

# Dr. Brian Kloppenborg

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## EDUCATION

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**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

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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 Maestro, 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).

**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  $\epsilon$  Aurigae prior to and during the 2009-2011 eclipse.” *a* **530**, A146+ (2011). [1105.0107](https://arxiv.org/abs/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. Sturmann, L. Sturmann, N. Thureau, N. Turner, and S. M. Carroll. “Infrared images of the transiting disk in the  $\epsilon$  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  $\epsilon$  Aurigae: Pre-Eclipse Observations.” *APJL* **689**, L137–L140 (2008). [0810.5382](https://arxiv.org/abs/0810.5382).

## PROCEEDINGS

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- 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

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- 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

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- 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

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- 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 10830Å 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 its 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  $\epsilon$  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*

## AWARDED OBSERVING TIME

**Center for High Angular Resolution Astronomy (CHARA) Array** 2008 - 2014

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

**Very Large Telescope Interferometer (VLTI)** 2011

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

**NASA Infrared Telescope Facility (IRTF)** 2009, 2010, 2011

Co-Investigator: *Transient 2 & 4 micron CO in the Spectrum of the Epsilon Aurigae Disk during Eclipse*. 1.2 nights (total)

**Meyer-Womble Observatory** 2008-2010

Co-Investigator *JH Photometry of Epsilon Aurigae*

**Palomar Testbed Interferometer (PTI)** 2008-2009

Co-Investigator: *Pulsation and Eclipse of Epsilon Aurigae*

## RESEARCH EXPERIENCE

**Research Scientist** ArrayFire; Atlanta, GA, Sept. 2014 - present

**Research topics:** High performance computing (HPC) with application to image processing and physics problems. HPC benchmarking. **Software development:** Contributions to ArrayFire (HPC library) and Celero (benchmarking library)

**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<sub>I</sub>JH* 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.

## TEACHING EXPERIENCE

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**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

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**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

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**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

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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