



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY**

Name(s) Vivek Vijayakumar	Project Number S1717
Project Title Analysis of Molecular Spectra in Asymptotic Giant Branch Carbon Stars	
<p style="text-align: center;">Abstract</p> <p>Objectives The objective of this project is to study the spectral abundances of CN, C2, and C3 in the spectrum of two relatively low temperature classes of carbon stars, C5 and C6 N-type carbon stars, in order to see how temperature and age affect nucleosynthesis and dredge-up in these stars.</p> <p>Methods A R~17000 Littrow spectrograph, 115mm apochromatic refractor, and cooled monochrome camera on a German equatorial mount (GEM) were used to image spectra for 21 carbon stars, between 6460 to 6630 angstroms. The spectra were stacked, processed, calibrated, and analyzed in IRIS, a self-made PixInsight script, and RSpec.</p> <p>Results The measurements showed that C6 N-type stars had higher spectral abundances overall over C5 N-type stars, with every single compound tested demonstrating a higher mean abundance by approximately 2.5 standard deviations, after band correction.</p> <p>Conclusions The measurements provide evidence that C6 N-type stars have higher average spectral abundances. This demonstrates that their characteristically lower temperatures facilitate the creation of these compounds. The spectra also lack the H-alpha spectral line, a normal absorption line in most stars that indicates the presence of hydrogen, showing these stars to be all hydrogen-deficient. CN is of especially higher concentration than most carbon stars in both types, demonstrating the dredge-up of nitrogen characteristic of C5-6 N-type stars.</p>	
Summary Statement I measured the spectral abundances of three carbon compounds to determine how temperature and age affects the abundance of carbon in a specific type of carbon stars.	
Help Received I conducted the observations myself, using my equipment. I asked Francois Cochard of Shelyak Instruments for advice on troubleshooting the spectrograph, and had Kin Searcy of the San Diego Astronomy Association review some of the material.	