

 COLUMBIA | QUANTUM INITIATIVE
IMPACT REPORT
July 2023 through June 2025

 COLUMBIA | QUANTUM INITIATIVE
CREATING THE QUANTUM FUTURE
WITH MATERIALS & LIGHT

Explore the quantum frontier with new physics and new materials

Build the foundations for new quantum devices

Deliver new quantum technologies

The rules of quantum mechanics are more than just a curiosity: they're becoming the foundation of real-world technologies, like ultra-powerful computers, perfectly secure communication systems, and ultra-capable sensors, that go far beyond what today's technologies can do.

Columbia scientists are making this new quantum future a reality.

Building this future requires systems that behave in uniquely quantum ways, like materials that can conduct electricity with no resistance, sense tiny changes in magnetic fields, and combine with light itself.

At Columbia, we are exploring entirely new kinds of matter and devising new devices that will enable the next generation of breakthroughs—from curing diseases to securing global communications to tackling climate change...and more.

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OUR PEOPLE

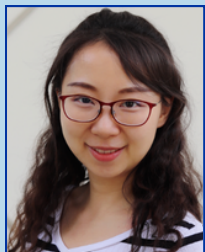
30

core faculty members with expertise in quantum physics and chemistry, photonics, materials science and engineering, and quantum computing

Seven New Hires Since July 2023



Aravind
Devarakonda



Xueyue (Sherry)
Zhang



Michele
Simoncelli



James
Bartusek



Zhenjie
Yan



Zhaoyou
Wang



Diptarka
Hait

Awards & Honors



2023 Nobel Prize
in Chemistry
for Quantum Dots

- + Inductions to the National Academy of Sciences, the National Academy of Engineering, and the American Academy of Arts & Sciences
- + Early Career Awards from the Department of Energy and National Science Foundation
- + Fellowships from the Sloan Foundation, Beckman Foundation, Brown Institute for Basic Sciences, and more

The Next Generation

- + **42** PhD students graduated in 2024 and 2025
- + **16** students joined Columbia's inaugural Master's in Quantum Science and Technology class, with 24 incoming students enrolled for Fall 2025
- + **Two** Columbia Quantum Initiative Postdoctoral Fellows joined dozens of others advancing quantum research
- + **Hundreds** of students from Columbia, Barnard, and those elected to undergraduate research experience programs have been exposed to the latest quantum research

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OUR RESEARCH

Quantum Research Themes



Theory &
Modeling



Atoms &
Molecules



Materials &
Nanoscience



Optics &
Electronics



Computing &
Simulation

99 active
research
awards,

totaling **~\$97 million**

With over **\$37.5 million** awarded
between July 2023 and June 2025

366 new
papers

62 new
patents

Columbia Quantum Centers Include:

- Department of Energy Energy Frontier Research Center on Programmable Quantum Materials
- National Science Foundation Material Research and Science Engineering Center on Precision-Assembled Quantum Materials
- Max Planck-New York Center on Non-Equilibrium Quantum Phenomena
- National Science Foundation National Virtual Quantum Laboratory
- Columbia Center for Computational Electrochemistry

OUR PUBLICATIONS

201 senior-author research and review papers, including eight in *Science* and four in *Nature*, that have received **nearly 1500** citations...

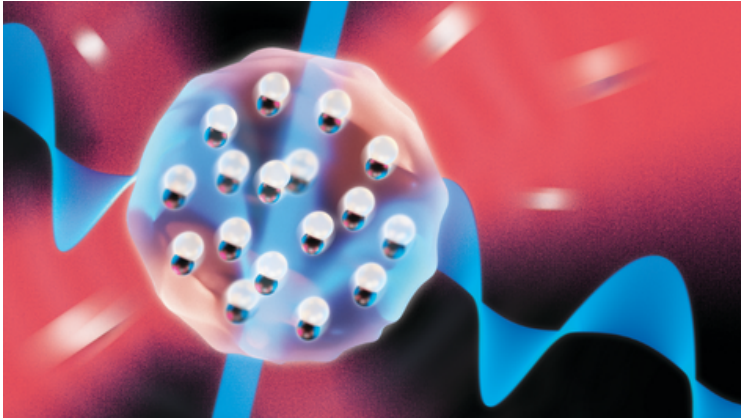
Ten Most Cited Titles Between July 2023 and June 2025

Observation of Bose–Einstein condensation of dipolar molecules	<i>Nature</i> 631 , 289–293 (2024)
Programming twist angle and strain profiles in 2D materials	<i>Science</i> 381 , 677–681 (2023)
All-optical frequency division on-chip using a single laser	<i>Nature</i> 627 , 546–552 (2024)
Petabit-Scale Silicon Photonic Interconnects With Integrated Kerr Frequency Combs	<i>IEEE Journal of Selected Topics in Quantum Electronics</i> 29 , 1–20, (2023)
Nonlinear and quantum photonics using integrated optical materials	<i>Nature Reviews Materials</i> 9 , 321–346 (2024)
Absorption and scattering limits of silicon nitride integrated photonics in the visible spectrum	<i>Optics Express</i> 32 , 5718–5728 (2024)
CrSBr: An Air-Stable, Two-Dimensional Magnetic Semiconductor	<i>Nano Letters</i> 24 , 4319–4329 (2024)
Collisionally stable gas of bosonic dipolar ground-state molecules	<i>Nature Physics</i> 19 , 1579–1584 (2023)
Quantum sensing and metrology for fundamental physics with molecules	<i>Nature Physics</i> 20 , 741–749 (2024)
Two-Step Flux Synthesis of Ultrapure Transition-Metal Dichalcogenides	<i>ACS Nano</i> 17 , 16587–16596 (2023)

