George Halal

Curriculum Vitae as of Apr. 2019

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Education

2019–Present **Stanford University**, *Stanford, CA, USA.*
- Ph.D. in Physics

2015–2019 **Lehigh University**, *Bethlehem, PA, USA.*
- B.S. in Physics – GPA: 3.97/4.00
- Minor in Applied Mathematics
- **Thesis in progress:** *"Machine Learning in Relativistic Heavy-Ion Collisions at RHIC: Applications to Jet Flavor Tagging, Centrality and Event Plane Determination, and the Trigger Definition"* (Advisor: Dr. Rosi Reed)

2012–2015 **Eastwood International School**, *Beirut, Lebanon*,
GPA: 4.00/4.00 (Valedictorian).

Computing Skills

Platforms	Linux, Microsoft Windows, Macintosh
Languages	C++, Python, Arduino, LabVIEW, Slurm, LaTeX
Technical	ROOT, PYTHIA, FastJet, JETSCAPE, DiffGeo
Machine Learning	Python: Keras (TensorFlow backend), scikit-learn ROOT: TMultilayerPerceptron, TMLPAnalyzer
Other	AutoCAD, Microsoft Office, Git

Laboratory Skills

Electronics	Oscilloscope, Function Generator, Multimeter, Lock-in Amplifier
Machine Shop	Metalworking & Soldering, Woodworking, 3D Printing

Languages

Fluent	English & Arabic
Proficient	French

Research Grants

2018 **Eckardt Scholar Research Project Grant**.
For conducting research at Yale University

2017 **CAS Undergraduate Research Grant**.
For conducting research at The Ohio State University

2017 **Summer Research Participation Fellowship**.
For conducting research at Lehigh University

Honors & Awards

2019 **Leigh Page Prize (declined)**, *Yale University*.
A prize awarded by the Yale Physics Department to the top students accepted into the Physics Ph.D. program for the promise that they show for making important contributions to the field of physics.

2019 **Dean's Fellowship (declined)**, *Columbia University*.
A five-year fellowship awarded to the top students accepted into the Graduate School of Arts and Sciences at Columbia University

2019 **E. Raymond Binkley Prize**, *Lehigh University*.
A prize awarded to the top-ranking senior majoring in physics.

2017 **Malcolm J. Gordon, Jr. Physics Prize**, *Lehigh University*.
A prize awarded to the top-ranking sophomore majoring in physics.

2015–present **Eckardt Scholar**, *Lehigh University*.
A highly selective honors program at Lehigh University with special benefits.

2015–present **Dean's List**, *Lehigh University*.

2015–present **Merit Scholarship**, *Lehigh University*.

Physics Research Experience Highlights

DATA ANALYSIS PROJECTS:

2018–present **Machine Learning Techniques for Tagging Heavy-Flavor Jets at RHIC**, *Advisors: Helen Caines & John Harris*,
Yale University.

- Simulated proton-proton and heavy-ion collisions at RHIC energies, clustered final state particles into jets, and added detector effects.
- Trained a neural network model made of Long Short-Term Memory (LSTM) layers and fully-connected layers using Keras and scikit-learn on a list of discriminators to be able to classify charm, bottom, and light jets.
- Developed a new jet tagging strategy for RHIC.

2018–2019 **Centrality & Event Plane Determination Using Machine Learning with the STAR Event Plane Detector**, *Advisors: Rosi Reed & Michael Lisa*,
Lehigh University & The Ohio State University.

- Trained an artificial neural network to identify the centrality of a collision, based on which of the detector tiles are hit during a given collision.
- Trained another network to identify the 2^{nd} order event plane of a collision by minimizing the difference between the event planes measured by the east and west detectors.

2017–2018 **Performance Analysis of the STAR Event Plane Detector**, *Advisor: Rosi Reed*,
Lehigh University.

- Analyzed data collected by the eighth of the detector that was installed for the RHIC 2017 run, colliding protons at $\sqrt{s} = 510$ GeV and gold ions at $\sqrt{s_{NN}} = 54.4$ GeV, to optimize its final design.
- Compared it to the other detectors at the STAR experiment to verify that they are measuring the same collisions at the same time and that the electronics work properly.
- Analyzed the charged particle multiplicity distribution in the detector as a function of pseudorapidity and compared it to the results from the RHIC PHOBOS experiment and to Monte Carlo simulations.
- Studied the ADC distributions of the tiles in the detector to quantify the number of minimum ionizing particles (MIP) hitting them.
- Studied whether it is useful to have a maximum ADC cap for each tile in order to suppress the effects of large Landau fluctuations and what that value should be.

2016 **Di-hadron & Jet-Hadron Correlations in Proton-Proton Collisions**, *Advisor: Rosi Reed*,
Lehigh University.

