Universidad de La Laguna

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Stellar populations of thick disks in Milky Way-mass galaxies: observations from the GECKOS survey and simulations

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MINISTERIO DE CIENCIA E INNOVACIÓN

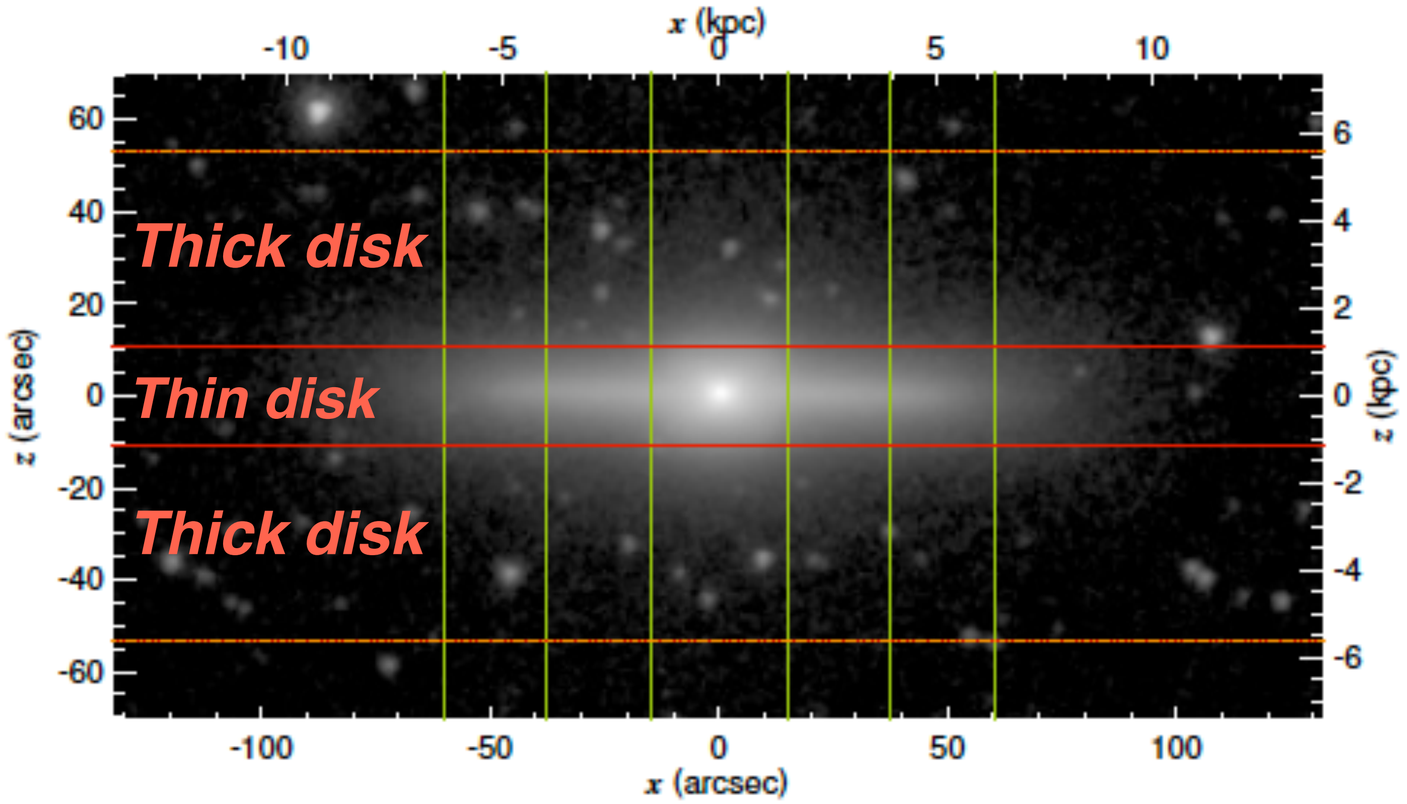
AGENCIA ESTATAL DE INVESTIGACIÓN

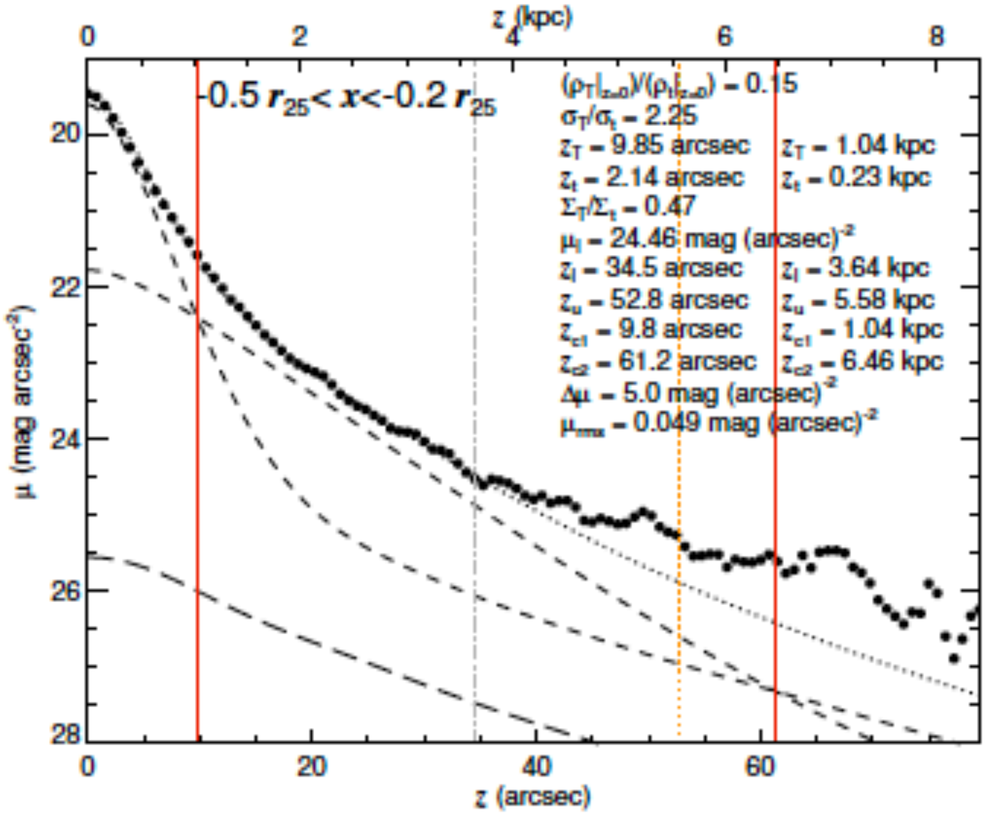
Thick disks in external galaxies

Edge-on external galaxies

Geometric definition

(morphological decomposition)





(Comerón et al., 2018)

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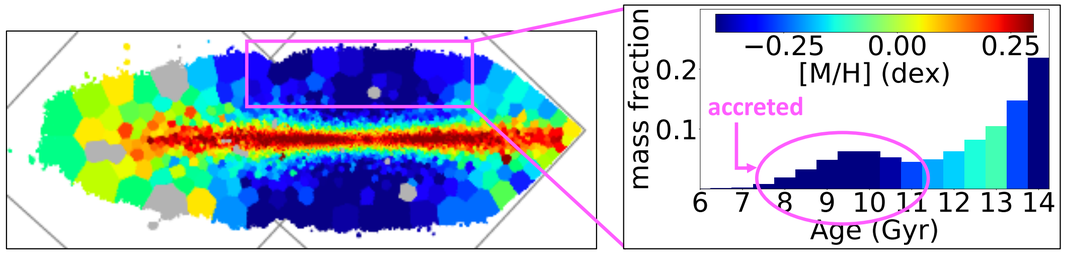
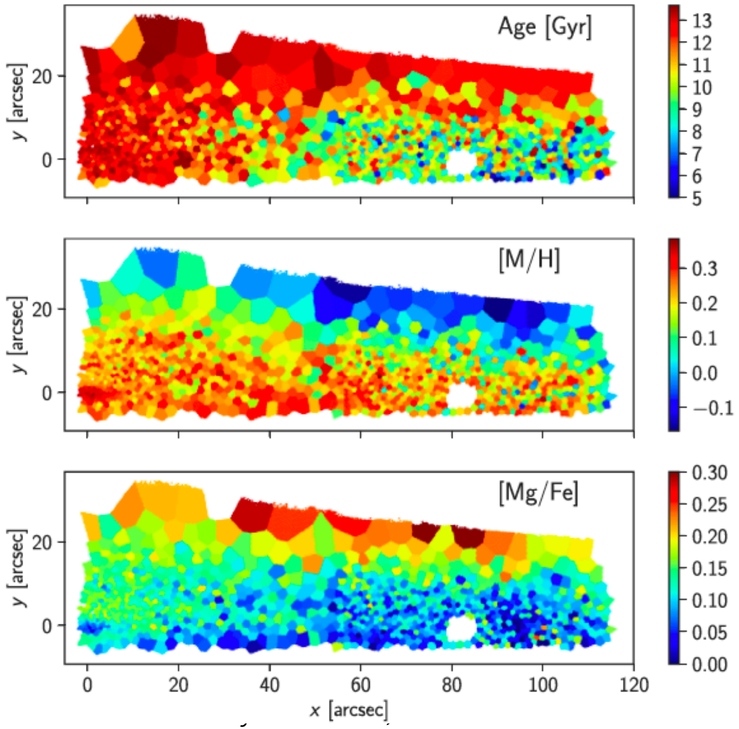
Thick disks in external galaxies

