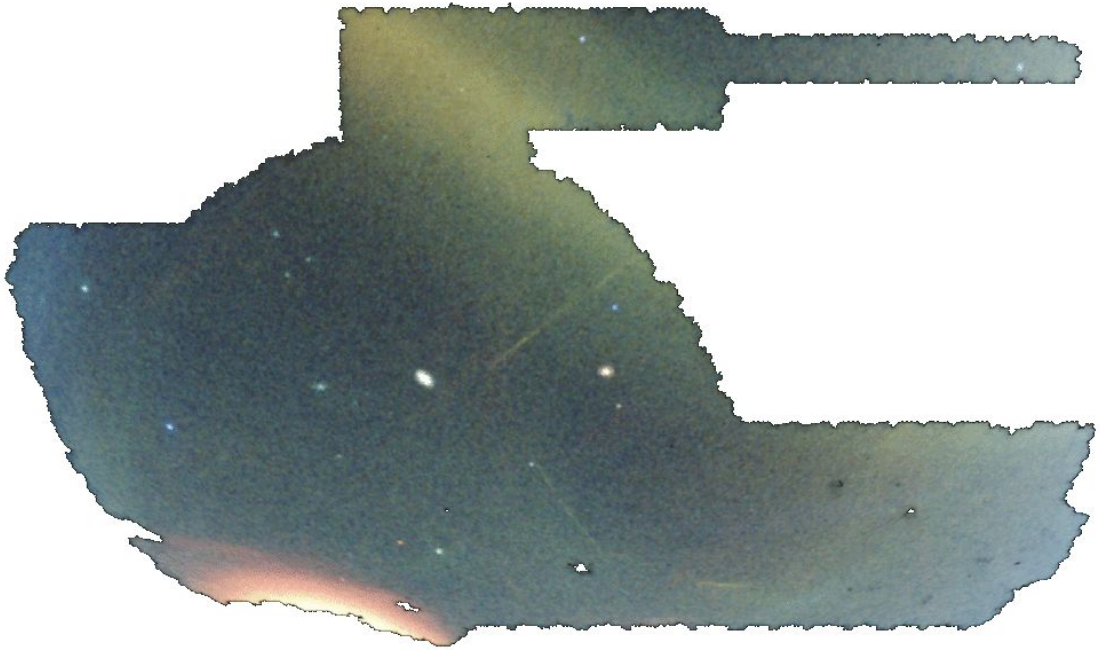
6D Stellar Streams in the Southern Sky



Nora Shipp | University of Chicago

with Ting Li, Denis Erkal, Alex Drlica-Wagner, Andrew Pace, Brian Yanny, Vasily Belokurov,
S^5 Collaboration

2 new papers on the arXiv last week

Proper Motions of Stellar Streams Discovered in the Dark Energy Survey

Shipp et al. 2019

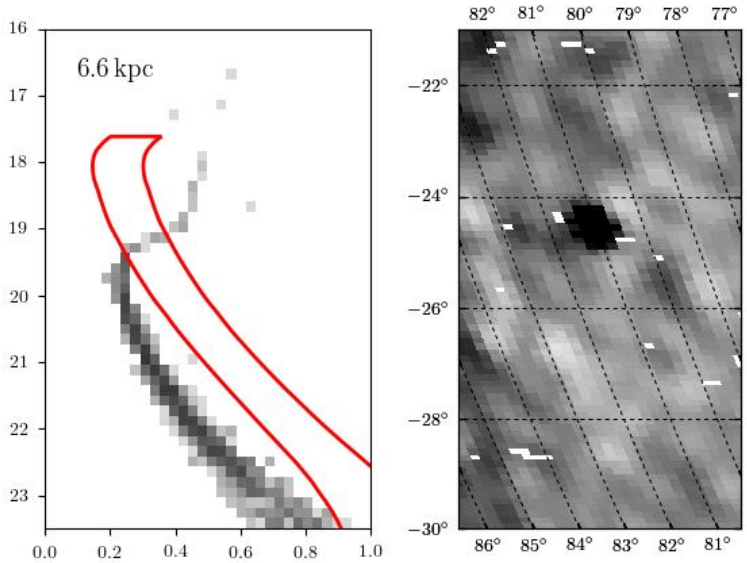
arXiv:1907.09488

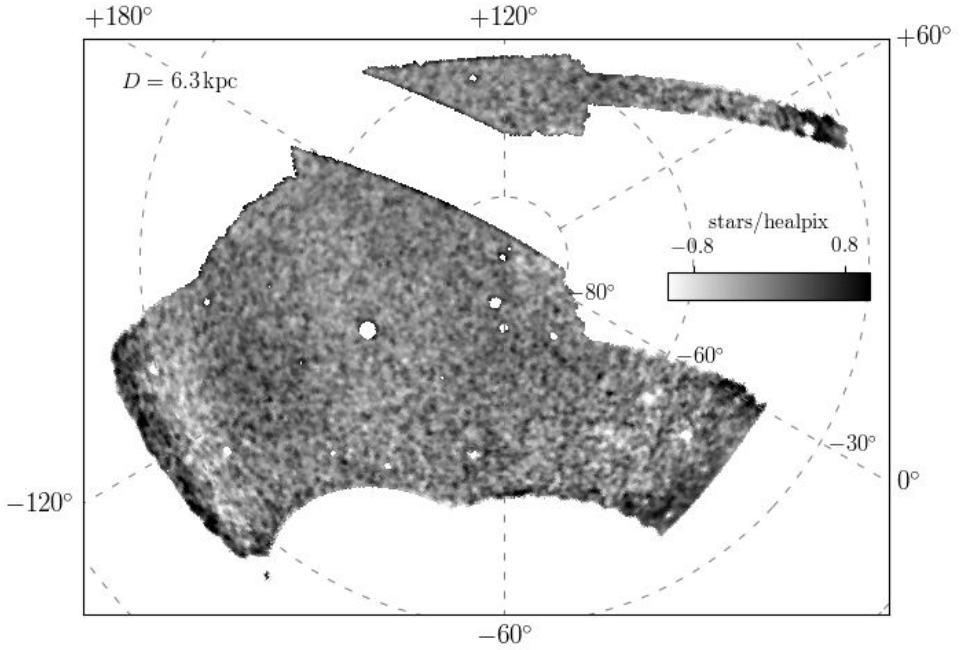
The Southern Stellar Stream Spectroscopic Survey (S^5): *Overview, Target Selection, Data Reduction, Validation, and Early Science*

