Ana Bonaca
Carnegie Observatories

Streams

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Part I

Streams

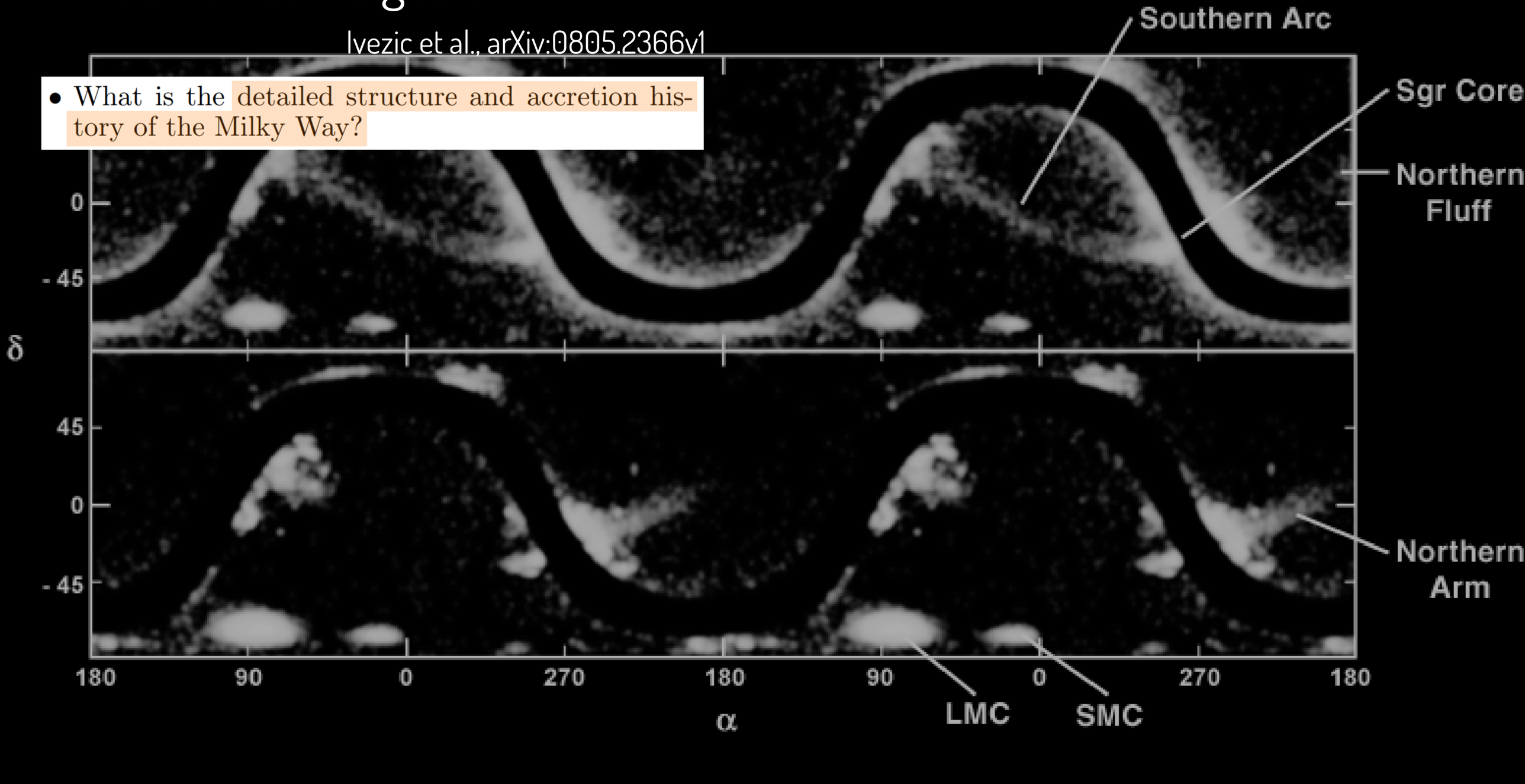
~current status~

LSST streams goals

Majewski et al. (2003)

Ivezic et al., arXiv:0805.2366v1

- What is the detailed structure and accretion history of the Milky Way?



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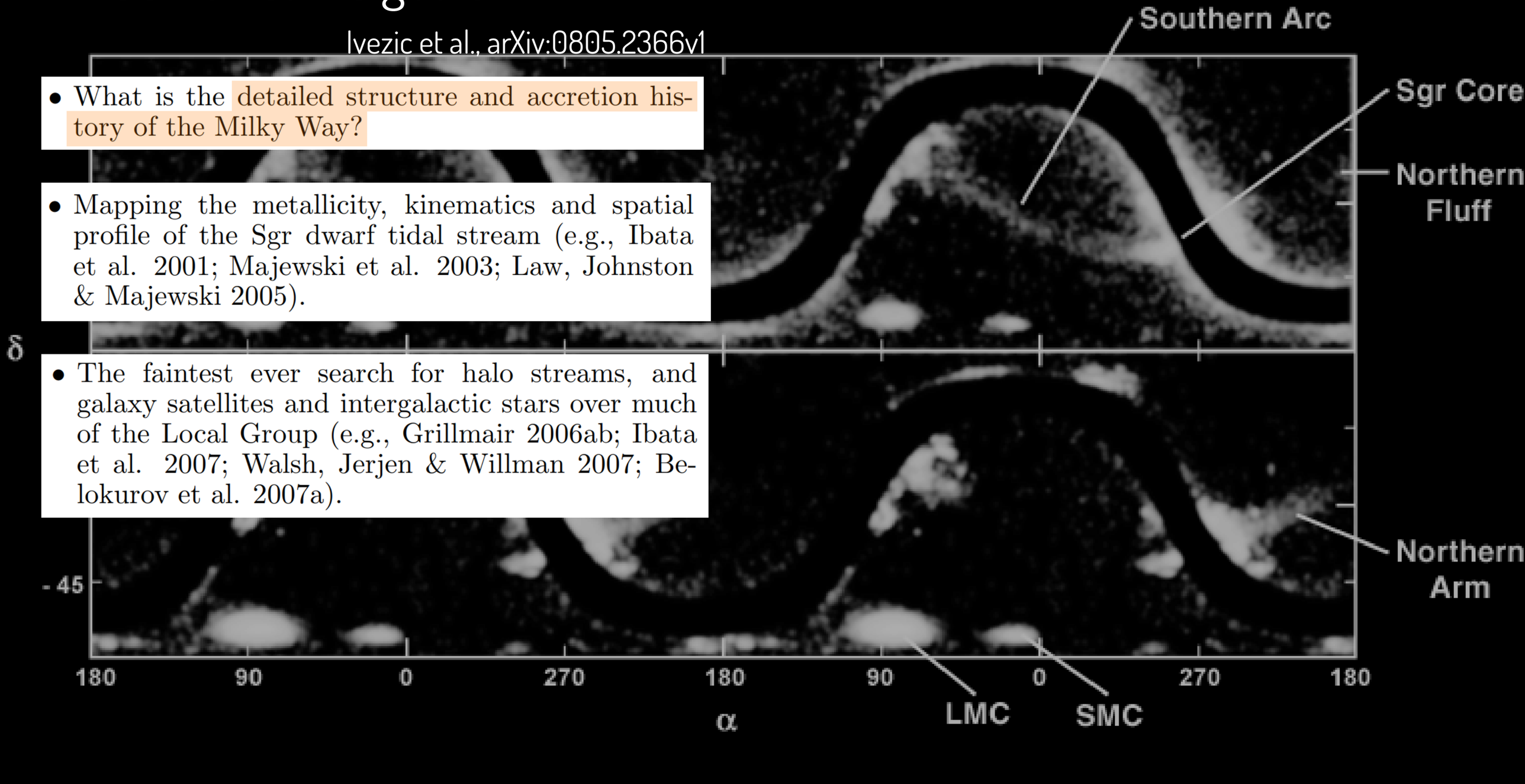

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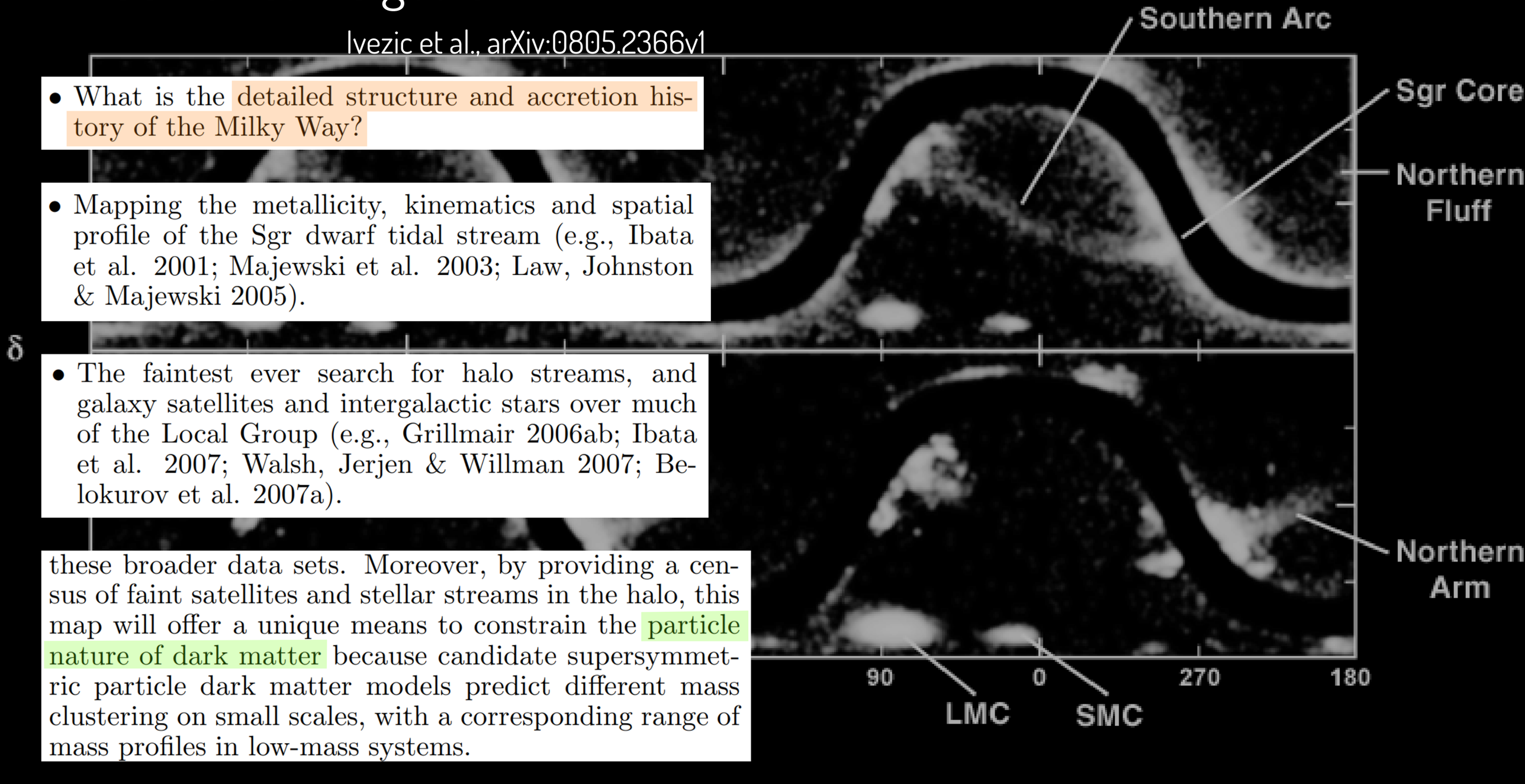

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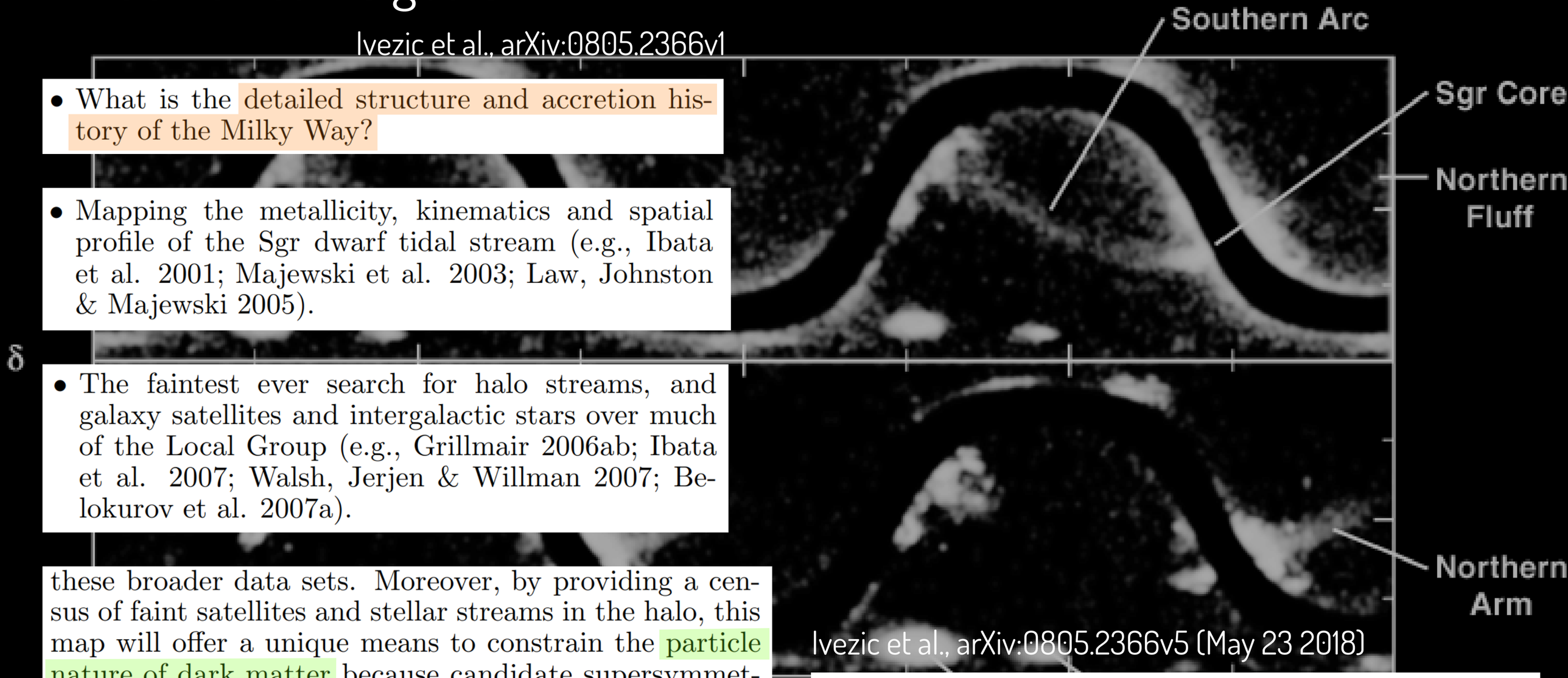

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Ivezic et al., arXiv:0805.2366v5 (May 23 2018)

the subtle perturbations of stellar streams in the Milky Way halo by dark matter substructure (Belokurov & Koposov 2016), and massive compact halo object mi-

THE MILKY WAY
STREAM ATLAS
May 2024

Legend

Prograde Polar — Planar — Retrograde Polar

-1.0 -0.5 0.0 0.5 1.0

$\mathrm{sgn}(L_z)\ L_\perp / |L|$

Streams

Total number: 87

Typical mass: $9 \times 10^3\ M_\odot$

Longest stream:
Orphan-Chenab [210 deg]

Narrowest stream:
C-20 [0.072 deg]

Most member stars:
Fimbulthul [3724]

