Tails from the Great Beyond: Constraining the Star Formation History within the Tidal Tail of F8D1

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Ultra-diffuse galaxies (UDGs) are a relatively new classification of dwarf galaxies, characterized by low stellar mass (<10^8 M_sun) high radii (>2 kpc), and low surface brightness (~25 mag/arcsec^2). These galaxies have been observed throughout the universe, and understanding how they form is critical to filling a gap in our knowledge of galactic evolution. Up until now, these galaxies have only been studied as a population, but the proximity of F8D1 allows us to analyze the stellar populations within this UDG to understand the inner workings of these galaxies. Recently, (Žemaitis, et. al. 2022) discovered that F8D1 has been tidally disrupted, estimating a tidal radius of around 60 kpc. By analyzing the stellar population and star-formation history (SFH) of this tidal stream, we can conclude the likely formation mechanisms that took place within this galaxy and possibly generalize this formation to other UDGs in the universe. By using an SFH predicting method outlined in (Harmsen, et. al. 2023), we have been able to calculate that 90% of the star formation within F8D1's tidal tail stopped 2.05 +/- 1.4 Gyr ago.

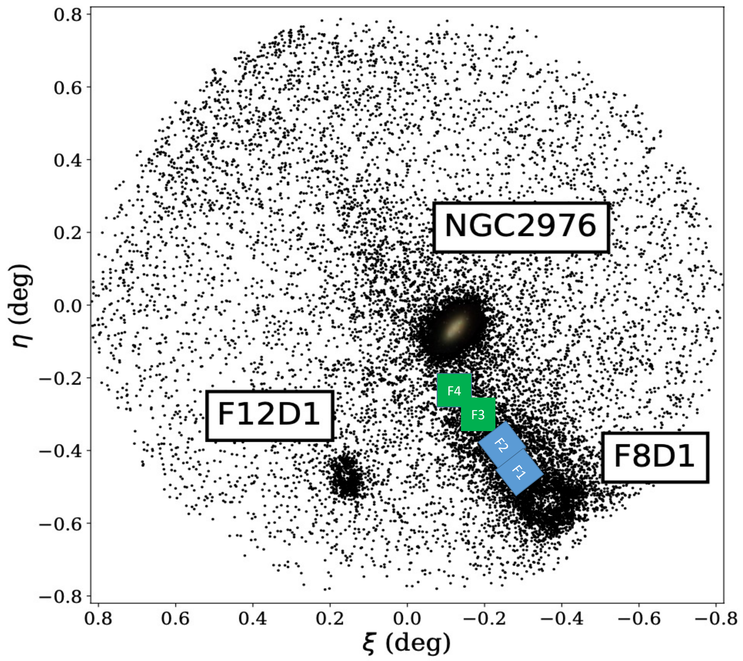


Figure 1 (above): An image taken from (Žemaitis, et. al. 2022) showing the tidal stream coming from F8D1 in the direction of the M81 group's center of mass. The four overlaid boxes, labelled F1 through F4, are the relative locations of four HST fields that have been analyzed. Blue fields were taken by the WFC3 camera, and the green were taken by the ACS camera.

