SUNDIAL
H2020 Innovative Training Network

# Jellyfish and UDGs: the fate of Fornax Cluster dwarfs

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FACULTY OF SCIENCES

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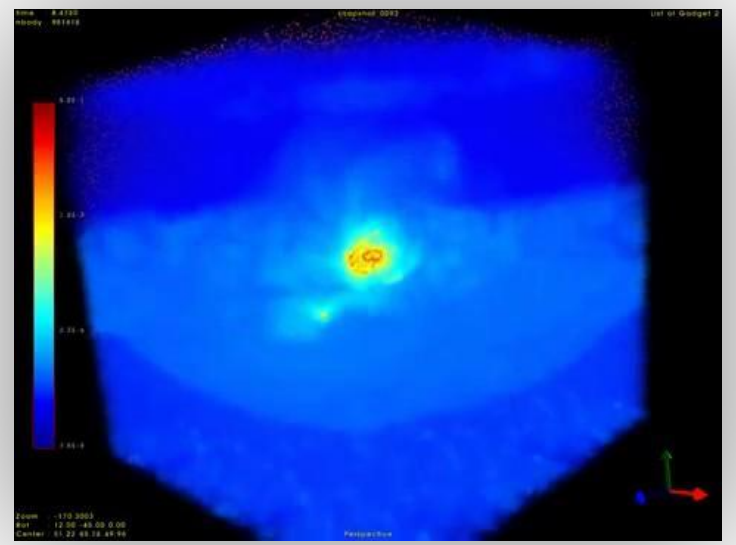
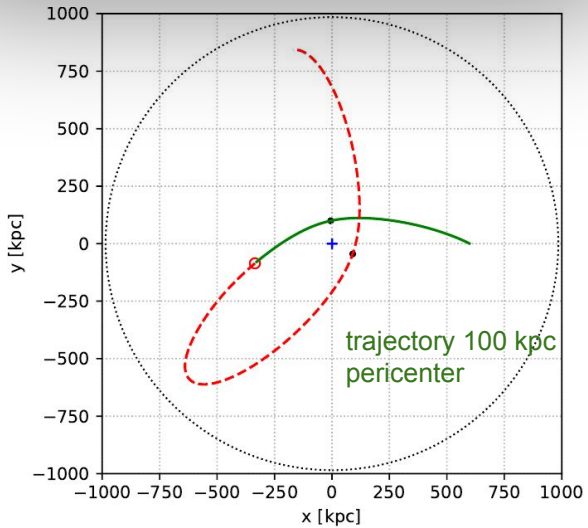
GHENT UNIVERSITY

# Cluster infall - Simulations setup

- Make use of MoRIA simulation (Verbeke+2017)
- Evolved up to ~8 Gyr in order to obtain realistic late-type dwarf galaxies to inject into the cluster.
- Fornax Cluster modeled as a static NFW potential with gas distribution in hydrostatic equilibrium following Paolillo+2002
- Injection on different orbits:
  - Apocenter: 800 kpc
  - Pericenter 50 - 100 -150 - 200 - 300 kpc
- Prototype galaxies with stellar masses:
  - $10^{7.5}$ - $10^{8}$ - $10^{8.5}$ $M_{\odot}$
- Adaptation of the Nichols+2015 Moving Box technique

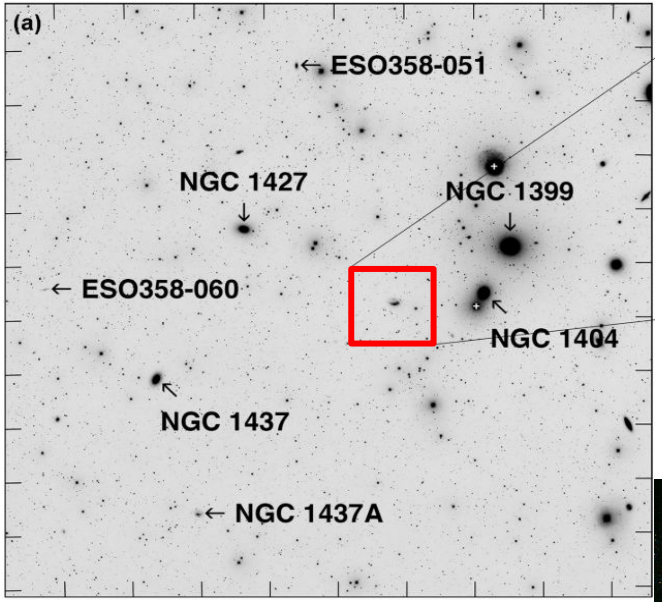




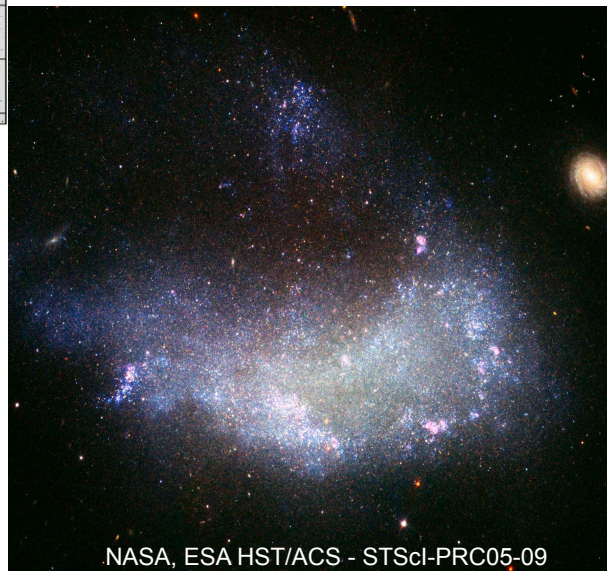
# Jellyfish NGC1427A

Features:

- Brightest dwarf irregular in Fornax
- The only HI detection seen in projection within the core region (Waugh+2002)
- Infalling for the first time (Mora+2015)
- Chaname+2000: passage through the hot ICM likely scenario to explain the morphological properties of NGC 1427A




