

Postdoc in Physics –18 Months

Laboratory: Laboratoire Charles Coulomb (L2C), Université de Montpellier

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Nanofluidics of water inside carbon nanotube addressed thanks to nanomechanics

Context and missions

Nanoscale confined water is drastically different from the bulk. When confined at the nanoscale, water can adopt structures that are unique in nature [1], with consequences on its phase diagram [2]. Moreover, at this scale the water flow diverges from the continuum hydrodynamics [3], with potentially intriguing concerted molecule motion [4], coupling to vibrations [5] or quantum effects [6]. This field is known as nanofluidics, and has implications in biology, medicine, clean energy, water filtration, to name a few.

Probing experimentally the confinement of water inside a carbon nanotube is challenging, as they are very few molecules involved, on the order of a few thousands. Therefore, it is necessary to imagine new methods to probe the physics of those objects.

Nanomechanics has the potential to overtake this challenge. A carbon nanotube mechanical oscillator can – in theory – weight masses down to a single proton [7].

The project will focus on fabricating the samples combining nanofluidics and nanomechanics in clean room, developing the measurement tools (including nanomechanics, but also electronics and optics when needed) and using such tools to measure both static (structure, phase diagram) and dynamic (mass transport) properties of confined water. The ultimate sensitivity of the resonator in presence of water should also be addressed.

Activities

The candidate will:

- Produce samples in clean room: lithography, etching, metallization, etc.
- Participate in the development of the nanomechanical measurement tools: low-noise electronics, fast measurements with a PLL, interfaces (Labview, Python)
- Acquire and analyze data
- Present the results

The candidate can:

- Participate in the supervision of students
- Participate in the dissemination activities: publications in scientific journals, conferences, general public communication, etc.

Skills/profile

The candidate (F/M) must have experience in clean room microfabrication techniques, and a minimal background in electronics. In addition, experience in mechanical resonators and/or soft matter will be considered as a plus.

Working environment

The work will be carried out in the 'Laboratoire Charles Coulomb' (L2C) at Montpellier University, France, in the team 'Nanomaterials'. The team is mainly composed of experimentalists. The work will be supervised by Adrien Noury (PI), CNRS researcher, and by François Henn, Full Professor.

The project is funded by the program 'Soutient à la recherche' of University Montpellier.

More info on our website: www.nanomechanics.fr

Salary

Net monthly salary (depending on experience): 1892.27 - 2150 €/month

Additional information:

Length of contract: 18 months

Starting date: flexible. End date before 31/12/2024

Website: <https://nanomechanics.fr/>

References

- [1] T. A. Pascal, W. A. Goddard and Y. Jung, *Proc. Natl. Acad. Sci. U.S.A.* 108 (2011)
- [2] D. Takaiwa, I. Hatano, K. Koga and H. Tanaka, *Proc. Natl. Acad. Sci. U.S.A.* 105 (2008)
- [3] L. Bocquet and E. Charlaix, *Chem. Soc. Rev.* 39 (2010)
- [4] G. Hummer, J. C. Rasalah and J. P. Noworyta, *Nature* 414 (2001)
- [5] M. Ma, F. Grey, L. Dhen, M. Urbakh, S. Wu, J. Z. Liu, Y. Liu and Q. Zheng, *Nat. Nanotechnol.* 10 (2015)
- [6] N. Kavokine, M.-L. Bocquet and L. Bocquet, *Nature* 602, 84-90 (2022)
- [7] J. Chaste, E. Eichler, J. Moser, G. Ceballos, R. Rurali and A. Bachtold, *Nat. Nanotechnol.* 7 (2012)