ZACHARIAH (ZACH) B. ETIENNE

Assistant Professor of Mathematics, West Virginia University

Department of Mathematics
West Virginia University
Morgantown, WV 26506

zbetienne@mail.wvu.edu
(304) 293-8515
http://math.wvu.edu/~zetienne/

Employment

2014–	Assistant Professor of Mathematics, West Virginia University
2013–2014	Joint Space–Science Institute Prize Postdoctoral Fellow, NASA Goddard Space Flight Center & University of Maryland
2010–2013	NSF Astronomy & Astrophysics Postdoctoral Fellow, University of Illinois
2009–2010	Postdoctoral Research Associate, University of Illinois Numerical Relativity Group

Education

2003–2009	University of Illinois — Ph.D. Physics Stuart L. Shapiro, Ph.D. thesis advisor
1999–2003	Indiana University — B.S. Physics, *Honors College Degree certification* Steven Gottlieb, senior thesis advisor
1999–2003	Indiana University — B.S. Mathematics
1999–2003	Indiana University — Minor Astronomy

Grants

2016–2018	Principal Investigator, *Speeding Up the Spinning, Precessing Effective One–Body–Numerical Relativity (SEOBNRv3) Code by ∼10,000x*, NSF LIGO Research Support Solicitation, **$99,020**
2015–2020	Funded Collaborator, *Waves of the Future: Capacity Building for the Rising Tide of STEM in West Virginia*, NSF Experimental Program to Stimulate Competitive Research (EPSCoR), **$9,668,382**.
2015–2018	Co-Investigator, *Prompt Electromagnetic Signatures of Merging Black Holes*, NASA-Astrophysics Science Division 13-ATP13-0077, **$439,788**.
2010–2013	Principal Investigator, *General Relativistic, Radiative Magnetohydrodynamic Simulations of Compact Binary Mergers*, NSF AST-1002667, **$249,000**.

Awards, Honors, & Fellowships

2016	Presidential Award for Excellence in Collaborative Research (West Virginia University)
2013–2014	Joint Space–Science Institute Prize Postdoctoral Fellow (NASA Goddard Space Flight Center and University of Maryland)
2010–2013	NSF Astronomy & Astrophysics Postdoctoral Fellowship
2007, 2009	APS April Meeting Travel Grant Awards, Topical Group on Gravitation
2003–2004	University of Illinois at Urbana-Champaign Distinguished Graduate Fellowship
2003–	Sigma Pi Sigma (the physics honor society)
2003	Indiana University Honors College Grant for Senior Undergraduate Thesis
2003	Indiana University Graduate School Grant for Senior Undergraduate Thesis
1999–2003	Indiana University Faculty Scholarship
1999–2003	Indiana University Honors College Scholarship
2001, 2002	REU Student, University of Michigan
1999–2000	General Electric STAR Award

Major Collaborations

2015–	LIGO Scientific Collaboration Senior Member
2010–2013	Numerical Relativity & Analytical Relativity (NRAR), University of Illinois *liason*
2010–2014	Numerical INJection Analysis 2 (NINJA-2), University of Illinois *liason*
2008–2009	Numerical INJection Analysis (NINJA), University of Illinois *liason*

Research Experience

- Compact binary inspirals & mergers: Simulations in fully dynamical spacetimes
  - Black hole–neutron star (Past work: **Pubs. 11, 12, 16, 17, 20, 25, & 27** in **Publications** section below.)
  - White dwarf–neutron star (**Pubs. 18 & 19**); planned follow-up: pulsar planet formation scenarios.
  - Black hole–black hole (**Pubs. 6, 8, 9, 10, 14, 15, 17, 20, 22, 23, & 28**).
  - Neutron star–neutron star (**Pubs. 13 & 26**).
- Black hole accretion (**Pubs. 5, 7, 12, 14, 16, 17, 20, 25, 27, & 29**)
- New techniques for performing compact object and compact binary simulations (**Pubs. 4, 6, 17, 20, 21, 24, 28, 29, & 30**)
- Gravitational wave astrophysics & data analysis (**Pubs. 1, 2 & 3**)

Teaching

2015 & 2016	MATH 521, *Numerical Analysis*, 3 credit hours.
Spring 2016	MATH 156, *Calculus 2*, 4 credit hours
2015 & 2016	MATH 522, *Numerical Solutions of Partial Differential Equations*, 3 credit hours.
Fall 2014	MATH 261, *Elementary Differential Equations*, 4 credit hours.