- Hints of diversity from previous IFU studies (Comerón+2015,2016,2019; Pinna+2019a,b; Martig,Pinna et al. 2021; Sattler, Pinna et al. 2023, 2024)

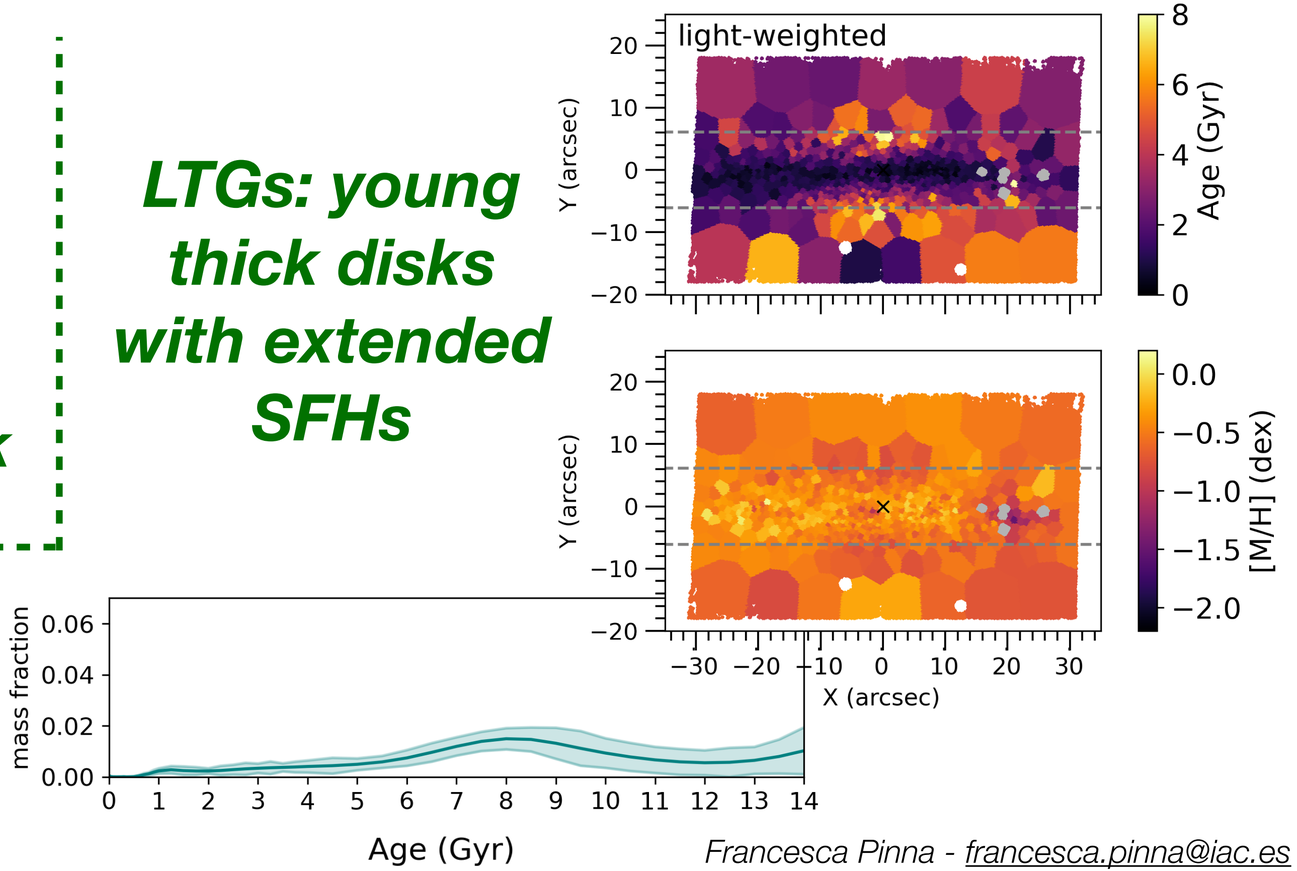




ETGs (S0/Sb): clear pattern - old, metal-poor, α-enhanced thick disk

+ young(er) metal-rich thin disk

LTGs: young thick disks with extended SFHs



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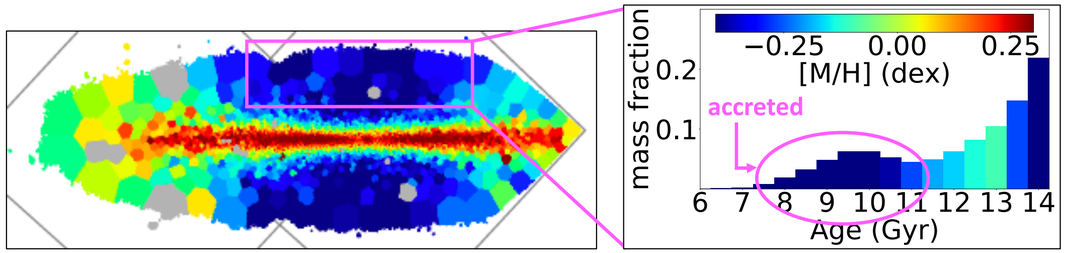

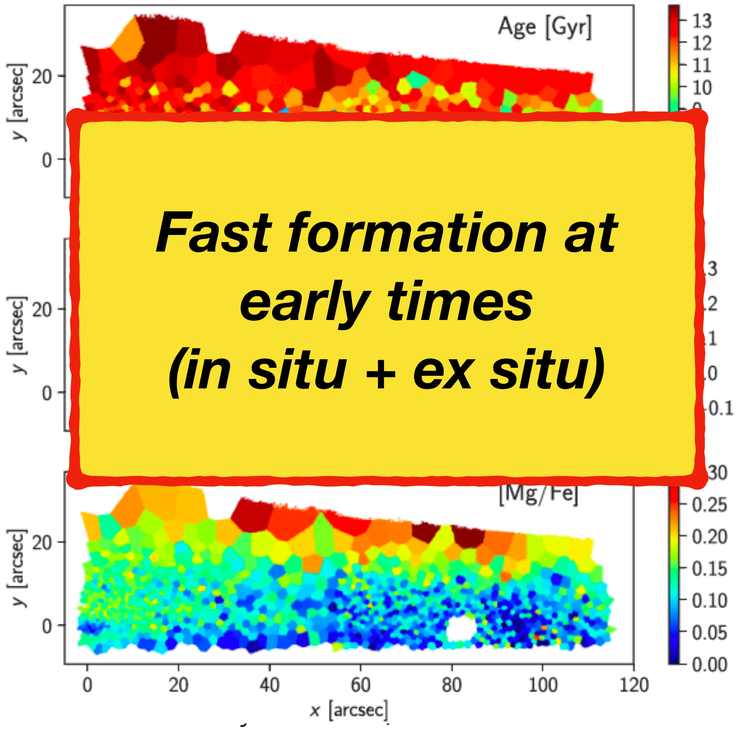

Fast formation at early times (in situ + ex situ)