Li et al. 2019

arXiv:1907.09481

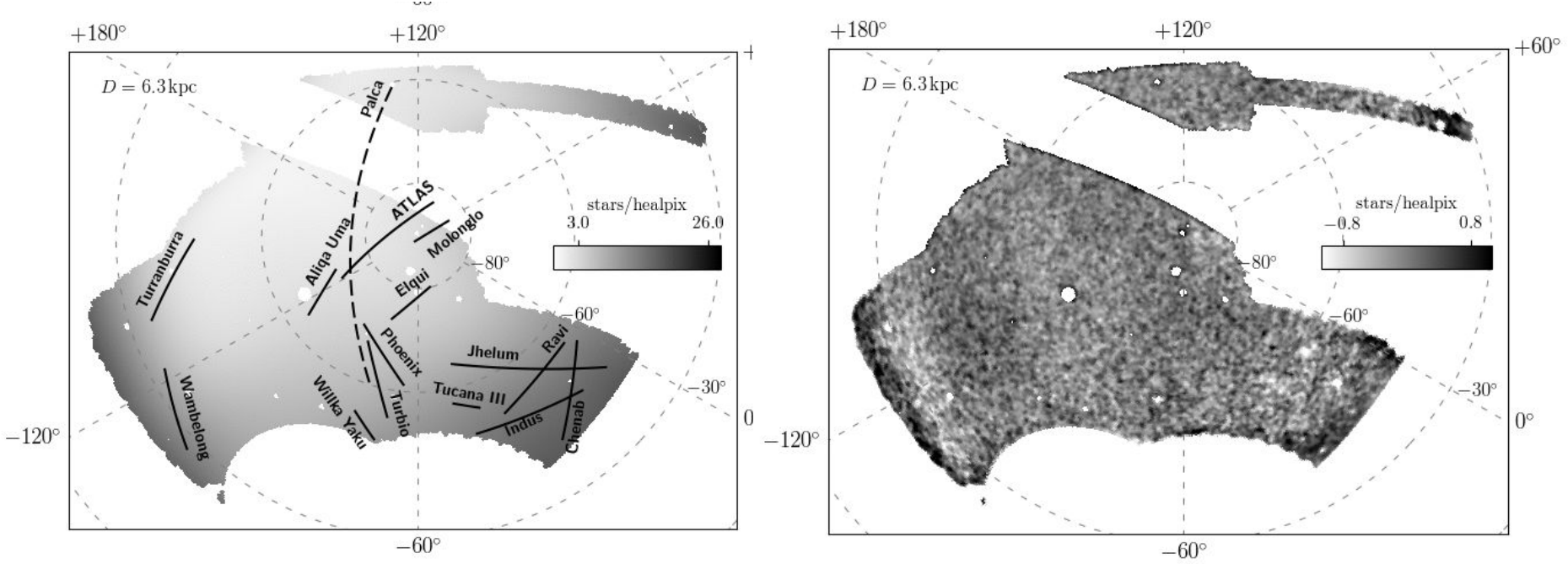
Stellar streams in the Dark Energy Survey





Shipp et al. 2018 arXiv:1801.03097

Stellar streams in the Dark Energy Survey



Shipp et al. 2018 arXiv:1801.03097

S^5 - Southern Stellar Stream Spectroscopic Survey

s5collab.github.io

- Using 3.9-m Anglo-Australian Telescope's 2-degree-Field fibre positioner and AAOmega spectrograph
- Efficient target selection with DES DR1 photometry and Gaia DR2 proper motions
- Completed observations of 12 streams (9 DES)

Leadership: Ting Li, Daniel Zucker, Geraint Lewis, Kyler Kuehn

Builders: Denis Erkal, Alex Ji, Sergey Koposov, Dougal Mackey, Nora Shipp, Jeffrey Simpson, Zhen Wan

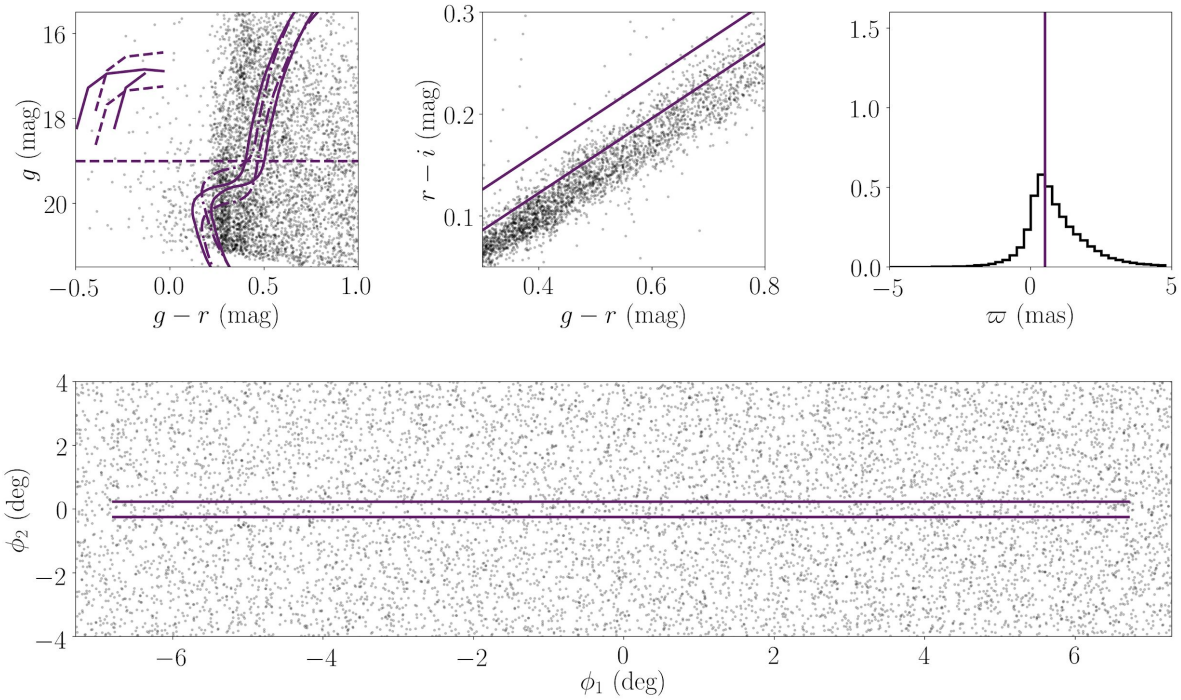
Members: Joss Bland-Hawthorn, Jeremy Mould, Sahar Allam, Eduardo Balbinot, Keith Bechtol, Vasily Belokurov, Andrew Casey, Lara Cullinane, Gary Da Costa, Gayandhi De Silva, Alex Drlica-Wagner, Marla Geha, Yao-Yuan Mao, Sarah Martell, Andrew Pace, Sanjib Sharma, Josh Simon, Douglas Tucker, Kathy Vivas, Risa Wechsler, Brian Yanny

