

# George Halal

*CV as of July 2019*

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## Education

- 2019–Present **Stanford University**, *Stanford, CA, USA*.  
◦ M.S. & Ph.D. Physics
- 2015–2019 **Lehigh University**, *Bethlehem, PA, USA*.  
◦ B.S. Physics (major) & Applied Mathematics (minor), Highest Honors  
◦ GPA: 3.97/4.00 – Summa Cum Laude  
◦ **Thesis:** "*Machine Learning for Relativistic Heavy-Ion Collisions at RHIC: Applications to Jet Flavor Tagging and Centrality and Event Plane Determination*" (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 Python, C++, Arduino, LabVIEW, Mathematica, L<sup>A</sup>T<sub>E</sub>X
- Technical ROOT, PYTHIA, FastJet, JETSCAPE, DiffGeo
- Machine Python: Keras (TensorFlow), scikit-learn
- Learning ROOT: TMLayerPerceptron, TMLPAnalyzer
- CAD SolidWorks, AutoCAD
- Tools Git, Emacs, Slurm, Microsoft Office

## Laboratory Skills

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

## Languages

- Fluent English & Arabic
- Proficient French

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## 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

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## Honors & Awards

- 2019 **Summa Cum Laude**, *Lehigh University*.
- 2019 **Leigh Page Prize (declined)**, *Yale University*.  
A prize awarded by the Yale Physics Department to the top students accepted into the Ph.D. program.
- 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 monetary prize awarded to the top-ranking senior majoring in physics.
- 2019 **LR Writing Award (tied for 1<sup>st</sup> place)**, *Lehigh University*.  
A monetary prize awarded to the authors of 7 papers chosen to be published in the Lehigh Review journal.
- 2017 **Malcolm J. Gordon, Jr. Physics Prize**, *Lehigh University*.  
A monetary prize awarded to the top-ranking sophomore majoring in physics.
- 2015–2019 **Dean's List**, *Lehigh University*.
- 2015–2019 **Merit Scholarship**, *Lehigh University*.
- 2015–2019 **Eckardt Scholar**, *Lehigh University*.  
A highly selective honors program at Lehigh University with special benefits.

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## 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*

## Physics Research Experience Highlights

### DATA ANALYSIS PROJECTS:

- 2018–2019 **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 using UrQMD simulations.
  - 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 using real data.
- 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:**

2019–Present **Detector R&D for the nEXO Experiment (for Measuring Neutrinoless Double Beta Decay)**, *Advisor: Giorgio Gratta*,  
Stanford University.

- Build and operate a set of tests to understand complicated electron emission phenomena when high voltage is applied in liquid xenon (LXe).
- Design and build a new LXe teststand setup, including cryogenics and controls.
- Analyze data collected from these tests.

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

- Build and test one of the detectors 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 plastic scintillator, 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 (SiPMs).

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

- Build two test stands that make use of cosmic rays and a radioactive source to quantify the quality and uniformity of the different sectors of the detector.
- Connect different electronics boards to each other and to silicon photomultipliers (SiPMs) to digitize the signals detected.
- Perform different calculations, such as the distance an electron from the radioactive source can travel through different materials before stopping.
- Analyze data collected from both tests.

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## **Work Experience**

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

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

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## 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