

Curriculum Vitae

Prof. Dr. Immanuel Bloch

Max Planck Institute of Quantum Optics
& Ludwig-Maximilians-Universität München

Personal & Professional Information

Date of Birth 16 November 1972 (Age 53)

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Professional Experience

2024, 2020–2021	Managing Director, Max Planck Institute of Quantum Optics
2012–present	Vice-Dean of the "Fakultät für Physik", LMU Munich
2012–2014	Managing Director, Max Planck Institute of Quantum Optics
2009–present	Full Professor (W3), Chair at LMU Munich
2008–present	Scientific Director, Max Planck Institute of Quantum Optics
2003–2009	Full Professor (C4), Chair at the Johannes-Gutenberg University
2002–2003	Senior Scientist, LMU Munich
2000–2002	Senior Scientist, Max Planck Institute of Quantum Optics

Education

1998–2000	PhD thesis in physics, Ludwig-Maximilians University, Munich (Prof. T.W. Hänsch)
1997–1998	Research visit, Stanford University (Prof. M.A. Kasevich)
1995–1996	Diploma thesis, Institute for Applied Physics, University of Bonn
1991–1995	Studies in physics, University of Bonn

Publications

Over **220** publications (**49 in Nature/Science, 99 in Phys. Rev. Lett./Nature Physics/Phys. Rev. X/PNAS**)
Google Scholar: *h*-index 122, >93,100 citations (Google Scholar Link)

Clarivate Citation Laureate 2022 (for Quantum Simulation)
Clarivate Highly Cited Researcher 2014–2026 (continuous citation)

Invited Talks and Lectures

Over **370 talks at international conferences and workshops** (including several schools) including many plenary and keynote talks. In addition, over **160 invited talks at national meetings**.

Download Full Publication List
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Research Fields

Quantum Simulation ▪ Quantum Computing ▪ Quantum Optics ▪ Strongly Correlated Quantum Many-Body Systems ▪ Topological Phases ▪ Non-Equilibrium Quantum Dynamics

International Awards – Named Lectures – Academy Memberships

2026	Wolf Prize in Physics (jointly with Jun Ye)
2025	Micius Quantum Prize 2025
2025	Elected International Member of the National Academy of Sciences
2025	Hightech Prize of the Bavarian Prime Minister
2024	APS Outstanding Referee
2024	Stern-Gerlach Medal of the German Physical Society (DPG)
2023	Racah Lecture 2023 – Hebrew University of Jerusalem
2023	Zeiss Research Award 2023
2022	Clarivate Citation Laureate 2022 for pioneering work on Quantum Simulation
2022	Hanna Visiting Professor, Stanford University
2021	Bavarian Maximilian Order for Science and Art
2020	Lise Meitner Distinguished Lecturer, AlbaNova Stockholm (held in 2022)
2019	Ernest Kempton Adams Lecturer, Columbia University
2019	Hanan Rosenthal Lecturer, Yale University
2018	Lehrpreis Bayern – Prize for excellence in teaching in Bavaria
2018	Scott Lecturer, Cambridge University
2018	Elected Member of the Berlin Brandenburg Academy of Sciences (BBAW)
2018	Elected Member of the Bavarian Academy of Sciences (BAdW)
2018	Paco Yndurain Lecture, Universidad Autonoma de Madrid
2017	Cherwell Simons Lecture, Oxford University
2017	Goldener Sommerfeld – Prize for excellence in teaching by LMU physics students
2016	Harvey Prize of the Technion
2015	Fellow of the American Physical Society
2014	Einstein Colloquium – Weizmann Institute of Science
2013	International BEC Award 2013
2013	Körber European Science Prize
2013	ERC Synergy Grant "UQUAM" (Corresponding PI, with E. Altman, J. Dalibard & P. Zoller)
2013	Hector Science Prize – Appointment as Hector Fellow
2013	Dr. Alexander M. Cruickshank Lecturer of the Gordon Research Conference program
2012	Distinguished Lecturer – MPI for the Science of Light
2011	Elected member of the German National Academy of Sciences (Leopoldina)
2011	EPS Senior Prize for Fundamental Aspects of Quantum Electronics and Optics
2010	Kavli Colloquium Lecturer – TU Delft
2008	Member of the Canadian Institute for Advanced Research (CIFAR)
2008	Distinguished Lecturer (Technion)
2007	Philip-Morris Research Prize
2005	International Commission for Optics Prize
2005	National Merit Medal of Germany (Bundesverdienstorden)
2005	Gottfried Wilhelm Leibniz Prize of the German Science Foundation (DFG)
2004	Arkady Aronov Memorial Lecturer (Weizmann Institute of Science)
2004	Marie-Curie Excellence Grant of the European Union
2003	Rudolf-Kaiser-Prize
2002	Otto-Hahn Medal of the Max-Planck Society
2001	PhD Prize of the Ludwig Maximilians University, Munich
2000	Research Prize of the Physics Faculty of the Ludwig Maximilians University, Munich
2000	Philip-Morris Research Prize (together with T.W. Hänsch & T. Esslinger)

