M101 Data Reduction and Analysis Project

We have a set of imaging data for the spiral galaxy M101, taken in two filters (B and V) using CWRU's Burrell Schmidt Telescope.

Project Goals:

- Work through data reduction process from raw data to scientific-ready imaging.
- Work out photometric calibration and how to extract accurate photometric data
- Measure surface brightness profile, fit exponential model, work out structural properties of the galaxy.
- Measure color profile, interpret colors and gradient in context of galaxy evolution models.
- Write up project in "research journal style".

Why so many images?

We can digitally combine individual images together into one master image of much better depth and quality.

Filter	Season	Number of Images	Exposure time
B	Spring 2009	8	1200s
V	Spring 2010	8	900s

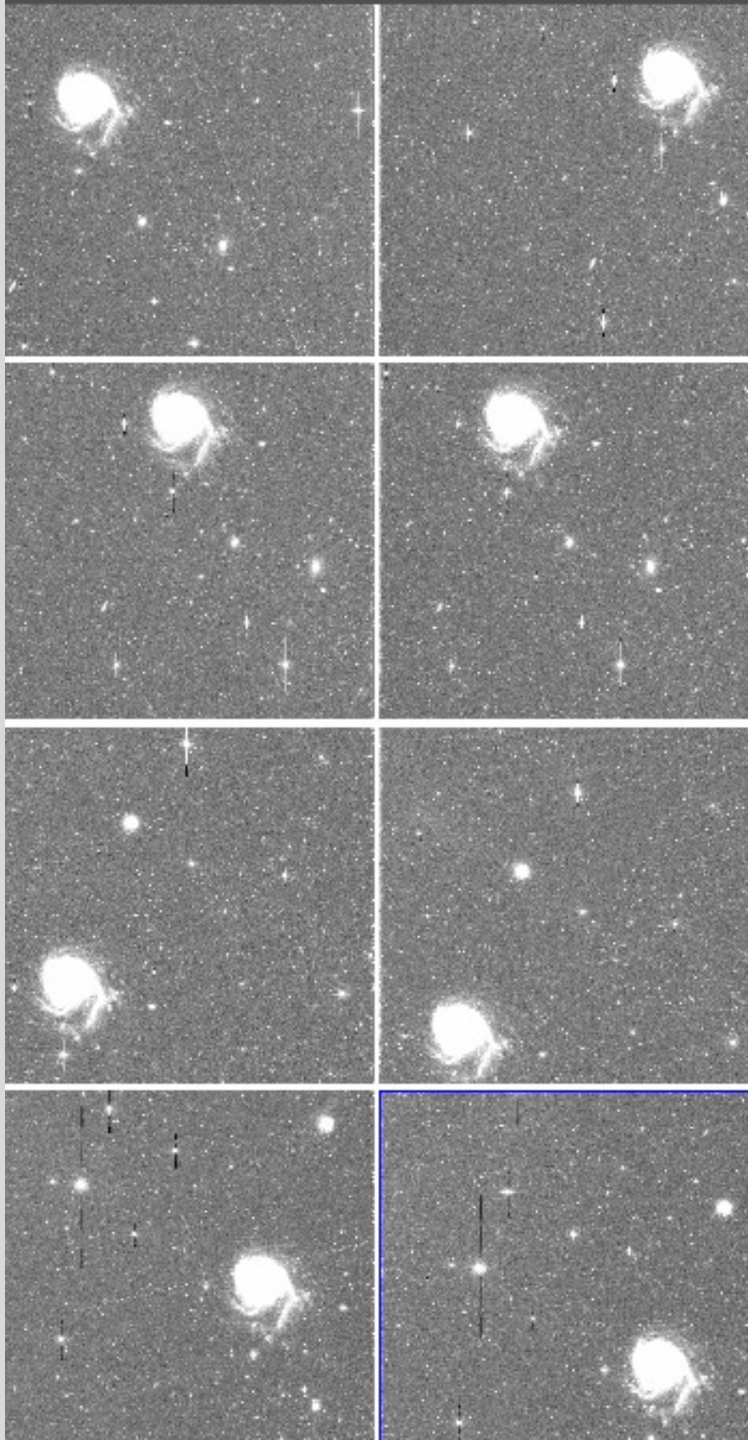
Advantage #1: Increase exposure time and signal-to-noise.

Advantage #2: Correct for image contaminants (cosmic rays, satellite trails, scattered light)

Advantage #3: Correct for detector problems (bad columns, flat fielding variations, etc)

Advantage #4: Reduce observing risk. (If something goes wrong, you only lose one exposure!)

Dithering: the telescope is pointed differently each time so that the galaxy shows up in a different spot on the detector ⇒



Remember the concept of image math and image combining

Images can be thought of as 2D arrays or matrices of intensity values

Images can be added, subtracted, multiplied, and divided by one another, or by a single value. This is done on a pixel by pixel basis.

An “image stack” can be thought of as a 3D array, with the third dimension being the different images in the stack.

When we do an “average” or “median” combine, we are averaging or medianing the values of each pixel down the third dimension (ie, the stack).

Basic Reduction to Individual images

Remember CCD data reduction steps

- Zero correction
  - take many zero-second images without exposing the CCD to light.
  - Average them together to create a “master zero” showing fixed pattern noise.
  - Subtract that master zero from all the “object frames”
- Flat fielding
  - Divide the object images by a “flat field” image: an image showing sensitivity/gain variations across the image.
  - Since the sensitivity is wavelength dependent, each filter must have its own flat field.