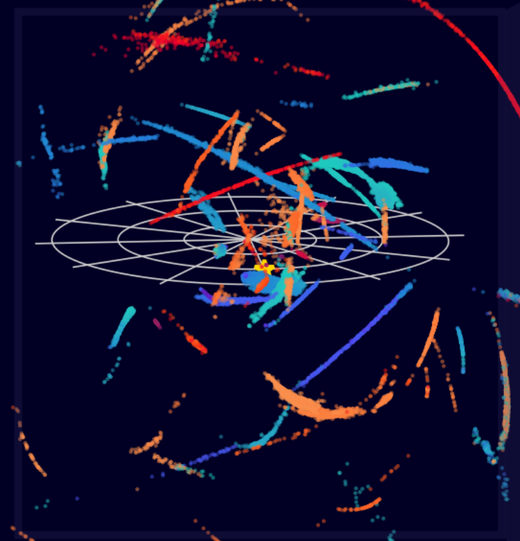
Largest Galactocentric distance:
Kwando [53 kpc]

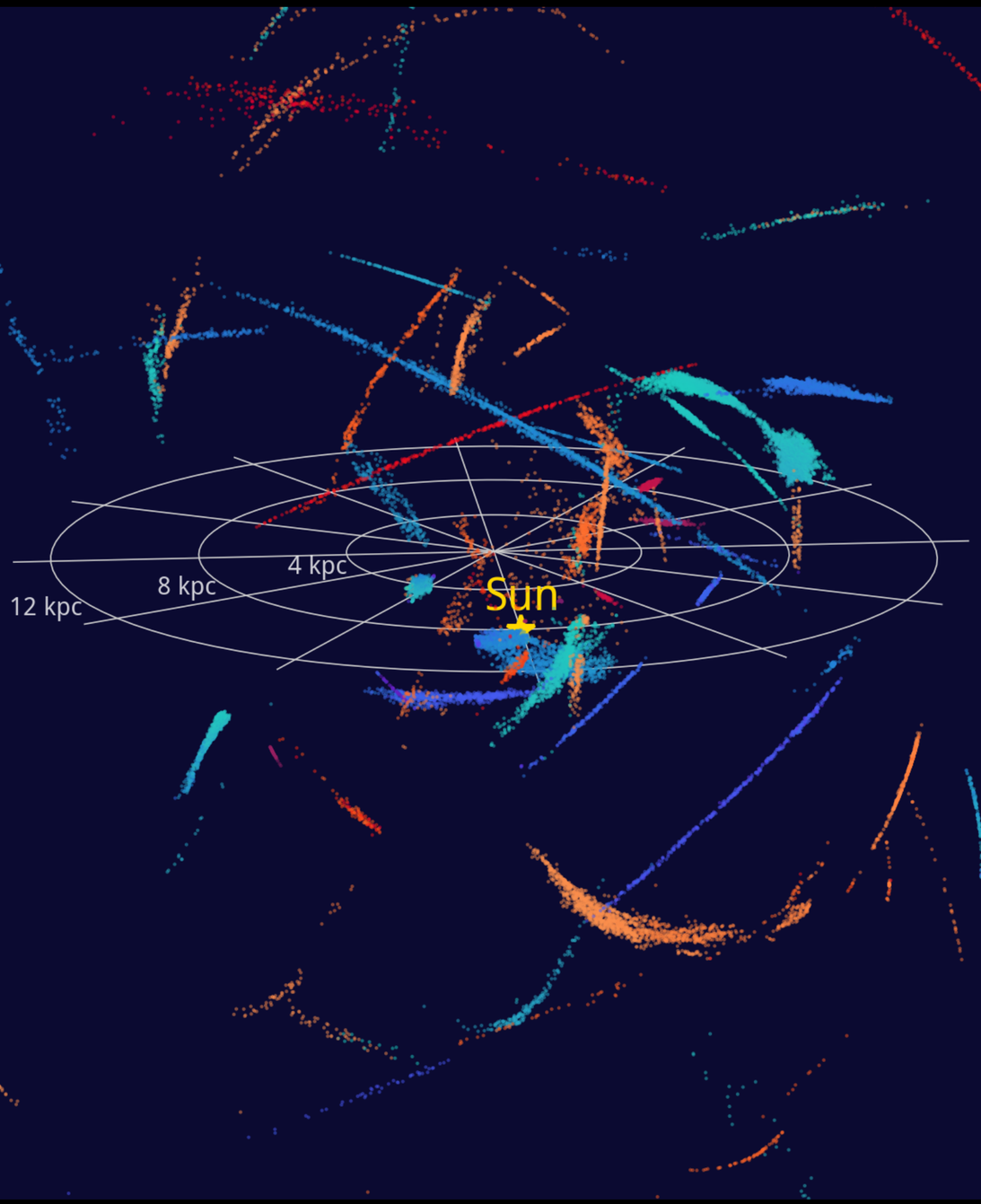
Closest to the Earth:
New-3 [1.0 kpc]

Credit

Ana Bonaca & Adrian Price-Whelan

Data: Ibata et al., arXiv:2311.17202

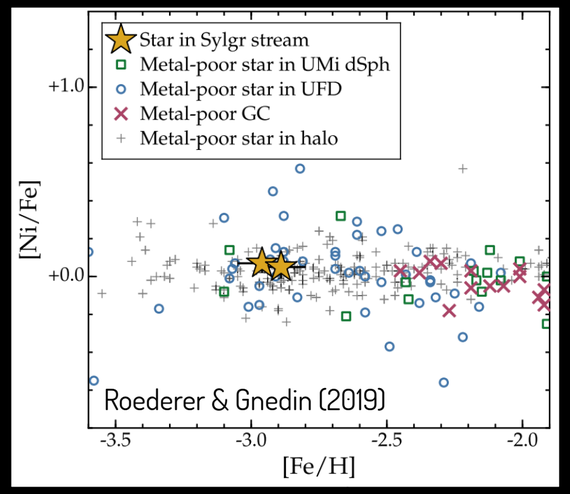


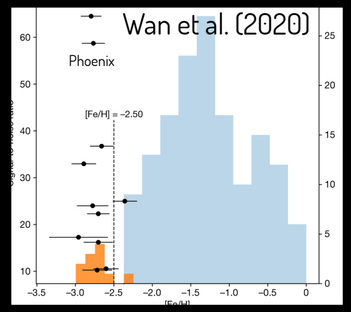


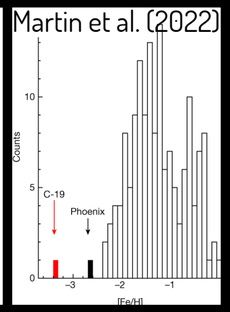
Bonaca & Price-Whelan, arXiv:2405.19410

Stream discoveries so far

Globular clusters can form at low masses and low metallicities







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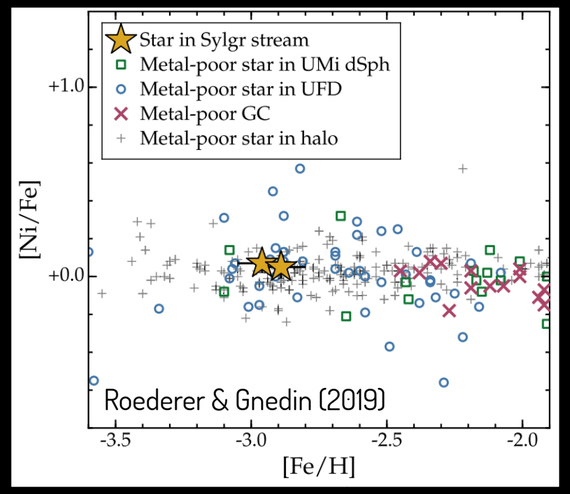
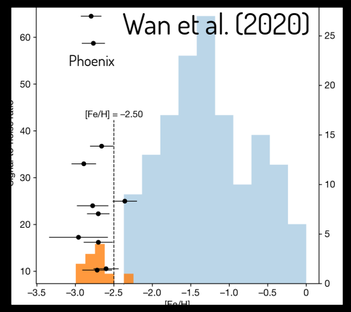
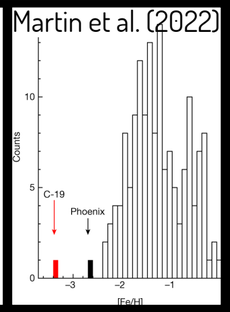
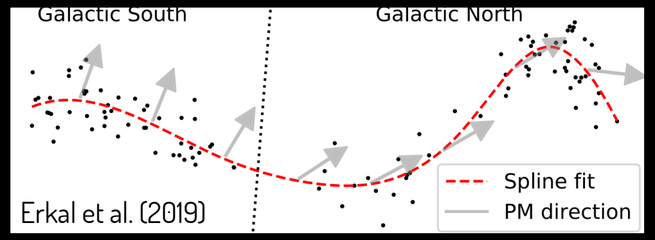
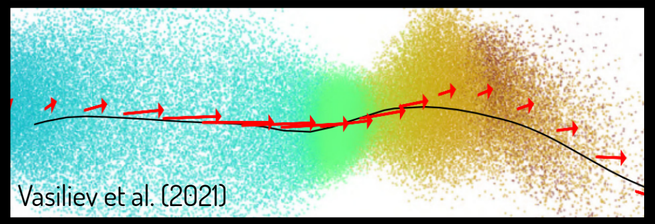


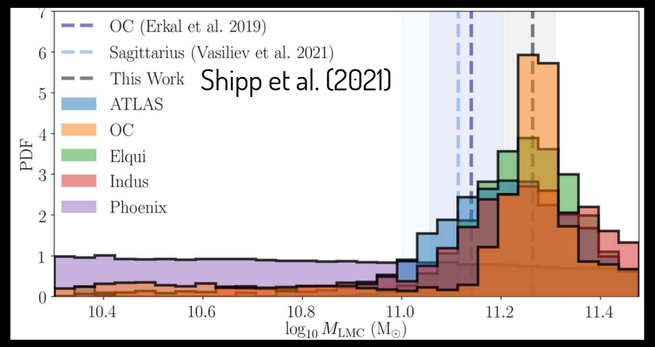




The dark matter halo masses of the Milky Way and the LMC







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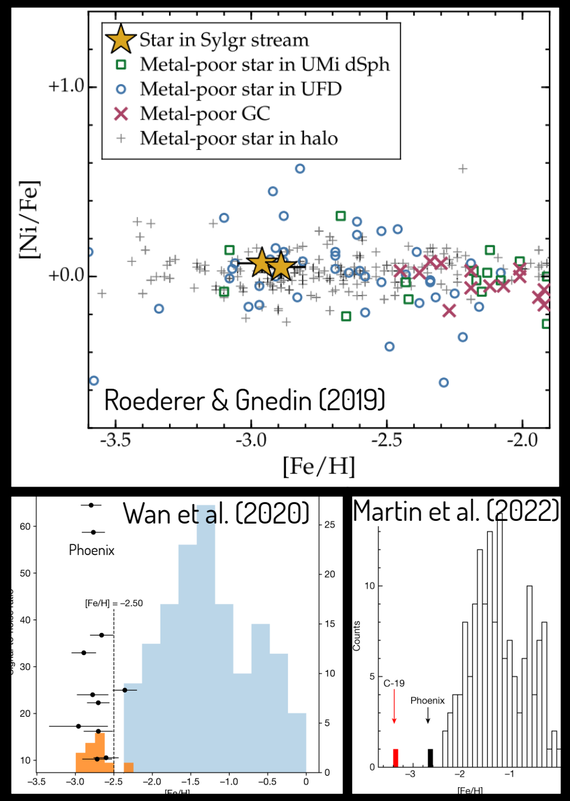

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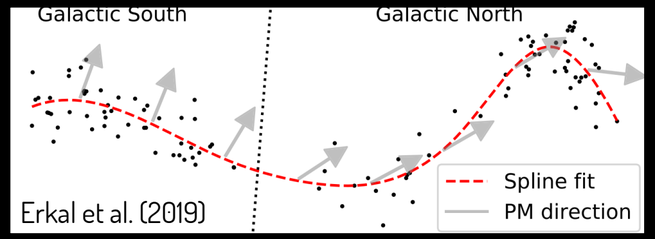
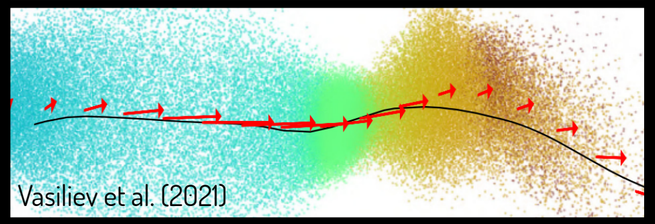
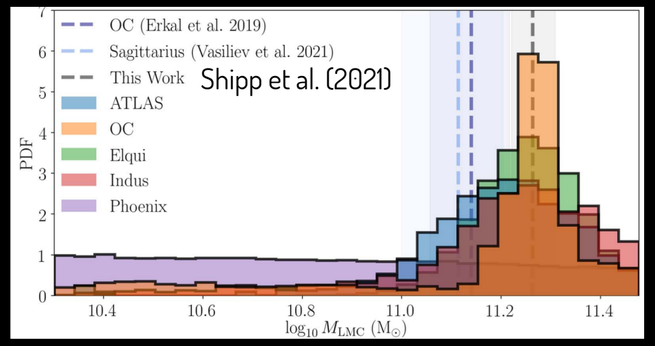
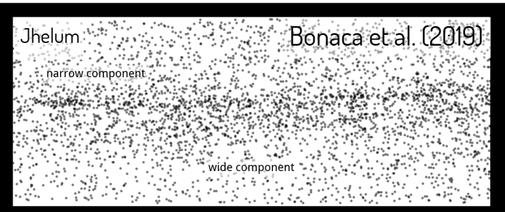
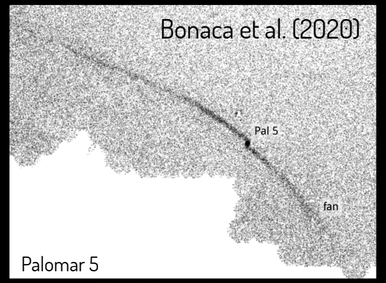


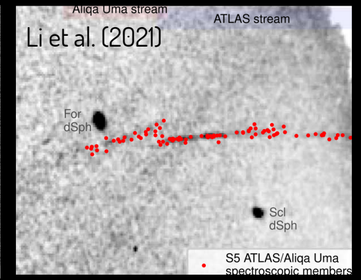


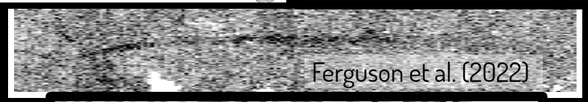


Streams' structure indicates they have been dynamically perturbed









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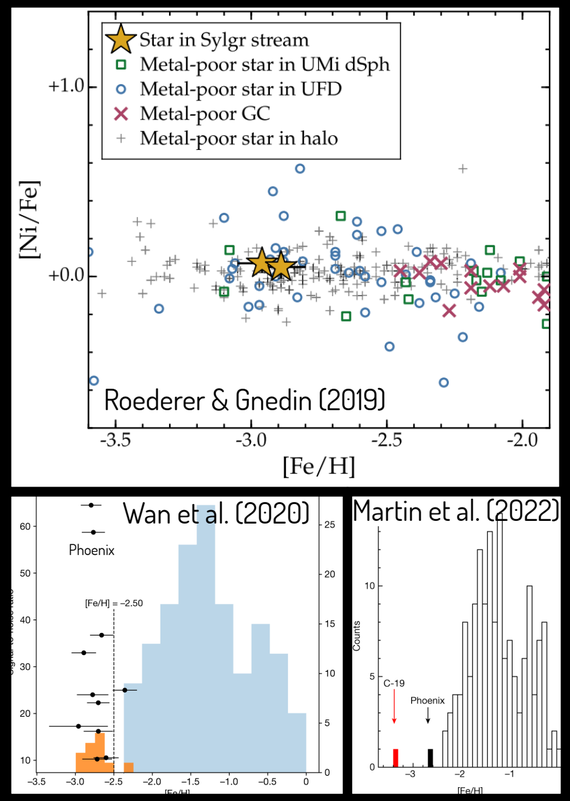

