Observational Astronomy: A look into W3(OH) Cluster

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Introduction

We present part of a larger project seeking to map the global distribution of star formation in the Galaxy and provide a new determination of the Galactic star formation rate (SFR). In this poster we demonstrate the procedures used for the data reduction, astrometry and photometry calibrations of the W3(OH) cluster. The images reduced were taken using the WIYN High-resolution InfraRed Camera (WHIRC) with broadband filters *J*, *H*, and K_S. In these images we removed the sky backgrounds, artifacts, and aligned the dither patterns of our observations by performing a variety of arithmetic functions in PyRAF and IDL. Astrometric and photometric calibrations were performed by comparing the stars in our WHIRC images to the Two-Micron All Sky Survey (2MASS) point-source catalogue. Our reduced data yield a color-color diagram representing the stellar population of W3(OH) that gives information on the foreground reddening and circumstellar disk fraction of the cluster.

WHIRC & 2MASS

WIYN (Fig. 1) is a 3.5-meter telescope which is operated in collaboration between the University of Wisconsin, University of Indiana, NOAO, and the University of Missouri. The WIYN high-resolution infrared camera (WHIRC) produces high resolution near-infrared images in multiple filter bands. Infrared wavelengths can penetrate dust, revealing young star clusters that are obscured at visible wavelengths. WHIRC has good sensitivity for a ground-based detector. It is the smallest camera built of its kind, costing an inexpensive $1.6 million (compared to the *Hubble Space Telescope*'s $1.5 billion cost). 2MASS was conducted between 1997 and 2001 and covered 99.998% of the celestial sphere delivering precise Astrometry and Photometry values, as well as producing 4.1 million FITS images. This data was used to produce the 2MASS All Sky Data Release which was released to the public in 2003 (Fig. 2).

Figure 1. WIYN telescope used for our observations.

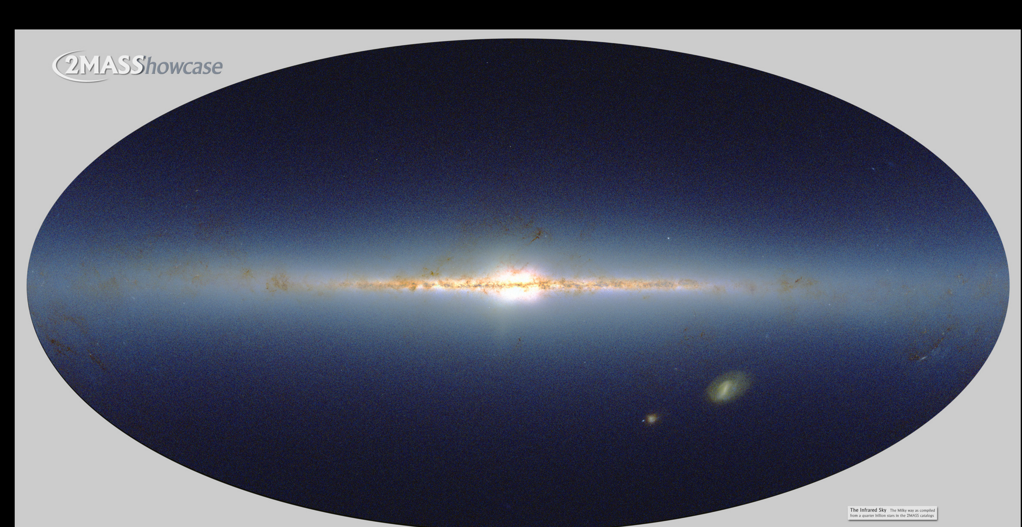


Figure 2. 2 Micron All Space Survey point sources used for our astrometric registration and photometric calibrations.