Lee-Waddell+2018



# The pieces of the puzzle

Peculiar arrow shape, two tails: stars and gaseous

- Gaseous tail

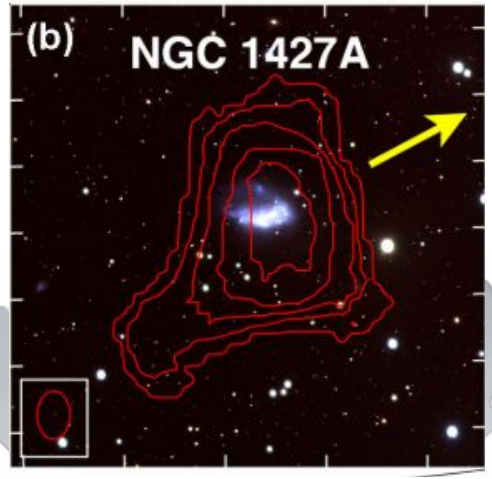
- South east gas elongation

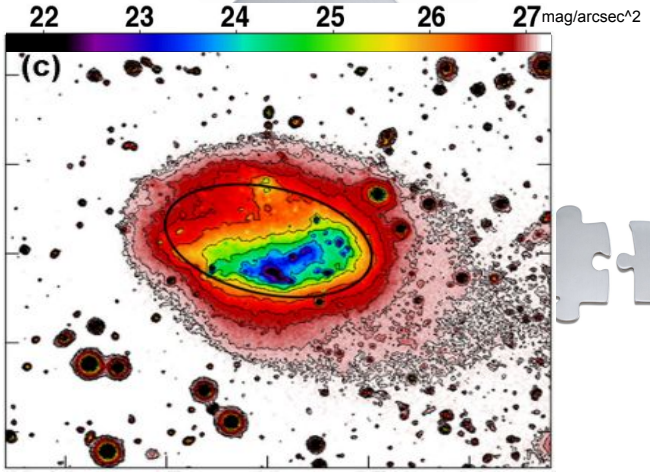
- Stellar tail pointing westward

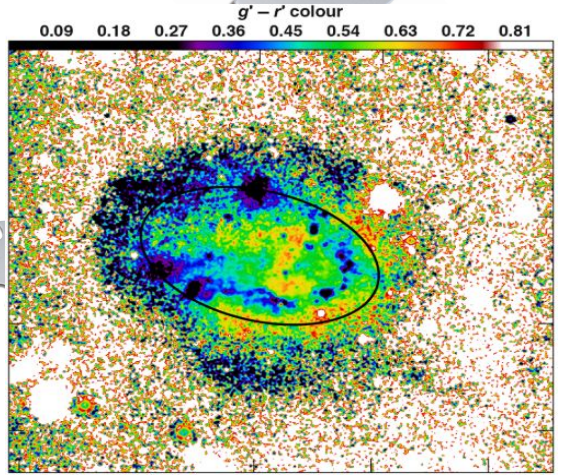
- Northern object: is it a remnant of a past interaction?

- Color: bluer part eastward

- Heavily star forming




Lee-Waddell+2018, HI map, *r'*-band, and color

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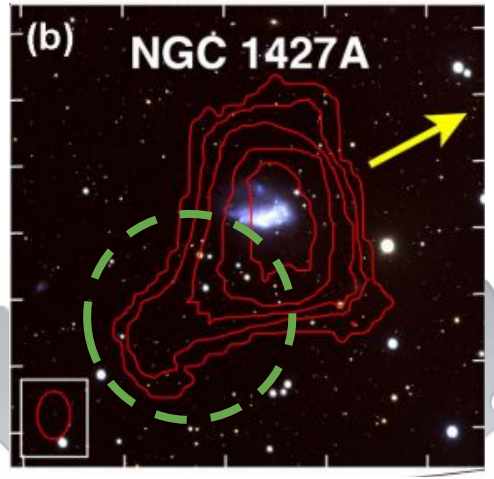
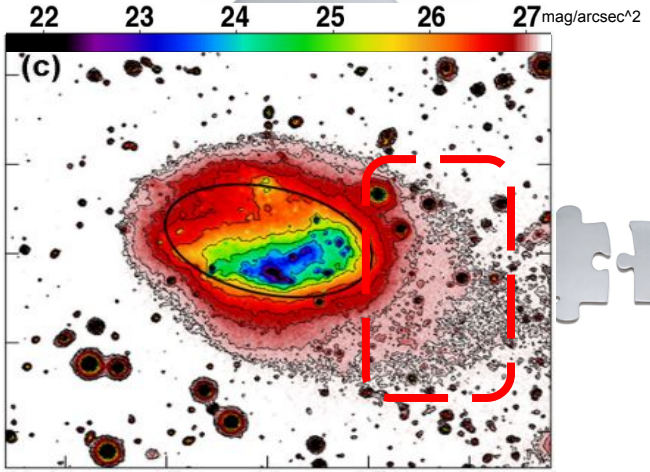
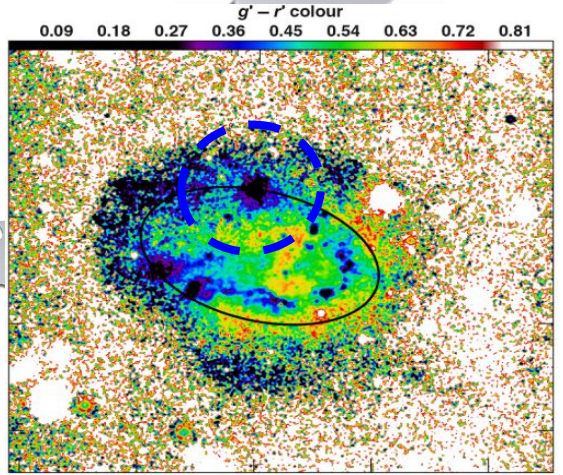



Lee-Waddell+2018, HI map, *r'*-band, and color

# Insights from simulations

**What we noticed:**

- Simulations on radial orbits show intriguing stellar and gaseous tails geometry when dwarfs undergo ram pressure stripping near pericenter

**To get deeper insights we selected a stage based on:**

- Presence of a gaseous tail *and* a stellar tail
- Clustercentric projected distance and recessional (projected) velocity (ongoing analysis)