Organization of Conferences (Steering & Program Committee)

2026	KITP program on "Engineering Fractionalization in Quantum Many-Body Systems: From New Quantum Materials to Quantum Simulators" – Co-organizer
2025	Steering Committee Member QSIM Conference
2024	Cal-Bay Quantum School (between Californian Universities and MCQST)
2024	Binational Italian-German WE-Heraeus-Seminar on Quantum Simulation
2024	Co-Director Enrico Fermi School on Quantum Computing and Simulation using Ultracold Atoms (with L. Fallani & A. Browaeys)
2024	Intl. Conference on Atomic Physics (ICAP 2024) – Intl. Advisory Committee
2023	Ultracold Atomic Gases: Thirty Years of Activities and Looking Forward 2023 (Hong Kong)
2020	Intl. Conference on Atomic Physics (ICAP 2020) – Intl. Advisory Committee
2019	MCQST-Technion Symposium on Quantum Science and Technology
2019	Intl. BEC Conference (San Feliu, Spain) – Chair
2019	Solvay Workshop on Quantum Simulation (Brussels, Belgium)
2018	Intl. Conference on Atomic Physics (ICAP 2018) – Intl. Advisory Committee
2018	Quantum Simulation & Computation (Bilbao, Spain)
2017	Intl. BEC Conference (San Feliu, Spain) – Vice Chair
2015	Frontiers in Quantum Simulations with Cold Atoms (INT, Seattle, USA)
2015	International Conference on Quantum Simulations (Benasque, Spain)
2014	ICTP Workshop on LZ Interferometry & Quantum Control in CM Physics (Izmir, Turkey)
2014	Intl. Conference on Quantum Communication, Measurement and Computing (Hefei, China)
2014	Intl. Conference on Atomic Physics (ICAP 2014)
2013	Intl. BEC Conference (San Feliu, Spain)
2013	Intl. Conference on Quantum Simulations (Benasque, Spain)
2013	Quantum Information Processing and Computing QIPC 2013 (Florence, Italy)
2012	Quantum Simulations with Ultracold Atoms (ICTP Trieste, Italy)
2012	Photonics Europe 2012 Quantum and Atom Optics (Brussels, Belgium)
2011	2nd Exploratory Round Table Conference on Quantum Information Science (Shanghai, China)
2011	Advanced Workshop on Non-Standard Superfluids and Insulators (ICTP Trieste, Italy)
2011	IQEC/CLEO Pacific Rim, Cold Atoms and Molecules Committee Chair (Sydney, Australia)
2011	Quantum Gases in Dilute Atom Vapours (Bad Honnef, Germany)
2011	International Conference on Quantum Technologies (Moscow, Russia)
2011	Frontiers in Quantum Gases: Bose-Einstein Condensation (Sant Feliu, Spain)
2011	26th International Conference on Low Temperature Physics (Beijing, China)
2010	Beyond Standard Optical Lattices (KITP, Santa Barbara, USA)
2010	Frontiers of Ultracold Atoms and Molecules (KITP Santa Barbara, USA)
2008	Frontiers of Degenerate Quantum Gases CASTU (Beijing, China)
2008	XXXII International Workshop on Condensed Matter Theories (Loughborough, UK)
2007	SCALA 3rd Annual Meeting (Mainz, Germany)