ETGs (S0/Sb): clear pattern - old, metal-poor, α-enhanced thick disk

+ young(er) metal-rich thin disk

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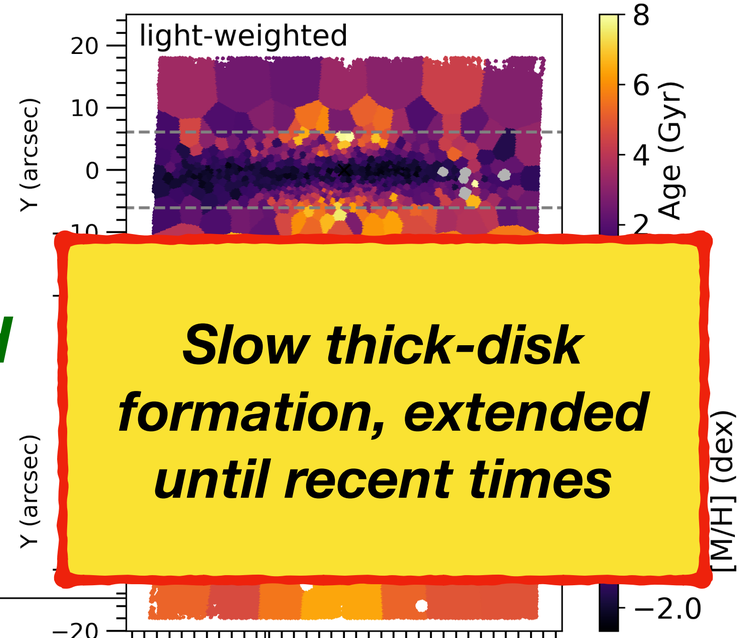
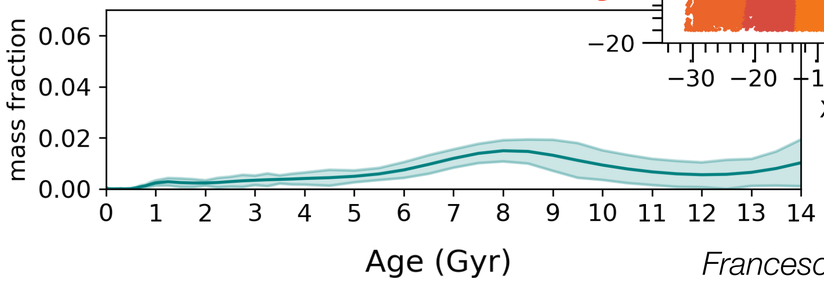


Slow thick-disk formation, extended until recent times



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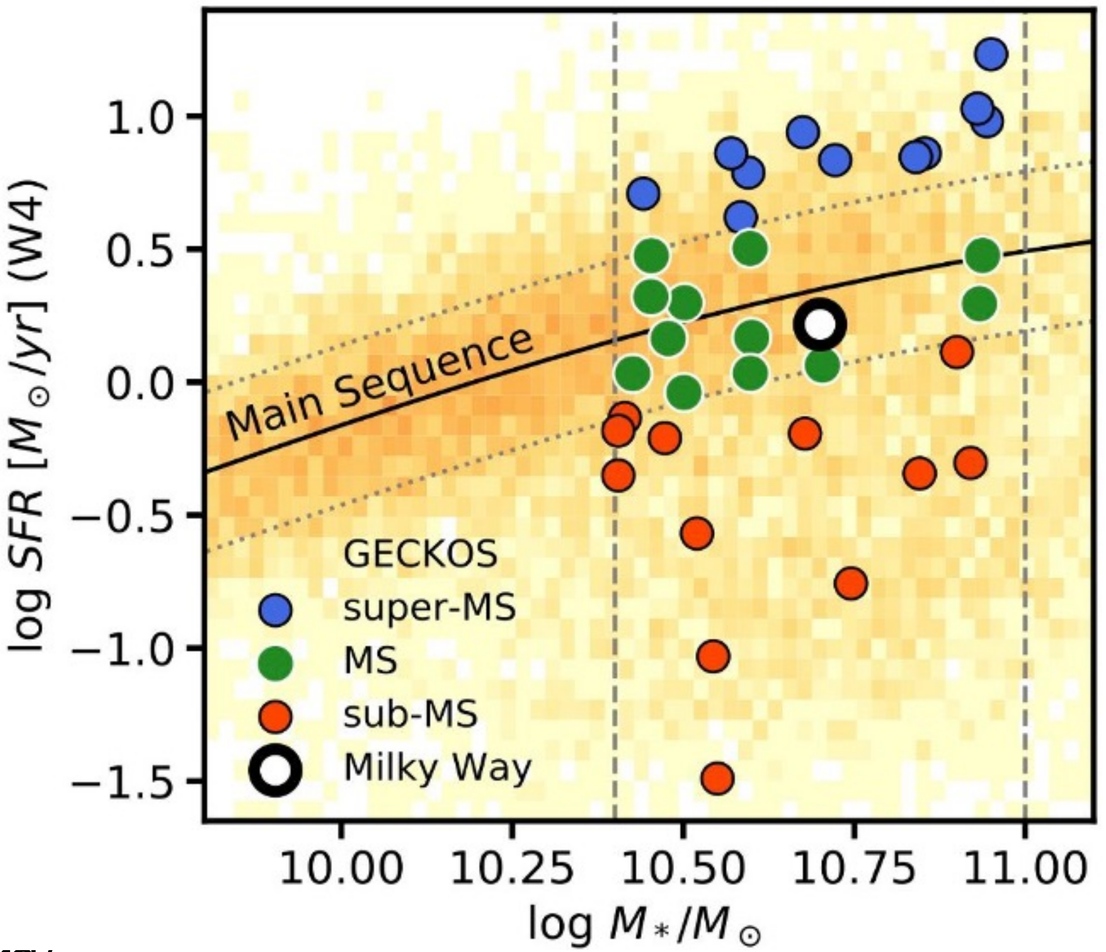
The GECKOS survey

GECKOS: Generalising **E**dge-on galaxies and their **C**hemical bimodalities, **K**inematics, and **O**utflows out to **S**olar environments

An ESO VLT/MUSE Large Program

- 317 hours of VLT/MUSE
- 35 edge-on **MW-mass** galaxies at D < 70 Mpc, variety of SFRs
- Better than 200pc spatial resolution out to solar environments
- Deep MUSE data - S/N = 40 at surface brightness 23.5 mag/arcsec^2



http://geckos-survey.org/

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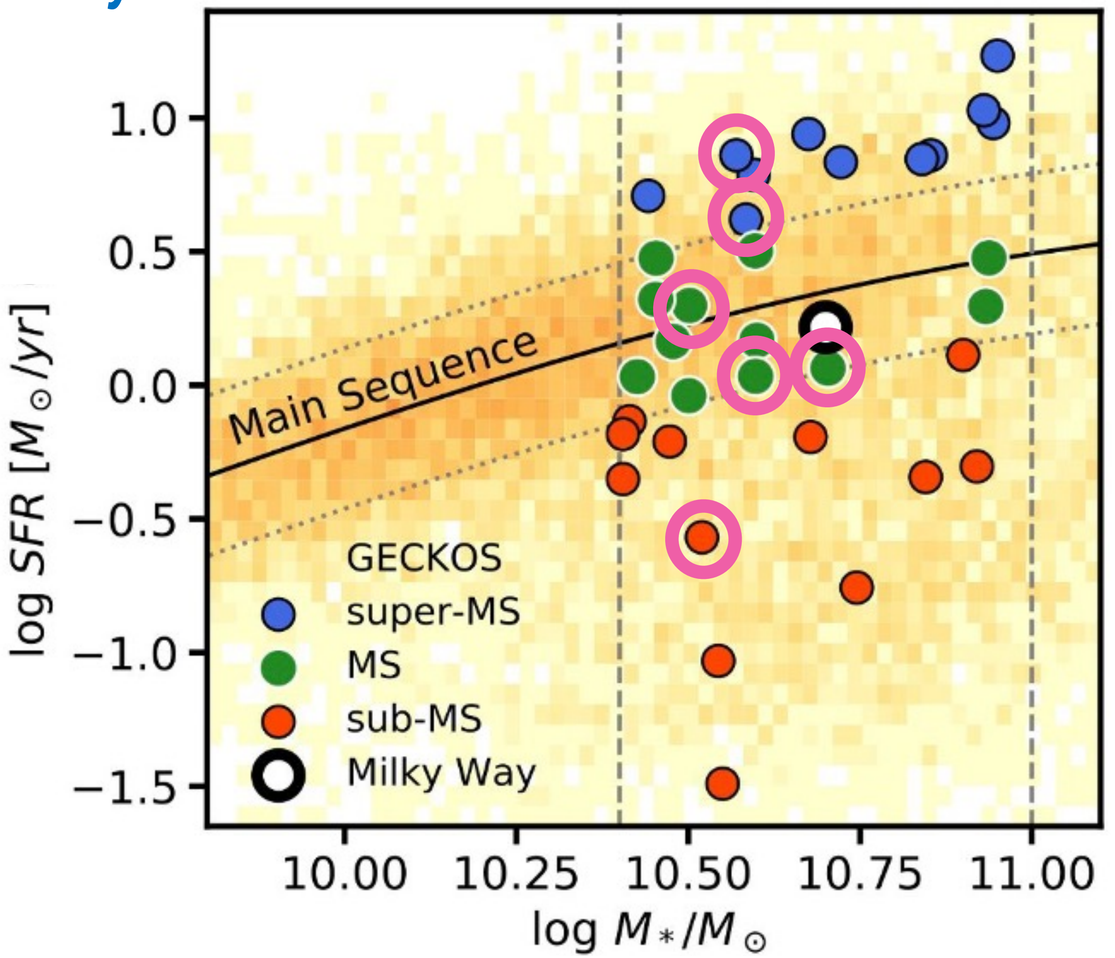
Stellar populations in GECKOS: uncovering the origin of thick disks

