The C-19 Stellar Stream
as seen by DESI

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We provide an analysis of the extremely metal-poor stellar stream (C-19). Data from the first three years of observations from the Dark Energy Spectroscopic Survey (DESI) identifies ~2.5 times more member stars than the most recent measurements, allowing us to better constrain the kinematic and chemical properties of the stream.

Stellar Streams

Milky Way (MW)-like galaxies evolve hierarchically through mergers of dwarf galaxies (DGs) and globular clusters (GCs) [1,2]. The tidal disruption of these satellites during the mergers creates **stellar streams** that we can observe today.

> **Streams** are tidally disrupted satellites merging with the MW

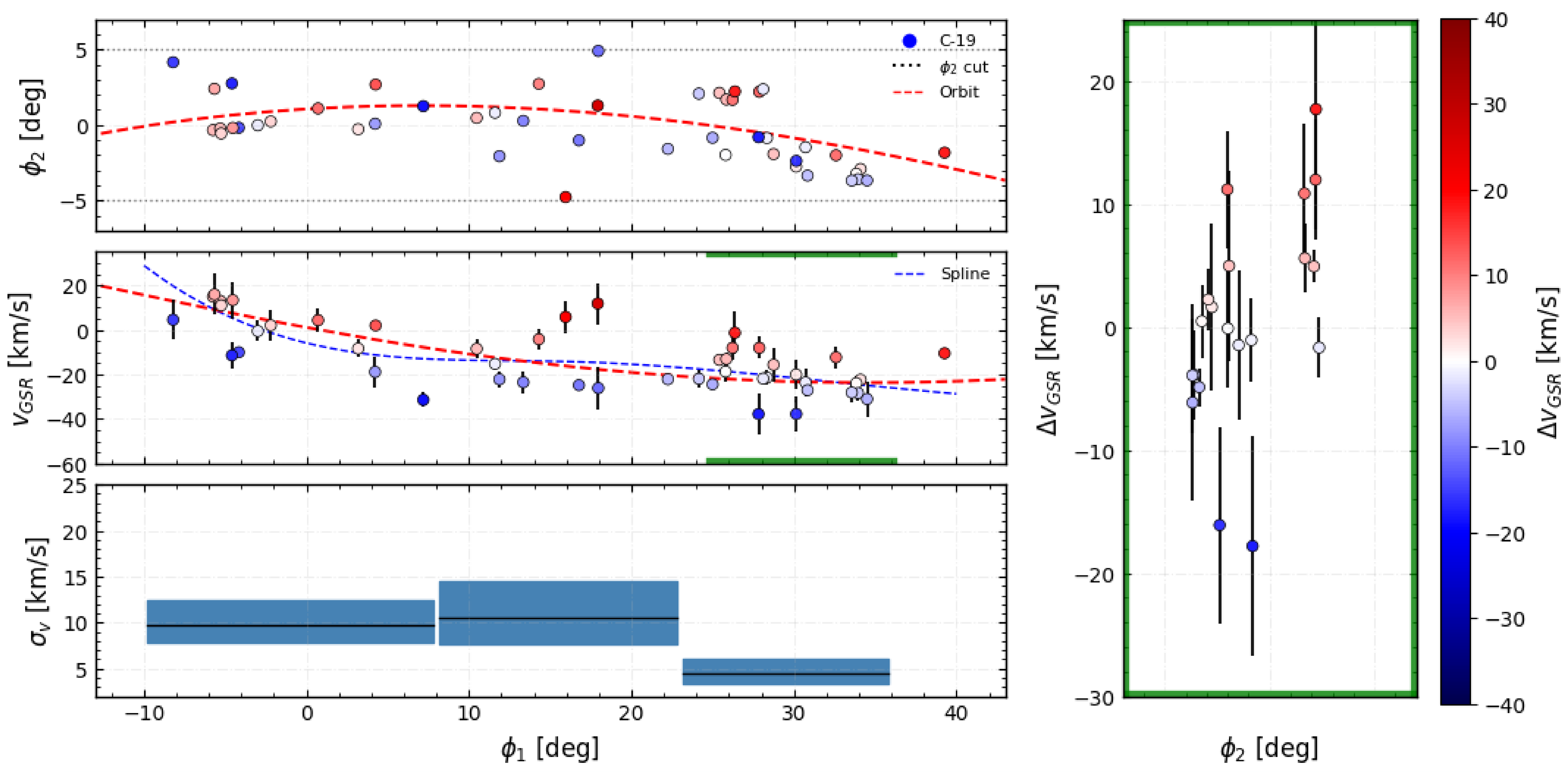

Fig 1. C-19 members with probabilities > 0.7, coloured by distance from fit radial velocity track. Binned velocity dispersion along stream track shown in bottom-left panel.

