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IAN KOLAJA

Objective

To explore, master, and innovate in the fields of advanced reactor core design and operation, and nuclear data and measurement. To develop powerful leadership skills and foster an equitable and socially responsible workplace culture.

Education

University of California, Berkeley August 2021 to August 2025 Berkeley, CA
PhD, Nuclear Engineering *3.63 GPA*
with a Designated Emphasis in Computational and Data Science and Engineering

- Applications of Parallel Computers
- Nuclear Reactions and Interactions of Radiation with Matter
- Nuclear Security: The Nexus Between Policy and Technology
- Advanced Nuclear Reactors
- Special Topics in Environmental Aspects of Nuclear Energy
- Applied Machine Learning
- Advanced Concepts in Radiation Detection and Measurements
- Physical Principles of CT, PET, and SPECT Imaging
- Introduction to Statistical Computing
- Concepts of Probability
- Gospel Chorus

University of California, Berkeley August 2017 to December 2019 Berkeley, CA
B.S., Nuclear Engineering *3.79 GPA*

- Nuclear Criticality Safety
- Design for Advanced Nuclear Systems
- STEM Communication
- Radiation Biophysics and Dosimetry

Fullerton College (FC) August 2015 to June 2017 Fullerton, CA
A.S., Mathematics, and A.A., Chemistry *3.76 GPA*

Academic Experience

Graduate Student Fellow Researcher
UC Berkeley *August 2021 to Present* *Berkeley, CA*

- Inventor on provisional patent for a bent crystal diffraction (BCD) spectrometer system that can filter gamma rays by energy, enabling more rapid and accurate assessment of fuel burnup and plutonium production in continuously fueled reactors without excessive fuel decay time.
- Generated gamma spectra for pebble bed reactors (PBRs) via pebble-wise depletion calculations in Serpent. Simulated BCD spectrometer measurements using SHADOW3 ray tracing and GADRAS gamma spectroscopy.
- Extended methodology to molten salt reactors (MSRs), performing unit cell depletion in liquid fuel and simulating corresponding gamma spectra.
- Developed machine learning (ML) model to predict pebble-wise burnup, fluence, residence time, and nuclide content from measurable gamma spectra. Achieved R^2 of 0.994 for burnup prediction.
- Built PBR core simulator using Serpent that tracks zone-wise pebble composition data, enabling fast and accurate prediction of k_{eff} and flux/power distribution in the core as a function of various operator control inputs.
- Trained a Long-Short Term Memory (LSTM) neural network to predict reactivity and flux/power profiles using input features derived from measurable quantities. Achieved R^2 of 0.965 for reactivity on unseen operation data and enabled forecasting of reactivity.

U.S. Citizen

- Designed a control algorithm that uses LSTM forecasts to steer the reactor simulator from towards user-defined target states (i.e. full power) while maintaining criticality. Used generated data to retrain the model in a self-reinforcing learning loop.
- Prototyped a flask-based web application in Python to assess and visualize the quality of nuclear cross section data from EXFOR and ENDF, incorporating metrics like uncertainty, experimental consistency, and spectral relevance. Built a user-facing interactive chart of nuclides for browsing nuclide and reaction specific scores.

Graduate Student Instructor (GSI): Introduction to Reactor Physics
UC Berkeley *January 2022 to May 2022* *Berkeley, CA*

- Held hybrid discussion sections going over course material in greater detail with an emphasis of helping students understand how to utilize content covered in lectures.
- Organized review sessions and held office hours to ensure students were prepared.
- Received a 4.94 out of 5.0 on various student-graded metrics including teaching effectiveness, helpfulness in understanding course material, and preparedness.
- Received Outstanding Graduate Student Instructor award from the Graduate Division Teaching & Resource Center.

Undergraduate Researcher
Lawrence Berkeley National Lab *January 2018 to December 2019* *Berkeley, CA*

- Determined a physically justifiable neutron flux spectrum for a fast neutron inelastic scattering experiment conducted at the Baghdad Nuclear Research Institution in 1978. Performed sensitivity analysis on the fitted flux function parameter in order to determine its uncertainty. Ongoing work will allow for the data coupled with the flux spectrum to serve as a nuclear model performance benchmark.
- Assessed the performance of the neutron flux spectrum by using it in a comparison between the experimental data and cross section calculations performed by TALYS, a nuclear reaction model.
- Developed code for the automatic analysis of gamma spectra that can identify and fit peaks using radioactive decay data. Utilized code to rule out the presence of fission products in the analysis of actinium-225, a coveted medical isotope.
- Acquired data for detection of super heavy element moscovium-288 using the Berkeley Gas-filled Separator (BGS) coupled with the 88-inch cyclotron. Utilized LabVIEW software to monitor detection events and adjust BGS parameters over time.

Undergraduate Researcher
Berkeley Thermal Hydraulics Lab *November 2018 to December 2019* *Berkeley, CA*

- Developed software in MATLAB and LabVIEW allowing a MIDI controller to be used as an analog controller for the Compact Integral Effects Test (CIET) facility.
- Developed an electronic procedure module in LabVIEW that guides reactor operators through experiments in CIET. Designed a data structure that can be easily created by other researchers to dynamically populate the electronic procedure with human readable instructions. The module is responsive to CIET's state, automatically advancing through the procedure as certain physical conditions are met.
- Designed procedures with graduate student for human factors experiment intended to test the effectiveness of different operator support tools. Wrote a set of survey questions to supplement experimenter observations with participant's qualitative feedback.