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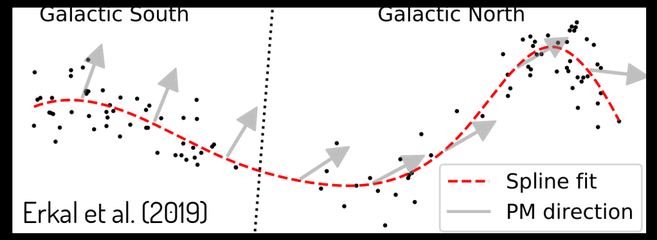

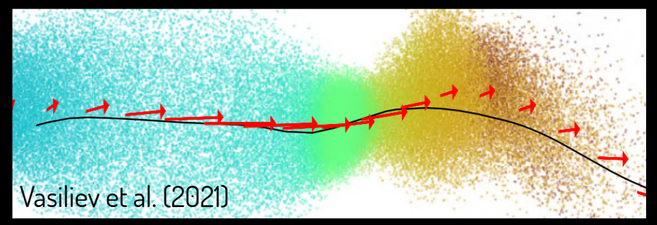

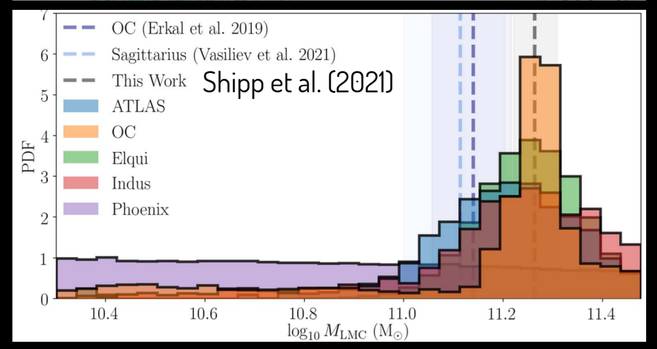

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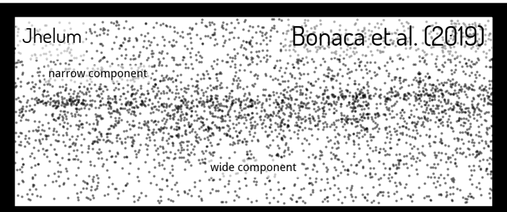
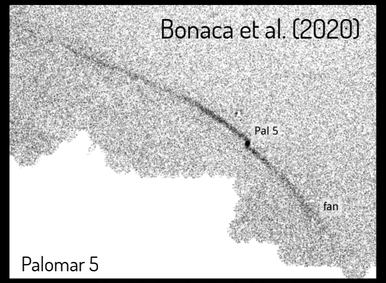
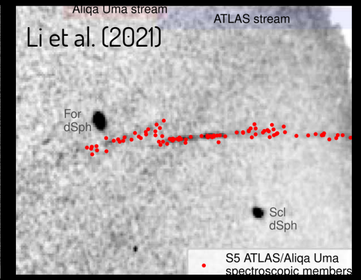
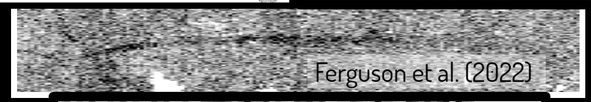








? What is the complete census of the Milky Way progenitors?

What is the 3D distribution of dark matter in the Milky Way?

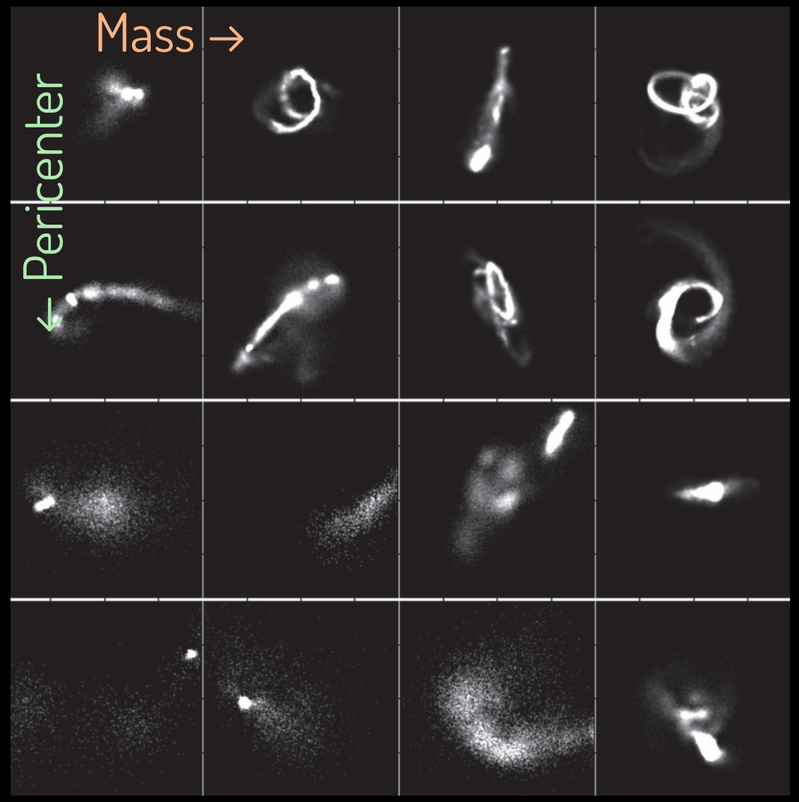
Are there dark-matter-only subhalos? ?

Part II

~and streams in the Milky Way~

How many streams does the Milky Way have?

Dwarf galaxy progenitors
(self-consistent in FIRE simulations)



Shipp et al. (2023)

~5 undetected, $> 5 \cdot 10^5\, M_\odot$

see also: Dropulic talk this afternoon

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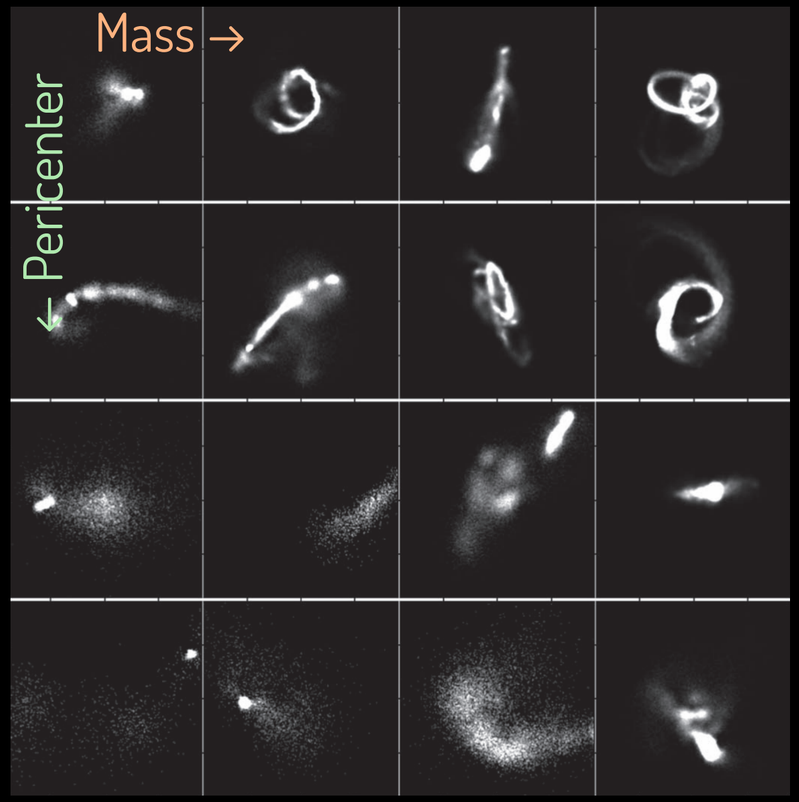

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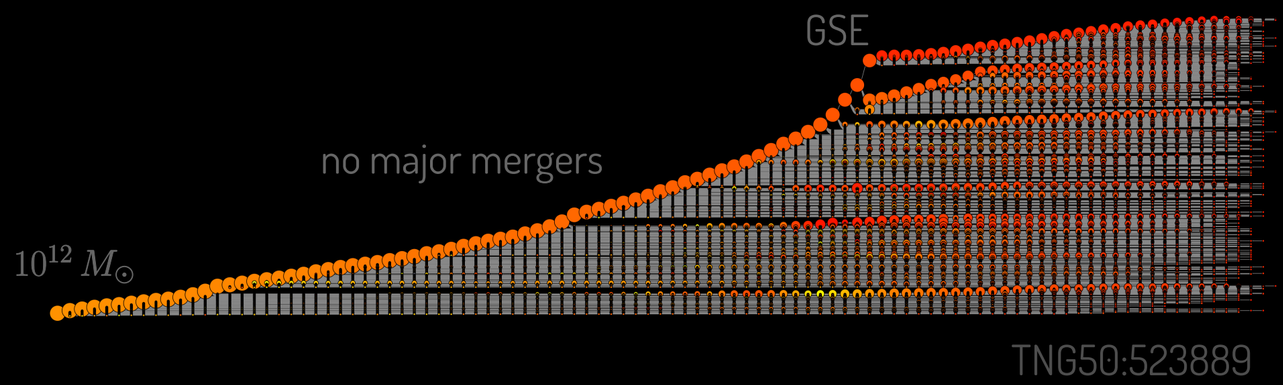
Globular cluster progenitors (empirical on top of TNG-50 simulation)



Pearson et al., arXiv:2405.15851

1) Trigger cluster formation on high mass-accretion rate

2) Draw cluster masses (>10^4 Msun) + assign particles

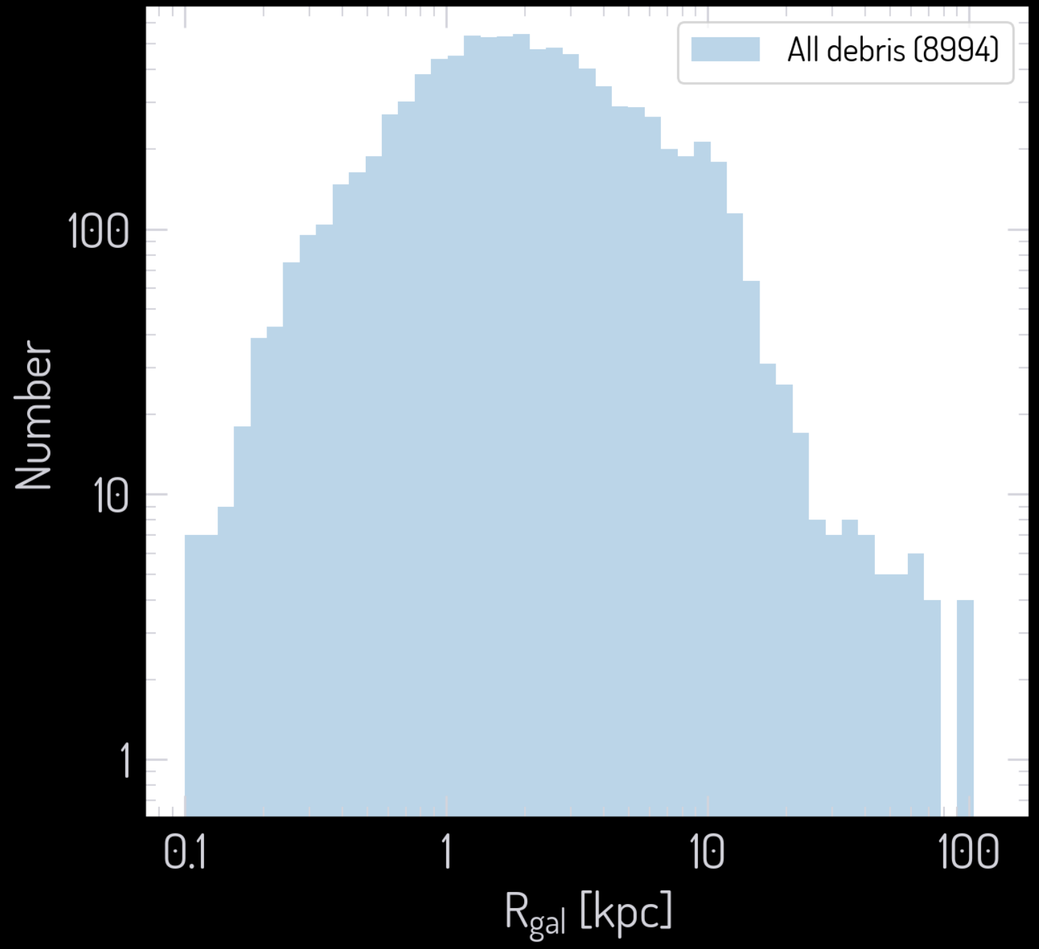
3) Estimate mass-loss rate from local tidal tensor

see also: Chen & Gnedin (2022, 2023), Chen poster

in progress: Panithanpaisal (FIRE), Aganze (KIPAC)

Milky Way may host thousands of dissolved globular clusters

Radial distribution of dissolved clusters



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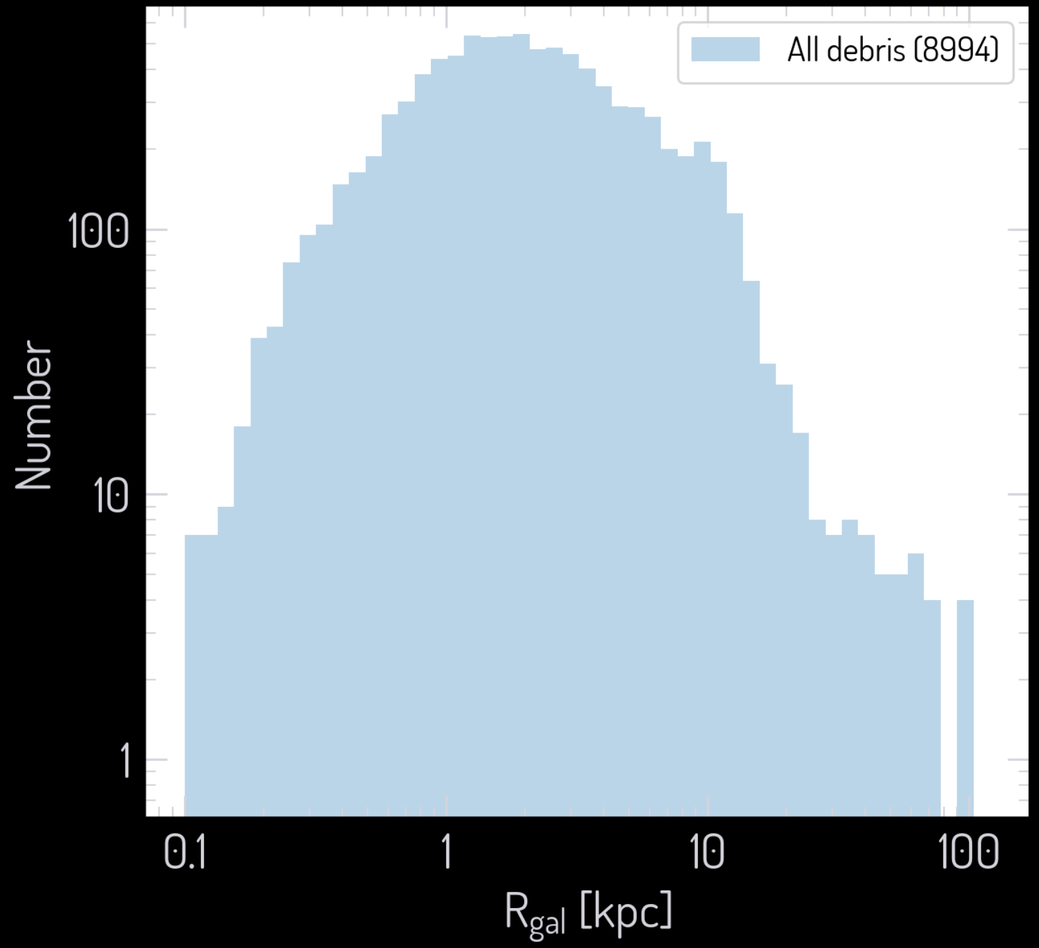
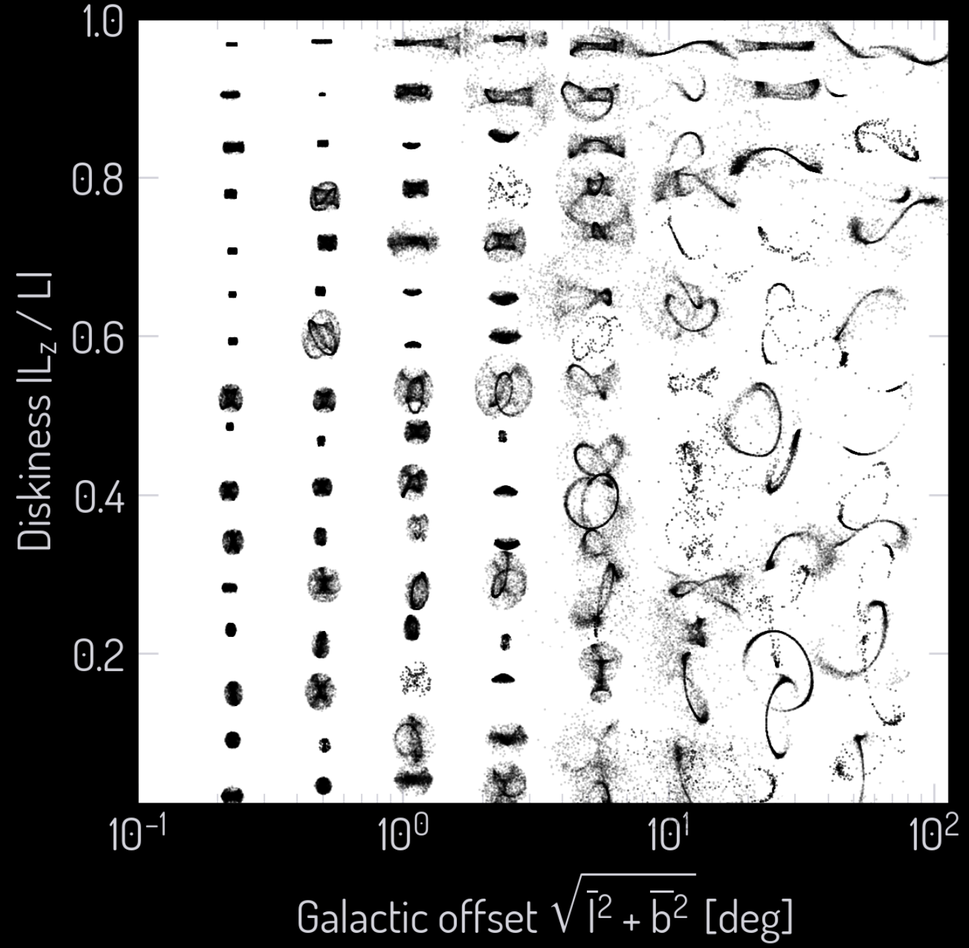