Proper motions with DES DR1 X *Gaia* DR2

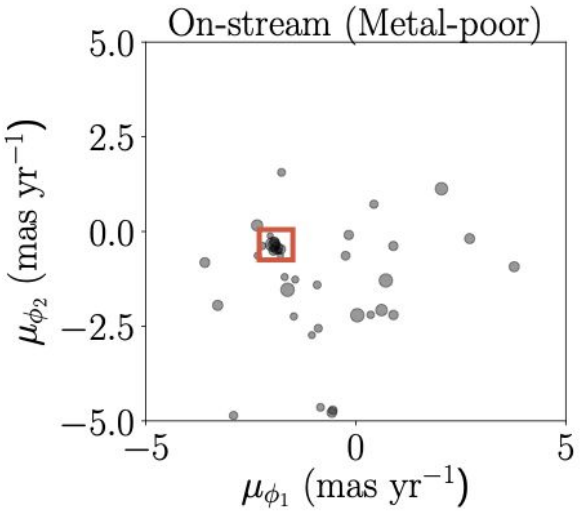
Proper motions with DES DR1 X *Gaia* DR2

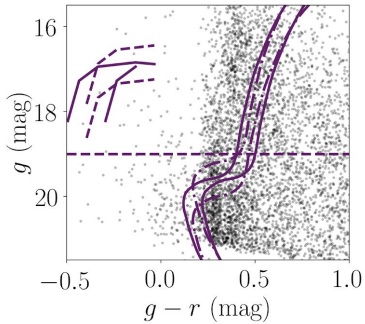
Data cuts

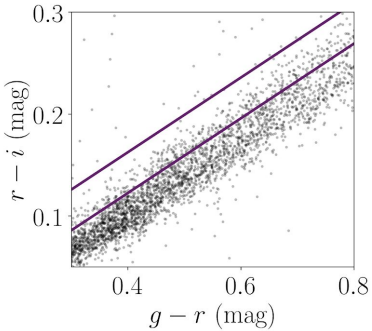
- Color-magnitude
- Color-color (metal-poor)
- Parallax
- Spatial
- Astrometric fit quality
- Star-galaxy

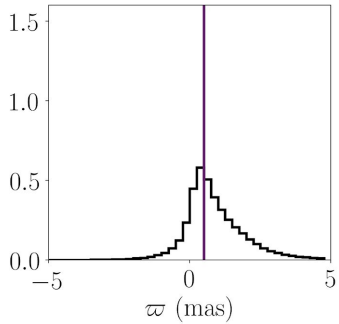


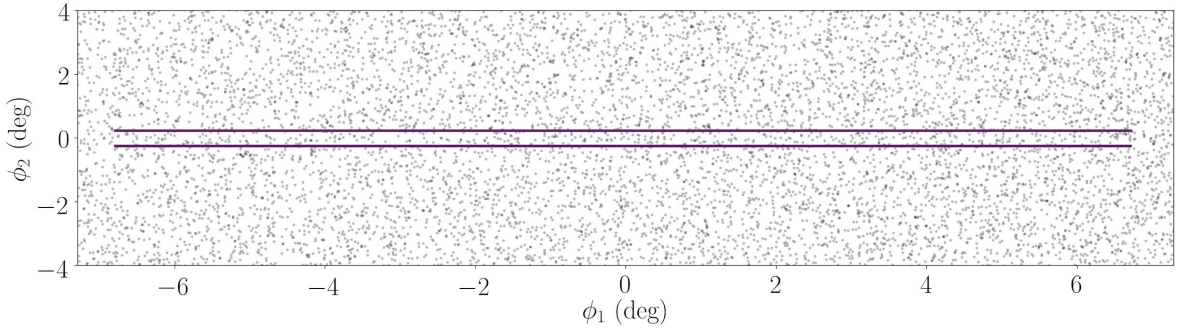
Proper motions with DES DR1 X *Gaia* DR2



