STARS
Magnitudes Instrumental

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Overview

This class focuses on a basic understanding of Instrumental Magnitude.

When discussing stars, we most commonly talk about apparent and absolute magnitude.

Instrumental Magnitude is the magnitude achieved on the CCD Image. From this magnitude, we can achieve apparent and absolute magnitudes, if distance is known.

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Introduction

Instrumental Magnitudes are found by directly measuring the flux values received in a CCD image.

These values are then entered into this formula $m = -2.5 * log_{10}(F)$

If you used the following value in the above formula, 24,000 counts measured from the CCD image, you would find the Instrumental Magnitude to be 10.951

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Measuring Instrumental Magnitudes

You can think of a CCD image as simply a number for each pixel in the image.

After the initial reduction steps (bias, dark, and flat) the number at each pixel should be linearly related to the number of photons that fell on that pixel. REMEMBER: CCDs are not linear at all count rates. It is incumbent to know where your CCD stops being linear.

Measuring Instrumental Magnitude requires understanding and addressing of several complications standard to CCD imaging:

(1) atmospheric seeing causing the star image to cover a number of pixels,
(2) the pixels that contain the counts from the star also contain light from the sky foreground (skyglow) which must be subtracted from the pixels containing the star + sky signal, and
(3) Possible image overlap from objects that are too close.

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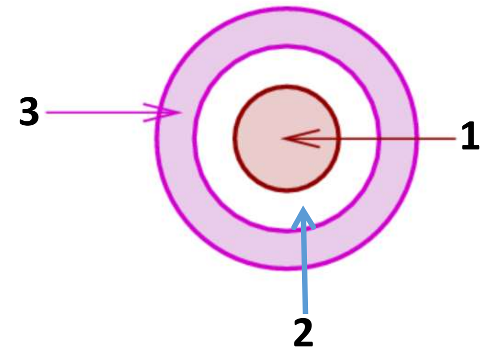
Determining Instrumental Magnitude



Achieving instrumental magnitude relies on aperture photometry.

Remember that aperture photometry uses three concentric rings to measure the counts around an object, in a null zone, and determine the standardized sky background levels.

Establish the correct radius for each aperture and center it on the star you are determining "instrumental magnitude" m of that star. This value is

$$m = -2.5 \log (S-B)$$

where S (the sum of the pixel values in the center aperture) minus B (the sum of the background value).

This logarithmic expression is consistent with the definition of magnitudes, but the zero of the magnitude scale is not correctly incorporated in this case definition. Zeroing will be used for apparent magnitudes.

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Instrumental magnitude to Apparent Magnitude

Though we can't actually calculate any magnitudes by themselves, ever, only magnitude differences, it is sometimes convenient to define an instrumental magnitude like this:

$m_{absolute}$ = -2.5log(flux) + C

where *t* is the exposure time,
Flux is the number of total number of photons from the source, and
C is a constant (zero point) added to the Instrumental Magnitude.

The Zero point is determined by measuring Vega with your imaging system. Vega's apparent magnitude for all filters is 0.03. To find the zero point for your system, measure Vega and determine the differential. The differential from your system to 0.03 is the Constant.

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Summary

Instrumental Magnitude is derived from the raw counts on your imaging system after some corrections.

This can be used as a differential from a known, or unknown, magnitude in the same image.

Also, if your system is calibrated against Vega, you can determine a constant to apply to the instrumental magnitude to achieve an apparent magnitude.

From there, if you know the distance, you can learn the absolute magnitude of the star.

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Questions?

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