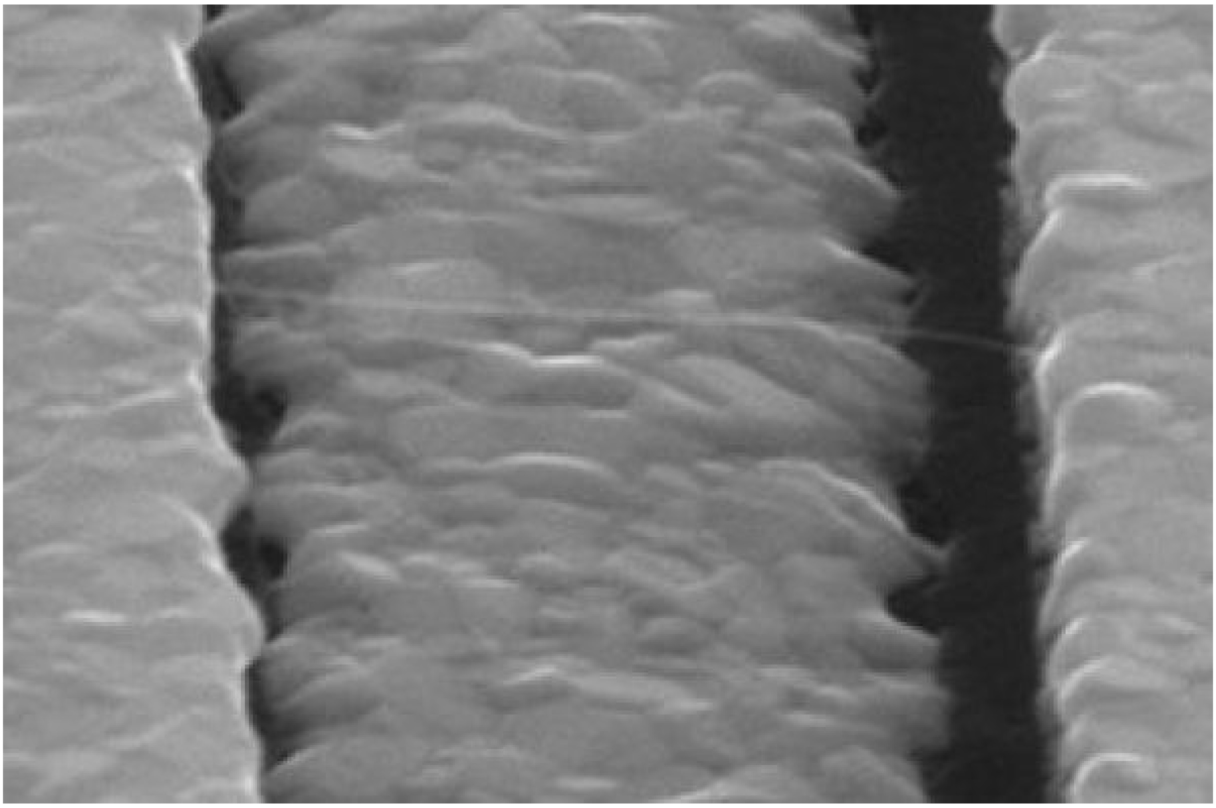

THESIS DEFENSE: New phenomena in high-quality suspended nanotube devices

CARLES URGELL FLORES

March 30, 2021
11:00
ICFO Auditorium and Online (Teams)

Carbon nanotubes (CNTs) have attracted the attention of the scientific community since their discovery in the 90s. They are an excellent material for the development of research fields as diverse as nanomechanics or quantum transport. Nanotube
mechanical resonators are endowed with exceptional properties, including extremely small mass, ultra narrow crosssection, and operation over a large frequency range from 10 kHz to 10 GHz. They are also fantastic sensors of both mass adsorption and forces.
Its electric transport properties are remarkably the long ballistic transport of charge carriers, strong electron-electron interaction, and the important role of the spin and valley degrees of freedom. It is possible to observe a wide range of quantum transport phenomena ranging from single-electron tunneling to Kondo physics and Fabry-Perot interference. It should be

noted that the electrical transport and mechanical motion of suspended nanotubes can be coupled by a large amount.

In the first part of this thesis, we present an advanced ultra-sensitive fabrication method that allows us to build and functionalize a nanotube cantilever for optical measurements. We grow a platinum particle at the end of the nanotube in order
to increase laser reflection. For this, we track the material deposition on the cantilever through the electromechanical coupling with the electron beam during the process.

Next, we show electron transport measurements in high-quality devices with high transmission. While high-temperature measurements indicate electron-electron correlations, low-temperature transport characteristics point towards singleparticle
Fabry-Perot interference. We observe this effect both by modifying the temperature and by tuning the source-drain voltage. This effect is attributed to the interplay between fluctuations and quantum interactions in a correlated Fabry-Perot regime.

In the last part, we show that it is possible to couple the mechanical movement of the CNT to the electron transport. By applying an electron current through the system, we can either cool or amplify the mechanical motion of the eigenmode. We cooled the nanoresonator down to 4.6+-2.0 quanta of vibration. The instabilities present in electron transport measurements are attributed to self-oscillation induced by the backaction amplification. These effects have an electrothermal origin. This method can be used in the future to cool NEMS into the quantum regime.

Due to recommendations in place to contribute containing the spreading of COVID-19, th defence will be carried out semi presencial with a maximum of 66 Icfonians in t e Auditorium, and partly remotely via MS Teams. This is the link to follow the Thesis Defe se onli Click here to join the meeting

If you are interested in attending in person, please address your request to mery.gil@icfo.eu **by Friday March 26th .**

Hosted by: Adrian Bachtold

Carlos Urgell's Thesi Cover