Whittier College

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Keck Undergraduate Summer Research Fellowship
Whittier College

Greetings,

My name is Jordan Hanson, and I am an assistant professor in the Department of Physics and Astronomy. I am recommending John-Paul Gómez-Reed for a Keck Undergraduate Summer Research Fellowship. John-Paul is an especially gifted Whittier College freshman who is interested in following the 3-2 Engineering Program with emphasis in mathematics. John-Paul was introduced to me by Prof. Seamus Lagan as a potential researcher in my laboratory, because John-Paul is interested in scientific applications of electrical engineering.

My research focuses on the ARIANNA project, a high-energy particle detector based on the Askaryan effect. The goal of the research is to isolate signals from extra-solar neutrinos and cosmic rays. For technical reasons, ARIANNA is being deployed and operated in Antarctica. The nature of the signal from the cosmic rays is a radio-frequency (RF) pulse, and the ARIANNA modules are designed to record them. The modules consist of RF hardware (radio antennas, amplifiers, and filters) and RF firmware (reprogrammable microchips that govern hardware behavior).

The ARIANNA module firmware gives the modules various autonomous abilities. John-Paul and I have the goal this summer of adding a specific firmware ability. The detector modules each have a threshold voltage that sets the minimum strength a passing RF signal must have to be recorded. The Antarctic environment, while generally RF quiet, has man-made RF noise and random RF thermal background radiation. Thresholds must be tuned by hand, which currently limits the number of modules (currently 10). In order to observe ultra-high energy (UHE) neutrinos, a long-time goal of the field, the number of modules must be expanded. Thus, John-Paul and I seek to alter the ARIANNA firmware to allow a module to *calibrate itself* autonomously.

John-Paul has already shown excellent engineering skills. College freshmen in science usually learn software programming. Firmware, on the other hand, is challenging enough that rarely can college freshmen teach themselves. John-Paul, however, wrote and installed his first firmware program in my lab this past semester. The next stage involves learning how to add complexity to our designs. For my part, I will provide John-Paul with formal training from Xilinx Inc., lab space, and hardware. Once we have learned to build RF-frequency counters, we will test design modifications on spare ARIANNA modules.

If successful, this project will greatly enhance an already vibrant field of Antarctic particle physics research. I highly recommend John-Paul Gómez-Reed for the Keck Fellowship.

Sincerely,

Jordan C. Hanson, PhD