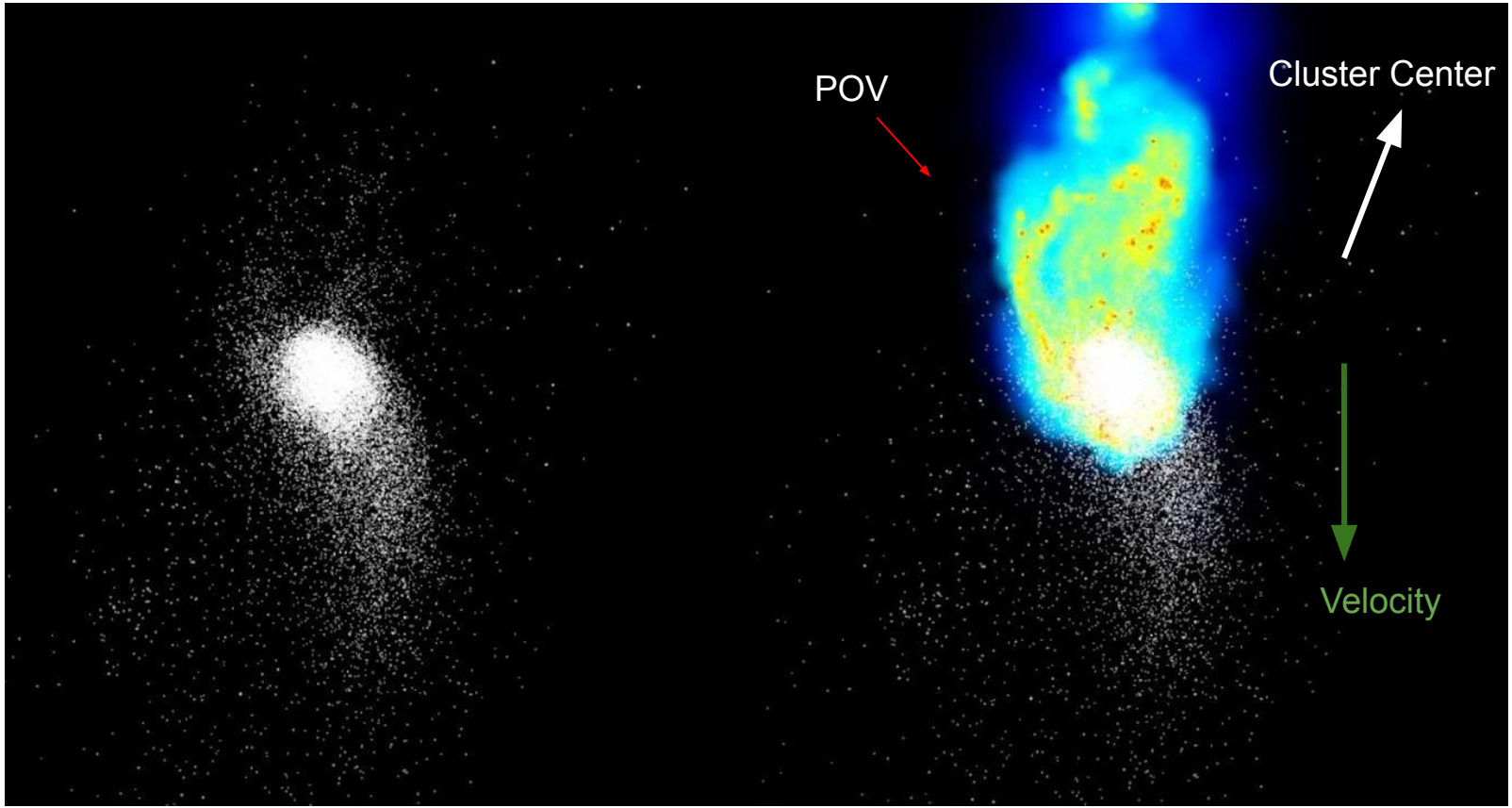
**Selection**: dwarf on 100 kpc pericenter orbit: $M_{*}=1.5 \cdot 10^{8}\ M_{\odot}$, $M_{HI}=6.1 \cdot 10^{8}\ M_{\odot}$

(NGC1427A: $M_{*}=1.1 \cdot 10^{9}\ M_{\odot}$, $M_{HI}=2.1 \cdot 10^{9}\ M_{\odot}$)

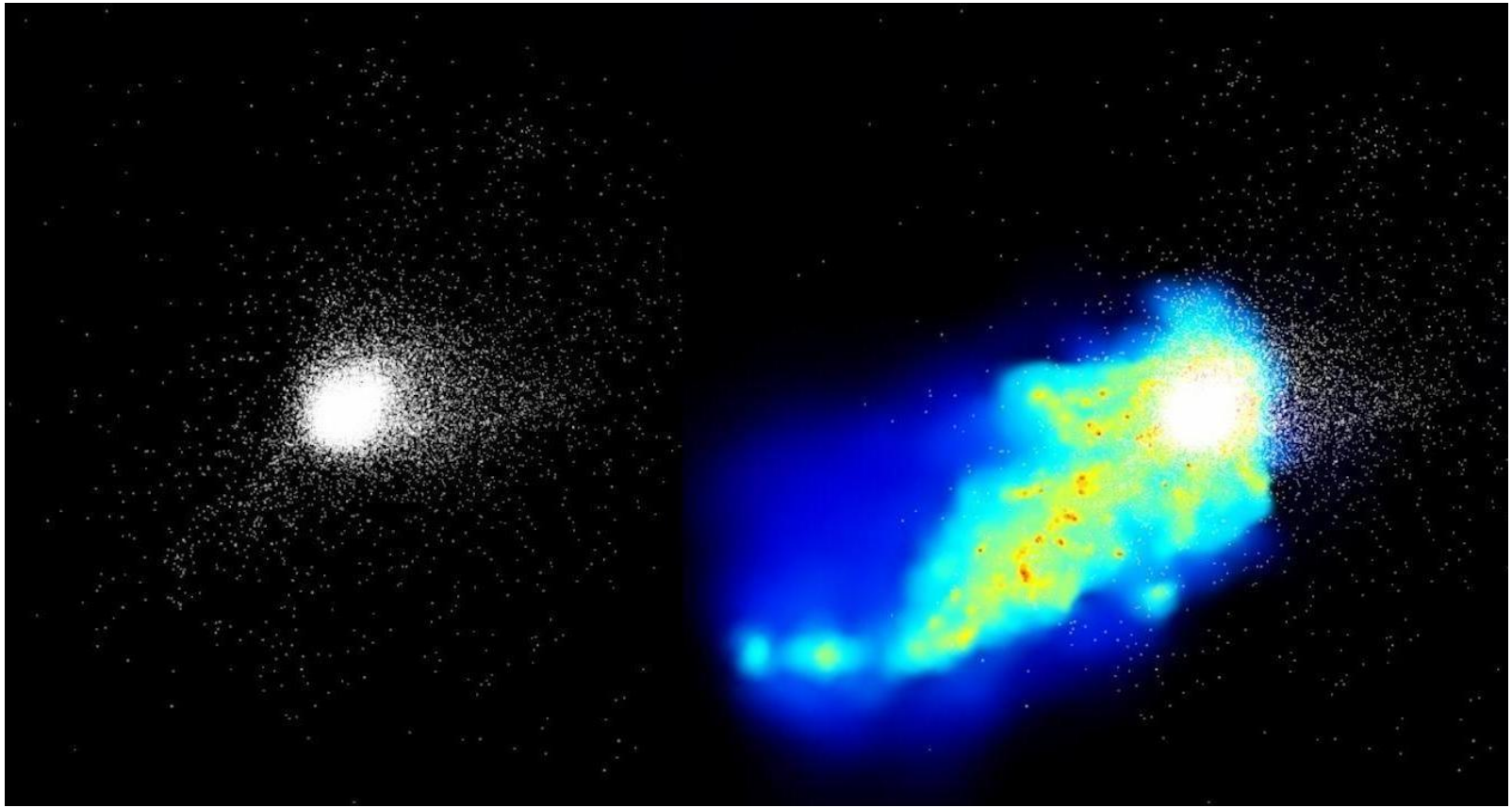
**Caveats:**

- The simulations were not meant to reproduce all details of NGC1427A
- The setup nonetheless proved to be useful to reproduce physical processes which could explain the peculiar shape of NGC1427A

