STELLAR STREAMS ON NUMERICAL SIMULATIONS

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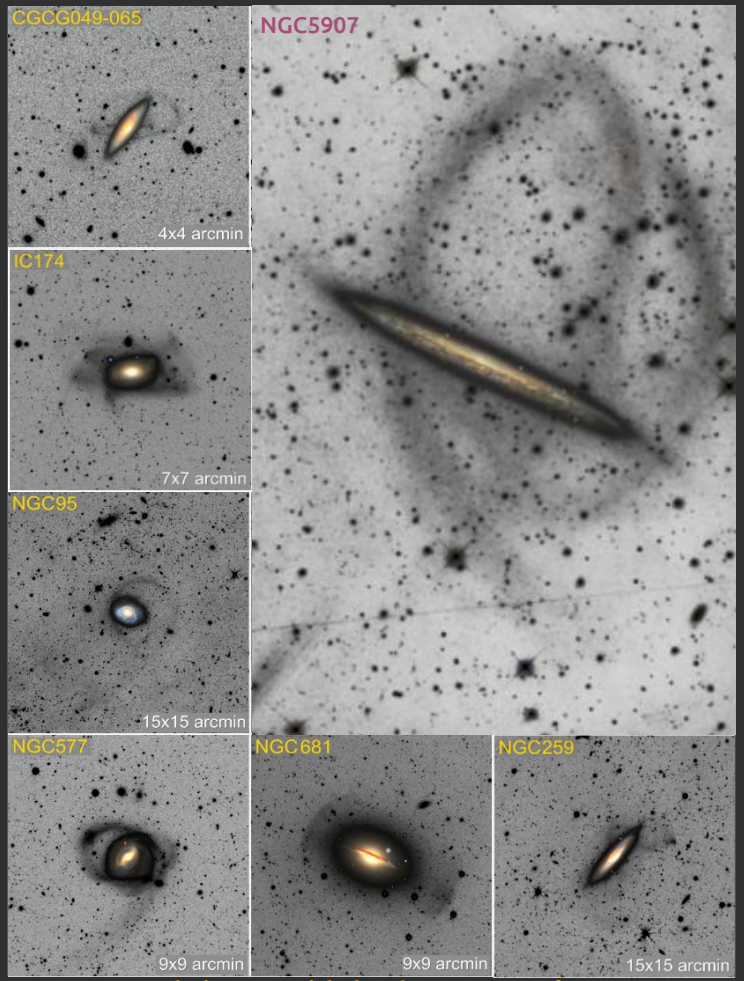
Introduction

SDSS DR19 composite images of the same targets.

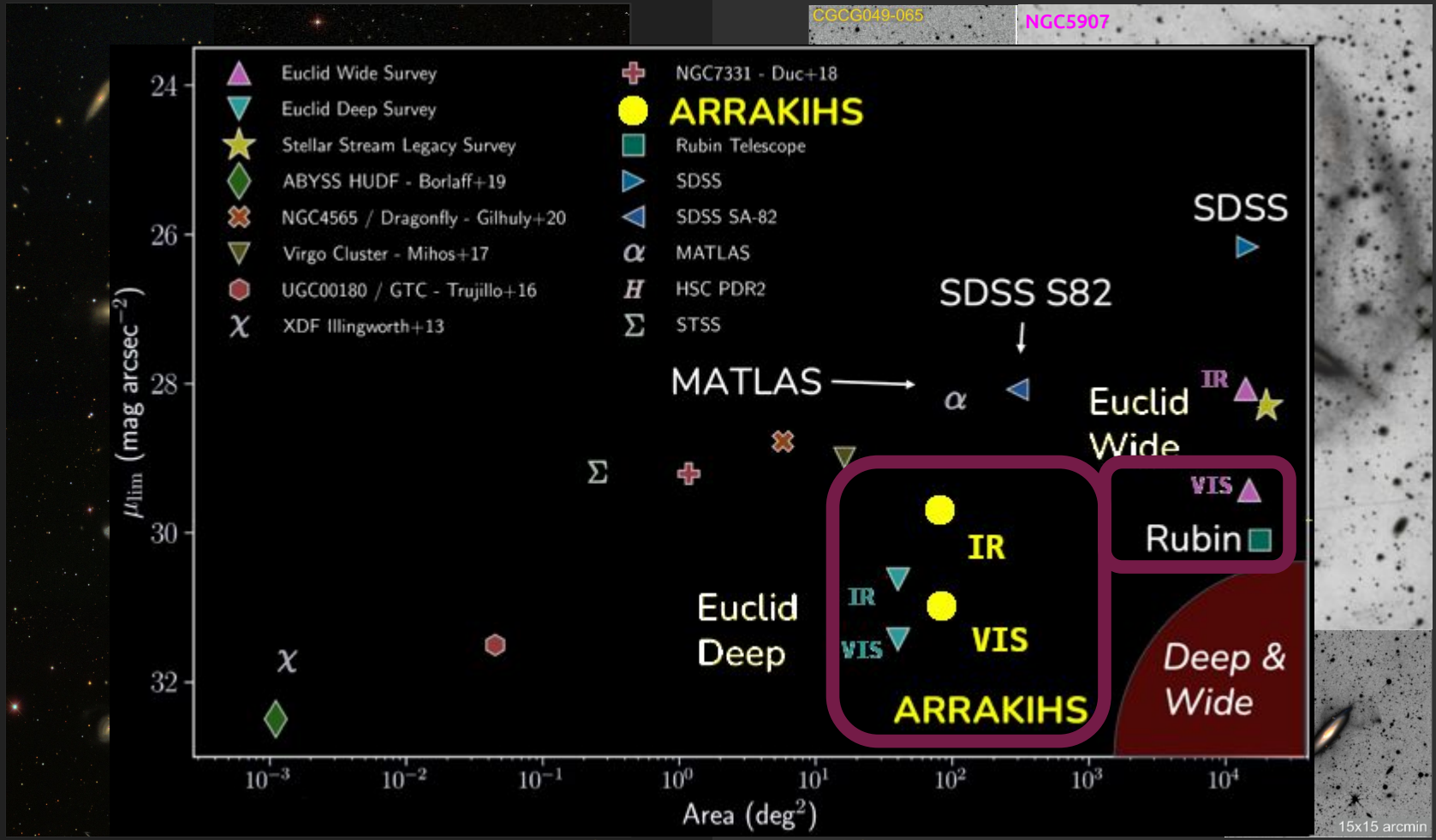
SDSS collaboration



SSLS g and r images with depth R~28.5 mag/arcsec^2.

