

# George Halal

CV as of March 2020

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📄 <https://georgehalal.github.io/>

## Education

- 2019–Present **Stanford University**, *Stanford, CA, USA*.
- M.S. & Ph.D. Physics (in progress)
  - GPA: 4.00/4.00
- 2015–2019 **Lehigh University**, *Bethlehem, PA, USA*.
- B.S. Physics (major) & Applied Mathematics (minor), *Summa Cum Laude*
  - GPA: 3.97/4.00
  - **Thesis:** "*Machine Learning Applications to Jet Flavor Tagging and Centrality and Event Plane Determination in Relativistic Heavy-Ion Collisions*"
- 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
- Machine Learning PyTorch, Keras, TensorFlow, scikit-learn
- Technical ROOT, PyROOT, PYTHIA, FastJet, JETSCAPE, DiffGeo
- CAD SolidWorks, AutoCAD
- Tools Git, Vim, Slurm, Microsoft Office

## Laboratory Skills

- Hardware Vacuum & Cryogenic Technologies, Ultrasonic Cleaning, Epoxying, Metalworking (incl. Soldering & Magnetic Drilling), Woodworking, 3D-Printing
- Electronics Oscilloscope, Function Generator, Multimeter, Lock-in Amplifier, High Voltage & Low Voltage Power Supplies

## 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 **"Machine Learning Techniques to Search for Two-Neutrino Double-Beta Decay of  $^{136}\text{Xe}$  to the Excited State of  $^{136}\text{Ba}$  in EXO-200,"** *Phys. Rev. C* (first-author)
- In Progress **"Machine Learning Techniques for Tagging Heavy Flavor Jets at RHIC,"** *Journal of High Energy Physics* (first-author)

## Research Experience Highlights

### DATA ANALYSIS PROJECTS:

- 2020–Present **Machine Learning Techniques for Stochastic Generation of Observed Galaxy Properties**, *Advisors: Daniel Gruen & Risa Wechsler, Stanford University.*
- Use a conditional Wasserstein generative adversarial network with gradient penalty (cWGAN-GP) to generate observed galaxy properties in wide-field surveys, given true galaxy properties from deep-field surveys and a set of sky maps that characterize observations.
  - Find the transfer function (probability of detecting a galaxy in the sky as a function of position) using deep neural networks.
- 2019–Present **Machine Learning Techniques to Search for Two-Neutrino Double-Beta Decay of  $^{136}\text{Xe}$  to the Excited State of  $^{136}\text{Ba}$  in EXO-200**, *Advisor: Giorgio Gratta, Stanford University.*
- Develop and train a deep learning model consisting of a concatenation of different neural networks, each of which is best at learning the output of different input variables, on Monte Carlo simulations.
  - Run the trained model on real data to search for this decay and set a limit on its half-life.
- 2018–2019 **Machine Learning Techniques for Tagging Heavy-Flavor Jets at RHIC**, *Advisors: Helen Caines & John Harris, Yale University.*
- Simulate proton-proton and heavy-ion collisions at RHIC energies, cluster final state particles into jets, and add detector effects.
  - Train a deep learning model made of Long Short-Term Memory (LSTM) and fully-connected networks on a list of discriminators to be able to classify charm, bottom, and light jets.
  - Develop a new jet tagging strategy for RHIC.
- 2018–2019 **Machine Learning Techniques for Centrality & Event Plane Determination with the STAR Event Plane Detector**, *Advisors: Rosi Reed & Michael Lisa, Lehigh University & The Ohio State University.*
- Train a 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.
  - Train another network to identify the second order event plane of a collision by minimizing the difference between the event planes measured by the east and west detectors using actual data.

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

- Analyze data collected by the detector that was installed for the RHIC 2017 run, colliding protons and gold ions, to optimize its final design.
- Compare the detector's measurements to the other detectors at the STAR experiment, and verify that the electronics work properly.

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

- Simulate particle collisions, and analyze the azimuthal angular correlations between back-to-back hadrons and jets to study quenching effects.

## **HARDWARE PROJECTS:**

2019 **Detector R&D for the nEXO Experiment to Search for 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.
- Design and build a new liquid xenon TPC test 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 a detector 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 wavelength-shifting fibers embedded in the tiles to clear optical fibers 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 teststands 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 these tests.

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## Research Communication Experience

### CONFERENCES & WORKSHOPS:

- 2019 **"Search for Excited State Decays with Machine Learning"**, *EXO-200 Collaboration Meeting*, Stanford, CA
- 2019 **"Feasibility of Tagging Heavy Flavor Jets at RHIC with Machine Learning"**, *APS April Meeting, Session L15.6*, Denver, CO
- 2019 **"Machine Learning Techniques for Tagging Heavy Flavor Jets at RHIC"**, *ML@STAR Workshop*
- 2019 **"Machine Learning Techniques for Tagging Heavy Flavor Jets at RHIC"**, *2nd JETSCAPE Winter School and Workshop*, Texas A&M University, College Station, TX
- 2018 **"Feasibility of Tagging Heavy Flavor Jets at RHIC Using Machine Learning"**, *The STAR Winter Analysis Meeting*
- 2018 **"Machine Learning and Optimization with the Event Plane Detector"**, *The STAR Collaboration Meeting*, Lehigh University, Bethlehem, PA
- 2017 **"A Centrality and Event Plane Detector for STAR to Complete the Phase Diagram of Quantum Chromodynamics"**, *APS Division of Nuclear Physics (DNP) Meeting, Section EA.075*, Pittsburgh, PA

### 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