AARON M. BAUER

ADDRESS
THE INSTITUTE OF OPTICS
275 HUTCHISON RD.
121 WILMOT BUILDING
E-MAIL: BAUER@OPTICS.ROCHESTER.EDU

EDUCATION

University of Rochester — Rochester, NY
Degree: Ph.D. — Graduated: June 2016
Dissertation Title: Optical design with freeform surfaces, with applications in head-worn display design

University of Wisconsin – Eau Claire — Eau Claire, WI
Degree: Bachelor of Science — Graduated: May 2009
Major: Physics
Minor: Mathematics
Honors: Summa Cum Laude

EMPLOYMENT

Research Assistant Professor — July 2021 - Present
University of Rochester — Rochester, NY

- Researching design modalities using freeform and metasurface optics in optical design. Continued the development of a wide variety of optical systems, such as wide field telescopes and visual instruments.
- Primary technical adviser to Ph.D. graduate students working on optical design projects.
- Served as senior staff for other research lab activities.

Senior Research Engineer — January 2017 – July 2021
University of Rochester — Rochester, NY

- Researched novel technologies in the context of optical design.
- Primary technical adviser to Ph.D. graduate students working on optical design projects.

Optical Design Consultant — April 2017 - Present
Rochester, NY

Research Engineer — June 2016 – January 2017
University of Rochester — Rochester, NY

- Led the design of multiple freeform optical systems, including a high-end camera viewfinder, a wide-field telescope, and a compact echelle spectrometer.
- Served as senior staff for other research lab activities.

AWARDS AND HONORS

Scholarships

- Wisconsin Academic Excellence Scholarship (2005)
- University of Wisconsin – Eau Claire Freshman Honor Scholarship (2005)
- Erle and Alice Porter Rounds Scholarship (Freshman w/ Great Potential for Success) (2005)

- W. Parker Clark Physics Scholarship (Most Outstanding Physics Major) (2009)
- SPIE Optics and Photonics Education Scholarship (2014)

Awards

- Most Outstanding Teaching Assistant – The Institute of Optics, Univ. of Rochester (2011)
- Robert S. Hilbert Memorial Optical Design Competition Winner (2014)
- Robert S. Hilbert Memorial Student Travel Grant – IODC (2014)
- OSA's Kevin P. Thompson Optical Design Innovator (2020)

Fellowships

- Carl Zeiss Optical Engineering Fellowship (2011-2012)

ACADEMIC TEACHING

Co-Instructor January 2019 - Present
University of Rochester Rochester, NY

- Spring 2019 – OPT 440 Freeform Optics
  - Led three optical design workshops and two weeks of lecture
- Fall 2020 – OPT 440 Freeform Optics
  - Contributed to the transition of the course to an all-online format
  - In charge of four optical design workshops
- Fall 2022 – OPT 440 Freeform Optics
  - In charge of four optical design workshops and overall administration

Guest Lecturer 2011-Present
University of Rochester Rochester, NY

- Optics 242/442: CodeV Introduction
- Optics 242/442: Distortion and Chromatic Aberrations

Graduate Student Technical Advisor and Mentor 2017-Present
University of Rochester Rochester, NY

- Eric Schiesser
  - Degree: Ph.D.
  - Topic: unobscured reflective imagers
  - Defense date: 10/04/2019
- Nicholas Takaki
  - Degree: Ph.D.
  - Topic: mathematical representations of freeform surfaces and applications
  - Defense date: 01/18/2021
- Yuxuan Liu
  - Degree: Ph.D.
  - Topic: freeform applications for CubeSats
  - Projected graduation date: Summer 2023

Teaching Assistant – Optics 2010-2012 Academic Year
University of Rochester Rochester, NY

- Fall 2010 – OPT 441 Geometrical Optics
- Spring 2011 – OPT 442 Instrumental Optics
- Fall 2012 – OPT 441 Geometrical Optics & OPT 461 Physical Optics

Academic Tutor – Physics Fall 2006
University of Wisconsin – Eau Claire, Department of Physics and Astronomy Eau Claire, WI

INVITED PRESENTATIONS

Analyzing the Aberration Fields of a Three-mirror Telescope and Correcting them Using Freeform Zernike Surface
A. Bauer, E. M. Schiesser, and J. P. Rolland
OSA Freeform Optics 2017 *July 9-13, 2017, Denver, CO*

Partnership in advancing freeform optics: Workshop on Ultraprecision Manufacturing of Aspheres and Freeforms
J. P. Rolland and **A. Bauer**
Fraunhofer Institute *September 19-20, 2018, Jena, Germany*

