Crafting Graphene: Magnetism, Superconductivity and Twistraintronics

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Our understanding of graphene's intrinsic properties is now sufficiently mature to move to the next stage: engineering and exploiting properties not naturally present in graphene, such as magnetism and superconductivity.
In this talk, I will present how we incorporate these properties into graphene and control them at the nanoscale using scanning tunneling microscopy (STM). In particular, we use atomic hydrogen as S=1/2 magnetic building blocks [1,2] and Pb nanoislands to induce superconductivity via the proximity effect [3,4]. Through selective manipulations of both H atoms and Pb nanoislands we are able to realize ultralong magnetic couplings, create graphene quantum dots and form exotic magnetic phases as altermagnets and Lieb ferromagnets.
If time permits, I will introduce "twistraintronics," where strain and twisting are combined to achieve highly correlated electronic states with geometries that were previously inaccessible [5].

References

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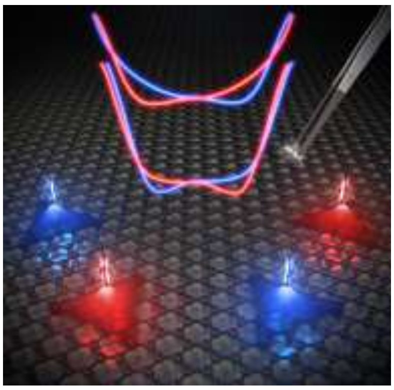
Figures



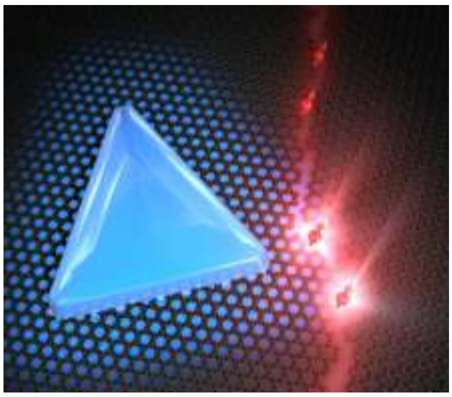


Figure 1: Left: realization of an altermagnet on graphene, with four H atoms on alternating sublattices. Right: inducing both superconductivity and magnetism in graphene generate exotic Yu-Shiba-Rusinov states, a starting point to ultimately create graphene topological qubits.