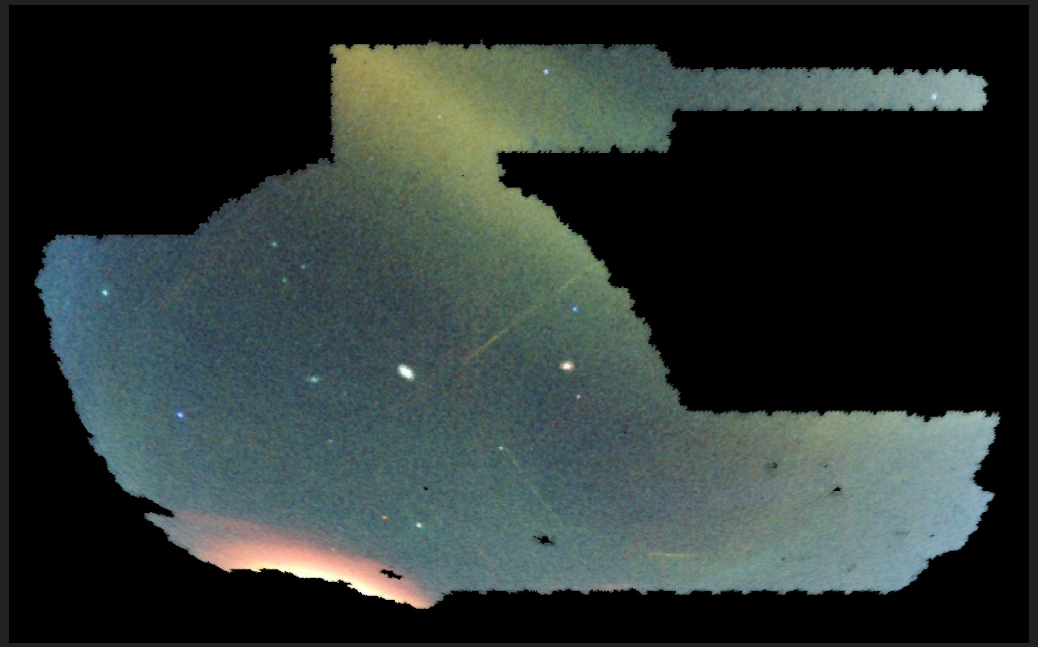
Stellar Streams Discovered in the Dark Energy Survey

arXiv:1801.03097



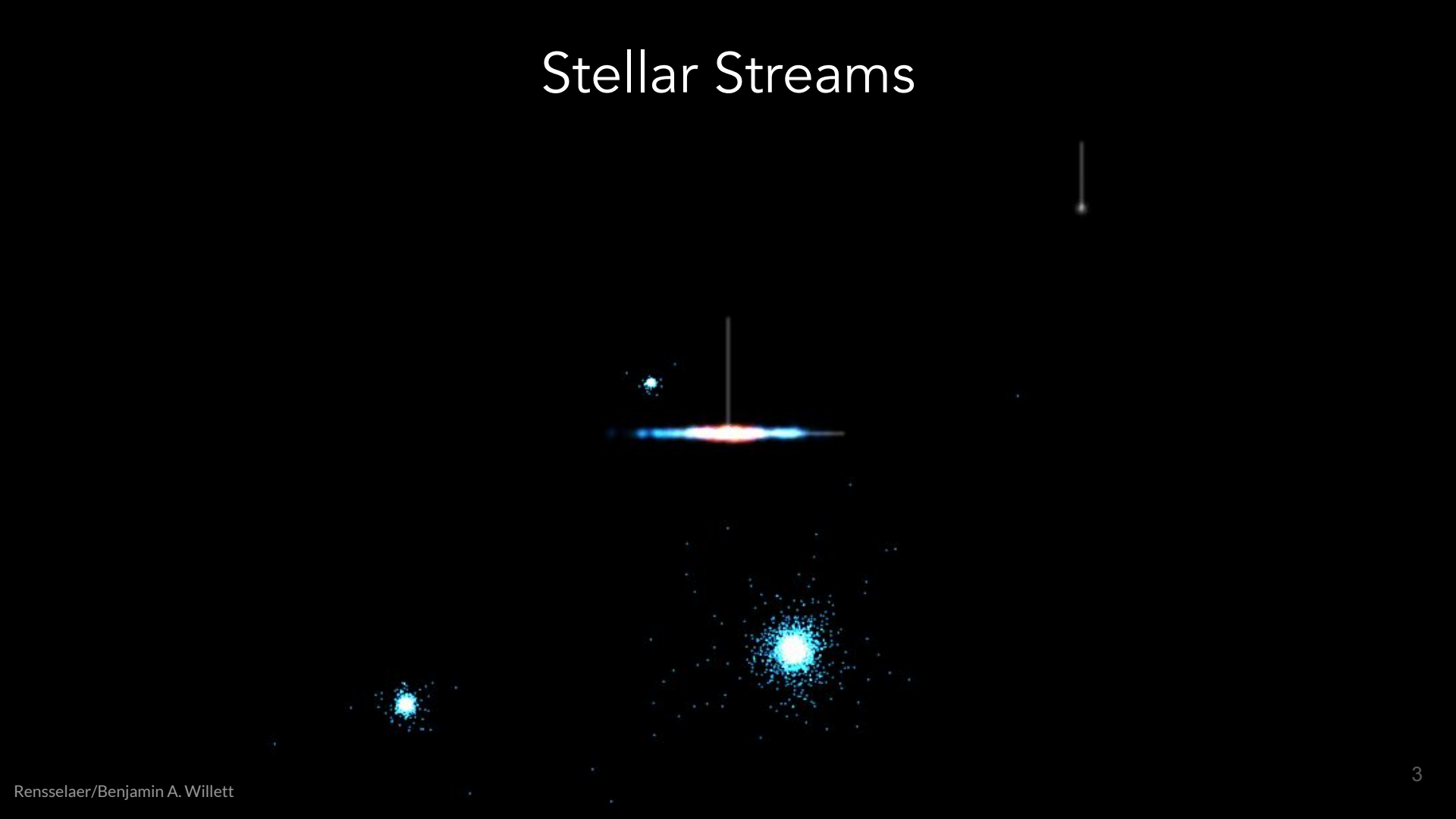
Nora Shipp (U. Chicago)

Alex Drlica-Wagner, DES Milky Way Working Group

DES Collaboration

Stellar Streams

Stellar Streams

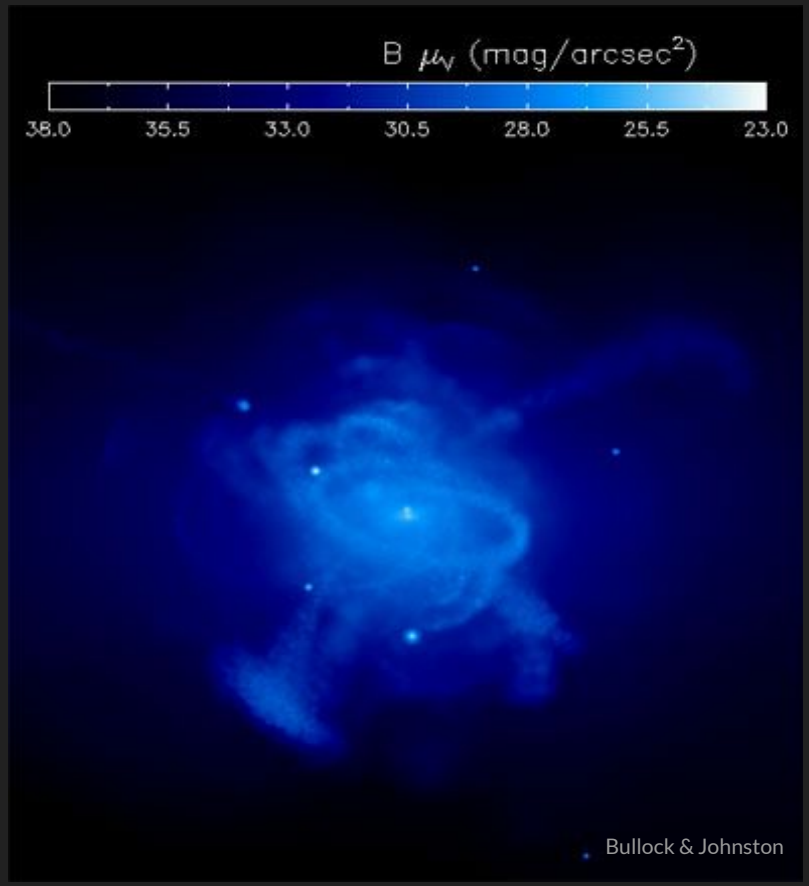


Why study stellar streams?

1. Galaxy formation

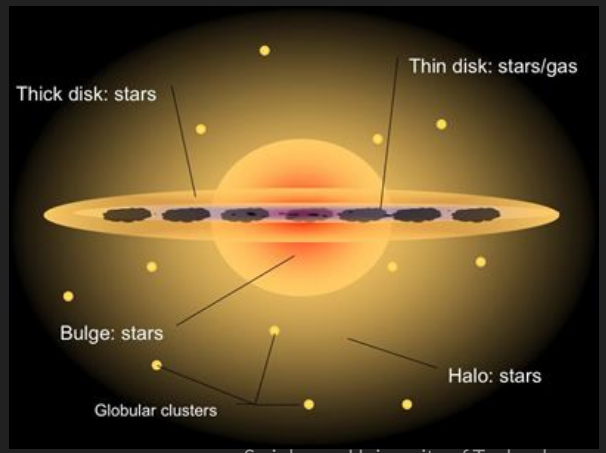
Why study stellar streams?

