

Postdoctoral Researchers in Quantum Nanomechanics Aalto University

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Posted Feb. 19, 2024, set to expire Dec. 30, 2024

Job Title Postdoctoral Researchers in Quantum Nanomechanics
Department T304 Dept. Applied Physics
Institution Aalto University
, , Finland

Date Posted Feb. 19, 2024

Application Deadline Open until filled
Position Start Date Available immediately

Job Categories Post-Doc

Academic Field(s) Physics - General

Job Website https://aalto.wd3.myworkdayjobs.com/aalto/job/Otaniemi-Espoo-Finland/Postdoctoral-Researchers-in-Quantum-Nanomechanics_R38778

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Job Description

Aalto University is where science and art meet technology and business. We shape a sustainable future by making research breakthroughs in and across our disciplines, sparking the game changers of tomorrow and creating novel solutions to major global challenges. Our community is made up of 13 000 students, 400 professors and close to 4 500 other faculty and staff working on our dynamic campus in Espoo, Greater Helsinki, Finland. Diversity is part of who we are, and we actively work to ensure our community's diversity and inclusiveness. This is why we warmly encourage qualified candidates from all backgrounds to join our community.

At the Department of Applied Physics, our pioneering research in physical sciences creates important industrial applications that hold great technological potential. Our research focuses on Materials physics, Quantum technology, Soft & living matter, and Advanced energy solutions. Topics extend from fundamental research to important applications. We educate future generations of research and

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development professionals, data specialists, technology experts, inventors, and scientists for industry and society.

[\[url=https://www.aalto.fi/en/department-of-applied-physics/quantum-nanomechanics\]](https://www.aalto.fi/en/department-of-applied-physics/quantum-nanomechanics)The Quantum Nanomechanics group at the Department of Applied Physics is looking for outstanding

Postdoctoral Researchers

to carry out experimental research on different projects related to quantum micromechanical systems. In our team, we investigate how mechanical oscillators can be utilized for fundamental research probing quantum mechanics in massive systems, or for usage in quantum information processing. The measurements are carried out at deep cryogenic temperatures in a dilution refrigerator. In our research, we have demonstrated quantum entanglement between two micromechanical oscillators realized as vibrating aluminum drumheads [\[\[url=https://www.nature.com/articles/s41586-018-0038-x\]](https://www.nature.com/articles/s41586-018-0038-x)Nature 556, 478 (2018), [\[url=https://science.sciencemag.org/content/372/6542/625\]](https://science.sciencemag.org/content/372/6542/625)Science 372, 625 (2021)].

Project 1: Gravitational coupling between nonclassical masses

In this project, the goal is to touch a hundred-year-old mystery of physics: Despite its success at describing phenomena in the low-energy limit, quantum mechanics is incompatible with general relativity that describes gravity and huge energies. The interface between these two has remained experimentally elusive, because only the most violent events in the universe have been considered to produce measurable effects due to the plausible quantum behavior of gravity. We aim at detecting gravitational forces for the first time within a quantum system. We use mechanical oscillators loaded by milligram masses and bring two such gravitationally interacting oscillators into nonclassical motional states. Initially, we will measure the gravitational force between gold particles weighing a milligram, representing a new mass scale showing gravitational forces within a system. This work is part of the ERC Advanced Grant project “QUANTUM: Probing the limits of quantum mechanics and gravity with micromechanical oscillators”.

Project 2: Measurement-based feedback control in quantum micromechanics

We realize “microwave optomechanical” devices, where micromechanical drum oscillators interact with on-chip microwave cavity resonators. Optomechanical techniques allow for both preparing, measuring and manipulation of the mechanical quantum states. Strong measurements and feedback operations allow for novel ways of creating nonclassical mechanical states, for example squeezed and entangled states. A grand goal is to realize quantum teleportation of the state between two oscillators. You will accommodate these devices into a quantum-limited detection system comprising of parametric amplifiers and real-time feedback realized with FPGA control. This work is part of European Union’s

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Quanterra Program project “MQSens: Quantum Sensing with Nonclassical Mechanical Oscillators”, where opto-/electromechanics is utilized to explore how quantum protocols can be adapted to mechanical sensors in the quantum regime for various applications.

Project 3: Quantum acoustics

For quantum technology, integrating acoustic modes into superconducting circuits shows great promise for applications as quantum memory elements, bosonic codes, or in frequency conversion. We are working on High-Overtone Bulk Acoustic (HBAR) resonances that extend through the chip, and couple resonantly to transmon qubits. In ongoing and future work, we are promoting the devices to host several qubits, each coupled one or several HBAR modes. This will allow for creating mechanical entanglement and is a step towards phononic quantum chips. To realize processing of flying quantum phonons on a chip, we will connect standing HBAR modes into phonon waveguides which can be used to connect qubits.

