

Dr. Brian Kloppenborg

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EDUCATION

Ph.D. Physics University of Denver, 2012

Specialization: Astrophysics

Dissertation: *Interferometric, Astrometric, and Photometric studies of epsilon Aurigae: Seeing the disk around a distant star.*

Advisor: Dr. Robert Stencel

B.A. Physics Minors: Mathematics and Computer Science. Hastings College, 2006

Senior Project: *Design, Construction and Implementation of a Radio Telescope to Study Neutral Hydrogen*

Advisor: Dr. James Dugan

PAPERS

J.R. Parks, R.J. White, F. Baron, J.D. Monnier, **B. Kloppenborg**, G. Henry, G. Schaefer, X. Che, E. Pedretti, N. Thureau, M. Zhao, T. tenBrummelaar, H. McAlister, S.T. Ridgway, N. Turner, J. Sturmann, and L. Sturmann. “First Images of Cool Starspots on a Star Other than the Sun: Interferometric Imaging of λ Andromedae.” *eprint arXiv:1508.04755* (2015). URL <http://stacks.iop.org/0067-0049/220/14>.

B. Kloppenborg, Robert Stencel, John D. Monnier, Gail Schaefer, Fabien Baron, Chris Tycner, Robert T. Zavala, Donald Hutter, Ming Zhao, Xiao Che, Theo ten Brummelaar, Chris Farrington, Robert Parks, Hal McAlister, Judit Sturmann, Laszlo Sturmann, P. J. Sallave-Goldfinger, Nils Turner, Ettore Pedretti, and Nathalie Thureau. “Interferometry of ϵ Aurigae: Characterization of the asymmetric eclipsing disk.” *Astrophysical Journal Supplementary Series* **220**, 1–22 (2015). URL <http://adsabs.harvard.edu/abs/2015arXiv150801909K>.

G H Schaefer, T Ten Brummelaar, D R Gies, B Farrington, C D **B. Kloppenborg**, O Chesneau, J D Monnier, S T Ridgway, N Scott, I Tallon-Bosc, H A McAlister, T Boyajian, V Maistro, D Mourard, A Meilland, N Nardetto, P Stee, J Sturmann, N Vargas, F Baron, M Ireland, E K Baines, X Che, J Jones, N D Richardson, R M Roettenbacher, L Sturmann, N H Turner, P Tuthill, G van Belle, K von Braun, R T Zavala, D P K Banerjee, N M Ashok, V Joshi, J Becker, and P S Muirhead. “The expanding fireball of Nova Delphini 2013.” *Nature advance on* (2014). ISSN 1476-4687. URL <http://dx.doi.org/10.1038/nature13834>.

B. Kloppenborg, J. L. Hopkins, and R. E. Stencel. “An Analysis of the Long-term Photometric Behavior of epsilon Aurigae.” *The Journal of the American Association of Variable Star Observers* **40**, 647 (2012).

Aaron Price, Rebecca Turner, E. Stencel, Robert, **B. Kloppenborg**, and Arne A. Henden. “The Origins and Future of the Citizen Sky Project.” *The Journal of the American Association of Variable Star Observers* **40**, 614–617 (2012). URL <http://www.aavso.org/ejaavso402614>.

B. Kloppenborg, R. Pieri, HB. Eggenstein, G. Maravellias, and T. Pearson. “A Demonstration of Accurate Wide-field V-band Photometry Using a Consumer-grade DSLR Camera.” *The Journal of the American Association of Variable Star Observers* **40**, 815–833 (2012).