1. Galaxy formation
   - Hierarchical structure formation

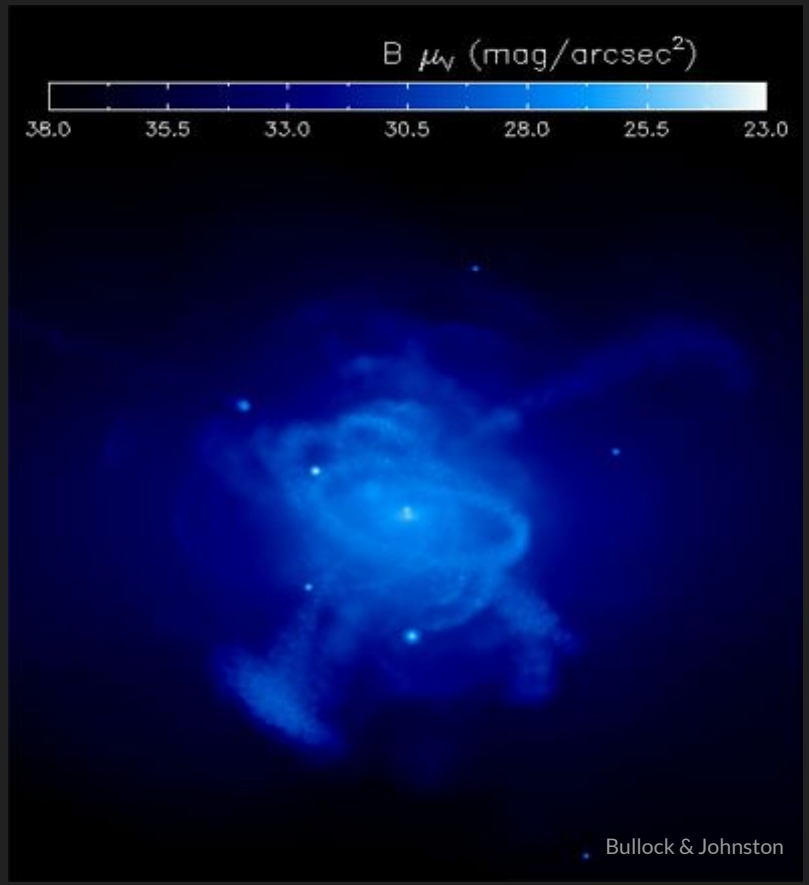


Why study stellar streams?

1. **Galaxy formation**
   - Hierarchical structure formation
   - **Formation of stellar halos**

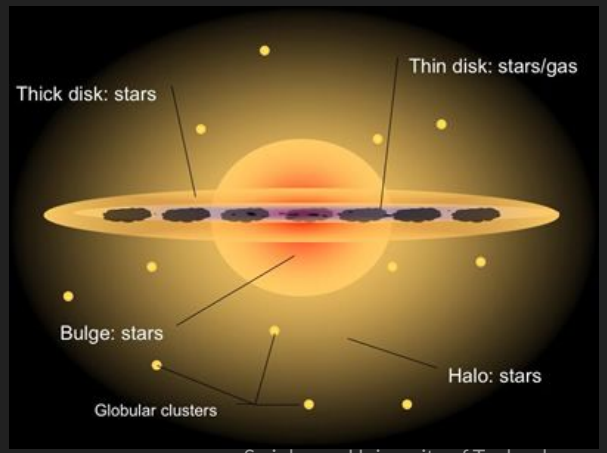


Swinburne University of Technology



Why study stellar streams?

1. **Galaxy formation**
   - Hierarchical structure formation
   - Formation of stellar halos
   - **Galactic archaeology**



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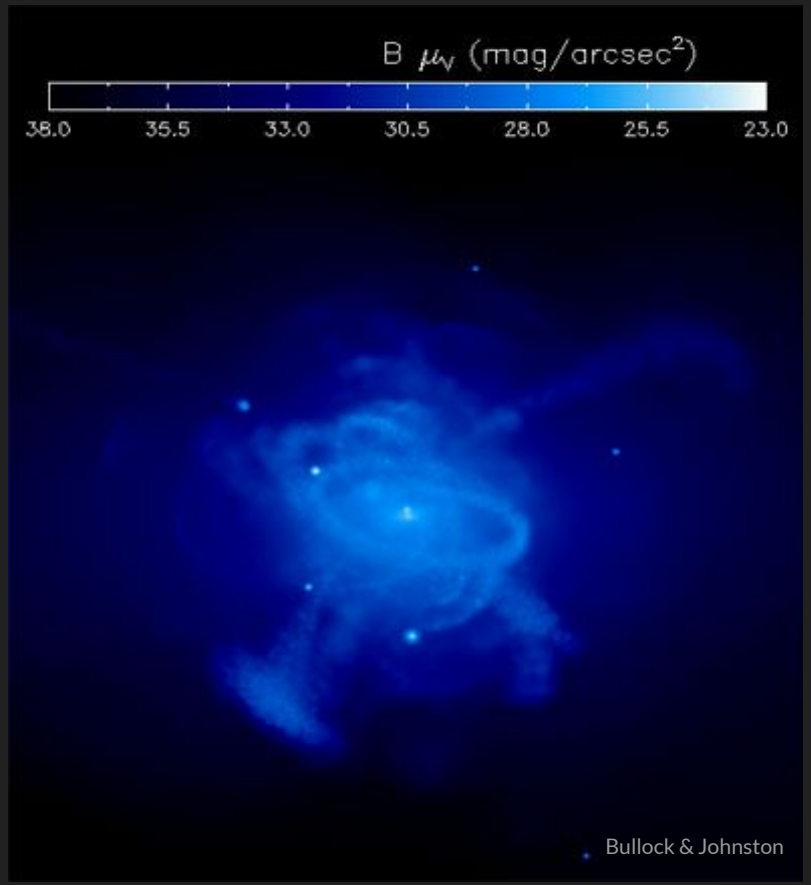


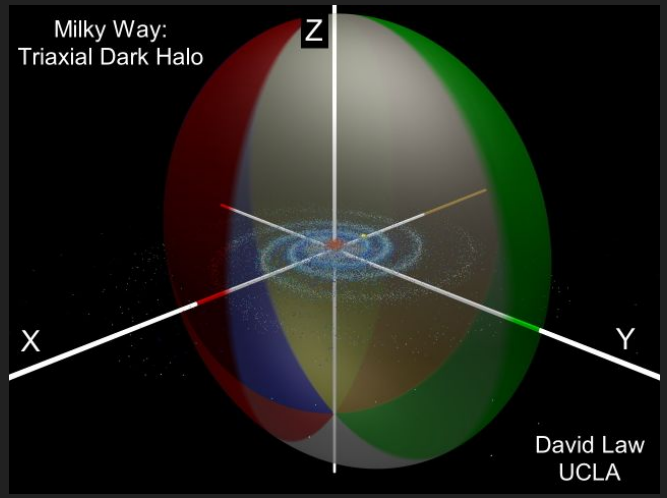
Why study stellar streams?

2. **Dark Matter**

Why study stellar streams?

2. Dark Matter

- Large scale: *What is the shape of the Milky Way potential?*



Why study stellar streams?

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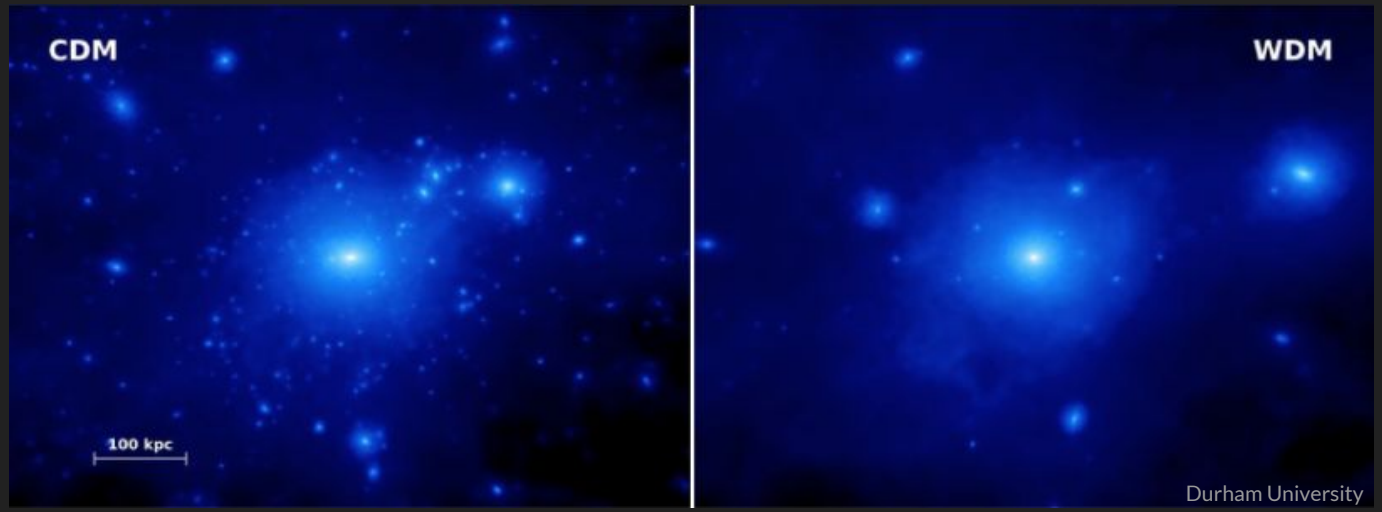
- **Small scale: *What is the abundance of low mass subhalos?***



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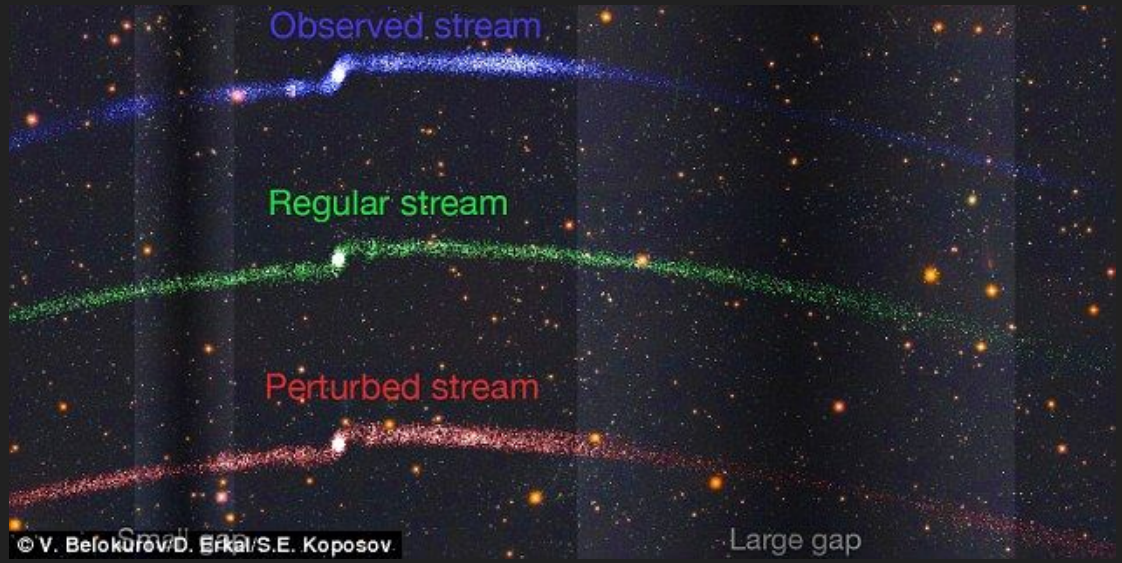
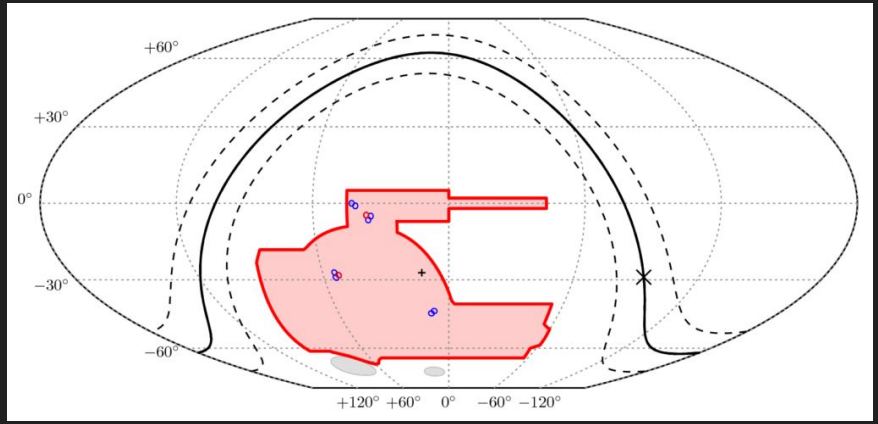


