THE SEARCH FOR LONG LOST RELATIVES: FILTERING FOR POTENTIAL CANDIDATE STARS IN THE PHOENIX STELLAR STREAM

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1. ABSTRACT

Stellar streams are remnants of globular star clusters that have been tidally pulled apart by the Milky Way Galaxy. By analyzing streams, we can constrain the hierarchical model of galaxy formation. We searched for an extension to the Phoenix Stellar Stream, using proper motions (PM) in both right ascension (RA) and declination (Dec). Also using metallicity of the stars [Fe/H] from the MAGIC Survey, and an isochrone filter to compare the average age of our candidates to the confirmed stars. We report the identification of 47 candidate stars within the Phoenix Stellar Stream, each fitting the expected kinematic and chemical parameters of the stream. These candidates nearly double the length of our stream.

2. PHOENIX STREAM CHARACTERISTICS

- A globular cluster is a dense group of stars that are gravitationally bound to each other. The Phoenix Stellar Stream — named after its resident constellation — is the remnant of a globular cluster that orbited too close to the Milky Way Galaxy, and is being tidally pulled apart by the Galaxy's gravitational force.
- The Phoenix Stream was discovered in 2015 with a length of 8.1° (2.5 kiloparsecs), and a width of ~54 parsecs. [1]
- Prior observations, show that the progenitor of the Phoenix Stream is ancient (age =11.5 Gyrs +/- 0.5), and very metal poor, with a metallicity [Fe/H] <-2.0 (less than 1/100th the metallicity of the Sun).

3. METHODS

- The Phoenix Stream follows a curved orbit around the Milky Way (see Fig. 2). To identify additional candidates along this path, we transform its RA and Dec into stream-aligned coordinates (length and width) using the `galstreams` Python package. This enables us to search for stars along projected track and extend the stream's spatial boundaries.
- Not all stars along the projected track share the Phoenix Stream's motion. Using proper motions (tangential velocities) measured by the Gaia satellite, we filtered out foreground stars inconsistent with the Phoenix Stream orbit.
- Next, we filtered out stars with higher metallicities [Fe/H] > -2.0 using data from the MAGIC Survey. MAGIC derives stellar metallicities by imaging with a specialized narrowband filter on the 4m Blanco telescope/Dark Energy Camera.
- Finally, we applied an isochrone filter to select stars with a similar age and distance of the Phoenix Stellar Stream. This is shown in Fig. 3, where we compare the color and brightness of stars to a theoretical stellar population model.

4. KEY RESULTS

- Based on the above criteria, we found 47 candidate stars, fitting within the known characteristics of the stream. These add to the 57 confirmed stars known previously as members of the Phoenix Stream.[2,3] (See Fig. 2)
- Using the data from the MAGIC Survey, we find that the average metallicity of candidate and confirmed Phoenix Stream stars is [Fe/H] = -2.46. This is consistent with previous spectroscopic measurements.[3]

5. NEXT STEPS

- The next step is to measure the radial velocities of our 47 candidates using spectroscopy. This will allow us to confirm if the candidates belong to the Phoenix Stellar Stream and let us test if the stream fans out (gets wider) to the south.
- The MAGIC Survey will continue to observe, and extend our stream search further north.
- We will search for deviations from its projected orbital track, and any density variations that might suggest the Phoenix Stream has been perturbed.