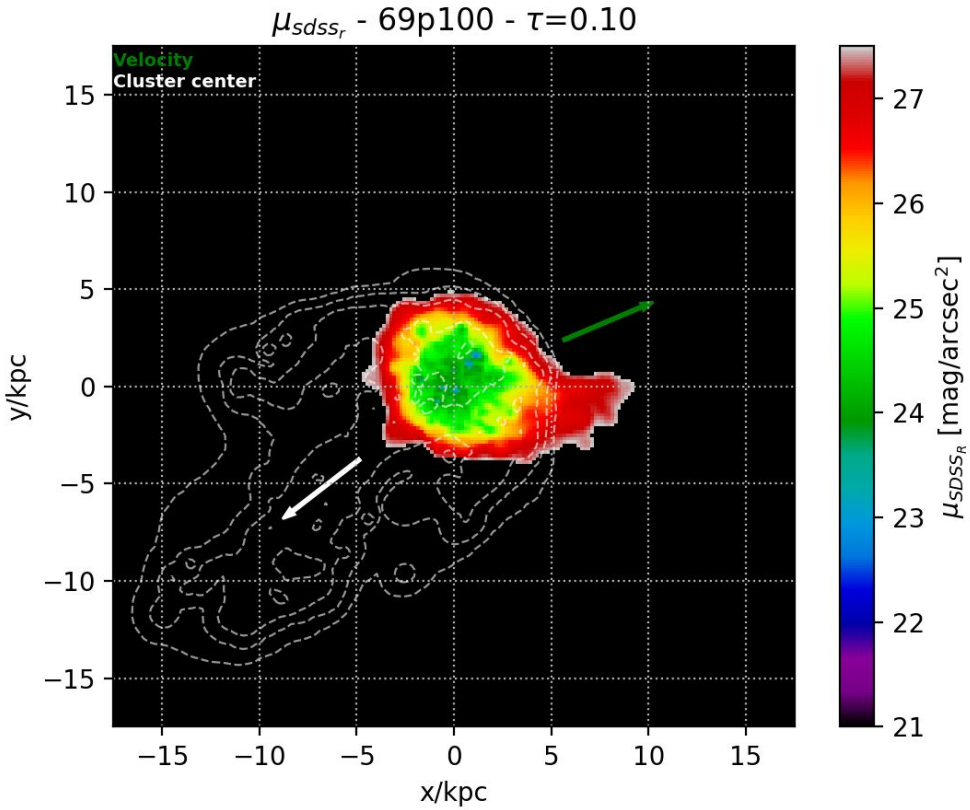
# The two tails

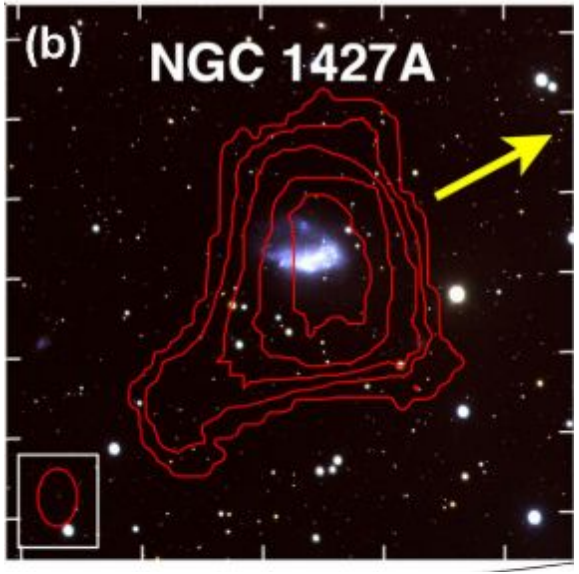


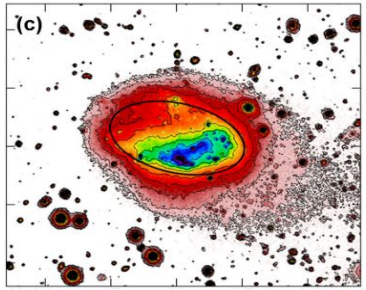
# Point of view



# Surface brightness + HI contours



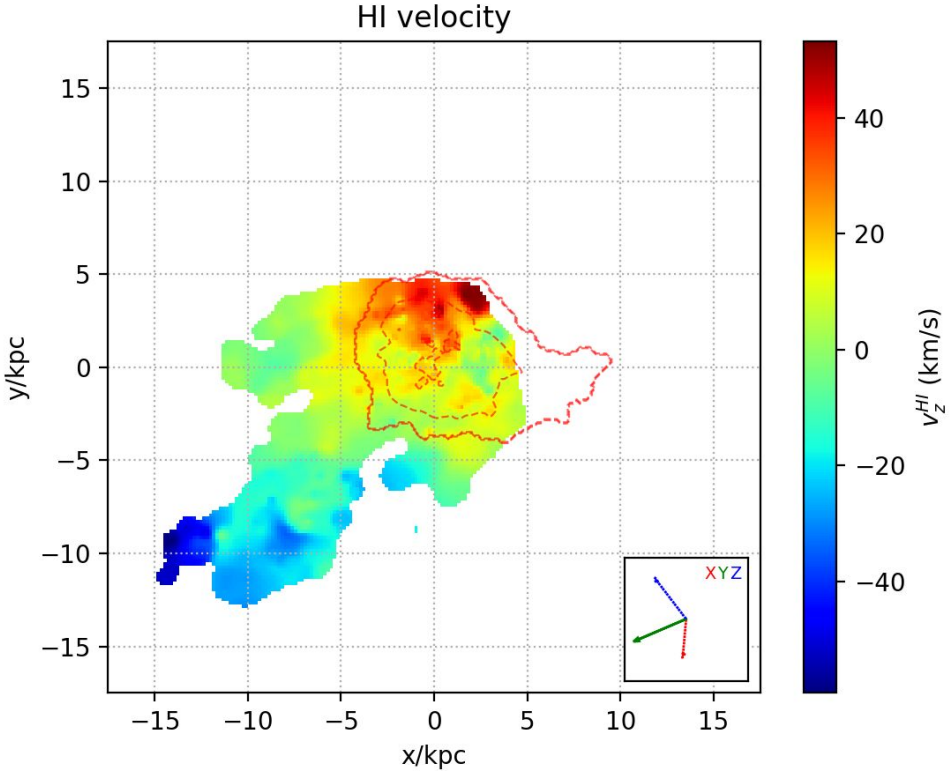



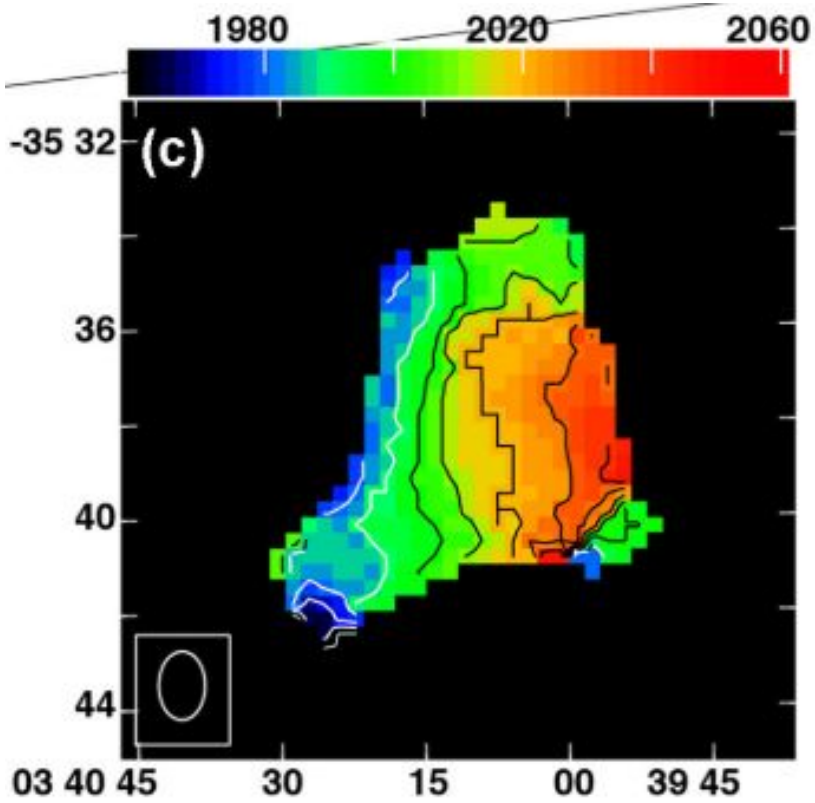




Lee-Waddell+2018, HI map, *r'*-band photometry

# HI Kinematics

@Fornax distance (20 Mpc): 1 kpc = 10''



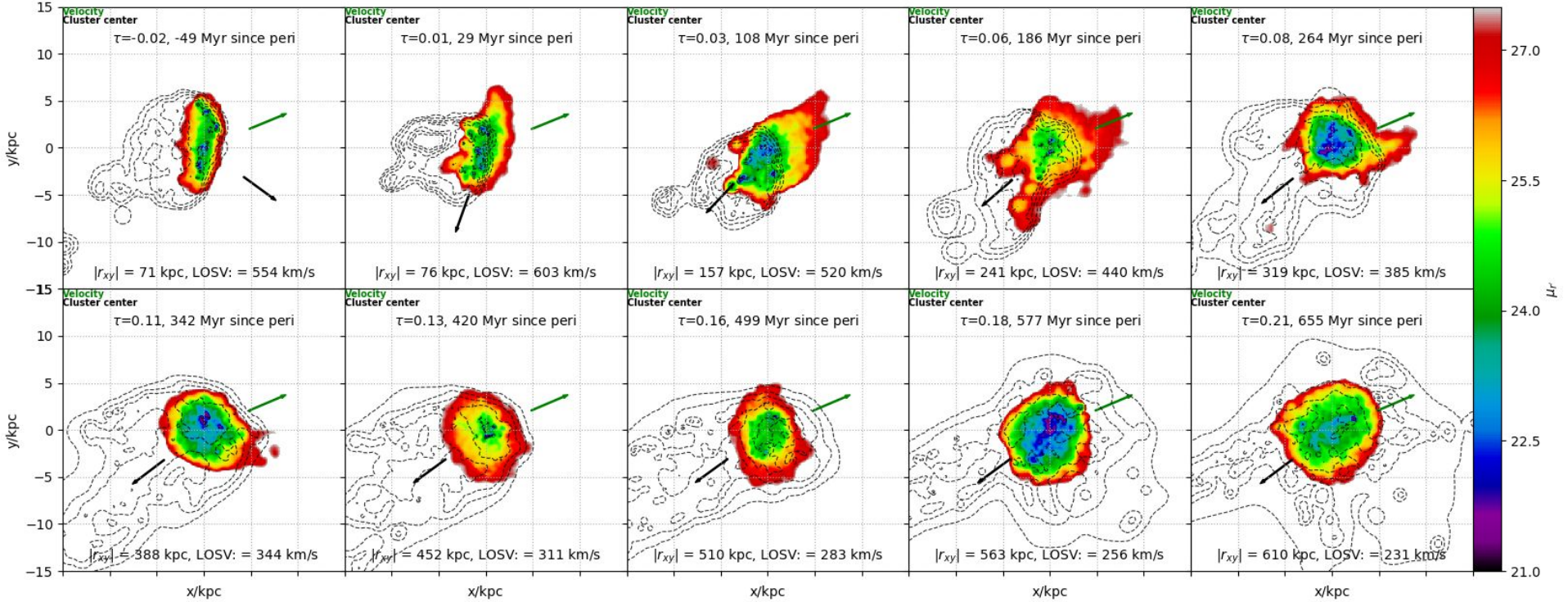

Lee-Waddell+2018, HI velocity map

# How long do these tails last?

NGC1427A
Projected clustercentric distance: 137 kpc (1373")
Velocity w.r.t. the cluster center (NGC1399): 693 km/s