Imaging Design with Freeform Optics with Applications in Visual Systems
A. Bauer
Light and Sound Interactive *June 25-27, 2019, Rochester, NY*

Design of an all-reflective freeform viewfinder
J. P. Rolland and **A. Bauer**
UK Optical Design Meeting *September 19, 2019, London, England*

Exploring the design space of 3-mirror freeform imager
A. Bauer and J.P. Rolland
OSA Frontiers in Optics *September 14-17, 2020, Virtual*

Specification Sweep for Three-Mirror Freeform Imagers
A. Bauer and J. P. Rolland
International Optical Design Conference *June 27 – July 1, 2021, Virtual*

Metaform Optical Imager
D. K. Nikolov, **A. Bauer**, F. Cheng, A. N. Vamivakas, and J. P. Rolland
OSA Optical Design and Fabrication Congress *June 27 – July 1, 2021, Virtual*

Metaform Optics Enabling a Conformal Combiner
J. P. Rolland, D. K. Nikolov, **A. Bauer**, F. Cheng, H. Kato, and A. N. Vamivakas
OSA Imaging and Applied Optics Congress *July 19 – 23, 2021, Virtual*

PUBLICATIONS

Peer-Reviewed Journals

1. **A. M. Bauer** and P. Thomas, "Determining the Mass of Saturn's Satellite, Daphnis." JURP Vol. **23**, August 2010.
2. **A. Bauer**, S. Vo, K. Parkins, F. Rodriguez, O. Cakmakci, and J. Rolland, "Computational optical distortion correction using a radial basis function-based mapping method," Opt. Express 20, 14906-14920 (2012).
3. **A. Bauer** and J. Rolland, "Visual space assessment of two all-reflective, freeform, optical see-through head-worn displays," Opt. Express **22**, 13155-13163 (2014).
    - Selected as Spotlight on Optics Paper (June 2014)
    - Selected for Re-publishing in Vol. 9, Iss. 8 of Virtual Journal for Biomedical Optics

4. **A. Bauer** and J. P. Rolland, "Design of a freeform electronic viewfinder coupled to aberration fields of freeform optics," Opt. Express **23**, 28141-28153 (2015)
5. **A. Bauer**, J. P. Rolland, and K. P. Thompson, "Ray-based optical design tool for freeform optics: coma full-field display," Opt. Express **24**, 459-472 (2016)
6. J. Reimers, **A. Bauer**, K. P. Thompson, J. P. Rolland, "Freeform spectrometer enabling increased compactness," Light: Science and Applications **6**, e17026 (2017)
7. D. K. Nikolov, F. Cheng, N. Basaran, **A. Bauer**, J. P. Rolland, and A. N. Vamivakas, "Long-term efficiency preservation for gradient phase metasurface diffraction gratings in the visible," Opt. Mater. Express **8**, 2125-2130 (2018)
8. **A. Bauer**, E. Schiesser, and J. P. Rolland, "Starting geometry creation and design method for freeform optics," Nature Communications **9**, 1756 (2018).
9. F. Cheng, L. Ding, L. Qiu, D. Nikolov, **A. Bauer**, Jannick P. Rolland, and A. Nick Vamivakas, "Polarization-switchable holograms based on efficient, broadband multifunctional metasurfaces in the visible regime," Opt. Express **26**, 30678-30688 (2018)
10. N. Takaki, **A. Bauer**, and J. P. Rolland, "Degeneracy in freeform surfaces described with orthogonal polynomials," Appl. Opt. **57**, 10348-10354 (2018)
11. N. Takaki, **A. Bauer**, and J. P. Rolland, "On-the-fly surface manufacturability constraints for freeform optical design enabled by orthogonal polynomials," Opt. Express **27**, 6129-6146 (2019)
12. F. Cheng, L. Qiu, D. Nikolov, **A. Bauer**, J. P. Rolland, and A. N. Vamivakas, "Mechanically tunable focusing metamirror in the visible," Opt. Express 27, 15194-15204 (2019)
13. J. Zhu, B. Zhang, W. Hou, **A. Bauer**, J. P. Rolland, and G. Jin, "Design of an oblique camera based on a field-dependent parameter," Appl. Opt. **58**, 5650-5655 (2019)
14. E. M. Schiesser, **A. Bauer**, and J. P. Rolland, "Effect of freeform surfaces on the volume and performance of unobscured three mirror imagers in comparison with off-axis rotationally symmetric polynomials," Opt. Express **27**, 21750-21765 (2019)
15. E. M. Schiesser, **A. Bauer**, and J. P. Rolland, "Estimating field dependent Nodal Aberration Theory coefficients from Zernike full-field displays by utilizing 8th-order astigmatism". JOSA A **36**, 2115-2128 (2019)
16. **A. Bauer**, M. Pesch, J. Muschaweck, F. Leupelt, and J. P. Rolland, "All-reflective electronic viewfinder enabled by freeform optics," Opt. Express **27**, 30597-30605 (2019)
17. D. Nikolov, F. Cheng, L. Ding, **A. Bauer**, A. N. Vamivakas, and J. P. Rolland, "See-through reflective metasurface diffraction grating," Opt. Mat. Express **9**, 4070-4080 (2019)
18. C. Yoon, **A. Bauer**, D. Xu, C. Dorrer, and J. P. Rolland, "Absolute linear-in-k spectrometers enabled by freeform optics," Opt. Express **27**, 34593-34602 (2019)
19. N. Takaki, J. C. Papa, **A. Bauer**, and J. P. Rolland, "Off-axis conics as base surfaces for freeform optics enable null testability," Opt. Express **28**, 10859-10872 (2020)
20. J. P. Rolland, M. A. Davies, T. J. Suleski, C. Evans, **A. Bauer**, J. Lambropoulos, K. Falaggis, "Freeform optics for imaging", Optica **8**(2), 161-176 (2021)
21. D. Nikolov, **A. Bauer**, F. Cheng, H. Kato, A. N. Vamivakas, and J. P. Rolland, "Metaform optics: bridging nanophotonics and freeform optics" Science Advances **7**(18), eabe5112 (2021)
22. Y. Liu, **A. Bauer**, T. Viard, and J. P. Rolland, "Freeform hyperspectral imager design in a CubeSat format," Opt. Express 29, 35915-35928 (2021)
23. **A. Bauer** and J. P. Rolland, "Roadmap for the unobscured three-mirror freeform design space," Opt. Express 29, 26736-26744 (2021)
24. **A. Bauer,** C. Zhang, and J. P. Rolland, "Exit pupil quality analysis and optimization in freeform afocal telescope systems," Opt. Express 31, 24691-24701 (2023)

