Adrian Bachtold

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Scientific Biography

Adrian Bachtold is an experimental condensed matter physicist whose work has shaped nanoelectronics and quantum nanomechanics. He pioneered quantum transport experiments in carbon nanotubes and later established nanotube-based nanoelectromechanical systems as a platform for mesoscopic physics.

Over the past decade, his research has advanced toward the quantum control of mechanical motion. His group demonstrated record mechanical quality factors, yoctogram mass sensing, zeptonewton force sensitivity, and cooling of nanotube vibrations down to a few phonons. More recently, he established the dispersive ultrastrong coupling regime in electromechanical systems, where the electromechanical interaction strength exceeds the bare mechanical frequency.

In this regime, mechanical motion becomes intrinsically nonlinear at the level of zero-point fluctuations, giving rise to giant mechanical Kerr nonlinearities and opening routes toward phonon quantum jumps, quantum bifurcation, and strongly non-Gaussian mechanical states.

He is a Fellow of the American Physical Society and recipient of multiple ERC grants, including two Advanced Grants.

Research Vision

Our group pushes quantum mechanics toward regimes where massive mechanical systems behave in profoundly nonclassical ways.

By engineering ultra-clean carbon nanotube devices operating at millikelvin temperatures, we create hybrid systems where mechanical motion, electronic qubits, and microwave photons interact quantum mechanically. Entering the dispersive ultrastrong coupling regime allows us to reshape the mechanical potential landscape itself, opening routes toward:

- mechanical qubits with long coherence times
- quantum bifurcation in nanomechanical motion
- strongly non-Gaussian states with large spatial delocalization
- macroscopic quantum superpositions of objects composed of millions of atoms
- novel architectures for quantum sensing and quantum information processing

In parallel, we explore correlated and topological electronic phases in twisted bilayer graphene and other low-dimensional materials.

The group combines frontier experiments with a strong training environment, and former group members have gone on to permanent academic positions.

Major Scientific Achievements

- Establishing nonlinear nanomechanics approaching the quantum ground state
- Discovery of the dispersive ultrastrong coupling regime in electromechanical systems
- Cooling of nanotube vibrations down to a few phonons using electron transport

- Demonstration of correlated and superconducting states in twisted bilayer graphene
- Unraveling nonlinear dissipation in nanomechanical resonators
- Record mechanical quality factors and thermal force sensitivities at the zeptonewton scale
- Yoctogram-resolution inertial mass sensing
- First coupling between quantum electron transport and mechanical vibrations in suspended carbon nanotubes
- First experimental test of multiterminal Landauer–Büttiker transport in one dimension
- First scanning-probe microscopy experiments of quantum electron transport in nanotubes
- First measurements of molecular-scale Aharonov–Bohm oscillations

Publications and Impact

- **98** peer-reviewed publications
- **3** publications in *Science*
- **15** publications in the *Nature* family
- **21** publications in *Physical Review Letters*
- **1** publication in *Reviews of Modern Physics*
- **26,450** citations (Google Scholar)
- **h-index: 61**
- **135** invited talks at international conferences
- **€14.2M** in external grants for his group as of February 2026

Awards and Distinctions

2025 — ERC Advanced Grant
2019 — ERC Proof of Concept
2017 — Fellow of the American Physical Society (APS Fellow)
2016 — ERC Advanced Grant
2011 — ERC Starting Grant
2005 — EURYI Award, European Commission
2004 — CNRS Bronze Medal
2001 — First author of the paper selected as *Scientific Breakthrough of the Year* by *Science*
2000 — IBM Award, Swiss Physical Society

Academic Positions

2012–present
Professor, ICFO – The Institute of Photonic Sciences, Barcelona
Head of the Quantum NanoElectronics and NanoMechanics Group
2010–2012
Professor, ICN-CSIC (CIN2), Barcelona
2005–2009
Professor / Researcher, CSIC (CIN2), Barcelona
2001–2004
Chargé de recherche (permanent position), CNRS
École Normale Supérieure, Paris
2000–2001
Postdoctoral Researcher
Technical University Delft
1999–2000
Postdoctoral Researcher
University of California, Berkeley

Education

Ph.D. in Physics, University of Basel, Switzerland
Summa Cum Laude
Dipl. Ing. EPFL, École Polytechnique Fédérale de Lausanne, Switzerland

Supervision and Leadership

- Supervised **28** PhD students and postdoctoral researchers
- **16** former group members have obtained permanent academic positions