$\tau = (t-t_p)/T_r$

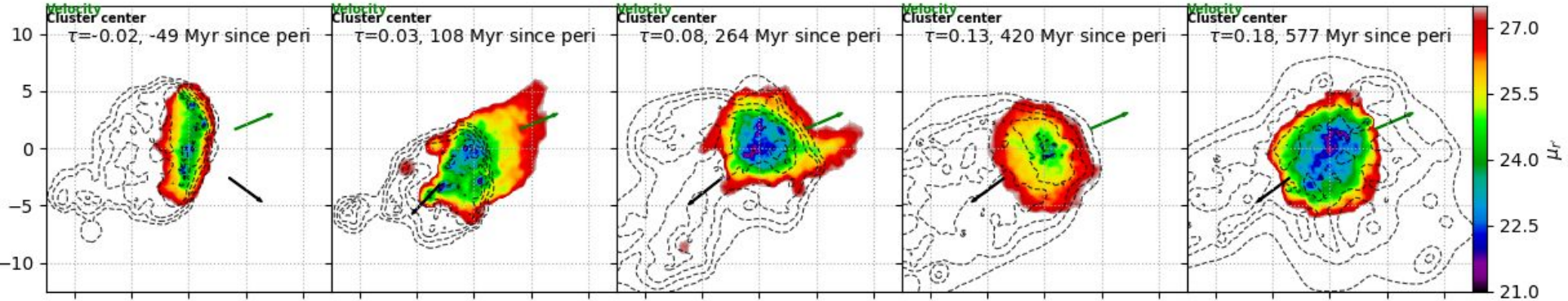
Surface brightness



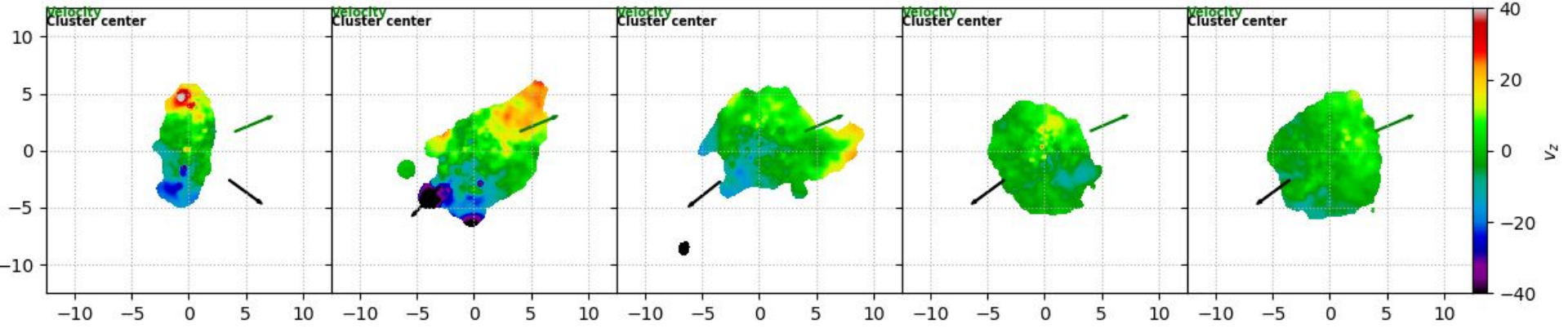

Even with pretty deep photometry (27.5 mag/arcsec), after ~350 Myr after peri, the tail is not there anymore.
High velocity passage in a steep potential → asymmetric tidal tails.

