# UH Hilo astronomy & physics undergraduate Tino Wells researches galaxies and rare stars

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By Staff

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**Tino Wells says with access to the best telescopes in the world combined with professors who are motivated to get students involved research, UH Hilo is "an absolutely perfect hub for astronomy and physics."**

**By Leah Sherwood**

*This story is part of a series on projects done by UH Hilo physics and astronomy students awarded research positions.*

A senior at the University of Hawai'i at Hilo majoring in physics and astronomy has conducted research over the past year exploring galaxies and rare stars. He was awarded two research opportunities to conduct his inquiries that took him from UH Hilo to Notre Dame, building his skills and his résumé along the way.


Tino Wells. Photo by John Coney/UH Hilo Physics & Astronomy Dept.

**Tino Wells** spent a year working with **Kathy Cooksey**, an associate professor of physics and astronomy at UH Hilo, on a project titled, "Non-parametric Clustering Analysis: Classifying Large-Scale Gaseous Structures in Circumgalactic Media to Establish Connections to Parent Galaxies." The project was funded through Cooksey's National Science Foundation grant during summer 2017 and a Hawai'i Space Grant Consortium fellowship during the 2017–2018 academic year. The

consortium trains the space
scientists, space settlers, and aerospace engineers of the future and is part of NASA's National Space Grant College and Fellowship Program.

"We studied the chemical signature in the gaseous regions around galaxies," explains Wells. "Using the Keck II telescope on Maunakea and a spectrograph called the Echellette Spectrograph and Imager, as well as publicly available data from the Sloan Digital Sky Survey, we used a technique called quasar absorption-line spectroscopy to see exactly what's in these gaseous regions to figure out what type of galaxy it is."

"We were looking at three characteristics," he continues. "The first is metallicity, which is about the abundance of one chemical species relative to another. We focused on singly-ionized magnesium and triply-ionized silicon and carbon. The second is the spatial distribution. For example, relative to the host galaxy, is the gas perpendicular to the disc or in the same plane as the disc? This helps determine if it's a spiral galaxy or an elliptical galaxy. Finally, we looked at temperature estimates. Hotter gas can't condense as much, so when the gas is hotter you're looking at less gas, and when the gas is colder, it can clump more and you can observe different densities and depths. These three characteristics all play a role in the spectral signatures we see. The overall project was trying to deduce what those signatures mean and how they relate to the structure and environment of galaxies."

For Wells, the year-long research was a whirlwind tour of the field of astronomy.

"This field fascinates me specifically because of its complexity," he says. "There were multiple times when I thought the data might represent one thing, but then Dr. Cooksey pointed out how it was different than what I anticipated. She's the expert and she's awesome."

**Research Experiences for Undergraduates**

Once the Hawai'i Space Grant Consortium fellowship ended, Wells spent the summer of 2018 participating in the Research Experiences for Undergraduates program, which is funded by the National Science Foundation to support active research participation by undergraduate students. On the recommendation of Cooksey, Wells traveled to the University of Notre Dame to work with physics professor **Timothy Beers**.

"With Dr. Cooksey we were using the absorption signatures of different chemical species to try to predict characteristics and extrapolate information," explains Wells. "At Notre Dame, I was using that exact same process, but instead of galaxies, I was working with single, individual stars."

At Notre Dame, Wells used spectrographic techniques to search for r-II stars, a rare type of metal-poor stars with particular nucleosynthesis properties.

"The type of star we were looking for is so incredibly rare that out of 25 years of research, they have found 24 or 25 total," says Wells.

“To increase the discovery rate for r-II stars, we take in an input data file, run it through all these different filtration systems, and we get out a result list of potential stars to apply high-resolution spectroscopy to in the future,” says Wells. “We were trying to get a correlation between the absorption signatures of certain chemical species in the stars with their metallicity and effective temperature parameters. I was able to empirically derive two correlations that relate these parameters to the absorption strength of the chemical species we were working with.”

Wells found himself inspired by the scientific questions he was working on, as well as the tantalizing prospect of answering them in the near future.

“The end goal of this research is to figure out the nucleosynthetic origins of various elements; in other words, how the elements are created throughout the cosmos throughout time,” says Wells. “Today 33 percent of them are still unknown, but Dr. Beers thinks we can figure them out within three years or so. The fact that the goal is achievable that soon was very motivating. It made me wake up ready to do things.”

**What’s next?**

Wells, who is currently applying to graduate programs in astronomy, believes that having the undergraduate research on his résumé will make him more attractive to admissions committees. He is grateful for the new skills he acquired.

“This research requires everything, from the fundamental ideas in astrophysics, to the statistics, the multiplex of clustering algorithms and their inherent level of robustness, as well as software development,” he says. “You truly get a taste of everything.”

As he pursues the next stage of his studies and research, Wells will leave with warm feelings for the Hilo campus.

“In my opinion, this place is an absolutely perfect hub for astronomy and physics,” he says. “These are the best telescopes in the world, considering the altitude and how secluded they are, with the cloud layer blocking the city lights. And it’s a small school, so you can get personal with the professors and develop relationships, and the professors are motivated to get students involved and have them working on projects. So it’s a win-win.”

*About the author of this story: Leah Sherwood is a graduate student in the tropical conservation biology and environmental science program at UH Hilo. She currently serves as an intern in the Office of the Chancellor. She received her bachelor of science in biology and bachelor of arts in English from Boise State University.*

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