Blagoje Zoran Djordjević
Curriculum Vitae

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SUMMARY:

I am a staff scientist at Lawrence Livermore National Laboratory with a current focus on modeling of short-pulse, laser-plasma interactions and implementing modern machine learning techniques with extensive experience and interest in plasma physics in general. My current work involves the study of laser-driven ion acceleration and how to use neural networks to build data-informed surrogate models. In addition, I am also working to apply the same techniques to ensembles of ICF capsule simulations. I am also interested in fluid dynamics, aerospace, and linguistics. I primarily perform computational and theoretical work, but I also work in close collaboration with experimentalists. I have a great deal of experience in various numerical methods and in several computer languages. In addition, I have presented my work at several conferences and published several articles in peer-reviewed journals.

PEER-REVIEWED PUBLICATIONS:

B.Z. Djordjević, A.J. Kemp, J. Kim, R. Simpson, S.C. Wilks, T. Ma, D. Mariscal, "Modeling laser-driven ion acceleration with deep learning," *Phys. Plasmas,* **28**, 043105 (2021) – **Editor's Choice**

B.Z. Djordjević, A.J. Kemp, J. Kim, J. Ludwig, R. Simpson, S.C. Wilks, T. Ma, D. Mariscal, "Characterizing the acceleration time of laser-driven ion acceleration with data-informed neural networks," *Plasma Phys. and Control. Fusion,* **63**, 094005 (2021)

D.A. Mariscal, **B.Z. Djordjević**, E.S. Grace, R. Hollinger, T. Ma, G.G. Scott, H. Song, R.A. Simpson, J.J. Rocca, and S.Wang, "Design of flexible proton beam imaging energy spectrometers (PROBIES)," *Plasma Phys. and Control. Fusion,* **63**, 114003 (2021)

T. Ma et al., including **B.Z. Djordjevic**, "Accelerating the rate of discovery: toward high-repetition-rate HED science," *Plasma Phys. and Control. Fusion,* **63**, 104003 (2021)

R.A. Simpson, et al., including **B.Z. Djordjevic**, "Demonstration of TNSA proton radiography on the National Ignition Facility Advanced Radiographic Capability (NIF-ARC) laser," *Plasma Phys. and Control. Fusion,* **63**, 124006 (2021)

B.Z. Djordjević, C. Benedetti, C.B. Schroeder, and E. Esarey, "Chromatic matching in a plasma undulator," *Phys. Plasmas,* **26**, 113102, (2019)

B.Z. Djordjević, C. Benedetti, C.B. Schroeder, E. Esarey, and Wim Leemans, "Control of transverse wakefields via phase-matched laser modes in parabolic plasma channels," *Phys. Plasmas,* **26,** 013107 (2019)

B.Z. Djordjević, C. Benedetti, C.B. Schroeder, E. Esarey, and Wim Leemans, "Filtering higher-order laser modes using leaky plasma channels," *Phys. Plasmas* **25**, 013103 (2018)

C. Benedetti, C.B. Schroeder, T. Mehrling, **B.Z. Djordjevic**, S. Bulanov, C. Geddes, E. Esarey, W. Leemans, "INF&RNO Modeling of 10 GeV-Class Electron Beams from a Laser-Plasma Accelerator Driven by the BELLA Laser." *2018 IEEE Advanced Accelerator Concepts Workshop,* 2018, pp. 1-5, doi: 10.1109/AAC.2018.8659411.

J.C. Kasper, et al., including **B. Djordjevic**, "Solar Wind Electrons Alphas and Protons (SWEAP) Investigation: Design of the Solar Wind and Coronal Plasma Instrument Suite for Solar Probe Plus," *Space Sci. Rev*. **204**, 131 (2016)

EDUCATION:

University of California, Berkeley	– Berkeley, California	**December 2019**
Doctor of Philosophy	– *Physics,* Adviser – *Dr. Carl B. Schroeder*	
l'Université Toulouse III - Paul Sabatier	– Toulouse, France	**June 2014**
Master of Science	– *Astrophysics, Space Science, & Planetology*	
Luleå University of Technology	– Luleå, Sweden & Würzburg, Germany	**June 2013**
Master of Science	– *Space Technology*	
University of Texas at Austin	– Austin, Texas	**May 2012**
Bachelor of Science	– *Physics (with High Honors), and Mathematics*	
Bachelor of Arts	– *Greek (with High Honors), and Latin*	

COMPUTATIONAL EXPERIENCE:

Programming languages: Python, Matlab (very experienced); C, C++, R, Java, OpenMP, LabVIEW, Julia (experienced).
Numerical methods: finite element, computational fluid dynamics, particle-in-cell, particle-tracking, spectral methods.
Other: big data analysis, natural language processing, machine learning, neural networks (Tensorflow & Keras).