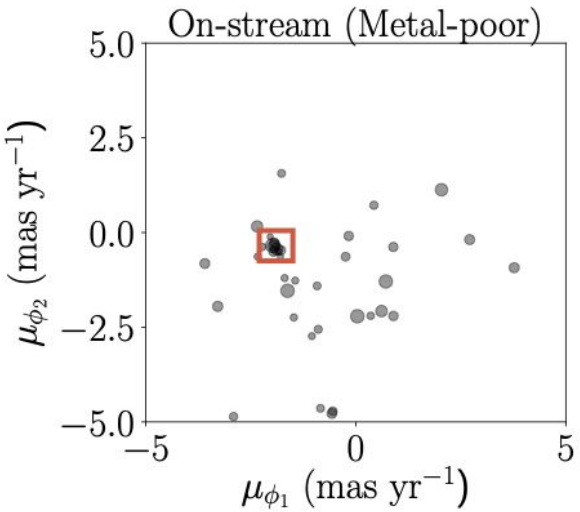


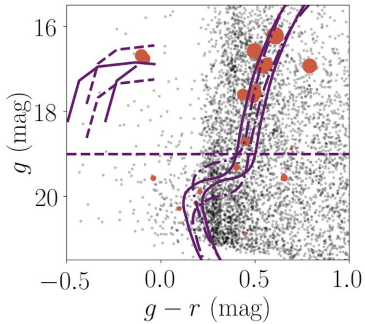


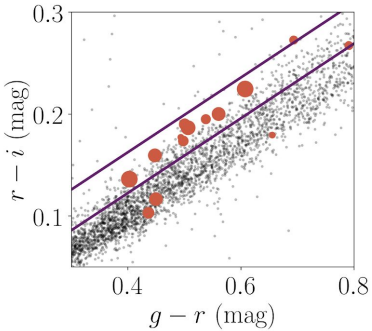


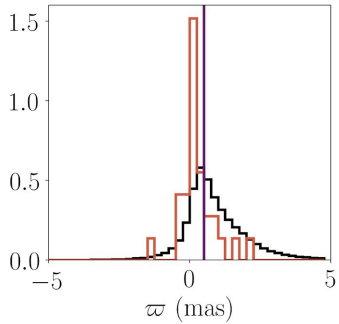


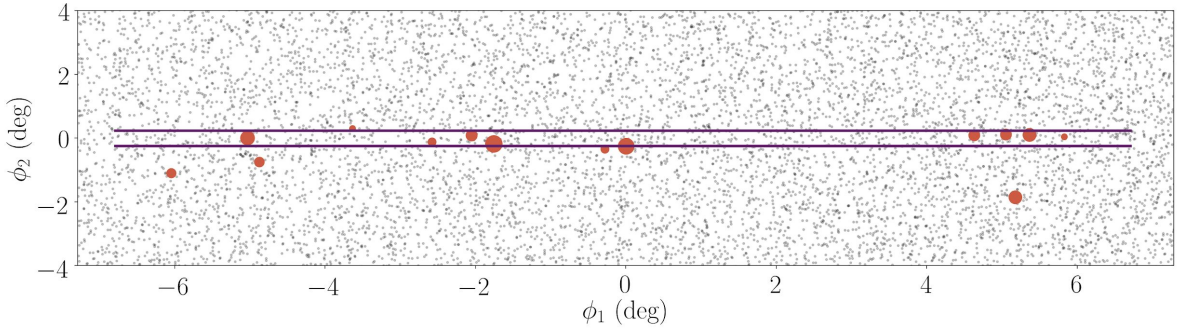
Proper motions with DES DR1 X *Gaia* DR2