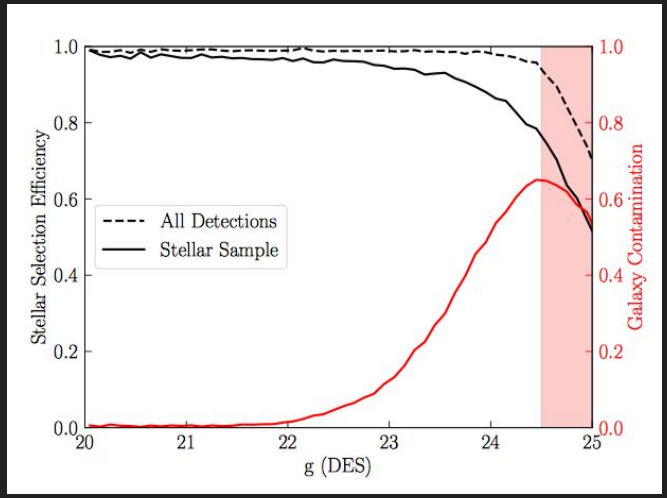
Need a large sample of stellar streams

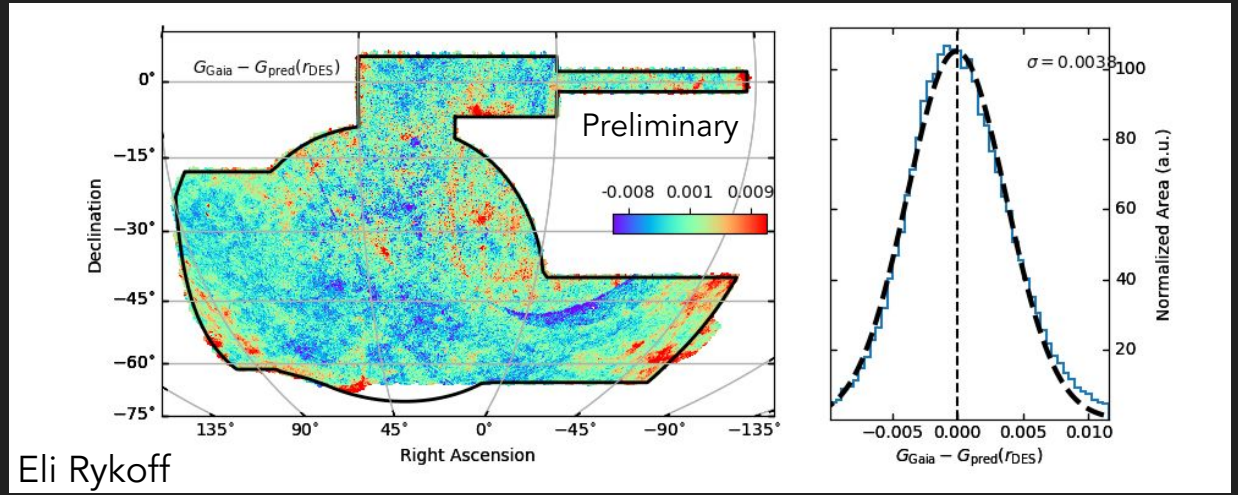
Searching for Stellar Streams

The Dark Energy Survey



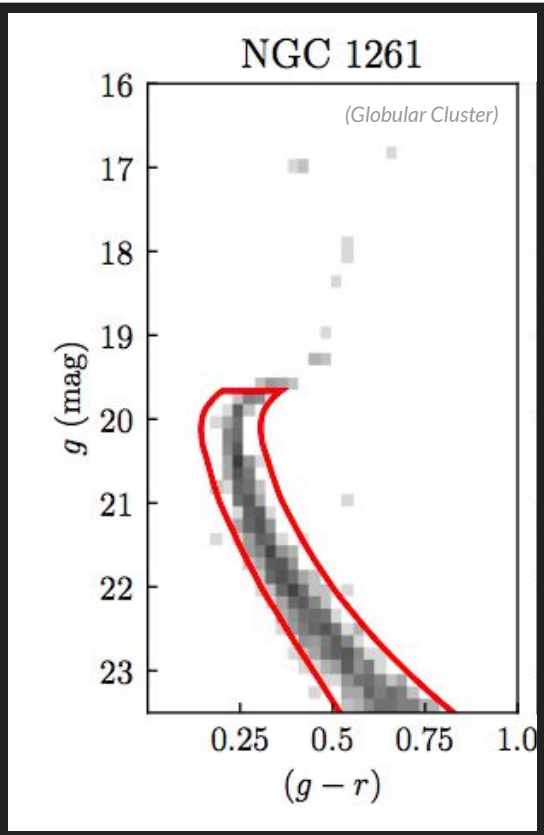
- Wide area in southern hemisphere
- High accuracy star-galaxy separation to g~23.5
- Excellent calibration





Eli Rykoff

We selected stars around old, metal-poor isochrones



Red = selection region around isochrone; $\boldsymbol{\tau}$ = 13 Gyr, Z = 0.0002, m-M = 14-19

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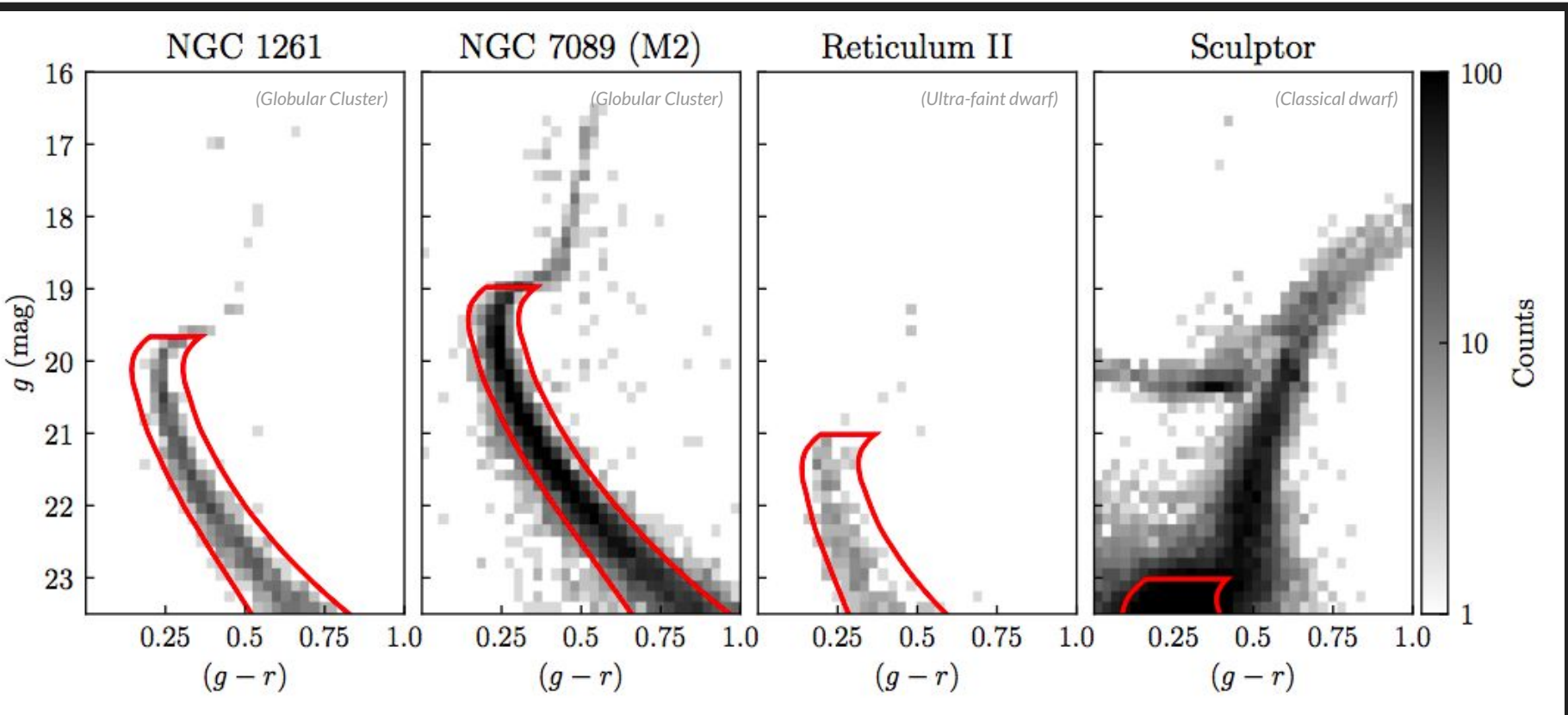