EXPERIMENTAL EXPERIENCE:

Experience working with high-strength magnetic fields (5 T), low-temperature cryogenics – both liquid nitrogen 77 K and liquid helium 5 K; spectral analysis of low-density plasmas for fusion applications; wet lab experience for biological applications – western blots, polymerase chain reaction, gene manipulation; clean lab experience – nano-scale semiconductor fabrication, UV photo-lithography, plasma-enhanced chemical vapor deposition; non-linear optics; laser-doppler velocimetry and wind tunnel.

TEACHING EXPERIENCE:

Graduate Student Instructor, "Physics for Scientists and Engineers," PHY 7A (Newtonian Mechanics), (Fall 2014 – Spring 2015). Department of Physics, University of California, Berkeley.

Teaching Assistant, "Big Data Analytics," CSCI E-63, "Cloud Computing & the Internet of Things," CSCI E-90, & "Deep Learning," CSCI E-89 - Harvard Extension School (Spring 2014 – present).

MENTORSHIP EXPERIENCE:

Conner Myers – Oregon State University, Physics, Ph.D., Physics. NIF-PS Internship at LLNL **2020-present**
"Optimization of GPU-based WarpX on Lassen for a Baseline Testing of Plasma Systems"

Anthony Hagey – Mississippi State University, Physics, B.S., Physics. ROTC Summer Internship at LLNL **Summer 2021**
"Data analysis of particle spectra from particle-in-cell simulation ensembles"

Andre Antoine – University of Michigan, Physics, Ph.D., Applied Physics. HEDS Internship at LLNL **2022-present**
"Characterizing hot electrons in ensemble PIC simulations of high-intensity, laser-plasma interactions with machine learning"

SCIENTIFIC OUTREACH:

APS DPP 2019, Student Day – Tutorial Session on Laser Plasma Acceleration
HEDS Center Outreach Video Series 2020 – Laser-Plasma Acceleration
Guest Lecture 2021, Western Washington University, Chemistry Department – Science of Sustainable Energy

CONFERENCE PRESENTATIONS:

American Physics Society – Division of Plasma Physics:
Analysis of non-Gaussian laser mode guidance and evolution in leaky plasma channels. San Jose, CA **2016**
Filtering of higher order laser modes using plasma structures. Milwaukee, WI **2017**
Wakefield manipulation via phase-matched laser modes in plasma channels. Portland, OR **2018**
Chromatic Matching in a Plasma Undulator. Ft. Lauderdale, FL **2019**
Mapping the Parameter Space of Laser-Driven Ion Acceleration via Neural Networks. Memphis, TN **2020**
Exploring the acceleration time of laser-driven ion acceleration via deep learning. Pittsburgh, PA **2021**
Transfer learning and multi-fidelity modeling of laser-driven ion acceleration. Pittsburgh, PA, **invited** **2022**

Society of Photographic Instrumentation Engineers – Photonics West:
Parameter Space Exploration of Short-Pulse Laser-Driven Ion Acceleration via Simulation Ensembles & Neural Networks **2020**

Advanced Accelerator Concepts:
Laser Mode Control Using Leaky Plasma Channels. National Harbor, MD **2016**
Control of transverse wakefields via phase-matched laser modes in plasma channels. Breckenridge, CO **2018**

Symposium on the Physics of Ionized Gases:
Transverse wakefield control via phase-matched laser modes in plasma channels. Belgrade, Serbia **2018**

American Geophysical Union:
Geometric Dependence of Electric Field Swelling in Simulation of HF Ionospheric Heating. San Francisco, CA **2014**
Non-linear analysis of PESA-Lo electrostatic analyzer data and solar wind temperature anisotropies. San Francisco, CA **2015**

ACADEMIC THESES:

Interaction of Higher-Order Laser Modes with Underdense Plasmas,
(Doctor of Philosophy). University of California, Berkeley
Co-advisor: C.B. Schroeder, Lawrence Berkeley National Laboratory
Co-advisor: S. Bale, Department of Physics, UC Berkeley

Geometric Dependence of Artificial Ionospheric Layers Driven by High Power HF-heating,
(Master of Science). Luleå University of Technology, Luleå, Sweden
Advisor: D. Papadopoulos, Department of Physics, UMD, College Park

Internal Waves and Tidal Conversion of a Finite Submarine Ridge,
(Bachelor of Science). University of Texas at Austin, Austin, Texas
Advisor: P. Morrison, Department of Physics, UT Austin

Perceptions of Science in Late Byzantine Theology – Geometry according to Gregory Palamas,
(Bachelor of Arts). University of Texas at Austin, Austin, Texas
Advisor: D. Armstrong & R.M. Taylor, Department of Classics, UT Austin

HONORS & AWARDS:

16th LLNL Institutional Computing Grand Challenge – Tier 2 award	**2021**
National Ignition Facility and Photon Science Award – Outstanding publication	**2021**
15th LLNL Institutional Computing Grand Challenge – Runner-up award	**2020**
Phi Beta Kappa	**2012**
Unrestricted Endowed Presidential Scholarship	**2011**

PROFESSIONAL AFFILIATIONS:

DOE High Energy Density Laboratory Plasmas Panel reviewer, member of the American Physical Society, Division of Plasma Physics, Division of Physics of Beams, and American Institute of Aeronautics and Astronautics.

