

Adapting Digital Masking for Improved Exoplanet Detection

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Introduction

- Our target object is HD15745, an F2V star with an extended scattered light disk, as shown in Figure 1.
- 27 Images were captured using the Hubble Space Telescope's (HST) Imaging Spectrograph (STIS) and its coronagraph, which helps to reveal faint structures while suppressing the star's glare.
- The images were captured using Angular Differential Imaging (ADI) by changing the roll angles of HST.

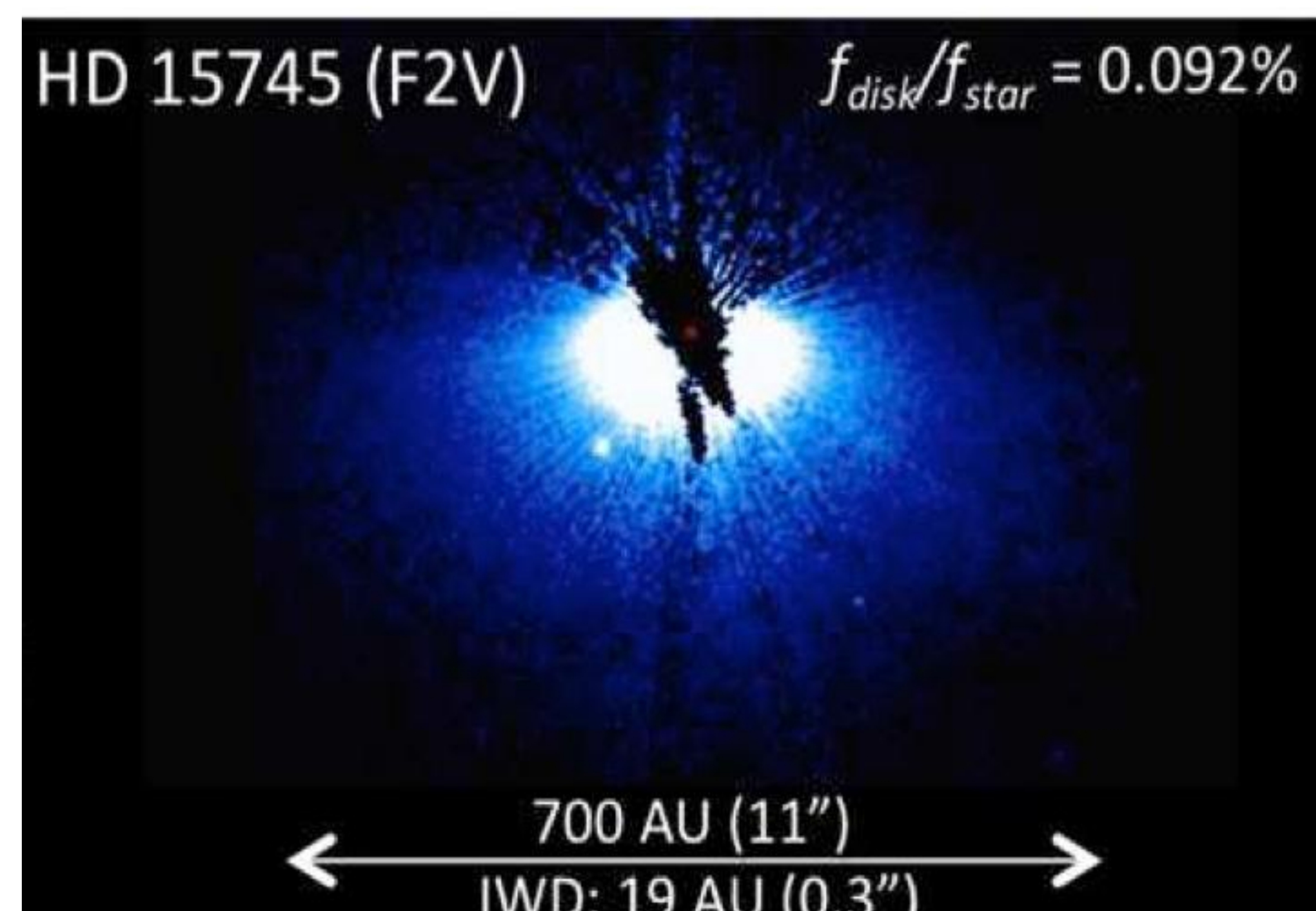


Figure 1: STIS Image of HD15745

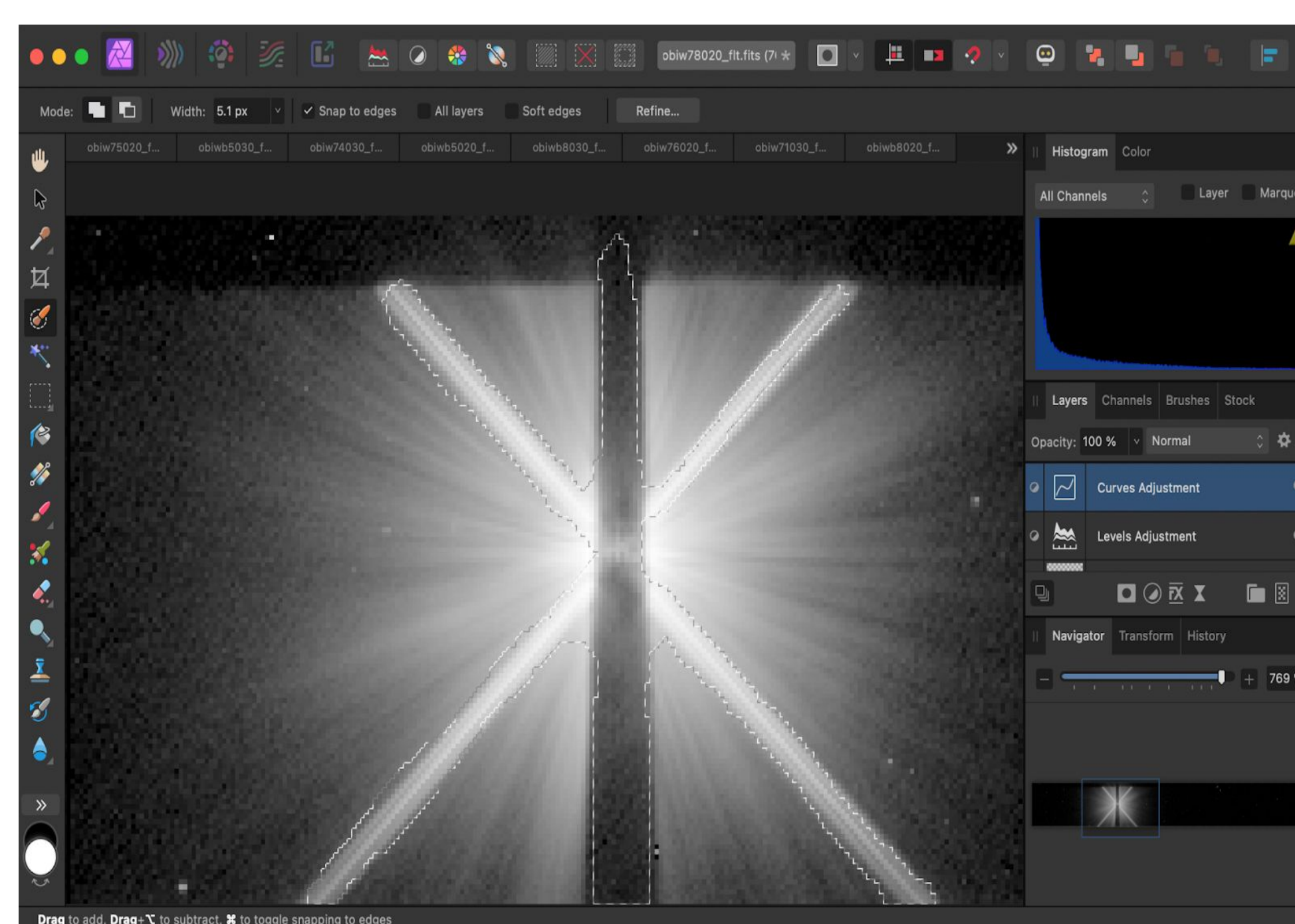
Schneider, et al. AJ, 148, 59

Objectives

1. Can new ways of digital masking help to find important features in our data, and reconstruct the data blocked by the coronagraph during Angular Differential Imaging?
2. What insight can Point Spread Function (PSF) Subtraction and Principal Component Analysis (PCA) give us on our newly masked images?

