

HOPE BRETSCHER

L  Germany

ORCID: 0000-0001-6551-4721

EDUCATION AND PROFESSIONAL EXPERIENCE

12/2020 – Present	Max Planck Institute for the Structure and Dynamics of Matter, Germany
09/2023 – Present	Marie Skłodowska-Curie Postdoctoral Fellowship
01/2022 – 08/2023	Alexander von Humboldt Research Fellowship
12/2020 – 12/2021	Postdoctoral researcher in the group of James McIver Research: On-chip THz spectroscopy of vdW heterostructures
10/2016 – 01/2021	University of Cambridge, UK PhD in Physics, Magdalene College, (awarded Sept 2021), Supervisor: Prof. Akshay Rao Thesis: Ultrafast spectroscopy of low-dimensional, excitonic materials
09/2015 – 08/2016	University of Edinburgh, UK MSc in Science, Technology, and Society Graduated with Distinction Supervisor: Dr. Jamie Cross Thesis: Powering light and cloaking darkness: Energy justice of lead acid batteries in India
09/2011 – 06/2015	University of Chicago, USA BA in Physics: Graduated with Honors Supervisor: Prof. David Awschalom Thesis: Toward characterizing the spin Seebeck effect in YIG using arrays of nanodiamond temperature sensors

FELLOWSHIPS AND AWARDS

09/2024	<u>Rising Stars in Physics Workshop</u>
09/2023 – Present	Marie Skłodowska-Curie Postdoctoral Fellowship
01/2023 – 08/2023	Alexander von Humboldt Research Fellowship
09/2020	<u>Outstanding Student contribution to Education,</u> Winner in Inclusive Practice, Cambridge UK
02/2020	<u>Young investigator award,</u> GRC Conference on ultrafast phenomena
07/2019	<u>Outstanding Student contribution to Education,</u> Highly Commended, Cambridge UK
06/2017	Nature Materials Prize for Best Talk, Optical Probes
10/2016	Cambridge Winton Scholar
11/2014	<u>Marshall Scholar:</u> Postgraduate fellowship
11/2014	Rhodes Finalist: Postgraduate fellowship
05/2014	Grainger Senior Scholarship: Award for best physics student
05/2014	Student Marshal: University of Chicago's highest undergraduate honors award
02/2014	Young Future Energy Leaders, UAE
2012 – 2015	University of Chicago's Dean's List: Academic Honors

03/2013

US Microsoft Imagine Cup Winner, World Citizenship Challenge

05/2011

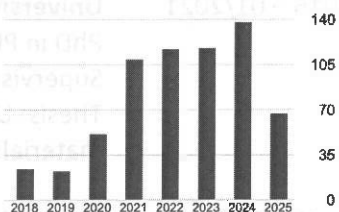
Valedictorian: Parkway West High School (>300 students)

