[Capstone Category]

Project Name **Imaging Brave New Worlds**

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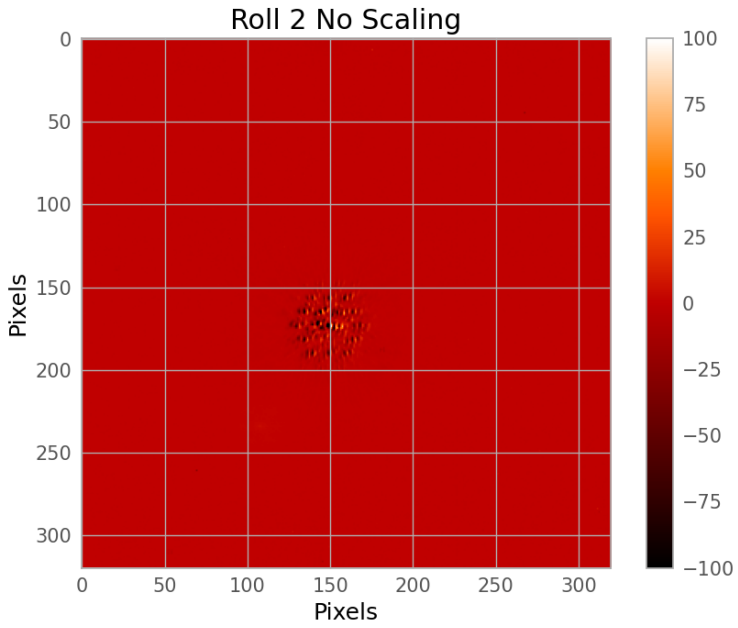

With the launch of the James Webb Space Telescope (JWST) in 2021, resolving the companion objects of host stars has entered the frontier of photometry. Methods for this data reduction have become pivotal for imaging potential exoplanets, white dwarfs, or other small and dim objects. This research aims to streamline point source function (PSF) subtraction methods using JWST data to create a simple program in Python for the telescope's NIRCam coronographic data. The processed final images will be used in the construction of a model at the Jet Propulsion Laboratory (JPL) to synthesize reference PSFs used in future observations. The primary goals of this project are to reduce errors in data reduction through modifying PSF subtraction after the PSF images have been processed through the JWST pipeline and to reduce errors in observational astronomy by eliminating the need for longer observation time on telescopes and more observational reference images through the development of the reference PSF synthesis model.

Major challenges stemmed from an error in the JWST image post-processing pipeline. In one of the two science images of the target, the white dwarf target was completely obscured in the coronagraphically removed intensities, and a detrimental hot pixel remained in the image, which contaminated the pixel counts and calculation of the scale factors for luminosity and stellar shifting. The hot pixel was removed by use of median pixel values rather than the mean in coadding the data cubes. However, the lacking intensity for the white dwarf is still skewing the scale factors. The initial method of using pixel medians to calculate the values was unsuccessful. Presently, the root mean square of localized shell annuli regions within the area of starlight is being used to produce a masking matrix over the reference images to scale the luminosity to that of the host star.

Through experimentation in methodology and mathematics, this project works to remove as much error as possible from the received coronagraphic data. The resultant product will be applied toward the creation of a program that synthesizes reference PSF data. This would reduce error majorly in high contrast imaging involving PSF subtraction by eliminating the need for observed, real reference PSFs, allowing for more frequent and less erroneous high contrast imaging to be performed for more small bodies, such as exoplanets. The image shown here is of the second science image with no applied scale factors. The white dwarf satellite is seen in the center of the removed starlight.

High contrast imaging in astronomy is dependent on the quality and success of error reduction of the received images; this research examines the methods of error reduction in the wake of JWST photometry and its applications toward exoplanet detection.

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