Patents

1. J. P. Rolland and **A. Bauer**, Optical display apparatus, method, and applications, US Patent 10,088,681 B2 (2018)
    a. Published in Europe as EP3004965B1 (2019)

2. J. P. Rolland, N. Vamivakas, A. Kitt, and **A. Bauer**, Freeform nanostructured surface for virtual and augmented reality near eye display, US Patent 10,371,951 B2 (2019)
    a. Published in China as CN107771297B (2021)
    b. Published in Japan as #JP6892827 (2021)
    c. Published in Europe as #EP 3278169 (2022)
3. J. P. Rolland, **A. Bauer**, D. Yates, and M. Farsad, Compact Freeform Echelle Spectrometer, US Patent 11,169,024 B2 (2021)
4. D. Nikolov, N. Vamivakas, F. Cheng, **A. Bauer**, and J.P. Rolland, Mechanically Tunable Reflective Metamirror Optical Device, US Patent 11,592,646 B2 (2023)
5. J. P. Rolland, **A. Bauer**, N. Vamivakas, F. Cheng, and D. Nikolov, Augmented Reality Display, US Patent 11,624,912 B2 (2023)
6. D. Nikolov, J. P. Rolland, N. Vamivakas, F. Cheng, and A. Bauer, See-through Reflective Metasurface, US Patent 11,675,107 B2 (2023)

Book Chapters

1. J. P. Rolland, K. P. Thompson, **A. Bauer**, H. Urey, and M. Thomas, "See-Through Head-Worn Display (HWD) Architectures," in Handbook of Visual Display Technology, J. Chen, W. Cranton, and M. Fihn, eds. (Springer International Publishing, Cham, 2016), pp. 2929-2961**.**
2. **A. Bauer** and J.P. Rolland, "The Optics of AR displays" in Springer Handbook of Augmented Reality, eds. Prof. A. Y. C. Nee, Prof. S. K. Ong (Springer, Cham, 2023)

