TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Physics

PHYSICS COLLOQUIUM

Speaker: **Prof. Päivi Törmä**
Aalto University,
Department of Applied Physics,
Finland

Topic: **Quantum geometry in flat band superconductivity, Bose-Einstein condensation and light-matter interactions**

Time and place: Tuesday, April 23, 2024, **2:50 pm** – hybrid event
The colloquium will be held in REC/C213.
Online participation possible:
Zoom-Meeting: Meeting-ID: 631 3817 8900 / passcode: PC-SoSe24
https://tu-dresden.zoom-x.de/j/63138178900?pwd=am9nSzYyeUh3SWxMdnNBWkpUaXl5UT09

Host: Prof. Carsten Timm

Abstract: We have found that superconductivity and superfluidity have a connection to quantum geometry. Namely, the superfluid weight in a multiband system has a previously unnoticed component which we call the geometric contribution. It is proportional to the minimal quantum metric of the band. Quantum metric is connected to the Berry curvature, and this allows to relate superconductivity with the topological properties of the band. Using this theory, we have shown that superconductivity is possible also in a flat band where individual electrons would not move. We and other groups have shown that these results may be essential in explaining the observation of superconductivity in twisted bilayer graphene and may eventually help realize superconductors at elevated temperatures. In addition to the promise of high critical temperatures and strong correlation effects, also the quantum transport in flat band shows unique behavior: while supercurrent can flow, quasiparticle transport is highly suppressed even in non-equilibrium conditions. This may have important consequences for superconducting devices. We have found that quantum geometry also governs Bose-Einstein condensates in flat bands and light-matter interactions. We have also experimentally observed the quantum metric and non-Hermitian Berry curvature in plasmonic lattices.

Bio: Päivi Törmä is a professor at the Department of Applied Physics, Aalto University, Finland. Her research ranges from theoretical quantum many-body physics to experiments in nanophotonics. Her theory work has revealed a new connection between quantum geometry and superconductivity that explains why flat bands can carry supercurrent. In her experiments, Törmä has worked on strong coupling of surface plasmon polariton modes and molecules, and her

group has realized lasing and Bose-Einstein condensation phenomena in plasmonic nanoparticle arrays. Törmä has a PhD from the University of Helsinki. She obtained the EURYI award in 2005, the ERC Advanced Grant in 2013, and the Academy Professorship of the Academy of Finland in 2017. She led the Nanoscience Centre of University of Jyväskylä 2002-2005 and the Finnish Centre of Excellence in Computational Nanoscience 2014-2017 and was a guest professor at ETH Zürich in 2015. In 2021, Törmä was elected as a member of the Academia Europaea.

Get-Together:

The colloquium will be followed directly by a Get-Together with Prof. Päivi Törmä in REC/B101 (around 4:00 p.m.). All students and staff are invited to talk to the speaker and discuss perspectives on the academic career, work-life balance and the professional life as a scientist.