Investigating Tidal Processing in M81's Ultra-Diffuse Galaxy, F8D1

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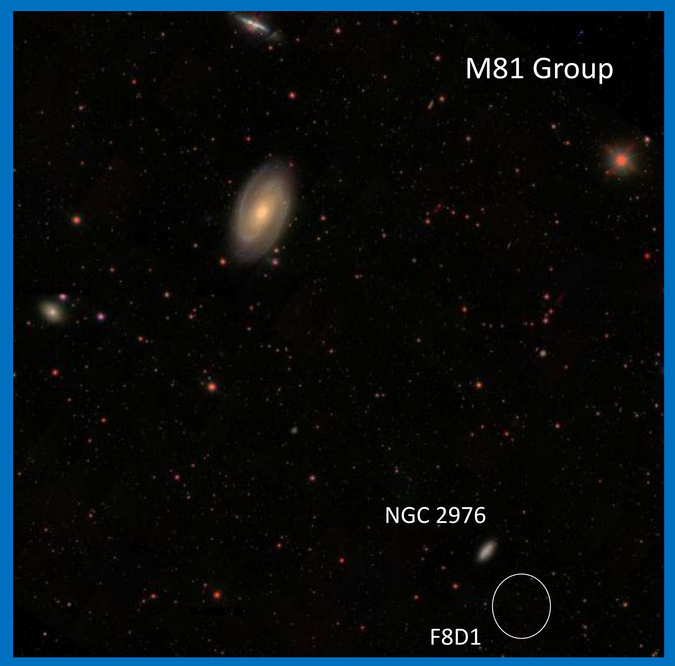

Introduction:

Ultra diffuse galaxies (UDGs) are a relatively new classification of low surface brightness galaxies with certain features that give them distinction. UDGs have low surface brightness (> 24 mag arcsec^-2), large physical size (> 2kpc), and low stellar mass (<10^8 M_sun). They also exhibit a high population of old stars, suggesting that their star formation was abruptly halted at some point in their evolution. Tidal processing explains all these special characteristics, and a more in-depth look at this population of galaxies is crucial to filling in a hole in the knowledge surrounding galaxy formation. The purpose of this research is to take a closer look at the M81 group's F8D1, the closest UDG to Earth, and determine if tidal processing played a role in its formation. Recent studies have simulated UDGs forming from normal galaxies undergoing tidal interactions (L. Sales et al. 2020), and observations done on distant galaxy clusters have found evidence of tidal streams emanating from satellite UDGs (P. Bennet et al. 2018). However, other recent studies (Mowla et. al 2017, Carleton et al. 2019) have shown that UDG formation may occur under different initial conditions and processes. The origin of these galaxies is still up for debate, but the results of this research have shown that F8D1 does in fact show evidence of tidal disruption with tidal arms around 20 kpc long.

