The Polar Bear Telescope
A Variable Star and Light Pollution Monitor for the Armagh Observatory

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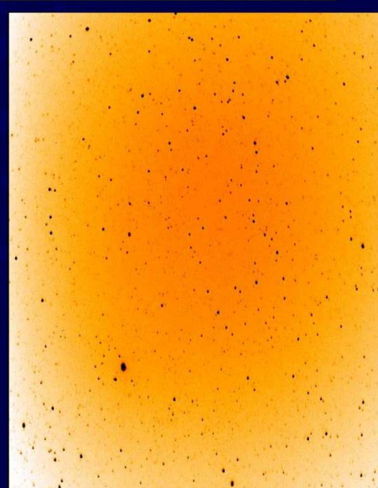
We were given a clear list of goals at the start of the project, these included:
- to obtain a time series of images of the night sky over hours and nights,
- to process these images so that they can be used for scientific measurement,
- to develop an algorithm for identifying the stars visible on each image,
- to develop an algorithm for measuring the light from each star in each image,
- to make a catalog of stars visible, with their magnitudes,
- to obtain light curves for a significant number of these stars,
- to pay due regard to the measurement errors at each stage of the project.

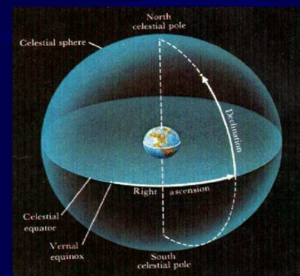
To the right here is an image of Polaris which is a part of the area of sky that the cameras will be focusing on to try and get results from. The actual cameras are focused on the North Celestial Pole, however Polaris is very close to this and will feature in all the images we receive.

This is an example of the images we receive from the cameras. This image contains details of how much brightness is coming from each star. The next thing to do is obtain co-ordinates for each star so we can work out what star on the image corresponds to what star in the night sky.

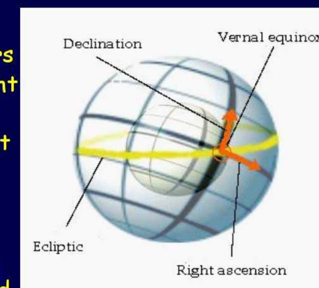


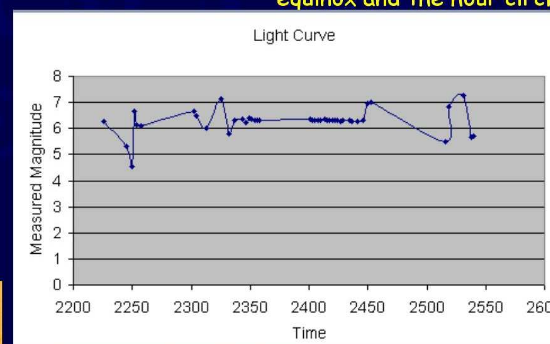
To do this we will use a computer program "Astrometry" which will convert the x/y co-ordinates to right ascension and declinations. It does this by picking out patterns of stars in your picture, comparing it to its catalog of the night sky and working out what area of sky your picture is focused on.

We can also use a cut across on this image to form a light curve across any of the stars shown, however this is pointless for the brighter stars as our light curves become saturated as they could only record so much light.



Equatorial Co-ordinate System:
This is the co-ordinate system used by astronomers to plot stars and other celestial objects in the night sky.
It has the vernal equinox as its origin, or zero point for the hour circles.
The declination is defined as the angular distance above or below the celestial equator, form -90 to +90.
The right ascension is the angle measured eastward along the celestial equator between the vernal equinox and the hour circle intersecting the point.





Light Curves:
To the left is an example of a typical light curve. This takes the brightness counts received from images of stars and plots them against the time of exposure. Our final goal will be for the computer to be able to track the one star over frames over several nights, then take the results from this and plot it in a light curve. The main problem with this plan is getting the computer to recognize and record the same star in every image. This is an image for one star which we tracked using an experimental program.

Error:
Error had to be clearly taken into account if i wanted to get accurate results at the end of my project, as not taking error into account at any stage would only cause that error to multiply as the project progressed.
One key area where i had to minimize the area was in the output from "Astrometry" Originally this error was quite large, due to problems with the image, such as vignetting. I improved upon this by only using the central part of the image. We were to improve the error even more by the use of flat fielding.

Acknowledgments:
I would like to thank all those that provided support and help as i progressed through my project at Armagh Observatory; Dr. Simon Jeffery, my project mentor and also everyone else in the observatory who were helpful and were always on hand to provide advice.