NGC 5907 r image with depth R~27.5 mag/arcsec^2.

Martínez-Delgado et al. 2019 (NGC 5907), Martínez-Delgado et al. 2023

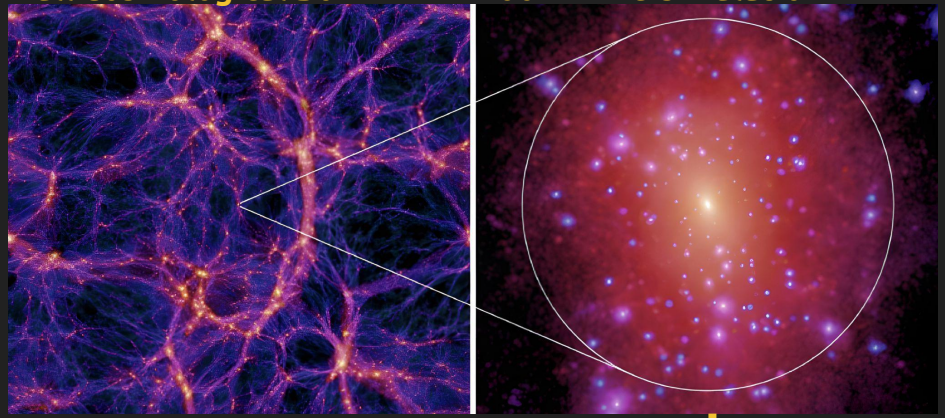


Area vs. Depth of past, current and future Surveys.

Credit: ARRAKIHS collaboration.

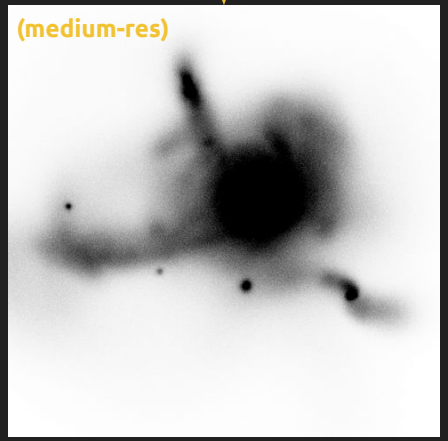
Full Cosmological Box

Zoom In Re-simulation

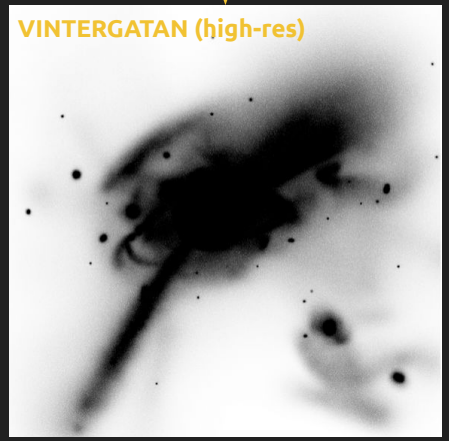


Credit: Auriga collaboration.

(medium-res)

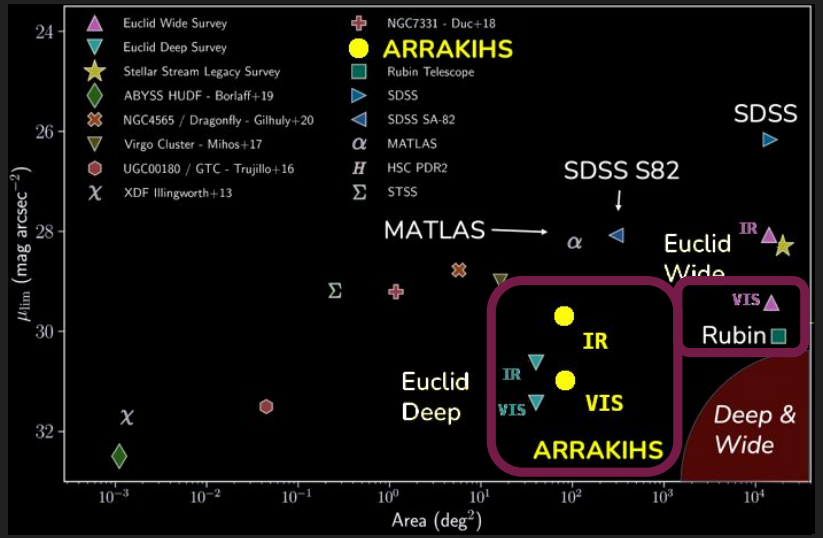


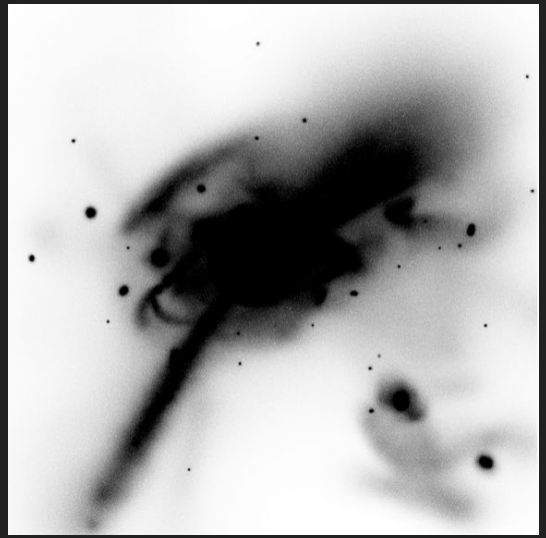
VINTERGATAN (high-res)



Deep and wide observational data are becoming available at the same time that simulations can resolve these structures for the first time!