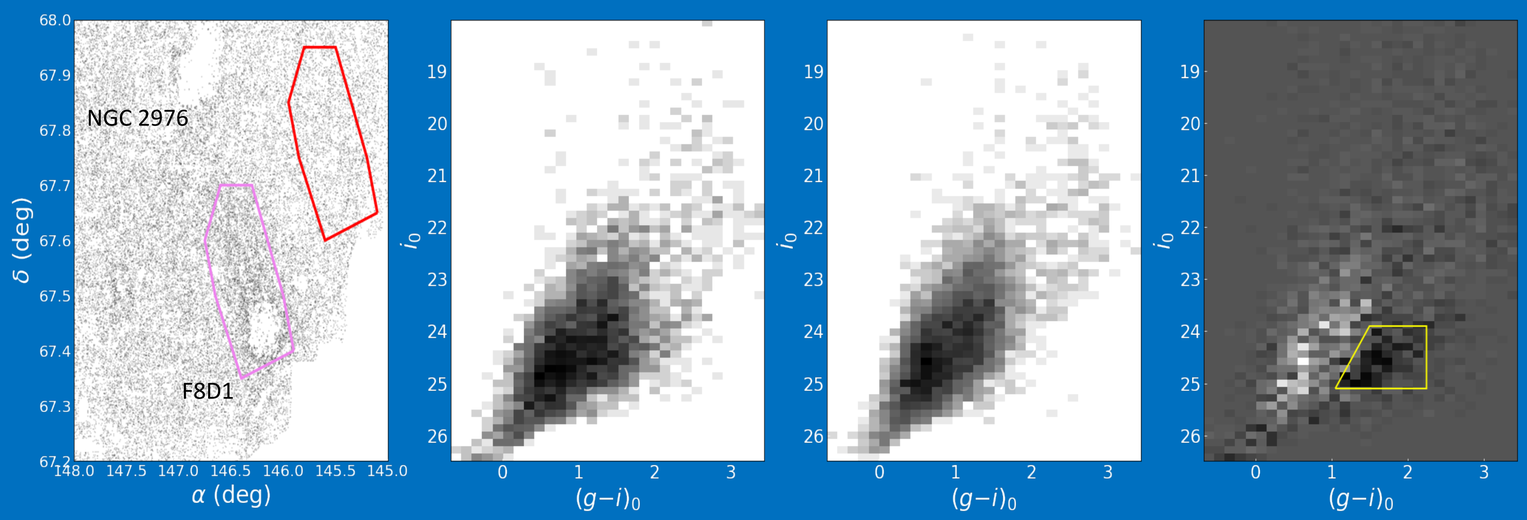

Figure 1: The leftmost diagram (a) is a full-sky plot of F8D1 and the surrounding stars. The next plot (b) is the purple selection box in (a), with the stars of F8D1 plotted in color-magnitude space. The third diagram (c) is the red selection box plotted in color-magnitude space, as a reference for background light sources. The last plot (d) is a color-magnitude diagram subtracting the background information from F8D1 with a yellow selection box enclosing the stars in F8D1.

Methods:

- Created Color-Magnitude Diagrams (CMDs) for F8D1 and background sources
- Eliminated background sources from F8D1 CMD (fig. 1)
- Plotted sources from subtracted CMD onto full-sky map (fig. 2)
- Estimated extent of visible tidal arm by the small angle approximation

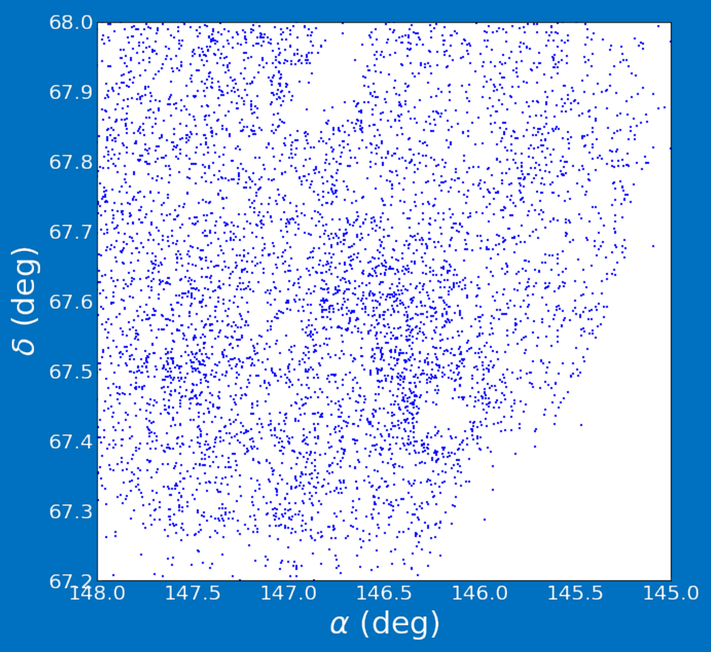

Figure 2: A plot of F8D1 and the surrounding sky with background galaxies removed so the structure of F8D1 is easier to see. F8D1 is a clearly defined, and a long tidal arm around 20 kpc in length is visible and stretching toward NGC 2976.

Results:

- Clear evidence of tidal disruption
- Visible tidal arm is roughly 20 kpc in length and is emanating in the direction of NGC 2976: a reasonably large galaxy in the M81 group
- Stars within F8D1 are primarily RGB stars implying little to no star formation

Future goals of this project:

- Further isolate F8D1 from the background galaxies to more clearly define the tidal arm
- Use HST data to investigate the star-formation history of F8D1 in order to see why star formation halted sometime in its evolution

References:

Lamiya Mowla et al. 2017 'Evidence of Absence of Tidal Features in the Outskirts of Ultra Diffuse Galaxies in the Coma Cluster', ApJL, 851, 27

Laura V Sales et al. 2020 ' The formation of ultradiffuse galaxies in clusters', *Monthly Notices of the Royal Astronomical Society*, 494, 2

P. Bennet et al. 2018'Evidence for Ultra-diffuse Galaxy "formation" through galaxy interactions', ApJL, 866, 1

Timothy Carleton et al . 2021 'The formation of ultra-diffuse galaxies in cored dark matter haloes through tidal stripping and heating', A&A, 654, 105

Sloan Digital Sky Survey, Google Sky (introduction photo)

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