# How long do these tails last? - Kinematics

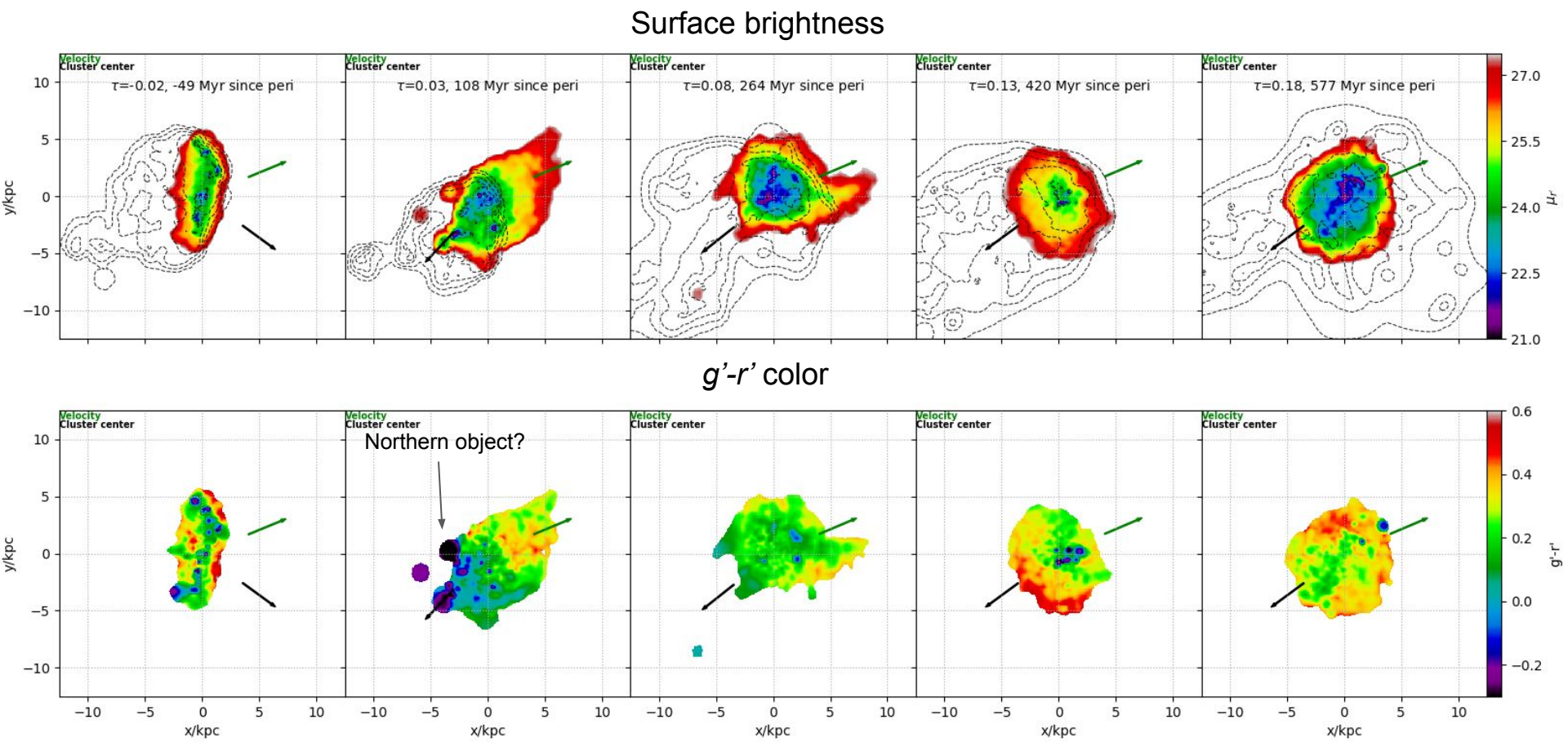
Surface brightness




Stellar kinematics

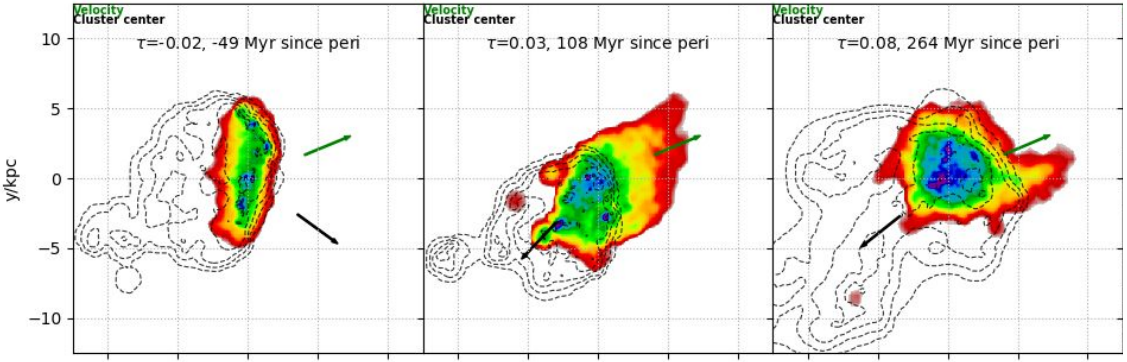


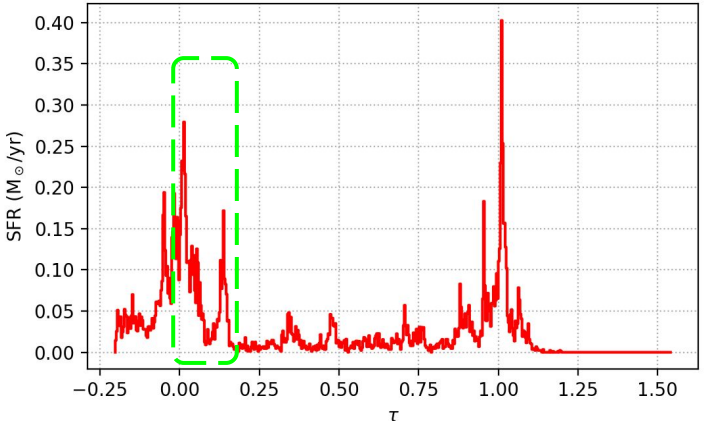
# How long do these tails last? - Color



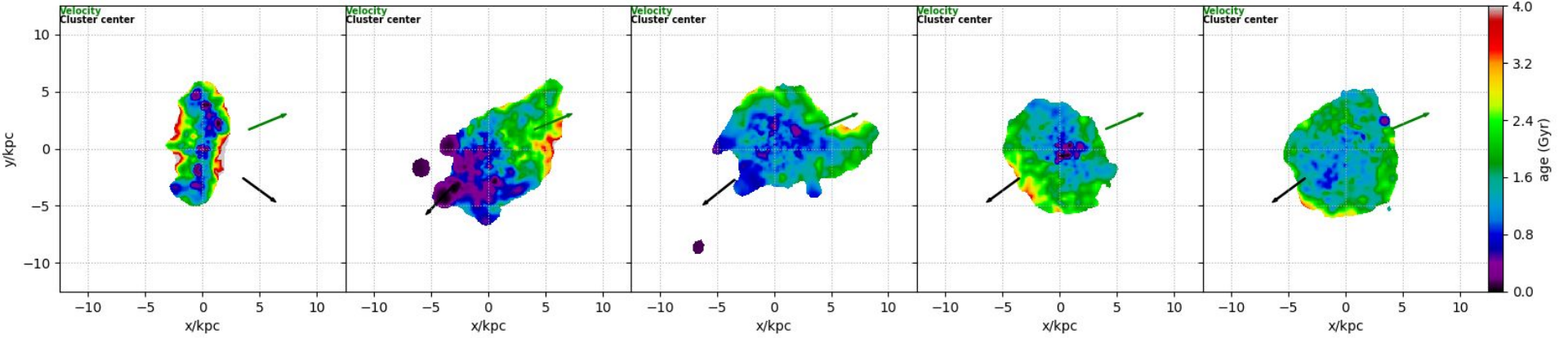