(not a coincidence of course)





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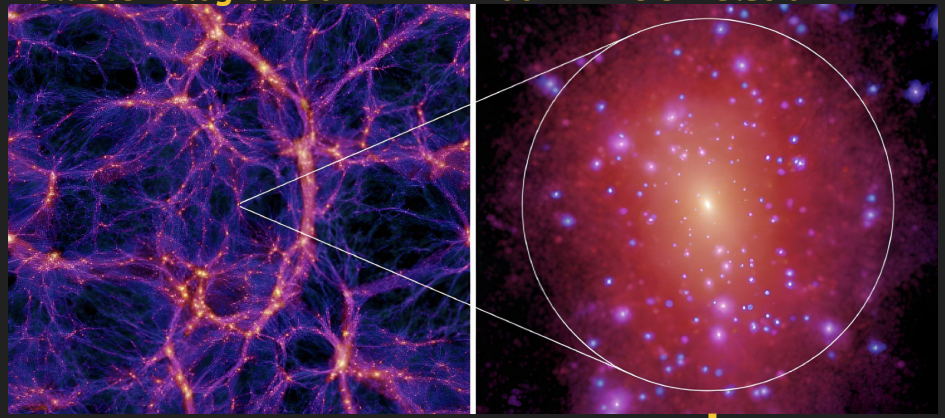

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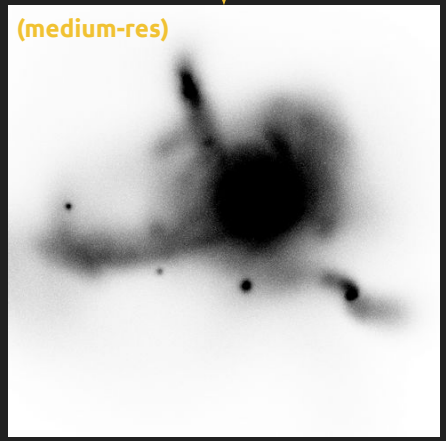

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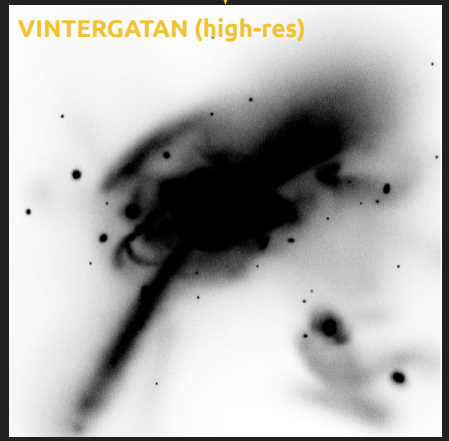


Simulations are just numerical models of a (very complex) physical system: the Universe.

Nothing fundamentally (except scale) different from:

- Models for Stellar Spectra.
- Models for Stellar Structure and Evolution.
- Models for Exoplanet Atmospheres.
- Models for AGN Growth and Feedback.
- ...

They even have the same issues: Humongous unknown/unresolved parameter!

Dark Matter flavour:

CDM, WDM, SDIM, Fuzzy, etc.

Subgrid Physics:

IMF, Star Formation, Stellar Feedback, Cooling etc.

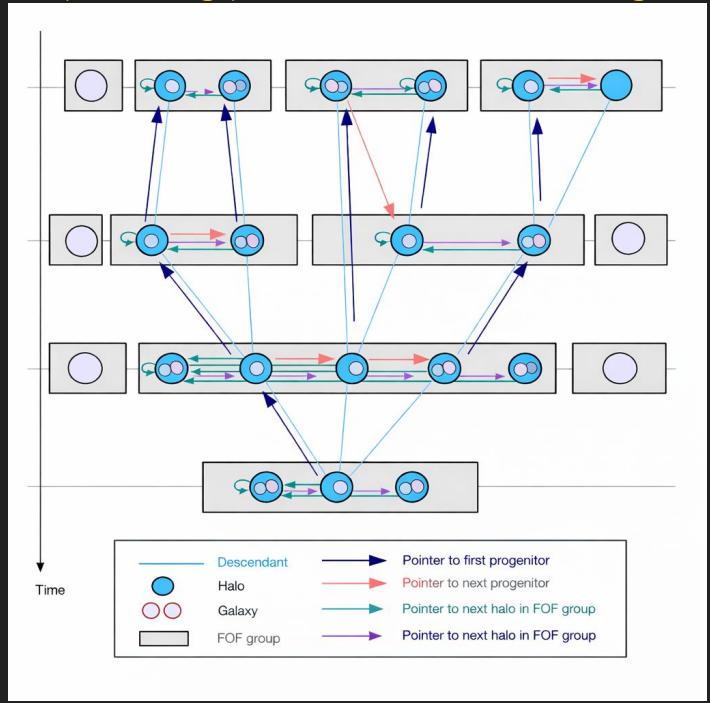
We use the very-high resolution VINTERGATAN simulations, implementing CDM and Subgrid Physics from Agertz et al. 2013. $M_{baryons} = 7070\ M_\odot$

¿ How do we find streams ?