Mentoring

2016–2017	Graduate advisor to five students (one M.S., four Ph.D.); Capstone advisor to two students (senior thesis project).
2015–2016	Graduate advisor to three students (two M.S.); Capstone advisor to three students (senior thesis project).
2014–2015	Graduate advisor to two students (one M.S., and one Ph.D.); Capstone advisor to one student (senior thesis project).
2008–2013	Mentor to six undergraduate students who generate stunning, freely-available visualizations of my simulation data. See, e.g., `http://tinyurl.com/mentormovies`.
2004–2013	Annual guest lecturer to five underserved high schools in southern Indiana, introducing students to Einstein's theories of relativity and science as a career. With no major research institutions nearby, most students had never interacted or communicated with a professional scientist before attending these lectures.
2008–2012	Mentor to two graduate students, helping them to understand, use, and extend the Illinois Numerical Relativity code to do new science. They have made great progress. See, e.g., Farris *et al.* Phys. Rev. D, 84, 024024/1-21 (2011) and **Pub. 14** in the **Publications** section above.

Service

2016–2017	Co-Organizer, *Celebrating Einstein* Event
2016	"Cool Talk" guest lecture for West Virginia Health Science and Technology Academy
2015–	WVU HPC (High Performance Computing) Faculty Steering Committee
2015–	NSF grant proposal review panelist
2015–	NASA grant proposal review panelist
2015–	West Virginia Children's Discovery Museum volunteer
2014–	Referee for *Physical Review D*
2015	Public lecture at the Chinese Mid-Autumn Research Symposium

Publications

Prefix denotes number of citations (***: 1–5, **: 6–13, ***: 14–49, ****: 50–119, *****: 120+**)

- Articles in Refereed Professional Journals:

1. ***Abbott et al. (the LIGO Scientific and Virgo Collaborations) *Improved Analysis of GW150914 Using a Fully Spin-Precessing Waveform Model.* Phys. Rev. X 6, 041014 (**2016**).
2. *****Abbott et al. (the LIGO Scientific and Virgo Collaborations) *Properties of the Binary Black Hole Merger GW150914.* Phys. Rev. Lett. 116, 241102 (**2016**).
3. *C. Devine, **Z. B. Etienne**, S. T. McWilliams. *Optimizing spinning time-domain gravitational waveforms for Advanced LIGO data analysis.* Class. Quantum Grav., 33, 125025/1-15 (**2016**).
4. ****Z. B. Etienne**, V. Paschalidis, R. Haas, P. Moesta, and S. L. Shapiro. *IllinoisGRMHD: An Open-Source, User-Friendly GRMHD Code for Dynamical Spacetimes.* Class. Quantum Grav., 32, 175009/1-33 (**2015**).
5. **R. Gold, V. Paschalidis, **Z. B. Etienne**, and S. L. Shapiro. *Accretion disks around binary black holes of unequal mass: GRMHD simulations of postdecoupling and merger.* Phys. Rev. D, 90, 104030/1-15 (**2014**).
6. ***Z. B. Etienne**, J. G. Baker, V. Paschalidis, B. J. Kelly, and S. L. Shapiro. *Improved Moving Puncture Gauge Conditions for Compact Binary Evolutions.* Phys. Rev. D 90, 064032/1-25 (**2014**).
7. ***R. Gold, V. Paschalidis, **Z. B. Etienne**, and S. L. Shapiro. *Accretion disks around binary black holes of unequal mass: GRMHD simulations near decoupling.* Phys. Rev. D, 89, 064600/1-28 (**2014**).
8. ***Aasi et al. (the NINJA-2, LIGO, and VIRGO Collaborations). *The NINJA-2 project: Detecting and characterizing gravitational waveforms modelled using numerical binary black hole simulations.* Class. Quantum Grav., 31, 115004/1-52 (**2014**).
9. ****I. Hinder, A. Buonanno, M. Boyle, **Z. B. Etienne**, J. Healy, et al. (the NRAR Collaboration). *Error-analysis and comparison to analytical models of numerical waveforms produced by the NRAR Collaboration.* Class. Quantum Grav., 31, 025012/1-47 (**2013**).
10. **Ajith et al. (the NINJA-2 Collaboration). *Addendum to "The NINJA-2 catalog of hybrid post-Newtonian/numerical-relativity waveforms for non-precessing black-hole binaries".* Class. Quantum Grav., 30, 199401/1-2 (**2013**).
11. ***V. Paschalidis, **Z. B. Etienne**, and S. L. Shapiro. *General relativistic simulations of binary black hole-neutron stars: Precursor electromagnetic signals.* Phys. Rev. D, 88, 021504(R)/1-6 (**2013**).
12. *****Z. B. Etienne**, V. Paschalidis, and S. L. Shapiro. *General relativistic simulations of black hole-neutron star mergers: Effects of tilted magnetic fields.* Phys. Rev. D, 86, 084026/1-6 (**2012**).
13. ***V. Paschalidis, **Z. B. Etienne**, and S. L. Shapiro. *Importance of cooling in triggering the collapse of hypermassive neutron stars.* Phys. Rev. D, 86, 064032/1-13 (**2012**).
14. ***B. D. Farris, R. Gold, V. Paschalidis, **Z. B. Etienne**, and S. L. Shapiro. *Binary black hole mergers in magnetized disks: simulations in full general relativity.* Phys. Rev. Lett., 109, 221102/1-5 (**2012**).
15. ****Ajith et al. (the NINJA-2 Collaboration). *The NINJA-2 catalog of hybrid post-Newtonian/numerical-relativity waveforms for non-precessing black-hole binaries* Class. Quantum Grav., 29, 124001/1-27 (**2012**),
16. *****Z. B. Etienne**, Y. T. Liu, V. Paschalidis, and S. L. Shapiro *General Relativistic Simulations of Black Hole-Neutron Star Mergers: Effects of magnetic fields.* Phys. Rev. D, 85, 064029/1-30 (**2012**).
17. *****Z. B. Etienne**, V. Paschalidis, Y. T. Liu, and S. L. Shapiro *Relativistic magnetohydrodynamics in dynamical spacetimes: Improved electromagnetic gauge condition for adaptive mesh refinement grids.* Phys. Rev. D, 85, 024013/1-10 (**2012**).
18. ***V. Paschalidis, **Z. B. Etienne**, Y. T. Liu, and S. L. Shapiro *Merger of binary white dwarf–neutron stars: Simulations in full general relativity.* Phys. Rev. D, 84, 104032/1-24 (**2011**).
19. ***V. Paschalidis, **Z. B. Etienne**, Y. T. Liu, and S. L. Shapiro *Head-on collisions of binary white dwarf–neutron stars: Simulations in full general relativity.* Phys. Rev. D, 83, 064002/1-23 (**2011**).
20. *****Z. B. Etienne**, Y. T. Liu, and S. L. Shapiro *Relativistic magnetohydrodynamics in dynamical spacetimes: A new adaptive mesh refinement implementation.* Phys. Rev. D, 82, 084031/1-21 (**2010**).