- Subsample of 6 galaxies with clearly distinct thick and thin disks

nGIST

(Fraser-McKelvie et al., subm.)
An updated version of the modular GIST DA pipeline (Bittner et al. 2019)

- Voronoi binning (Cappellari & Copin 2003)
- **Stellar populations from full spectrum fitting (pPXF - Cappellari & Emsellem 2004)**
- **sMILES SSP models (Knowles et al. 2023)**



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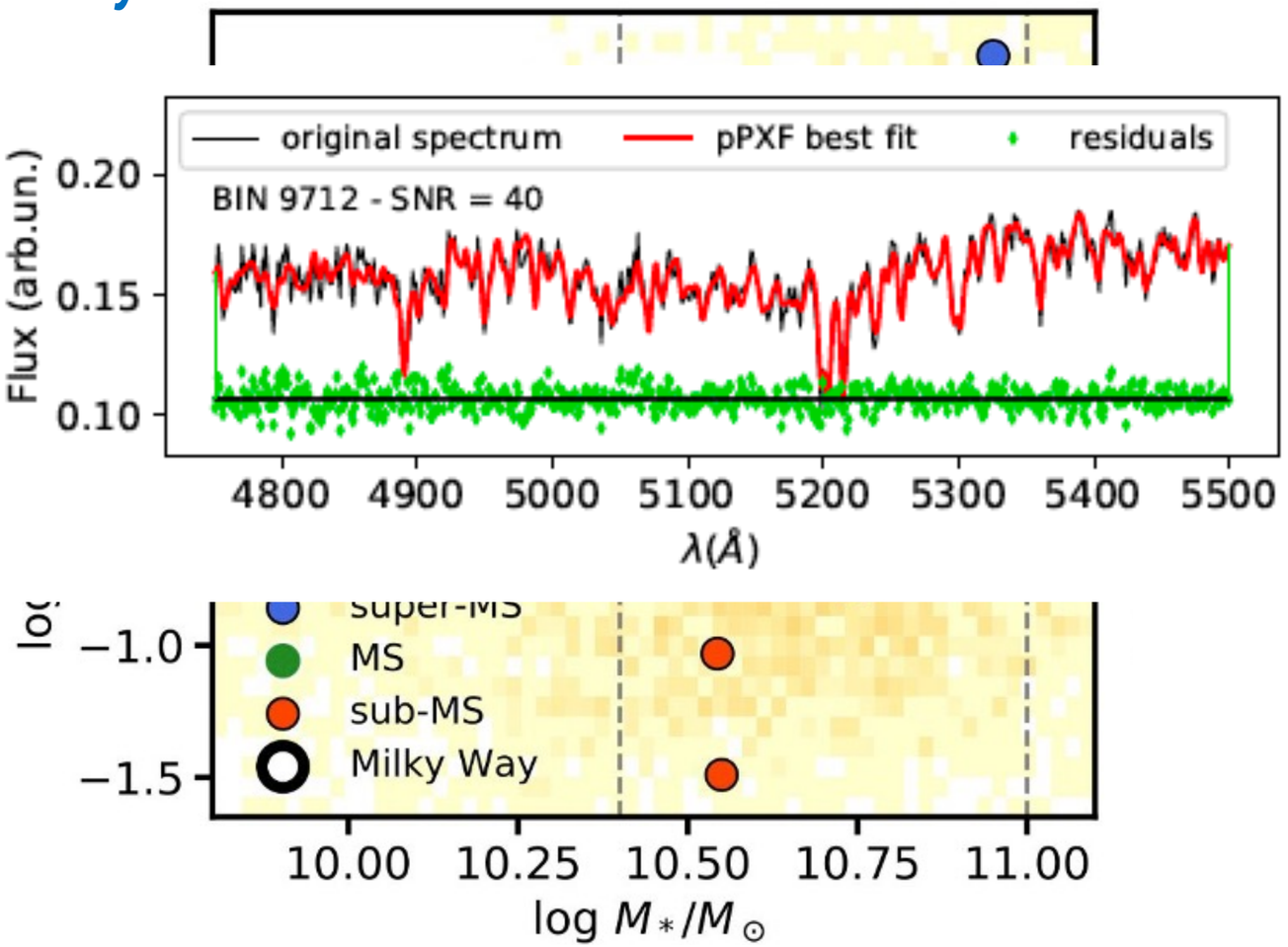

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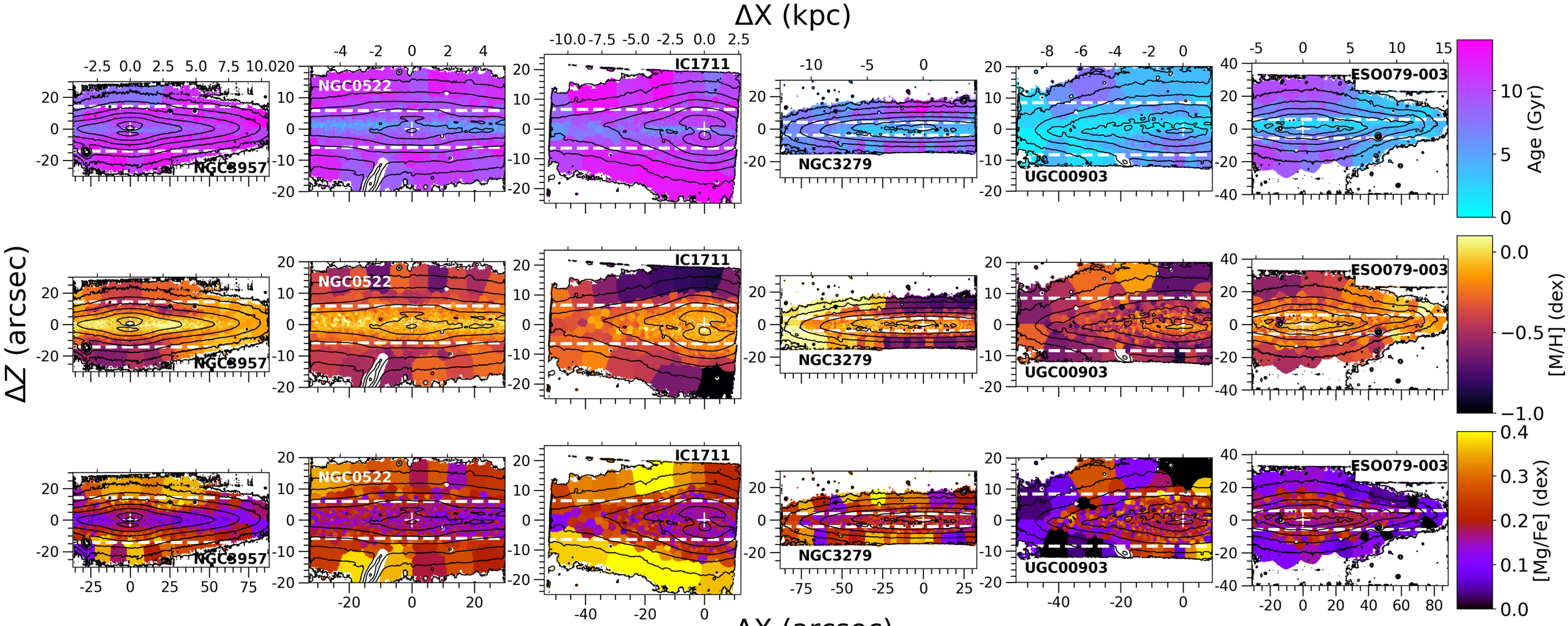
Stellar populations: the origin of thick disks