Conference Proceedings and Abstracts

1. **A. Bauer**, S. Vo, K. Parkins, F. Rodriguez, O. Cakmakci, and J. Rolland, "Optical distortion correction using radial basis function interpolation," in Frontiers in Optics 2012/Laser Science XXVIII, OSA Technical Digest (online) (Optical Society of America, 2012), paper FTu2E.4.
2. J. Rolland, K. Fuerschbach, **A. Bauer**, and K. Thompson, "Freeform Optics Enabling Optics in Three Dimensions," in Imaging and Applied Optics, OSA Technical Digest (online) (Optical Society of America, 2013), paper CW4C.1.
3. **A. M. Bauer** and J. P. Rolland, "Two All Reflective, Freeform, Optical See-Through Head-Worn Displays," in *Classical Optics 2014*, OSA Technical Digest (online) (Optical Society of America, 2014), paper ITh3A.6.
4. **A. Bauer**, J. P. Rolland, "Two all reflective, freeform, optical see-through head-worn displays", Proc. SPIE 9293, International Optical Design Conference 2014, 92930Q (December 17, 2014); doi:10.1117/12.2073291.
5. **A. M. Bauer** and J. P. Rolland, "Design Process for an All-Reflective Freeform Electronic Viewfinder," in *Imaging and Applied Optics 2015*, OSA Technical Digest (online) (Optical Society of America, 2015), paper FW3B.2.
6. **A. Bauer**; K. P. Thompson; J. P. Rolland; "Coma full-field display for freeform imaging systems." Proc. SPIE 9633, Optifab 2015, 963316 (October 11, 2015); doi:10.1117/12.2196061.
7. **A. M. Bauer**, E. M. Schiesser, and J. P. Rolland, "Analyzing the Aberration Fields of a Three-mirror Telescope and Correcting them Using Freeform Zernike Surfaces," in Optical Design and Fabrication 2017 (Freeform, IODC, OFT), OSA Technical Digest (online) (Optical Society of America, 2017), paper JW3C.4.
8. J. Reimers, K. Thompson, J. Troutman, J. Owen, **A. M. Bauer**, J. C. Papa, K. Whiteaker, D. Yates, M. Farsad, P. Marasco, M. Davies, and J. P. Rolland, "Increased Compactness of an Imaging Spectrometer Enabled by Freeform Surfaces," in Optical Design and Fabrication 2017 (Freeform, IODC, OFT), OSA Technical Digest (online) (Optical Society of America, 2017), paper JW2C.5.
9. A. B. Hayes, W. Zhou, **A. M. Bauer**, J. Owen, C. J. Evans, M. Davies, and J. P. Rolland, "Software Tools to Simplify the Transfer of a Lens Design to Manufacturing," in Optical

Design and Fabrication 2017 (Freeform, IODC, OFT), OSA Technical Digest (online) (Optical Society of America, 2017), paper JTh2B.2.

10. N. Horvath, N. W., I. W. Barron, J. D. Owen, B. S. Dutterer, E. Schiesser, **A. Bauer**, J. P. Rolland, M. A. Davies, Optomechanical Design and Fabrication of a Snap Together Freeform TMA Telescope, Accepted for 32nd ASPE Annual Meeting, Charlotte, NC, October 19-November 3, 2017
11. **A. Bauer**., E. M. Schiesser., and J.P. Rolland, "Analyzing the Aberration Fields of a Three-mirror Telescope and Correcting them Using Freeform Zernike Surfaces," Mirror Technology SBIR/STTR Workshop, Nov. 14-16 Los Angeles (2017)
12. **A. Bauer**, E. M. Schiesser, J. P. Rolland, "Concurrent engineering of a next-generation freeform telescope: optical design," Proc. SPIE 10998, Advanced Optics for Imaging Applications: UV through LWIR IV, 109980W (14 May 2019);
13. **A. Bauer**, M. Pesch, J. Muschaweck, and J. P. Rolland, "All-Reflective Freeform Viewfinder," in Optical Design and Fabrication 2019 (Freeform, OFT), OSA Technical Digest (Optical Society of America, 2019), paper FM2B.4.
14. Y. Liu, **A. Bauer**, and J. P. Rolland, "CubeSat Format 3-Mirror Spectrometer Designed with Freeform Surfaces," in Optical Design and Fabrication 2019 (Freeform, OFT), OSA Technical Digest (Optical Society of America, 2019), paper FM4B.3.
15. E. M. Schiesser, **A. Bauer**, and J. P. Rolland, "The Effect of Freeform Surfaces on the Volume and Performance of Unobscured Three Mirror Imagers," in Optical Design and Fabrication 2019 (Freeform, OFT), OSA Technical Digest (Optical Society of America, 2019), paper FM3B.2.
16. J. P. Rolland and **A. Bauer**, "Design of an all-reflective freeform viewfinder", UK Optical Design Meeting 2019.
17. N. Takaki, **A. Bauer,** and J. P. Rolland, "Improving freeform surface manufacturability estimates by leveraging orthogonal polynomials in design", UK Optical Design Meeting 2019.
18. Y. Liu, **A. Bauer**, and J. P Rolland, "CubeSat Format Freeform Hyperspectral Imager" in Optical Design and Fabrication 2021 (Freeform), OSA Technical Digest (Optical Society of America, 2021), paper RW1A.5.
19. **A. Bauer**, and J. P Rolland, "Specification Sweep for Three-Mirror Freeform Imagers" in Optical Design and Fabrication 2021 (Freeform, IODC), OSA Technical Digest (Optical Society of America, 2021), paper JTh4A.1.
20. N. Takaki, J. C Papa, **A. Bauer**, and J. P. Rolland, "Aberration-Based Design Example for Freeform Optical Designs With Base Off-Axis Conics" in in Optical Design and Fabrication 2021 (Freeform, IODC), OSA Technical Digest (Optical Society of America, 2021), paper JTh3A.6.
21. N. Takaki, **A. Bauer**, and J. P. Rolland, "Aberration-based design example for freeform optical designs with base off-axis conics," Proc. SPIE 12078, International Optical Design Conference 2021, 120781M (19 November 2021); https://doi.org/10.1117/12.2603673