Identifying coherent stellar streams



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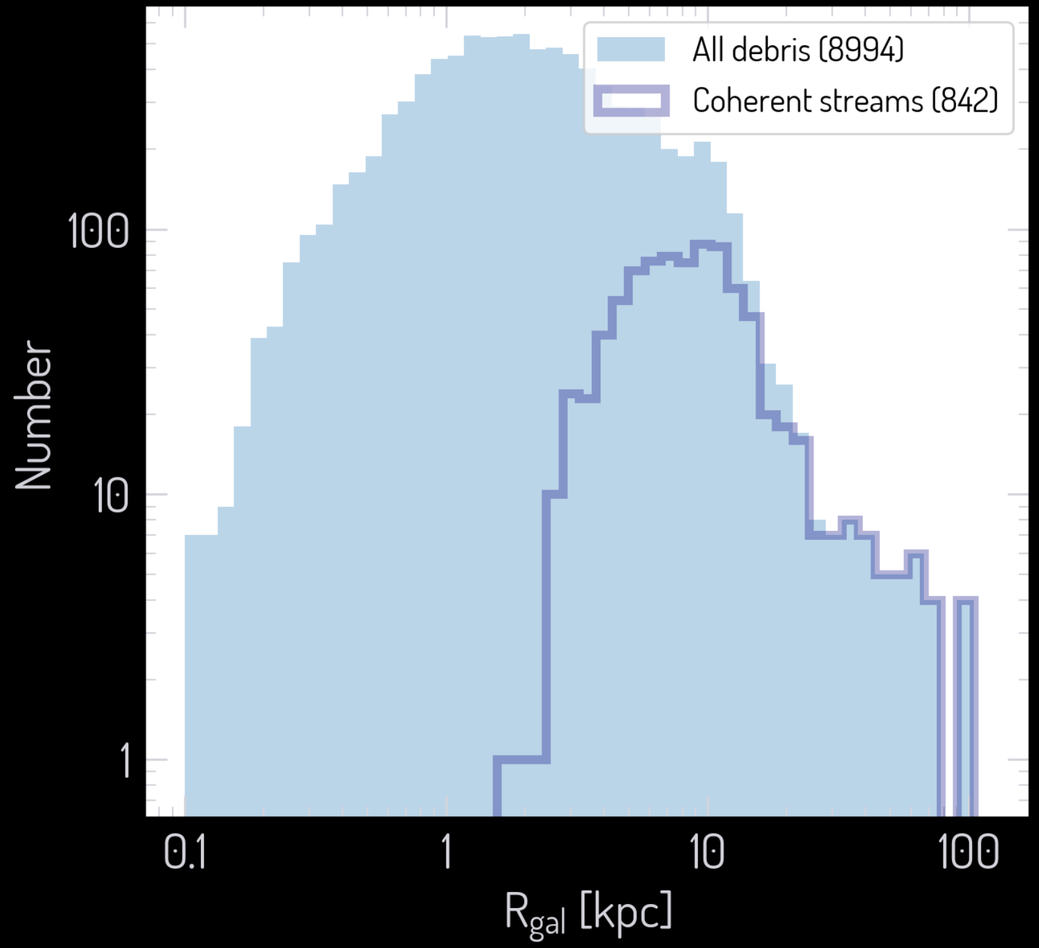

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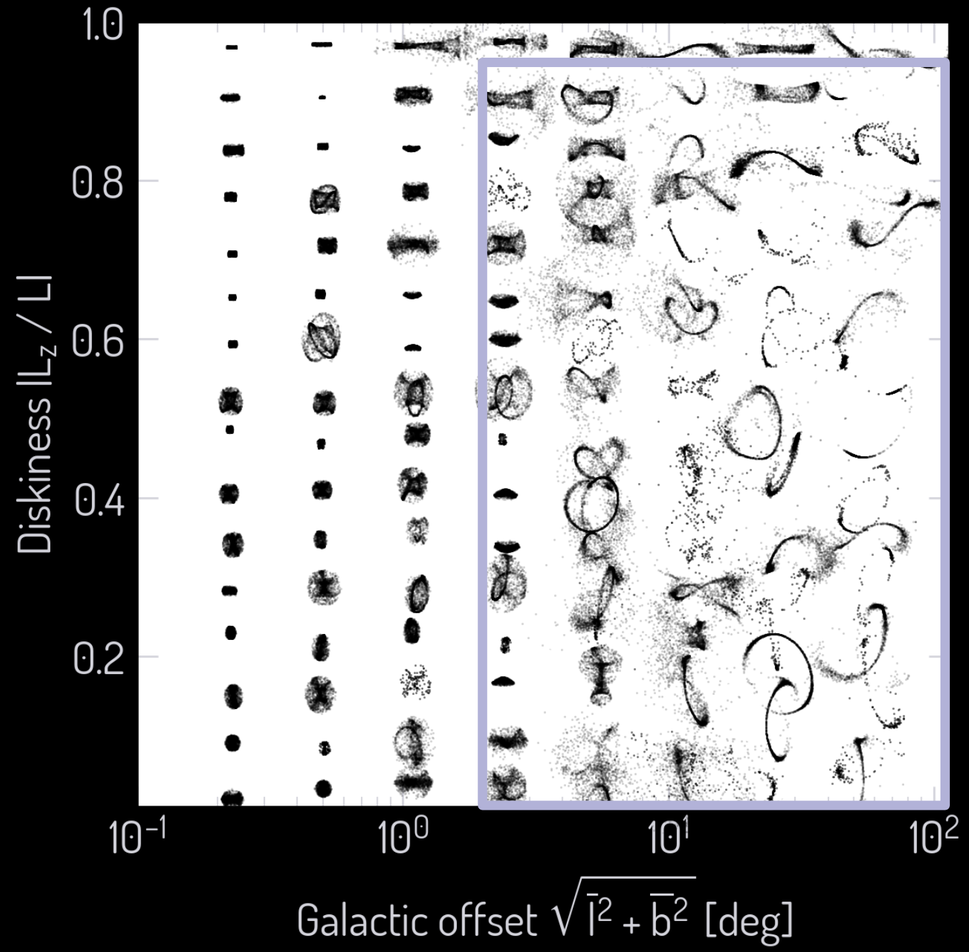
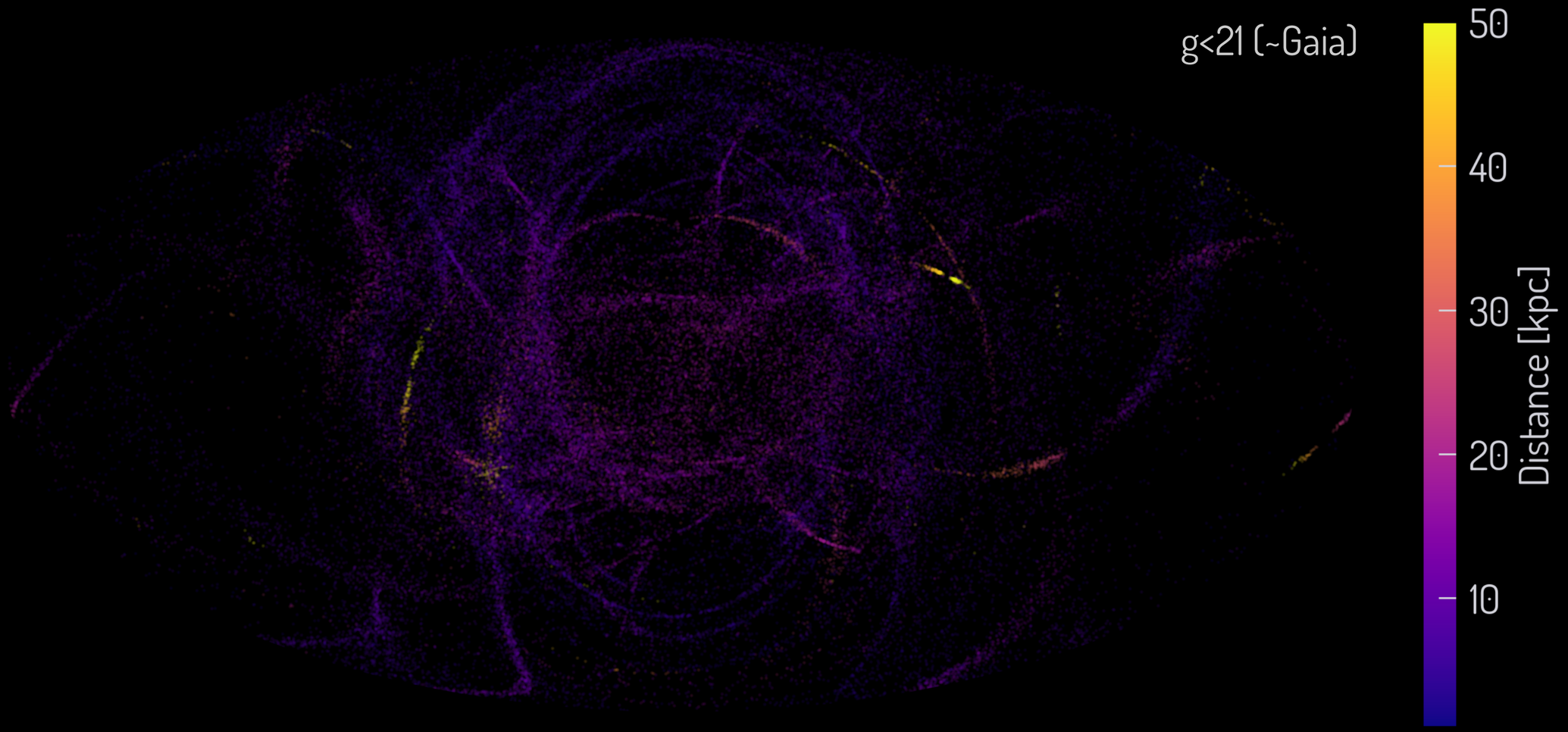


LSST is poised to reveal the entire web of streams



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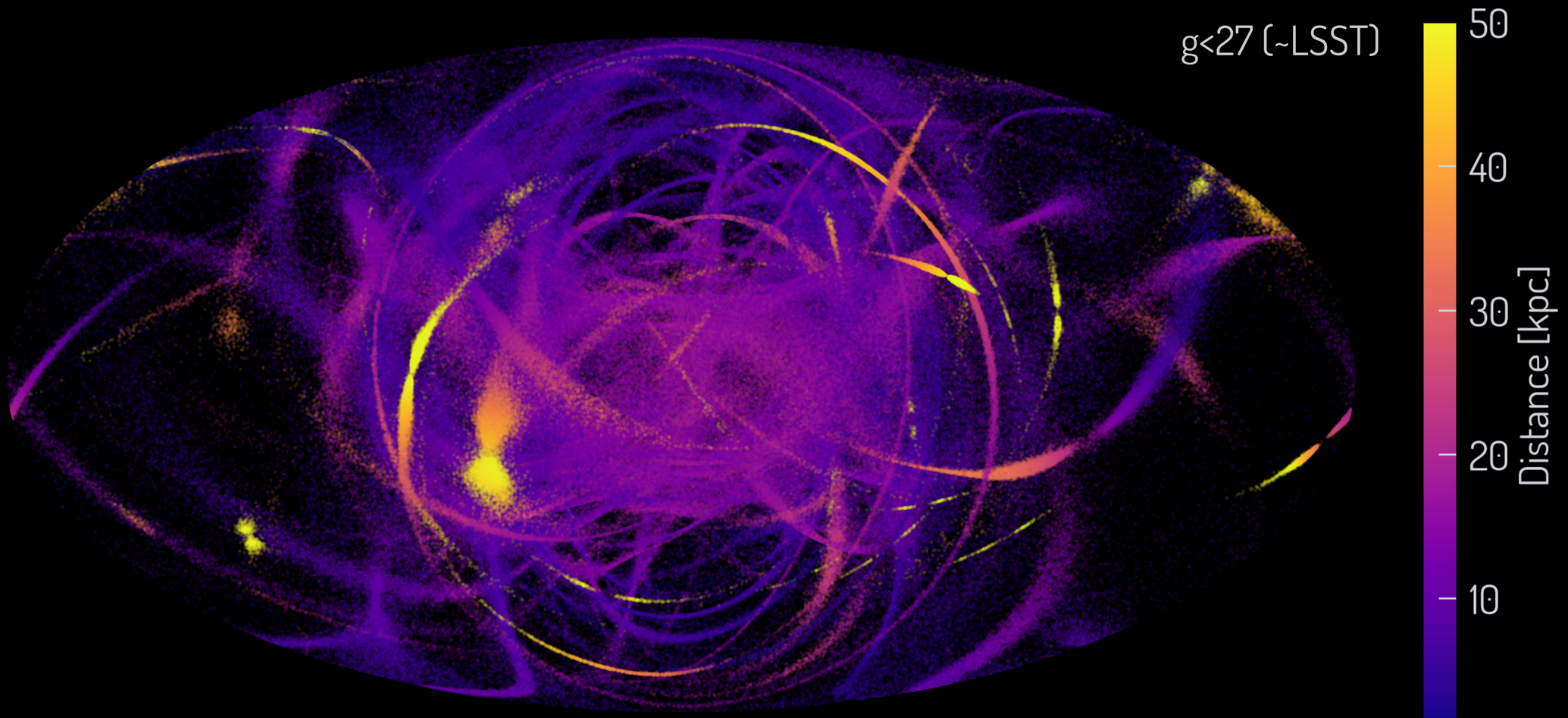

