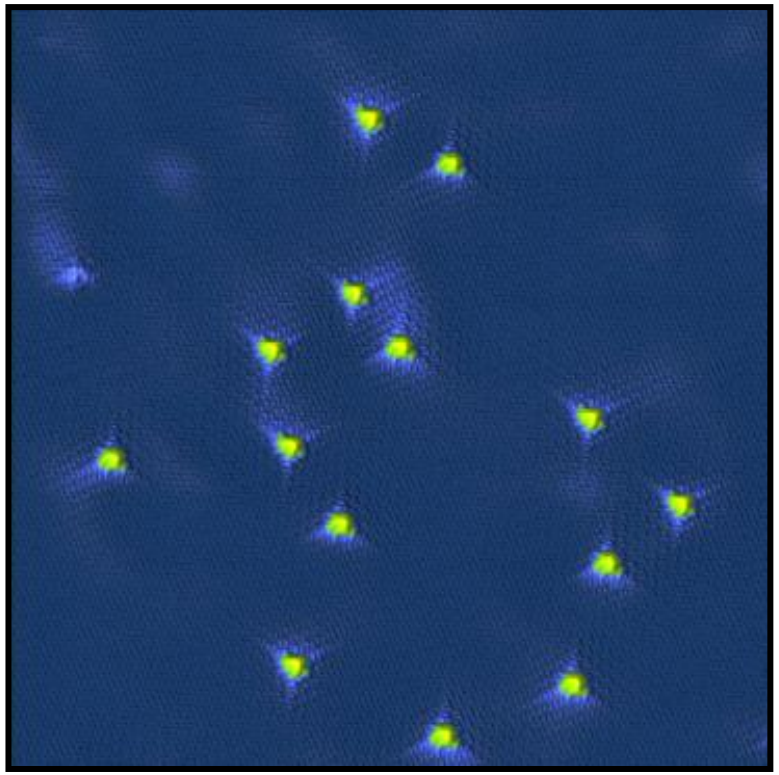

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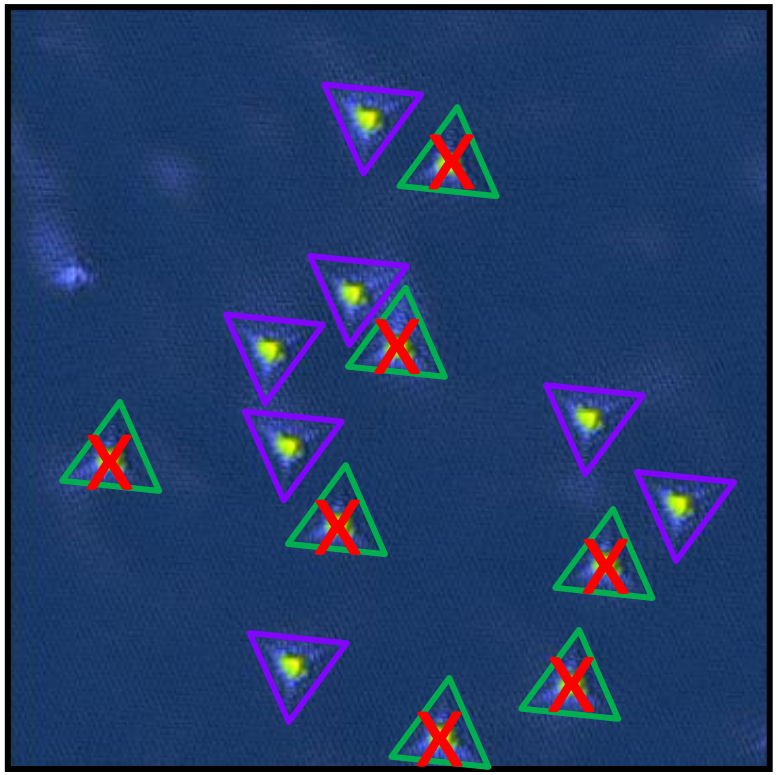
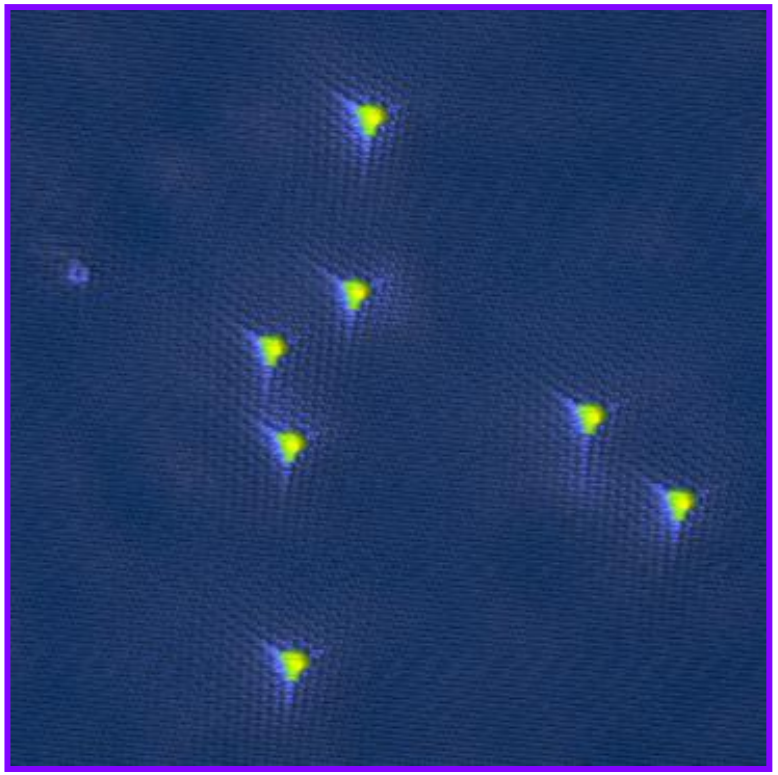