SFR

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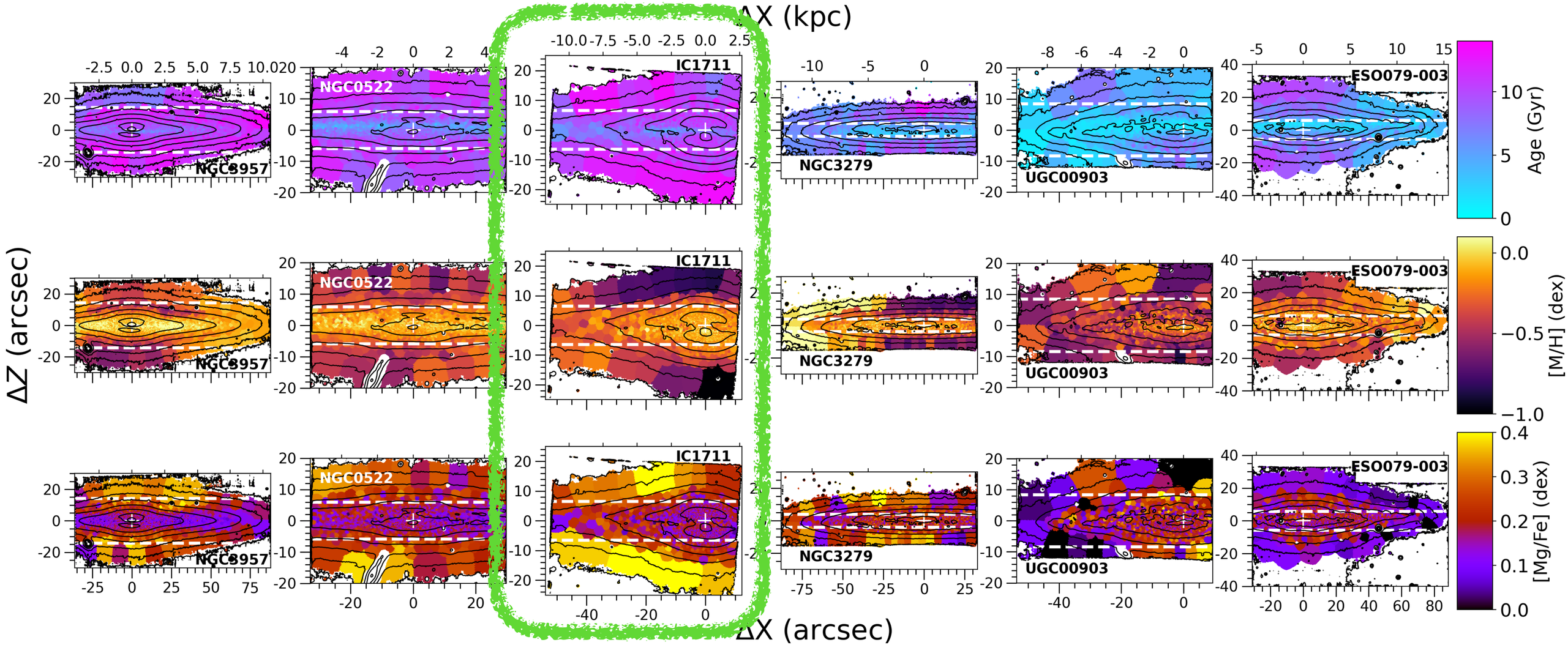
Stellar populations: the origin of thick disks



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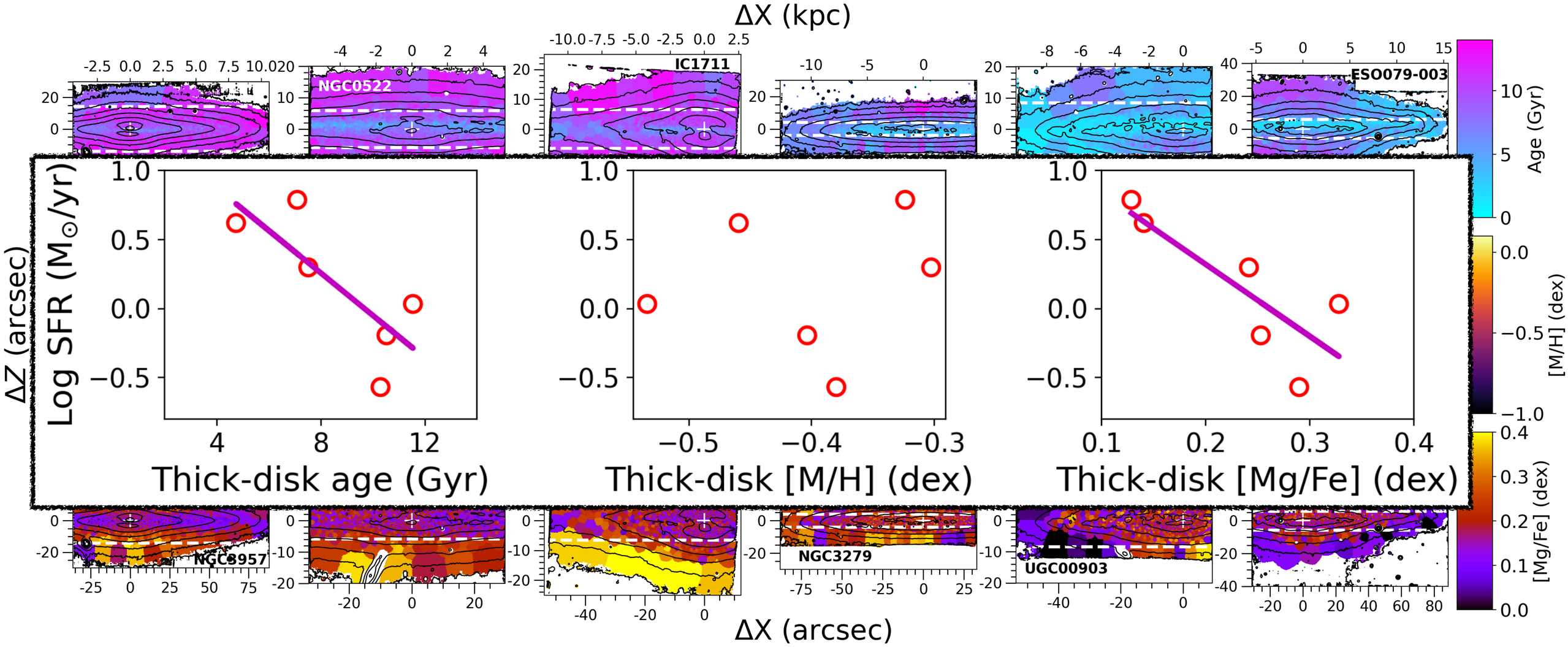

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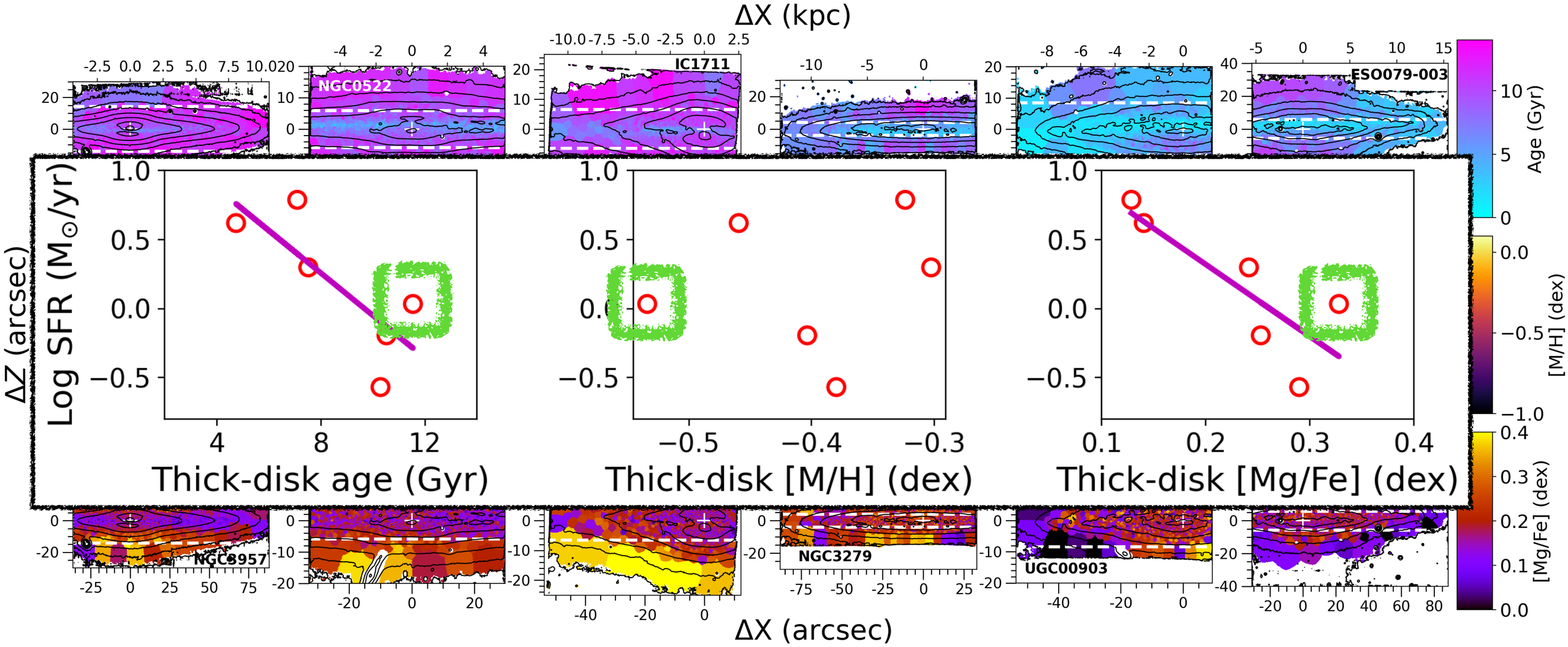