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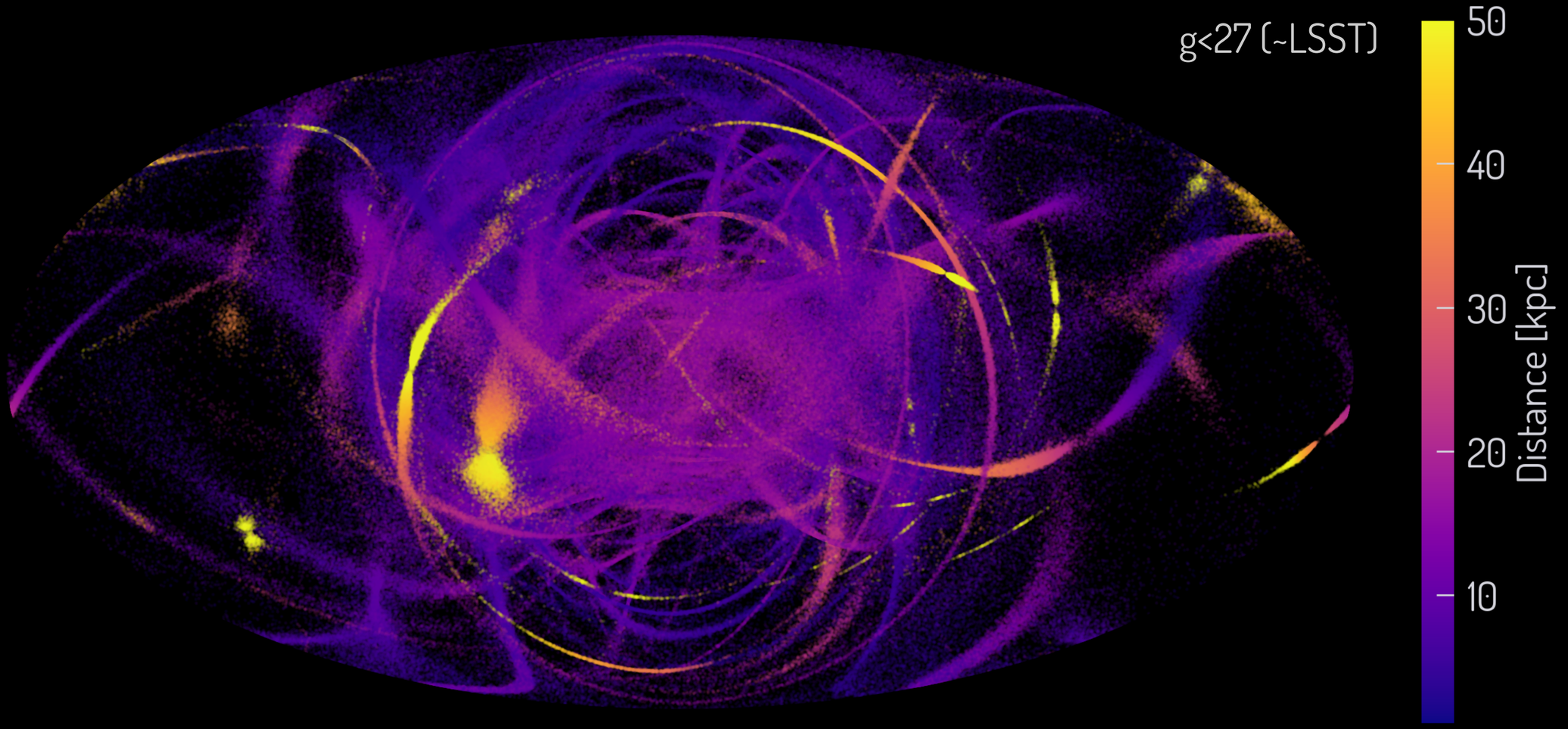


More realistic observability:

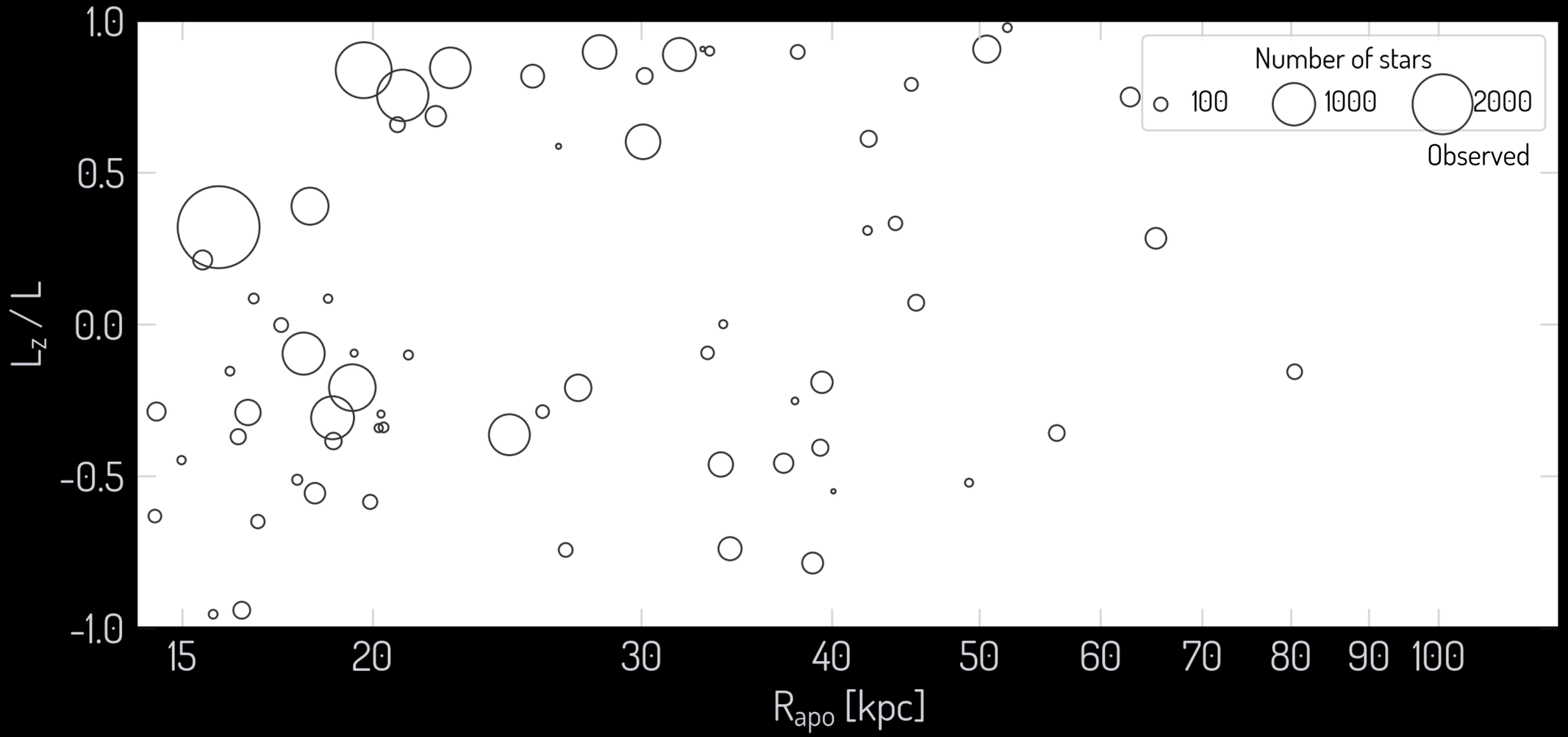
deep u band — see Xue poster

Ca H&K — SkyMapper, Pristine, Chiti

add LSST mock Milky Way — hack day project?

How well could undetected streams probe dark-matter subhalos?

Alex Drlica-Wagner, intentionally controversional at KITP: "We already know of all the streams we'll care about."



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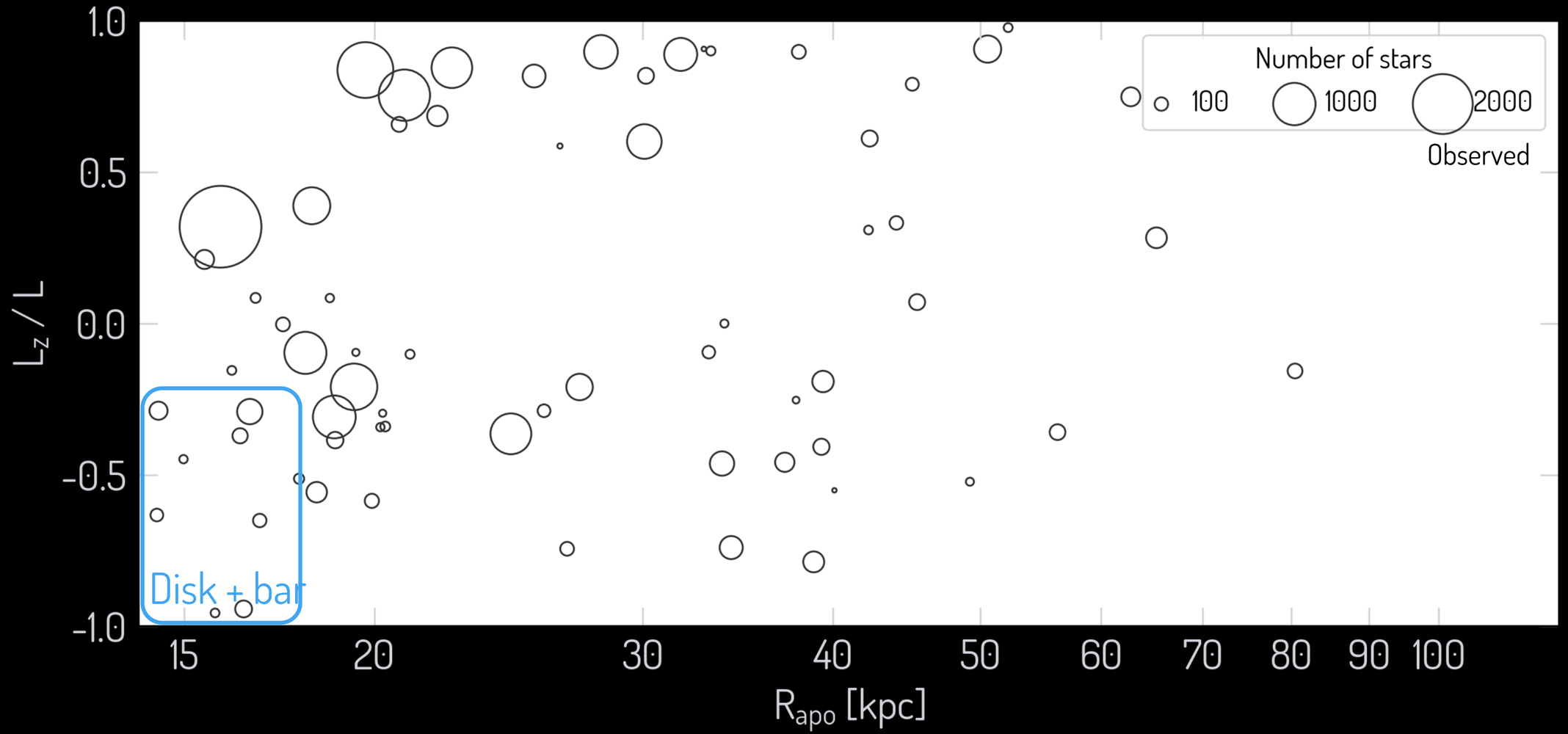

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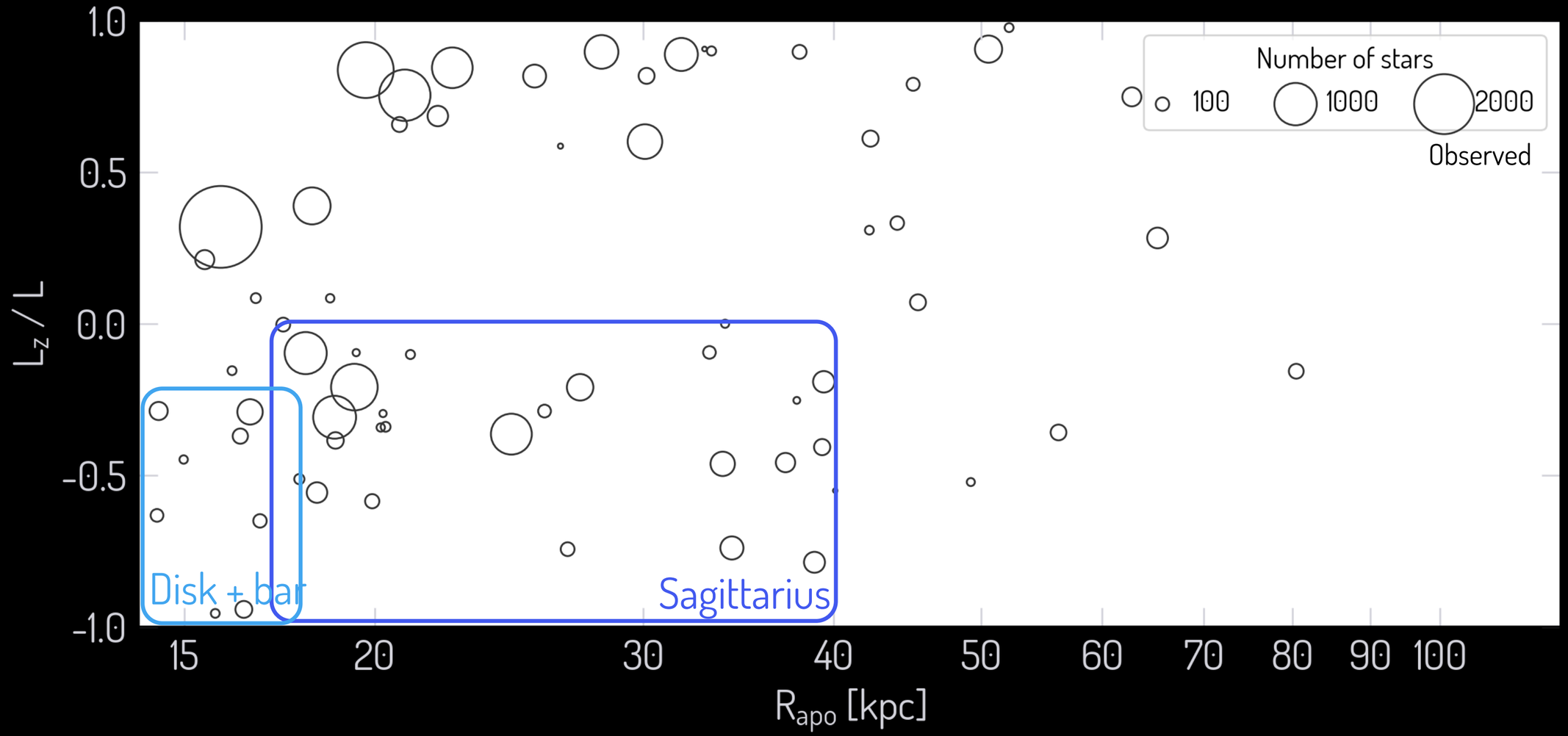

