

A Census of Milky Way Outer Halo Satellites

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Motivation/Problem

Motivation:

- Ultra-faint Dwarf Galaxies (UFDs) are some of the **most dark matter dominated** systems.
- Previous observations of these two UFDs had a **small sample size**, and large uncertainty.
- Our values for velocity and metallicity differ from literature.

Goal:

- We aim to **classify** and determine widely applicable **characteristics**.

Satellite and Observation Info

- Two suspected **dwarf galaxies** observed.
- Observations completed with **IMACS spectrograph** on Magellan telescope in Chile in 2021.
- 30-50 stars observed each.

Table 1. Observation Details.

Satellite	Date	MJD	RA	DEC	Total Exposure (s)	Number of Spectra
Aquarius II	June 18, 2021	59384.35	338.55648	-9.28793	9600	13
Aquarius II	July 13, 2021	59409.26	338.53523	-9.3278	4800	13
Bootes II	June 18, 2021	59383.8	209.43238	12.79053	9600	25

NOTE—Aquarius II RA and DEC from Torrealba et al. (2016), Bootes II RA and DEC from Walsh et al. (2008).

References

Torrealba, G., Koposov, S. E., Belokurov, V., et al. 2016, Monthly Notices of the Royal Astronomical Society, 463, 712, doi: <http://doi.org/10.1093/mnras/stw2051>

Koch, A., Wilkinson, M. I., Kleyna, J. T., et al. 2008, The Astrophysical Journal, 690, 453, doi: <http://doi.org/10.1088/0004-637x/690/1/453>

Aquarius II

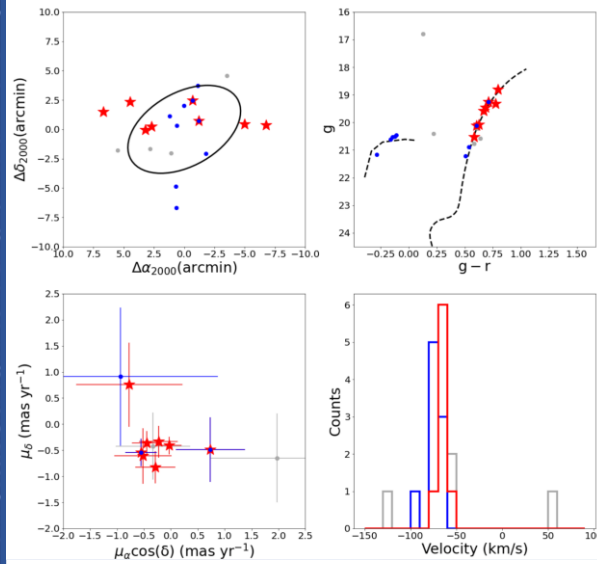


Fig 1: Top left: A position plot showing observed non-members (grey), observed members (red), and literature members from Torrealba et al. (2016) (blue), with an ellipse showing the half-light radius. Top right: A CMD with an isochrone shown in black. Bottom left: Proper motion plot. Bottom right: velocity histogram.

Radial Velocity (km/s): $-71.1 \pm 2.5 \rightarrow -65.37^{+1.68}_{-1.86}$

Velocity Dispersion (km/s): $5.4^{+3.4}_{-0.9} \rightarrow 4.68^{+1.82}_{-1.21}$

Metallicity (dex): $-2.3 \pm 0.5 \rightarrow -2.60^{+0.14}_{-0.13}$

Blue is from Torrealba et al. (2016), red is our data

Bootes II

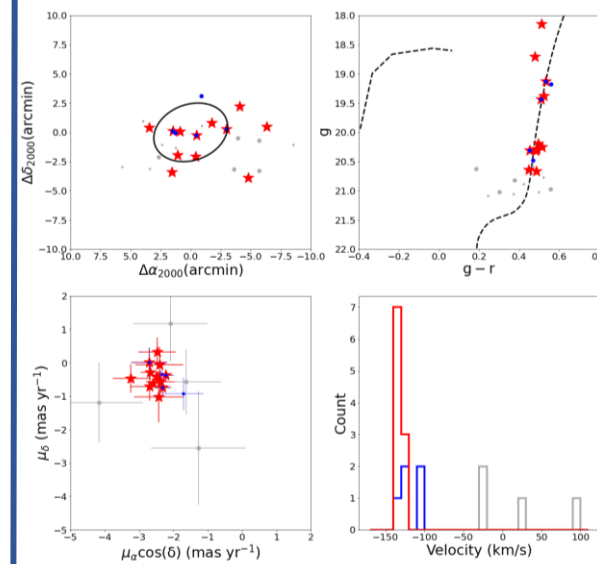


Fig 2: Top left: A position plot showing observed non-members (grey), observed members (red), and literature members from Koch et al. (2008) (blue), with an ellipse showing the half-light radius. Top right: A CMD with an isochrone shown in black. Bottom left: Proper motion plot. Bottom right: velocity histogram.

Radial Velocity (km/s): $-117 \rightarrow -130.96^{+1.44}_{-1.27}$

Velocity Dispersion (km/s): $10.5 \pm 7.4 \rightarrow 3.56^{+1.62}_{-1.27}$

Metallicity (dex): $-1.79 \rightarrow -2.71^{+0.10}_{-0.09}$

Blue is from Koch et al. (2008), red is our data

Methods

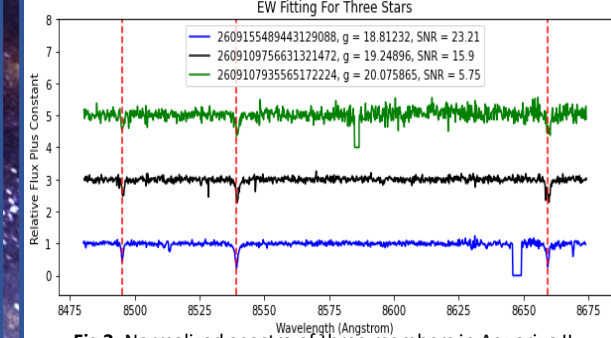


Fig 3: Normalized spectra of three members in Aquarius II. Calcium triplet line locations are highlighted in red.

- Analyzed **1D spectra**.
- Fit template and equivalent widths to **Calcium Triplet** absorption lines.
- Determined metallicity of RGB stars.
- Used **MCMC sampler** to compute dispersions.
- Determined mass with velocity dispersion.
- Computed orbits using GALPY.

Other Projects

- Analyzing 6 other satellites (both GC and UFD).
- Part of a project compiling/investigating the MW satellite population and its properties.
- Assisting in the supervision of two high school students completing a summer internship.

Drastically increased member star **sample size**
 Significantly **improved values** of systemic characteristics
 Both satellites can be classified as **dwarf galaxies**