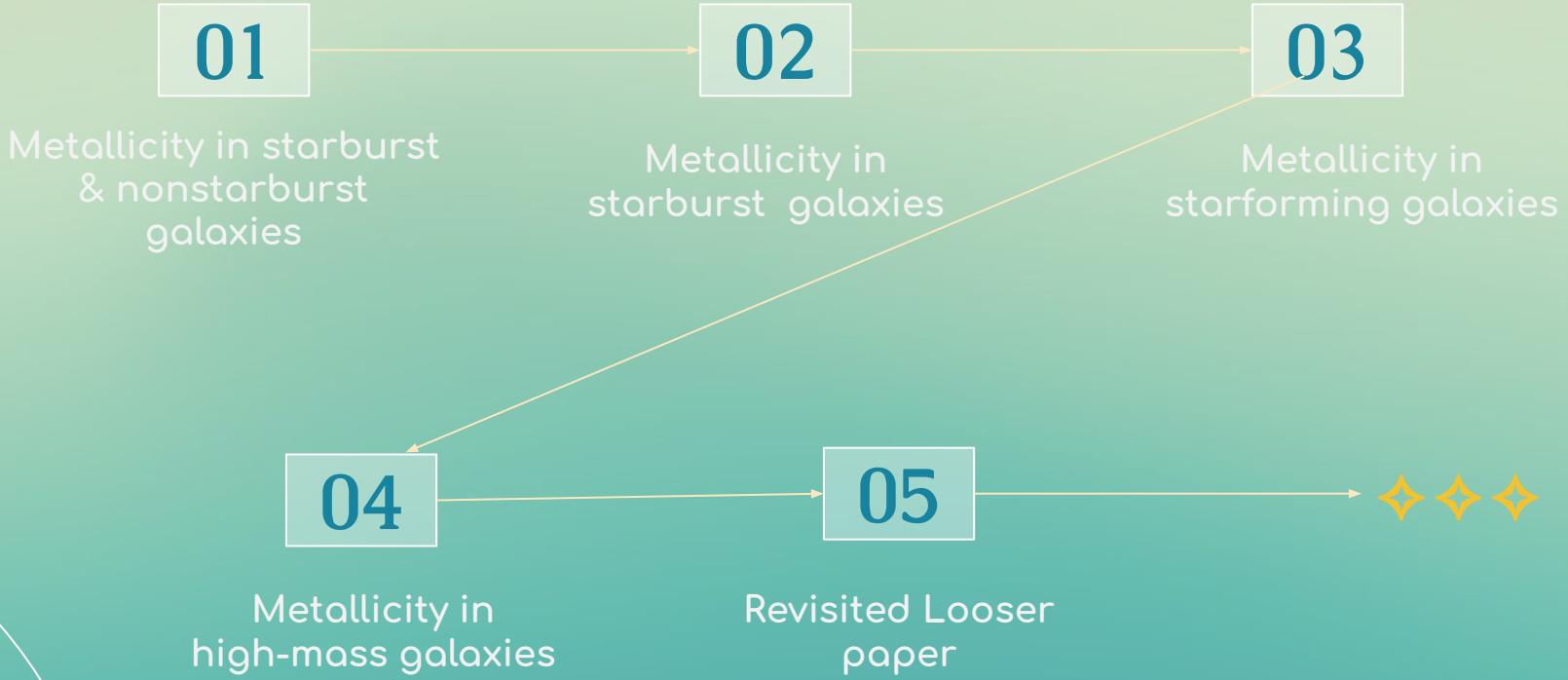
Exploring Metallicity Relations of Young Stellar Populations

✧ Presented by: Alisha Choudhary ✧

Project Evolution



Remembering Looser et. al

The stellar Fundamental Metallicity Relation: the correlation between stellar mass, star-formation rate and stellar metallicity

Tobias J. Looser[1,2⋆] Francesco D'Eugenio[1,2], Joanna M. Piotrowska[1,2,3], Francesco Belfiore[4], Roberto Maiolino[1,2,5], Michele Cappellari[6], William M. Baker[1,2] and Sandro Tacchella[1,2]

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There is a distinct young (<300 Myr) sFMR but this needs to be analyzed further

Looser, T. J., D'Eugenio, F., Piotrowska, J. M., et al. 2024, arXiv e-prints, arXiv:2401.08769, doi:10.48550/arXiv.2401.08769

Question

Are there metallicity trends in younger stellar populations?