PUBLICATIONS

1. Resolving self-cavity effects in two-dimensional quantum materials. *Michael, M.H, Kipp, G., Potts, A.M., Day, M.W., Matsuyama, T., Meier, G., Bretscher*, H.M., McIver, J.W. *, ArXiv: 2505.12799*
2. Purcell enhancement of photogalvanic currents in WTe₂ Plasmonic Cavities. *Li, X., Hagelstein, J., Kipp, G., Sturm, F., Kusyak, K., Huang, Y., Schulte, B.F., Potts, A.M., Stensberg, J., Cordero, V.Q., Trovatiello, C., Peng, X.H., Hu, C., DeStefano, J.M., Fechner, M., Taniguchi, T., Watanabe, K., Shin, D., Schuck, P.J., Xu, X., Chu, J-H, Zhu, X.Y., Rubio, A., Michael, M.H., Day, M.W., **Bretscher, H.M. ***, McIver, J.W. **
Submitted to Light Science and Applications (2025).
3. Monolithic optoelectronic circuit design for on-chip terahertz applications. *Kusyak, K., Schulte, B.F., Matsuyama, T., Kipp G., **Bretscher H.M.**, Day, M.W., Meier, G., Potts, A.M., McIver, J.W. **
Submitted to APL Photonics (2025).
4. On-chip THz emission from Floquet-Bloch states *Li, X., Hagelstein, J., Sturm, F., Kusyak, K., Aranzadi, J.I., Huang, Y., Schulte, B.F., Potts, A.M., Cordero, V.Q., Trovatiello, C., Peng, X.H., Hu, C., DeStefano, J.M., Taniguchi, T., Watanabe, K., Sentef, M.A., Shin, D., Schuck, P.J., Xu, X., Chu, J-H, **Bretscher, H.M.**, Day, M.W. *, McIver, J.W. **
Accepted to Optical Materials Express (2025).
5. Nonperturbative Nonlinear Transport in a Floquet-Weyl Semimetal
*Day M.W., Kusyak, K., Sturm, F., Aranzadi, Juan I., **Bretscher, H. M.**, Fechner, M., Matsuyama, T., Michael, M.H, Schulte, B.F., Li, X., Hagelstein, J., Herrmann, D., Kipp, G., Potts, A.M., DeStefano, J.M., Hu, C., Huang, Y., Taniguchi, T., Watanabe, K., Meier, G., Shin, D., Rubio, A., Chu, J-H., Kennes, D.M., Sentef, M.A., McIver, J.W. *,
arXiv: 2409.04531 (2024). (Under review at Nature Materials)*
6. Cavity electrodynamics of van der Waals heterostructures
Bretscher, H.M. ^o, *Kipp, G. ^o, Schulte, B., Herrmann, D., Kusyak, K., Day, M.W., Kesavan, S., Matsuyama, T., Li, X., Langner, S.M., Hagelstein, J., Sturm F., Potts, A.M., Eckhardt, C.J., Huang, Y., Taniguchi, T., Rubio, A., Kennes, D.M., Sentef, M.A., Baudin, E., Meier, G., Michael, M.M., McIver, J.W.*.*
arXiv: 2403.19745 (2024). (Under review at Nature Physics)
7. Chemical Passivation of 2D Transition Metal Dichalcogenides: Strategies, Mechanisms, and Prospects for Optoelectronic Applications
*Li, Z. **Bretscher, H.**, Rao, A. **
Nanoscale 16 (20), 9728-974, 2024 (2024).
8. Understanding the Photoluminescence Quenching of Liquid Exfoliated WS₂ Monolayers
*Li, Z., Rashvand, F., **Bretscher, H.**, Szydłowska, B., Xiao, J., Backes, C., Rao, A. *,
J. Phys. Chem C. 125, 51, (2022).*
9. Extracting Quantitative Dielectric Properties from Pump-Probe Spectroscopy