POSTDOCTORAL RESEARCH CONTENT:

Lawrence Livermore National Laboratory, LLNL, Livermore, California **2020-present**

I am currently pursuing research in laser-driven ion acceleration and how modern machine learning techniques may be leveraged. The scientific focus is on using short-pulse, high intensity lasers to accelerate ions to MeV energies, primarily via the target normal sheath acceleration mechanism. My modeling work involves building up a large ensemble of simulation results of various fidelities to explore the parameter space of interest. Using these data ensemble we train neural networks to learn the more salient features. These networks can be used as a surrogate model to rapidly explore extended parameter space in search of optimal solutions and potentially discover new features of interest. LLNL also provides 25% of our postdoc time for independent projects, which I use to study ICF capsule simulations, specifically the effects of modal perturbations, and apply machine learning to that as well.

DOCTORAL RESEARCH CONTENT:

Berkeley Lab Laser Accelerator (BELLA) Center, LBNL, Berkeley, California **2015-2019**

My doctoral research focused on laser-plasma acceleration and interactions from a theoretical and computational perspective. The primary thrust of this research was to study how higher-order modes affect the evolution characteristics of a laser pulse propagating through a plasma. Higher-order mode content typically is deleterious and leads to poor guiding in systems designed for Gaussian pulses. I theoretically and numerically demonstrated how a plasma-based leaky channel can be used to filter out higher-order modes. I also demonstrated how higher-order modes can be intentionally included to shape and control the wakefields and thereby the transverse properties of an accelerated electron bunch, which can be extended to flat bunches, positron acceleration, and free electron lasers. I applied the concept of color-tuning to the plasma undulator, proposing a better optimized design for an LPA light source. I also pursued basic research on filamentation of laser pulses as they propagate through a plasma. In addition to analytical work I have experience working with high-performance codes such as the Berkeley-based PIC code INF&RNO and have written several of my own codes, i.e., particle tracking, PIC, and fluid.

ADDITIONAL RESEARCH EXPERIENCE IN PLASMA PHYSICS:

Space Science Laboratory, Berkeley, California **2014-2015**

During this research period I worked on two projects at SSL. The first was with Dr. Davin Larson to calibrate and test the electrostatic analyzer SPAN that is currently on the Parker Solar Probe Spacecraft which is being used to gather measurements of the coronal and solar wind plasma. This was done using an ion gun as well as supporting simulations. In addition, I worked on large scale data analysis of the PESA-Low electrostatic analyzer from the still operational WIND spacecraft with Dr. Bennett Maruca, which studies near-Earth Solar Wind as well as the Earth's magnetosphere. The object of this study was to look for non-thermal effects in the Solar Wind, such as temperature anisotropies and beams.

Space and Plasma Physics Groups, College Park, Maryland **2013-2014**

Performed research on ionospheric modification and manipulation using the HAARP ionospheric heater with an eye on modeling turbulent structures. The primary effort was to create theoretical and computational models focusing on electron heating and small turbulent structures associated with upper hybrid ionospheric high frequency heating. This resulted in a 2D model of descending atmospheric ionospheric layers (DAILs) as well as highly versatile ray tracing algorithm to model the distribution of energy around DAIL structures. This work was done with Drs. K. Dennis Papadopoulos, Gennady Milikh, and Xi Shao.

Helimak Plasma Physics Lab, Austin, Texas **Fall 2010**

My primary task was to use a spectrometer to measure the spectral line widths in order to determine the vertical velocity of the plasma within the Helimak. I also analyzed data from MIT's Alcator C-Mod tokamak.

OTHER RESEARCH EXPERIENCE:

Philip J. Morrison Physics Research Group, Austin, Texas **2011- 2012**

Worked with Dr. Morrison to develop fluid dynamics models of geophysical systems. The topic was wave-beam propagation through a density stratified fluid, e.g. ocean water. The main issue at hand was the disagreement between experimental results made at UT by the group of Harry Swinney and previous theories. We used the WKB approximation to model the propagation of evanescent waves in vicinity of bottom obstacles of various forms.

Condensed Matter Physics, Experimental Physics III, Würzburg, Germany May **Summer 2011**

Spent three months in the Quantum Transport group under Dr. Buhmann of Experimental Physics III at the Julius-Maximilians-Universität Würzburg. The topic of my research was topological insulators and I worked with HgTe and Bi2Se3 samples. Part of my work involved the fabrication of MBE wafers into testable samples through chemical and optical lithography. The second component of my internship involved taking characterization measurements of new samples at high magnetic fields and near 0 K temperatures.

Georgiou Chemical Engineering Lab, Austin, Texas **Summer 2010**

Worked with a graduate student on studying redox pathways in E-Coli and how they reduce oxidative stress. We looked at the enzyme glutathione and how cells function when this enzyme is disabled via gene manipulation.