# How long do these tails last? - Stellar age

Surface brightness




Age



# Low dimensional manifold extraction

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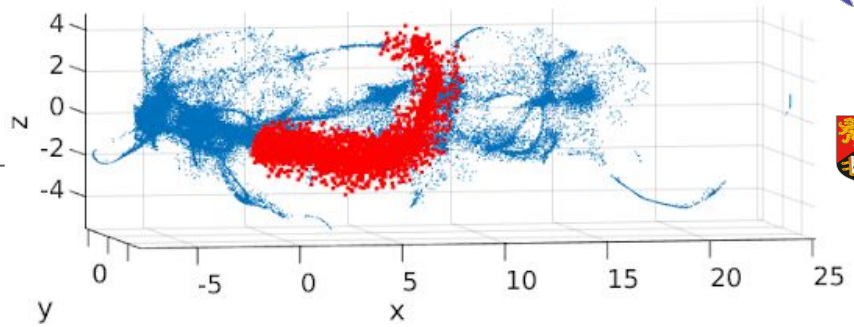
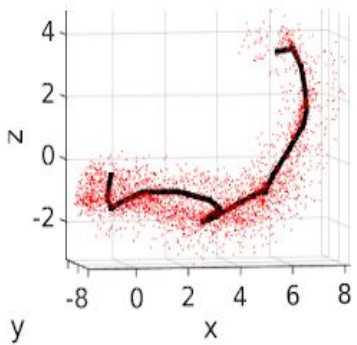
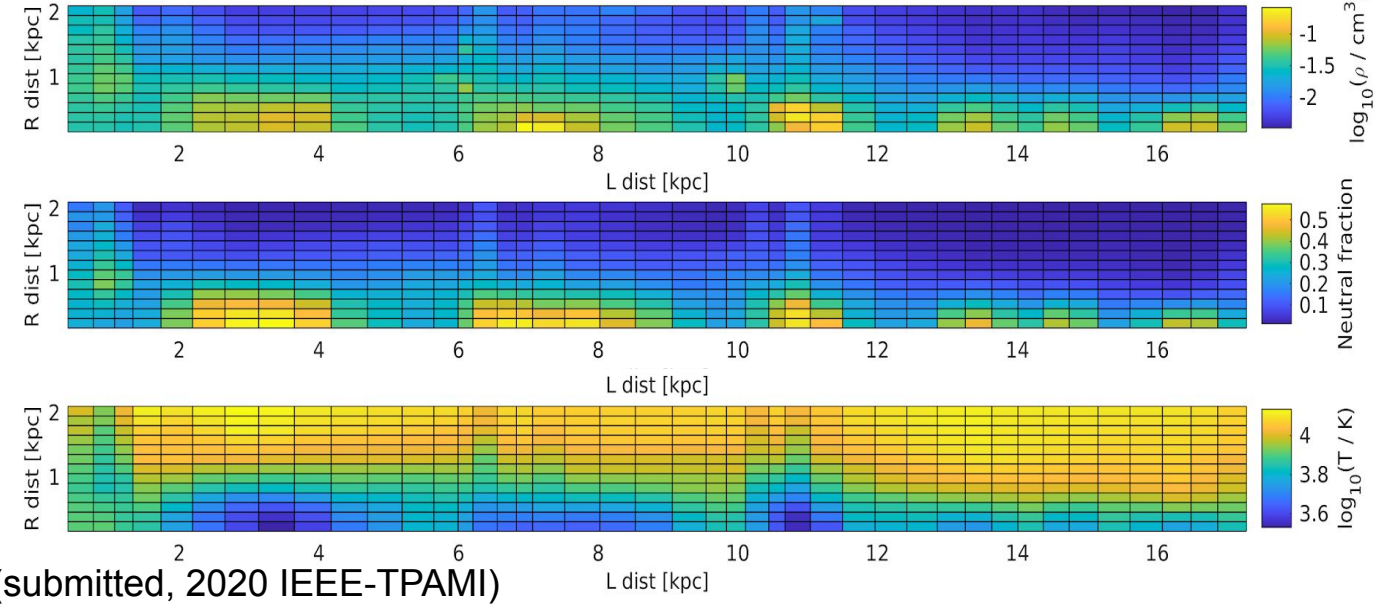
Abstract Generative Topographic Mapping (AGTM)