Feature-Space Clustering

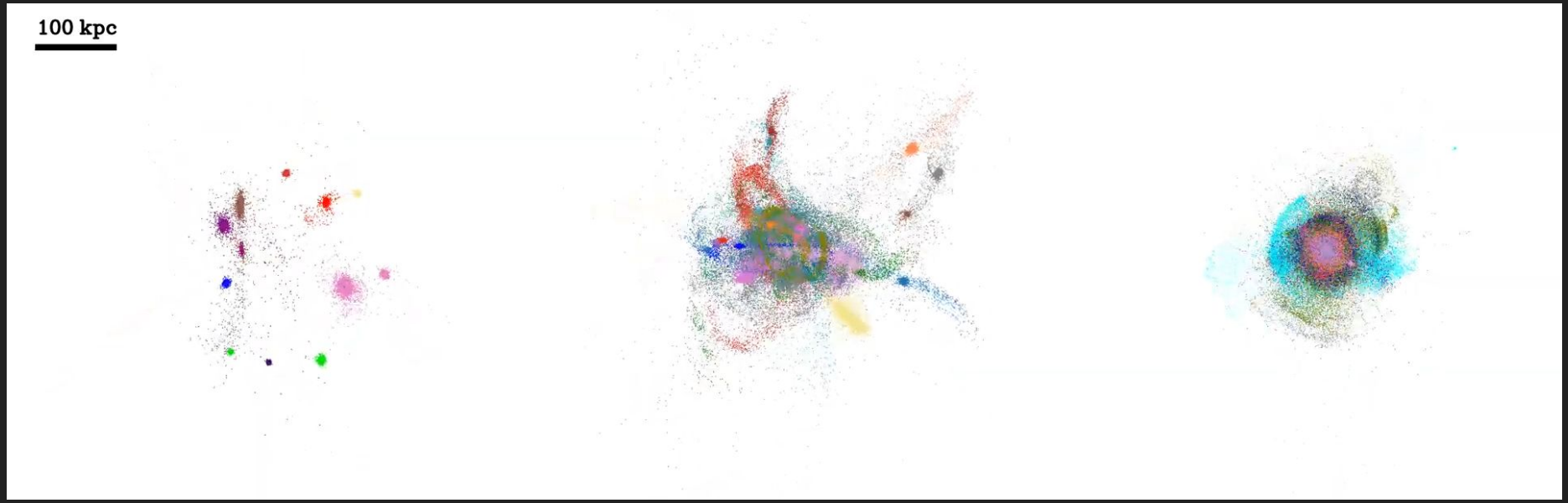
(e.g. AstroLink; by William et al. 2024)

(Galaxy) Accretion History



We identify Stellar Streams by reconstructing the whole accretion history using corrected merger-tree's provided by Sergio & Ramon (recall Sergio's talk).

Intact Satellite vs. Stream is based on bound fraction ($f_b<0.97$)[1]
Stream vs. Mixed is decided based on velocity dispersion of the debris[1]
[1]Riley et al. 2025



We identify Stellar Streams by reconstructing the whole accretion history using corrected merger-tree's provided by Sergio & Ramon (recall Sergio's talk).

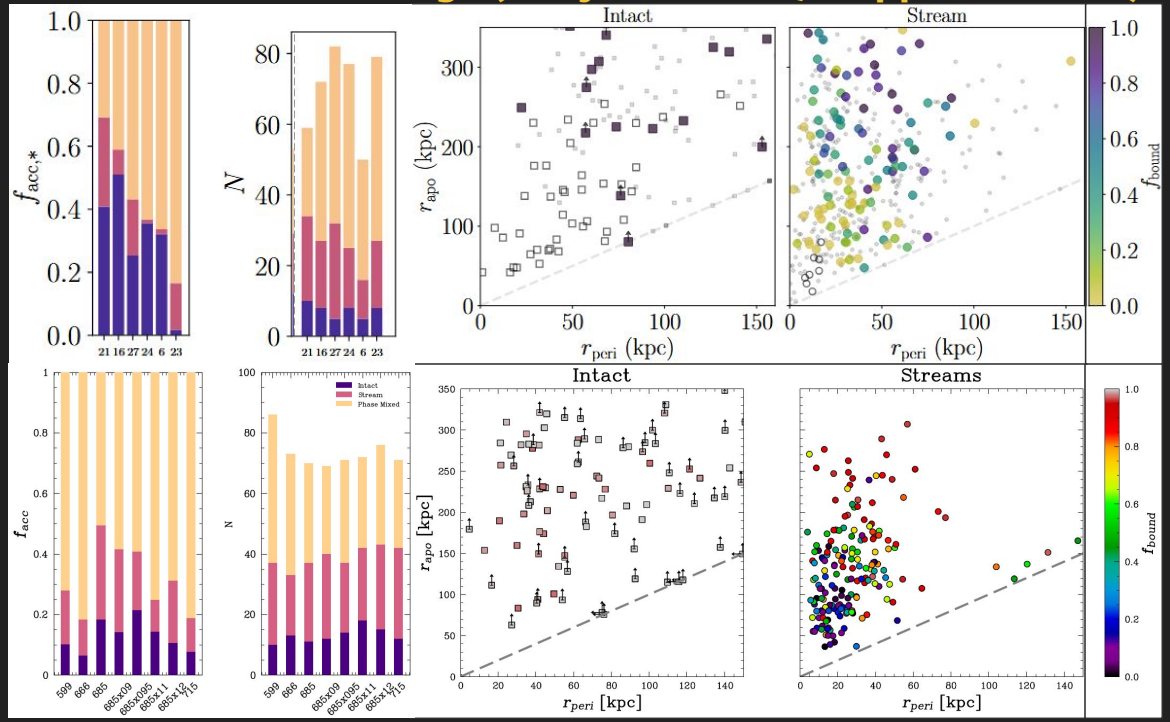
Some results

- Similar number of intact, stream and mixed systems.
- Bigger fraction of accreted stellar mass on satellites.
- Deeper pericenters in vintergatan simulations.

Baryonic physics has a tangible effect on accreted stellar mass deposition!

Next: ¿What parameter space defines streamification?

Auriga (Riley et al 2025, Shipp et al. 2025)



Vintergatan (this work)