7 H atoms "down"



H. González-Herrero, J.M .Gómez-Rodríguez, P. Mallet, M. Moaied, J.J. Palacios, C. Salgado, M.M. Ugeda, J.Y. Veuillen, F. Ynduráin and I Brihuega, submitted

Manipulating H magnetism

7 H atoms “up”

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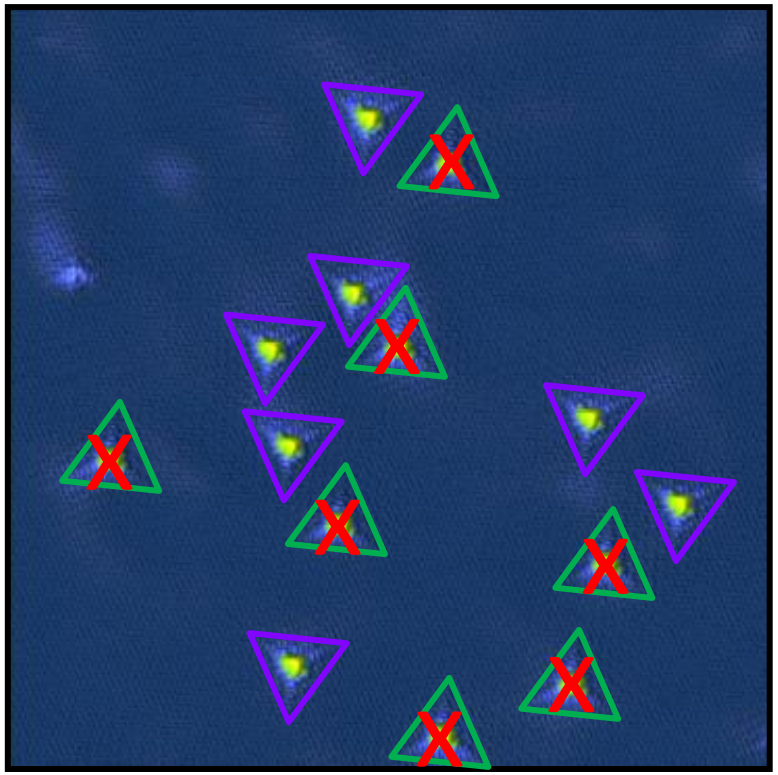

