EW, THIS BEAKER IS FILTHY!

*RUB*

*RUB*

I’M A GENIUS

WOAH! ARE YOU A GENIE?

Poof!

DO YOU GRANT WISHES?

I WISH FOR GRANTS

Cyanide and Happiness © Explosm.net

Steven Clark 9/29/2020
General Info

● Three year fellowship awarded to students in all STEM disciplines

“The NSF Graduate Research Fellowship Program recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based Master's and doctoral degrees at accredited United States institutions”

https://www.nsfgrfp.org/
General Info

- Award is for annual stipend of $34k for 3 years, plus tuition coverage
- Eligibility
  - Senior Undergraduates, first and second year research based master’s and Ph.D students
  - Full time enrollment in STEM field at U.S institution
  - U.S Citizens only
- May apply once as a graduate student
  - Can only apply first or second year of grad school
  - Senior undergraduates may apply once as undergrads and once as grads
- 2021 Deadline for Physics: Thursday, October 22 at 5:00 pm
- Reference letter deadlines: Oct 30
- 2020: > 13,000 applicants, ~2,000 awards offered
Application Requirements

- Personal, Relevant Background and Future Goals Statement
- Graduate Research Plan Statement
  - In each statement, applicants should address Intellectual Merit and Broader Impacts under separate headings to provide reviewers with the information necessary to evaluate the application with respect to both Criteria.
- 3 Reference letters
- College Transcripts
Application Requirements

- **Intellectual Merit**: The Intellectual Merit criterion encompasses the potential to advance knowledge
  - Why you will become a great, Nobel-Prize winning scientist

- **Broader Impacts**: The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.
  - In what ways can you advance STEM, the overall scientific community beyond your research?
Research Statement Tips

● 2 page max
  ○ This is short. Be concise

● Work closely with your advisor, lab group

● Write to a non-specialized physics audience- avoid too much jargon

● Include clear hypothesis, goals, measures of success
  ○ Don't be afraid to underline, bold important statements

● Do not neglect broader impacts
  ○ Why is this research important? How will this work extend to other scientific field?

● Have a bunch of people read this
  ○ Including at least one non-physicist
Graduate Research Proposal

Search for a Light Extended Higgs Sector at the Large Hadron Collider

Introduction: The Standard Model (SM) of Particle Physics explains the forces and properties of elementary particles and is considered one of the most successful theories ever formulated. An important prediction of the SM was the existence of a massive spin-0 boson known as the SM Higgs boson, $H$, which explains the breaking of electroweak symmetry and leads to the masses of other elementary particles. The Higgs boson was experimentally discovered in 2012 at the Large Hadron Collider (LHC) and found to have a mass of about 125 GeV [1]. This discovery is considered one of the most important scientific achievements of the century.

The SM has made many predictions that have been successfully observed experimentally, but there are still many areas in which the SM offers no explanations. For example, the dark matter of astrophysics is a major issue that the SM cannot resolve: a particle physics explanation of this phenomenon would require physics Beyond the Standard Model (BSM).

This research project focuses on a recent BSM model that predicts the existence of other Higgs bosons (denoted $a$), an extended Higgs sector. These particles could be produced when a heavy resonance, $X$, decays to pairs of $a$ particles. We assume the $a$’s have couplings to and decay in the same way as $H$. The primary objective of my research will be searching for the decay of $X \rightarrow aa \rightarrow (bb)(b\bar{b})$ and $X \rightarrow aa \rightarrow (\gamma\gamma)(\gamma\gamma)$ to determine the existence of these non-SM Higgs bosons and thus observe new BSM physics. The decay to bottom quark pairs ($b\bar{b}$) has the largest branching fraction and the decay of $H \rightarrow b\bar{b}$ has been recently observed, confirming our ability to identify such events [2]. The diphoton decay ($\gamma\gamma$), despite having a small branching fraction, was a channel used in the discovery of $H$ and has excellent mass resolution [1].
enough resolution to distinguish the two separate particles. I will be developing and employing new reconstruction algorithms with sufficient resolution for distinguishing merged pairs of particles.

To develop new reconstruction algorithms, I will be applying machine learning techniques to improve existing software. There is a group of physicists at Rutgers University interested in invoking machine learning for CMS experiments with whom I will be working. Using a server cluster at Rutgers I will explore new computing techniques and their applications to particle physics.

