

Spatial Mapping of Stellar Populations in M31

Abstract

This project analyzed stellar populations across the Andromeda Galaxy (M31) using photometric data from the Panchromatic Hubble Andromeda Treasury (PHAT) survey. We utilized Python (astropy, pandas, and matplotlib) to read the PHAT catalog, select three distinct bricks, and create 2D stellar-density and mean color maps showing how properties of stars change based on their location within spiral galaxies. By selecting bricks 1, 12, and 23, we were able to analyze the full range of M31 (from the galactic center to beyond the spiral arms) without downloading the full PHAT survey. Through our analysis, we conclude that the center of spiral galaxies like M31 contain older, cooler stars that over time have drifted inwards from the hotter, younger, and star-forming outer regions.

Tools/Resources

- Imported libraries:
 - numpy
 - matplotlib.pyplot
 - pandas
 - astropy (constants, units, fits, Table, vstack)
- Williams, *The Panchromatic Hubble Andromeda Treasury XXI. The Legacy Resolved Stellar Photometry Catalog*, July 18 2023, <https://arxiv.org/abs/2307.09681>
- HST ACS v3 from MAST <https://mast.stsci.edu/portal/Mashup/Clients/Mast/Portal.html>

Method

1. Downloaded data for each half brick (east and west) from the MAST site
2. Combined the half bricks using the function vstack from astropy
3. Checked and extracted necessary columns to reduce file sizes
4. Converted the list into a pandas dataframe
5. Removed all NaN values
6. Filtered the data using the following parameters: sharpness, crowding, signal to noise ratio, error in the magnitudes of each filter
7. Calculated the color indices
8. Plotted the graphs of RA vs Dec and the mean color maps for each bricks

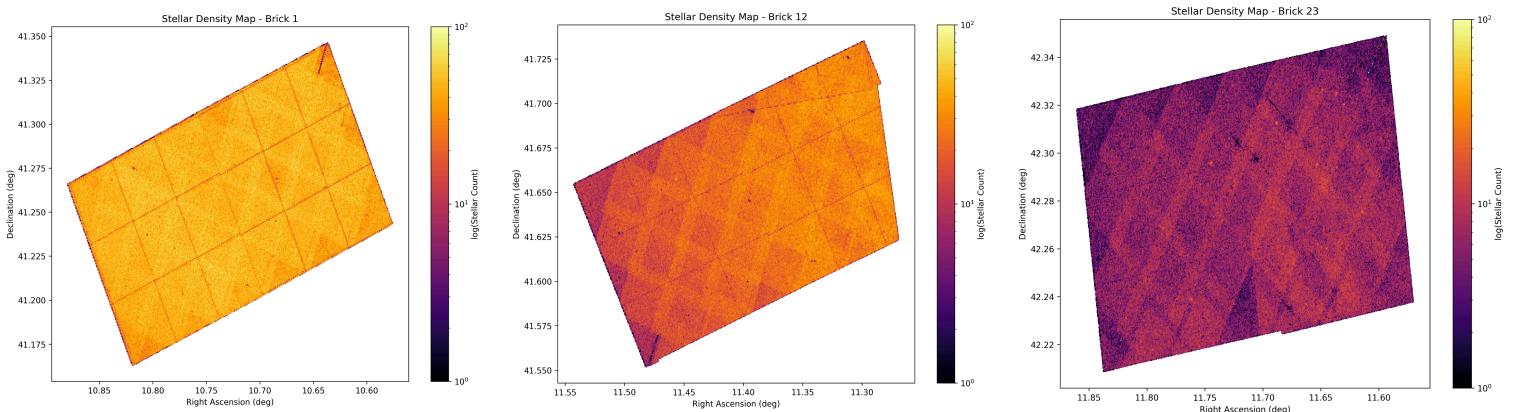
Analysis

Stellar Density: Brick 1 had a much higher stellar density, as expected, compared to the other two. Moreover, Brick 23 had the lowest stellar density. From this we can conclude that for spiral galaxies similar to M31, a higher concentration of stars can be found at the nucleus.

Mean Color: Brick 1 had much more red mean color compared to bricks 12 and 23 (white and blue, respectively). With stars, red correlates to a lower temperature while blue correlates to a higher one. On the graphs below white falls between the two. This suggests that hotter (and therefore younger) stars can be found farther from the nucleus

Combined: With the presence of younger, hotter stars in the spiral arms but a higher density of stars in the bulge, we can posit that stars are formed in the outer regions of spiral galaxies before moving, under the influence of gravity, towards the nucleus, where they contribute to a higher stellar density.

Results: Stellar Density



Results: Mean Color