Data Reduction

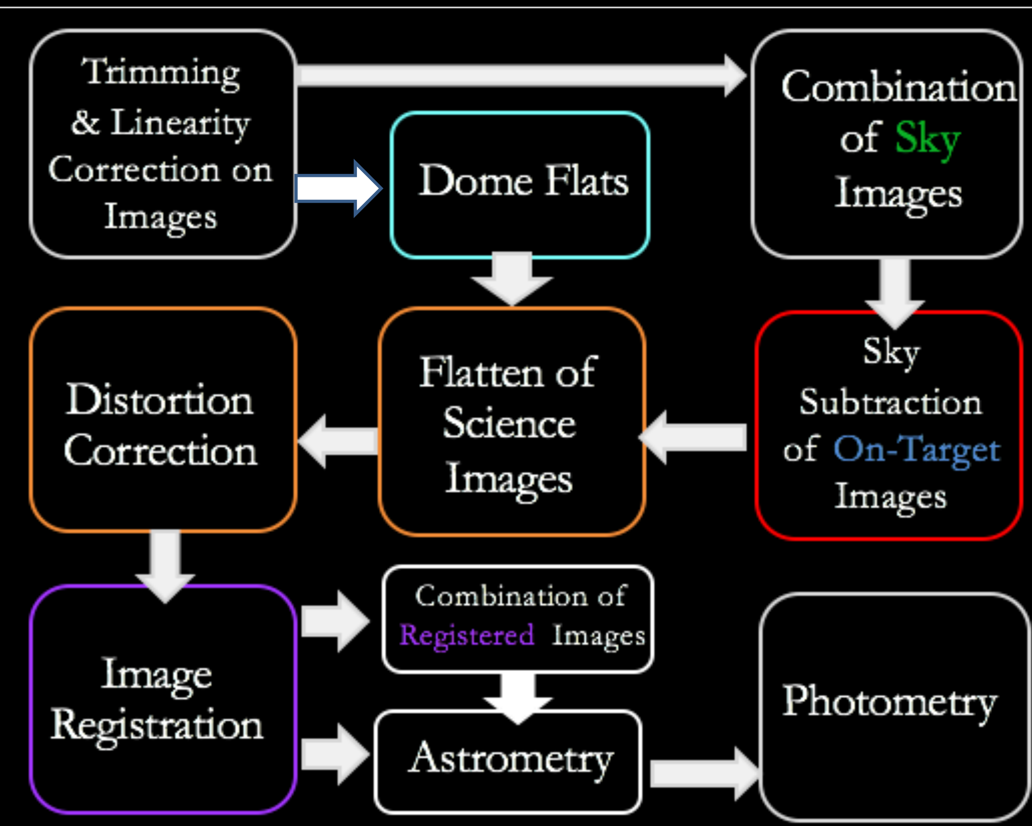


Figure 3. Flow chart showing the steps taken in reducing the data.

Sky Subtraction, Flattening & Distortion Correction

On-target images were taken pointed at W3(OH), while sky images were taken a couple degrees away, in a field relatively empty of stars. We subtract the sky images from the on-target images to remove the sky background and instrumental backgrounds such as dark current and pupil ghosts **(Fig. 4).**

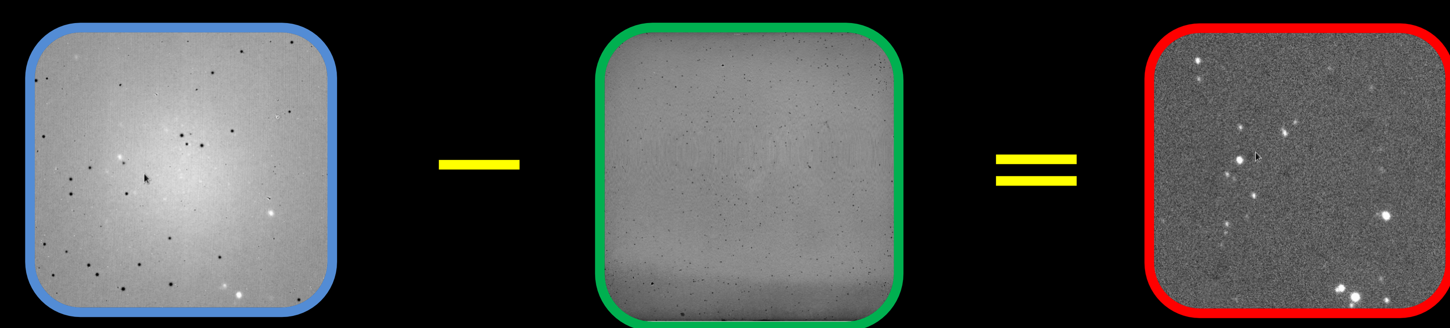
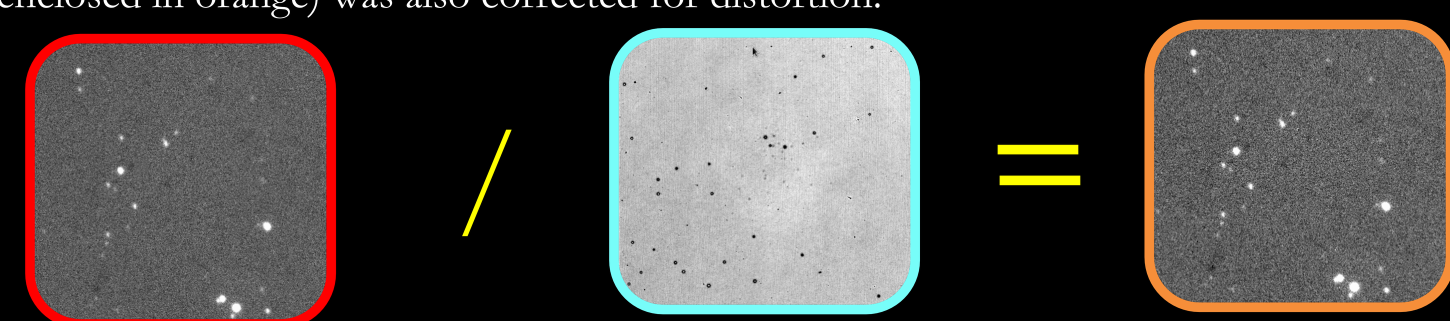


Figure 4. Visualization of sky subtraction (enclosed in green) from our on target images (enclosed in blue) for our Ks filter.