Your role

The experimental work in all these projects involves design of the samples and of the measurement setups, cleanroom fabrication, running microwave measurements in dilution refrigerators, and data analysis. You are expected to participate in instructing PhD students.

Your experience and ambitions

For this challenging research, we are looking for brilliant and energetic individuals who are motivated in experimental, low-temperature quantum physics. We require the candidates to have a proven track record in experimental research with similar or related topics, clean room microfabrication, and strong interest in micromechanical systems. Additionally, the candidates should be excellent team players. Experience with cryogenics and dilution refrigerators, and skill in theoretical understanding of the studied phenomena, are considered significant assets.

We require the candidates to have excellent skills in English. Finnish language is not required. To be eligible, a postdoctoral researcher must hold a PhD degree in a suitable field.

What we offer

The Quantum Nanomechanics team, ambitious but relaxed with a great team spirit, carries out top - notch experimental research on the foundations of quantum mechanics. With superconducting qubits, we explore processing of quantum information with mechanical motion. In our more applied research, we lay the foundation for a new generation of devices that use various types of microwave-

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optomechanical effects for efficient signal processing. We have realized quantum-limited microwave amplifiers and nonreciprocal components to be used in superconducting quantum technology.

The fixed term contract is typically initially for two years and can be extended on mutual agreement. Aalto University follows the salary system of Finnish universities. The starting salary for a Postdoctoral researcher is approx. 4020 €/month. The salary ranges from 4020 € to 4420 € per month, depending on previous experience. The contract includes occupational healthcare.

The workplace will be the Otaniemi Campus of Aalto University, in the premises of the [\[url=https://www.aalto.fi/en/otananano\]](https://www.aalto.fi/en/otananano)OtaNano national research infrastructure for micro- and nanotechnologies. OtaNano provides access to all the advanced nanofabrication, nanomicroscopy and measurement facilities and techniques. VTT Technical Research Centre of Finland on campus leverages the bridge between research and innovation. Several startup companies working with electronics, cryogenics, and quantum technology have recently emerged in the community. Our team belongs to the national Centre of Excellence - [\[url=https://qtf.fi/\]](https://qtf.fi/)Quantum Technology Finland that is harnessing quantum phenomena for solid-state-based quantum devices and applications. We also belong to the [\[url=https://emplatform.eu/\]](https://emplatform.eu/)European Microkelvin Platform collaboration.

Ready to apply?

To apply for the position, please submit your application including the attachments mentioned below as one single PDF document in English through our online recruitment system by using the link on Aalto University's web page ("Apply Now").

- (1) Letter of motivation
- (2) CV including list of publications
- (3) Degree certificates and academic transcripts
- (4) Contact details of at least two referees

The deadline for applications is April 30, 2024. We will go through applications, and we may invite suitable candidates to interview already during the application period. The positions will be filled as soon as suitable candidates are identified. For additional information, kindly contact Prof. Mika Sillanpää, [\[url=mailto:Mika.Sillanpaa@aalto.fi\]](mailto:Mika.Sillanpaa@aalto.fi)Mika.Sillanpaa@aalto.fi. Aalto University reserves the right for justified reasons to leave the position open, to extend the application period, reopen the application process, and to consider candidates who have not submitted applications during the application period.

Please note: Aalto University's employees and visitors should apply for the position via our internal

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Check out our new virtual campus experience: [url=https://virtualltour.aalto.fi/]https://virtualltour.aalto.fi/

About Finland

Finland is a great place for living with or without family - it is a safe, politically stable and well-organized Nordic society. Finland is consistently ranked high in quality of life and was just listed again as the happiest country in the world: [url=https://worldhappiness.report/news/its-a-three-peat-finland-keeps-top-spot-as-happiest-country-in-world/]https://worldhappiness.report/news/its-a-three-peat-finland-keeps-top-spot-as-happiest-country-in-world/. For more information about living in Finland: [url=https://www.aalto.fi/en/careers-at-aalto/living-in-finland]https://www.aalto.fi/en/careers-at-aalto/living-in-finland & [url=https://www.aalto.fi/en/services/welcome-to-aalto-university-and-finland-info-package]https://www.aalto.fi/en/services/welcome-to-aalto-university-and-finland-info-package.

Contact Information

Please reference Academickeys in your cover letter when applying for or inquiring about this job announcement.

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Finland