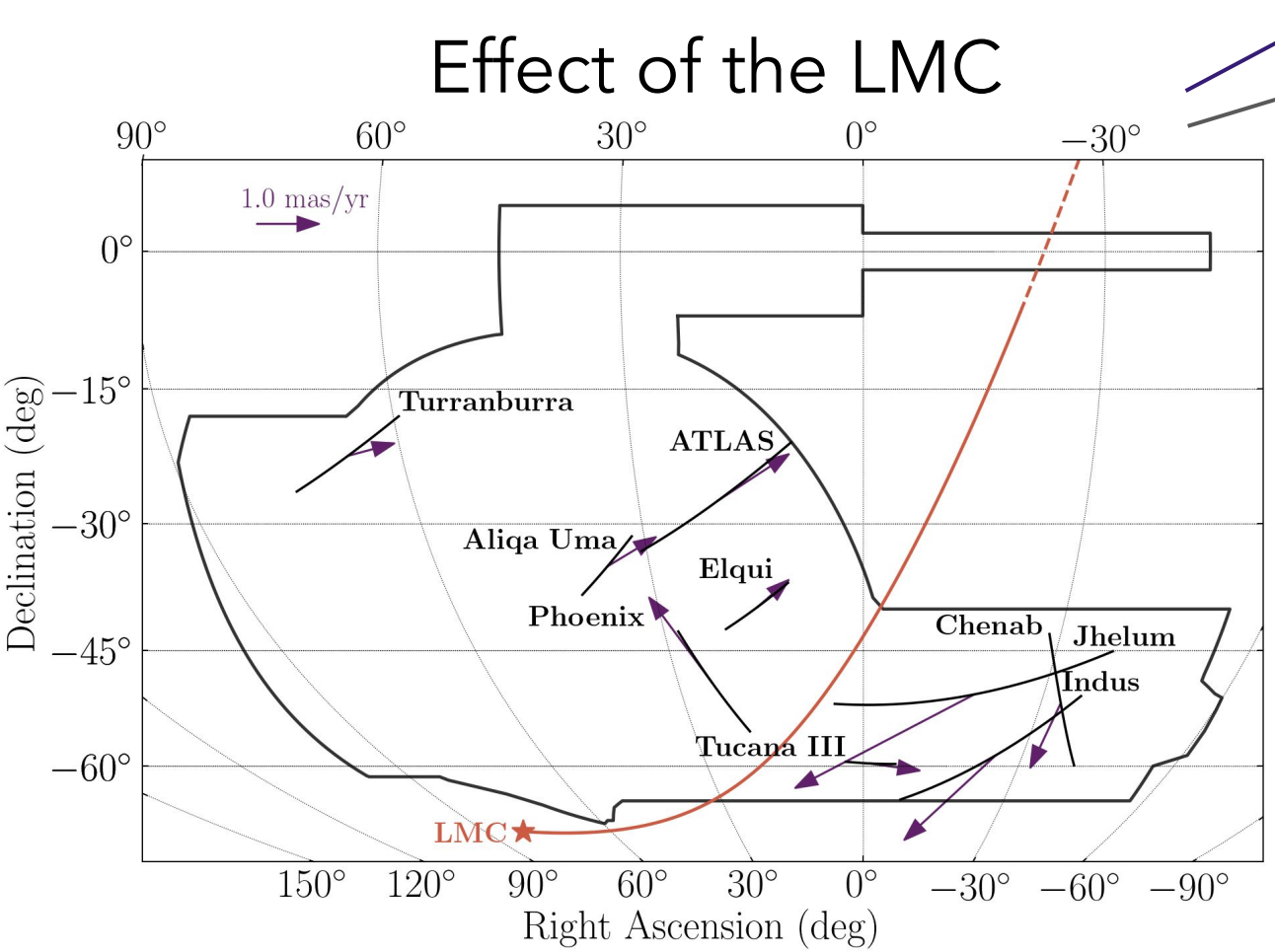




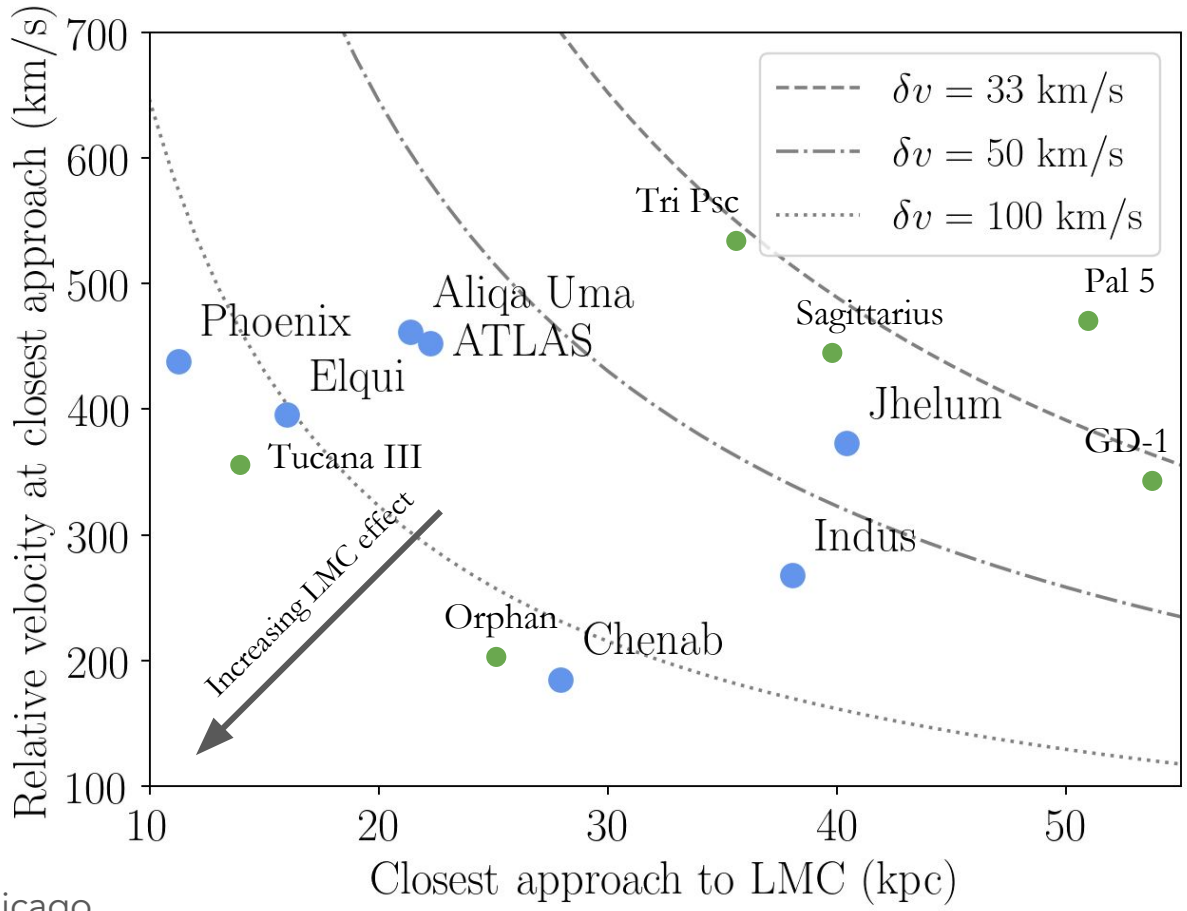




Effect of the LMC



Effect of the LMC



- This work
- Previous measurements

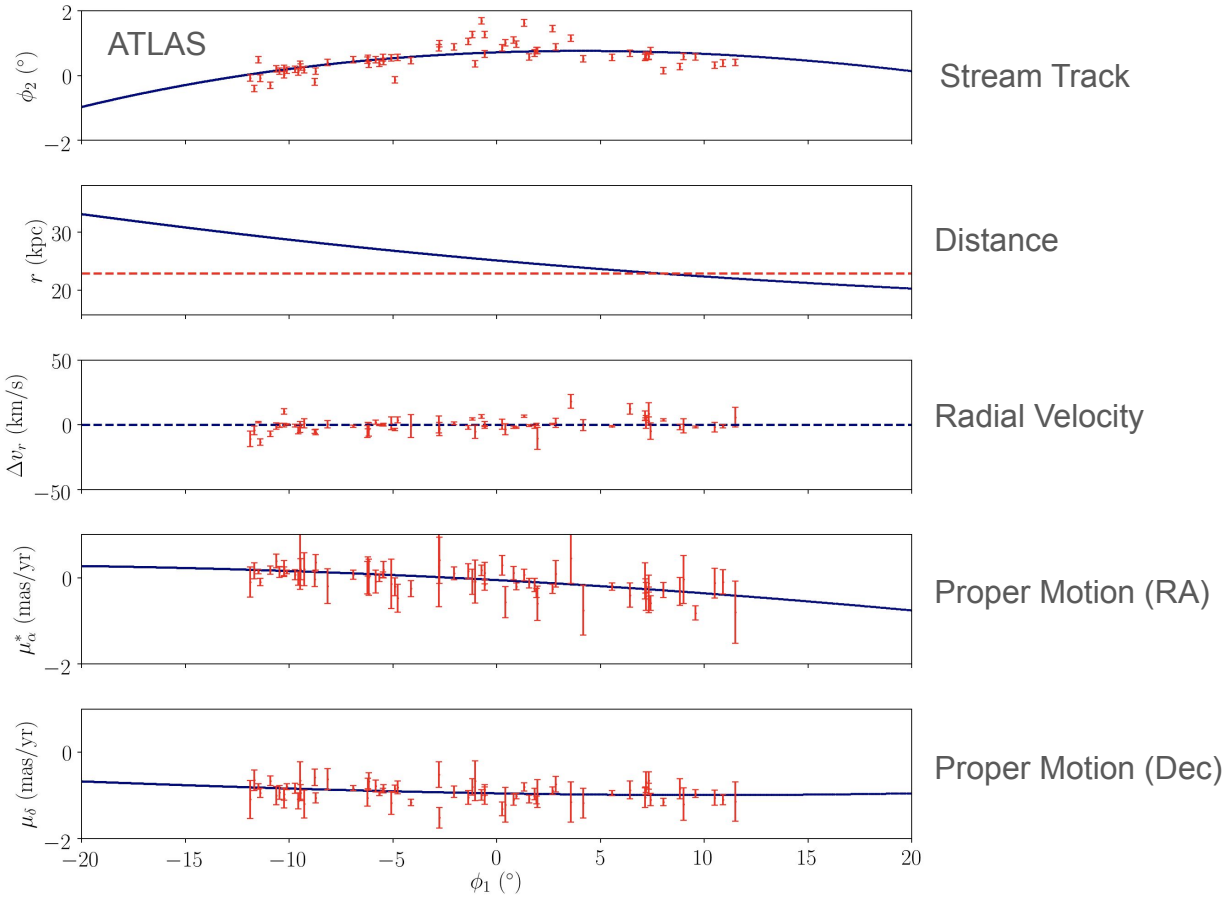
With LMC ($M = 1.5 \times 10^{11} M_{\odot}$)

Effect of the LMC

(Motivated by Erkal et al., 2019 fit to the Orphan stream)