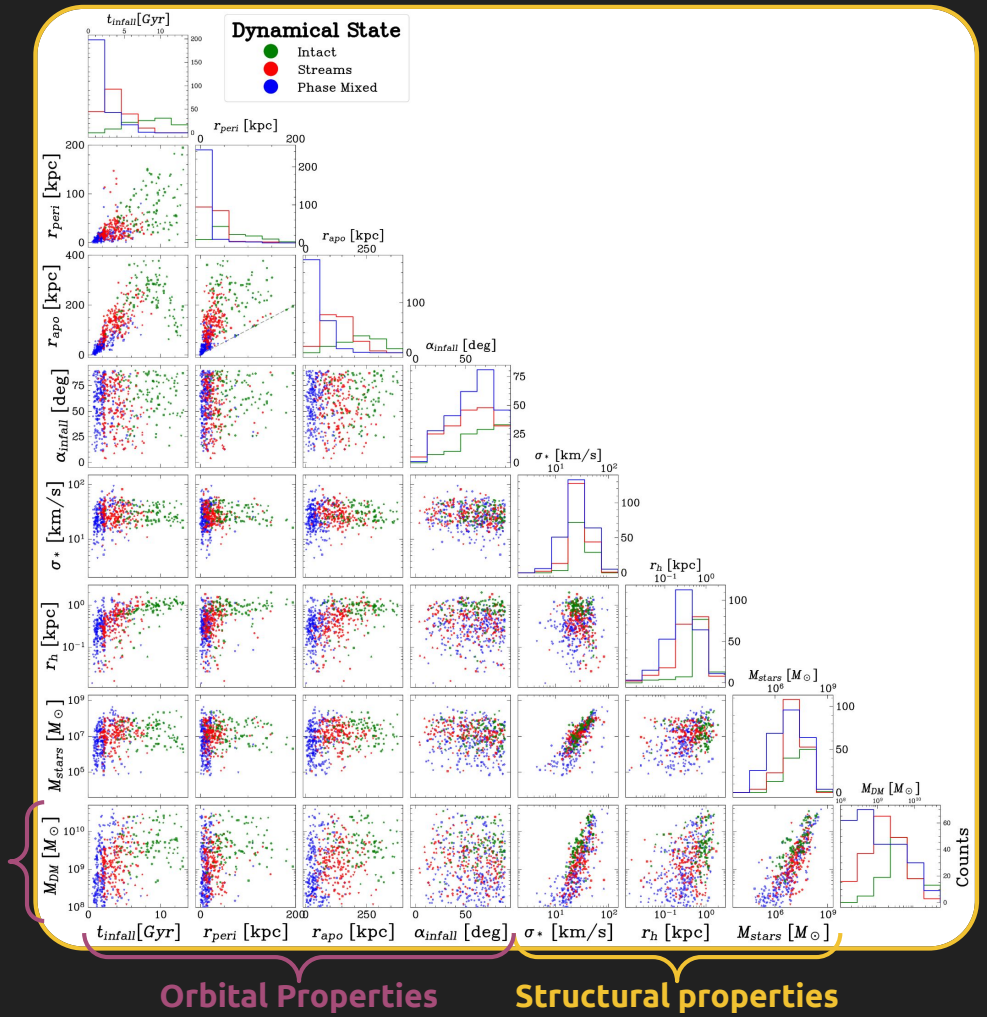
Parameter Space relevant to Stream formation:

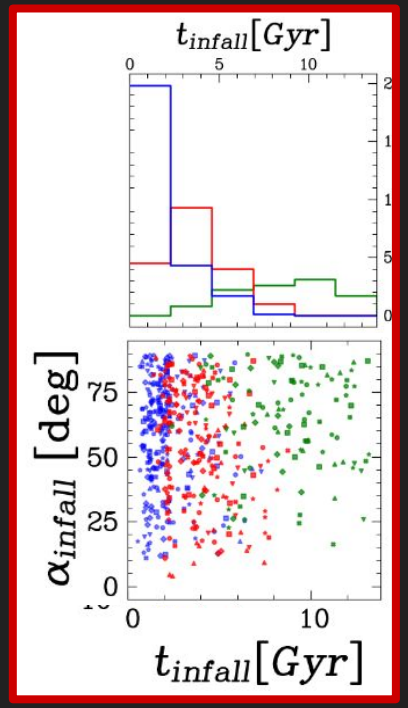
Structural properties

- Stellar Mass.
- Dark Matter Mass.
- Half-Light radius.
- Stellar Dispersión velocity.

Orbital properties

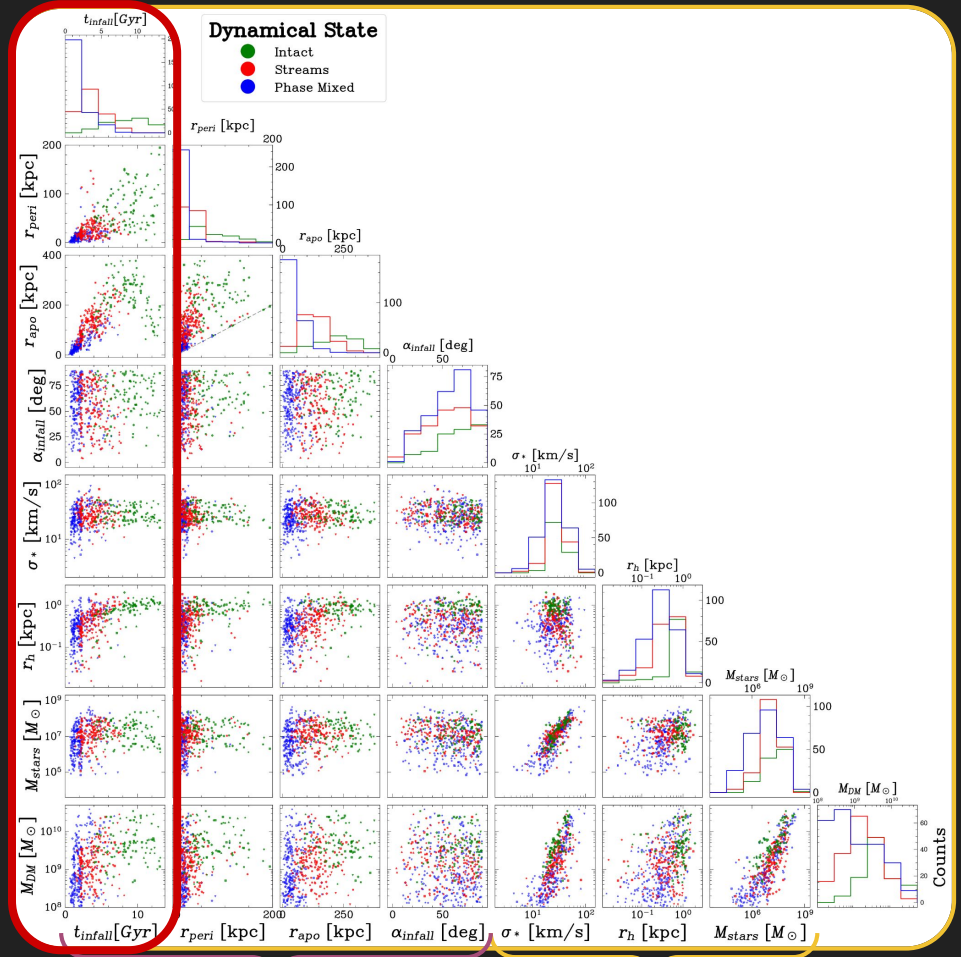
- Infall Time.
- First pericenter radius.
- First apocenter radius.
- Infall angle w.r.t. disk.





