Weak-Lensing in the DELVE Survey

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What is weak lensing and the DELVE Survey?

In cosmology, we know that distant galaxies can have their light warped through the process of weak lensing. This is when the filament structure of the universe bends the light reaching us. The intensity of this "warp" can be correlated with the mass of a filament, which we call shearing. We can measure the intensity of this shearing and use it to measure the growth of structure in the universe. The growth of cosmic structure is a sensitive probe of both dark matter and dark energy (B. Ryden, 2017).

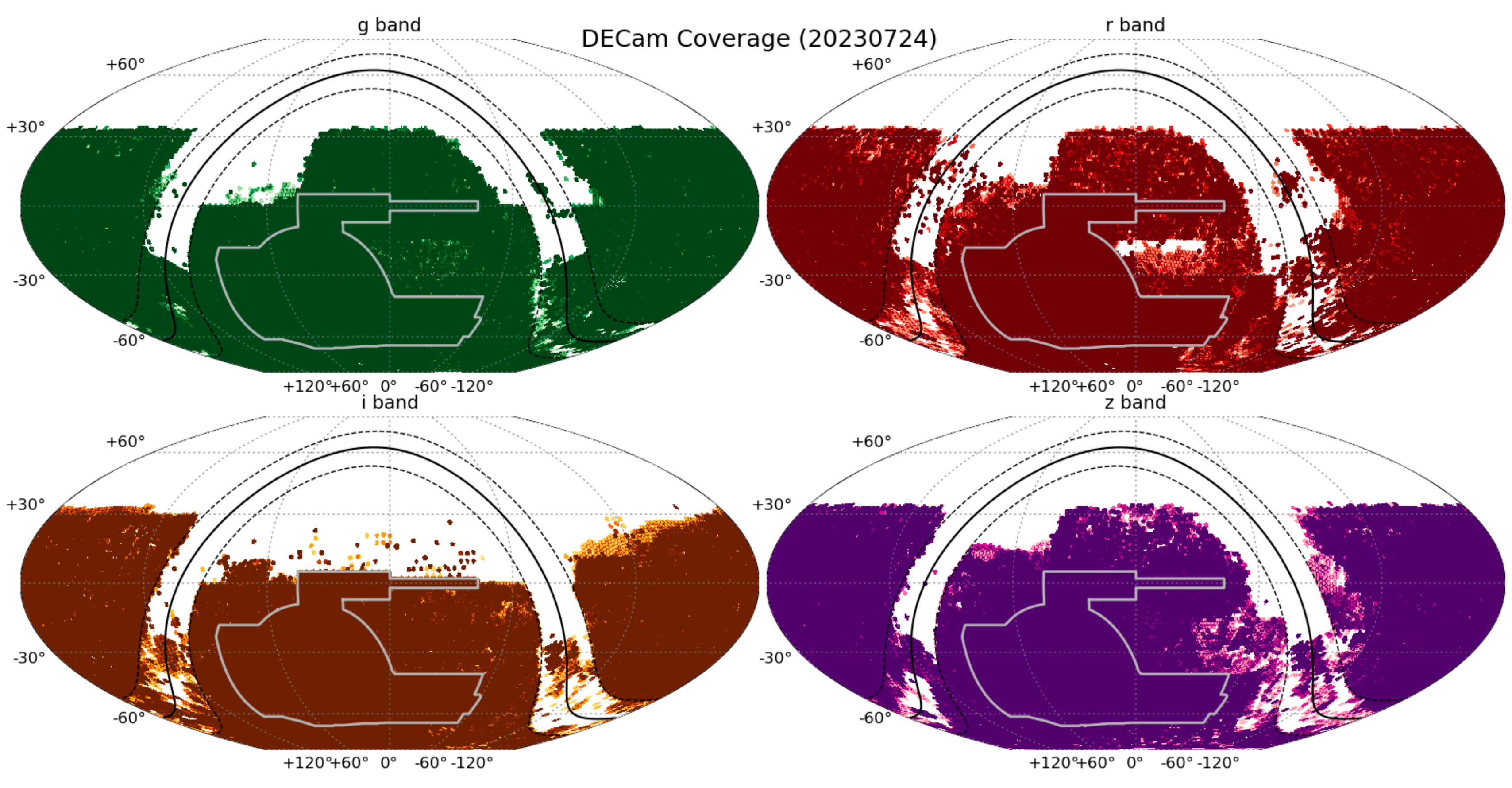

Fig 1: Graphs showing the DELVE footprint and coverage in the g, r, i, and z bands. The white outlined region shows the Dark Energy Survey (DES) footprint, a sky survey which also utilized DECam to study weak-lensing among other cosmological probes.

The DECam Local Volume Exploration (DELVE) Survey is a sky survey which utilizes DECam mounted on the 4-meter Blanco Telescope to observe 17,000 deg^2 of the southern night sky (DELVE Collaboration, 2021). This wide coverage provides us with a large sample of galaxies where we can study the effects of weak-lensing from the filamentary structure of our universe in excellent detail.

Improving Shear Measurements and Eliminating Imaging Artifacts

One of the main problems with measuring shear signals from galaxies found in large sky surveys is ensuring that you are selecting quality data to use. Modern surveys generate so much data that its almost impossible to look at every image you're using in your study. Developing tools to shrink down the human workload can help with identifying these errors in a timely fashion.