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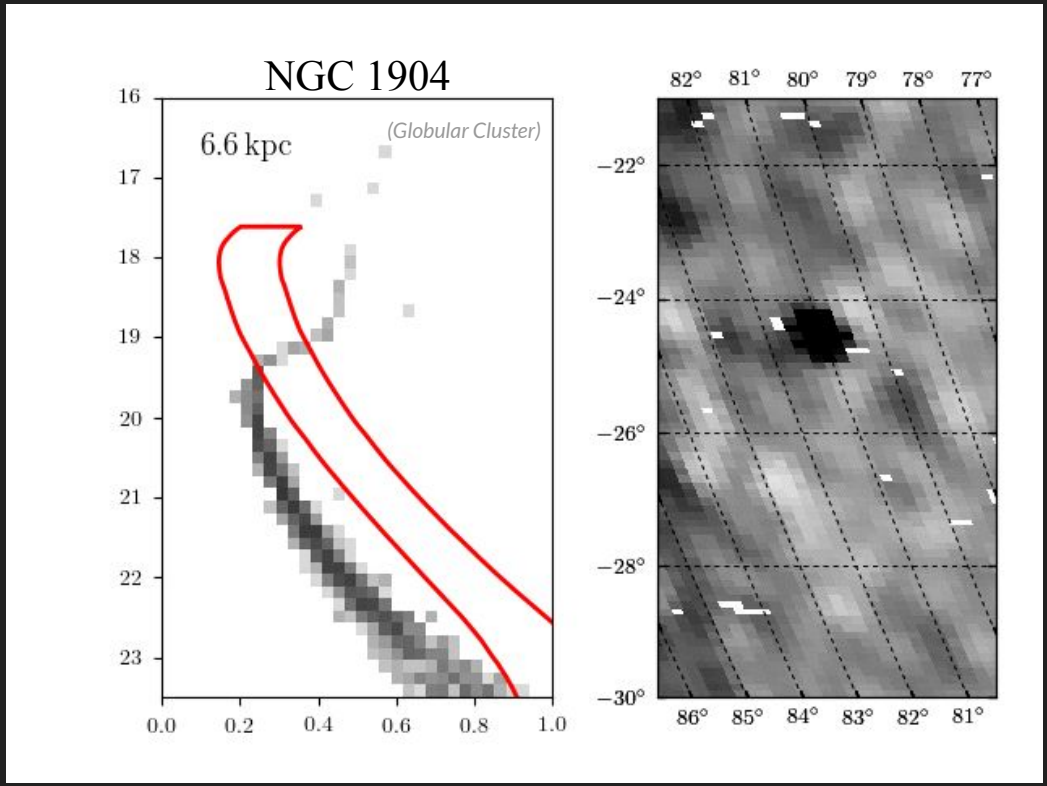

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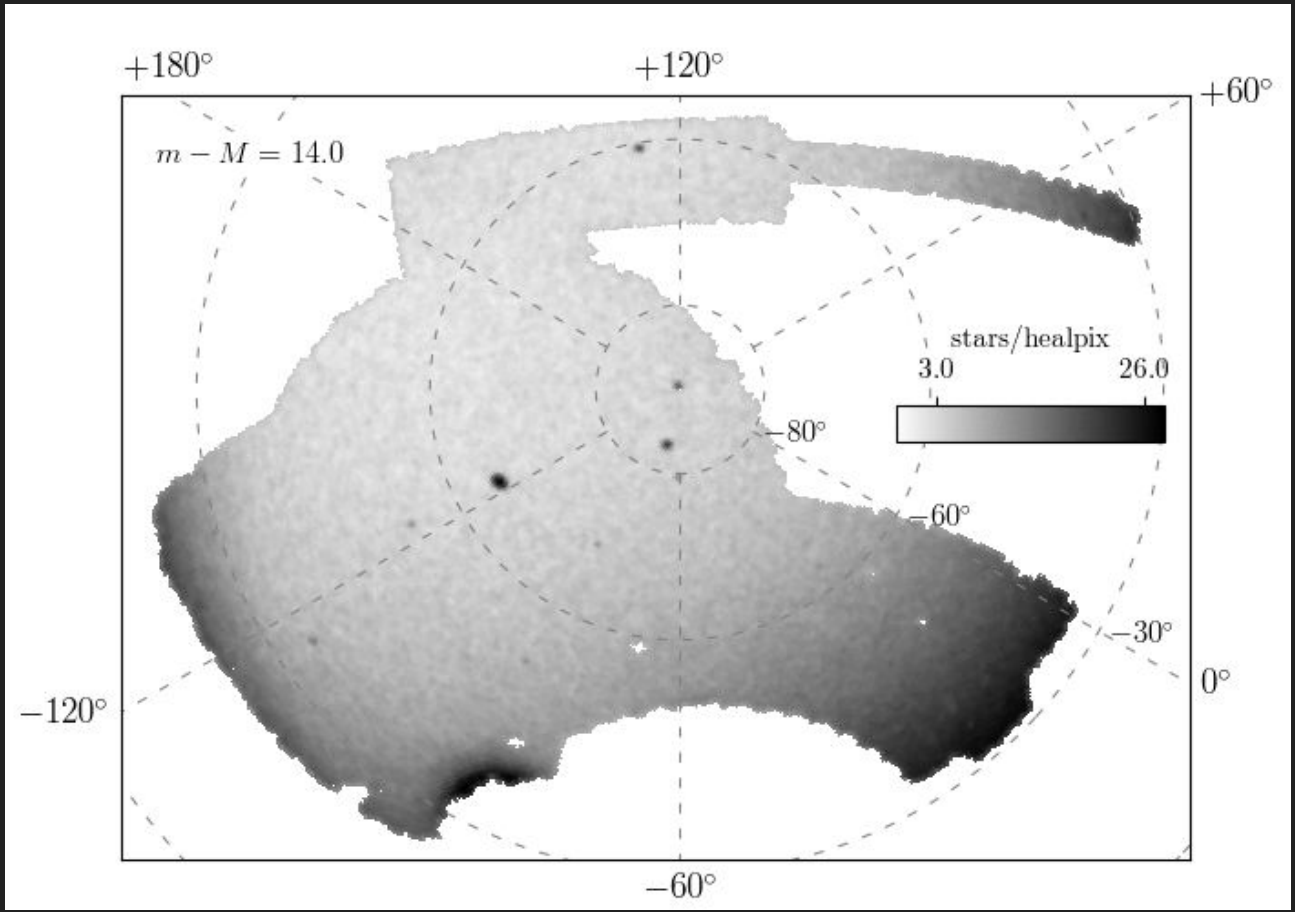
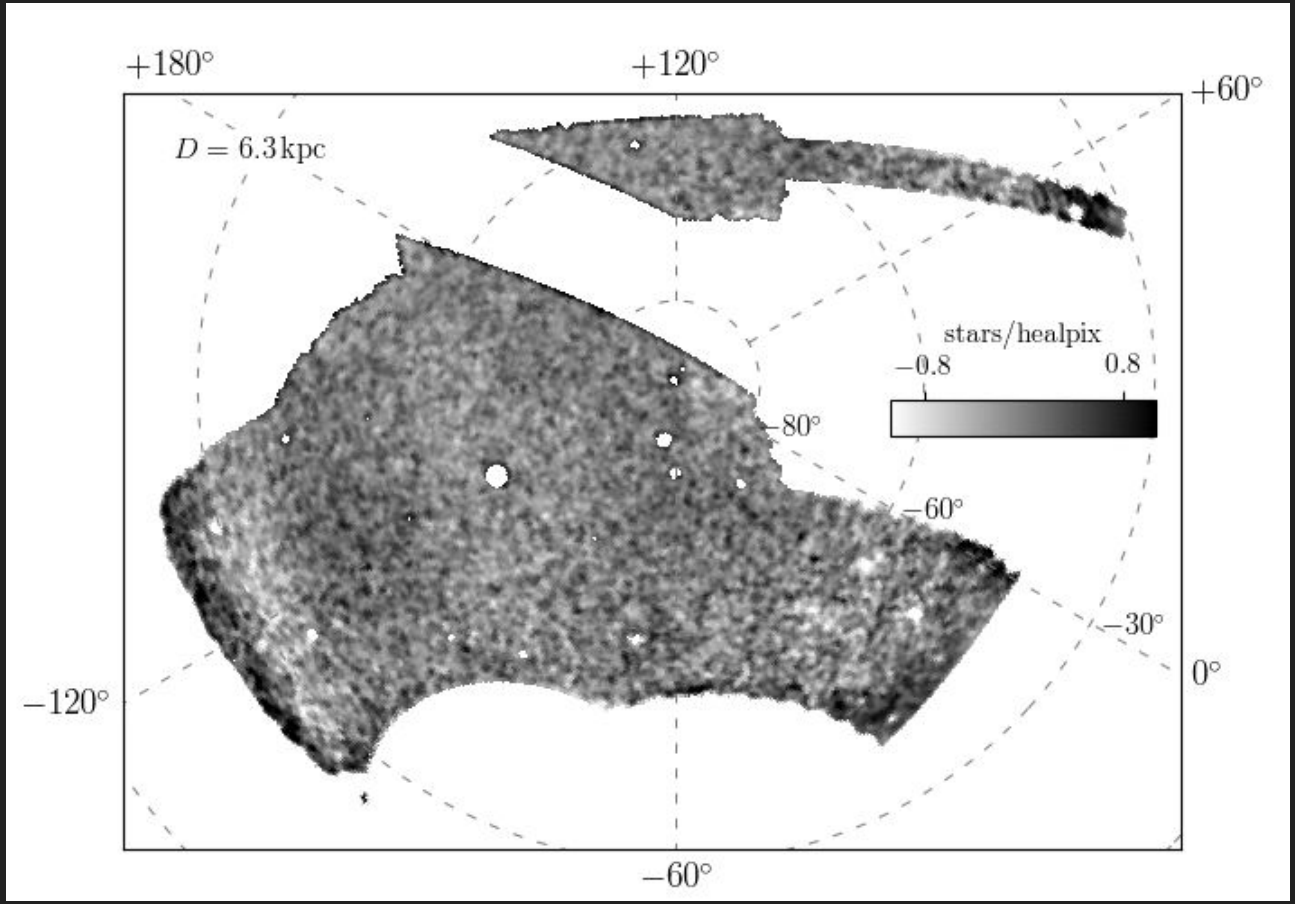
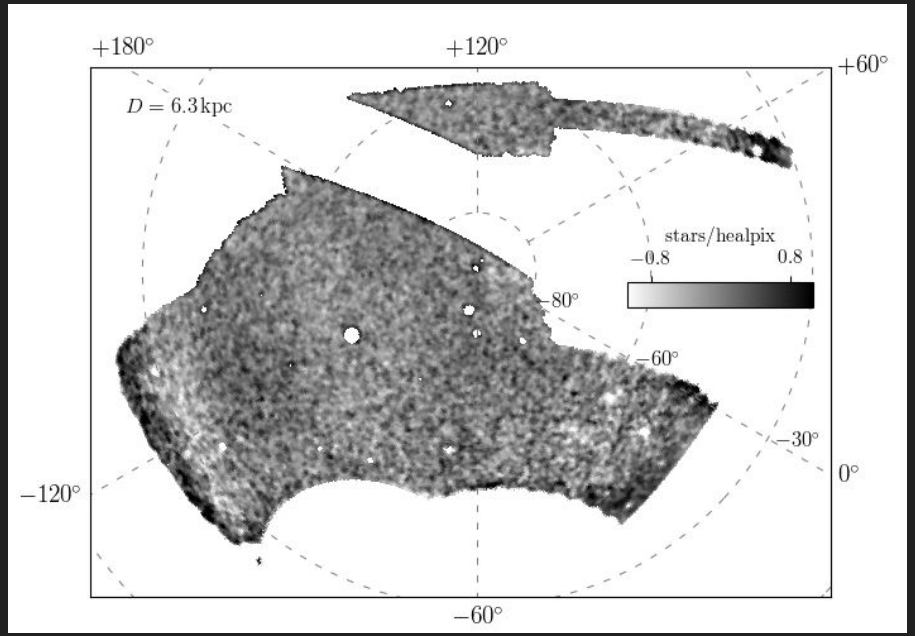


