UC Physics Major Publishes in Astrophysical Journal

Two years ago UC undergraduate student Kevin Wagner began his research career in astrophysics by studying the properties of young stars during the time that planets ought to be forming from the remnant material still surrounding the star. Most stars in the sky are now thought to have planets, and as the planets form they sweep up material from the disk they are forming from, opening up a gap in the disk.

Kevin has spent the past 2 years investigating the structure of the disks in young stars with evidence of such a gap, in particular the star HD 169142, about 470 light-years from the Earth, in the constellation of Sagittarius. His work on this star began in earnest in July 2013 when, along with his advisor Professor Michael Sitko and colleague Ray Russell (The Aerospace Corporation), he helped obtain spectra of the star using NASA's Infrared Telescope Facility on the summit of Mauna Kea, Hawaii. After carefully calibrating the spectra, he combined them with data obtained by a vast array of astronomical facilities, such as the Hubble and Spitzer Space Telescopes, the Infrared Space Observatory, and the Kuiper Airborne Observatory.

The next phase of his work required detailed theoretical modeling of the disk system, in order to reproduce the brightness of the system from ultraviolet to millimeter wavelengths, and to generate computed images of the disk that could be compared with recent images obtained with state-of-the-art astronomical instruments. This two-pronged approach is necessary in order to be able to explain all of the existing information astronomers have about the disks.

To do this Kevin made computational models to do “Monte Carlo” radiative transfer calculations of the disk structure and its interaction with the light from the star. In these simulations, individual “photons” are followed as they leave the star and interact with the disk. With enough of these photons, both the spectrum and an image can be gradually built up. For high-quality images, over a billion such calculations are required. The case of HD 169142 was chosen for this work because data obtained over the past decade showed that the structure of the disk had changed during that time. Kevin’s work determined how the structure must have changed to explain this difference. Whether these changes are due to the gravitational influence of the planets that are likely present is not yet known. But such dynamical effects are likely present in all young planetary systems, and that includes our own when it was only a few million years old.

Kevin presented his preliminary work in January 2014 at a meeting of the American Astronomical Society in Washington, DC, and will show the completed work at the 2015 meeting in Seattle, WA. Kevin was also the lead author of the paper entitled “VARIABILITY OF DISK EMISSION IN PRE-MAIN SEQUENCE AND RELATED STARS. III. Exploring Structural Changes in the Pre-transitional Disk in HD 169142”, which will appear in a future issue of The Astrophysical Journal.