

Greg A. Riggs

CONTACT INFORMATION

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EDUCATION

West Virginia University, Morgantown, WV

Ph.D., Physics, December 2024

Dissertation: Experimental Verification and Time-resolved Bispectral Analysis of Non-linear Coupling in the Toroidicity-induced Alfvén Eigenmode 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

Postdoctoral Researcher, Dept. of Physics & Astronomy

Fall 2024–Present

West Virginia University

Supervisor: *Prof. Weichao Tu*

- Quantification of ultra-low frequency (ULF) wave power distribution in the outer radiation belt

January 2025–Present

- Developed efficient code to analyze magnetic fluctuations from THEMIS spacecrafts (14-year dataset) and Arase/ERG mission (3.5-year dataset).
- Inferred ULF wave power dependence on magnetic local time (MLT), magnetic latitude (MLat), radial location (L shell), geomagnetic activity index K_p , and frequency. Results show substantial deviations from fundamental mode during times of high activity.
- Performed regression fitting of ULF power in given frequency band as function of MLat and K_p ; these data will be used to develop pitch-angle dependent radial diffusion coefficients.

Demo coordinator, Dept. of Physics & Astronomy

Fall 2024

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
West Virginia University
Advisor: *Prof. Mark E. Koepke*

Summer 2019–Summer 2024

- 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 ($\sim 20\text{kHz}$) 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.
 - 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 – Fall 2024

- Introductory Physics I (PHYS 101) *August 2024– December 2024*
 - 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 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.

JOURNAL PUBLICATIONS

4 TIME-RESOLVED BIPHASE SIGNATURES OF QUADRATIC NONLINEARITY OBSERVED IN COUPLED ALFVÉN EIGENMODES ON THE DIII-D TOKAMAK (**Featured Article**)
(2024) *Physics of Plasmas*, 31(4), p. 042305

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

3 ROLE OF SIMPLE SPATIAL GRADIENT IN REINFORCING THE ACCURACY OF TEMPERATURE DETERMINATION OF HED PLASMA VIA SPECTRAL LINE-AREA RATIOS
(2023) *Atoms*, 11(7), p. 104

G. Riggs, M. Koepke, T. Lane, T. Steinberger, P. Kozlowski, I. Golovkin

2 ESTABLISHING AN ISOELECTRONIC LINE RATIO TEMPERATURE DIAGNOSTIC FOR SOFT X-RAY ABSORPTION SPECTROSCOPY
(2022) *High Energy Density Physics*, 45, p. 101019

T. Lane, M. Koepke, P. Kozlowski, **G. Riggs**, T. Steinberger, I. Golovkin

1 BISPECTRAL ANALYSIS OF BROADBAND TURBULENCE AND GEODESIC ACOUSTIC MODES IN THE T-10 TOKAMAK
(2021) *Journal of Plasma Physics*, 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

MANUSCRIPTS SUBMITTED/ IN PREPARATION

5 STATISTICAL ULF WAVE LATITUDE DISTRIBUTION: A KEY TO UNDERSTANDING OFF-EQUATORIAL RADIATION BELT ELECTRON RADIAL DIFFUSION
(2025) In preparation for submission to *Journal of Geophysical Research: Space Physics*
G. Riggs, W. Tu, T. Sarris

4 INSTANTANEOUS DIFFERENCE-FREQUENCY LOCKING OBSERVED IN COUPLED EIGENMODES ON THE DIII-D TOKAMAK
(2025) In preparation for submission to *Physical Review Letters*

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

3 DEPENDENCE OF ION-CYCLOTRON RANGE OF FREQUENCIES INSTABILITIES ON SPECIES MIX AND FAST-ION DISTRIBUTION (PART 2: TIME EVOLUTION)
(2025) Submitted to *Nuclear Fusion*

W. Heidbrink, G. DeGrandchamp, J. Lestz, K. Thome, S. Vincena, N. Crocker, X. Du, R. Pinsker, **G. Riggs**, S. Tang, M. Van Zeeland

2 FORMAL POWER SERIES EXPANSION FOR INFINITE EXPONENTIAL OF ANALYTIC FUNCTION
(2025) Submitted to *The American Mathematical Monthly*

G. Riggs

	<p>1 BICAN: AN INTEGRATED, OPEN-SOURCE FRAMEWORK FOR POLYSPECTRAL ANALYSIS (2025) Submitted to <i>Computer Physics Communications</i> G. Riggs, M. Koepke, T. Matheny</p>
ORAL PRESENTATIONS	<p>6 Statistical ULF wave latitude distribution: A key to understanding off-equatorial radiation belt electron radial diffusion <i>GEM/CEDAR Workshop</i> (Jun. 25, 2025) G. Riggs, W. Tu, T. Sarris</p> <p>5 Instantaneous difference-frequency locking observed in coupled eigenmodes on the DIII-D tokamak <i>ITPA EP Topical Group Meeting</i> (Mar. 21, 2025) G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong, Y. Ghai</p> <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>
CONFERENCE POSTERS	<p>11 Statistical ULF wave latitude distribution: A key to understanding off-equatorial radiation belt electron radial diffusion <i>GEM/CEDAR Workshop</i> (June 2025) G. Riggs, W. Tu, T. Sarris</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> <p>9 Time-resolved biphasic signatures of quadratic nonlinearity observed in coupled eigenmodes on the DIII-D tokamak <i>Sherwood Fusion Theory Conference</i> (May 2023) G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong</p> <p>8 Preliminary identification and characterization of nonlinear wave-wave, wave-beam, and wave-particle interactions in beam-driven tokamak plasma <i>64th Annual Meeting of the APS Division of Plasma Physics</i> (November 2022) G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong</p>

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. Papousek, 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. Kozlowski, 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. Kozlowski

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. Kozlowski, 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 and Python

Substantial experience (MATLAB: 13 years, Python: 8 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 7 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.

IDL

Developed numerous routines for acquisition, analysis, and output of DIII-D tokamak data over 5 year period. Familiar with SPEDAS package for interacting with data from multiple spacecraft, *e.g.*, THEMIS, Arase, or Cluster.

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

17 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 Fortran and Java, 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, Clemson University
pacassak@mix.wvu.edu

Dr. Earl Scime

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

Dr. Thomas Steinberger

Assistant Professor of Physics, West Virginia University
testeinberger@gmail.com