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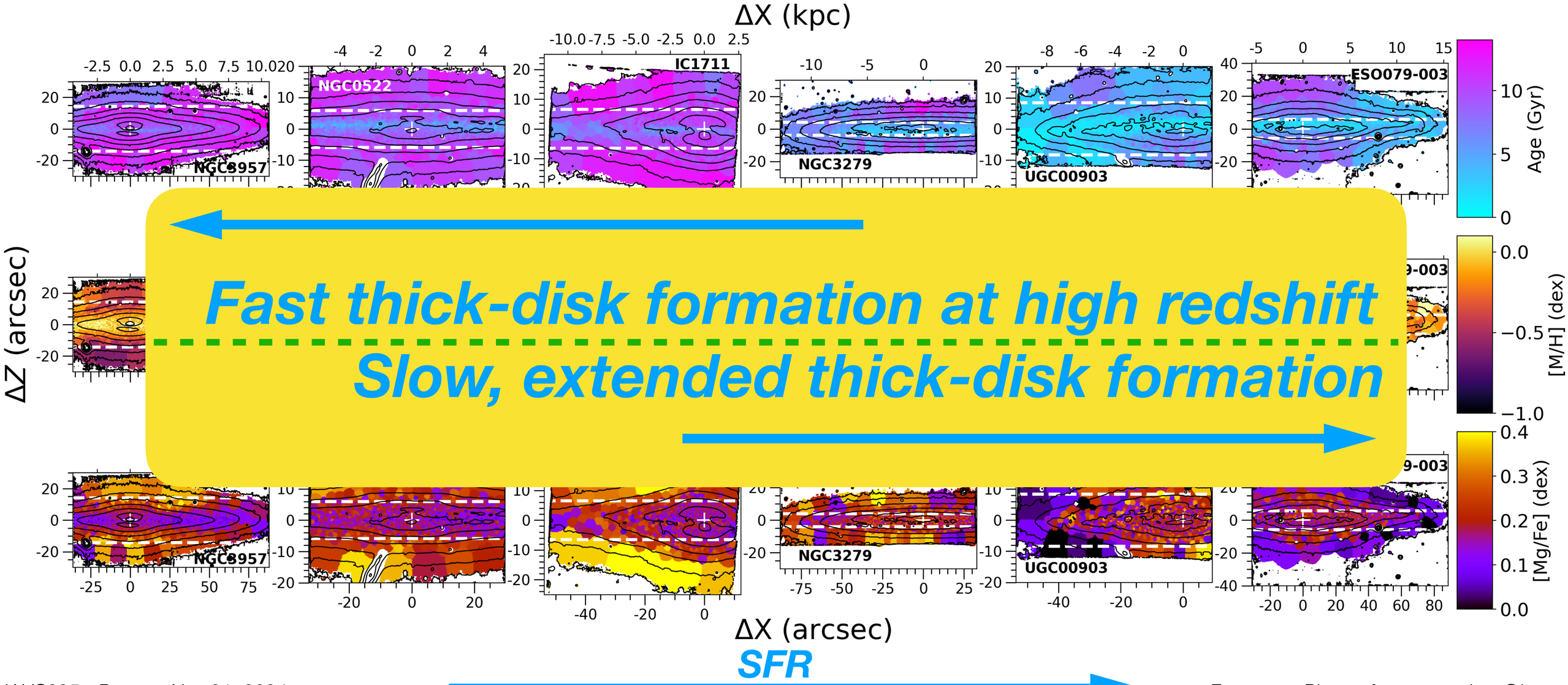

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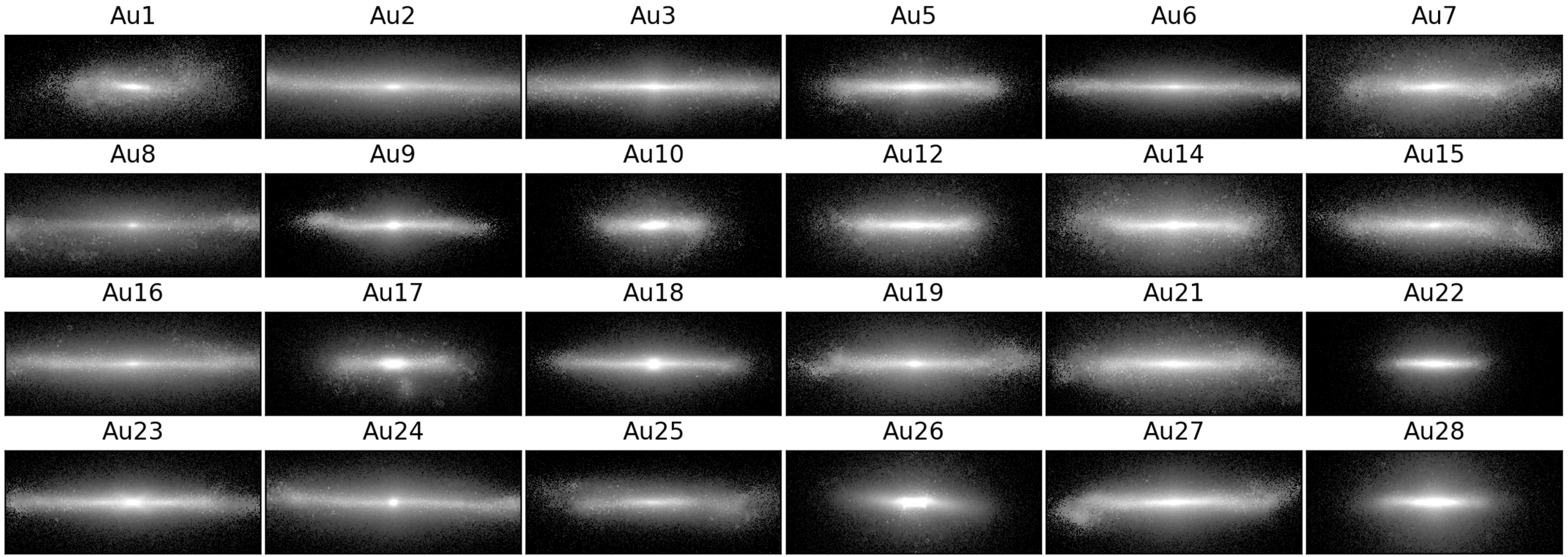
Thick disks in simulated MW-mass galaxies

AURIGA: Zoom-in cosmological simulations
Sample of 24 galaxies

- Milky Way-mass ~10^{10} - 10^{11} $M_\odot$
- “Isolated” spirals

- “Similar” approach to observations: Edge-on projection, Voronoi binning



(Pinna et al., 2024a)

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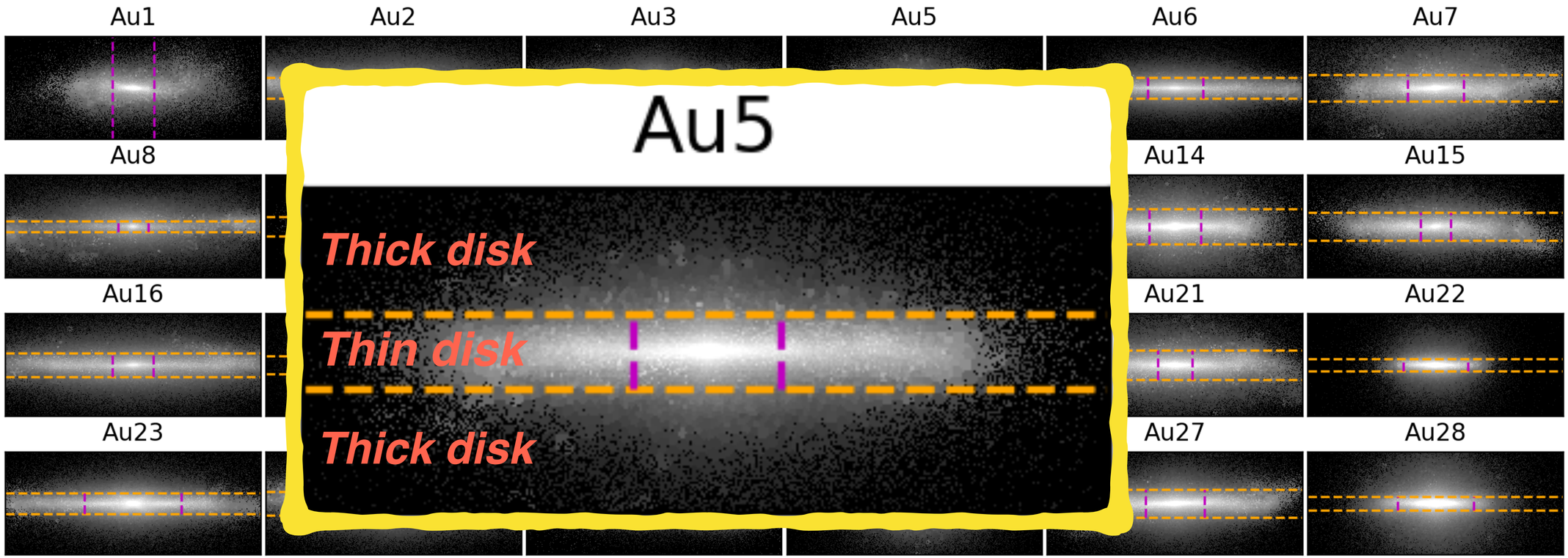
Thin and thick disks in AURIGA

Geometrical/morphological decomposition into thin and thick disks

- Vertical surface brightness profiles



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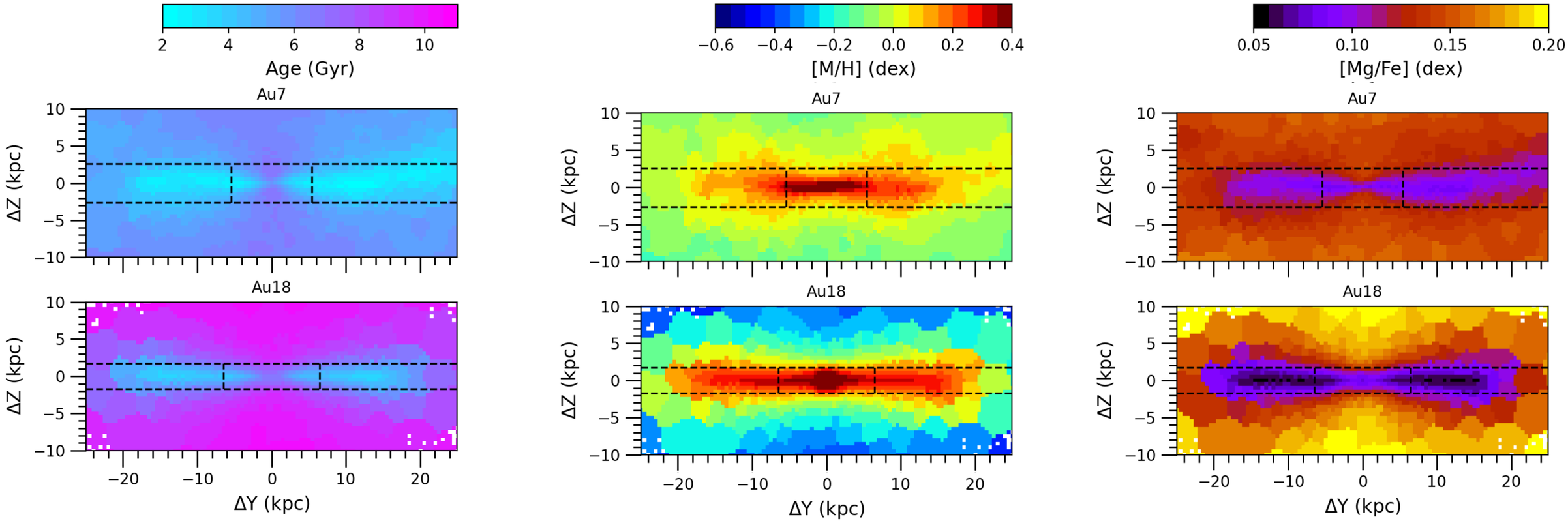
AURIGA: Stellar-population edge-on mock maps



(Pinna et al., 2024a)

Why these differences?

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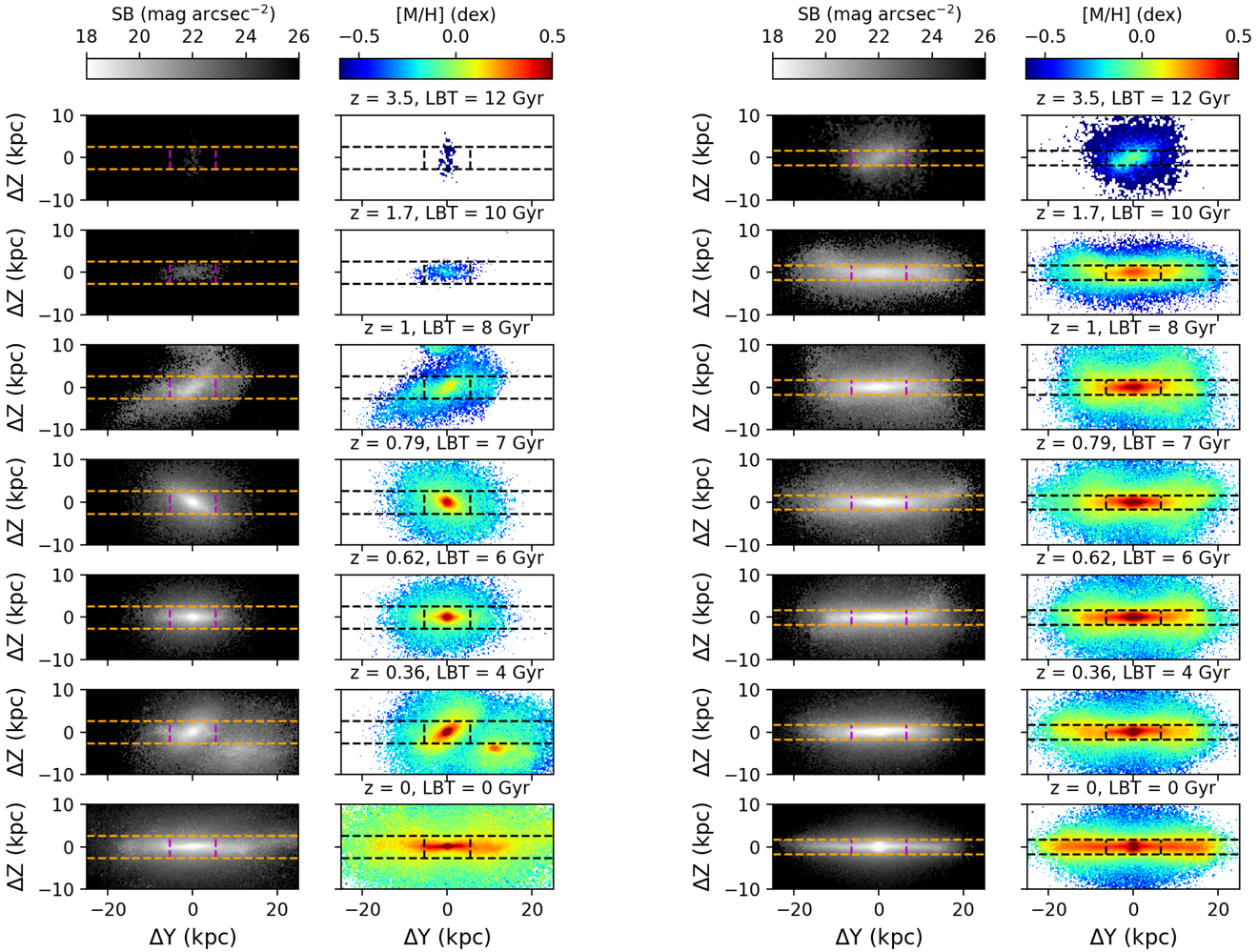
Time evolution

Au7

- Thick structure (rotation)
- Merger
- Late thin disk formation



Au18

- Thin and thick structures

(Pinna et al., 2024a)

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Time evolution

Au7

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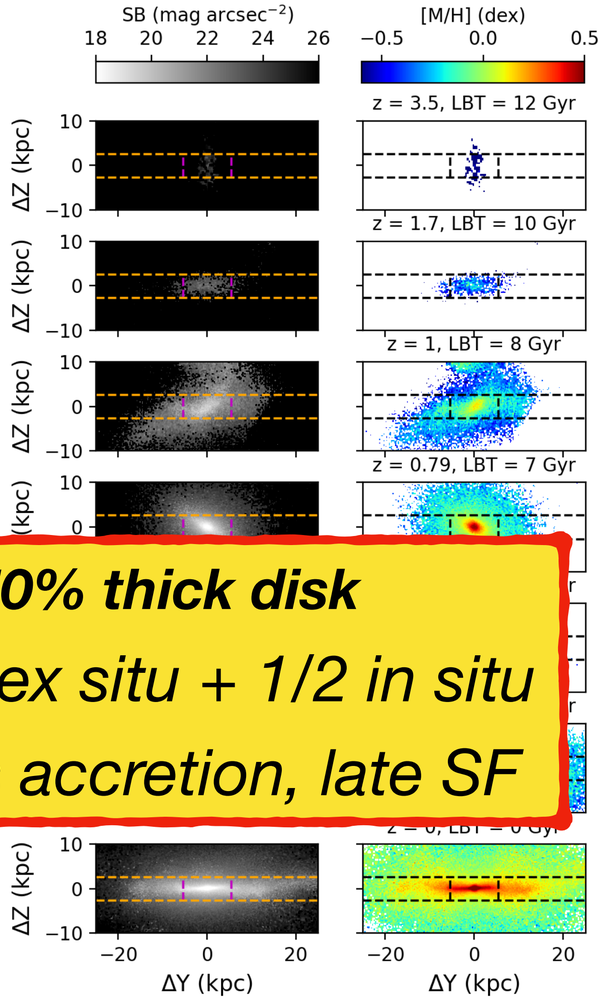


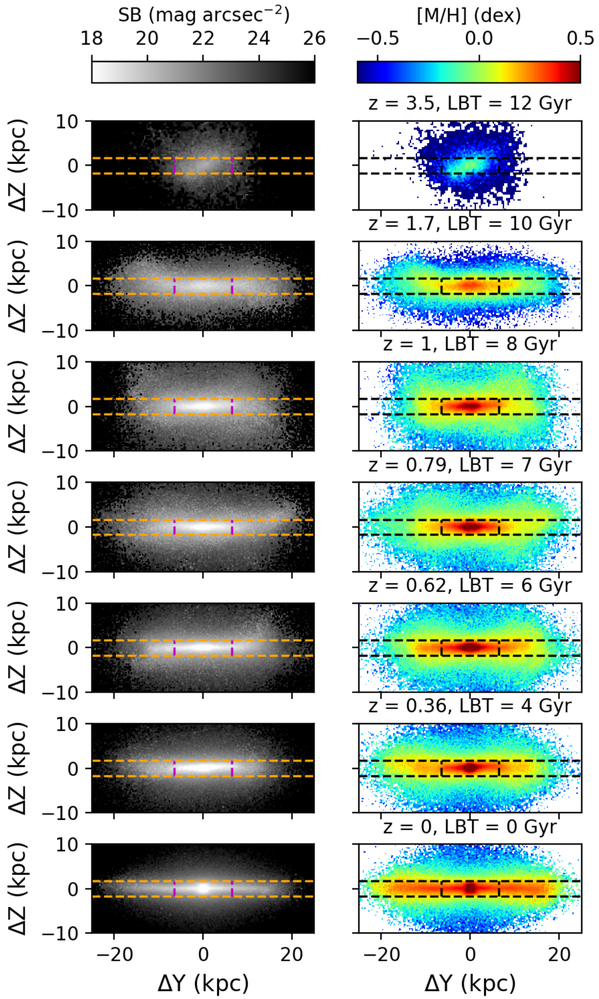
50% thick disk

1/2 ex situ + 1/2 in situ

gas accretion, late SF

Au18

- Thin and thick structures



7% thick disk is accreted

in-situ thick disk

(Pinna et al., 2024a)

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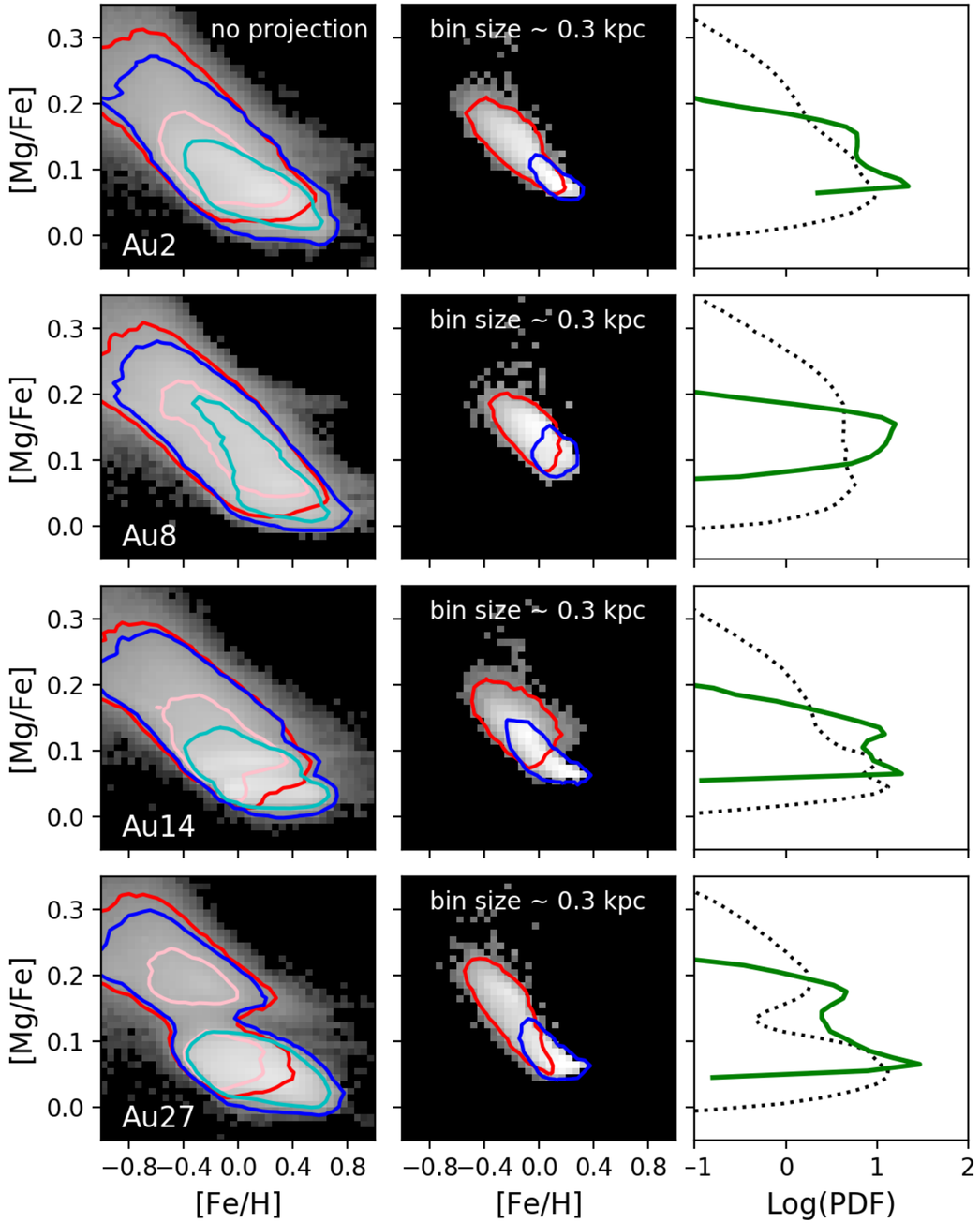
AURIGA: Do geometric thick and thin disks show chemical bimodality?

- Chemical bimodality is not ubiquitous and can be found in different shapes

- Thick and thin disks are not traced by different sequences of star particles.
- Voronoi bins in thick and thin disks often correspond to two peaks in the [Mg/Fe] - [Fe/H] distribution.



(Pinna et al., 2024b)

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Take-home messages

1. Thick disks are complex and result from the interplay of different (internal and external) processes
   - *First in-situ formation + later growth:*
     - *In-situ SF (+accreted gas)*
     - *Ex-situ important component*

2. Thick disks are diverse: different in different MW-mass galaxies

Not all thick disks are old!!

   - *Strongly SF galaxies have "young" thick disks with extended SFHs*

3. Different formation histories:

- *SFR ↓ - early, fast formation*
- *SFR ↑ - slow, extended formation with prominent in-situ recent component*

THANK YOU VERY MUCH!

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