Data




Model

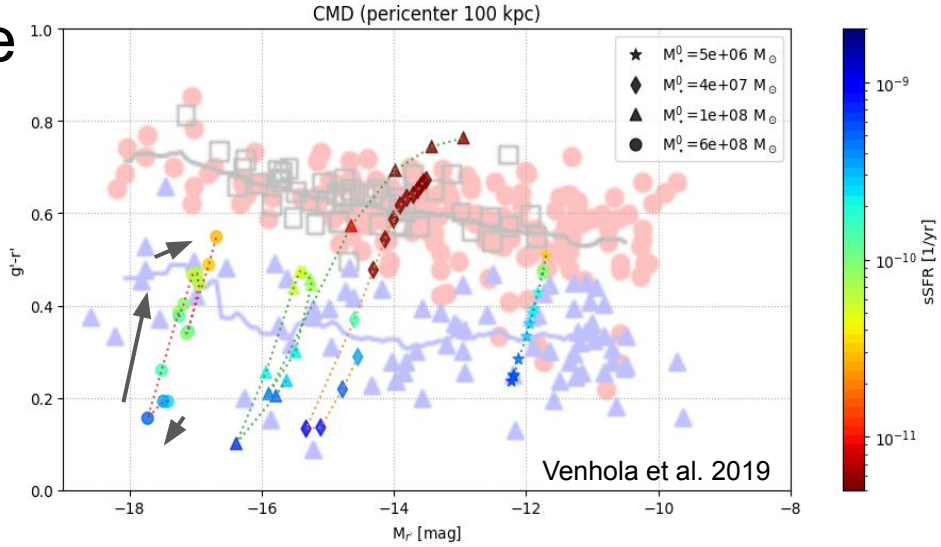


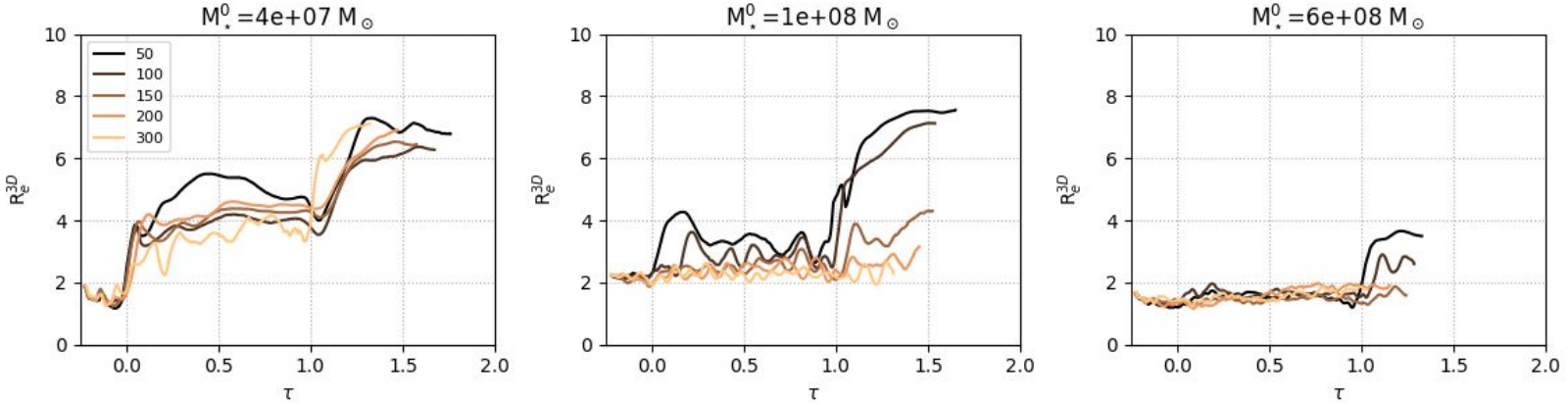




Canducci, Tiňo, Mastropietro (submitted, 2020 IEEE-TPAMI)

# Color magnitude diagram & size

- Late-type to early type conversion visible on color magnitude diagram
- Injection of energy due to pericenter passages → dwarf size increases (transient UDG phase)



# Conclusions

**Insights from simulations:**

- Infall burst and quenching, and late to early type conversion. (Mastropietro et al. in prep.)

**Jellyfish:**

- A tail not aligned with the galaxy orbital velocity can form a couple of hundreds Myr after pericentre passage. Stellar clumps are common when stripping is at play → The “Northern object” fits in this scenario.

- The combination of ram pressure and tidal stripping can produce peculiar geometry similar to the one of the jellyfish NGC1427A.

- Study simulated properties in elongated manifold of the jellyfish.

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