In my first year of research, I will be developing the algorithms and analyzing the data acquired from 2015-2018 at an integrated luminosity of 160 fb$^{-1}$. In years two and three I will refine the algorithms and prepare for the 2021-2023 data taking.
Examples: More here

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To be successful, the new algorithms must be capable of identifying closely merged $b\bar{b}$ and $\gamma\gamma$ pairs. This will allow us to either prove the existence of $a$ and thus find new BSM physics, or exclude a mass range for which we know $a$ cannot exist. The ultimate goal is to be able to observe BSM physics at the LHC, but regardless of this, the development of new reconstruction
Examples: More here

Integrating Mechanical Behavior and Calcium Bursts in Human Neutrophils

Key Terms: mechanotransduction, micropipettes, chemotaxis, phagocytosis, β2 integrin

Introduction: Future medical innovation will require a detailed knowledge of the causal sequences of events in biological processes. Currently, much of the understanding of these processes comes from correlative studies, whereas cause-effect relationships are less often explored. For instance, in immune cells, several signaling pathways are associated with dramatic, global bursts in cytosolic calcium concentration, but it remains unclear which pathways trigger the calcium burst and which depend on it. In human neutrophils, these bursts are correlated with several mechanically demanding processes, including β2-integrin-mediated cell arrest\(^1\), the onset of active cell spreading on immobilized IL-8\(^2\), and the acceleration of β2-integrin-mediated phagocytosis\(^3\). On the other hand, my prior work in the Heinrich Lab has shown that pure (i.e. adhesion-free) complement-mediated chemotaxis neither causes nor requires such global calcium surges\(^4\) (see Fig. 1B). We further demonstrated that unphysiologically high levels of chemoattractant can cause calcium bursts, but contractile forces stalled or even reversed pseudopod formation in such cases. These findings imply a close connection between calcium bursts and mechanical behavior. The purpose of this project is to examine the cause-effect relationship between changes in cytosolic calcium concentration and mechanical responses of human neutrophils to chemotactic and phagocytic stimuli on a single-cell basis.

Background: Store-operated calcium entry (SOCE) is considered the dominant mechanism for calcium bursts in human neutrophils. In this paradigm, ligation of certain receptors, such as G-protein coupled receptors (GPCRs), triggers a signaling cascade that leads to the depletion of intracellular calcium stores (usually via IP\(_3\) production). This prompts a calcium influx from the extracellular space through channels such as Orai1. However, our own findings and several
Examples: More here

also be used to calculate the probabilities of the existence or absence of additional bound exoplanets or brown dwarfs orbiting a given star (e.g. Bryan et al 2016), and guide future observations of these systems.

Proposed Timeline:

Year 1: Modify OFTI and compile brown dwarf astrometric and RV data.
Year 2: Publish early results for individual systems and finish fitting orbits to remaining systems.
Year 3: Produce eccentricity distribution of long-period brown dwarfs, publish comparison to planet population.

References:
Personal Statement Tips

● 3 page max
● In my opinion, this is the more important statement
  ○ I received more comments from reviewers on this statement
● The NSF wants to fund students, not projects
  ○ Why do you want to do this? What makes you unique? Why are you great?
● **Read examples**
● This is not simply a grad school app personal statement
  ○ NSF cares about your non-physics activity
  ○ Include academic successes, research experience, awards
  ○ Also include outreach, volunteering, impactful jobs, internships, etc.
● Have a bunch of people from many backgrounds read this and give feedback
Personal Statement Tips

- Things you want to mention:
  - How you got involved in this field
  - Research experience, presentations, conferences
  - Academic awards
    - Explanation of any troubling application points
  - Scientific outreach, involvement in SPS, Honors societies, volunteer experience
  - Future Goals
    - How will the NSF GRFP help you achieve these goals?
Reference Letters

- 2 letter min, but 3 is strongly recommended
- Contact referees asap
- Get a diverse group of referees
  - Try to get people that line up with things you mention in your statements
  - My referees: Summer REU Research advisor, Physics Professor I was close with, Physics Professor I worked on a semester long service project with.
- If you are a second-year grad applicant, your advisor should write a letter
- Can only submit 3 letters, but can list 5 on the website.
  - Contact 4 people, have 1 person as backup, but don’t tell them
- Send your statements to your referees asap
- Bother them
General Application Tips

● Read Program Solicitation
  ○ Lots of very important details here
  ○ Very specific guidelines on formatting
● Have as many people as possible read your statements, including your advisor and at least one non-physicist
● Plan to submit at least one day before deadline
● Read examples online
● Tell Ron and Shirley you are applying
Last Step:

- Try to stay calm during the ~200 days before you will hear back…
  - 2019 decisions announced April 9 just before midnight
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gracklebird 49 points · 1 year ago

I was so desperate that I actually filed my taxes last night to take my mind off of the impending rejection.
Resources

- NSF GRFP Home: https://www.nsfgrfp.org/
- Helpful tips and examples: https://www.alexhunterlang.com/nsf-fellowship
- More tips: