Exploring the Outskirts of Nearby Dwarf Galaxies with Blue Stars

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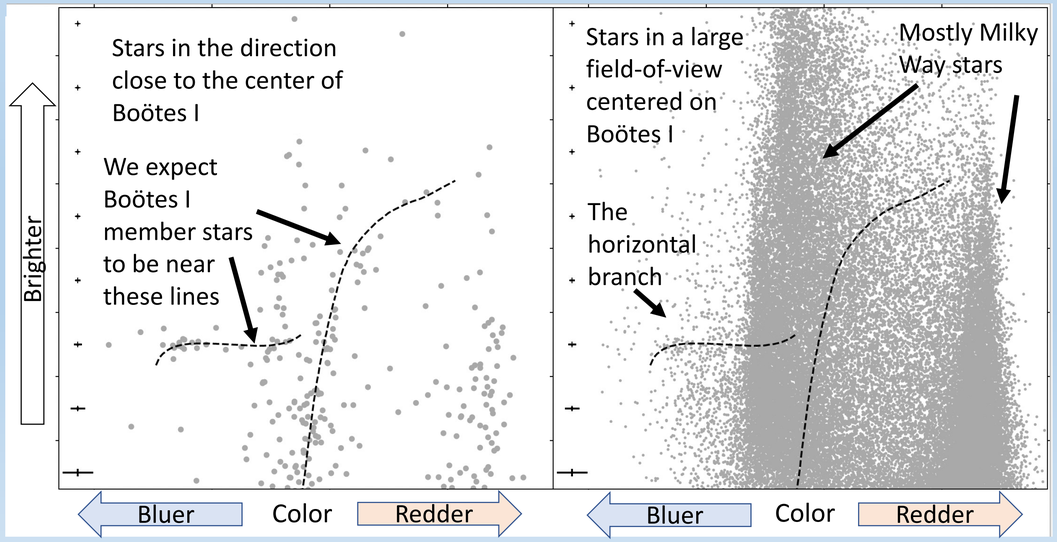
Abstract:
The identification and study of stars far from the center of their host galaxy enables exploration of that galaxy's total mass and current dynamical state. It is difficult to identify candidate member stars in a wide field-of-view around a given galaxy, as the density contrast between the galaxy's member stars and non-member Milky Way stars decreases as a function of distance from the center of the galaxy. We have developed a technique to find candidate member stars of nearby dwarf galaxies, and we present a demonstration of this technique on the Boötes I ultra-faint dwarf galaxy, a satellite of the Milky Way Galaxy.

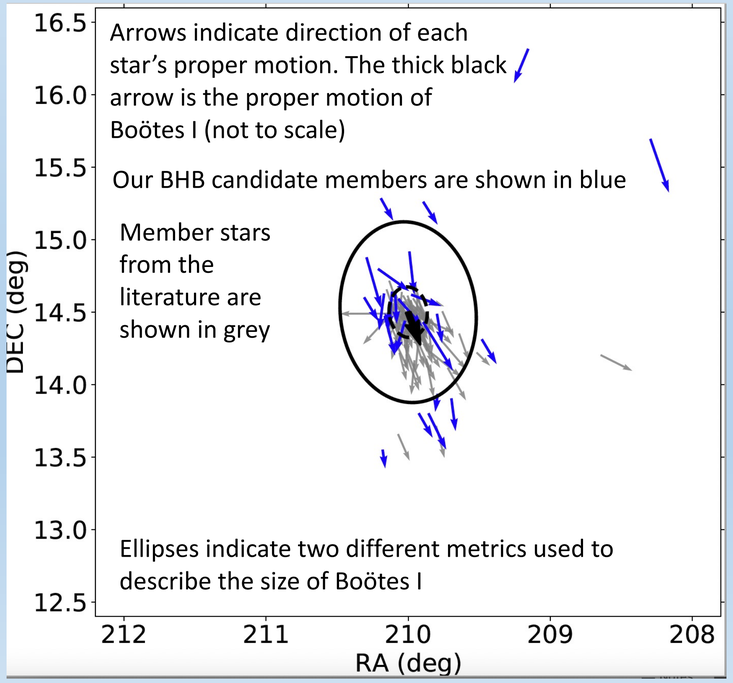
Why Blue Stars?

- We look for blue horizontal branch stars (BHB) for a few reasons. There are fewer blue Milky Way stars along a given line-of-sight than there are red Milky Way stars, which helps to reduce contamination from Milky Way stars (see plot below).
- BHB stars have low surface gravities and high temperatures, which makes them stand out from the other blue sources in different combinations of the filters of the Pan-STARRS survey. We leveraged this fact, and trained a k-nearest neighbors classifier on a sample of stars with known labels from the SEGUE spectroscopic survey. We used this classifier to identify likely BHB stars in the Pan-STARRS data.



How do you determine if the blue stars are likely members of Boötes I?

- The sample of likely BHB stars from the k-nearest neighbors classifier contains both Boötes I member stars and Milky Way stars!
- From observations and stellar models, we know that BHB stars of a given color should have a narrow range of intrinsic brightness – the line indicating the expected brightness as a function of color for horizontal branch stars at the distance of Boötes I can be seen in the lower left figure. We selected only BHB stars near this line, removing BHB that are too close or too far away to be at the distance of Boötes I.
- We matched the remaining BHB with *Gaia* data, which provide information about motion in the plane of the sky (proper motion). We then selected BHB stars with proper motions consistent with that of Boötes I. The remaining BHB form our candidate member sample, which are shown in the plot below.
- These new candidate members reveal an extended stellar envelope, which could indicate that Boötes I is either more massive than previously thought, or it is being disrupted by the Milky Way



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See Filion & Wyse, 2021 (arXiv:2110.05468) for the full analysis and literature references

All data used in this work are publicly available. We thank the teams behind Pan-STARRS, SEGUE, and *Gaia* that made this research possible