7 H atoms “up”

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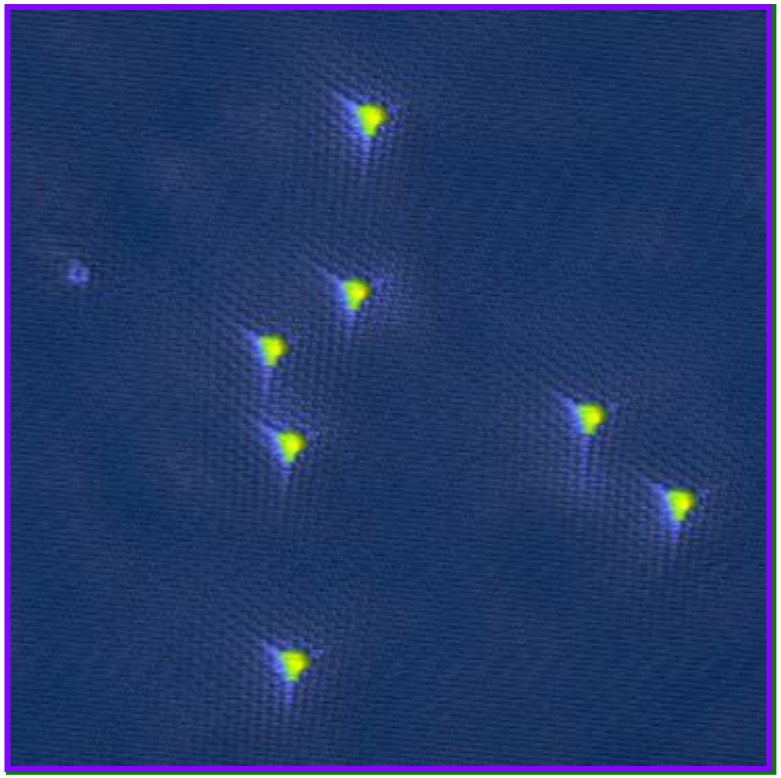
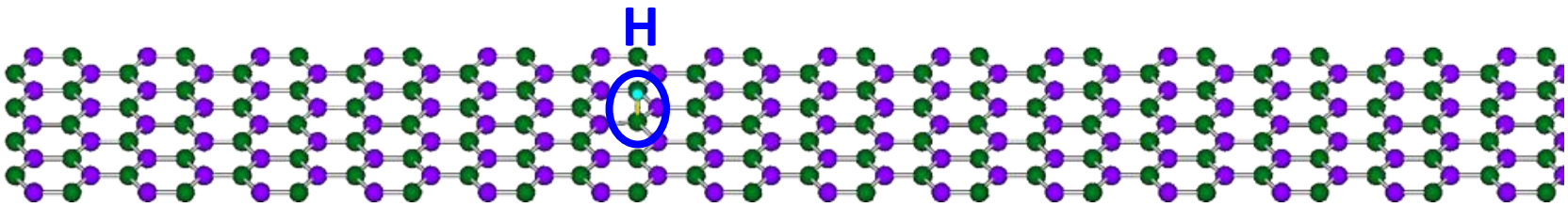


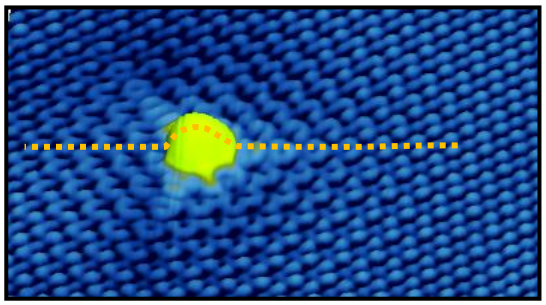
H. González-Herrero, J.M .Gómez-Rodríguez, P. Mallet, M. Moaied, J.J. Palacios, C. Salgado, M.M. Ugeda, J.Y. Veuillen, F. Ynduráin and I Brihuega, submitted

