

Greg A. Riggs

CONTACT INFORMATION

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EDUCATION

West Virginia University, Morgantown, WV

Ph.D., Physics, December 2024

Thesis: Experimental verification and time-resolved bispectral analysis of nonlinear coupling in the toroidicity-induced Alfvén eigenmode (TAE) spectrum

Advisor: *Prof. Mark E. Koepke*

M.S., Physics, May 2020

Thesis: Interpretations of Bicoherence in Space & Lab Plasma Dynamics

Advisor: *Prof. Mark E. Koepke*

B.S., Physics, August 2017

Capstone: Vibrational Modes of a Square Membrane

RECOGNITION

Research Trust Fund Seehra Research Award (April 2021, 2024)

Sherwood Fusion Theory Student Poster Award (May 2023)

ITPA EP topical group expert member (March 2024)

Featured Article in *Physics of Plasmas* (April 2024)

FELLOWSHIP

Oleg D. and Valentina P. Jefimenko Physics Fellowship

Fall 2023–Spring 2024

WORK EXPERIENCE

Demo coordinator, Dept. of Physics & Astronomy

Fall 2024–Present

West Virginia University

Supervisor: *Prof. Paul Miller*

- Managed construction and implementation of approximately three dozen unique demonstrations for introductory physics lectures.
- Supervised application of physics demonstrations in outreach events.

Research Assistant, Dept. of Physics & Astronomy

Summer 2019–Summer 2024

West Virginia University

Advisor: *Prof. Mark E. Koepke*

◦ **Quantification of nonlinear coupling between toroidicity-induced Alfvén eigenmodes (TAE) in DIII-D tokamak**

March 2021–July 2024

- Participated in planning and execution of experimental run-day.
- Characterized nonlinear interactions involving two TAE and low-frequency (~ 20 kHz) magnetohydrodynamic (MHD) mode via wavelet-based bicoherence analysis of poloidal magnetic fluctuations; uncertainty quantified via statistical method appropriate for nonstationary time series.
- Evaluated toroidal and poloidal modenumbers and radial localization of participating fluctuations using inductive probe array, interferometry, and beam-emission spectroscopy (BES).
- Conducted global simulations of tokamak with benchmarked gyro-Landau-fluid code (FAR3d) on NERSC Perlmutter supercomputer.
- Developed open-source, object-oriented packages in MATLAB and Python for polyspectral analysis of scalar and multidimensional data.

- Conceptualized and implemented novel bispectral analysis which captures time-resolved “signature” of non-vanishing bicoherence.
- Demonstrated instantaneous difference frequency $\Delta f = f_1 + f_2 - f_3$ locking during three-wave coupling; discovered dozens of nonlinear interactions with sub-millisecond duration.
- **Investigation of gradient effects in spectroscopic determination of temperature and density in high-energy density (HED) plasma** — *June 2019–May 2023*
 - Performed spectroscopic simulations of NaFMgO plasma using collisional-radiative model (PRISMPECT), some incorporating gradients in space or time. Results compared with data from experiments on the Z-machine at Sandia National Laboratory (SNL).
 - Optimized analysis code to enhance throughput by factor of ~ 300 .
 - Inferred temperature and density of plasma by comparing line-area ratios and line widths, respectively, of experimental spectral features with output of model.
 - Generalized one-dimensional method of temperature determination to enable statistical assessment of best-fit temperature gradient.

Lab Assistant, Dept. of Physics & Astronomy
West Virginia University
Supervisor: *Prof. Mark E. Koepke*

Spring 2018–Fall 2018

- **Bispectral analysis of archived DIII-D data** *February 2018–December 2018*
 - Developed stand-alone application for analysis of bispectral features in time-series.
 - Analyzed magnetic fluctuations of ~ 100 DIII-D discharges to assess likelihood of nonlinear coupling.

TEACHING EXPERIENCE

Instructor, Dept. of Physics & Astronomy
West Virginia University

Summer 2024 – Present

- **Introductory Physics I (PHYS 101)** *August 2024– Present*
 - Exhibited proficiency in teaching (algebra-based) first course on mechanics.
 - Demonstrated effectiveness in lecturing to large number (~ 150) of students.
 - Performed simple experiments and demonstrations to confirm the consistency of physical laws.
 - Assisted in the development, coordination, and proctoring of exams.
- **Introductory Physics II (PHYS 102)** *June 2024–August 2024*
 - Taught first course in (algebra-based) electromagnetism to class of 24 undergraduates.
 - Developed and graded homework problems, quizzes, and exams to assess students’ mastery of physics concepts and applications.