OTHER PRESENTATIONS

Ghost Imaging Using a Pseudothermal Light Source
A. Bauer, M. Sullivan, and R. Boyd
Frontiers in Optics: Laser Science XXIV — *October 20, 2008 Rochester, NY*
Symposium on Undergraduate Research

Determining the Mass of Saturn's Satellite, Daphnis
A. Bauer and P. Thomas
National Conferences on Undergraduate Research — *April 16-18, 2009, La Crosse, WI*
UW-Eau Claire Student Research Day — *April 27-29, 2009, Eau Claire, WI*

Moving from phi-polynomials to multicentric radial basis functions
A. Bauer, I. Kaya, and J. P. Rolland
OSA Freeform Optics Incubator Meeting *October 30–November 1, 2011, Washington D.C.*

Emergence of Freeform Optics in Imaging Systems: A Leap Forward
J. P. Rolland and **A. Bauer**
Photonics Media Webinar *February 27, 2019, Virtual*

Freeform Optics for Imaging: Design Methods
J. P. Rolland and **A. Bauer**
Photonics Media Webinar *May 26, 2021, Virtual*

PROJECT FUNDING

Current Funding Awards as PI
2021-2023 CeFO: Zoom afocal freeform telescopes (**$269,404**)

Current Funding Awards as Co-PI
2022-2024 CeFO: Image quality improvement (**$108,860**)
2023-2024 Army STTR Phase II with Vision Products (**$304,207**)
2023-2024 CeFO: MSF specification and tolerancing (**$103,497)**

Current Funding Awards as Investigator
2022-2023 System architecture towards the ultimate display (**$1,182,698**)

Completed Funding Awards as PI/co-PI
2022 CeFO: Understanding thermal behavior of freeform systems (**$53,924**)
2022 CeFO: Transmissive freeform zoom imaging systems (**$128,034**)
2018-2021 Industry (**$539,928**)
2020 Army STTR with SA Photonics (**$45,000**)
2020 Aperture Optical Systems (**$71,034**)
2018-2020 CeFO: Cubesat Format Optical Freeform Systems (**$146,211**)
2016-2020 CeFO: 250 mm Class Wide Field-of-View Freeform Imager (**$466,207**)
2017-2019 CeFO: Freeform Optical Design with Forbes 2D Q-Polynomials (**$150,121**)
2018 Lucyd (**$107,318**)
2016-2017 ARRI **($126,653**)

Completed Funding Awards as Investigator
2021-2022 CeFO: MSF Specification and Tolerancing (**$51,006**)
2021-2022 GD-OCM for brain (**$60,000**)
2020-2022 GD-OCM for cornea (**$97,249**)
2016-2021 Industry/CEIS (**$925,340/$30,000**)
2016-2017 Perkin Elmer **($387,070)**

SERVICE

Thesis Committees
University of Rochester

- Adam Briggs (Primary, Masters)
  - Graduated: 2022
- Ankur Desai (Internal, Ph. D.)
  - Anticipated Graduation : 2025

Conference Program Committee 2023
- Optica – IODC Quebec City, Canada

Optica Award Selection Committee 2022-2024
- Kevin Thompson Optical Design Innovator

Conference Program Committee 2021
- OSA Optical Design and Fabrication – Freeform Optics Virtual
- OSA Optical Design and Fabrication - IODC

Conference Program Committee 2019
- OSA Optical Design and Fabrication – Freeform Optics Washington, D.C.

University of Rochester SPIE Executive Board 2013-2015
University of Rochester Rochester, NY
- Web-Administrator (2013-2014)
- Vice President (2014-2015)