- R. E. Stencel, **B. Kloppenborg**, R. E. Wall, Jr., J. L. Hopkins, S. B. Howell, D. W. Hoard, J. Rayner, S. Bus, A. Tokunaga, M. L. Sitko, S. Bradford, R. W. Russell, D. K. Lynch, H. Hammel, B. Whitney, G. Orton, P. Yanamandra-Fisher, J. L. Hora, P. Hinz, W. Hoffmann, and A. Skemer. “Infrared Studies of Epsilon Aurigae in Eclipse.” *AJ* **142**, 174 (2011).
- P. Chadima, P. Harmanec, P. D. Bennett, **B. Kloppenborg**, R. Stencel, S. Yang, H. Božić, M. Šlechta, L. Kotková, M. Wolf, P. Škoda, V. Votruba, J. L. Hopkins, C. Buil, and D. Sudar. “Spectral and photometric analysis of the eclipsing binary ϵ Aurigae prior to and during the 2009-2011 eclipse.” *ã* **530**, A146+ (2011). [1105.0107](#).
- B. Kloppenborg**, R. Stencel, J. D. Monnier, G. Schaefer, M. Zhao, F. Baron, H. McAlister, T. Ten Brummelaar, X. Che, C. Farrington, E. Pedretti, P. J. Sallave-Goldfinger, J. Sturmman, L. Sturmman, N. Thureau, N. Turner, and S. M. Carroll. “Infrared images of the transiting disk in the ϵ Aurigae system.” *Nature* **464**, 870–872 (2010).
- D. E. Mais, **B. Kloppenborg**, and R. Stencel. “Adventures in Interferometry.” *Society for Astronomical Sciences Annual Symposium* **27**, 77 (2008).
- R. E. Stencel, M. Creech-Eakman, A. Hart, J. L. Hopkins, **B. Kloppenborg**, and D. E. Mais. “Interferometric Studies of the Extreme Binary ϵ Aurigae: Pre-Eclipse Observations.” *APJL* **689**, L137–L140 (2008). [0810.5382](#).

PROCEEDINGS

- B. Kloppenborg** and Gerard vanBelle. *Giants of Eclipse: The ζ Aurigae Stars and Other Binary Systems*, volume 408 of *Astrophysics and Space Science Library* (Springer International Publishing, Cham, 2015). ISBN 978-3-319-09197-6. URL <http://adsabs.harvard.edu/abs/2015ASSL..408..157K>.
- B. Kloppenborg**. “Interferometric Techniques for Binary Stars.” *Resolving The Future Of Astronomy With Long-Baseline Interferometry Proceedings of a conference held 28-31 March 2011* **487** (2014). URL <http://adsabs.harvard.edu/abs/2014ASPC..487..129K>.
- B. Kloppenborg**. “Accelerating optical interferometric image reconstruction and modeling using graphical processing units (GPUs).” *In Proceedings of the International Biomedical and Signal Processing Workshop2*, p. 42 (2012).
- F. Baron, **B. Kloppenborg**., and J. D. Monnier. “5D image reconstruction of stellar systems.” *In Proceedings of the International Biomedical and Signal Processing Workshop*, pp. 36–36 (2012).
- F. Baron, **B. Kloppenborg**, and J.D. Monnier. “Toward 5D image reconstruction for optical interferometry.” *In* Françoise Delplancke, Jayadev K. Rajagopal, and Fabien Malbet (Editors), *Optical and Infrared Interferometry III. Proceedings of the SPIE*, volume 8445, pp. 84451D–84451D–9 (2012).
- B. Kloppenborg**. “Interferometric Techniques for Binary Stars.” *In* Michelle Creech-Eakman; Robert E. Stencel (Editor), *Resolving the Future of Astronomy with Long-Baseline Interferometry* (ASP, 2012, in press).
- Fabien Malbet, William Cotton, Gilles Duvert, Peter Lawson, Andrea Chiavassa, John Young, Fabien Baron, David Buscher, Sridharan Rengaswamy, **B. Kloppenborg**, Martin Vannier, and Laurent Mugnier. “The 2010 interferometric imaging beauty contest.” *In* William C. Danchi, Françoise Delplancke, and Jayadev K. Rajagopal (Editors), *Optical and Infrared Interferometry II*, volume 7734, p. 77342N (SPIE, 2010).
- Fabien Baron and **B. Kloppenborg**. “GPU-accelerated image reconstruction for optical and infrared interferometry.” *In* William C. Danchi, Françoise Delplancke, and Jayadev K. Rajagopal (Editors), *Optical and Infrared Interferometry II*, volume 7734, p. 77344D (SPIE, 2010).
- Fabien Baron, John D. Monnier, and **B. Kloppenborg**. “A novel image reconstruction software for optical/infrared interferometry.” *In* William C. Danchi, Françoise Delplancke, and Jayadev K. Rajagopal (Editors), *Optical and Infrared Interferometry II*, volume 7734, p. 77342I (SPIE, 2010).

