



Whittier
College

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Fletcher-Jones Summer Research Fellowship

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Greetings,

My name is Jordan Hanson, and I am an assistant professor in the Department of Physics and Astronomy. I am recommending Raymond Hartig for a Fletcher-Jones Summer Research Fellowship. Raymond is an especially gifted Whittier College freshman who will double major in Physics and Mathematics. I first met Raymond in the Fall of 2019 as his freshman mentor, and I have since become his adviser.

My research focuses on the ARIANNA project, a high-energy particle detector based on the Askaryan effect (<https://arianna.ps.uci.edu>). The goal of the research is to isolate signals from cosmic neutrinos and cosmic rays. For technical reasons, ARIANNA is operates in Antarctica. The nature of the signal from the neutrinos and cosmic rays is a radio-frequency (RF) pulse, and the ARIANNA modules are designed to record them. Cosmic rays are usually protons and other ions, and neutrinos are similar except they are electrically neutral.

Raymond is interested in theoretical physics, and would like to use the Fletcher-Jones opportunity to help me study the Askaryan effect. Specifically, we need to produce the equations for the electric field in the time-domain, for a variety of new conditions. The new results would aid other ARIANNA researchers in identifying neutrino signals in a library of more than several million signals already collected. Raymond is suited to the task, and is usually my best student.

I have taught Raymond in Calculus-based physics 1 (PHYS150), Calculus-based physics 2 (PHYS180), and an upper-division computer science course entitled Computer Logic and Digital Circuit Design (COSC330). I am especially impressed with his ability to lead, and to work independently on a long-term project. The final project of Raymond's group in PHYS150 used concepts from PHYS180, *the following course*, and was the best I've seen in my time here since 2017. Raymond gets the top marks in my courses, and demonstrates discipline.

Raymond dove into extra work I assigned him outside of class, in which I began to prepare him with mathematical training suitable for this summer project. Specifically, I have been teaching him how to use calculus tools when the variables are complex numbers. This is directly relevant to the project, and he has already finished the chapters of the book I've loaned him. We worked out all the examples and he seems ready for the task. Raymond did this work alongside his other classes, and while being involved in his campus society.

In closing, I highly recommend Raymond Hartig for the Fletcher-Jones Summer Fellowship. Feel free to email me with any questions.

Sincerely,

Jordan C. Hanson, PhD