

PhD position available at CIC nanoGUNE, San Sebastián, on

Quantum Nanoscience in Magnetic Graphene Nanostructures

We are seeking for candidates to fill a PhD position in experimental physics, in the fields of molecular physics and condensed matter.

Motivation of the PhD project: Molecular spins can form qubit elements for quantum computation, thus expanding our current Information Technology landscape. Optimal molecular materials are required that combine well-defined spin localization and coherence, with electrical addressability, and precise integration into mesoscopic architectures and scalability. A promising material combining these properties is graphene. Graphene is a diamagnetic material but shaped in specific forms it can host localized spins.

Objective of the PhD project: The PhD project focuses on the fabrication of custom-crafted graphene nanostructures on metallic surfaces and investigates the emergence of electronic magnetic states using low-temperature scanning tunneling microscopy (STM). The primary objective is to demonstrate the magnetism of these nanostructures and manipulate their spin quantum state through advanced single-molecule spectroscopy measurements.

To achieve atomic-scale precision in fabricating graphene flakes, a cutting-edge method called "on-surface synthesis" will be employed. This technique leverages an organic molecule with a predetermined shape and active sites as a precursor or building block. By carefully controlling temperature and utilizing a metallic surface as a catalyst, the bottom-up covalent assembly of these precursor molecules will be directed, leading to the formation of larger and more complex graphene structures.

Activities: The project's research activities will involve the following:

- **Graphene Nanostructure Fabrication:** Design and implement protocols for creating graphene nanostructures with tailored geometries and properties on metallic surfaces using the on-surface synthesis technique. Explore different precursor molecules and optimize synthesis conditions to achieve the desired graphene architectures.
- **Low-Temperature Scanning Tunneling Microscopy (STM):** Employ state-of-the-art STM techniques to probe and characterize the electronic and magnetic properties of the fabricated graphene nanostructures at low temperatures. This will involve mapping the spatial distribution of electronic states and investigating spin-related phenomena.
- **Single-Molecule Spectroscopy:** Utilize advanced single-molecule spectroscopy techniques to study the spin quantum states of individual graphene nanostructures. Investigate how external stimuli, such as electric fields, magnetic fields, or microwave photons, can be used to manipulate and control the spin quantum behavior of these structures.
- **Data Analysis and Interpretation:** Process and analyze the experimental data obtained from STM and single-molecule spectroscopy measurements. Extract relevant information about spin localization, coherence, and other magnetic properties. Develop theoretical models and simulations to interpret the experimental results and gain deeper insights into the underlying physics.

Host Group & city: The successful candidate will have the opportunity to work in a highly collaborative and interdisciplinary research environment. They will closely collaborate with senior researchers and experts in the field to advance the understanding of spin-related phenomena in graphene nanostructures and contribute to the development of next-generation information technologies. The group combines various methods of probe microscopy and spectroscopy with a

wide variety of synthesis, growth, and characterization techniques. The research will be performed under the supervision of Prof. Nacho Pascual. More information about our research group can be found in www.nanogune.eu/nanoimaging

San Sebastian is a middle size city lying directly at the Atlantic seacoast and surrounded by a sensational environment of hills and mountains full of tradition and nature. The city is close to the French border, showing a dynamical cultural scene and renowned for its Basque cuisine.



Requirements for the position:

- Education: Hold a Master's degree (or equivalent) in Physics, Materials Science, Nanotechnology, or a related field.
- Knowledge & Experience: Background in experimental condensed matter physics, nanoscience, or a closely related discipline. Previous experience with scanning tunneling microscopy (STM), low-temperature experimental setups, or single-molecule spectroscopy will be advantageous.
- Skills: Strong programming skills and experience with scientific software packages (e.g., MATLAB, Python) for data analysis and simulation. Excellent written and verbal communication skills in English. Ability to present research findings effectively and collaborate within an international and multicultural research team.

Application Process: To apply for the PhD position, please submit the following documents:

- Curriculum Vitae (CV): Include your educational background, research experience, publications (if any), and any relevant skills.
- Cover Letter: Clearly state your motivation for applying to this PhD position and explain how your qualifications align with the research project.
- Academic Transcripts: Provide copies of your Bachelor's and Master's degree transcripts.
- Contact information of at least two academic references who can attest to your research capabilities.

For application, please fill the form in <https://www.nanogune.eu/en/research/nanoimaging/join-us-nanoimaging> and submit a single PDF file combining all the documents.