SOFTWARE

- Pavan Yalamanchili, Umar Arshad, Zakiuddin Mohammed, Pradeep Garigipati, Peter Entschew, **B. Kloppenborg**, James Malcolm, and John Melonakos. “ArrayFire - A high performance software library for parallel computing with an easy-to-use API.” (2015). URL <https://github.com/arrayfire/arrayfire>.
- B. Kloppenborg** and F. Baron. “SIMTOI: SIMulation and Modeling Tool for Optical Interferometry.” (2012). URL <https://github.com/bkloppenborg/simtoi>.
- B. Kloppenborg** and F. Baron. “LibOI: The OpenCL Interferometry Library.” (2012). URL <https://github.com/bkloppenborg/liboi>.

ASTRONOMY MAGAZINES

- T. Pearson, **B. Kloppenborg**, and H.B. Eggenstein. “Measuring Star Brightness with a Digital Camera.” *The Classroom Astronomer* pp. 3–7 (2011).
- B. Kloppenborg**, T. Pearson, and H.B. Eggenstein. “Photometry for all in the Digital Age.” *Sky & Telescope* pp. 64–66 (2011).

POSTERS

- Travis Fischer, Michael Crenshaw, Fabien Baron, **B. Kloppenborg**, and Crystal Pope. “Bayesian Model Selection in ‘Big Data’ Spectral Analysis.” *American Astronomical Society* (2015). URL <http://adsabs.harvard.edu/abs/2015AAS...22542208F>.
- Simone Antonucci, ArkadyA. Arkharov, Andrea DiPaola, Teresa Giannini, Makoto Kishimoto, **B. Kloppenborg**, ValeriM. Larionov, Gianluca LiCausi, Dario Lorenzetti, and Fabrizio Vitali. “EXOR-CISM: EXOR optiCal Infrared Systematic Monitoring.” *Protostars and Planets VI* (2013). URL <http://adsabs.harvard.edu/abs/2013prpl.conf2B055A>.
- J. Parks, R.J. White, P. Plavchan, J.D. Monnier, F. Baron, G.W. Henry, **B. Kloppenborg**, X. Che, G. Schaefer, M. Zhao, J. Jones, E. Pedretti, N. Thureau, T. TenBrummelaar, C.D. Farrington, H.A. McAlister, J. Sturmann, L. Sturmann, N.H. Turner, and S.T. Ridgway. “Stellar Rotation and Proto-Planetary Disks: What Interferometric Imaging and High Cadence Photometry Can Tell Us.” *American Astronomical Society* (2013).
- B. Kloppenborg**, P. Hemenway, E. Jensen, W. Osborn, and R. Stencel. “Towards A Full Orbital Solution For Epsilon Aurigae.” *In American Astronomical Society Meeting Abstracts #218*, p. 230.05 (2011).
- R. Stencel, **B. Kloppenborg**, M. Sitko, J. Rayner, and A. Tokunaga. “Discovery Of Strong Helium 10830A Absorption In The Mid-eclipse Disk Of Epsilon Aurigae.” *In American Astronomical Society Meeting Abstracts #218*, p. 225.04 (2011).
- B. Kloppenborg**, A. Price, R. Turner, A. Henden, and R. Stencel. “Collaborative Research Efforts For Citizen Scientists.” *In American Astronomical Society Meeting Abstracts #218*, p. 126.12 (2011).
- A. Price, G. Billings, B. Gary, **B. Kloppenborg**, and A. Henden. “High Speed UBV Photometry Of Epsilon Aurigae’s 2009-2011 Eclipse.” *In American Astronomical Society Meeting Abstracts #218*, p. 126.03 (2011).
- R. E. Stencel, **B. Kloppenborg**, R. Wall, S. Howell, D. Hoard, J. Rayner, S. Bus, A. Tokunaga, M. Sitko, R. Russell, D. Lynch, S. Brafford, H. Hammel, B. Whitney, G. Orton, P. Yanamandra-Fisher, J. Hora, W. Hoffman, and A. Skemer. “Infrared Studies of Epsilon Aurigae in Eclipse 2010.” *In American Astronomical Society Meeting Abstracts #217*, volume 43 of *Bulletin of the American Astronomical Society*, p. 257.09 (2011).