Dark Matter

Theories of cold and alternative dark matter (DM), while consistent on cosmological scales, make distinct predictions for the abundance of star-free subhalos within the MW. Stellar streams are **long** (~10-100 kpc) and have likely had gravitational interactions with DM substructure. Stellar streams hold memories of these interactions in morphological features and kinematic heating. [3,4]

> **Streams** are useful probes of **dark matter** substructure

The C-19 Stellar Stream

This stream merits study in its own right; discovered by the `STREAMFINDER` algorithm [5] in the *Gaia* Data Release 3 [6], C-19 is the **most metal-poor stellar population** discovered to date [7]. It's metallicity ([Fe/H] = $-3.34^{+0.05}_{-0.04}$) is well below the apparent 'floor' in metallicity for GCs in the MW ([Fe/H] $\gtrsim -2.5$) [8]. The chemical compositions (i.e. variations of light element abundances) are characteristic of a GC [6], however, measurements of its velocity dispersion are in tension with a GC progenitor [9]. It is feasible that the stream's kinematics could have been **'heated'** by perturbations with **dark substructure** [9,10], but better measurements of the full 6D kinematics of member stars are required to constrain the amount of heating due to DM.

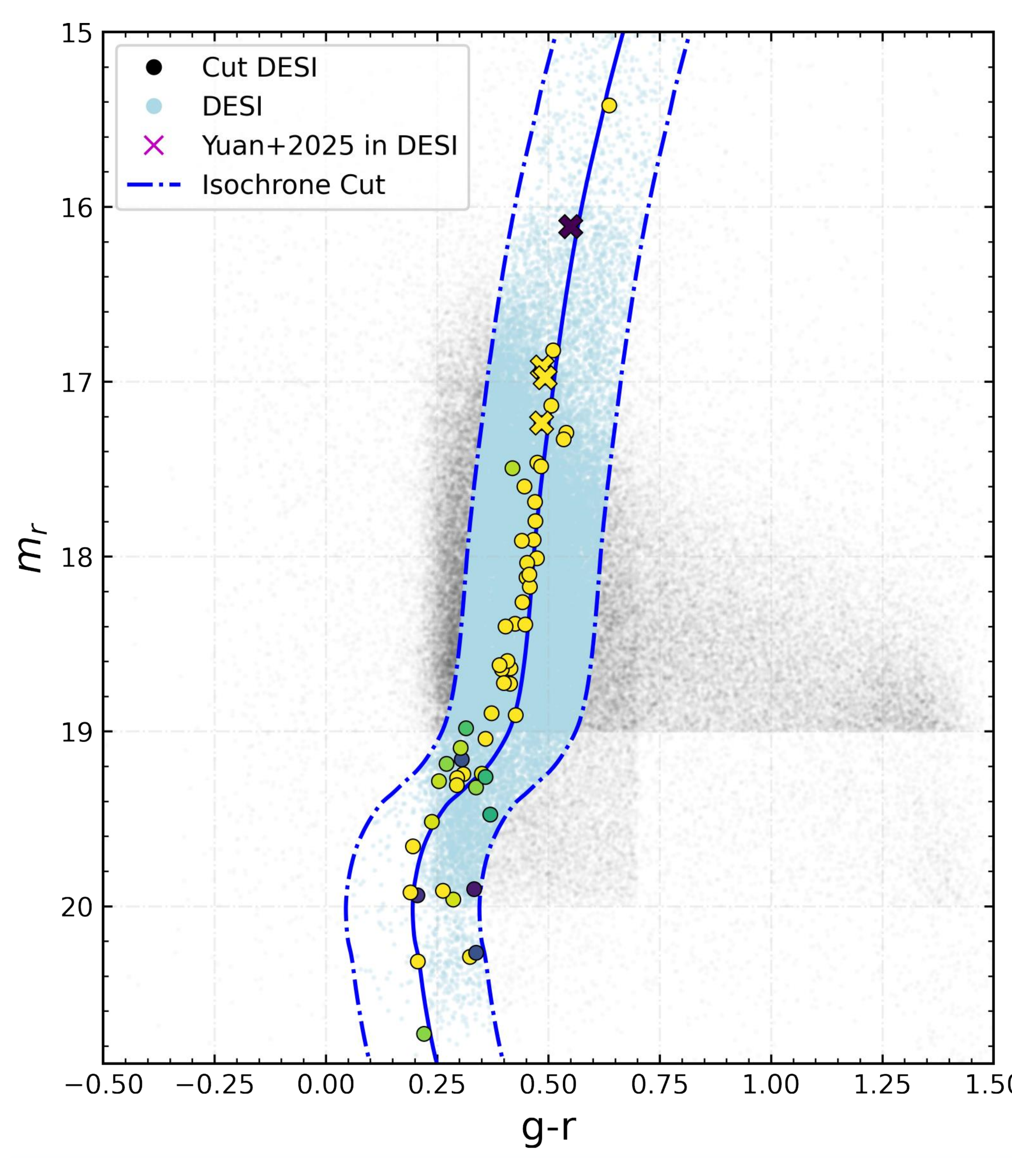

Fig 2. 13.5 Gyr Isochrone for [Fe/H] = -2.49 stellar population.

> C-19 is extremely **metal-poor.** Its chemical makeup suggests **GC origins**, but its kinematics suggest **DG origins.**

Bayesian Mixture Modelling

We use a 2-component finite mixture model to separate stream member stars from 'background' stars in the same field of view. We model the background and stream stellar populations with Gaussian distributions, where the best-fit parameters are found using Bayesian inference.