Stellar Density



Stellar Density (Background Subtracted)

Eleven new streams discovered



Stellar Density
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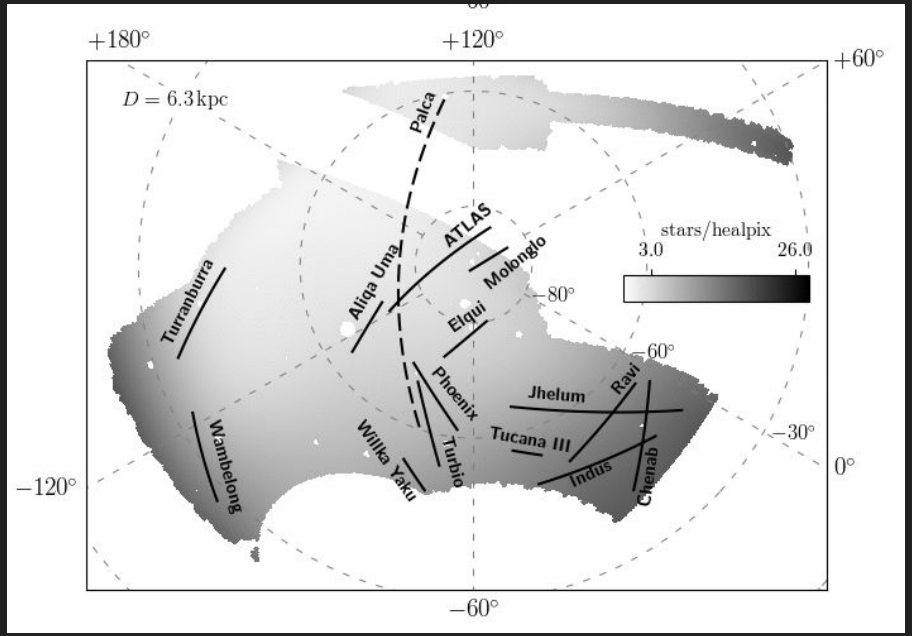
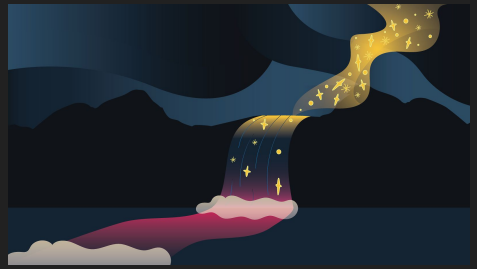


Smooth Background Fit

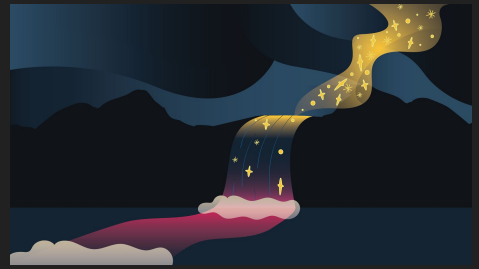
Naming the streams



Symmetry Magazine: Rivers in the Sky

Naming the streams

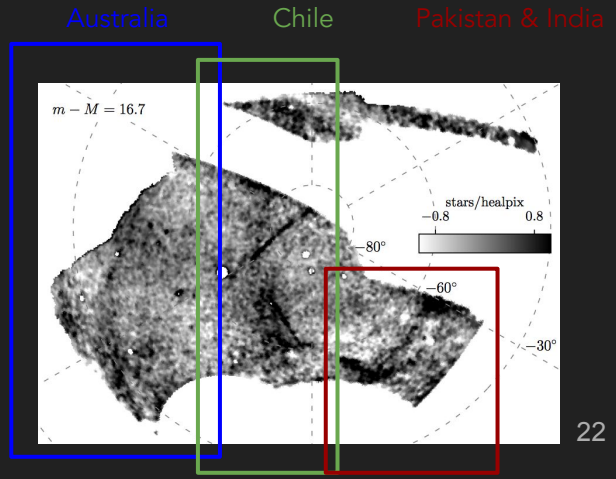
Pakistan & India



Symmetry Magazine: Rivers in the Sky

Australia

Chile



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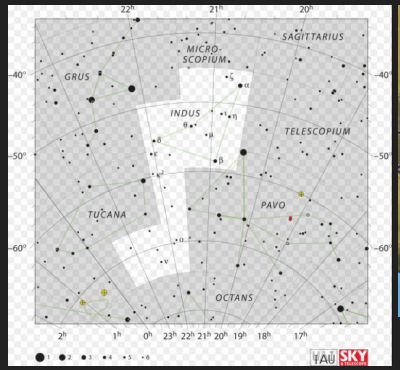

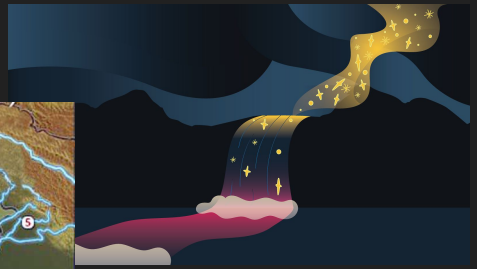

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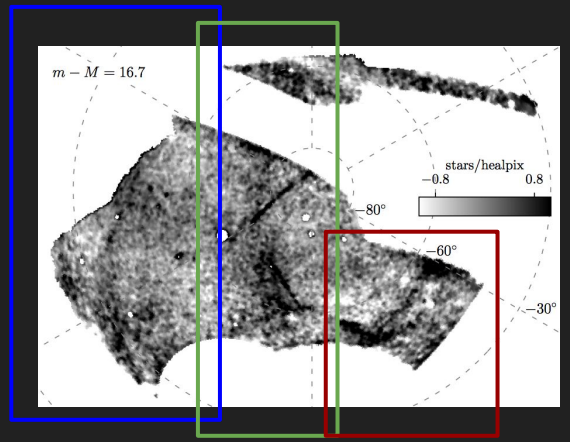

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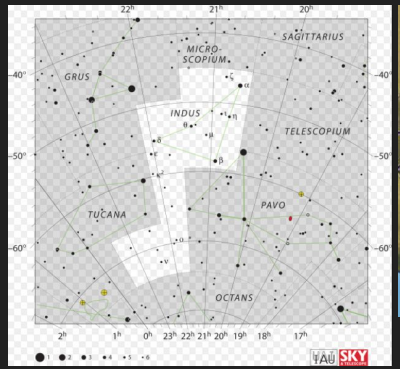
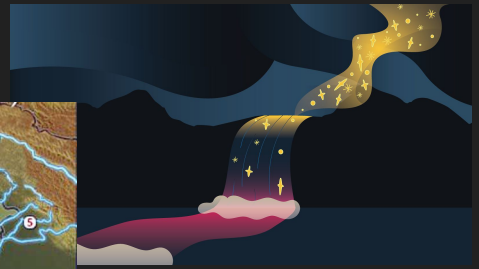


Australia



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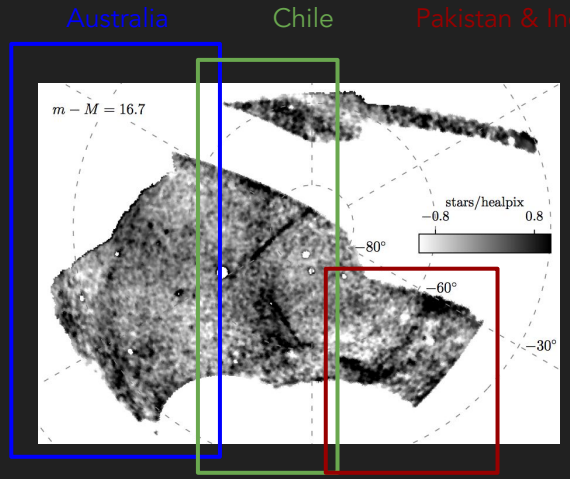

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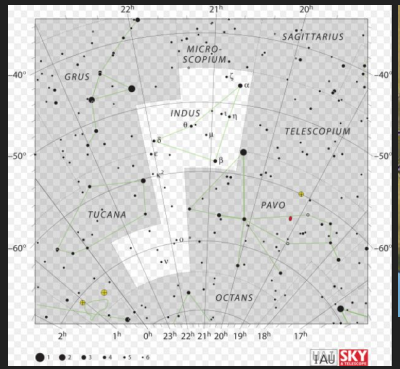

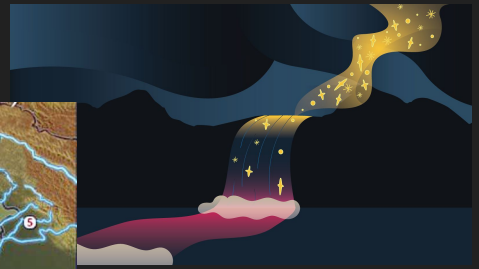

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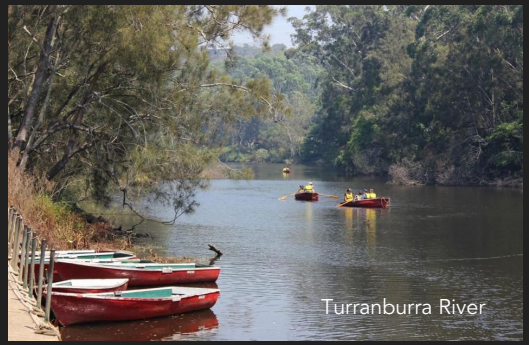
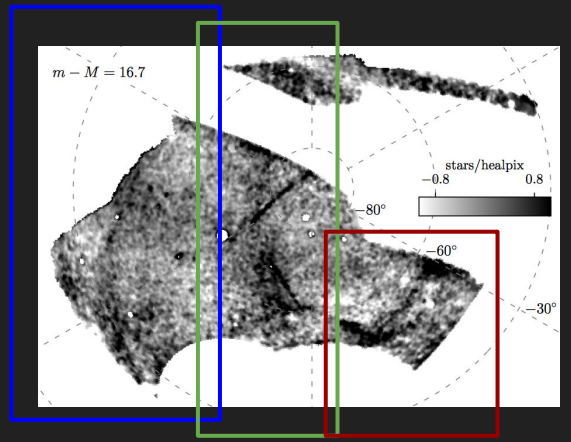


