Greg A. Riggs

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Education

West Virginia University, Morgantown, WV

Ph.D., Physics, August 2024 (expected)
Thesis: Experimental verification and time-resolved bispectral analysis of coupling and growth in the TAE spectrum on the DIII-D tokamak
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)
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

Research Assistant, Department of Physics & Astronomy — Summer 2019–Present
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 (∼20kHz) 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 modenumber 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 hundreds 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 (PrismSPECT), 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, Department of Physics & Astronomy — Spring 2018–Fall 2018
West Virginia University
Supervisor: *Prof. Mark E. Koepke*

- **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

Teaching Assistant, Department of Physics & Astronomy — Spring 2019
West Virginia University

- **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

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

Oral Presentations

2 Time-resolved biphase signatures of quadratic nonlinearity observed in coupled eigenmodes on the DIII-D tokamak
Princeton Plasma Physics Laboratory Energetic Particle Seminars (Nov. 29, 2023)
G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong, Y. Ghai

1 Time-resolved biphase signatures of quadratic nonlinearity observed in coupled eigenmodes on the DIII-D tokamak
DIII-D Energetic Particle Group (Oct. 11, 2023)
G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong

Conference Posters

10 Time-resolved biphase signatures of quadratic nonlinearity observed in coupled eigenmodes on the DIII-D tokamak
65th Annual Meeting of the APS Division of Plasma Physics (November 2023)
G. Riggs, M. Koepke, W. Heidbrink, M. Van Zeeland, D. Spong

9 Time-resolved biphase 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 Alfven-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/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 LaTeX typesetter.

References

Dr. Paul Cassak
Professor of Physics, West Virginia University
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Dr. Earl Scime
Professor of Physics, West Virginia University
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Dr. Thomas Steinberger
Research scientist, Riverside Research
testeinberger@gmail.com