B. Ryden, *Introduction to Cosmology,* 2nd ed. (Pearson Education, Inc., 2017)
DELVE Collaboration, "The DECam Local Volume Exploration Survey: Overview and First Data Release," ApJS 256(1), 2 (2021).
DES Collaboration, "The Dark Energy Survey Data Release 2," ApJS 255(2), 20 (2021).
Morganson et al. "The Dark Energy Survey Image Processing Pipeline," PASP 130(989), 074501 (2018).

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Using cuts based on the DES Y6 Gold catalog (DES Collaboration 2021), we were able to identify suspicious coadded tiles (like the one above) and have them reprocessed (Morganson et al. 2018). We then implement these cuts to remove objects which are not likely physical objects or have poor quality.

With these imaging artifacts removed, we will then construct a magnitude-limited galaxy sample, where we can begin to understand how matter is distributed within the DELVE footprint.

Given DELVE's wide sky coverage, we can gather important information on ΛCDM and place limits on the energy densities of the universe. Shear measurements combined with measurements of galaxy clustering gives us extensive insight into the underlying physics of our universe.

Fig 2: An example of an astrometry error in DELVE DR3. These errors are caused by misalignment of the images being added together, often in different bands, causing these odd-colored objects.

Conclusions and Future Work

Over the course of the summer, our team has developed code to aid the cosmic shear working group within DELVE to develop a quality, magnitude-limited galaxy sample. Filtering out these imaging artifacts brings us one step closer to testing our cosmological models.

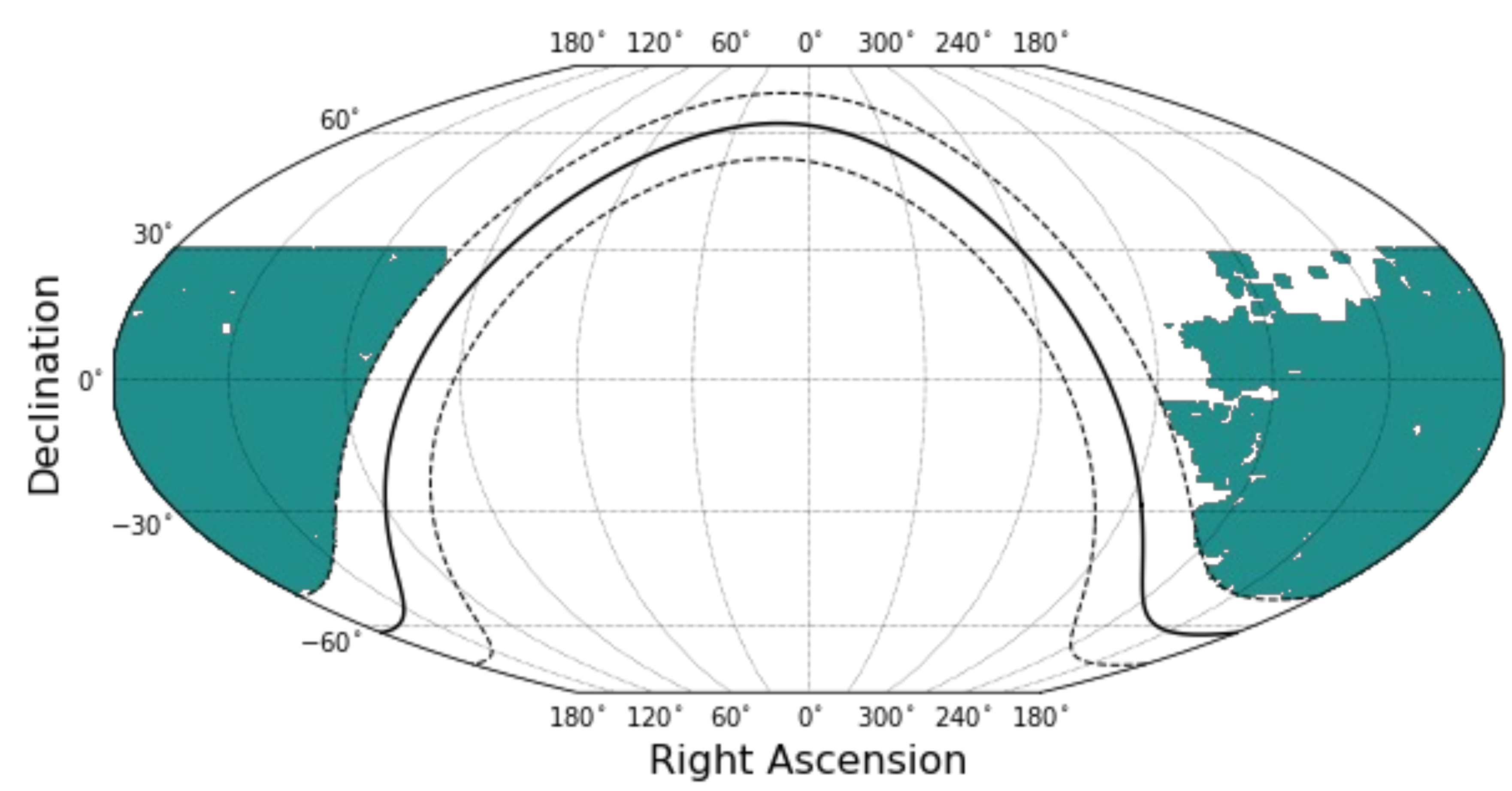

Fig 4: To better understand what objects should be used in our studies, we made high-resolution coverage maps so that we only use objects which have been imaged in the bands we are interested in (typically r, i, and z for cosmic shear measurements).

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