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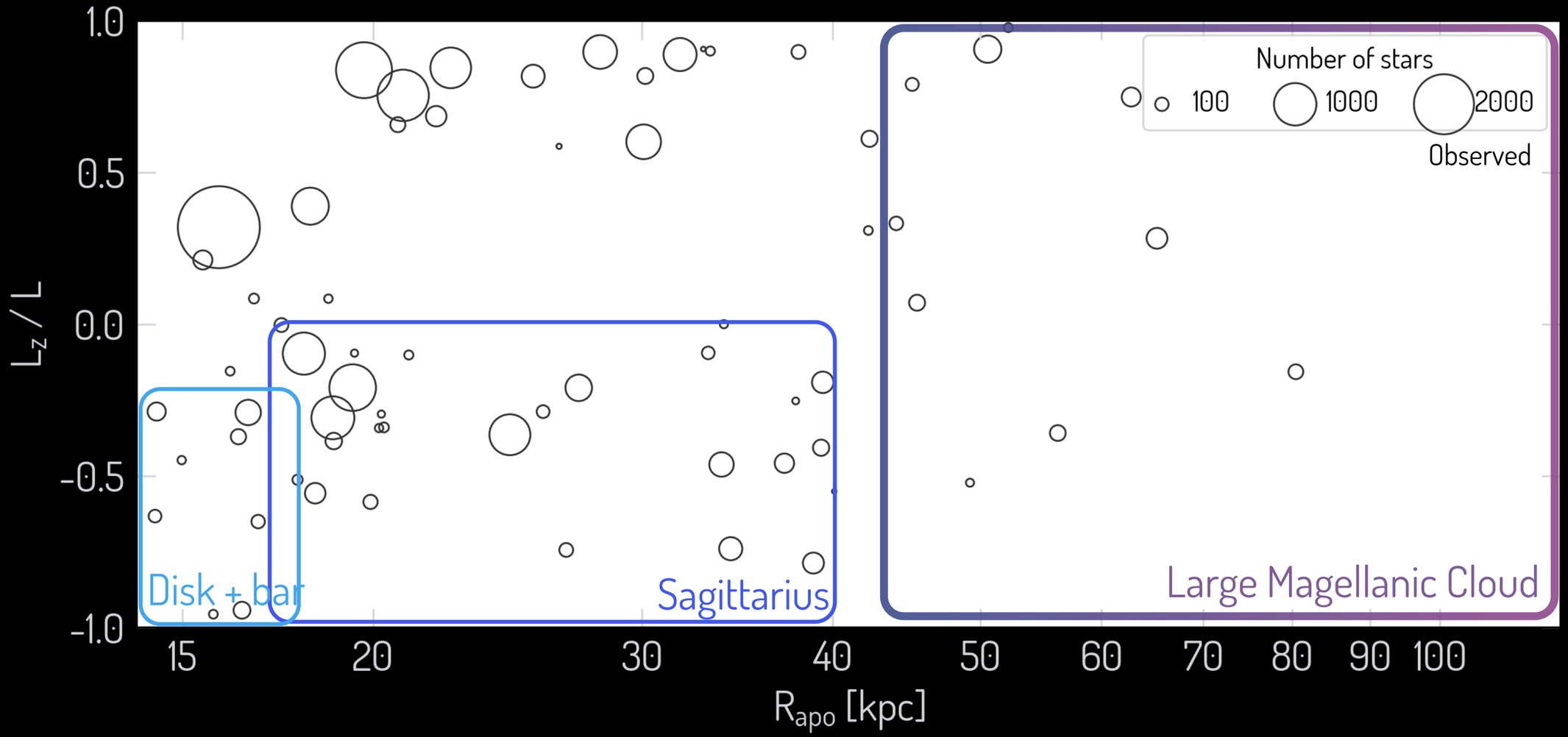

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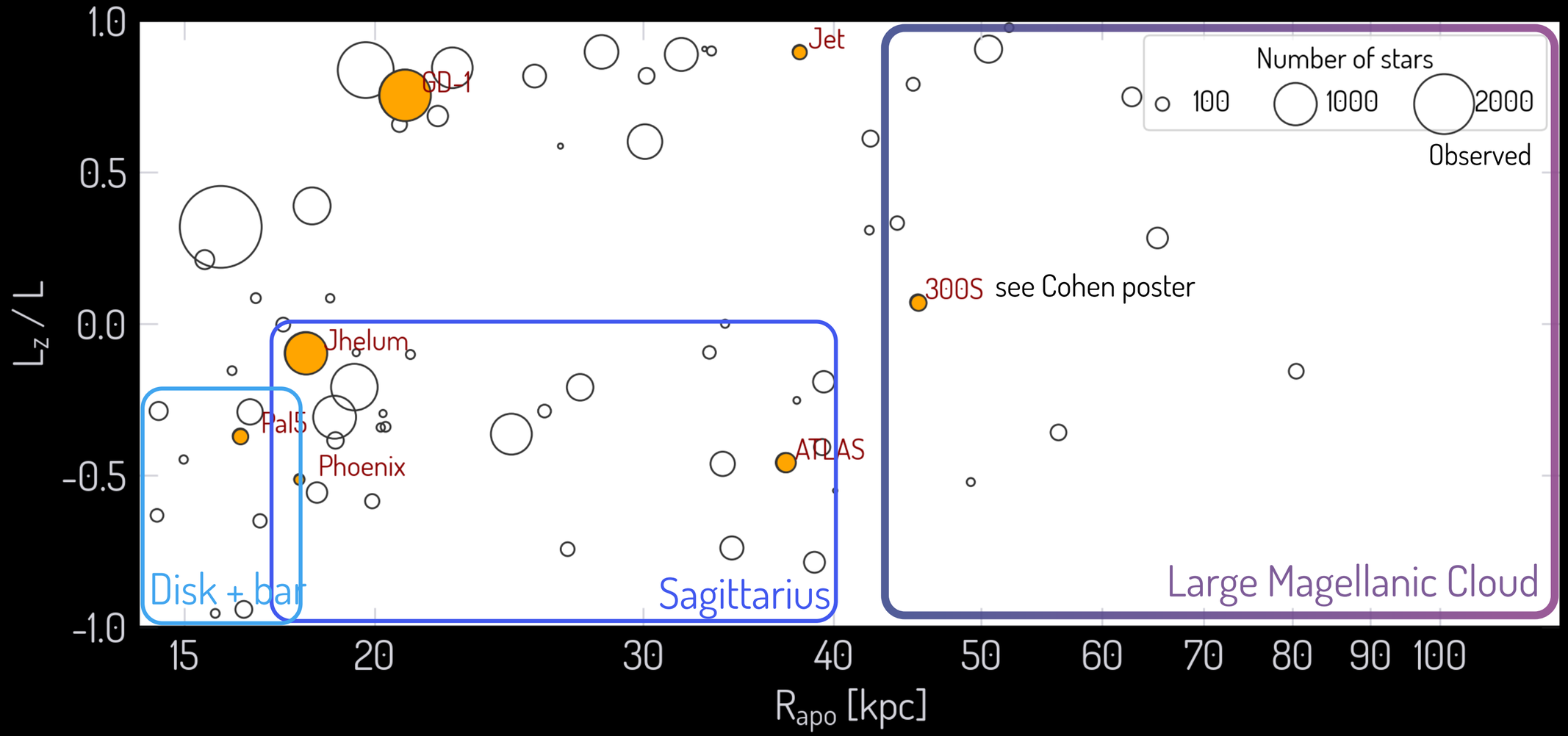

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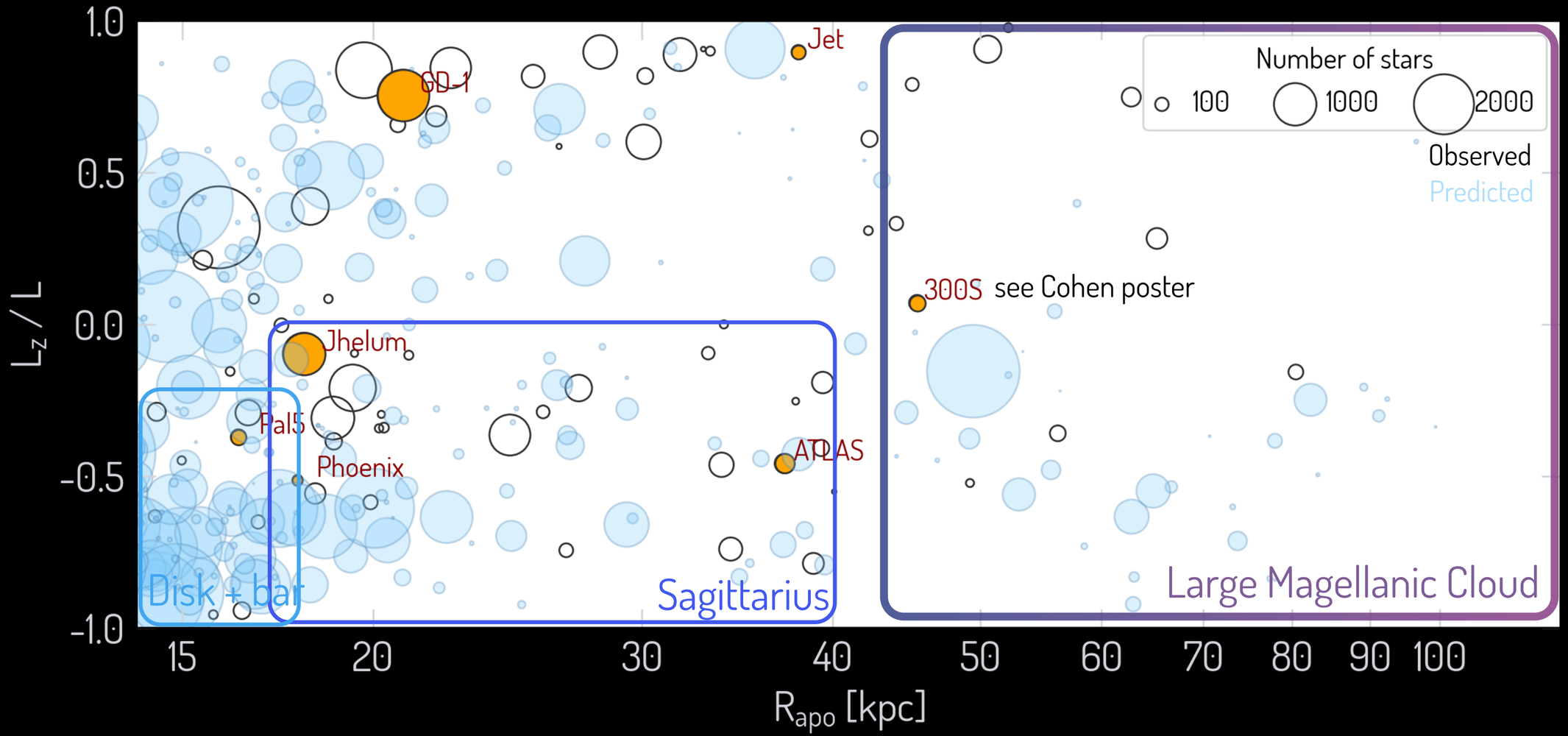
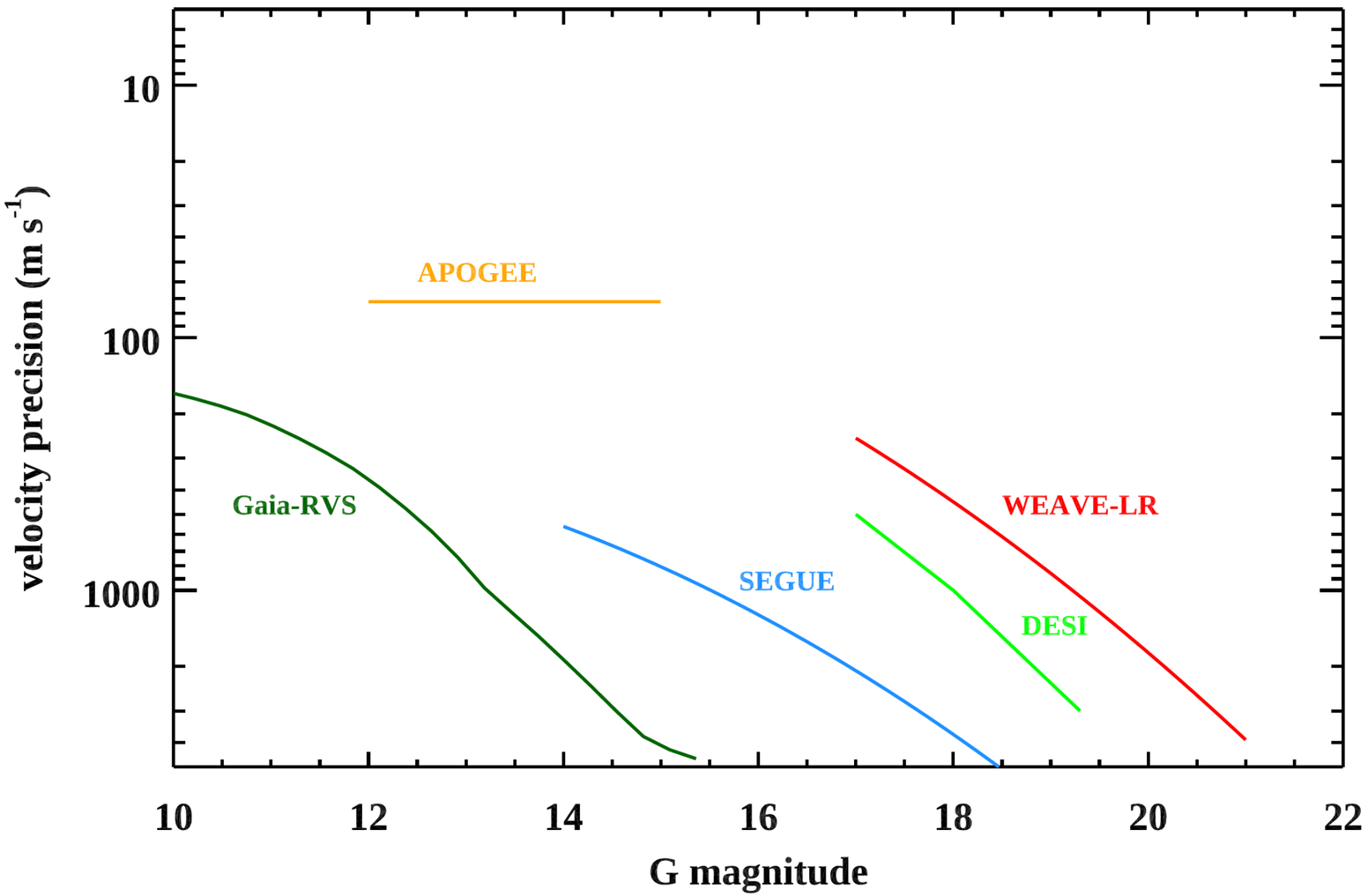