21. **Y. T. Liu, **Z. B. Etienne**, and S. L. Shapiro *Evolution of near-extremal-spin black holes using the moving puncture technique.* Phys. Rev. D, 80, 121503/1-5 (**2009**).
22. ****Aylott et al. (the NINJA Collaboration). *Testing gravitational-wave searches with numerical relativity waveforms: Results from the first Numerical INJection Analysis (NINJA) project.* Class. Quantum Grav., 26, 165008/1-51 (**2009**).
23. ***Cadonati et al. (the NINJA Collaboration). *Status of NINJA: the Numerical INJection Analysis project.* Class. Quantum Grav., 26, 114008/1-13 (**2009**).
24. *T. W. Baumgarte, **Z. B. Etienne**, Y. T. Liu, K. Matera, N. Ó. Murchadha, S. L. Shapiro, & K. Taniguchi. *Equilibrium initial data for moving puncture simulations: the stationary 1 + log slicing.* Class. Quantum Grav., 26, 085007/1-17 (**2009**).
25. ****Z. B. Etienne**, Y. T. Liu, S. L. Shapiro and T. W. Baumgarte. *Relativistic simulations of black hole-neutron star mergers: Effects of black hole spin.* Phys. Rev. D, 79, 044024/1-26 (**2009**).
26. ****Y. T. Liu, S. L. Shapiro, **Z. B. Etienne** and K. Taniguchi. *General relativistic simulations of magnetized binary neutron stars.* Phys. Rev. D, 78, 024012/1-20 (**2008**).
27. ****Z. B. Etienne**, J. A. Faber, Y. T. Liu, S. L. Shapiro, T. W. Baumgarte, and K. Taniguchi. *Fully general relativistic simulations of black hole-neutron star mergers.* Phys. Rev. D, 77, 084002/1-22 (**2008**).
28. ****Z. B. Etienne**, J. A. Faber, Y. T. Liu, S. L. Shapiro, and T. W. Baumgarte. *Filling the holes: Evolving excised binary black hole initial data with puncture techniques.* Phys. Rev. D, 76, 101503/1-5 (**2007**).
29. ***J. A. Faber, T. W. Baumgarte, **Z. B. Etienne**, S. L. Shapiro, and K. Taniguchi. *Relativistic hydrodynamics in the presence of puncture black holes.* Phys. Rev. D, 76, 104021/1-21 (**2007**).
30. ***Z. B. Etienne**, Y. T. Liu, and S. L. Shapiro. *General Relativistic Simulations of Slowly and Differentially Rotating Magnetized Neutron Stars.* Phys. Rev. D, 74, 044030/1-21 (**2006**).
31. ***V. S. Morozov, **Z. B. Etienne**, M.C. Kandes, A. D. Krisch, M. A. Leonova, D. W. Sivers, V. K. Wong, K. Yonehara, V. A. Anferov, H. O. Meyer, P. Schwandt, E. J. Stephenson, & B. von Przewoski. *First Spin Flipping of a Stored Spin-1 Polarized Beam.* Phys. Rev. Lett., 91, 214801/1-4 (**2003**).
32. *B. V. Przewoski, V. A. Anferov, H. O. Meyer, P. Schwandt, E. J. Stephenson, V. S. Morozov, **Z. B. Etienne**, M. C. Kandes, M. A. Leonova, D. W. Sivers, & K. Yonehara. *Vector and tensor polarization lifetimes for a stored deuteron beam.* Phys. Rev. E, 68, 046501 (**2003**).
33. ***B. B. Blinov, **Z. B. Etienne**, A. D. Krisch, M. A. Leonova, W. Lorenzon, V. S. Morozov, C. C. Peters, V. K. Wong, K. Yonehara, V. A. Anferov, P. Schwandt, E. J. Stephenson, B. von Przewoski, & H. Sato. *99.6% Spin-Flip Efficiency in the Presence of a Strong Siberian Snake.* Phys. Rev. Lett., 88, 014801/1-4 (**2001**).

- Chapters in Professional Books:
  - **Z. B. Etienne**, V. Paschalidis, and S. L. Shapiro. *Advanced Models of Black Hole–Neutron Star Binaries and Their Astrophysical Impact*, in C. F. Sopuerta (Ed.), *Gravitational Wave Astrophysics: Proceedings of the Third Session of the Sant Cugat Forum on Astrophysics*, Vol 40, pp 59–74 (**2014**). Springer.
- Other: Papers in Conference Proceedings:
  - **Z. B. Etienne**, Y. T. Liu, V. Paschalidis, and S. L. Shapiro. *Numerical Relativity Simulations of Magnetized Black Hole-Neutron Star Mergers*, in R. T. Jantzen, K. Rosquist, R. Ruffini (Eds.) *Proceedings of the 13th Marcel Grossmann Meeting* (**2015**). World Scientific, Singapore. Not refereed.