Publication Overview

Cited by	VIEW ALL	
	All	Since 2020
Citations	667	600
h-index	10	9
i10-index	11	9



Google scholar profile
As of 5/2025

- Ashoka, A., Tamming, R.R. Girija, A.V., **Bretscher, H.**, Dev Verma, S., Yang, S., Lu, C., Hodgkiss, J.M., Ritchie, D., Chen, C., Smith, C.G., Schnedermann, C., Price, M.B., Chen, K., Rao, A.*
Nature Communications 13, 1, (2022). (>30 citations)
10. Imaging the coherent propagation of collective modes in the excitonic insulator Ta₂NiSe₅ at room temperature
Bretscher, H.M.,[◊] Andrich, P.^{◊*}, Murakami, Y., Golez, D., Remez, B., Telang, P., Singh, A., Harnagea, L., Cooper, N.L., Millis, A.J., Werner, P., Sood, A.K, Rao, A.* (2021)
Science Advances, 7, 28, (2021). (>50 citations)
11. Rational Passivation of Sulfur Vacancy Defects in Two-Dimensional Transition Metal Dichalcogenides
Bretscher, H. Li, Z., Xiao, J., Qiu, D.Y., Rafaely-Abramson, S., Alexander-Webber, J.A., Tanoh, A., Fan, Y., Delpont, G., Williams, C.A., Stranks, S.D., Hofmann, S., Neaton, J.B., Louie, S.G., Rao, A.*.
ACS Nano, 15, 5, 8780-8789 (2021). (>80 citations)
12. Ultrafast melting and recovery of collective order in the excitonic insulator Ta₂NiSe₅
Bretscher, H.M.,[◊] Andrich, P.^{◊*}, Telang, P., Singh, A., Harnagea, L., Sood, A.K., Rao, A.*
Nature Communications 12.1 (2021). (>50 citations)
13. Mechanistic Insight to the Chemical Treatments of Monolayer Transition Metal Disulfides for Photoluminescence Enhancement
 Li, Z. **Bretscher, H.**, Zhang, Y., Delpont, G., Xiao, J., Lee, A., Stranks, S.D., Rao, A*
Nature Communications 12, 1, (2021). (>25 citations)
14. Racism, Equity and inclusion in Research Funding
 Li, Y.L., Oliver, R., **Bretscher, H.**, Ochu, E.*
Science in Parliament, 76(4), 17-19. (2020).
15. Enhancing Photoluminescence and Mobilities in WS₂ Monolayers with Oleic Acid Ligands
 Tanoh, A.O.A., Alexander-Webber, J., Xiao, J., Delpont, G., Williams, C. A., **Bretscher, H.**, Gauriot, N., Allardice, J., Pandya, R., Fan, Y., Li, Y., Vignolini, S., Stranks, S.D., Hofmann, S., Rao, A.*
Nano Letters 19.9: 6299-6307 (2019).(>110 citations)
16. Ultrafast Tracking of Exciton and Charge Carrier Transport in Optoelectronic Materials on the Nanometer Scale
 Schnedermann, C.* , Sung, J., Pandya, R., Verma, S.D., Chen, R.Y.S., Gauriot, N., **Bretscher, H.M.**, Kukura, P., Rao, A.*
Journal of Physical Chemistry Letters, 10, 21, 6727-6733 (2019). (>60 citations)
17. Long-range spin wave mediated control of defect qubits in nanodiamonds
 Andrich, P., de las Casas, C.F., Liu, X., **Bretscher, H.L.**, Berman, J.R., Heremans, F.J., Nealey, P.F., Awschalom, D.D.*
npj Quantum Information, 3, 28 (2017). (>130 citations)
18. Composition Optimization of Layered Lithium Nickel Manganese Cobalt Oxide Materials Synthesized via Ultrasonic Spray Pyrolysis
 Lengyel, M., Zhang, X., Atlas, G., **Bretscher, H.L.**, Belharouak, I., Axelbaum, R.L.*
Journal of The Electrochemical Society 161, no. 9 (2014). (>25 citations)

* = Corresponding author

◊ = These authors contributed equally

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INVITED TALKS AND CONFERENCE PRESENTATIONS (21)

06/2025	Invited Colloquia, University of Bremen
04/2025	Invited Talk, Max Planck- New York Center Kickoff
02/2025	Invited seminar, University of Michigan, USA
02/2025	Invited seminar, Cornell University, USA
02/2025	Invited seminar, Boston University, USA
01/2025	Invited seminar, Bostin College, USA
01/2025	Invited talk, <u>SPIE Photonics West</u> , USA
10/2024	Invited seminar, Washington University, USA
05/2024	Invited talk, <u>Cavity Control of Quantum Materials</u> , Germany
04/2024	Invited talk, <u>Emergent Relativistic Effects in Condensed Matter</u> , Germany
02/2024	Invited talk, Light-matter seminar, New York, USA
02/2024	Invited talk, Center for Computational Quantum Physics, USA
08/2023	Invited talk, PSI Condensed Matter Summer School, Switzerland (unable to attend)
10/2021	Invited talk, Solid State Seminar, Univ. of Gottingen, Germany
10/2021	Invited talk, IMPRS Workshop, Frontiers of quantum Materials, Germany
06/2021	Invited talk, <u>New Trends in Nonequilibrium Many-Body Systems</u> , Virtual
03/2021	Invited talk, <u>APS March Meeting</u> , Virtual
01/2021	Invited Seminar, UCLA Condensed Matter Journal Club, Virtual
08/2021	Invited Seminar, Stockholm University, Sweden
08/2021	Invited Seminar, University of Trieste, Italy
08/2021	Invited Seminar, MPSD, Germany

CONTRIBUTED TALKS AND POSTERS (9)

06/2024	Poster, GRC 2D electronics beyond graphene, USA
05/2024	Talk, Ultrafast Surface Dynamics, Germany
05/2022	Talk, Capri Spring School, Italy
02/2020	Talk and Poster at GRC Ultrafast, USA
09/2019	Talk, New Generation in Strongly Correlated Electron Systems, Italy
09/2018	Poster, CECAM Workshop, New Perspectives in Long-Range interacting systems, Switzerland
06/2018	Poster, GRC 2D Electronics Beyond Graphene, USA
10/2017	Poster at CECAM workshop, Charge Carrier Dynamics in Nanostructures, Germany
06/2017	Talk at Optical Probes Conference, Canada

