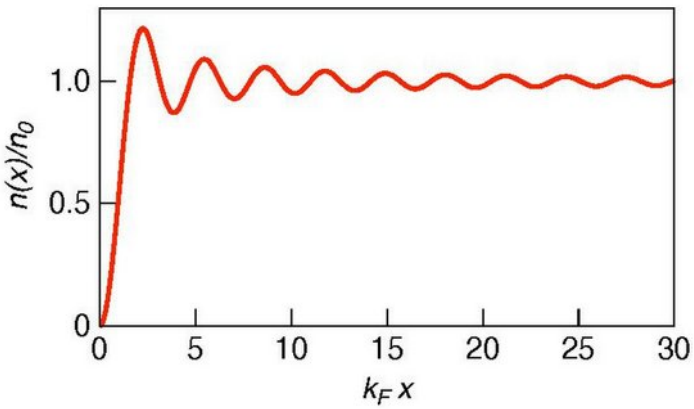
Φ – 575 Διάλεξη 18

Φυσική διατάξεων δισδιάστατων ημιαγωγών

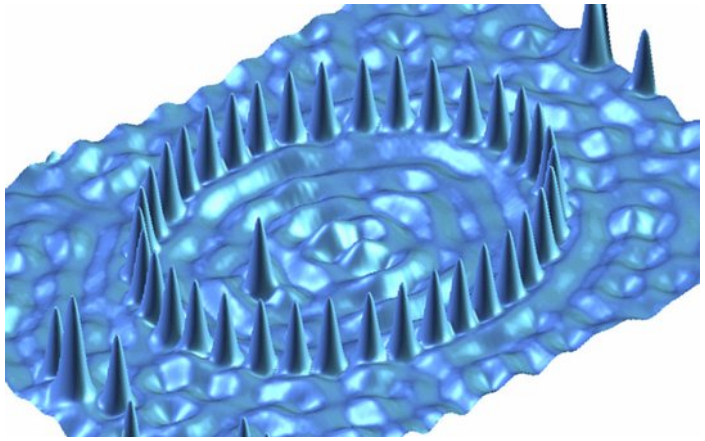
Γιώργος Δεληγεώργης (deligeo@physics.uoc.gr)

Friedel oscillations

Friedel oscillations, arise from localized perturbations in a metallic or semiconductor system caused by a defect. Friedel oscillations are a quantum mechanical analog to electric charge screening of charged species in a pool of ions

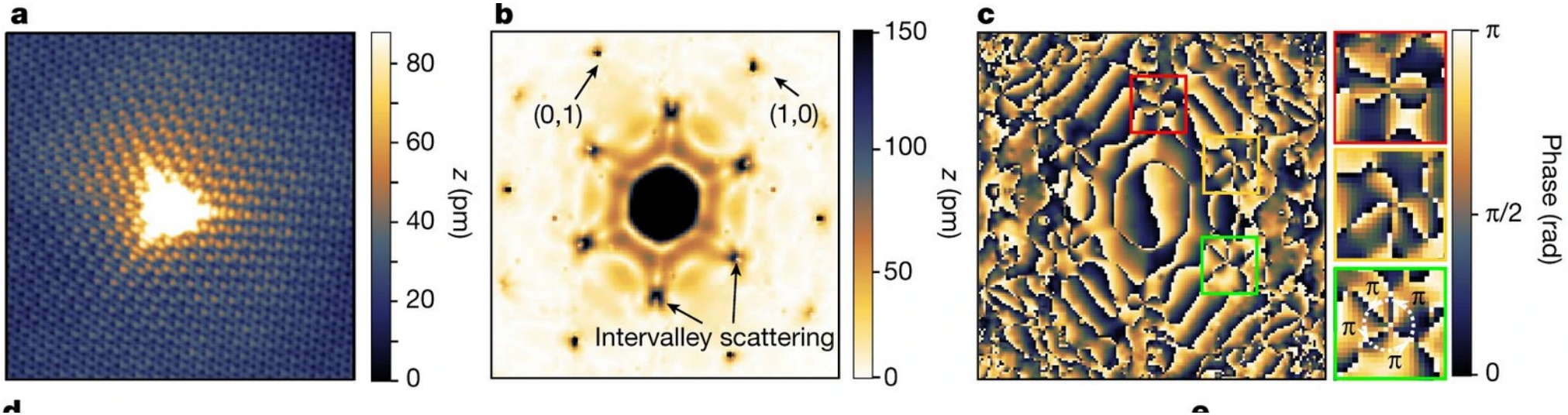


Scanning tunneling microscopy image of an elliptical quantum corral built by Co atoms on a Cu surface.



"Magnetic Friedel Oscillation at the Fe(001) Surface: Direct Observation by Atomic-Layer-Resolved Synchrotron Radiation 57 F e Mössbauer Spectroscopy". Phys. Rev. Lett. 125 (23): 236806. doi:10.1103/PhysRevLett.125.236806

Friedel in graphene



a, Topography STM image of a H adatom at the surface of graphene. The image is 10 nm × 10 nm in size. The tunnelling bias is Vb = 0.4 V and the tunnelling current is it = 45.5 pA.
b, Modulus of the fast Fourier transform (FFT) of the image in a. The points labelled (1, 0) and (0, 1) correspond to the atomic signal.
c, Phase of the FFT of the image in a. Magnifications of the inter-valley backscattering signal are presented on the right, with corresponding border colours red, yellow and green. The phase winds by 4π around each of these spots; the sharp boundary between bright and dark indicates a phase shift of π. The FFT images are 62.8 nm−1 × 62.8 nm−1.

Measuring the Berry phase of graphene from wavefront dislocations in Friedel oscillations Nature volume 574, pages 219–222 (2019)

Majorana particles

Majorana particle is a fermion that is its own antiparticle.

Because particles and antiparticles have opposite conserved charges, Majorana fermions have zero charge, hence among the fundamental particles, the only fermions that could be Majorana are sterile neutrinos, if they exist. All the other elementary fermions of the Standard Model have gauge charges, so they cannot have fundamental Majorana masses

In superconducting materials, a quasiparticle can emerge as a Majorana fermion (non-fundamental), more commonly referred to as a Bogoliubov quasiparticle in condensed matter physics. Its existence becomes possible because a quasiparticle in a superconductor is its own antiparticle.

Majorana in graphene

Majorana fermions, exotic quasiparticles that are their own antiparticles, can be realized in graphene under specific conditions. By combining graphene with superconductivity and applying a magnetic field, researchers have theoretically demonstrated the possibility of creating Majorana states at the edges of graphene, which could have implications for quantum computing

https://doi.org/10.1103/PhysRevB.101.245441
http://stacks.iop.org/PhysScr/T146/014013