Teaching Assistant, Dept. of Physics & Astronomy
West Virginia University

Spring 2019

- **General Physics I (PHYS 111)** *January 2019–May 2019*
 - Served as instructor in advanced introductory physics laboratory.
 - Led simple experiments to enhance intuition and conceptual understanding.
 - Graded weekly quizzes in addition to midterms and final exams.
 - Assisted coordinating professor with administrative duties when necessary.

JOURNAL PUBLICATIONS	<p>4 TIME-RESOLVED BIPHASE SIGNATURES OF QUADRATIC NONLINEARITY OBSERVED IN COUPLED ALFVÉN EIGENMODES ON THE DIII-D TOKAMAK (Featured Article) (2024) <i>Physics of Plasmas</i>, 31(4), p. 042305 G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong</p>
	<p>3 ROLE OF SIMPLE SPATIAL GRADIENT IN REINFORCING THE ACCURACY OF TEMPERATURE DETERMINATION OF HED PLASMA VIA SPECTRAL LINE-AREA RATIOS (2023) <i>Atoms</i>, 11(7), p. 104 G. Riggs, M. Koepke, T. Lane, T. Steinberger, P. Kozlowski, I. Golovkin</p>
	<p>2 ESTABLISHING AN ISOELECTRONIC LINE RATIO TEMPERATURE DIAGNOSTIC FOR SOFT X-RAY ABSORPTION SPECTROSCOPY (2022) <i>High Energy Density Physics</i>, 45, p. 101019 T. Lane, M. Koepke, P. Kozlowski, G. Riggs, T. Steinberger, I. Golovkin</p>
	<p>1 BISPECTRAL ANALYSIS OF BROADBAND TURBULENCE AND GEODESIC ACOUSTIC MODES IN THE T-10 TOKAMAK (2021) <i>Journal of Plasma Physics</i>, 87(3), p. 885870301 G. Riggs, S. Nogami, M. Koepke, A. Melnikov, L. Eliseev, S. Lysenko, P. Khabanov, M. Drabinskij, N. Kharchev, A. Kozachek, M. Ufimtsev and HIBP Team</p>
MANUSCRIPTS IN PREPARATION	<p>2 INSTANTANEOUS DIFFERENCE-FREQUENCY LOCKING OBSERVED IN COUPLED EIGENMODES ON THE DIII-D TOKAMAK G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong, Y. Ghai</p>
	<p>1 BICAN: AN INTEGRATED, OPEN-SOURCE FRAMEWORK FOR POLYSPECTRAL ANALYSIS G. Riggs, M. Koepke, T. Matheny</p>
ORAL PRESENTATIONS	<p>4 . Time-resolved bispectral signatures of TAE mode-mode coupling observed in the DIII-D tokamak <i>ITPA EP Topical Group Meeting</i> (Oct. 2, 2024) G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong, Y. Ghai</p>
	<p>3 Time-resolved biphasic signatures of quadratic nonlinearity observed in coupled eigenmodes on the DIII-D tokamak <i>KINETIC Center Workshop</i> (Aug. 22, 2024) G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong, Y. Ghai</p>
	<p>2 Time-resolved biphasic signatures of quadratic nonlinearity observed in coupled eigenmodes on the DIII-D tokamak <i>Princeton Plasma Physics Laboratory Energetic Particle Seminars</i> (Nov. 29, 2023) G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong, Y. Ghai</p>
	<p>1 Time-resolved biphasic signatures of quadratic nonlinearity observed in coupled eigenmodes on the DIII-D tokamak <i>DIII-D Energetic Particle Group</i> (Oct. 11, 2023) G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong</p>
	<p>10 Time-resolved biphasic signatures of quadratic nonlinearity observed in coupled eigenmodes on the DIII-D tokamak <i>65th Annual Meeting of the APS Division of Plasma Physics</i> (November 2023) G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong</p>
CONFERENCE POSTERS	

9 Time-resolved biphasic signatures of quadratic nonlinearity observed in coupled eigenmodes on the DIII-D tokamak

Sherwood Fusion Theory Conference (May 2023)

G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong

8 Preliminary identification and characterization of nonlinear wave-wave, wave-beam, and wave-particle interactions in beam-driven tokamak plasma

