

# George Halal

CV as of June 2020

+1 (650) 422-9033

✉ georgech@stanford.edu

📄 <https://georgehalal.github.io/>

## Education

- 2019–Present **Stanford University**, *Stanford, CA, USA*.
- Ph.D. Physics (in progress)
  - GPA: 4.00/4.00
  - **Advisor:** Chao-Lin Kuo
- 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, MATLAB, C++, LabVIEW, Arduino, Mathematica, L<sup>A</sup>T<sub>E</sub>X
- Machine Learning PyTorch, Keras (TensorFlow backend), scikit-learn
- Technical Healpy, Meander, ROOT, PyROOT, PYTHIA, FastJet, DiffGeo
- CAD SolidWorks, AutoCAD
- Tools Git, Vim, Slurm, Microsoft Office

## Laboratory Skills

- Hardware Vacuum & Cryogenic Technologies, Ultrasonic Cleaning, Epoxying, Metal-working (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

## Teaching Experience

2020 Special Relativity and Mechanics

## Research Experience

### DATA ANALYSIS PROJECTS:

2020–present **Correlating BICEP/Keck Data with HI-Derived Foreground Maps**, *Advisors: Chao-Lin Kuo & Susan Clark*,  
Stanford University.

- Reobserve 21-cm neutral hydrogen (HI) maps in the BICEP/Keck (BK) region and correlate them with BK and Planck maps to improve the understanding of polarized dust properties in the BK region.
- Develop test statistics to compare the significance of a detection of an HI-component in Planck and BK maps.
- Optimize the HI parameter model and algorithm design using correlations with the BK data.

2020 **Modeling Polarized CMB Foregrounds [rotation]**, *Advisor: Chao-Lin Kuo*,  
Stanford University.

- Simulate a galactic magnetic field, modeling the emission of aligned galactic dust grains. Produce polarization maps, comparing their power spectra to Planck HFI 353 GHz maps.
- Fit the model to the power law spectrum used in the BICEP/Keck (BK) analysis pipeline to find the best-fit parameters of the model.
- Study the effect of increasing the size of the BK field of view on the dust amplitude.

2020–Present **Machine Learning Techniques for Stochastic Generation of Observed Galaxy Properties [rotation]**, *Advisors: Daniel Gruen & Risa Wechsler*,  
Stanford University.

- Develop a conditional Wasserstein generative adversarial neural 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 **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 [rotation]**, *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 [rotation]**, *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.

---

## 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 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.

---

## 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 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:

- 2020 **"Conditional Generative Adversarial Networks and Gaussian Processes"**, *KIPAC Machine Learning Seminar*, Stanford University, Stanford, CA
- 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