ACADEMIC SERVICE

09/2023	<u>Mini-colloquia organizer, CMD FisMat2023</u> (>80 attendees)
06/2021 – 12/2022	Seminar organizing committee, MPSD
10/2020	Co-chair, <u>Spectroscopy of Strongly Correlated Electron Systems</u> (>200 attendees) (Virtual)

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03/2019 – 01/2021	Cavendish Community Forum, student representative
11/2019 – 10/2020	TIGERinSTEMM, social media coordinator
10/2017 – 10/2020	Cavendish Inspiring Women, co-president
08/2017 – 06/2019	Cavendish postgraduate student consultative committee member

TEACHING EXPERIENCE AND PUBLIC OUTREACH

2019 – Present	Skype a Scientist: Spoken with 25+ schools with students age 6-18
11/2021	<u>Podcast</u> , Science Chatter Hamburg
2018 – 2019	STEM ambassador- speaker in schools on science and careers
10/2018	Guest writer, <u>She Speaks Science</u> blog
09/2018 – 12/2018	Teaching Assistant, Electricity and Magnetism
01/2018 – 03/2018	Teaching Assistant, Advanced Quantum Physics

MENTORSHIP AS POSTDOC

2020 – Present	PhD student 1
2023 – Present	PhD students 2, 3, 4, MSc student 1
2024 – Present	PhD student 5
2022 – 2023	MSc students 2, 3, BSc student 1

RESEARCH HISTORY

Postdoc | James McIver Group | MPSD | 12/2020 – Present

I developed an on-chip THz spectroscopy platform with *in-situ* referencing to investigate the low-energy electrodynamics of gate-tunable quantum materials. Using this platform, I demonstrated the ultrastrong light-matter coupling between graphene and a subwavelength cavity formed by the microstructured electrostatic graphite gate.

PhD student | Akshay Rao Group | Cambridge | 10/2016 – 12/2020

I investigated the spectroscopic properties of low-dimensional, excitonic materials primarily using PL, and optical/NIR nonlinear free space, and microscope-based, spectroscopy (two and three pulse techniques). I developed and provided mechanistic insight into a chemical treatment to passivate defects in monolayer transition metal chalcogenides. In addition, I demonstrated the role of electronic interactions in an excitonic insulator candidate, Ta₂NiSe₅, by characterizing an ultrafast photoinduced quenching of long-range order, and anomalous spatial propagation of collective modes.

Undergraduate student | David Awschalom Group | UChicago | 10/2013 – 6/2015

I built a confocal microscope to use diamond nitrogen vacancy centers for spin phenomena.

Undergraduate student | Richard Axelbaum Group | WashU | 6-8/2012, 6/2013 – 8/2013

I synthesized lithium-ion battery cathodes using spray pyrolysis.

RESEARCH SKILLS AND EXPERTISE

Designing vdW heterostructure microcavities and vdW heterostructure fabrication

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On-chip THz transmission and emission spectroscopy
Operating helium flow, closed cycle (liquid helium free), He3-He4 cryostats
Quantum materials: graphene, transition metal chalcogenides, Weyl semimetals
Nonlinear and ultrafast dynamics of strongly correlated electron systems
Performing and building two and three-pulse transient absorption measurements with tunable nonlinear optical parametric amplification (NOPAs)
Sample characterization using AFM, Raman, steady state and time-resolved PL, XRD
Programming in Matlab, IgorPro, Python, Labview, and Mathematica

UNPUBLISHED WORKS IN PROGRESS

QED of correlated quantum materials

Bretscher, H.M., Eckstein, M., Faist, J., Fausti, D., Kennes, D.M., McIver, J.W., Michael, M.H., Montanaro, A., Rubio, A. *Nature Physics*.

We review the use of cavities, which structure and engineer fluctuations, to engineer quantum phases of matter. This research brings quantum optics concepts in solid state materials. The use of cavities to prepare, manipulate, and probe correlated phases of quantum materials are reviewed from experimental and theoretical perspectives.

Particle — hole symmetry breaking in graphene due to back gate quantum capacitance

Bretscher, H.M.[◇], Kipp, G.[◇], Schulte, B., Day, M.W., Matsuyama, T., Meier, G., Michael, M.H., McIver, J.W.*.

We demonstrate that particle-hole asymmetry in graphene can be a sensitive probe for minority bands in 2D materials.