George Halal

CV as of August 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 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, LaTeX
Technical	ROOT, PyROOT, PYTHIA, FastJet, JETSCAPE, DiffGeo
Machine Learning	Python: Keras (TensorFlow), scikit-learn ROOT: TMultilayerPerceptron, TMLPAnalyzer
CAD	SolidWorks, AutoCAD
Tools	Git, Vim, Slurm, Microsoft Office

Laboratory Skills

Hardware	Vacuum & Cryogenic Technologies, Ultrasonic Cleaning, Epoxying
Electronics	Oscilloscope, Function Generator, Multimeter, Lock-in Amplifier, Power Supply
Machine Shop	Metalworking (incl. Soldering & Magnetic Drilling), 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 **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^{st} 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.

Peer-Reviewed Publications

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

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

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 deep 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 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.

- 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.
- Verified that the detector is measuring the same collisions at the same time as the other detectors at the STAR experiment and that the electronics work properly.

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

- Simulated particle collisions using PYTHIA, and analyzed the azimuthal angle differences between back-to-back hadrons and jets to study quenching effects.

HARDWARE PROJECTS:

2019–Present **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 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 teststands that make use of cosmic rays and a radioactive source to quantify the quality and uniformity of the different sectors of the detector made of plastic scintillator.
- 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.

Work Experience

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

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

Research Communication Experience

CONFERENCES & WORKSHOPS:

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