¿ What causes this transition independently of other parameters ?

We don't know yet!



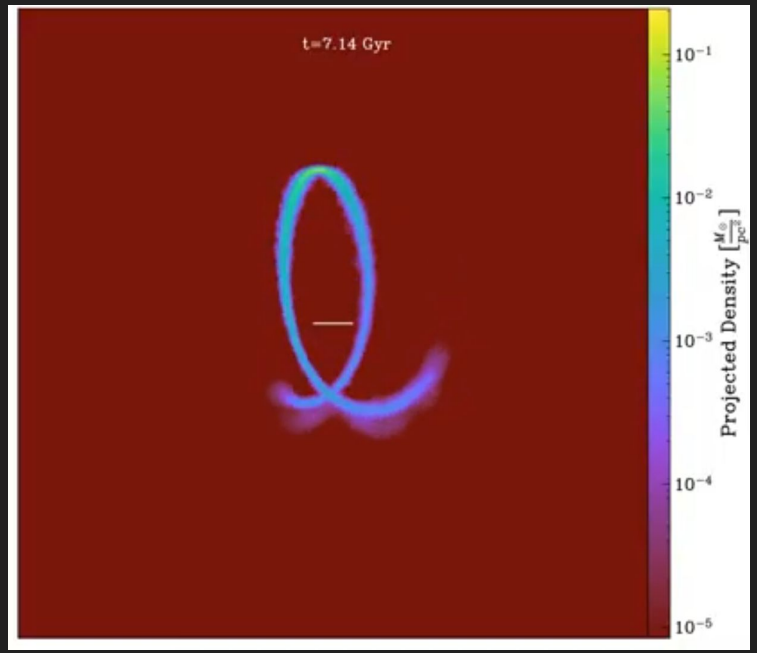
If you notice the lack of conclusive results…

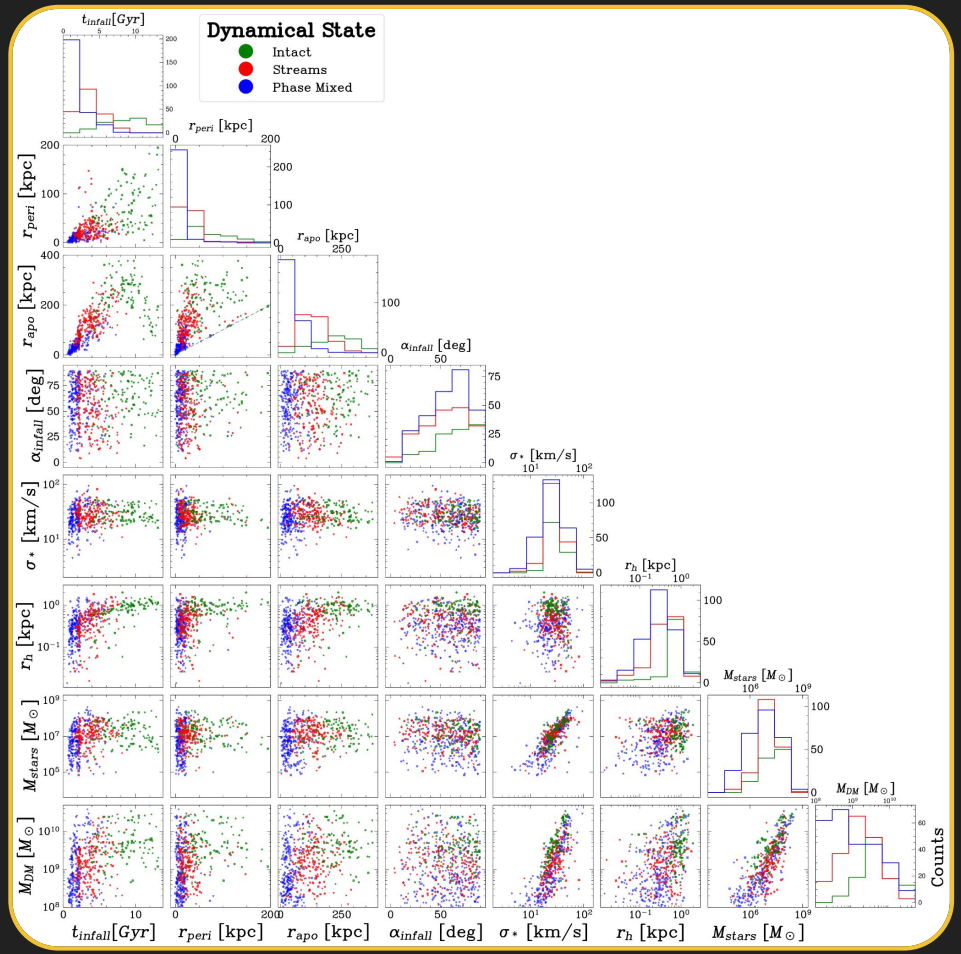
It is because i am still collecting the evidences to find who killed (and how) the dwarfs!

(you could call me the Benoit Blanc of galaxies)

This parameter space can be used to create a synthetic, idealized Stellar Stream library.