- B. Kloppenborg**, R. Stencel, J. D. Monnier, G. Schaefer, M. Zhao, F. Baron, H. McAlister, T. ten Brummelaar, X. Che, C. Farrington, E. Pedretti, P. Sallave-Goldfinger, J. Sturmann, L. Sturmann, N. Thureau, N. Turner, and S. Carroll. “Interferometric Images Of The Transiting Disk In The Epsilon Aurigae System.” *In American Astronomical Society Meeting Abstracts*, volume 217 of *American Astronomical Society Meeting Abstracts*, p. 257.03 (2011).
- B. Kloppenborg**, R. E. Stencel, A. Price, R. Turner, and A. Henden. “Development of DSLR Photometry as an Example of a Citizen Sky Team.” *In American Astronomical Society Meeting Abstracts*, volume 217 of *American Astronomical Society Meeting Abstracts*, p. 158.12 (2011).
- J. Clover, B. V. Jackson, A. Buffington, P. P. Hick, **B. Kloppenborg**, and R. Stencel. “Analysis of Epsilon Aurigae light curve from the Solar Mass Ejection Imager.” *In American Astronomical Society Meeting Abstracts*, volume 217 of *American Astronomical Society Meeting Abstracts*, p. 257.02 (2011).
- R. Turner, A. Price, A. Henden, R. Stencel, and **B. Kloppenborg**. “Citizen Sky, An Update on the AAVSO’s New Citizen Science Project.” *In American Astronomical Society Meeting Abstracts*, volume 217 of *American Astronomical Society Meeting Abstracts*, p. 158.11 (2011).
- R. Turner, A. Price, **B. Kloppenborg**, and A. Henden. “Citizen Sky, Solving the Mystery of epsilon Aurigae.” *In Bulletin of the American Astronomical Society*, volume 41 of *Bulletin of the American Astronomical Society*, p. 509 (2010).
- B. Kloppenborg**, R. E. Stencel, and J. L. Hopkins. “Epsilon Aurigae - Two-year Totality Transpiring.” *In Bulletin of the American Astronomical Society*, volume 41 of *Bulletin of the American Astronomical Society*, p. 282 (2010).

SPECIAL SESSION TALKS

- B. Kloppenborg**. “Interferometric results from the epsilon Aurigae eclipse: Its more than just images!” *In AAS topical meetings: Giants of Eclipse*, volume 45 (2013).
- B. Kloppenborg**. “Spots, Eclipses, and Pulsation: The Interplay of Photometry and Optical Interferometric Imaging.” *In American Astronomical Society Meeting Abstracts #218*, p. 114.03 (2011).
- B. Kloppenborg**. “Summary and the Future of Studies of Epsilon Aurigae.” *In American Astronomical Society Meeting Abstracts*, volume 217 of *American Astronomical Society Meeting Abstracts*, p. 224.06 (2011).

OTHER PRESENTATIONS OR TALKS

Max-Planck-Institut für Radioastronomie Group Talks Bonn, Germany, 2012-2013

Epsilon Aurigae: the non-interferometry story,
A tour of optical interferometers in the United States,
Bayesian and frequentist statistics,
Minimization engines

Practical imaging with optical interferometers workshop Ann Arbor, MI 2012

How to identify artifacts in your reconstruction: method and examples,
Imaging the transiting disk in the Epsilon Aurigae system

Max-Planck-Institut für Radioastronomie colloquia Bonn, Germany, 2012

Optical Interferometric image reconstruction and it’s application to epsilon Aurigae

Citizen Sky “Astro April“ talks Online, 2012

Writing a dissertation about epsilon Aurigae and experience with Citizen Sky

University of Denver colloquia Denver, CO 2008-2012

Interferometric, Astrometric, and Photometric studies of epsilon Aurigae: Seeing the disk around a distant star,
Towards solving the mystery of epsilon Aurigae,
Challenges Related to Interferometric Imaging,
Computationally Intensive Astrophysics,
Interferometry and its Application to the Study of ϵ Aurigae

Citizen Sky Conference 2. San Francisco, CA 2010

The Evolutionary Status of Epsilon Aurigae
Using ADS and SIMBAD
An update from the DSLR photometry team

Citizen Sky Conference. Chicago, IL 2009

Circumstellar Disks and their application to Epsilon Aurigae

116th Annual Nebraska Academy of Sciences. Lincoln, NE 2006

The Design, Construction, and implementation of a Radio Telescope to study Neutral Hydrogen Spectral Emissions

