Absolute Relative Photometry For DES

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What Is DES and What Is The Goal?

The Dark Energy Survey (DES) (Sevilla-Noarbe et al. 2021) is mapping the cosmos to refine the constraints on the Dark Energy Equation of State. To refine this equation DES uses different means to understand dark energy. These means are geometry, expansion, and the structures of the cosmos. Each technique has specific targets, for instance: expansion is derived from the thousands of supernovae DES has viewed, geometry of the cosmos relates directly to Baryon Acoustic Oscillation (Bassett et al. 2009), and the structures relate to gravitational lensing and viewing galaxy clusters to also help in determining the makeup of the cosmos. The DES telescope is shown in Figure 1. Our contribution to this project is to calibrate the absolute relative flux of the stellar component of the survey.

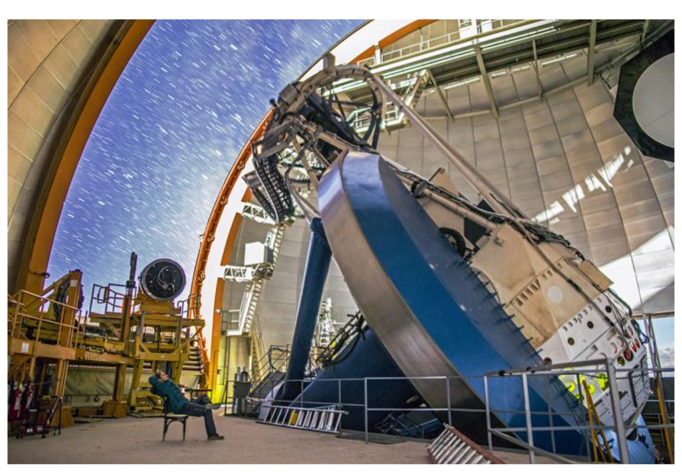

Figure 1: The 4-meter Telescope DECam in the Chilean Andeas at CTIO

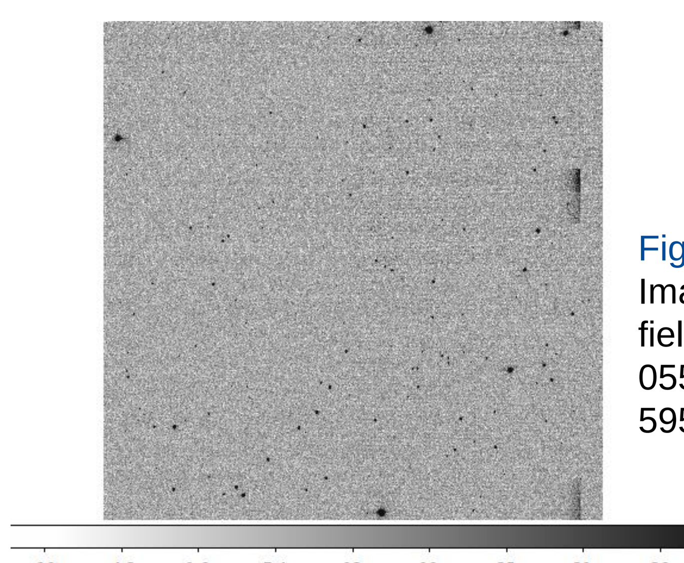

Figure 2: Image of field 055950-595600

Current Work

Currently I am extracting the magnitudes of DA white dwarfs (pure hydrogen atmosphere). For this I use the software IRAF (Tody, et al., 1986) (Image Reduction and Analysis Facility). Figure 2 depicts what images look like throughout this process. This project uses the Sloan Digital Sky Survey (SDSS) ugriz standard star network (Smith et al. 2002). This network is based off the SDSS photometric system defined by Fukugita et al. (1996). The extraction aperture for this system is 14.86 arc seconds and we use the plate scaling of the specific telescopes used to obtain a specific aperture (in pixels) for the given telescope. The SDSS uses the AB magnitude system: a wideband variant of monochromatic flux and is based on BD+17:4708. This is different from the Vega magnitude system.