Red: Data

Blue: Model

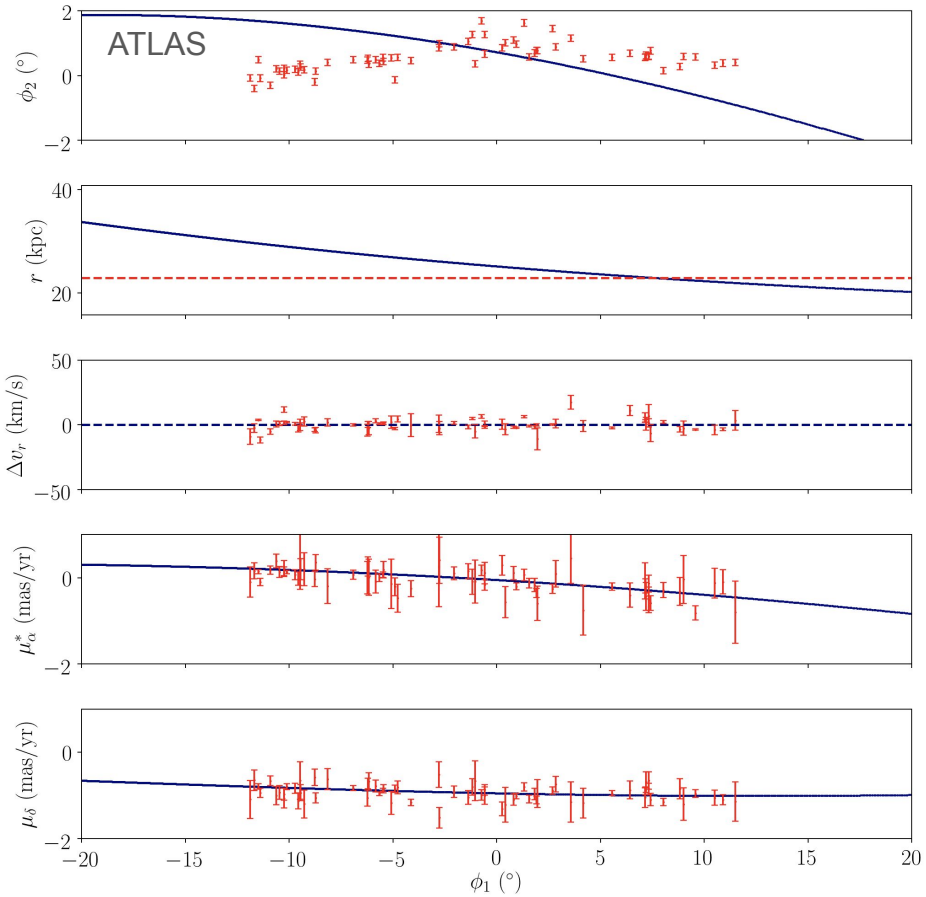


Without LMC

Effect of the LMC

Red: Data

Blue: Model



Stream Track

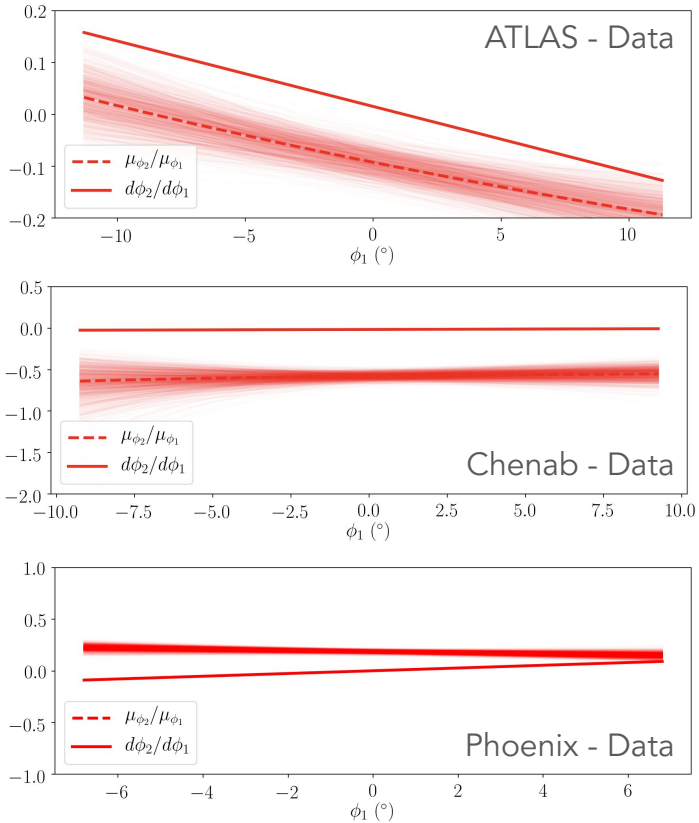
Distance

Radial Velocity

Proper Motion (RA)

Proper Motion (Dec)