Hastings College Academic Showcase Day. Hastings, NE, 2006

Construction of a Radio Telescope and its Application in the Study of Extraterrestrial Hydrogen

Hastings College Computer Science Colloquium. Hastings, NE, 2006

SpectraCyber Control Software

Platte Valley Astronomical Observers Hastings, NE, 2006, 2010

A Homemade Radio Telescope to Study Neutral Hydrogen,
Epsilon Aurigae: A journey through 20th century astrophysics

RESEARCH EXPERIENCE

Research Scientist II Georgia Tech Research Institute; Atlanta, GA, Sept. 2016 - present

Research Topics: Radar Tracking Methodologies; Fog Computing **Certificates:** Target Tracking in Sensor Systems (GTRI DEF 3520P) **Software Development:** Custom Conversion of MatLab to C++, individual tracking using computer vision techniques

Research Scientist ArrayFire; Atlanta, GA, Sept. 2014 - Sept. 2016

Research topics: High performance computing (HPC) with application to cybersecurity, graph analytics, physics, and image processing; HPC benchmarking; GPU-accelerated graph analytics; Real-time situational awareness software for 10 GbE computer networks; **Training Content Development:** OpenCL for Xilinx FPGAs (exclusive contract with Xilinx), CUDA for NVIDIA GPUs, OpenCL for AMD, Intel, and NVIDIA GPUs **Software development:** Contributions to ArrayFire (HPC library) and Celero (benchmarking library). **Administration:** Executive board member, grant administrator

Sponsored Funded Professional - Research Associate Georgia State University; Atlanta, GA, Nov. 2013 - Sept. 2014

Research topics: Interferometry of YSOs (Herbig, T Tauri), eruptive YSO variables (FUor, EXor, and UXor), and Novae (2013 Del, 2013 Cen)
Software development: GPU computing library for optical interferometry, *liboi*. 3D, time-dependent, geometrical modeling for optical interferometry, *SIMTOI*.

Postdoctoral fellow Max-Planck-Institut für Radioastronomie; Bonn, Germany, Jul. 2012 - Sept. 2013

Research topics: Interferometry of YSOs (Herbig, T Tauri) and eruptive YSO variables (FUor, EXor, and UXor).
Software development: GPU computing library for optical interferometry, *liboi*. 3D, time-dependent, geometrical modeling for optical interferometry, *SIMTOI*.

Research Assistant University of Denver, Denver, CO, 2008-2009

Research topics: epsilon Aurigae (interferometric imaging/modeling, NIR spectroscopy, *UBVR_IJH* photometry). Proposals or support for MOST, Spitzer, SOFIA, WYRO, Hubble, Hershel space telescope, and several ground observatories.

Software development: Telescope control system for DU's rooftop telescope. Control software for the Optec SSP-4 J/H-band photometer.

Notable items: A total of 9 months of high altitude (14,128 ft, 4306 m) observing experience.

Undergraduate research Hastings College, Hastings, NE, 2006

Senior project: *The Design, Construction, and implementation of a Radio Telescope to study Neutral Hydrogen Spectral Emissions*

Software development: A new control suite for the SpectraCyber, a 21-cm radio spectrometer.

EDUCATION AND PUBLIC OUTREACH

Citizen Sky American Association of Variable Star Observers. Cambridge, MA, 2010-2012

An NSF ISE project to teach the public how to conduct variable star observations, reduce their own data, and publish in a peer-reviewed scientific journal

Tasks: Professional liaison to several teams, DSLR photometry team leader, and regular blogging about professional research activities

Accomplishments: Development of DSLR photometry tutorials

Assistant to the Curator of Astronomy Hastings Museum. Hastings, NE, 2005-2007

Tasks: Presented twice-daily one-hour tours of *The Sky Tonight* to the public along with automated shows. Several presentations for elementary school classes (mostly pre-recorded with 5-10 minute live session).

Observatory Assistant. Hastings College, Hastings, NE, 2004-2007

Tasks: Assisted the director during the two monthly public observing sessions. Guided the public through the constellations and explained basic astrophysical phenomena.