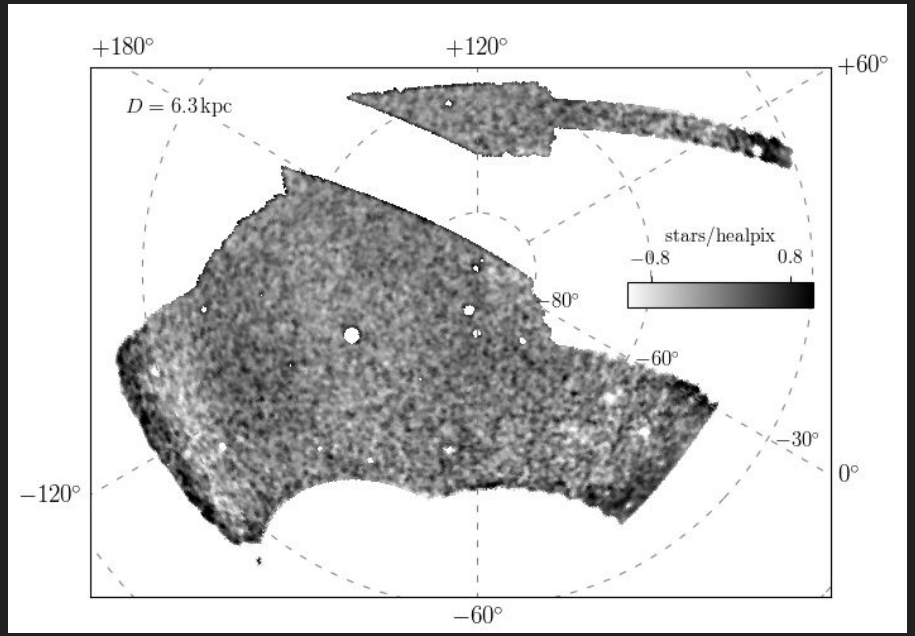
Chile

Australia Chile Pakistan & India



Results

Eleven new streams discovered



Stellar Density
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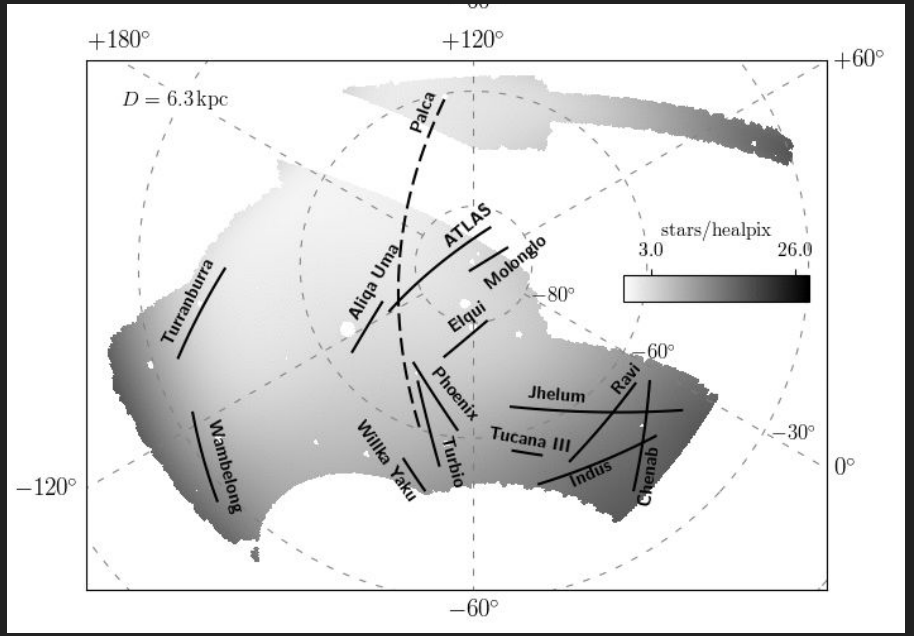
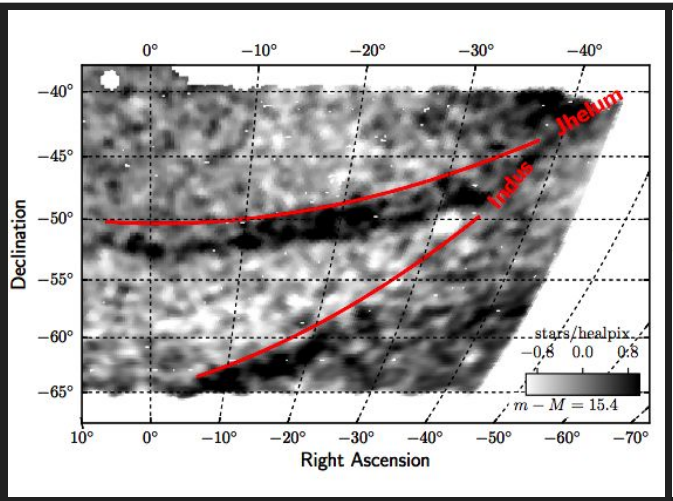
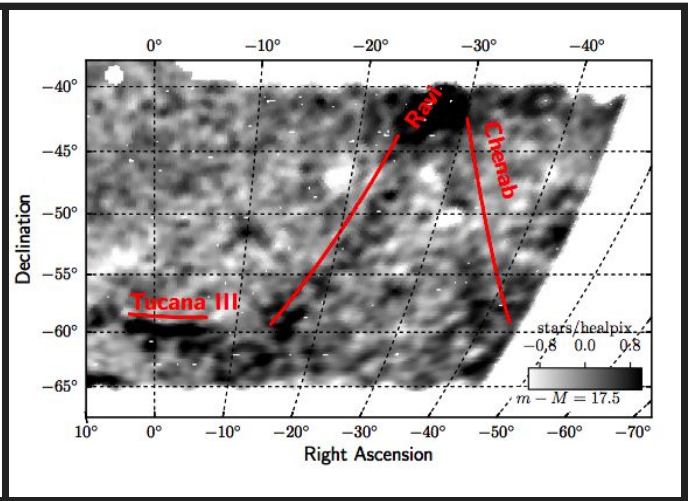
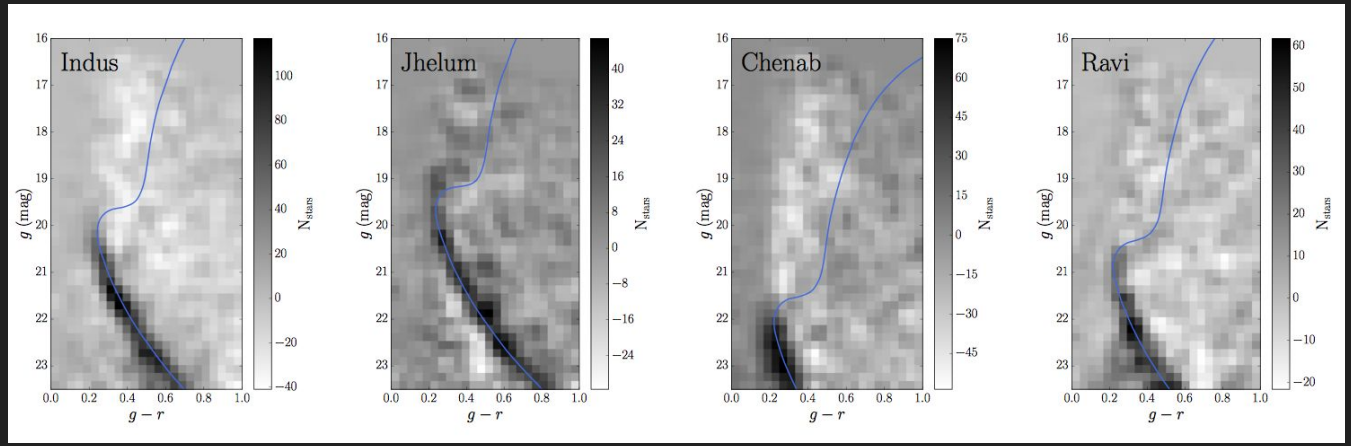