Methods

Step 1: Digital masking using Affinity Photo

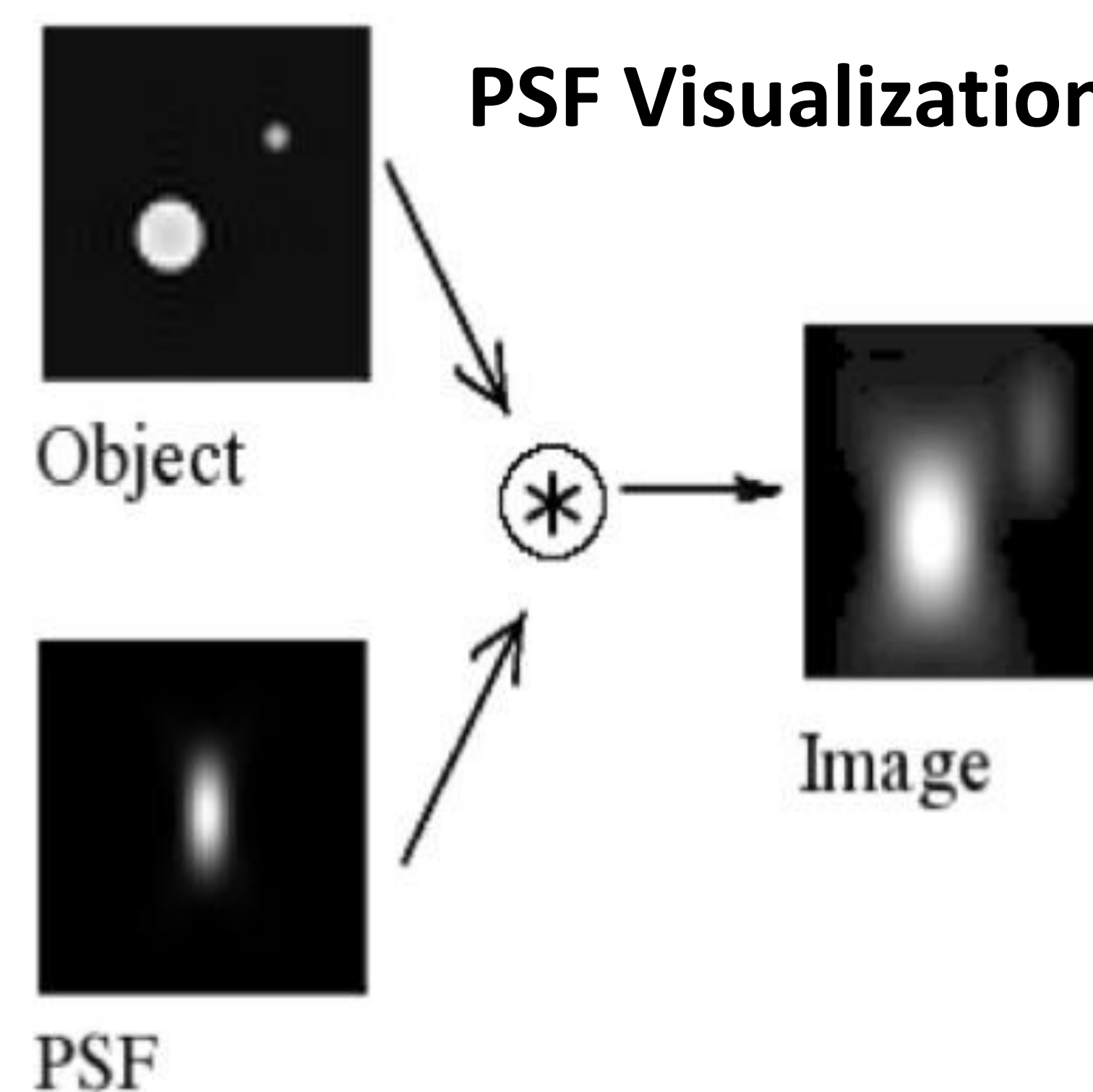


Affinity Photo Selected Region

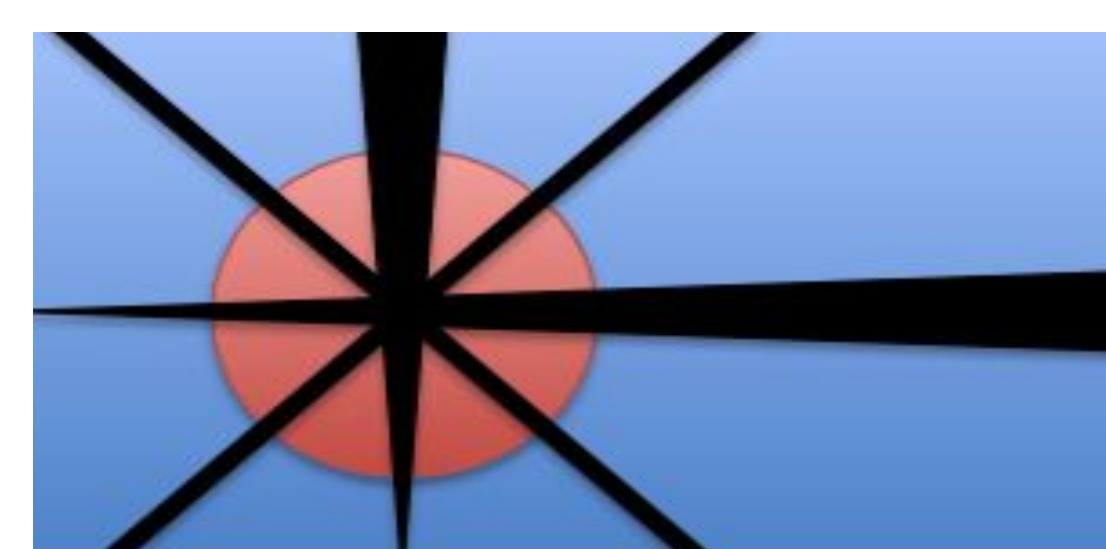
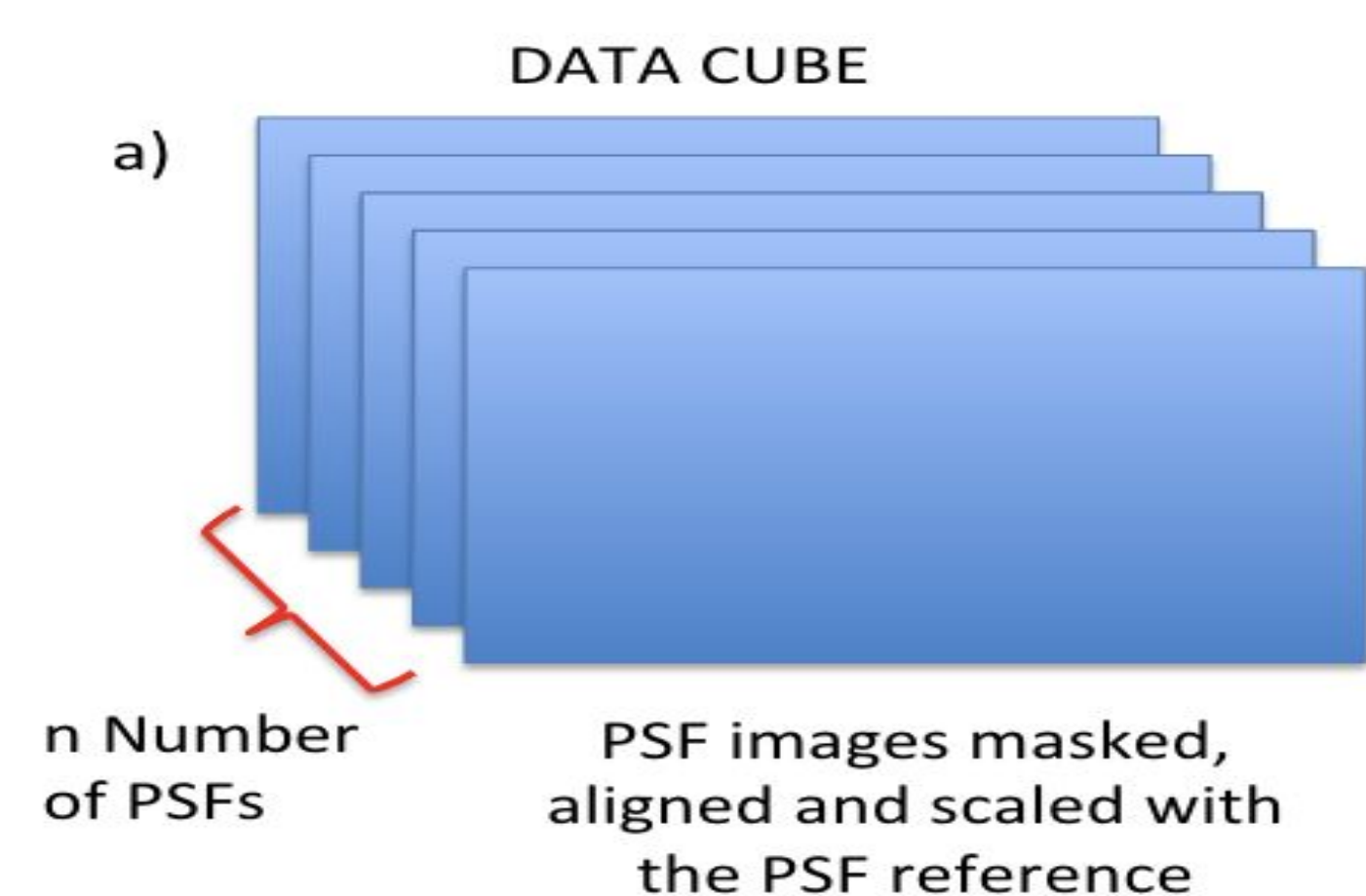
- Affinity Photo 2 is a photo editing software, which we used to carefully select regions for masking.
- Masks were created for all 27 images, then applied to the original science images using Python.