Other Activities (Editorial Work & Research Management)

Over the past **20 years**, Immanuel Bloch has managed and coordinated more than **25 research grants** awarded by different national and international funding agencies. Funding agencies include DFG, MPG, EU, BMBF, DARPA, USAF, Landesstiftung Rheinland-Pfalz, Körber Stiftung, Free State of Bavaria.

- APS Outstanding Referee (2024)
- Member of the SAB of the **Center for Quantum Technologies (CQT)** Singapore (since 2024)
- Member of the **John Stewart Bell Prize 2024 & 2026** committee
- Member of the Scientific Advisory Board of the **Walther-Meissner-Institute (WMI)**
- Member of the **Munich Quantum Valley Initiative** – MQV (since 2021)
- Scientific Spokesperson **Programmausschuss Quantensysteme** (2018–2022)
- Spokesperson of the DFG Excellence Cluster
  Munich Center for Quantum Science and Technology (MCQST) (since 2018)
- Spokesperson of the **DFG Research Unit 2414** (2016–2021)
  "Artificial Gauge Fields and Interacting Topological Phases in Ultracold Atoms"
- Board member of **Physik Journal** (2015–2019)
- Board member of the **Hector Fellow Academy** (since 2014)
- International Scientific Advisory Board – **KITP** Santa Barbara (2014–2016)
- **International Editorial Board: Physical Review B**, American Physical Society (2013–2017)
- **International Editorial Board: Annalen der Physik** (since 2013)
- Advisory Committee Member: **NIM Excellence Cluster** at LMU Munich
- Speaker of the **DFG Research Unit 801** (2007–2014)
  "Strong Correlations in Multiflavor Quantum Gases"
- Member of the Steering Committee of the DFG funded **SFB/TRR49** (until 2008)
- Member of the **Heinz-Maier Leibnitz Prize Committee** of the DFG (2006–2012)
- Member of the **Perspective Committee of the Max-Planck Society** (2009–2015)
- Referee for Nature, Science, Nature Physics, Physical Review X, Physical Review Letters, and others

Support of Young Researchers

The support of young researchers is a vital part of the work of Immanuel Bloch. Over **30 young academics** working in the group have received a professorship, **20 postdoctoral researchers** have obtained permanent positions in academia, and **over 60 PhD students** have finished their thesis and moved on to prestigious positions in **academia and industry**.

Among some of the former group members now holding distinguished positions in academia are:
A. Rubio-Abadal (Barcelona), M. Aidelsburger (MPQ/LMU), J. Barreiro (UC San Diego), K. Blaum (MPIKP), T. Chalopin (Institut d'Optique), Y.-A. Chen (USTC), M. Cheneau (Institut d'Optique), J.-Y. Choi (KAIST), N. Darkwah-Oppong (Caltech), M. Endres (Caltech), T. Fukuhara (RIKEN), M. Greiner (Harvard), C. Gross (Tübingen), L. Hackermüller (Nottingham), T. Hilker (Strathclyde), S. Hodgman (ANU), S. Kuhr (Strathclyde), X.-Y. Luo (Hainan), S. Nascimbène (Paris), H. Ott (Kaiserslautern), A. Rauschenbeutel (HU Berlin), J. Rui (USTC), G. Salomon (Hamburg), P. Schauss (Hamburg), F. Scazza (Trieste), M. Schleier-Smith (Stanford), U. Schneider (Cambridge UK), J. Sherson (Aarhus), J. Vijayan (Manchester), C. Weitenberg (Dortmund), A. Widera (Kaiserslautern), S. Will (Columbia), T. Yefsah (ENS), J. Zeiher (LMU), M. Zwierlein (MIT)