Part III

~spectroscopy in the age of LSST~

High-resolution spectroscopy is needed, but hard to obtain



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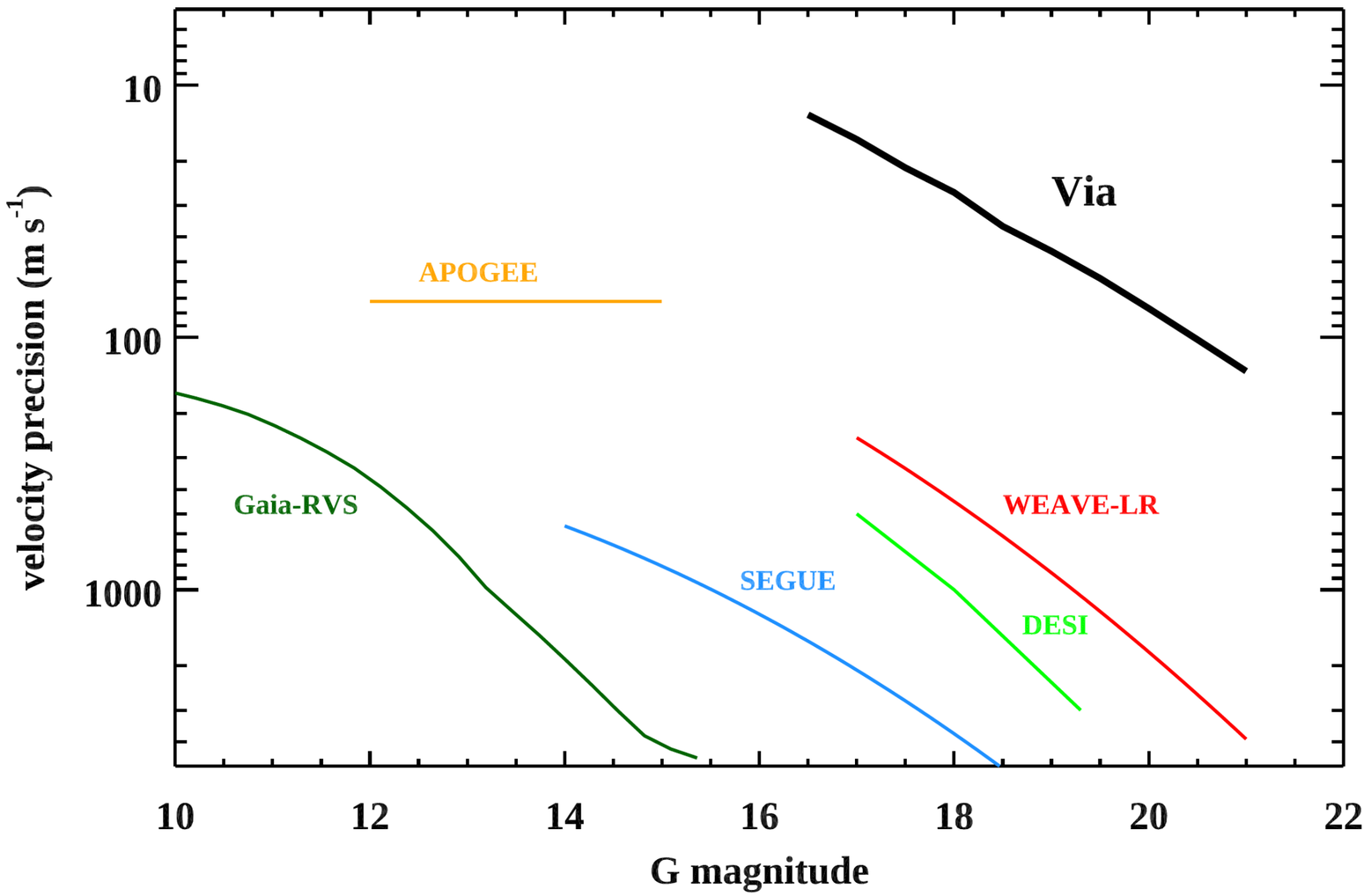


The Via project

via-project.org

Carnegie | CfA | Stanford

PIs: Bonaca & Conroy

Instrument PI: Fabricant

Stanford Science Lead: Wechsler

Robotic fibers: 600

Field-of-view: 1 deg

High resolution: R~15,000

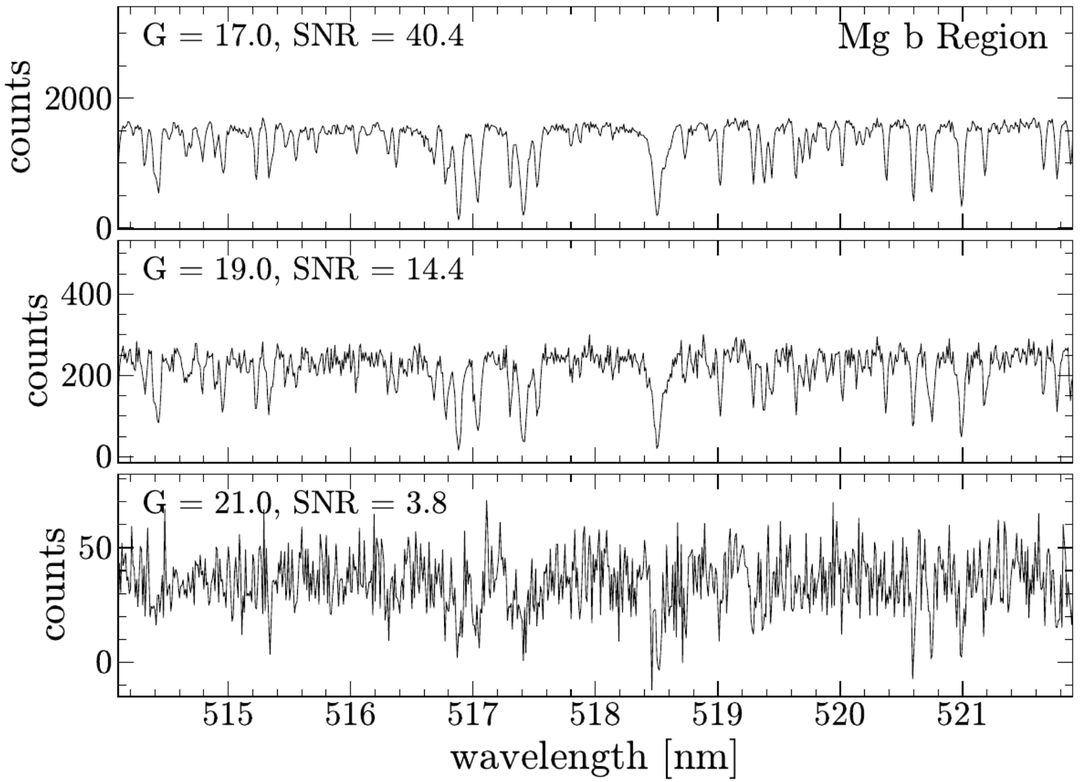
Dual hemisphere: MMT & Magellan

Survey: 50 nights / year / telescope

Targets: streams, dwarfs, halo stars

Spectral modeling and stellar parameter recovery in Via

Full spectrum: 5,000 Å – 6,000 Å



Exposure time calculator courtesy of Vedant Chandra

Spectral modeling and stellar parameter recovery in Via

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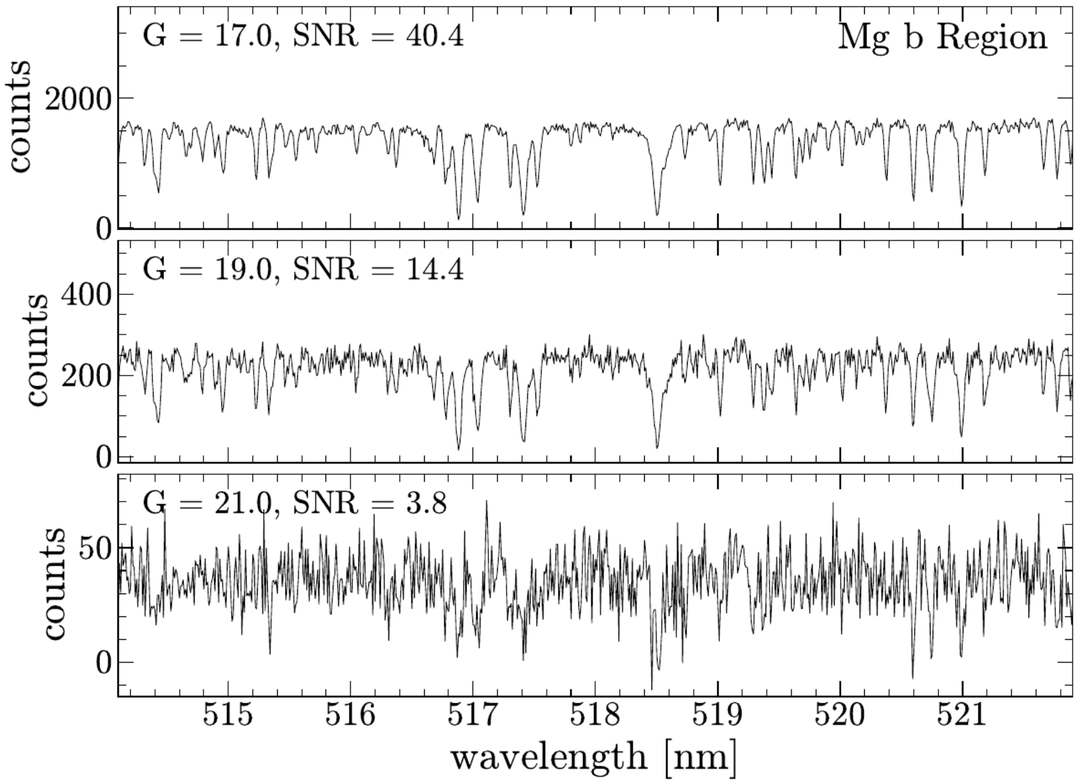
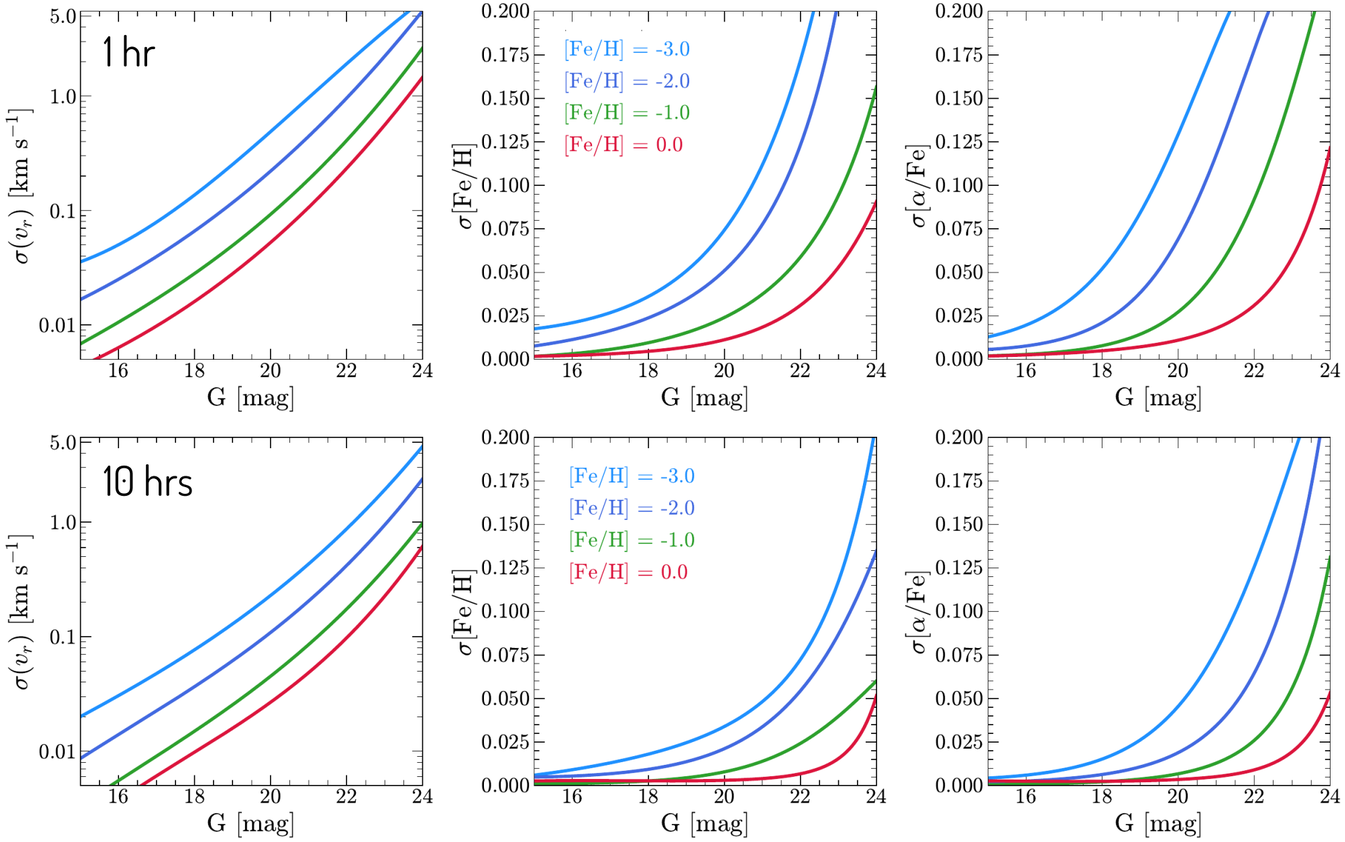