Step 2: PSF Subtraction

- A Point Spread Function (PSF) describes how light spreads from a point source in an image.
- PSF subtraction involves removing the PSF contribution from an image to reveal the underlying structure or features.
- Python was used to perform PSF subtraction on our 27 images.



Step 3: Principal Component Analysis (PCA)

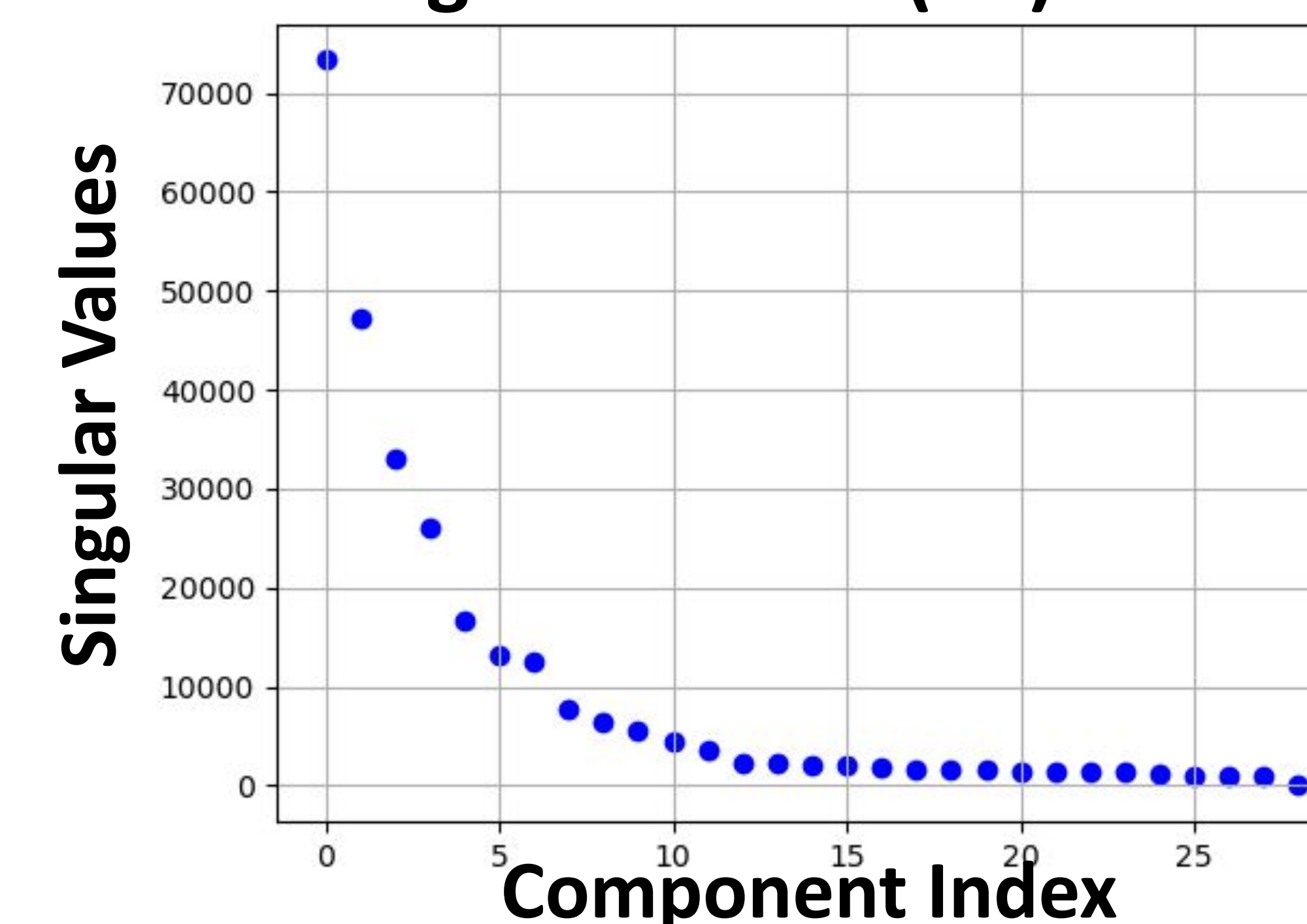


PCA Visualization

- PCA is a statistical technique used to reduce the dimensionality of data by identifying patterns and extracting the most important features.
- Python programming was used to perform this analysis.