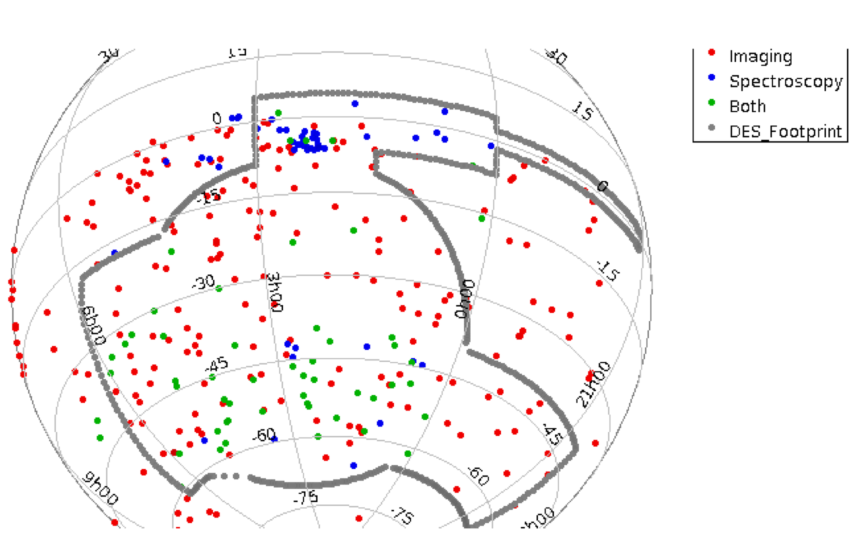

Figure 3: This graph shows the DA white dwarfs we have photometric and spectroscopic data of within the DES footprint

Figure 4: SMARTS 0.9-meter (m) telescope on Cerro Tololo in Chile

Future work

Once the instrumental magnitudes are obtained, we can calculate the extinction coefficient values. Extinction coefficient values account for the dispersed light from star to telescope. We use the standard stars to calculate the extinction coefficient then apply these to the DA white dwarfs. This gives us the magnitude of the stars at the top of the atmosphere. The white dwarfs being used are shown within Figure 3. The accuracy of the magnitude is then checked by a process called synthetic photometry. Synthetic photometry is the process in which you calculate magnitudes based on what the magnitude would be through different filters. We then compare the synthetic photometry to our magnitudes to determine whether our answers are accurate.

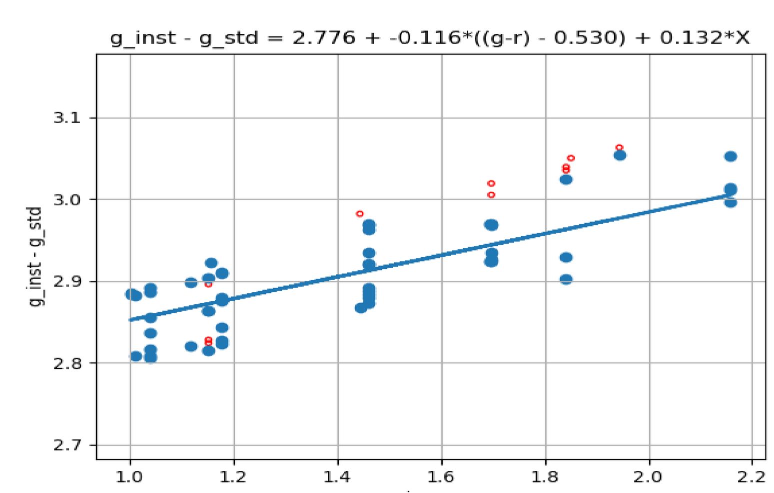

Figure 5: This graph shows the difference of instrumental magnitude and standard magnitude plotted against airmass to result in the slop being the extinction coefficient.

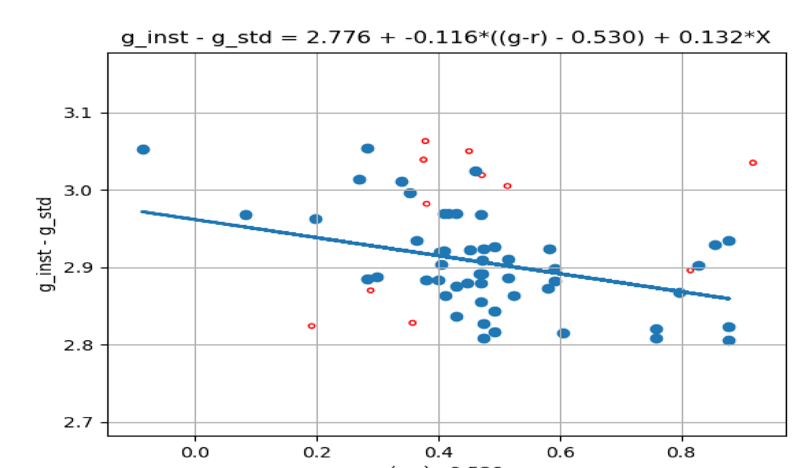

Figure 6: This graph shows the difference of instrumental magnitude and standard magnitude plotted against the observed color minus cosmic color. From this graph you derive the color transformation of the g filter.

Results and Conclusion

We used the 0.9m Small and Moderate Aperture Research Telescope System (SMARTS) at Cerro Tololo in Chile. Figure 4 shows a picture of the SMARTS 0.9m telescope. This telescope provided the data we used for Figures 5 and 6 on October 20, 2018. Figure 5 shows an example of the extinction coefficient from the slope, zero point, and the color transformation. Figure 6 obtains the color term we use in Figure 5. In conclusion this night seems to have higher residuals from the standard stars causing a higher uncertainty than expected.

References

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