Brief Research Summary

Immanuel Bloch's work focuses on ultracold quantum matter at temperatures near absolute zero. With the help of laser beams, he generates artificial crystals of light, in which ultracold atoms or molecules can be captured in a matrix of microscopic light traps. In this way, artificial model systems can be generated, such as for real solids and beyond that can be controlled and probed in fundamentally new ways. For example, this makes it possible to precisely adjust the crystal structure or the interactions between the atoms and observe ground states, topological states or non-equilibrium dynamics with single site resolution and single atom and spin sensitivity. This also opens up entirely new parameter ranges to study the behavior of matter under most extreme conditions. In addition, the trapped atomic and molecular gases can be used to realize novel quantum optical light-matter interfaces without external optical elements. Exploring novel pathways for cooling, rapid preparation, potential engineering, and interaction control of such quantum gases forms a central focus of his team's research.

With his research, Immanuel Bloch has opened a new and interdisciplinary research field at the interface of **quantum physics, quantum information science, atomic- molecular- and condensed matter physics**. His work marks the first realization of **quantum simulators**, as initially proposed by **Richard Feynman** for exploring complex quantum matter, a field that is now intensely pursued in a wide variety of quantum systems ranging from trapped ions, and superconducting arrays to atomic tweezer arrays, to name just a few. Quantum simulations can be seen as one of the earliest scientific applications of quantum technologies, significantly enhancing our understanding of quantum many-body systems through innovative experimental observations and control techniques.

Immanuel Bloch has explored a wide array of research fields within quantum simulation. His work encompasses research on strongly correlated bosonic and fermionic quantum systems, as well as topological systems, disordered quantum gases, phenomena related to high-energy physics, non-equilibrium quantum dynamics, and innovative quantum optical light-matter interfaces. This diverse range of research not only highlights the extensive applications of quantum simulations but has also inspired numerous experiments across various experimental platforms.

Main Scientific Achievements (Short List)

- First experimental realization of strongly correlated quantum phases with ultracold atoms in the **quantum phase transition from a superfluid to a Mott insulator** *(one of the most cited papers overall in Atomic, Molecular and Optical Physics with >8,640 GS citations).* This work marks the **experimental starting point of the field of quantum simulations**, Nature **415**, 39 (2002)
- Direct observation of the dynamical **collapse and revival of a macroscopic quantum field** induced by interactions, Nature **419**, 51 (2002)
- First experimental realization of **collisional quantum gates** with neutral atoms, Nature **425**, 937 (2003)
- First experimental realization of a 'fermionized' **Tonks-Girardeau gas** of neutral atoms, Nature **429**, 277 (2004)
- Experimental realization of **noise correlation measurements** with ultracold quantum gases and first observation of **fermionic Hanbury-Brown & Twiss** type antibunching with neutral atoms, Nature **434**, 481 (2005) & Nature **444**, 733 (2006)
- First observation of **superexchange spin interactions** with ultracold atoms, Science **319**, 295 (2008)
- Realization of **fermionic Mott Insulators**, Science **322**, 1520 (2008)
- Together with the group of M. Greiner (Harvard), first **single-atom resolved observation of a Mott insulator**, Nature **467**, 68 (2010)
- First **single-site and single-atom resolved spin control** in large 2D arrays of neutral atoms, Nature **471**, 319 (2011)
- Direct observation of quantum fluctuations and **hidden order** in strongly interacting quantum systems, Science **334**, 200 (2011)
- Generation of tuneable **artificial magnetic fields** for ultracold atoms in an optical lattice, Phys. Rev. Lett. **107**, 255301 (2011)
- Observation of **'Higgs' mode in two-dimensional quantum gases** at the SF-MI QPT, Nature **487**, 454 (2012)
- Realization of **negative absolute temperatures** in motional states of atoms, Science **339**, 52 (2013)
- First observation of **light-cone-like spreading** of correlations in a many-body system *(marked the first observation of Lieb-Robinson light cones and information spreading in experiments)*, Nature **481**, 484 (2012)
- Direct measurement of the **Zak-Phase** (Berry Phase) in topological Bloch bands, Nat. Physics **9**, 795 (2013)
- Microscopic observation of **two-magnon bound states**, Nature **502**, 76 (2013)
- Realization and direct observation of **mesoscopic Rydberg quantum crystals**, Nature **491**, 87 (2012)
- First realization of **topological two-dimensional Bloch bands** with ultracold atoms via the **Hofstadter model**, Phys. Rev. Lett. **111**, 185301 (2013)
- First measurement of **Chern number** and **Hall transport** in non-electronic systems, Nat. Physics **11**, 162 (2015)
- First realization of an **Aharonov-Bohm type interferometer** for the measurement of Bloch band topology, Science **347**, 288 (2015)
- First realization of a **Thouless quantum pump** (simultaneous with the group of Y. Takahashi), Nat. Physics **12**, 350 (2016)
- Observation of **Many-Body Localization** using interacting fermions in quasi-random lattices, Science **349**, 842 (2015)

