Sample Selection and Bright Star Masking in DELVE

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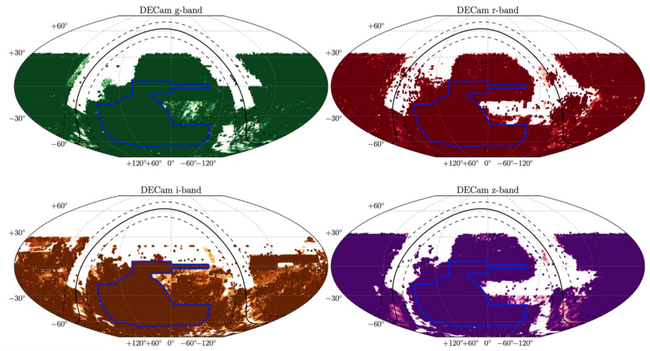
Introduction

We study dark energy through its effects on geometry and growth of structure. One of the ways we can do this is through galaxy surveys.

The DELVE survey images the sky in different bands (g, r, i, z). By taking information from the filters, we can determine how far each object is. Gathering a sample of galaxies and analyzing their large scale structure can give us new cosmological information.

However, not every single object detected by DELVE is a galaxy. First, we must select our sample of galaxies and mask out bright stars.



Completeness in each of the four regions of DELVE. The tank-shaped region is also covered by DES (the Dark Energy Survey) . DELVE is most complete in the g-band.
Credit: A. Drlica-Wagner — private comm.

Sample Selection

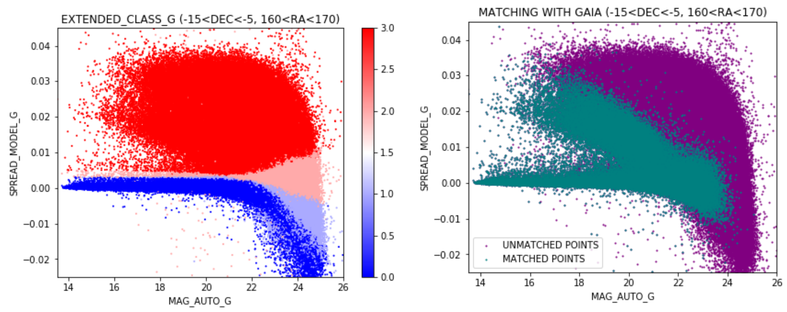
One method of distinguishing galaxies from stars is by using `EXTENDED_CLASS_G`, which takes spread model values (where a positive value likely indicates a galaxy) and spread model error values to determine whether an object is likely either a star or a galaxy (Drlica-Wagner et al. 2021).

`EXTENDED_CLASS_G` is defined as:

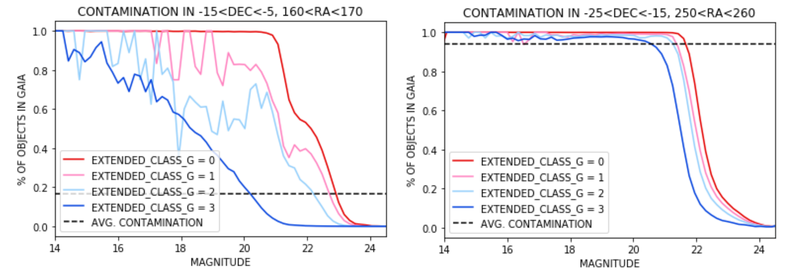
```
((spread_model_g + 3 * spreaderr_model_g) > 0.005) +
((spread_model_g + spreaderr_model_g) > 0.003) +
((spread_model_g - spreaderr_model_g) > 0.003)
```

An `EXTENDED_CLASS_G` value of 3 would mean a high-confidence galaxy. 0 would mean a high-confidence star.

We then matched all objects with the GAIA catalog. Because we are very confident that GAIA objects are stars, we can determine the level of stellar contamination in `EXTENDED_CLASS_G`.



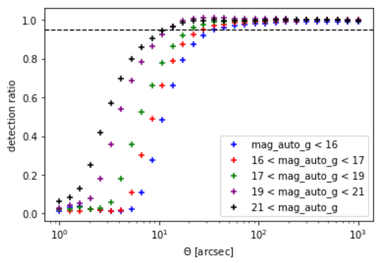
Left: **Plot of `EXTENDED_CLASS_G` over one region of the sky.** ***Right:*** **Plot of GAIA matches over the same region, where teal points are in GAIA/likely stars.**



Left: **Stellar contamination in -15<DEC<-5, 160<RA<170.** ***Right:*** **Stellar contamination in -25<DEC<-15, 250<RA<260. Because stellar contamination is so high in that area, it tells us that we should not include that in our sample**

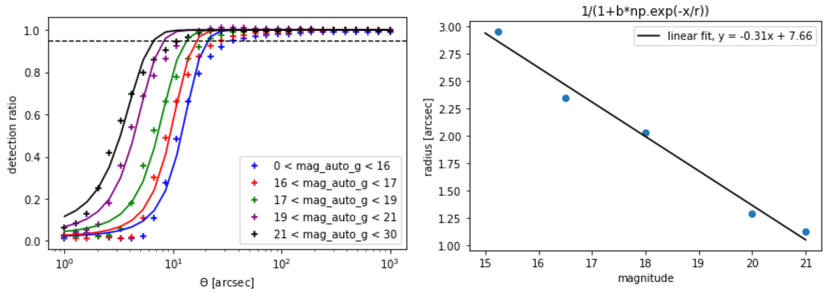
Bright Star Masking

Similar to ordinary photos, bright objects in DELVE mask out dimmer objects beside them. We want to see how galaxy detection drops around bright stars as a function of radius and magnitude.



Left: **Detection ratio (number of galaxies detected around a star over the number of galaxies detected around a random point) as a function of radius away from the star and the magnitude of the star, in -15<DEC<-5, 160<RA<170.**

We can then fit a an exponential function onto each of these curves, and extrapolate how large our radius should be when we mask out the bright stars, as a function of magnitude.



Left: **Detection ratio plot with fitted curves of y = 1/(1 + b*exp(-x/r)).** ***Right:*** **Taking the value of *r* for each magnitude and determining a linear fit as a function of magnitude to determine masking radius for each star, in arcseconds.**

Conclusions and Future Work

We have determined a way of establishing whether an object in DELVE is a galaxy and star, and by comparing to a pre-existing catalog of stars, we can eliminate both magnitude ranges and areas of the sky where stellar contamination is very high. We have also determined the detection ratios around bright stars, and how large our radius should be to mask out such stars.

Our next step will be to take our masking radii and generate a mask for bright stars. From then on, the DELVE LSS group can use the map and the galaxy sample to describe the large scale structure of galaxies, and obtain new constraints on the cosmological constant.

Acknowledgements

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