Smooth Background Fit

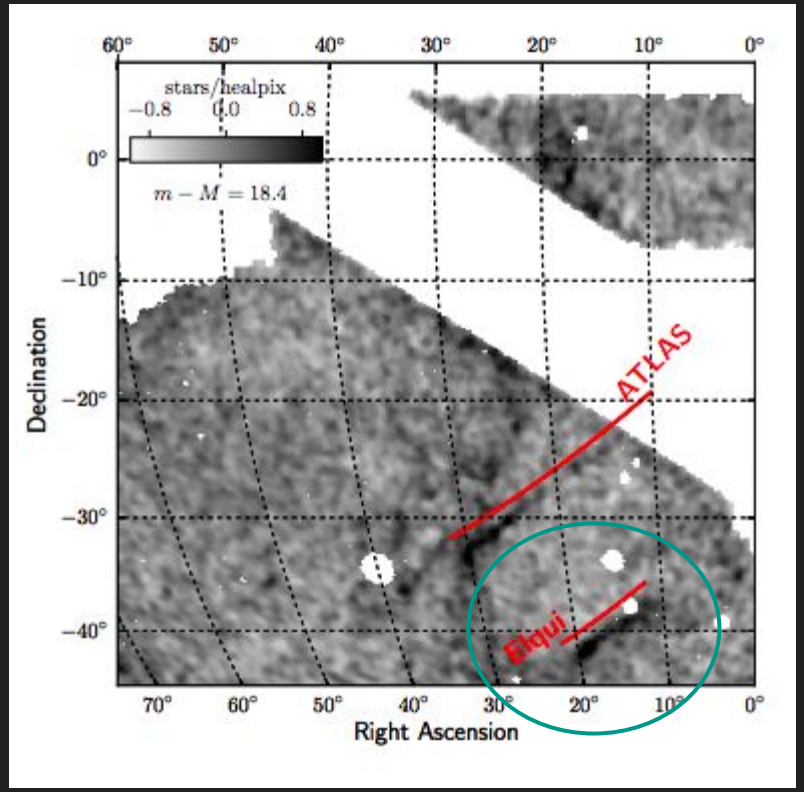
New Stellar Streams



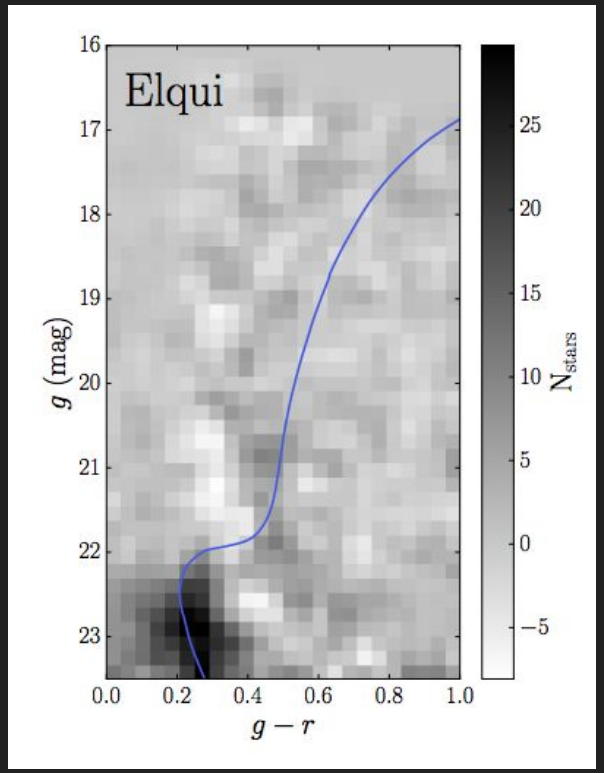




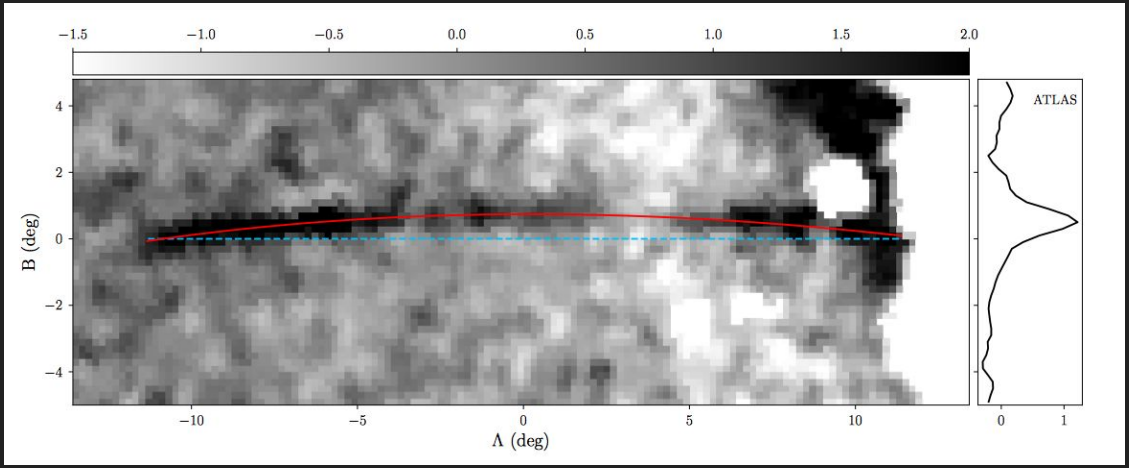
Elqui stream discovered at 50 kpc

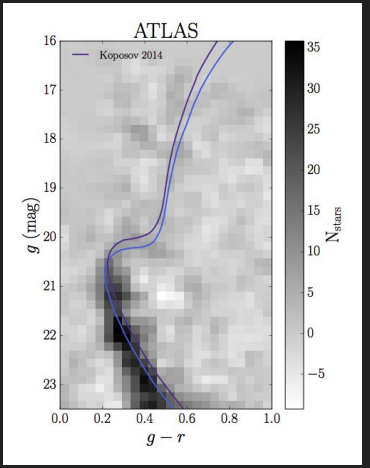


50.1 kpc (m-M = 18.5)



ATLAS stream





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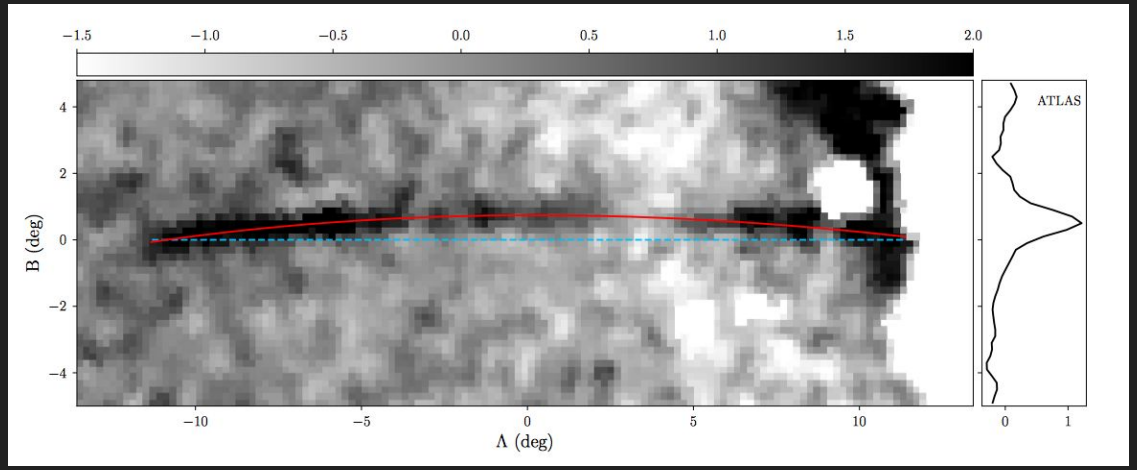

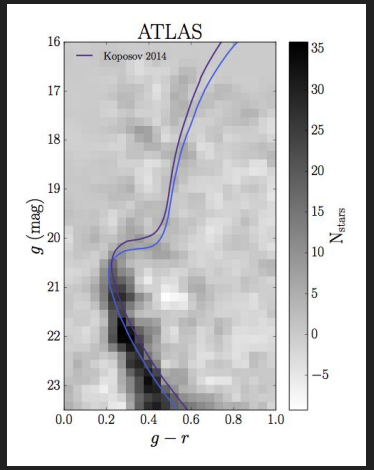

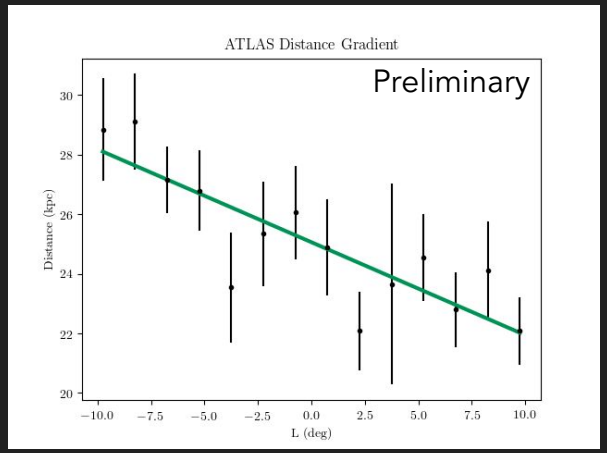

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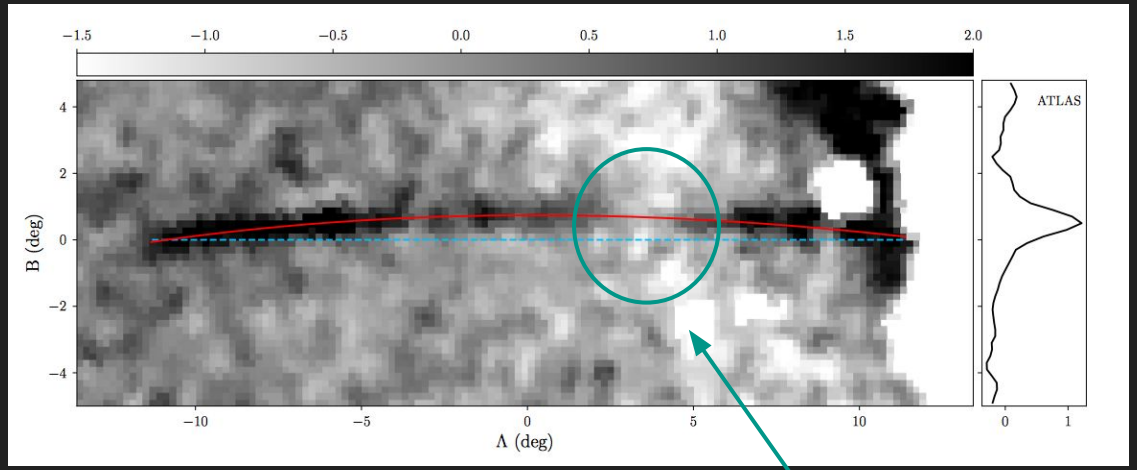
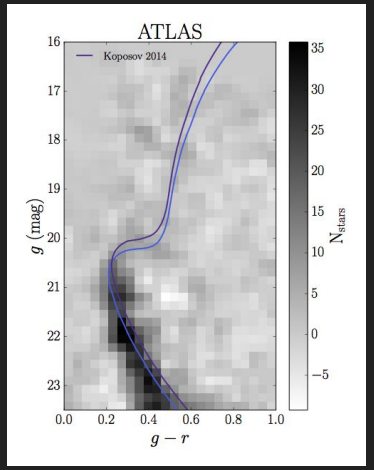
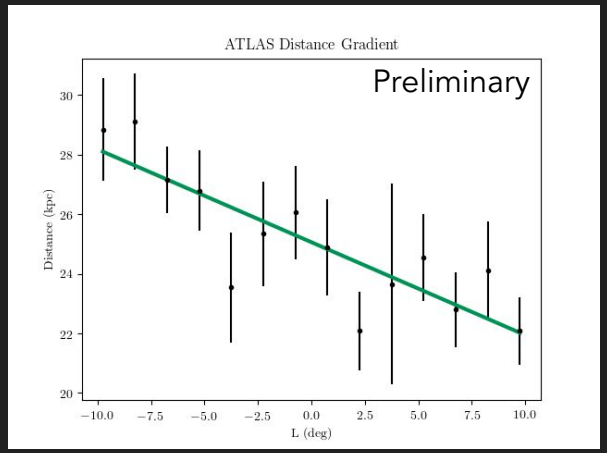
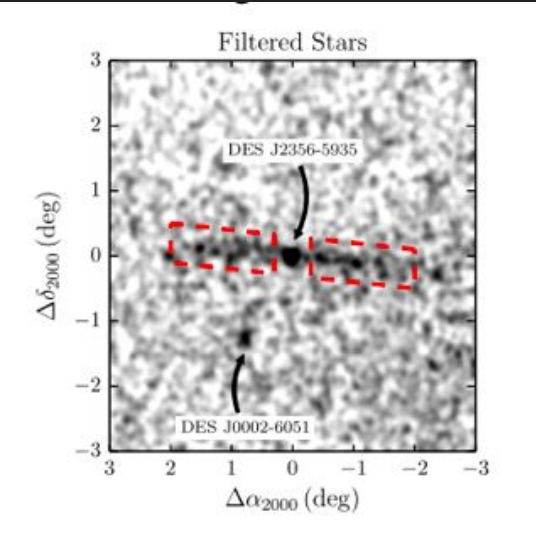






