# STARS ON THE RISE

When astrophysicist Alicia Aarnio had leftover time on a session at the Apache Point Observatory, she called undergraduate Kamara Culbreath. "Hey, I have some telescope time with a three-and-a-half meter," she said. "Are there any galaxies you want to look at?"

From Dr. Aarnio's office at UNCG, they examined remote galaxies through the telescope in New Mexico. It was 4 a.m., but such is the life of astronomers.

Aarnio and her student researchers study young star systems – ones that are a mere 1 million to 40 million years old. When a star is born, Aarnio says, material from the surrounding molecular cloud is gravitationally attracted to it and, under rotation, "flattens out like pizza dough spinning on a skilled chef's finger." This flattened disc of "all the leftover dust and gas material from the formation of the star," explains undergrad Mariann Juarez, "is where planets are born."

The team's goal is to better understand what these young stars look like before they hit the main sequence – a middle age, when planets are no longer forming. To gather data on young stars, Culbreath combs existing surveys of the night sky in visible light, infrared, the far infrared, radio, and other wavelengths. "Gathering the data is a long process that requires complex coding," Culbreath says, "but I'm interested in the computational side." The results give him a full picture of a star's spectral energy distribution.

If the data Culbreath gathers does not match an existing database of 200,000 star and disk models, the team must develop new models. That's where Juarez comes in, with information from the star's spectra, which provides hints about a star system's chemical composition, temperature, and rotation speeds.

Stellar research is technique driven, says Aarnio, and her research group stands out by combining several. "Our work is unique in that we're object-focused and bringing simulations into the mix as well. And there are not many universities that have young star research as a focus."

*Clockwise, from top:* Juarez, Culbreath, and Aarnio get data on the brightest stars from the Three-College Observatory, with red lights helping to maintain their night vision. Two computers work together here – one controls the telescope, and one the spectrograph, sending light the telescope receives through a prism. From that detailed spectrum, researchers can discern chemical elements in a star's atmosphere and more.

Aarnio calls her undergraduate research group the UNCG Stars, playing on the University's name and position in the galaxy – our sun, a yellow star with a surface temperature around 5,500 kelvins, is a G star. The moniker also describes what she sees in her young researchers.

Culbreath, for example, has conducted research not just at UNCG but at the Maria Mitchell Observatory in Massachusetts, and he has earned several awards for his academic achievements and research. "I'm most proud of going to conferences and talking about the research I've done," he says. This year, he presents a poster at the American Astronomical Society Meeting, which many in the field call the "Super Bowl" of astronomy.

"But it's one step at a time," Culbreath says. "I needed to be able to do research first and know what the meaning of research is. A lot of accomplishments came from asking for guidance early in my college years."

Part of that guidance came from UNCG's NSF STAMPS and NIH MARC U-STAR programs, which offer opportunities to talented students from groups traditionally underrepresented in the sciences. Similarly, Juarez is in UNCG's McNair Scholar Program that prepares promising students for graduate education.

"There's really a strong focus at UNCG on getting undergrads prepared," Aarnio says.

Culbreath and Juarez came to UNCG with a strong interest in the stars, but the team also emphasizes the impact of their work here on earth. "Astronomy is on the frontier of big data," Aarnio says. "Telescopes are getting petabytes of data every night, so astronomers have to build machine learning algorithms to process data quickly." Culbreath recently developed one to try to automatically identify galaxies – his particular passion.

Juarez's interest differs: "I like the astrochemical aspect of stars." Her first project with Aarnio modeled chemical reactions in a star disk. "We created 18 separate simulations on a supercomputer to analyze the disk and the emission of carbon monoxide and hydroxide." Modeling these reactions, particularly those involving organic molecules, offers researchers clues on how and if carbon-based life can develop.

What both students agree on are the opportunities UNCG afforded them, including funding for undergraduate research and interactions with professors. "We have great professors, and we can be one-on-one and have small classes because of the size of the school," Culbreath says. "It helps you learn and actually retain."

Juarez echoes the sentiment. "I'm a shy person, but it was easier to create relationships with my professors here. That helped push me and made me aware of what I have to do, to do well."

*by Susan Kirby-Smith* • *learn more* physics.uncg.edu