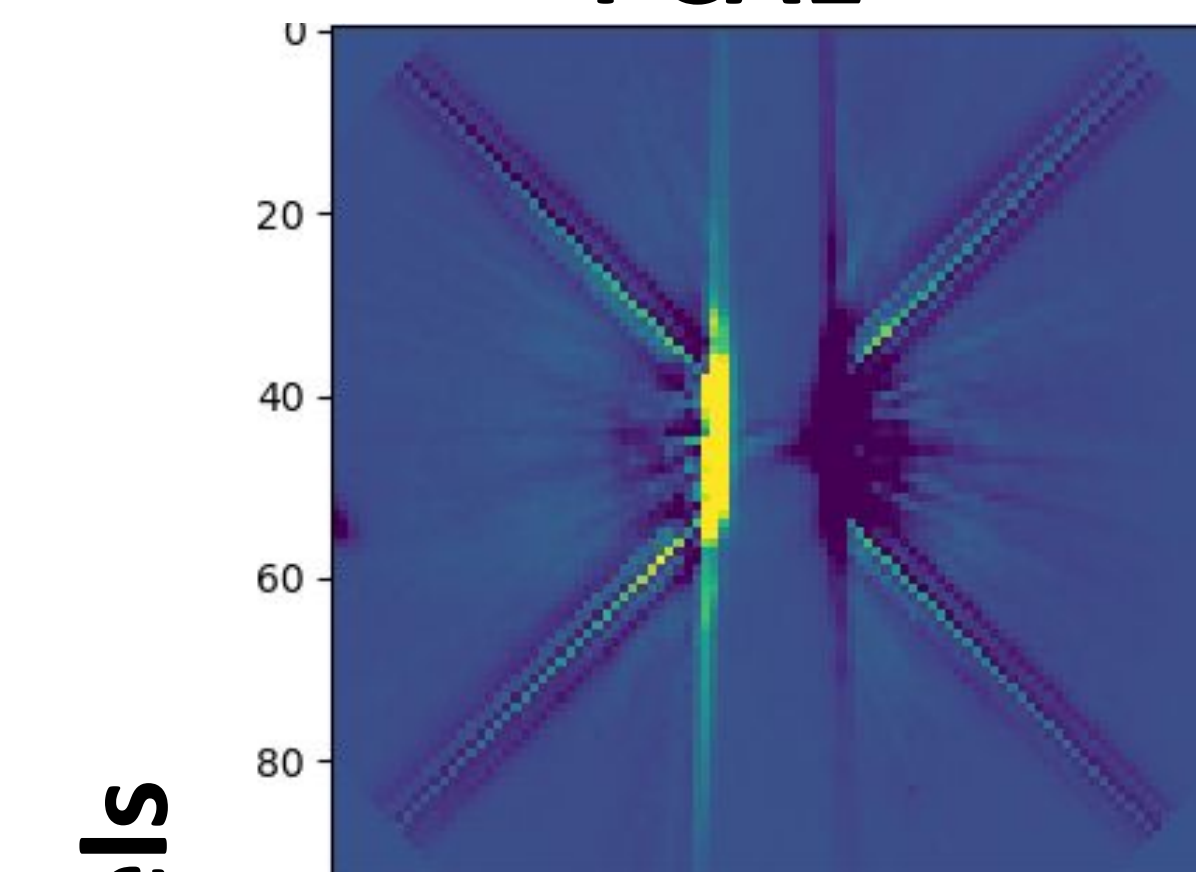
Results

Singular Values (SV) Plot

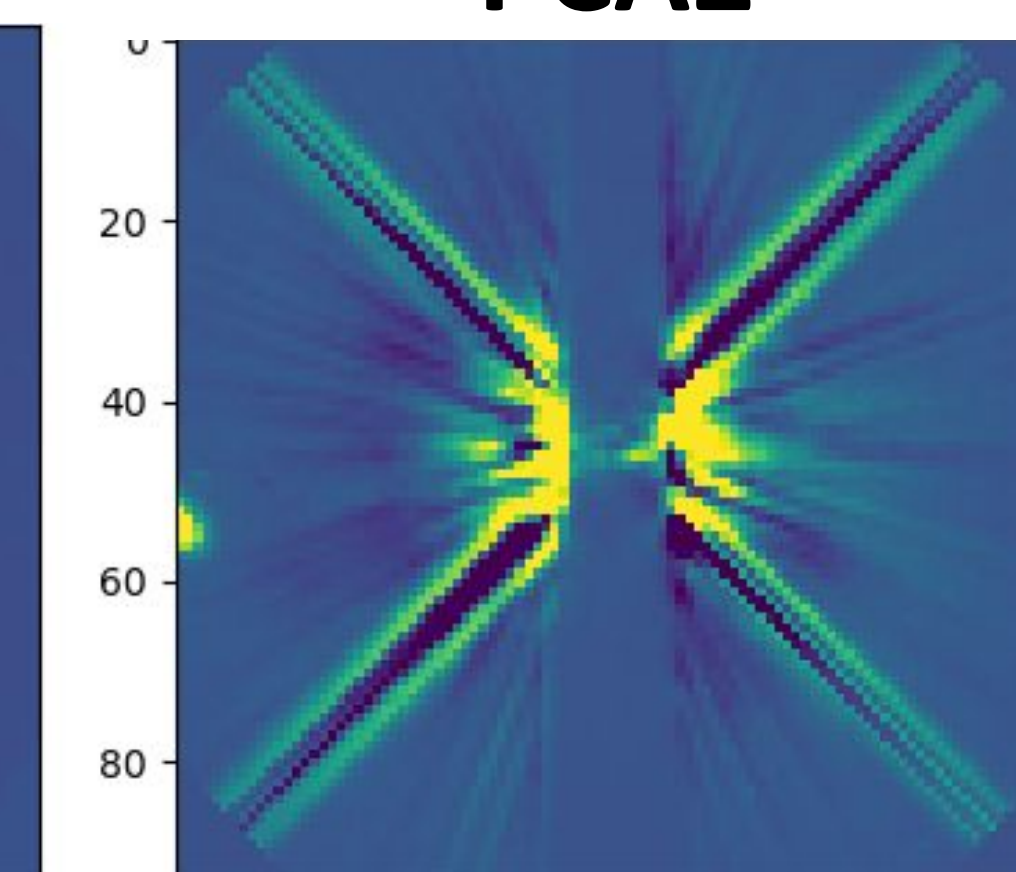


- The plot shows the singular values, which represent the contribution of each component in capturing the variability of the data.