Course Reader
Nuclear Engineering Department *August 2018 to December 2018* *Berkeley, CA*

- Graded homework assignments and examinations for Nuclear Reactions and Radiation course at UC Berkeley. Contributed to the development of assignment and exam content using insight as a student. Hosted office hours to answer student questions about course material and grading policy.

Professional Experience

Core Design Engineer
Kairos Power *June 2019 to August 2021* *Berkeley, CA*

- Developed a python-based pebble bed reactor simulator that explicitly tracks the movement of fuel and graphite pebbles through the core and generates corresponding Serpent input files. Provides high fidelity reactor information including transport parameters, fission product inventory, and burnup over operational history. The method used for pebble inventory management allows burnup calculations to be performed roughly 11 times faster than the previous method with much higher accuracy.
- Developed tool to calculate figures of merit associated with reactor safety and criticality as a function of the effective enrichment and carbon to heavy metal ratio values associated with a mixture of different types of fuel pebbles in the FHR using Serpent. Illustrated the viable design space for core start up fuel mixtures.
- Created Github repositories for each of the tools developed. Documented the core simulator with comments and a user manual. Taught colleagues how to create input decks in order to run the simulator.

Community Service

Tutor and Mentor
Joya Scholars *September 2015 to May 2017* *Fullerton, CA*

- Tutored ten high school students from families of low-income communities to help a population that historically has had little access to higher education excel academically. Helped students with math, computer science, and biology.
- Mentored five middle school students in career selection, college admission, and overcoming academic challenges. Inspired one student to pursue aerospace engineering as a major and apply to Stanford University.

Skills

Seasoned leader with effective communication, organization, and attention to detail. Works well both independently and on a team utilizing the following skills:

- **Programming Languages:** Python (Advanced), MATLAB (Advanced), C++ (Intermediate), R (Intermediate), Lua (Intermediate)
- **Scientific Modeling & Simulation:** Serpent (Advanced), MCNP (Intermediate), TALYS (Intermediate), SHADOW 3 (Intermediate), GADRAS (Novice), RELAP5 (Novice), ORIGEN (Novice)
- **Data Science & ML Tools:** Keras (Intermediate), scikit-learn (Advanced), Cloud Computing (Intermediate), SLURM (Intermediate), Python Multiprocessing (Intermediate), CUDA (Novice)
- **ML Techniques**: Regression, Classification, Clustering, Neural Networks (Feed forward, convolutional, recurrent), PCA, Time Series Forecasting
- **Version Control & DevOps:** Git (Intermediate), Conda (Intermediate)
- **Web & UI Development:** HTML (Intermediate), CSS (Intermediate), JavaScript (Novice), Flask (Intermediate), Apache2 (Novice), SQLite (Novice)
- **Scientific Visualization:** Matplotlib (Advanced), Bokeh (Intermediate), Mayavi (Novice)
- **Instrumentation:** Gamma Spectroscopy (Advanced), LabVIEW (Intermediate)
- **Documentation & Communications:** Microsoft Office Suite (Advanced), LaTeX

(Intermediate), Overleaf (Intermediate), Speech Writing (Intermediate), Technical Writing (Intermediate), Social Media Outreach (Intermediate)

- **Operating Systems:** Linux (Advanced), Windows (Advanced), Mac OS (Advanced)
- **Creative & Media Tools:** Adobe Premiere Pro (Advanced), Adobe Photoshop (Intermediate), Music Production (Intermediate), Music Theory (Intermediate)

Major Honors

Student of Distinction

Fullerton College *May 2017* *Fullerton, CA*

- Selected among twenty students recognized for academic achievement in a school of twenty-five thousand students by committee of faculty and students.
- Invited to audition to speak at commencement, became one of four finalists.

Carbon Contributions Challenge Finalist

MIT Solve *March 2017* *New York City, NY*

- Proposed a solution with team for Massachusetts Institute of Technology (MIT) Solve's Carbon Contributions Challenge and was selected as one of eleven finalists. Solutions were accepted from around the world with many finalists being graduate students from top tier schools. Designed a process called "Direct Methane Conversion" which allows for the collection, filtration, and conversion of methane into graphene and hydrogen. Research was presented at the United Nations headquarters to global thought leaders, entrepreneurs, and innovators. Answered questions from a panel of judges selected from industry and academia.

Publications

- I. Kolaja, et al., "Machine Learning Prediction of Pebble History in Pebble Bed Reactors," in *Proceedings of the International Conference on Physics of Reactors (PHYSOR 2024* , Apr. 2024, pp. 1437–1446. doi: 10.13182/PHYSOR24-43890.
- N. Satvat *et al.*, "Neutronics, thermal-hydraulics, and multi-physics benchmark models for a generic pebble-bed fluoride-salt-cooled high temperature reactor," Nuclear Engineering and Design, vol. 384, p. 111461, 2021, doi: https://doi.org/10.1016/j.nucengdes.2021.111461.
- J.M. Gates *et al.*, "First direct measurements of superheavy-element mass numbers," Phys. Rev. Lett. 121, 222501 (2018)

Other Honors

• Nuclear Regulatory Commission	May 2018	UC Berkeley
• Outstanding GSI	Spring 2022	Berkeley Graduate Division
• Nuclear Regulatory Commission Scholarship Recipient	May 2018	UC Berkeley
• Honors Certification	May 2017	Fullerton College
• Nettleship Scholarship Recipient	May 2017	FC Foundation (Fdn.)
• Osher Fdn. Scholarship Recipient	May 2016	FC Foundation
• Honor Society Membership	August 2016	Phi Theta Kappa
• Senator of the Month	November 2015	FC Associated Students
• Distinguished Scholar Award	June 2015	El Dorado High School (EDHS)