AWARDED OBSERVING TIME

Center for High Angular Resolution Astronomy (CHARA) Array

PI: *Investigation of tidal effects of zet Aur after periastron.* MIRC; 2 nights. 2015

PI: *Unveiling the inner structure of EXor eruptive variables* CLIMB; 4 nights. 2013

Co-I: *Interferometric and Doppler imaging of Cr II spots on eps UMa and a survey of stars with surface features.* MIRC, CLIMB, and VEGA; 5 nights. 2011

PI: *Egress observations of Epsilon Aurigae, Post eclipse calibration of epsilon Aurigae, and Co-I: Imaging the Disk During Epsilon Aurigae's First Eclipse of the Millennium.* MIRC; 24 nights. 2009, 2010, 2011

Very Large Telescope Interferometer (VLTI)

PI: *A study of the geometry and kinematics of the rapidly expanding ejecta of Nova Cen 2013 with VLTI-AMBER* Director's Discretionary Time. 4x 2hr, 3x 1.5 hr, 2013.

Co-I: *Unveiling the structure of EXor sources: VLTI observations of EX Lup.* AMBER and MIDI; 3.5 nights. 2011

NASA Infrared Telescope Facility (IRTF)

Co-I: *Transient 2 & 4 micron CO in the Spectrum of the Epsilon Aurigae Disk during Eclipse.* 5 x 2 hr. 2009, 2010, 2011

Meyer-Womble Observatory **Co-I:** *JH Photometry of Epsilon Aurigae* 2008, 2009, 2010

Palomar Testbed Interferometer (PTI)

Co-I: *Pulsation and Eclipse of Epsilon Aurigae* 2008, 2009

TEACHING EXPERIENCE

Adjunct Professor. Georgia State University 2015 - present

Research and Teaching Assistant. University of Denver, 2007-2008

Tasks: Taught five sections of University Physics labs (electricity, magnetism, circuit, Newtonian mechanics, thermodynamics) over one year. **Awards:** AAPT Outstanding Teaching Assistant Award

Volunteer Hastings Literacy Foundation, 2005

Tutor for the GED program in the topics of science and mathematics.

Laboratory Assistant. Hastings College, 2003

Provided assistance to the instructor of the *Introduction to the Night Sky* astronomy course.

OTHER WORK EXPERIENCE

Personal Computer Technician, Mary Lanning Memorial Hospital. Hastings, NE, 2006-2007

Tasks: Provide in-house support for 1200 personal workstations and 200 servers primarily running Microsoft Windows.

Freelance computer consultant, Hastings, NE 2003-2007

Tasks: Performed installations of networks (LAN/WLAN), servers, and software. Web-based application development and website design. Stand-alone application development.

Technician and acting station manager, Hastings Public Access Corporation. Hastings, NE 2002-2007

Tasks: Managed all station operating tasks; trained new employees; produced and recorded City Council, City Planning, and Public School board meetings; programming and queuing daily programming; creation of promotional videos; installation of hardware; maintaining community bulletin board.

COMPUTER SKILLS

Operating Systems: Linux (Ubuntu, SuSE, RedHat), Microsoft Windows (3.11 - Vista, Server 2000 and 2003), DOS

Programming Languages: C, C++, C#, IDL, Visual Basic, minor experience with FORTRAN

Scripting Languages: ASP, Javascript, Perl, PHP, Python

Parallel Processing: OpenCL (ATI, NVidia, Intel via. Beignet), CUDA, MPI

Databases: SQL supporting databases (MySQL, Microsoft SQL Server, Microsoft Access, etc.)

HONORS AND AWARDS

2009 - 2011 Citizen Sky Graduate Student Funding (\$17,500), Citizen Sky / NSF

2008 William Herschel Womble Graduate Research Fellowship (\$45,000), University of Denver

2007 American Association of Physics Teachers Outstanding Teaching Assistant Award (\$100), University of Denver

2004 - 2006 Deans List for Academic Excellence, Hastings College

2006 Sachtleben Honors Scholarship (\$500), Hastings College

2005 Madgett Physics Scholarship (\$), Hastings College

2003 Harry R. James Physics Award (\$), Hastings College

2003 -2004 Artist Lecture Series Student Symposium Subcommittee Treasurer

2002 Ronald E. Talcott Scholarship (\$1,000), Hastings Senior High School