Distinguished Talks

2016 *SENR: A Super-Efficient Numerical Relativity Code for the Age of Gravitational Wave Astronomy*

- Selected Talk, 2016 Joint Space–Science Institute Workshop: "Astrophysics in the Era of Gravitational Wave and Multimessenger Observations".

2015 *An Overview of IllinoisGRMHD*

- Invited Talk, 2015 Einstein Toolkit Workshop.

Numerical Relativity's Contribution to Theoretical Astrophysics, and Its Path Forward

- Invited Talk, 2015 American Physical Society April Meeting.
- Colloquium, National Radio Astronomy Observatory, Green Bank, WV.
- Invited Talk, 2015 American Physical Society Mid-Atlantic Section Meeting.

GRMHD modeling of the most luminous outbursts in the Universe

- Invited Talk, University of Trento.

West Virginia University LSC New Senior Member Application Presentation

- Invited Talk, 2015 LIGO Scientific Collaboration Pasadena Meeting.

2014 *A Man, a Plan, a Code, a New Technique (or Two), ... Panama?*

- Invited Talk, Rochester Institute of Technology Center for Computational Relativity and Gravitation.

Modeling of Black Hole–Neutron Star Systems and Their Astrophysical Impact

- Plenary Talk, Sant Cugat Forum on Astrophysics, Sant Cugat, Barcelona, Spain

Throwing in the Kitchen Sink: Adding Mixed-Type PDEs to Better Solve Einstein's Equations

- Invited Talk, Applied Analysis Seminar, West Virginia University Department of Mathematics.

2013 *Can Black Hole–Neutron Star Binary Mergers Produce Gamma-Ray Bursts?*

- Invited Talk, Joint Space–Science Institute Mini-Symposium, University of Maryland.
- Seminar, Theoretical AstroPhysics Including Relativity and Cosmology (TAPIR), California Institute of Technology.
- Seminar, General Relativity Theory Seminar, University of Maryland.
- Colloquium, Shanghai–Jiaotong University Center for Astrophysics, Shanghai, China.
- Colloquium, Shanghai Astronomical Observatory, Shanghai, China.
- Seminar, Center for Gravitation, Cosmology & Astrophysics Seminar, University of Wisconsin–Milwaukee
- Colloquium, Computational Data Mining and Analysis Center, Virginia Tech

2013 *Solving the Einstein–Maxwell Equations to Model the Most Energetic Outbursts in the Universe*

- Colloquium, Department of Mathematics, West Virginia University

2012 *Simulations of Magnetized Neutron Star–Black Hole Binaries in Full General Relativity*

- Invited Talk, 13th Marcel Grossmann Meeting, Stockholm, Sweden.
- Selected Talk, KITP Conference: Rattle and Shine: Gravitational Wave and Electromagnetic Studies of Compact Binary Mergers, Santa Barbara, California.

2011 *Numerical Simulations of Binary Systems with Matter Companions.*

- Invited Talk, 2011 APS April Meeting, Anaheim, California.

2010 *Fully General Relativistic Simulations of Black Hole-Neutron Star Mergers: A Current Overview.*

- Invited Talk, Numerical Relativity Data Analysis (NRDA) Conference, Perimeter Institute, Waterloo, Ontario.
- Seminar, Peking University, National Observatory, and Institute of High Energy Physics Joint Seminar, Beijing, China.
- Colloquium, Shanghai Astronomical Observatory, Shanghai, China.

2009 *Simulations of Black Hole-Neutron Star Binary Mergers: Gravitational Waves and Gamma-Ray Bursts.*

- Seminar, Center for Gravitation & Cosmology, University of Wisconsin-Milwaukee.