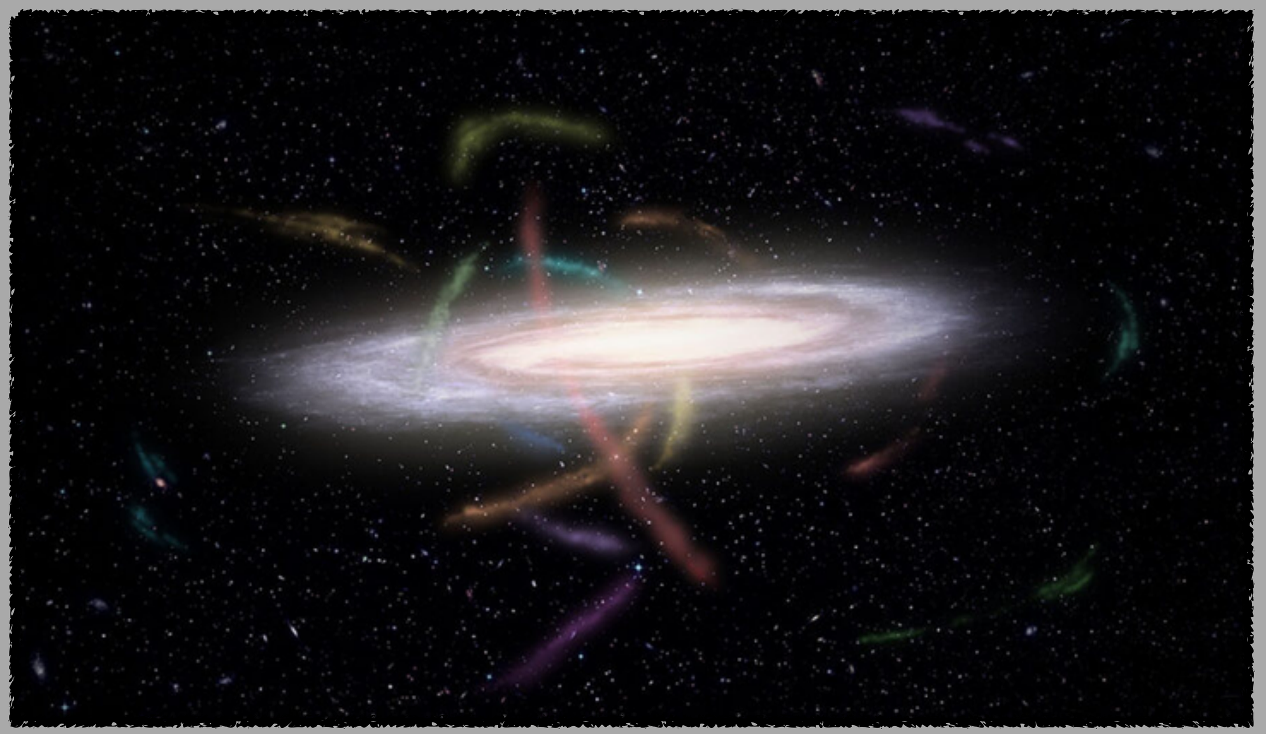

FIG. 1: A visual representation of Stellar Streams in orbit around the Milky Way. (Credit: James Josephides and S^5 Collaboration).

SCAN ME

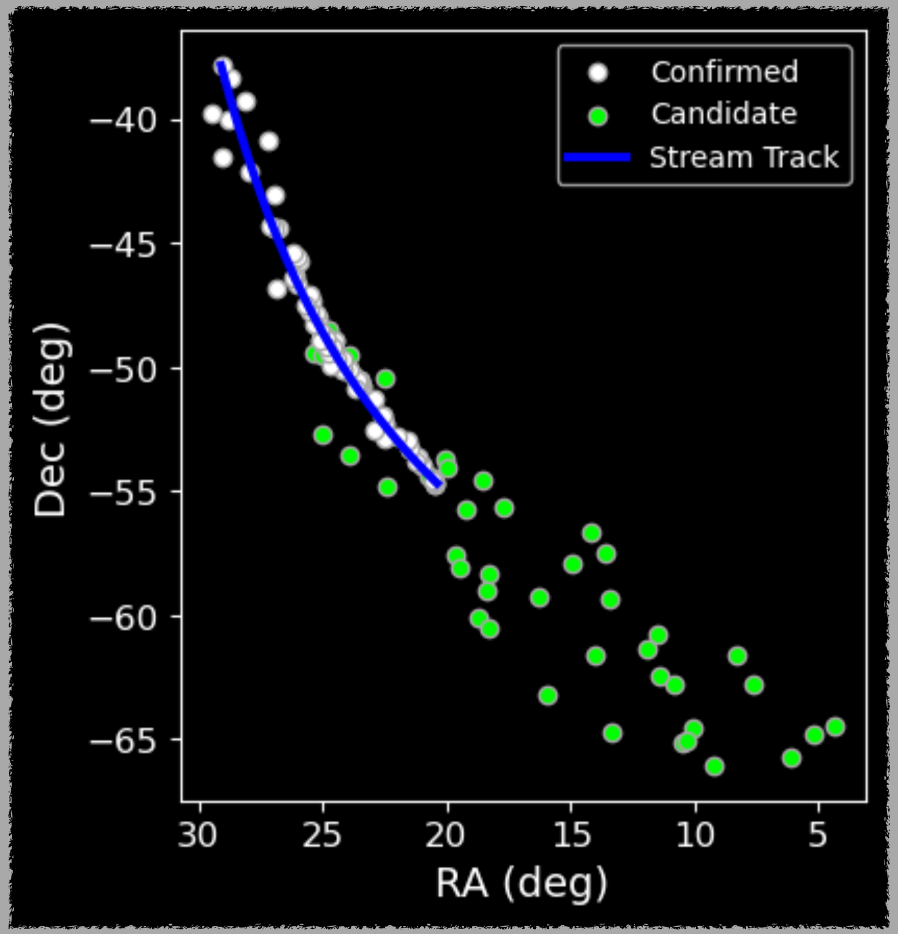

FIG. 2: The spatial distribution of filtered stars in the Phoenix stream region. The previously known stream track is shown in blue. Our new candidates (green) extend to the south, beyond the known stream track (blue), and are possibly more diffuse.

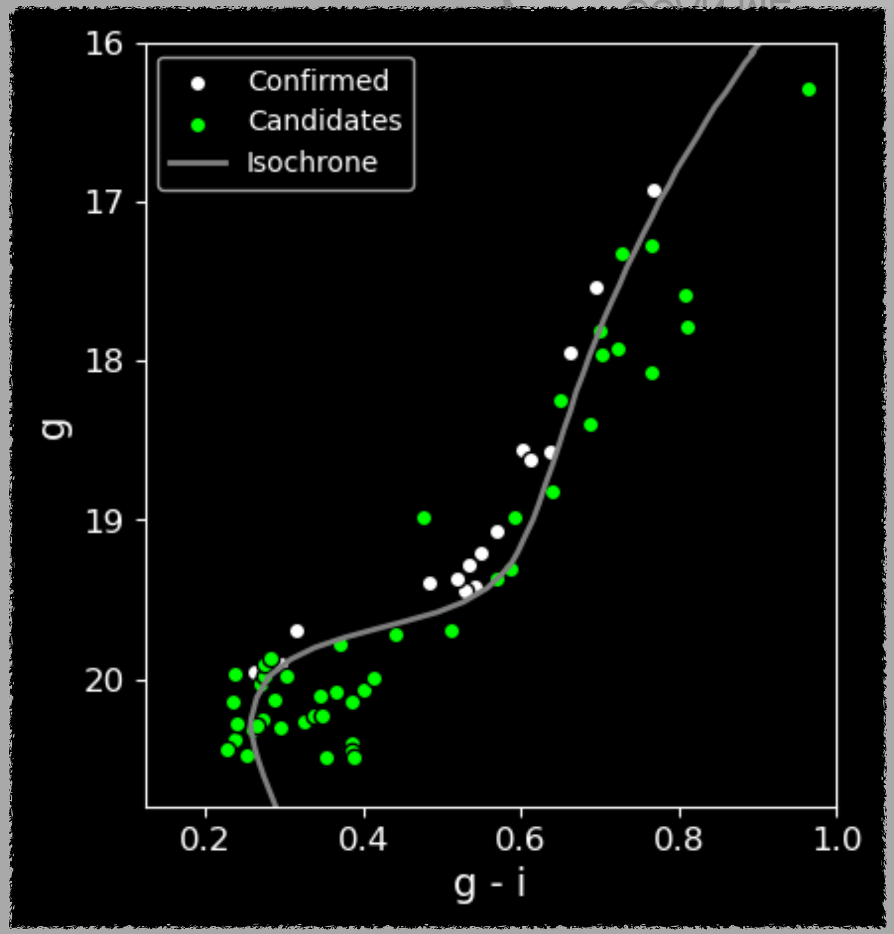

FIG. 3: A color-magnitude diagram of the confirmed (white) stream stars, and our candidate (green) stars. In gray, we show an isochrone model for an old and metal poor stellar population.

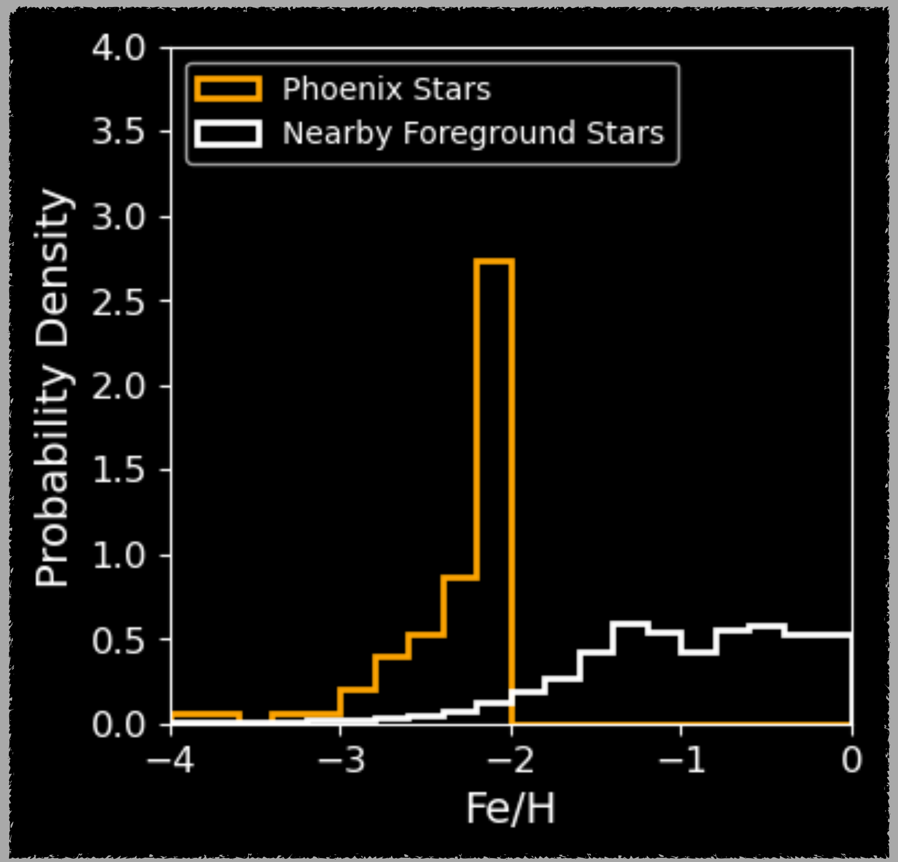

FIG. 4: A histogram showing the probability density of metallicities ([Fe/H]) for Phoenix stars (orange) compared to Milky Way foreground stars (white). The Phoenix stars show a sharp peak at very low metallicities, indicating they are more metal-poor than the surrounding Milky Way stars.

REFERENCES

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