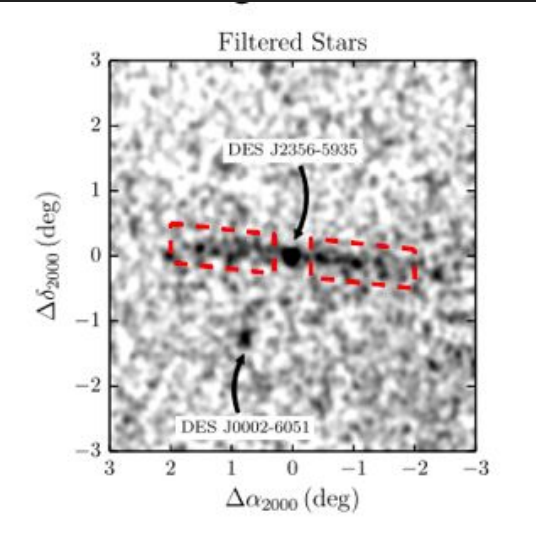
Stream gap?

Tucana III Stream



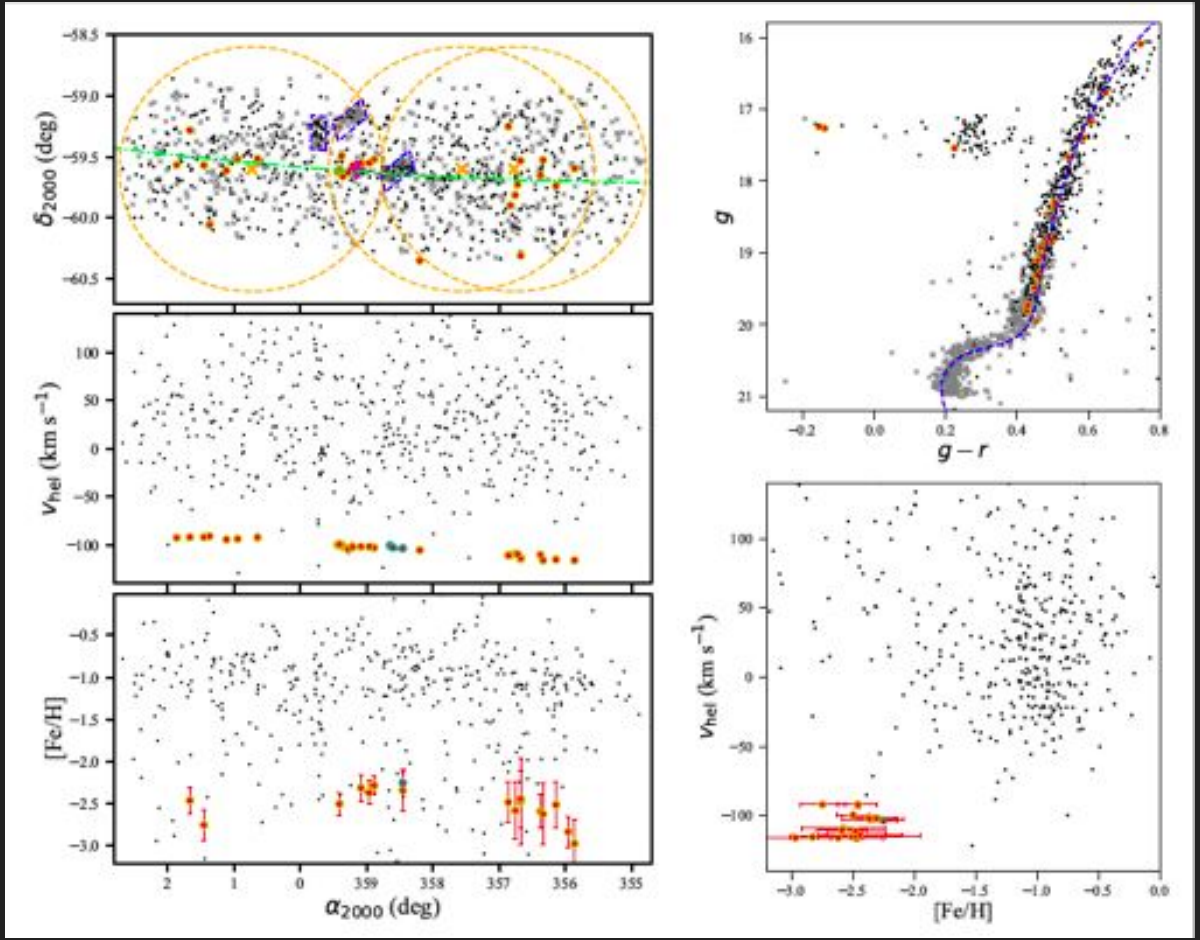
Drlica-Wagner+ 2015

Tucana III Stream

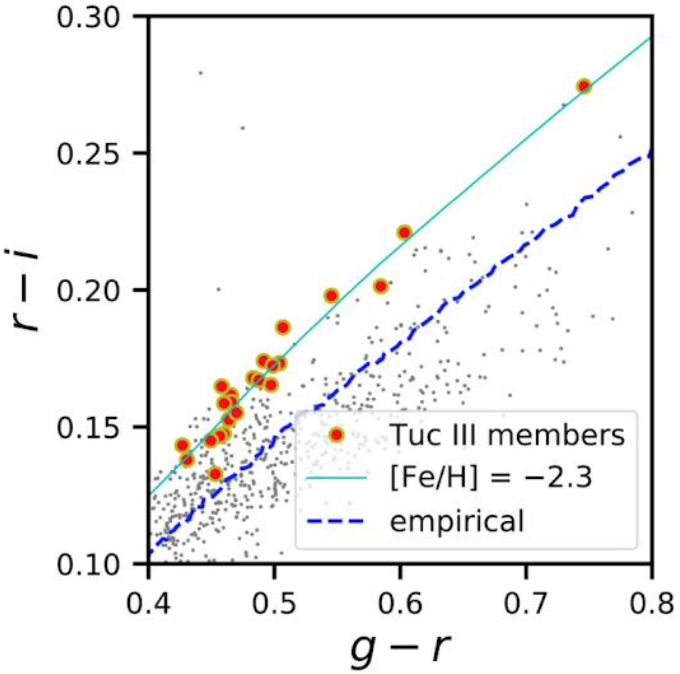


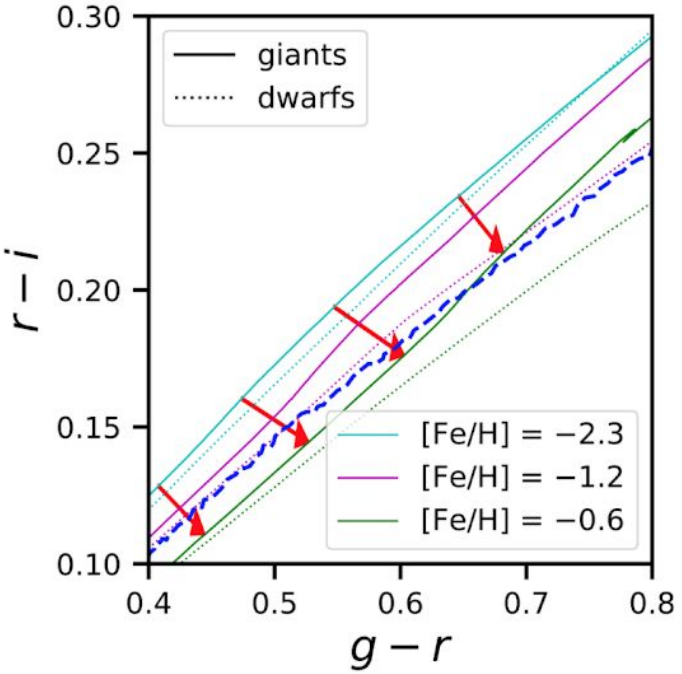
Drlica-Wagner+ 2015

Li+ 2018
arXiv:1804.07761



Tucana III Stream





With only DES photometry we can identify metal poor stars

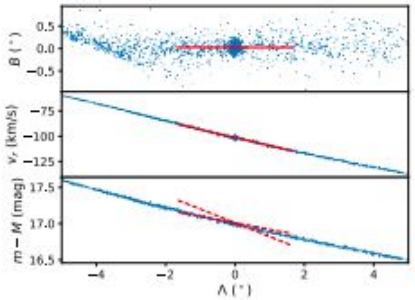
Ting Li

Erkal+ 2018 arXiv:1804.07762

Tuc III stream and the LMC

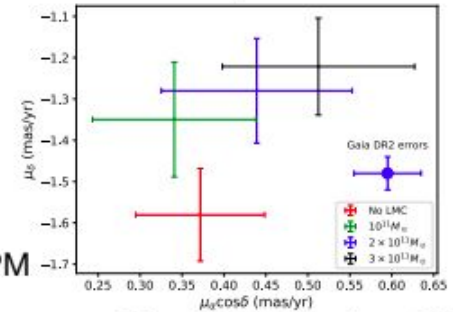
Pre-Gaia DR2 we modelled the stream and predicted a close passage with the LMC

Stream fit



★Gaia PM

Predicted PMs depend on LMC mass

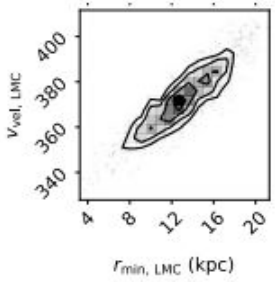


Gaia PM differs from prediction

PM depend heavily on Milky Way potential

Gaia DR2 PMs from Simon 2018 imply a close passage with the LMC so can be used to measure LMC mass

Closest approach to LMC



Summary

- Stellar streams are powerful tools for studying the Milky Way
- Discovered **eleven** new stellar streams in DES
- DES photometry combined with velocity measurements allows for strong constraints on stream parameters
- Paper available at https://arxiv.org/abs/1801.03097

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Questions?