Figure 5. Visualization of the flattening of the image in Figure 3. The sky subtracted image (enclosed in red) was divided by dome flats (enclosed in sky blue). The final product (enclosed in orange) was also corrected for distortion.



Flattening corrects for gain (quantum efficiency) variations across the detector measured for each filter independently. Flattened images were then corrected for optical distortion using a geometric transformation **(Fig. 5).**

Registration, Astrometry & Photometry

Registering images is crucial because each image was obtained as part of a dither pattern, by offsetting the pointing of the telescope from the target center. We align stars common to all images, so that when we combine the dithered images the stars average together but artifacts are rejected (Fig. 6). Following from registration we determine how the pixels in our images are matched to positions in our sky which is known as astrometry. Aperture photometry was performed in each filter using an IDL Photometry Visualization Tool to detect stars and measure magnitudes calibrated against the magnitudes of 2MASS stars identified in our WHIRC images.

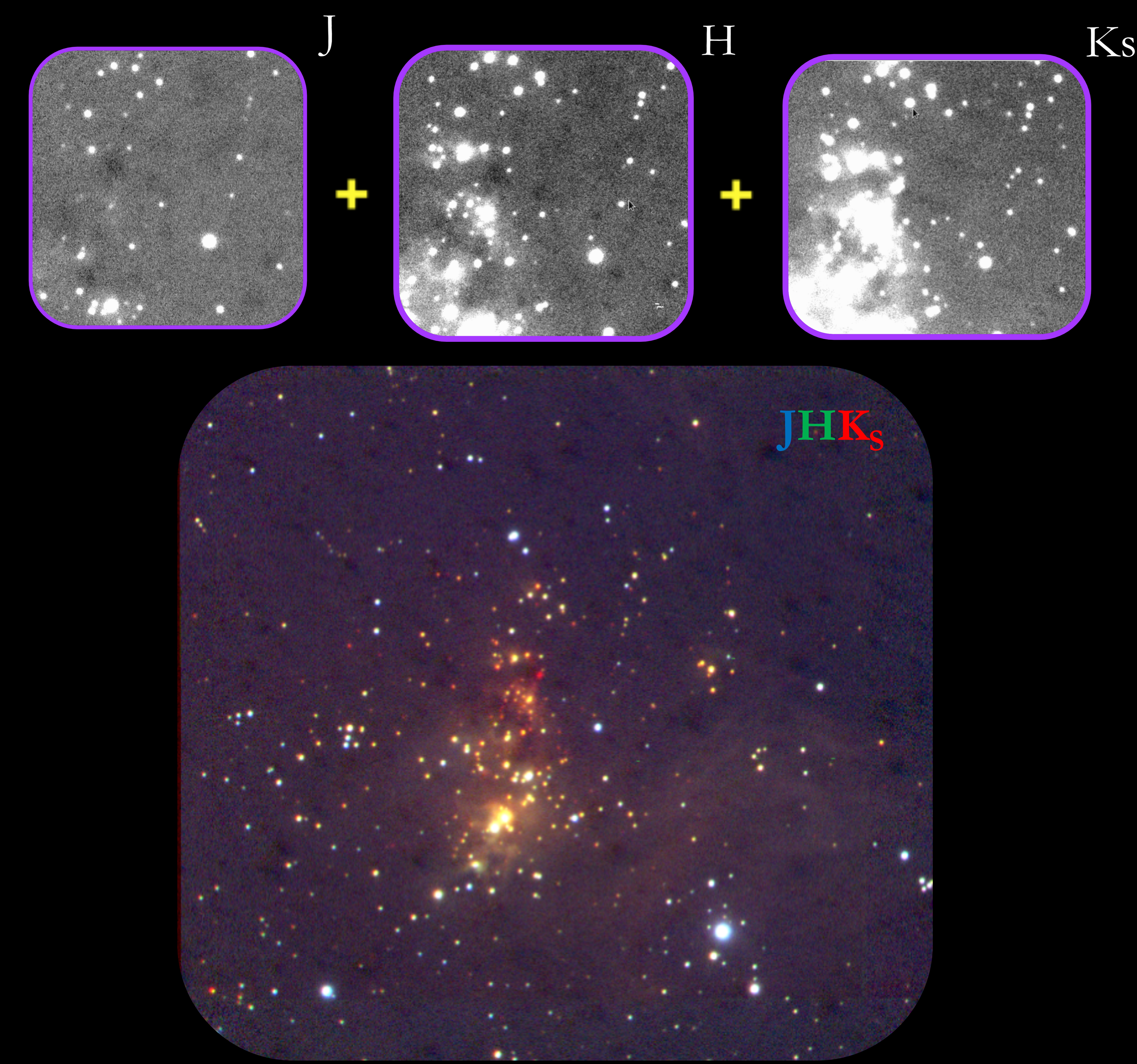


Figure 6. *Top:* Registered images in each filter. *Bottom:* RGB color composite image combining all three filters.

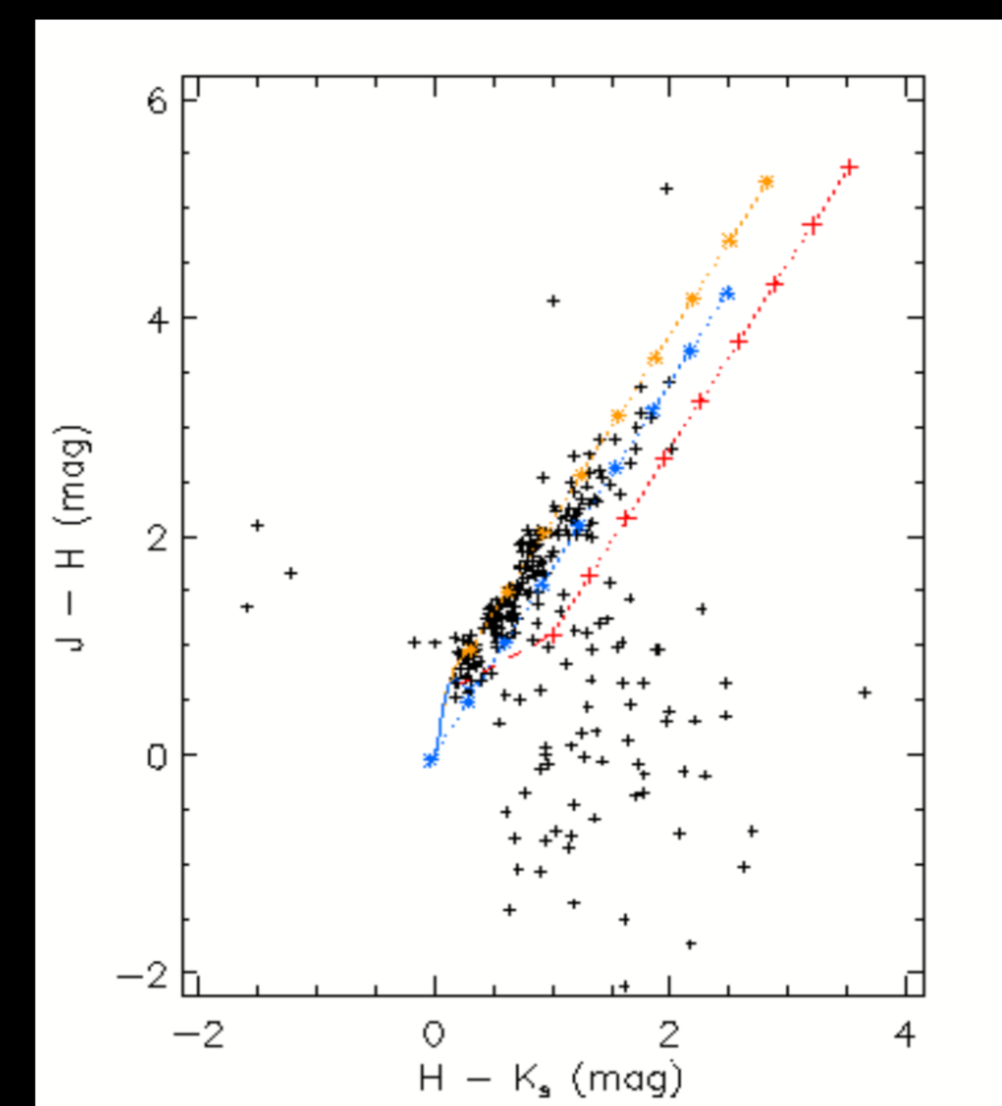


Figure 7: Results

Color-color diagram showing the subset of the 541 point sources detected in K_S that were also detected in *J* and *H*. Strong differential reddening is evident, with the majority of cluster members obscured by 5–20 visual magnitudes. Stars with anomalously blue $J-H$ or $H-K_S$ are probably spurious detections in at least one filter.

References

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