Search for young eclipsing binary stars

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Eclipsing Binaries: Background

Eclipsing binaries are a special type of binary star system, in which periodically one star eclipses in front of the other. The probability of being able to observe such a star system is so low, that to date there has only been three systems cataloged among very young stars.

Eclipsing binary star systems are important because astronomers can use them to measure the masses of the two stars, which is the most important property of the star.

Detecting eclipsing binary stars involves the monitoring of how the brightness of a system rises and falls; the brightness drops when one eclipses the other, partially or completely blocking the light from the one behind it.

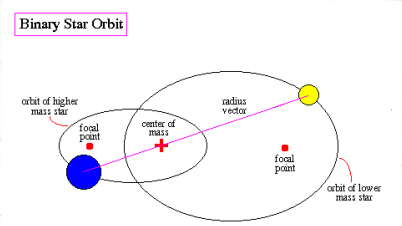


Image Subtraction

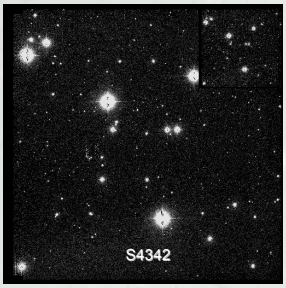
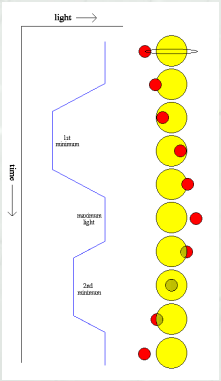


Image subtraction is a relatively new method used to identify variable and other types of stars from a series of images. This procedure consists of obtaining a series of images of a particular region, and subtracting a reference image from each. These subtracted images are then stacked, and the detection of varying light sources is performed. The results produce candidates for eclipsing binary stars.

ISIS



ISIS is a program created by French scientist, Dr. Christophe Alard to run image subtraction procedures, and was designed to run on LINUX/UNIX environment.

This project was done using the UNIX environment on an SGI computer.

ISIS works by registering a series of images, and “subtracting” a reference image from each, leaving a stack of subtracted images. Putting all these subtracted images together results in an image where variable stars are identified by bright stars in this final image.

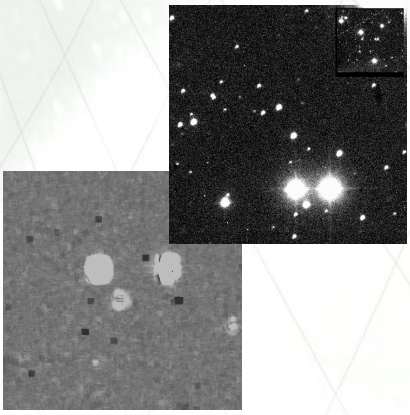


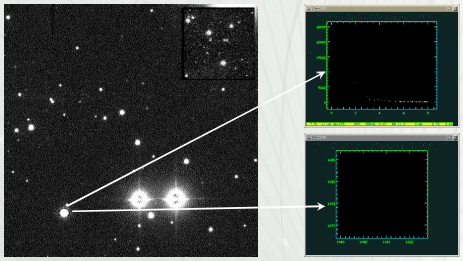
Image Selection

Before any processing can take place, each image in the set has to be inspected for good seeing. Using images that have bad seeing result in errors in the final image, probably falsely identifying stars as varying (or in our case, eclipsing), or may just result in bad pixels.

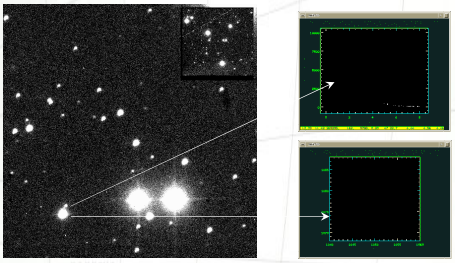
UNIX contains an image processing and analysis program named IRAF, which contains tools to verify two aspects of the image of particular interest; the radial profile and the contour of any particular star chosen in the image.

The radial profile shows the light distribution of the pixels from the center of the star in the image towards the outside of the star. A good radial profile would have a graph with as little pixel distribution as possible. In the contour analysis, the "rounder" the star indicates a better seeing image.

The Good …



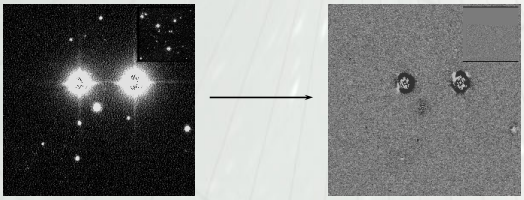
The Bad…



The Procedure

Subtraction

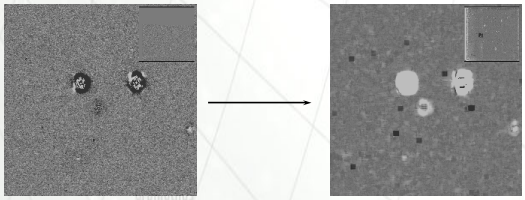
In this stage of the procedure, on reference image is chosen (or a composite of a few of the best seeing images can be made, as in this project). This reference image is then subtracted from each of the images in the set, in turn producing a set of subtracted images. The subtraction is done pixel for pixel, and no change in luminosity is usually shown as gray.



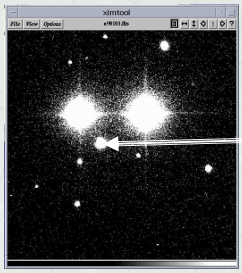
Detection

The detection stage of the procedure entails combining the set of subtracted images into one composite image, where the change in luminosity of the variable stars (usually shown in white) effectively add up.

The white spots indicate that there has been a change in luminosity, and such stars are candidates for eclipsing binary stars.



What's Next?... The Future



So far, we have been able to confirm that the procedure using ISIS does work. One of the stars in the area S4342 that we have been working with this summer is a confirmed variable star, and we are confident that this procedure would be ideal for finding eclipsing binary stars.

So what's next? The remaining stages of ISIS' subtraction procedure include finding the position of the variable stars from the composite subtracted image, and adding these coordinates to file. It would be up to the researcher from there on to determine, using the composite subtraction and the coordinates, to determine possible eclipsing binary stars.

Acknowledgements

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For more information on this project, please visit
http://wisp11.physics.wisc.edu/~reu2003/leblanc/

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