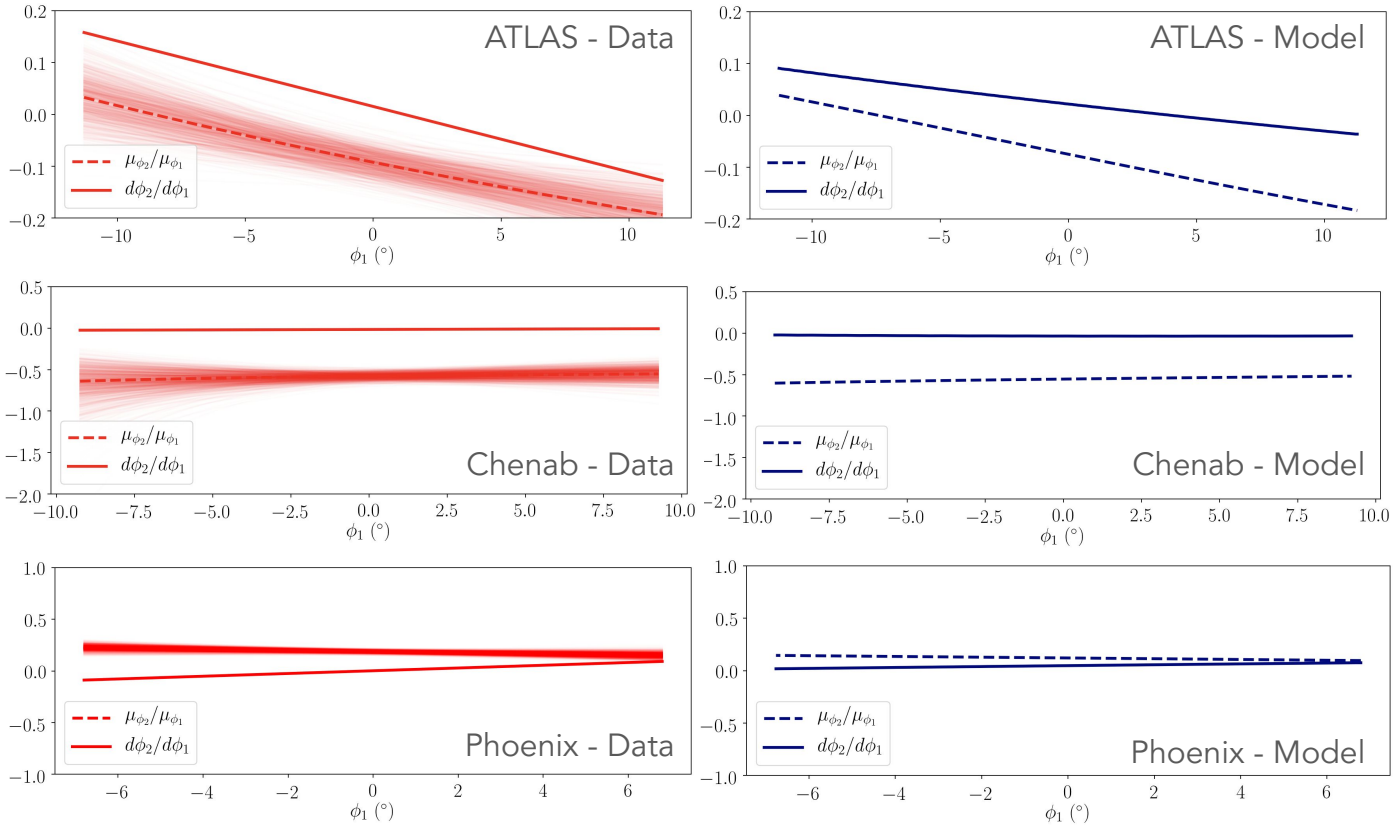
Effect of the LMC



For a stream on an unperturbed orbit: $\frac{\mu_1}{\mu_2} = \frac{d\phi_1}{dt} / \frac{d\phi_2}{dt} = \frac{d\phi_1}{d\phi_2}$

With LMC ($M = 1.5 \times 10^{11}\ M_{\odot}$)

Effect of the LMC



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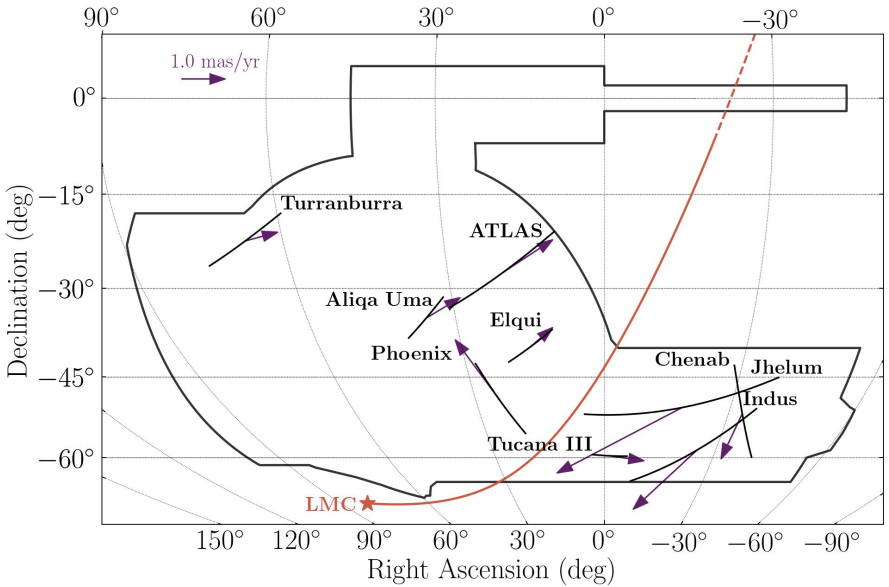
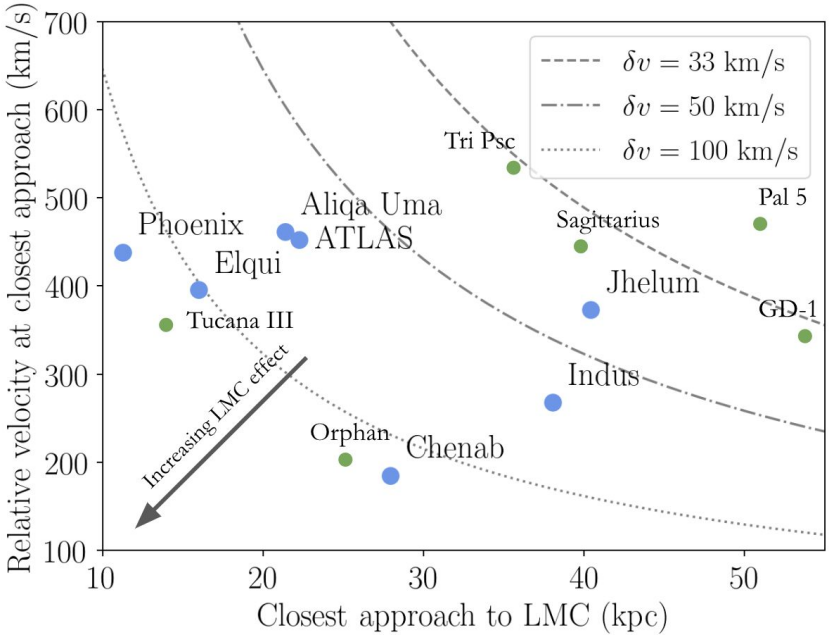
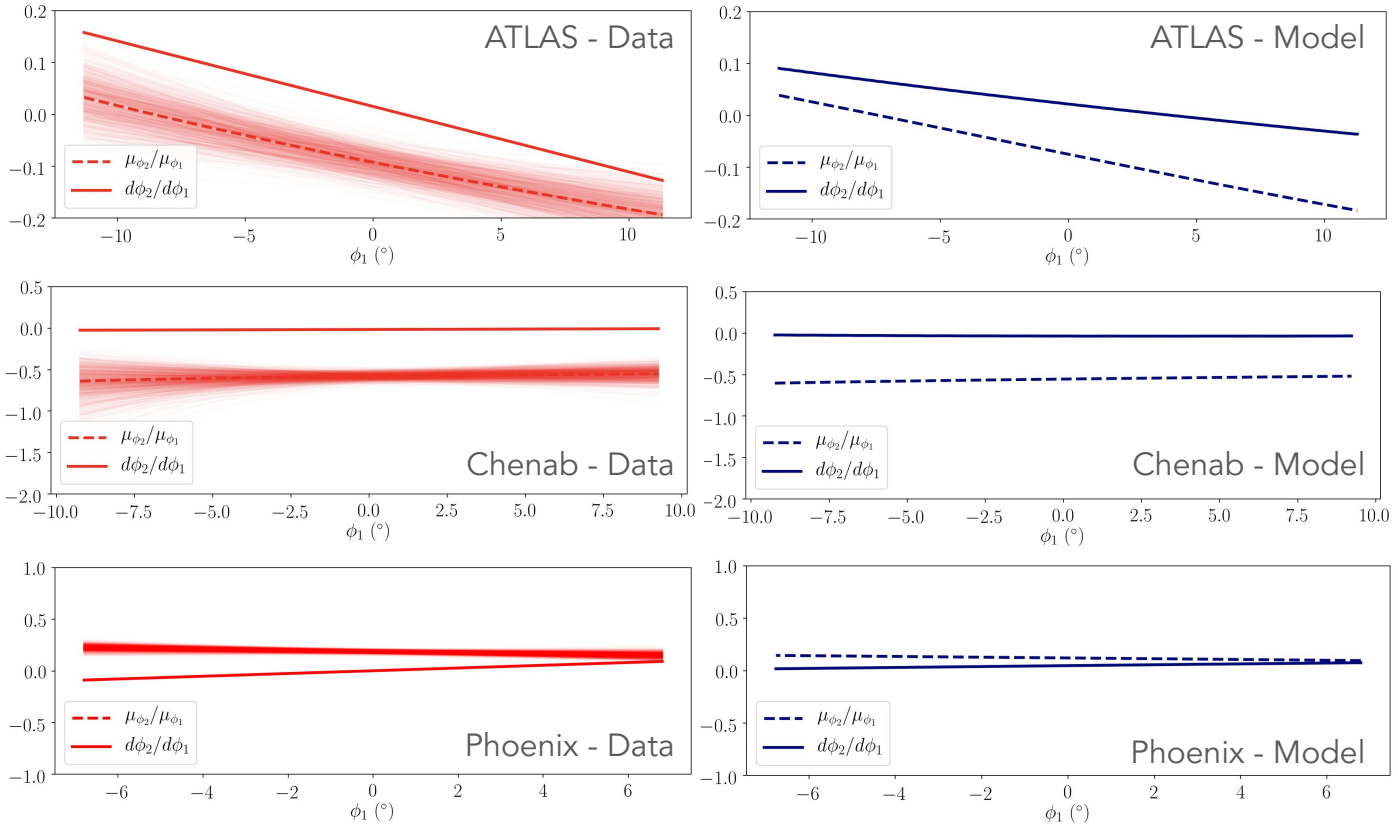