Sublattice localization of the polarized peak

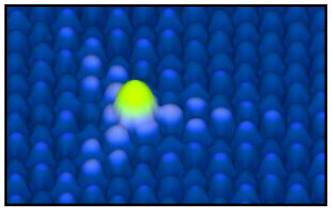


TOPOGRAPHY

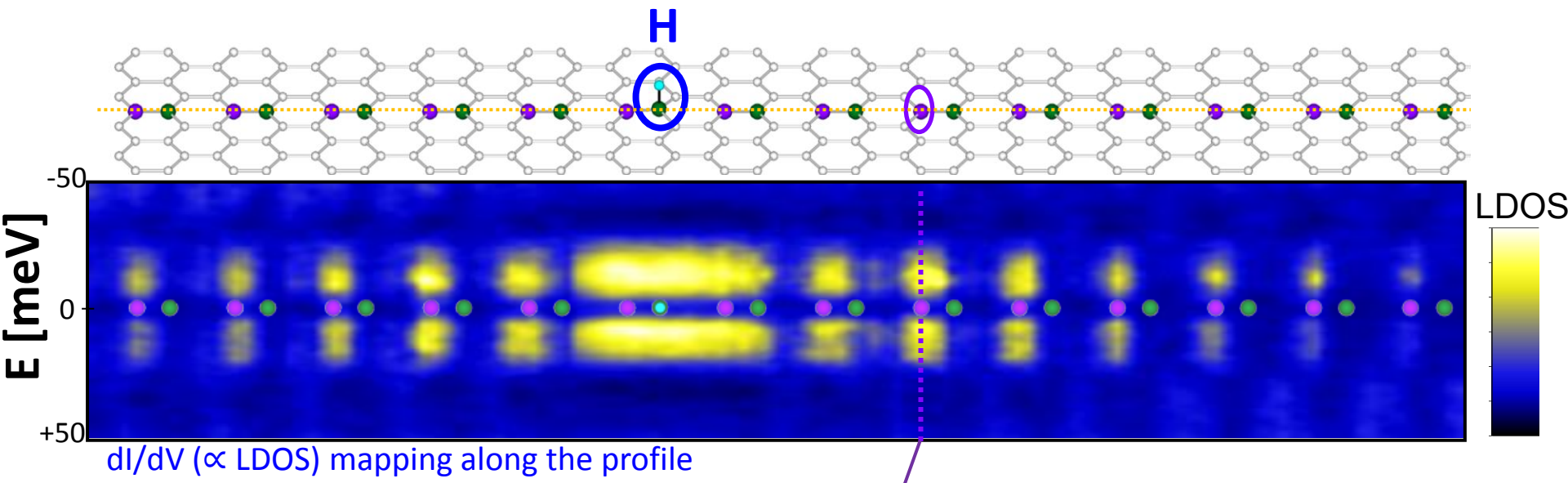
STM



DFT



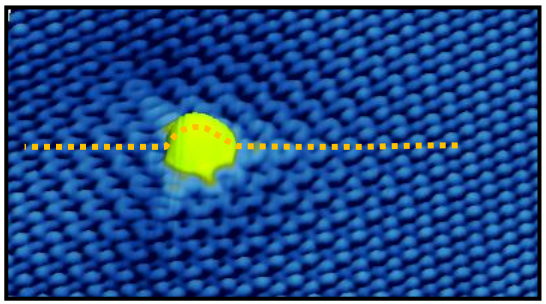
Sublattice localization of the polarized peak