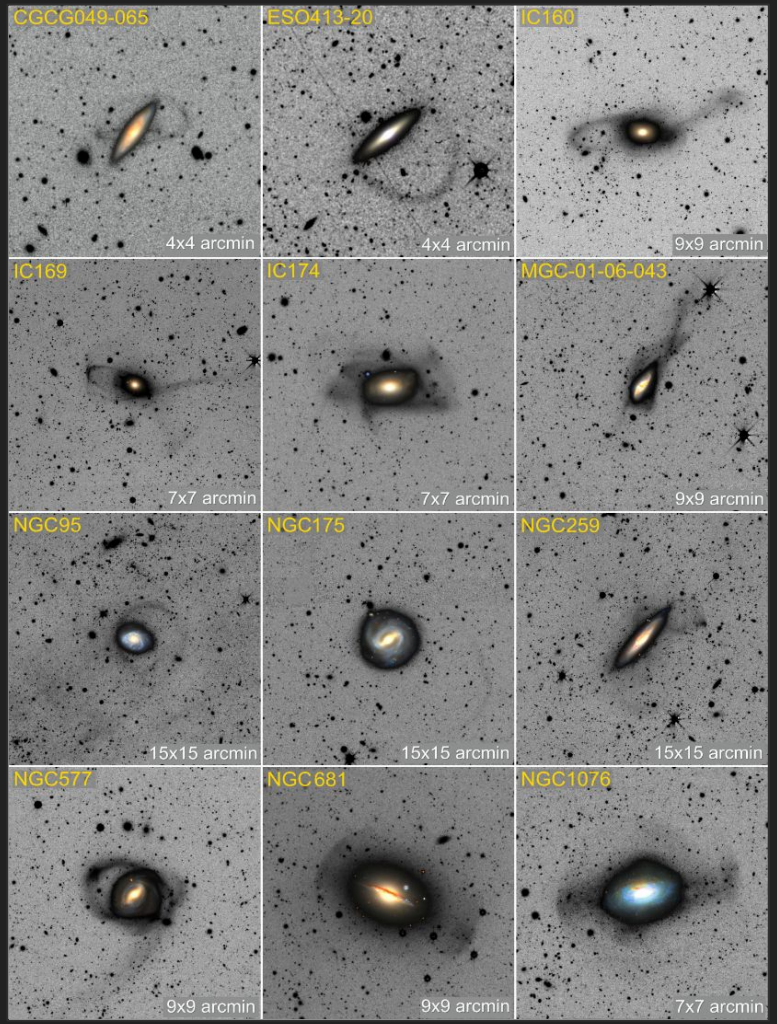
Useful to perform inference from real observations!





no **QUESTIONS ?** please

SDSS DR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NGC95
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NGC175
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NGC259
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NGC577
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NGC681
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NGC1076
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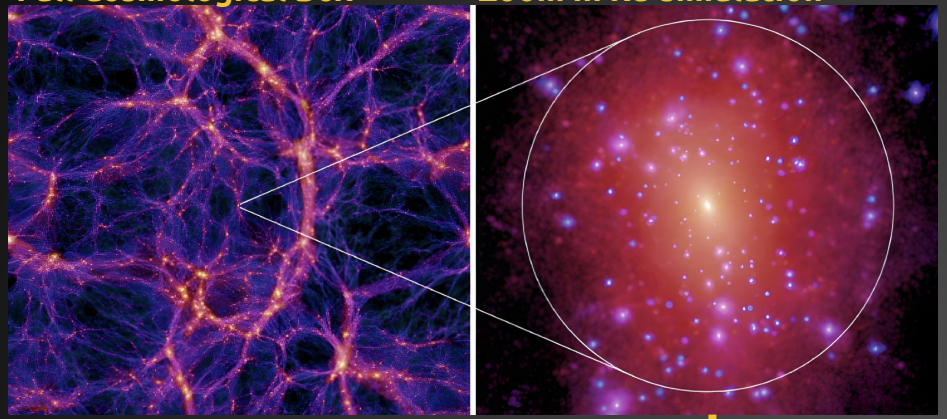