64th Annual Meeting of the APS Division of Plasma Physics (November 2022)

G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong

7 TJ-II observations of nonlinear wave-wave coupling in play during Alfvén-Eigenmode / Turbulence / Zonal-Flow interactions

64th Annual Meeting of the APS Division of Plasma Physics (November 2022)

M. Koepke, F. Papoušek, M. Ochando, C. Hidalgo, B. van Milligen, **G. Riggs**

6 Constraining magnitudes of nonzero temperature and density gradients using absorption spectra of radiatively heated target-foil plasma

Stewardship Science Academic Programs Symposium (February 2022)

G. Riggs, T. Lane, P. Kozłowski, M. Koepke

5 Constraining magnitudes of nonzero temperature and density gradients using absorption spectra of radiatively heated target-foil plasma

63rd Annual Meeting of the APS Division of Plasma Physics (October 2021)

G. Riggs, M. Koepke, T. Lane, P. Kozłowski

4 Spectroscopic method to obtain n , T applied to soft x-ray absorption spectra in radiatively heated Z-pinch plasmas

Stewardship Science Academic Programs Symposium (February 2021)

G. Riggs, T. Lane, P. Kozłowski, M. Koepke

3 Bispectral analysis of broadband and quasi-coherent oscillations (geodesic-acoustic modes) to interpret wave-wave interactions in the T-10 Tokamak

61st Annual Meeting of the APS Division of Plasma Physics (November 2019)

M. Koepke, S. Nogami, **G. Riggs**, A. Melnikov, L. Eliseev, S. Lysenko, P. Khabanov, M. Drabinskij, N. Kharchev, A. Kozachek, M. Ufimtsev

2 Interpretation of bi-coherence in space and lab plasma-wave dynamics

60th Annual Meeting of the APS Division of Plasma Physics (November 2018)

G. Riggs, S. Nogami, M. Koepke, N. Crocker, G. Howes, S. Savin, V. Budaev, L. Zelenyi

1 Alfvén Eigenmode (AE) interactions in Tokamaks: DIII-D Frontier Science Experiments connecting the physics of nonlinear waves and processes in space plasmas

60th Annual Meeting of the APS Division of Plasma Physics (November 2018)

M. Koepke, S. Nogami, **G. Riggs**, G. Howes, N. Crocker, T. Carter, W. Heidbrink, M. Van Zeeland

SKILLS

Matlab/Octave and Python

Substantial experience (MATLAB: 12 years, Python: 7 years) designing, developing, debugging, benchmarking, and deploying analysis routines, visualizations, GUIs, and games. Highlights include simulation of field from curvilinear antenna, 2.5D Landau-fluid MHD simulations, real-time bispectral analyzer, and open-source platforms for polyspectral analysis (PyBic/BICAN).

C/C++

Approximately 6 years experience enhancing throughput and efficiency of analysis routines originally written in MATLAB/Octave or Python. Used extensively for back-end of Arduino projects (see below) and hobbyist game design.

Shell scripting

Practiced with Unix systems and command-line interfaces, with preference for Bash. Experienced with connecting diverse workflows in multiple languages. Source code management and version control of dozens of routines performed with Git.

Electronics

Familiarity with printed circuit board (PCB) design, soldering, and prototyping. Completed 12-bit breadboard computer using von Neumann architecture and custom machine code, for which various algorithms (*e.g.*, Fibonacci sequence, Collatz conjecture) and rudimentary games were manually programmed. Have designed and developed custom projects using Arduino Nano, Uno, and Mega microcontrollers; notable products are MIDI controllers, holiday ornaments with adjustable lights and music, and multipurpose LED arrays featuring Bluetooth control and dedicated Android app.

Music production

16 years experience with digital audio workstations (DAWs), with preference for FL STUDIO. Extensive knowledge of additive and subtractive synthesis, sound design, recording, mixing, and mastering.

Miscellaneous

Literate in IDL and Fortran, with exposure to parallel programming and high-performance computing (HPC). Considerable experience with L^AT_EX typesetter.

OUTREACH

SPARK Center Science Day (*Oct 14, 2023*)

Led basic physics demonstrations for elementary school children.

REFERENCES

Dr. Paul Cassak

Professor of Physics, West Virginia University
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Dr. Earl Scime

Professor of Physics, West Virginia University
escime@wvu.edu

Dr. Thomas Steinberger

Research scientist, Riverside Research
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