dI/dV (∝ LDOS) mapping along the profile

TOPOGRAPHY

STM



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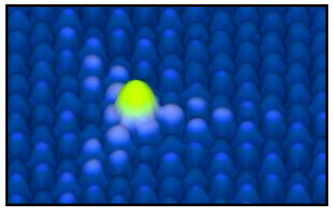
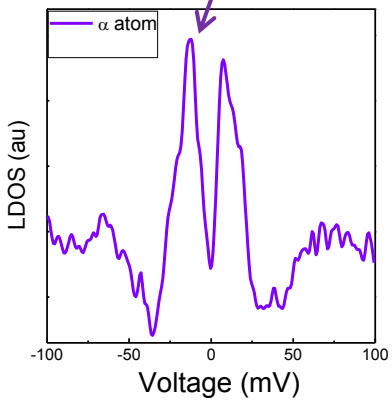
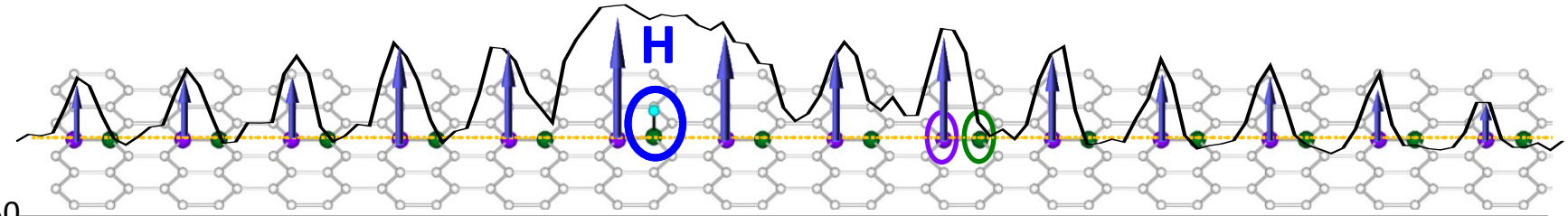
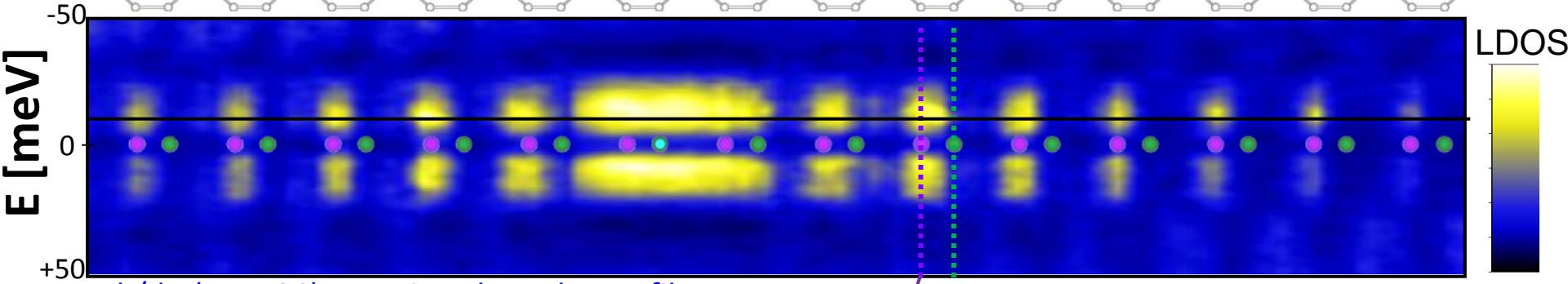




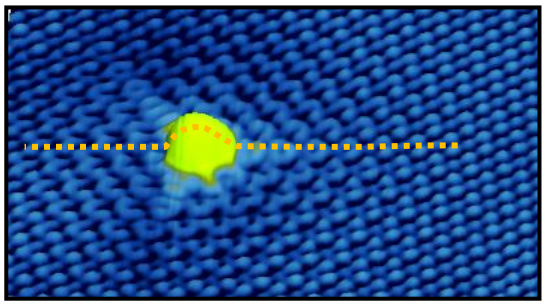
Sublattice localization of the polarized peak

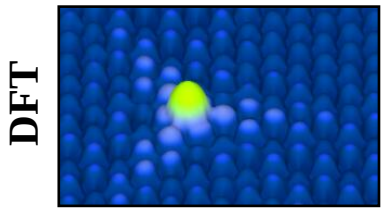


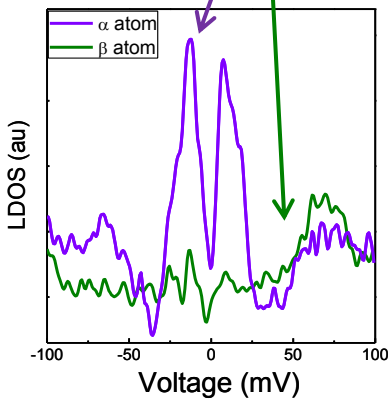


dI/dV (∝ LDOS) mapping along the profile

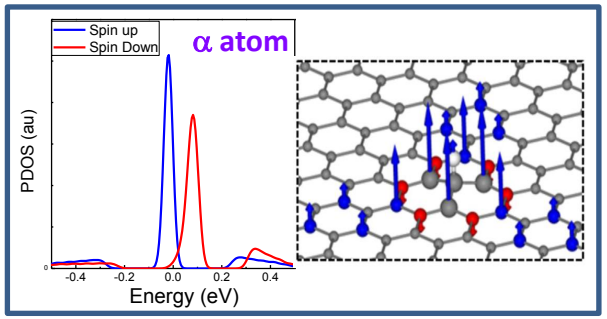
TOPOGRAPHY







DFT



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True variable Temperature experiments