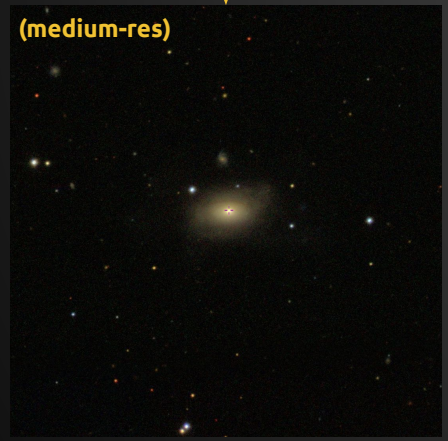

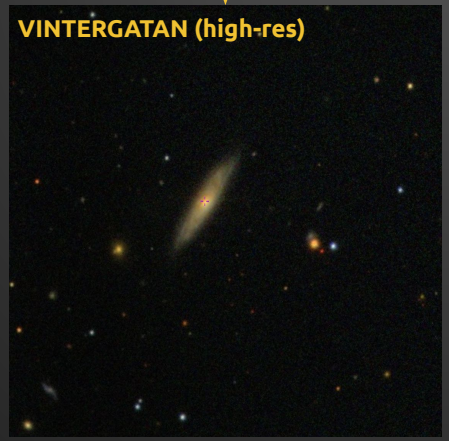

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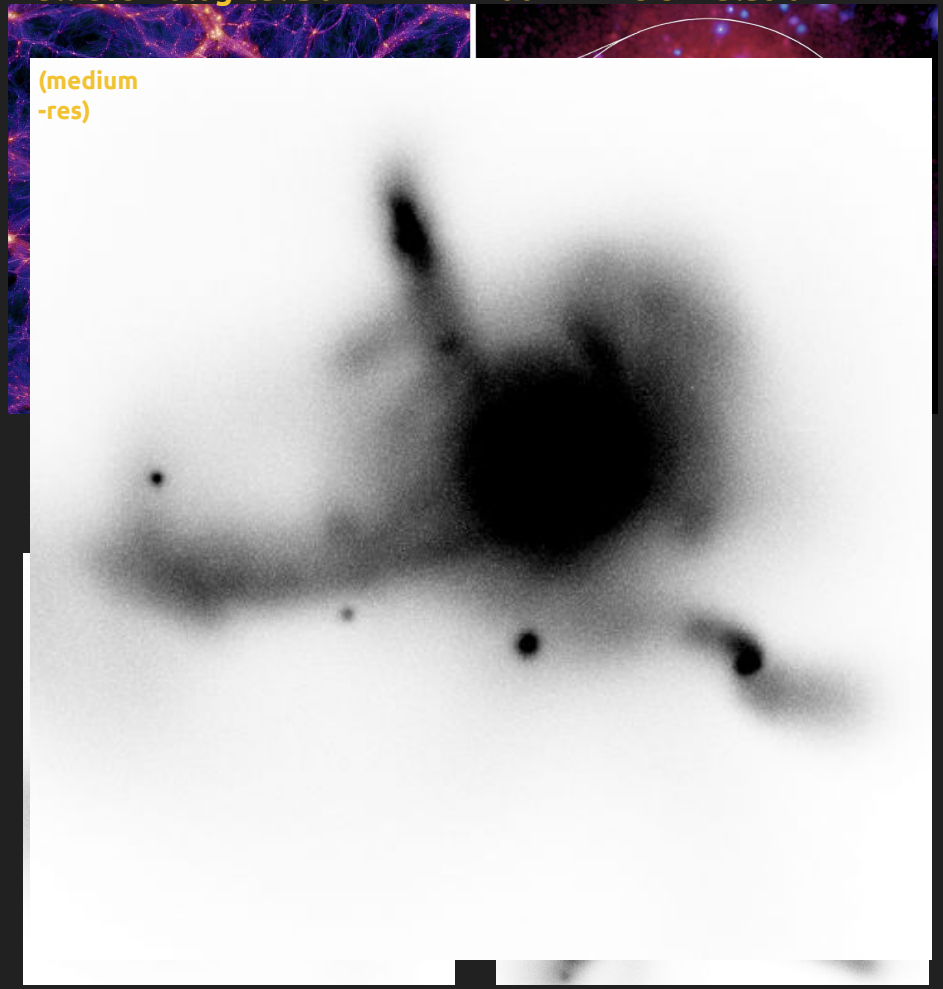

(medium
-res)

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VINTERGATAN (high-res)

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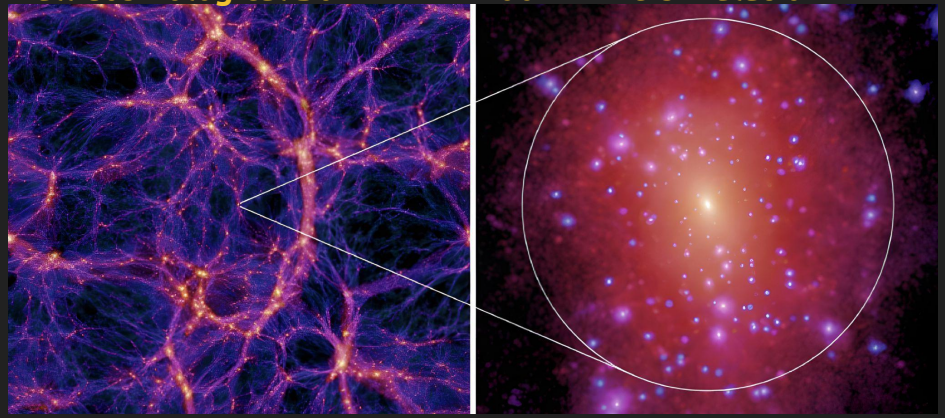

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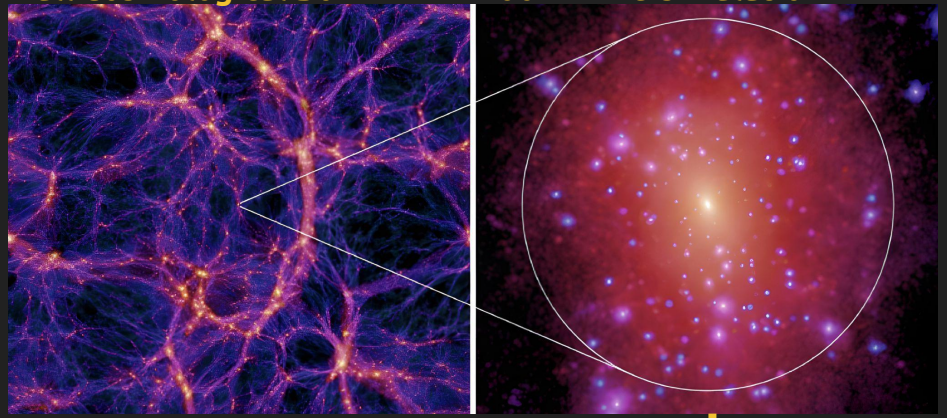

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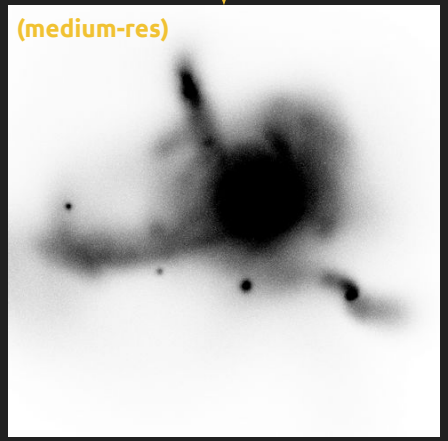

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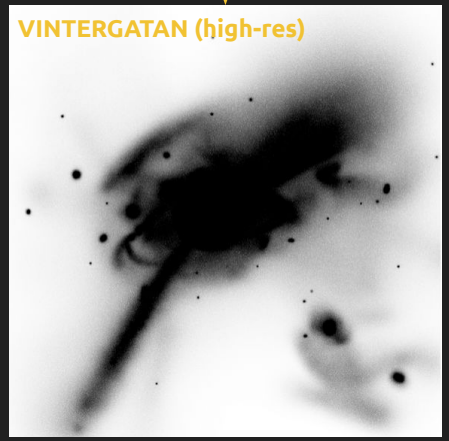

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Low mass dN/dM