McLeanゼミ

Section 9 Exercise 6

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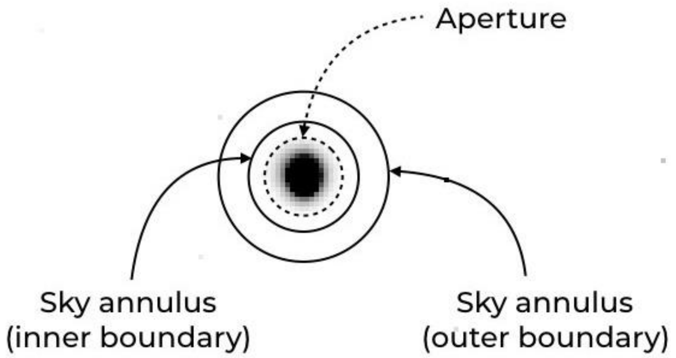
6. Explain the two approaches of extracting magnitudes from CCD and infrared images.

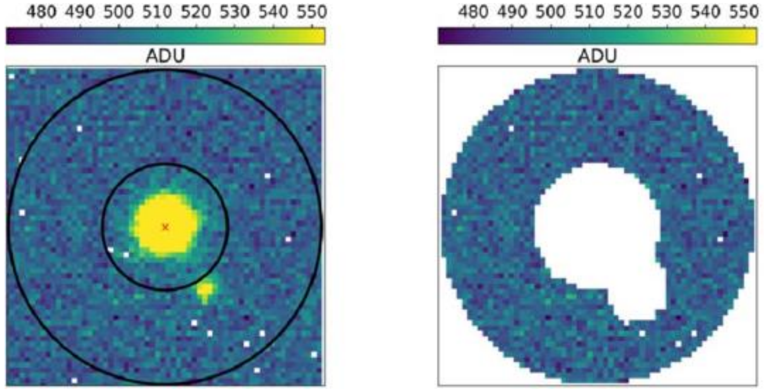
Aperture photometry

A computer program reconstructs the signal which would have been obtained from an object in the field of view if the light had passed through a physical aperture of a certain diameter.

Typically, the background sky brightness will be taken as the average in an annular ring with inner radius just beyond the limit of the object and extending a few pixels out. When one of the pixels in the sky annulus contains a star (higher signal than the rest) this value should be eliminated from the average.



https://sites.soka.edu/suo/resources/maximdl/



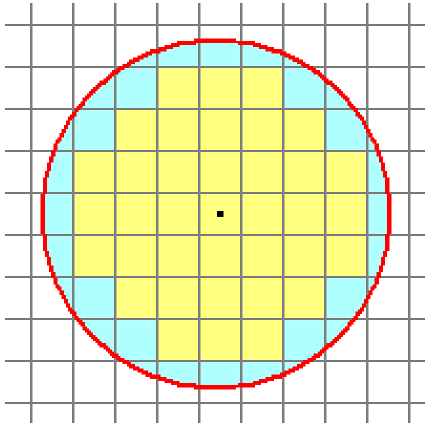
Tamburo et al. (2022)

6. Explain the two approaches of extracting magnitudes from CCD and infrared images.

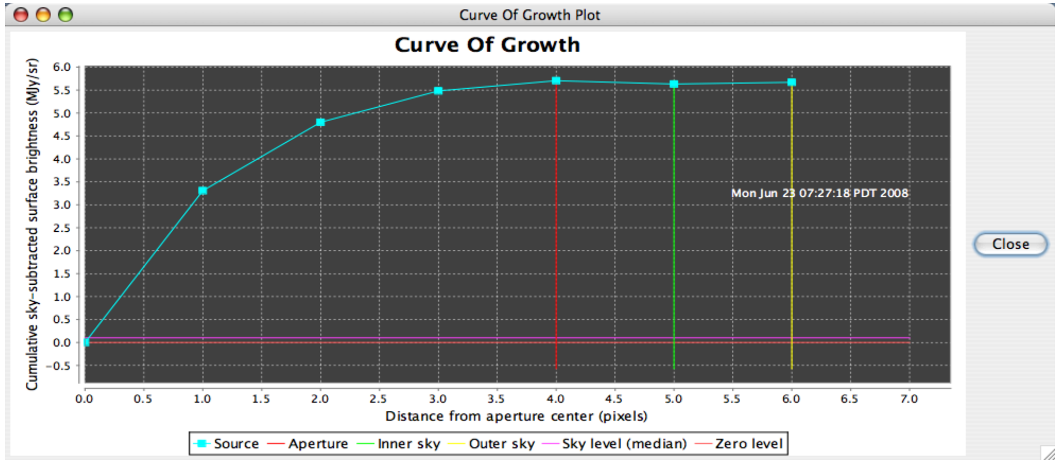
Aperture photometry

To know whether or not to include pixels that are only partially within the annulus, the best solution is to increase star aperture until the signal becomes reasonably constant.

A plot of the derived "instrumental" magnitude (-2.5 log{counts/s within aperture}) vs. the radius of the aperture yields a "curve of growth" from which "aperture corrections" can be deduced.



https://mirametrics.com/help/mira_al_8/source/magnitude_calculations.htm



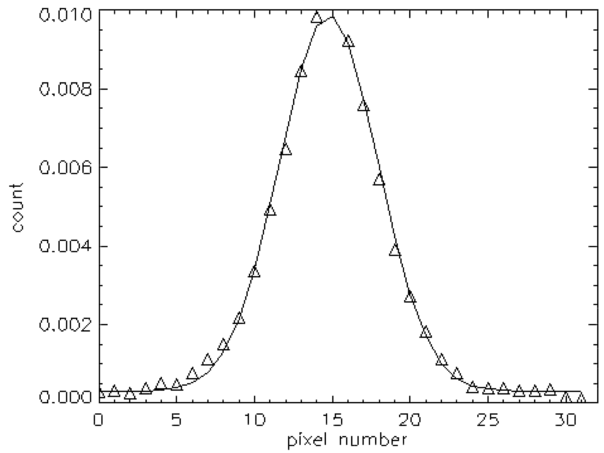
https://www.aperturephotometry.org/features-functions/

6. Explain the two approaches of extracting magnitudes from CCD and infrared images.

Profile fitting (or point-spread-function (PSF) fitting)

Mathematical curves are “fitted” to the real data using computer programs until a good match is obtained. The stellar image is usually compared with a Gaussian profile:

$$I(r) = I(0)\, e^{-r^2/2\sigma^2}$$



Yagola et al. (2003)

$I(0)$ is the peak intensity and r is the radial distance from the center of the image.

The quantity σ measures the width of the distribution; 68% of the light lies within 1σ, and 98.7% of the light lies within 2.5σ.

Provided the PSF (i.e., σ) is constant across the image, programs like DAOPHOT (Stetson, 1987) will identify the bright stars, deduce their Gaussian profiles and subtract those profiles away, thereby revealing fainter stars.