With LMC ($M = 1.5 \times 10^{11}\ M_{\odot}$)

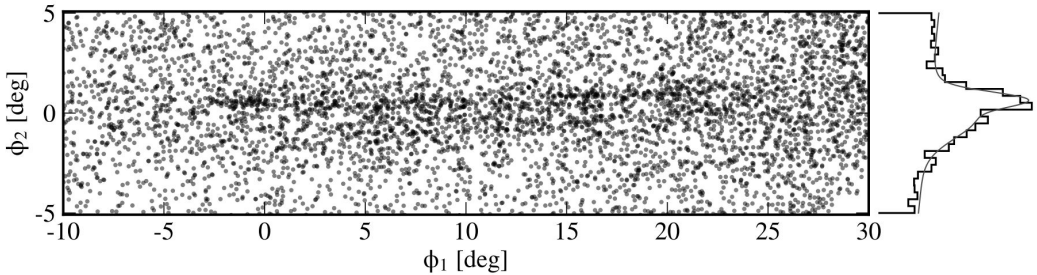
Effect of the LMC



Weird Streams: Jhelum

Bonaca et al. 2019:

2 spatial components



Weird Streams: Jhelum

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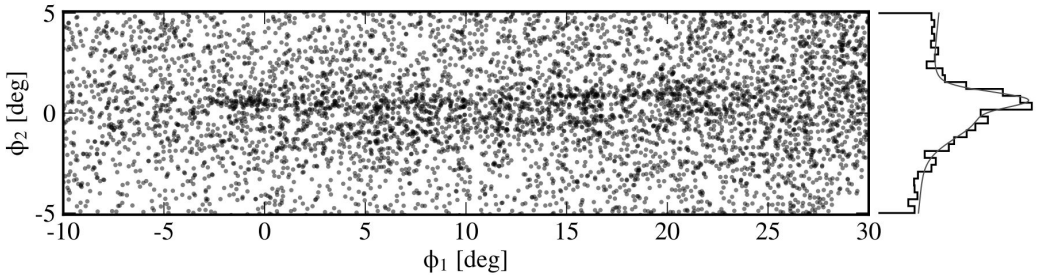

Shipp et al. 2019:

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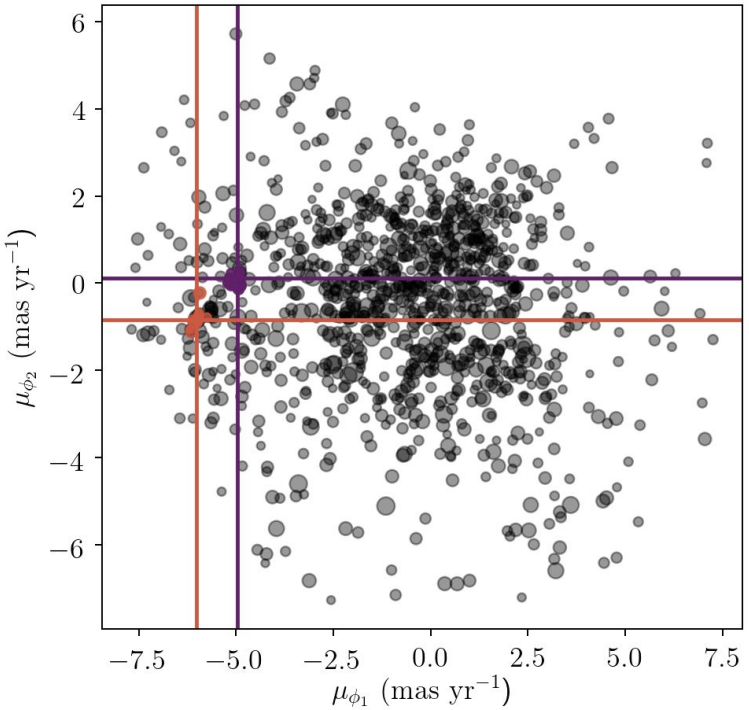

Summary

- Combining photometric, astrometric, and spectroscopic observations of stellar streams will allow us to take full advantage of these powerful probes of the MW matter distribution.

- DES, Gaia, S^5 datasets together provide 6D+1 measurements of southern streams.

- Southern streams can be used to constrain the mass distribution of the LMC. Many of the observed stream perturbations are consistent with previous LMC mass measurements.

- Stay tuned for upcoming S^5 papers on individual streams and population statistics!

Proper motion measurements: arXiv:1907.09488

S^5 overview: arXiv:1907.09481