...with contributions to an additional **165** publications between July 2023 and June 2025

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HIGHLIGHTED NEWS



The Coldest Lab in New York Has a New Quantum Offering

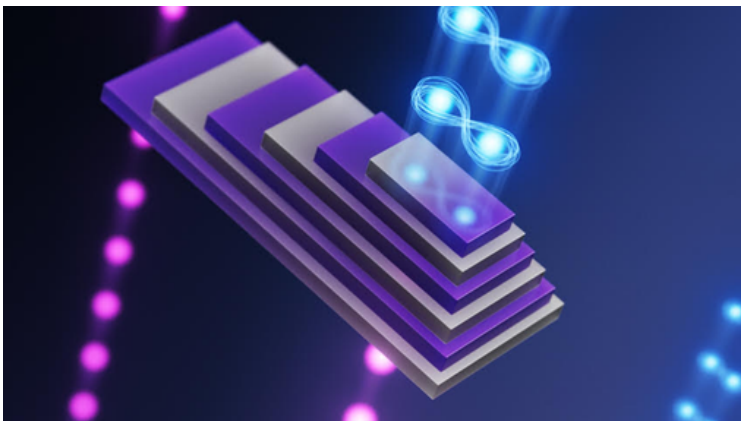
Columbia physicists have taken molecules to a new ultracold limit and created a state of matter where quantum mechanics reigns.

Looking for New Physics? Try a Bad Metal

Bad metals have unique electronic properties that make them a good place to look for elusive quantum particles.

Columbia Chemists Create First 2D Heavy Fermion

The layered crystal, CeSiI, with heavier-than-normal electrons is a new platform to explore quantum phenomena.



Engineering Quantum Entanglement at the Nanoscale

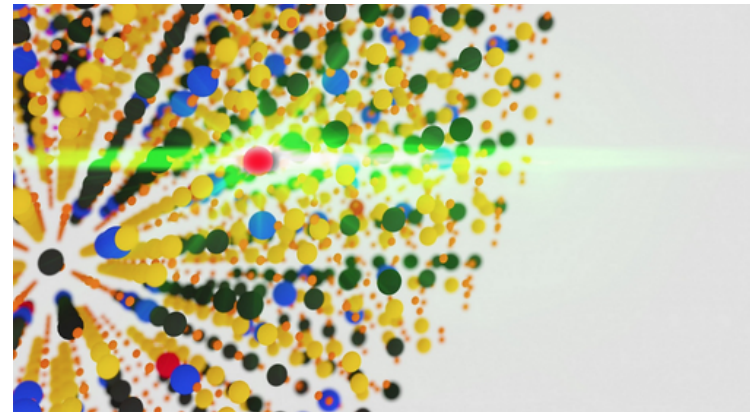
Columbia engineers have developed a drastically smaller and more energy efficient method of creating coveted photon pairs that influence each other from any distance.

Max Planck-New York Center on Non-Equilibrium Quantum Phenomena Renewed

The quantum research center will continue its international collaboration for an additional five years with Cornell University as a new partner institution.

High-Quality Microwave Signals Generated From Tiny Photonic Chip

Columbia engineers create a compact, all-optical device with the lowest microwave noise ever achieved for an integrated chip.



New “All-optical” Nanoscale Sensors of Force

Photon-avalanching nanosensors access previously unreachable environments and could disrupt technologies from robotics to cellular biophysics & medicine to space travel.

Searching for Unorthodox Improvements to Quantum Systems

Professor Sherry Zhang is working on new approaches to enhance quantum computing performance.

Graphene Gets Cleaned Up

Columbia engineers link oxygen to graphene quality and develop new techniques to reproducibly make the wonder material at scale.

It’s a Quantum Zoo Out There, and Columbia Just Discovered a Dozen New “Species”

Researchers observe over a dozen never-before-seen quantum states in a unique quantum material.



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IN SUMMARY

- 30 core faculty members with expertise in quantum physics and chemistry, photonics, materials science and engineering, and quantum computing
- Seven new quantum hires since July 2023: Aravind Devarakonda; Xueyue (Sherry) Zhang; Michele Simoncelli; James Bartusek; Zhenjie Yan; Zhaoyou Wang; Diptarka Hait
- Faculty honors and awards include:
 - The 2023 Nobel Prize in Chemistry
 - Inductions to the National Academy of Sciences, the National Academy of Engineering, and the American Academy of Arts & Sciences
 - Early Career Awards from the Department of Energy and National Science Foundation
 - Fellowships supported by the Sloan Foundation, Beckman Foundation, Brown Institute for Basic Sciences, and more.
- In support of the next generation of quantum scientists:
 - 42 PhD students graduated in 2024 and 2025
 - 16 students joined Columbia's inaugural Master's in Quantum Science and Technology class, with 24 incoming students enrolled for Fall 2025
 - Two Columbia Quantum Initiative Postdoctoral Fellows joined dozens of others advancing quantum research
 - Hundreds of students from Columbia, Barnard, and those elected to undergraduate research experience programs have been exposed to the latest quantum research
- Our faculty hold 99 active research grants totaling almost \$97 million, with approximately \$37.5 million awarded between July 2023 and June 2025
- Our faculty published 201 senior-author research and review papers, including eight in *Science* and four in *Nature*, that have received nearly 1500 citations, with contributions to an additional 165 publications
- Our faculty filed 62 new patents filed
- Quantum Centers include:
 - Department of Energy Energy Frontier Research Center on Programmable Quantum Materials
 - National Science Foundation Materials Research and Science Engineering Center on Precision-Assembled Quantum Materials
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