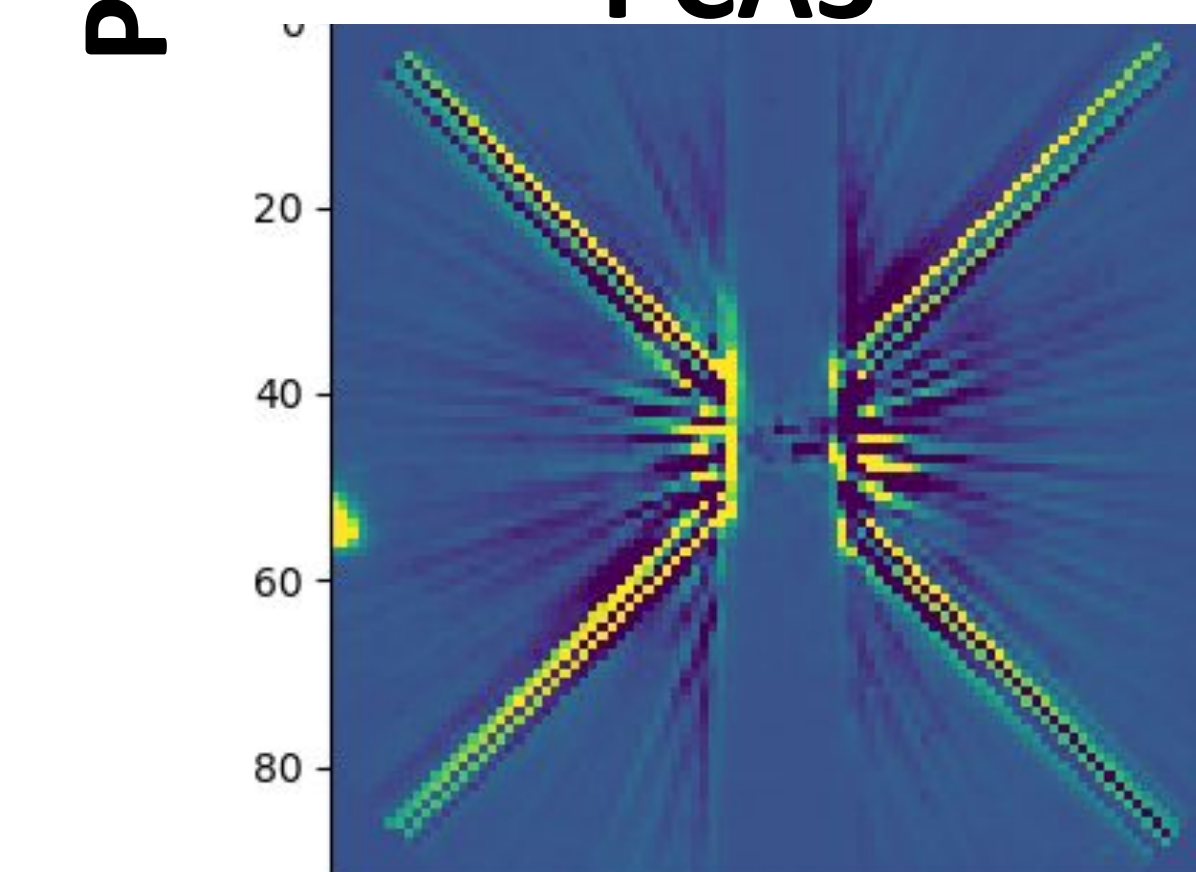
PCA1



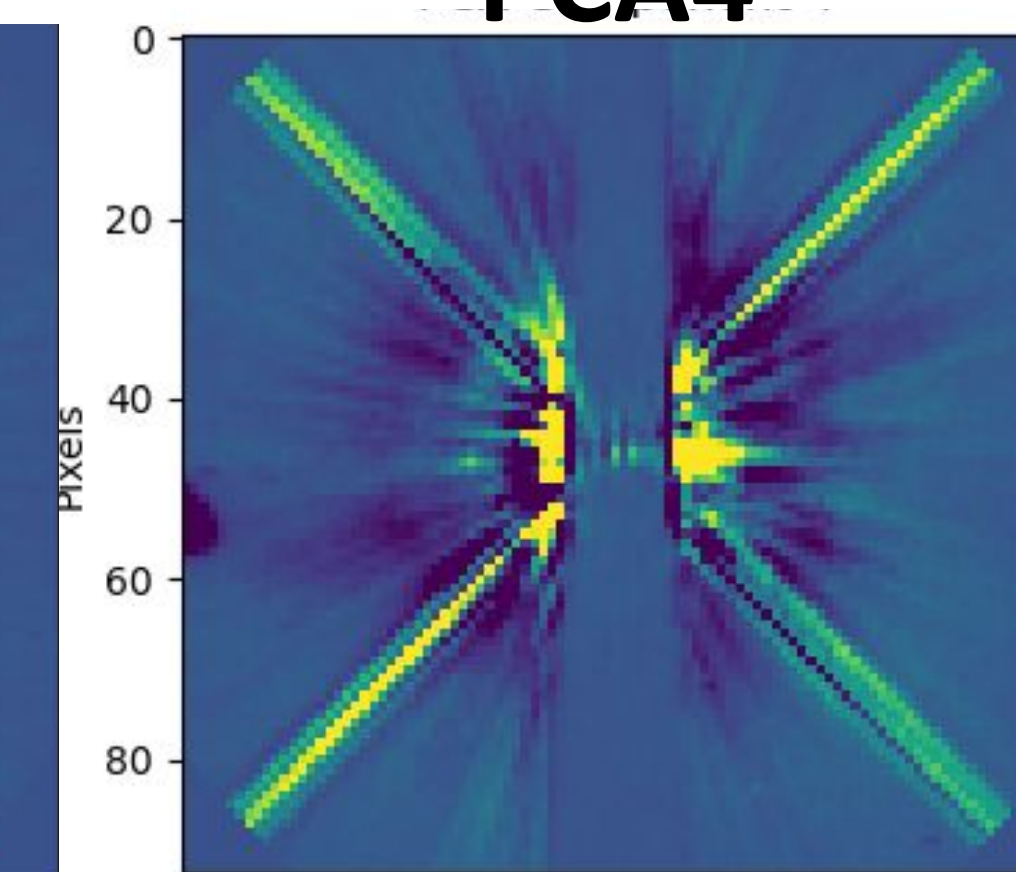
PCA2



PCA3



PCA4



Pixels

- The PCA plots visually represent the reconstructed data based on the principal components, highlighting the dominant patterns or structures captured by the analysis.

Future Work

- Further analysis involves comparisons of standard deviations of PSF subtractions to extract patterns.
- Further refining of masking techniques could increase our ability to detect faint features in HD15745's scattered light disk.