HARDWARE PROJECTS:

2016–2018 **Building an Event Plane & Centrality Detector for the STAR Experiment**, *Advisors: Rosi Reed & Michael Lisa*,
Lehigh University & The Ohio State University.

- Helped build and test one of the detector upgrades proposed for the second phase of the Relativistic Heavy Ion Collider (RHIC) Beam Energy Scan (BES). It is designed such that when a minimum ionizing particle (MIP) hits one of the optically-isolated tiles of this detector, which are made of special plastic material, photons are generated through scintillation. The photons then travel through a wavelength-shifting fiber embedded in the tile to a clear optical fiber to be detected by silicon photo-multipliers.

2017 **Cosmic Ray & Radioactive Source Testing of the Event Plane Detector**, *Advisors: Rosi Reed & Michael Lisa*,
The Ohio State University.

- Helped build two test stands that use cosmic rays and a radioactive source to quantify the quality and uniformity of the different sectors of the detector.
- Connected different electronics boards to each other and to silicon photomultipliers to digitize the signals detected.
- Performed different calculations, such as the distance an electron from the radioactive source can travel through different materials before stopping.
- Analyzed data collected from both tests using ROOT.

Peer-Reviewed Publications

In Progress **"An Event Plane Detector for STAR,"** *Nuclear Instruments and Methods in Physics Research*

In Progress **"Machine Learning Techniques for Tagging Heavy Flavor Jets at RHIC,"** *Journal of High Energy Physics*

Research Communication Experience

CONFERENCES & WORKSHOPS:

2019 **Halal, G.**, 2019, "Feasibility of Tagging Heavy Flavor Jets at RHIC With Machine Learning", *APS April Meeting*, Oral Presentation Session L15.6

2019 **Halal, G.**, 2019, "Machine Learning Techniques for Tagging Heavy-Flavor Jets at RHIC", *ML@STAR Workshop*, Oral Presentation

2019 **Halal, G.**, 2019, "Machine Learning Techniques for Tagging Heavy-Flavor Jets at RHIC", *2nd JETSCAPE Winter School and Workshop*, Oral Presentation

2018 **Halal, G.**, 2018, "Feasibility of Tagging Heavy Flavor Jets at RHIC Using Machine Learning", *The STAR Winter Analysis Meeting*, Oral Presentation

2018 **Halal, G.**, 2018, "Machine Learning and Optimization with the Event Plane Detector", *The STAR Collaboration Meeting*, Oral Presentation

2017 **Halal, G.**, 2017, "A Centrality and Event Plane Detector for STAR to Complete the Phase Diagram of Quantum Chromodynamics", *APS Division of Nuclear Physics Meeting*, Poster Presentation Section EA.075

SEMINARS & SYMPOSIA:

2019 **"Neural Networks: a Quick-start Guide"**, *Lehigh Astro-Particle-Nuclear Physics Seminar*, Lehigh University, Bethlehem, PA

2018 **"Feasibility of Jet Flavor Tagging at RHIC"**, *Lehigh Astro-Particle-Nuclear Physics Seminar*, Lehigh University, Bethlehem, PA

2018 **"Machine Learning for Heavy Flavor Jet Tagging"**, *Yale Wright Laboratory Undergraduate Summer Research Symposium*, Yale University, New Haven, CT

2018 **"An Event Plane Detector to Better Understand the Strong Force"**, *Lehigh Astro-Particle-Nuclear Physics Undergraduate Research Symposium*, Lehigh University, Bethlehem, PA

2018 **"Introduction to Machine Learning in Physics"**, *Lehigh Astro-Particle-Nuclear Physics Seminar*, Lehigh University, Bethlehem, PA

2017 **"An Event Plane Detector to Understand the Structure of Quantum Chromodynamics"**, *Lehigh Physics Undergraduate Research Symposium*, Lehigh University, Bethlehem, PA

Work Experience

2018 **Peer Tutor for Introductory Physics II (Electricity & Magnetism),** *Lehigh University*

2016 **Structural Engineering Intern,** *GGICO PSC Property Development & Engineering, UAE*

References

Dr. Helen Caines, *Associate Professor of Physics*, Yale University.
Email: helen.caines@yale.edu Phone: (203) 432-5831

Dr. Michael Lisa, *Professor of Physics*, The Ohio State University.
Email: lisa@physics.osu.edu Phone: (614) 292-8524

Dr. Rosi Reed, *Assistant Professor of Physics*, Lehigh University.
Email: rosijreed@lehigh.edu Phone: (610) 758-3907

Dr. Sera Cremonini, *Assistant Professor of Physics*, Lehigh University.
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