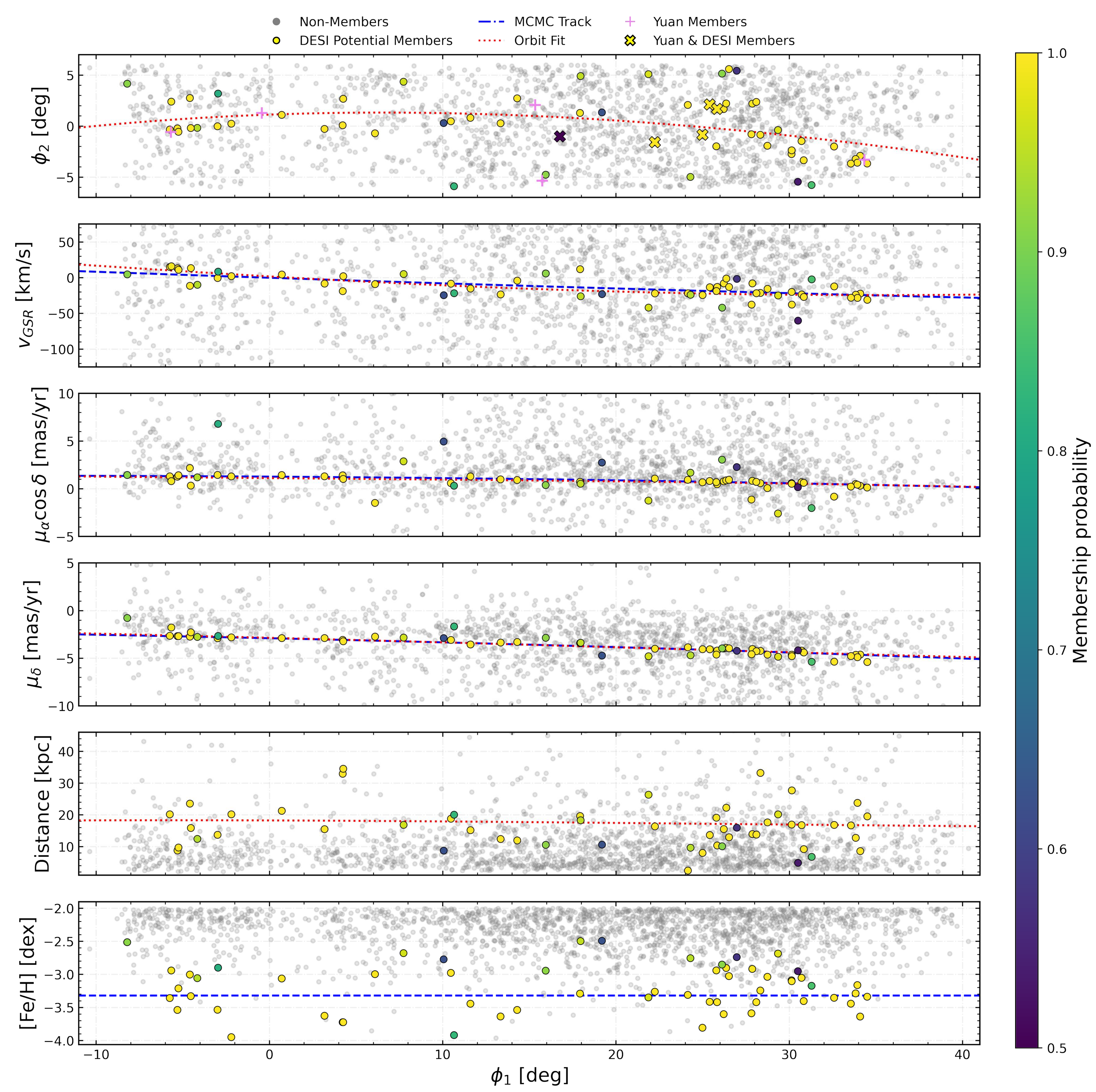

Fig 3. Membership probability of high-probability (p > 0.5) C-19 stars and derived stream tracks from mixture model.

Results

We find **51 high probable members**, recovering all members identified in Yuan et al. 2025 [11] that are in the DESI footprint. We measure kinematic and metallicity properties in agreement with past literature. We also note a novel spur in the spatial morphology of the stellar stream, similar to features previously