Two survey modes: nominal and deep

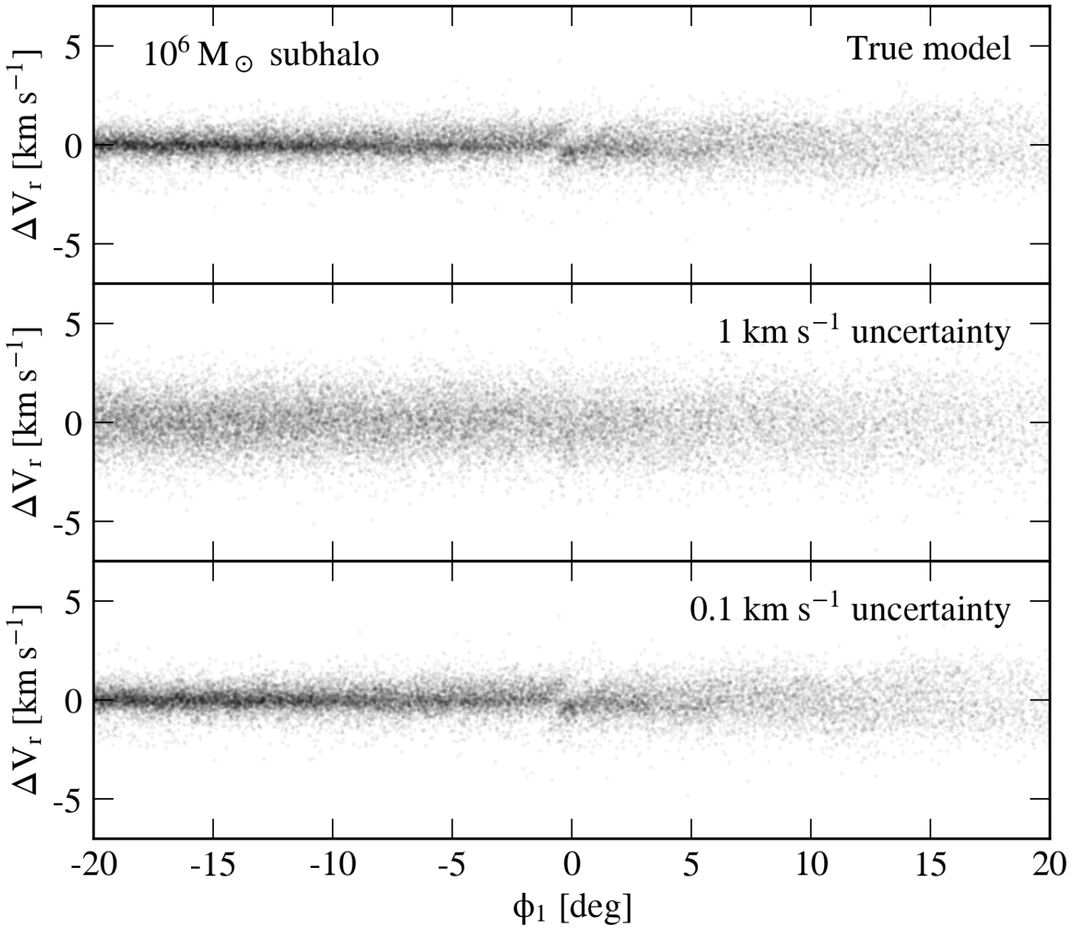


Exposure time calculator courtesy of Vedant Chandra

MINESweeper-based pipeline courtesy of Phill Cargile

Science complementary to LSST enabled by Via

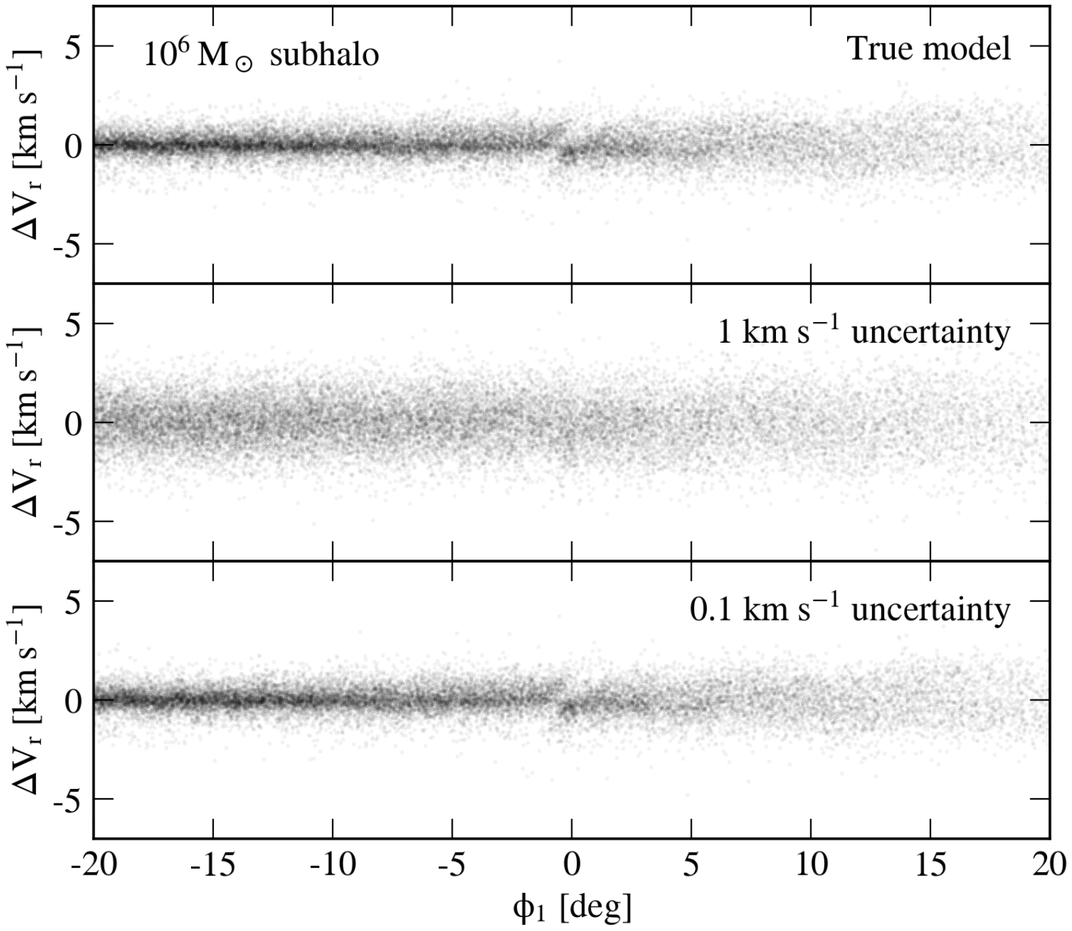
Impacts of low-mass subhalos on streams



see also next talk, Nibauer

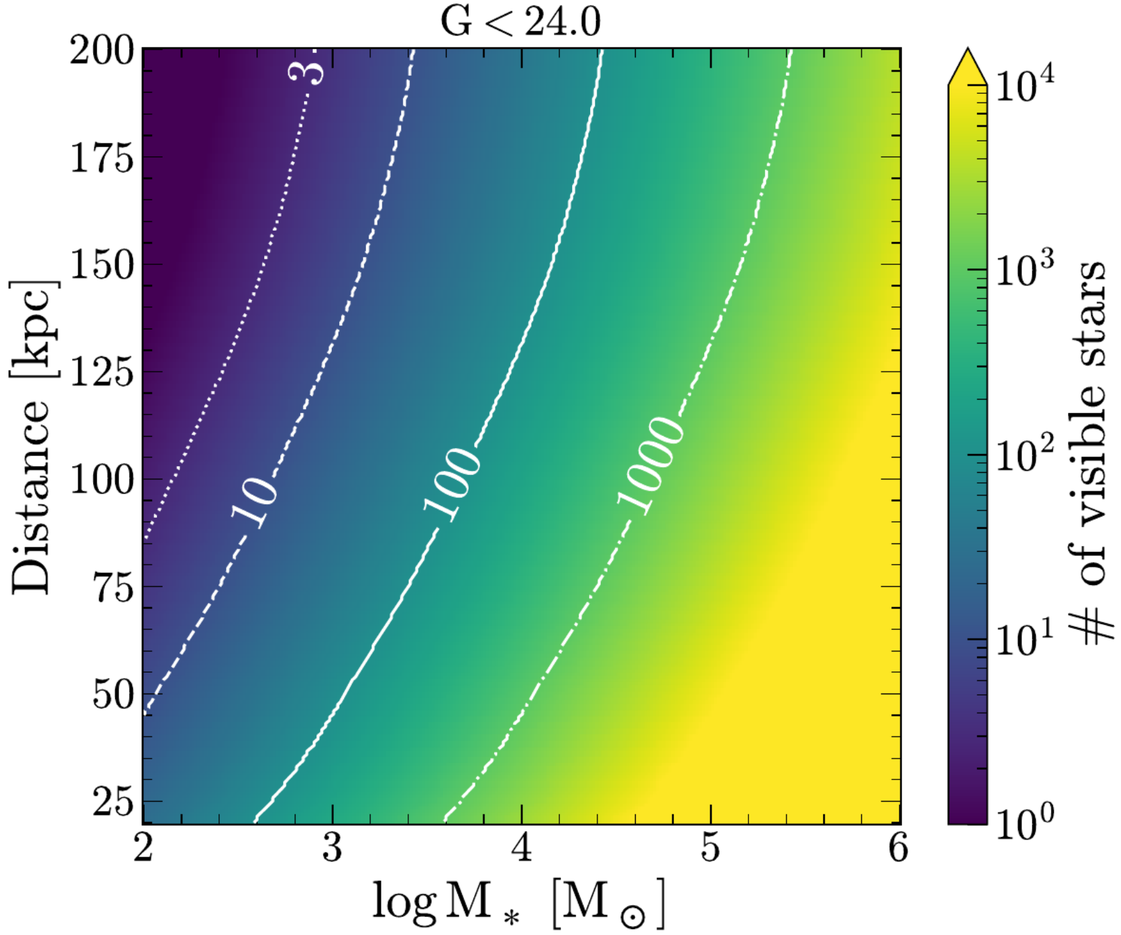
Science complementary to LSST enabled by Via

Impacts of low-mass subhalos on streams

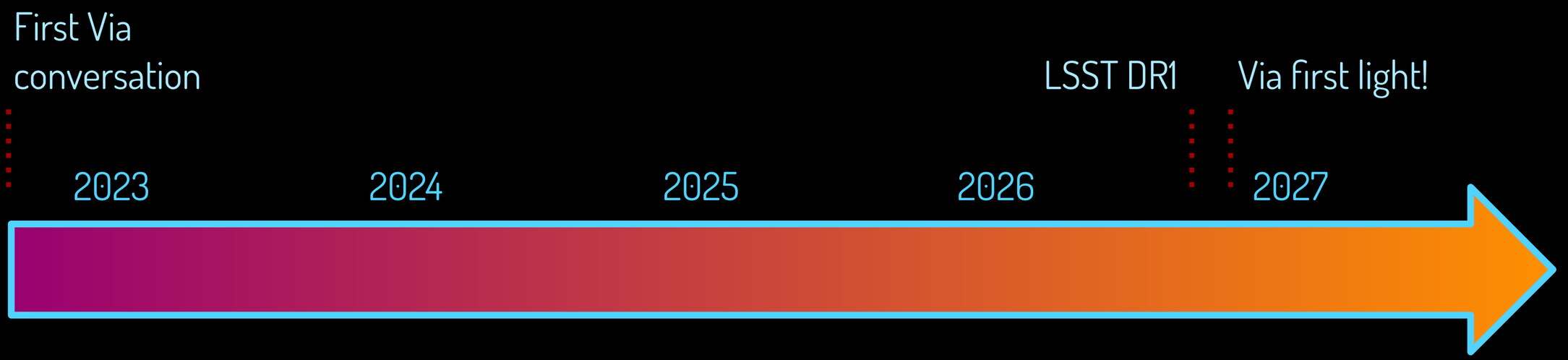


see also next talk, Nibauer

Follow-up of dwarf galaxy candidates



Via timeline



Via timeline

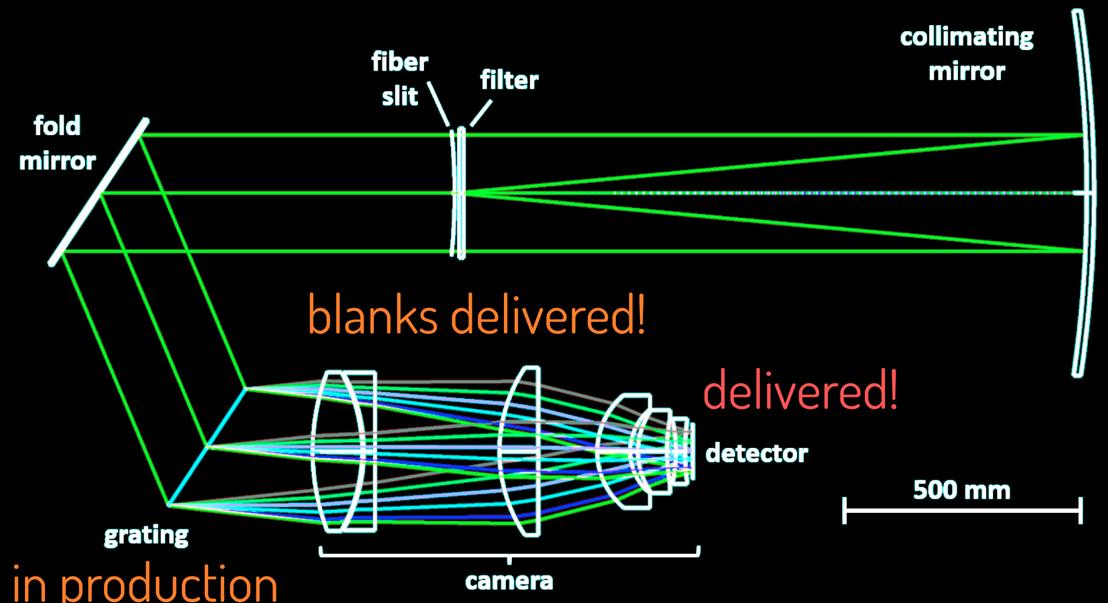
First Via conversation

LSST DR1

Via first light!

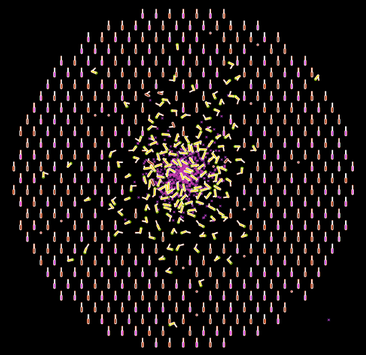
2023 2024 2025 2026 2027

Spectrograph design



in production

Via timeline



First Via conversation

Actuator choice (DESI vs PFS-style)

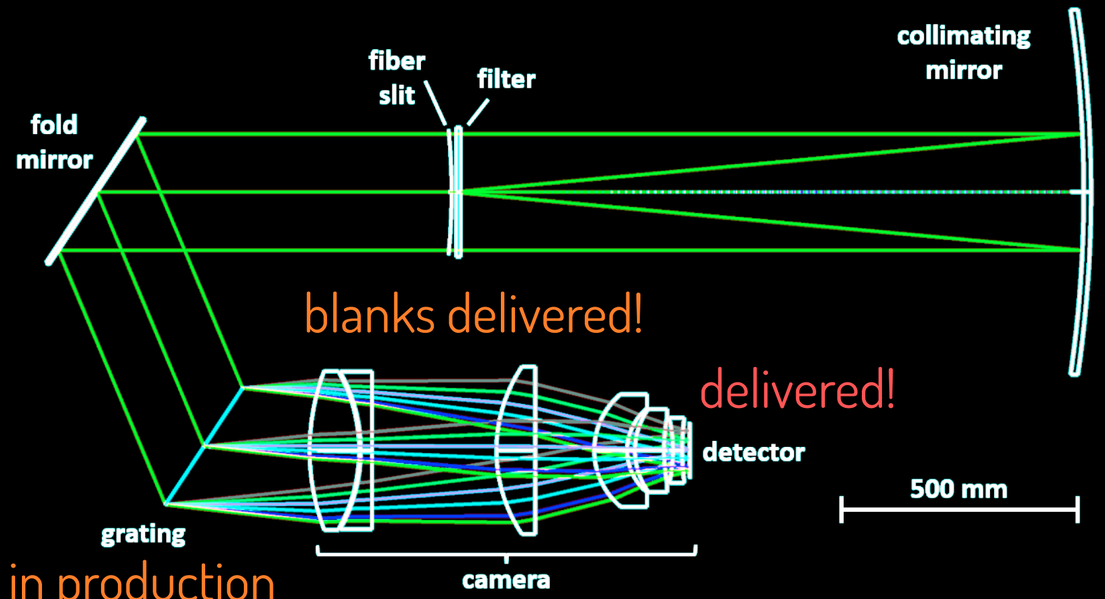
LSST DR1

Via first light!

2023 2024 2025 2026 2027

Spectrograph design

Fiber positioner design



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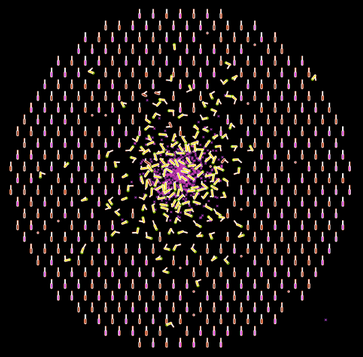


First Via conversation

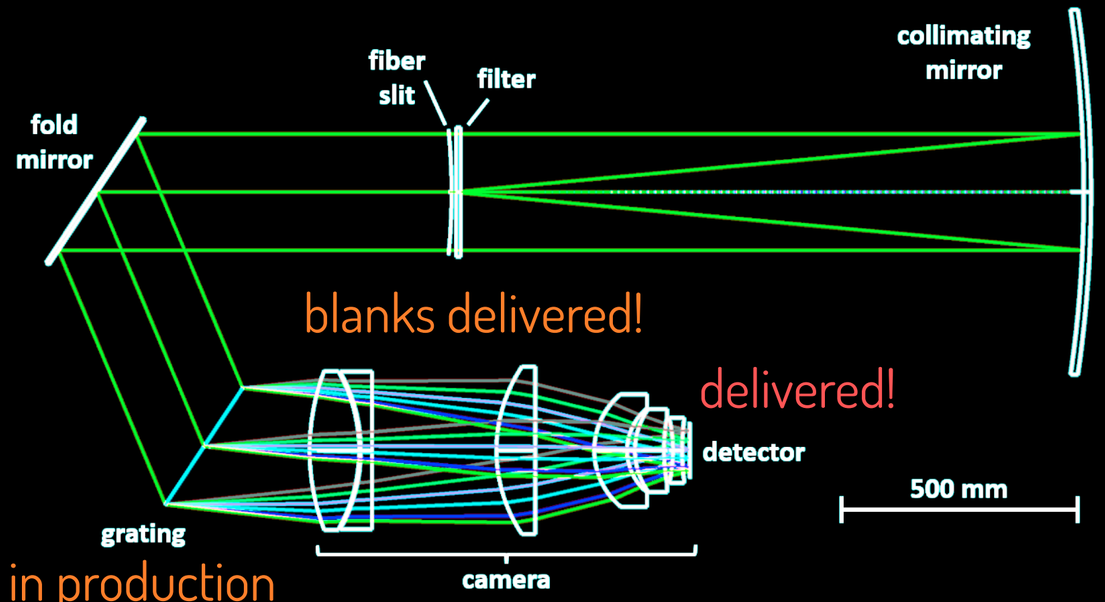
Actuator choice (DESI vs PFS-style)

LSST DR1

Via first light!

2023 2024 2025 2026 2027

Spectrograph design → Fiber positioner design → Assembly → Commissioning → Survey



in production