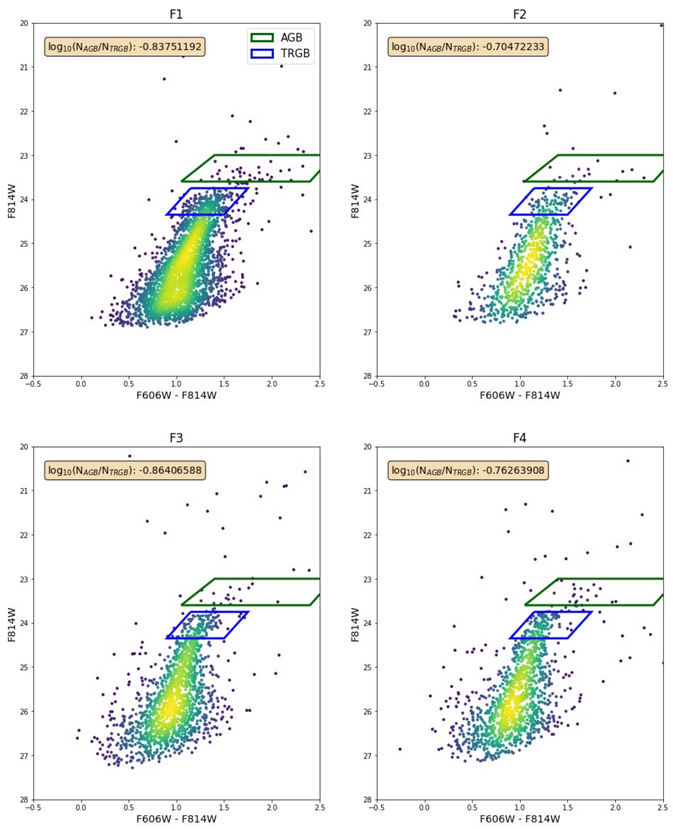
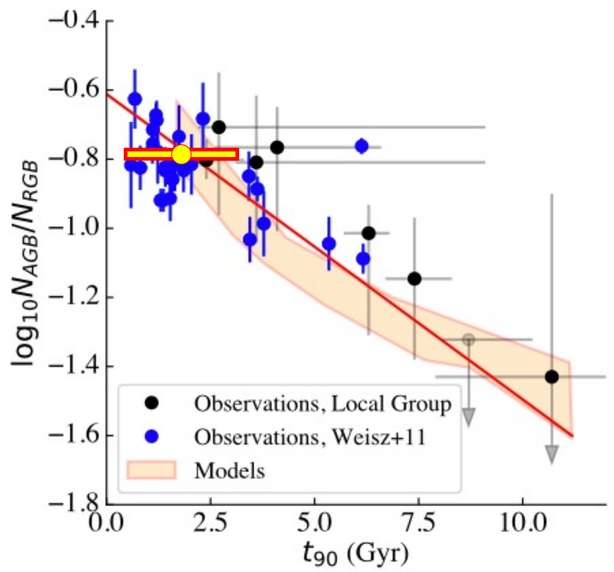


Figure 2: Four CMDs, corresponding to the four fields in Fig. 1, each with the AGB and TRGB selection boxes on top. The ratio used in the final calculation is shown in each subplot.

Mean Ratio: -0.79 +/- 0.042



t_{90} = 2.05 +/- 1.44 Gyr

Figure 3: The data and fit taken from (Harmsen, et. al. 2023) to fit the observed ratio to the t_{90} of the tidal tail. The wide error bar on the x-axis is due to the large error on the slope of the red line above. My well-measured ratio will be used in the future to better constrain this calibration and fit.

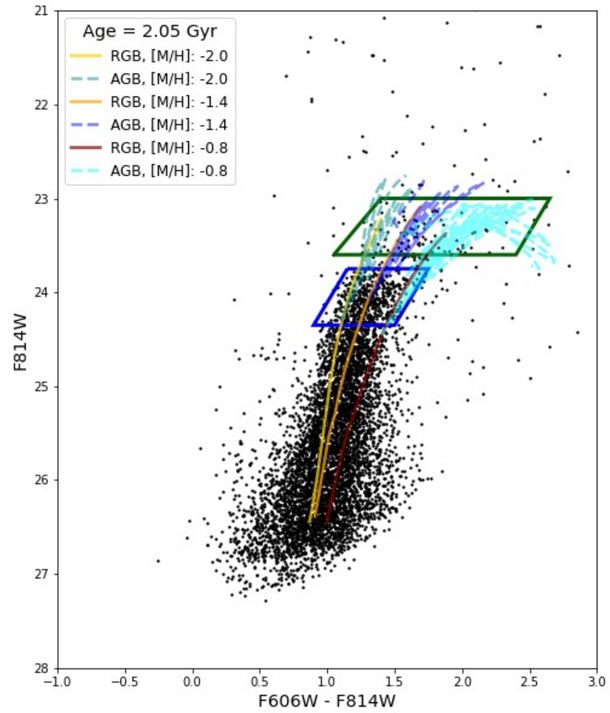


Figure 4: The four CMDs from Fig. 2 stacked on top of one another. 2.05 Gyr isochrones are overlaid with a range of metallicities, and RGB and AGB selections indicated. This confirms the calculated t_{90} and shows the most likely metallicity of -1.4 dex.

Future Goals:

- Use the SFH of the tail and center, as well as other timescale constraints to determine the interaction history of F8D1.
- Explore the evolutionary history of other tidally disrupted dwarfs.
- N-body simulations

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References:
Žemaitis, R., Ferguson, A. M. N., Okamoto, S., Cuillandre, J.-C., Stone, C. J., Arimoto, N., & Irwin, M. J. (2022). A Tale of a Tail: A Tidally-Disrupting Ultra-Diffuse Galaxy in the M81 Group. arXiv. 2209.09713
Harmsen, Benjamin et. al. (2023). Constraining the assembly time of the stellar haloes of nearby Milky Way-mass galaxies through AGB populations [Article submitted for publication].
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