identified in the GD-1, Atlas Altiqa-Uma, and Ophiuchus streams [12, 13, 14].

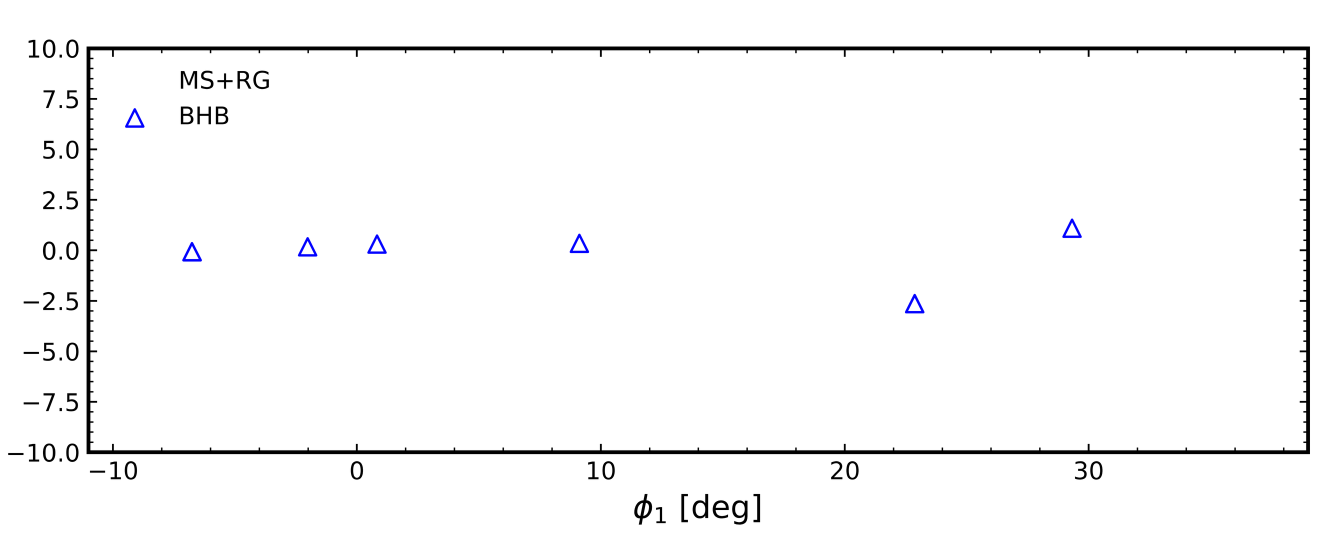

Fig 4. C-19 members from box-cut technique, removing dependance on apt modelling of background component.

Take Aways

- C-19 is **an extremely metal-poor stellar population**, reaffirmed with 2.5x spectroscopic members
- We discover a **spur** in **C-19 indicative of a past collision**
- **Mixture Modelling** with 6D kinematics is a **powerful tool** for studying streams