Main Scientific Achievements (Short List) continued

- Exploring **Many-Body Localization using interacting bosons in 2D**, Science **352**, 1547 (2016)
- Observation of single-site **spin- and charge resolved AFM correlations** Fermi-Hubbard model, Science **353**, 1257 (2016)
- First realization of a **Topological spin pump in 2D realizing the 4D Integer Quantum Hall Effect**, Nature **553**, 55 (2018)
- First observation of **hidden non-local antiferromagnetic ordering**, Science **357**, 484 (2017)
- First direct **microscopic imaging of a magnetic polaron** in the 2d doped Fermi-Hubbard model, Nature **572**, 358 (2019)
- Direct observation of **dynamical spin charge deconfinement (fractionalization)** in 1D Fermi-Hubbard chains, Science **367**, 186 (2020)
- First realization of **subwavelength cooperative atom-light interfaces** in the optical regime, Nature **583**, 369 (2020)
- Observation of **Floquet prethermal phases of matter**, Phys. Rev. X **10**, 021044 (2020)
- Realization of the **symmetry-protected Haldane phase** in Fermi-Hubbard ladders, Nature **606**, 484 (2022)
- Observation of **Kardar-Parisi-Zhang universality in the quantum dynamics of 1d Heisenberg spin chains**, Science **376**, 716 (2022)
- Demonstration of **novel evaporation scheme for polar molecules** using microwave shielding. Cooling in 3d to deep quantum degeneracy, Nature **607**, 677 (2022)
- Observation of **magnetically mediated hole pairing** in mixed dimensional Fermi-Hubbard Systems, Nature **613**, 463 (2023)
- First demonstration of **field linked scattering resonances** for polar molecules, Nature **614**, 59 (2023)
- First realization of **quantum metasurfaces** (subwavelength optical array switched by a single atom), Nat. Physics **19**, 714 (2023)
- First realization of **ultracold field-linked tetratomic molecules**, Nature **626**, 283 (2024)
- Observation of **Hilbert space fragmentation** in 2D and first detection of **fractonic excitations**, Nature **636**, 80 (2024)
- Formation of **individual stripes** in a mixed-dimensional cold-atom Fermi-Hubbard system, Nature **637**, 57 (2025)
- First realization of **quantum gates using fermionic atoms** (in parallel with T. Esslinger), Nature **652**, 602 (2026)

Member of International Academic Societies

Deutsche Physikalische Gesellschaft
European Physical Society
Fellow of the American Physical Society
German National Academy of Sciences (Leopoldina)
Bavarian Academy of Sciences (BAdW)
Berlin Brandenburg Academy of Sciences (BBAW)
National Academy of Sciences (NAS)
Scientific Member of the Max-Planck Society