Background Information

Metallicity increases with cosmic time for individual galaxies

Quiescent galaxies have higher metallicities than active galaxies

Importance to Galaxy Evolution

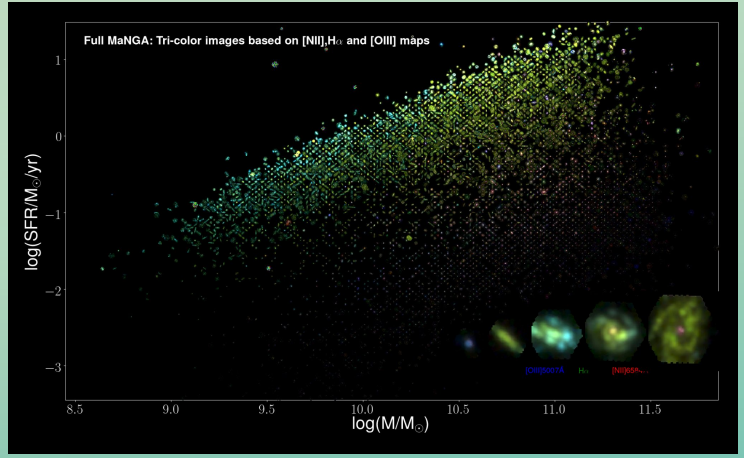
Understanding metallicity evolution is essential for creating accurate models for galaxy evolution

Young stellar populations offer us the unique opportunity to observe ongoing galactic evolution processes

Data Sample

Source: SDSS

DR 17



Source: SDSS

Pipe3D Value Added Catalogue

Analysis Tools

Marvin

Galaxy Zoo

Seaborn

Selection Criteria

- No old galaxies (> 300 Myr)
- No elliptical galaxies
- S/N > 3 for H-alpha,[N II] 6585, & [O III] 5008
- QCFLAG = 0

Sample of 30 galaxies

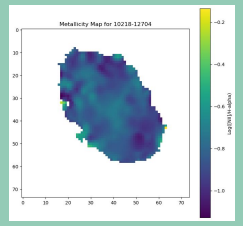
Spatially Resolved Metallicity Gradients

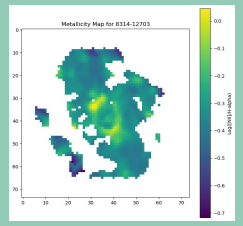
[O III]/[N II]
- Pettini & Pagel (2004) [N II] calibration

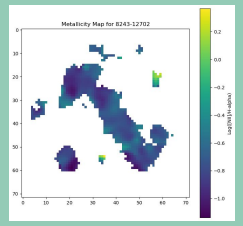
$$12 + \log(O/H) = 8.90 + 0.57 + \log(F(N\ II)/(F(H\text{-}alpha))$$

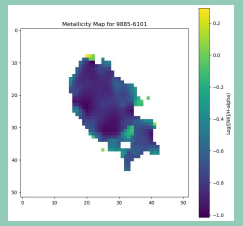
Pettini, M., & Pagel, B. E. J. 2004, Monthly Notices of the Royal Astronomical Society, 348, L59, doi: 10.1111/j.1365-2966.2004.07591.x

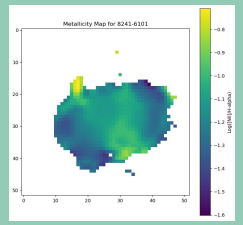
https://sdss-marvin.readthedocs.io/en/latest/tutorials/exercises/resolved_mass_metallicity_relation_SOLUTION.html

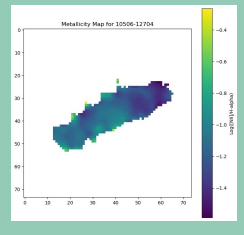


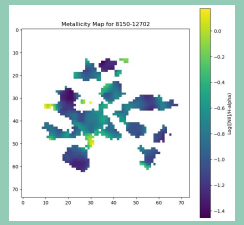


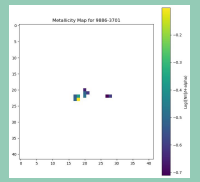


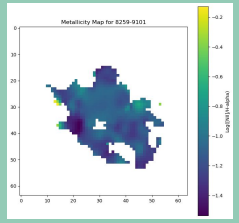


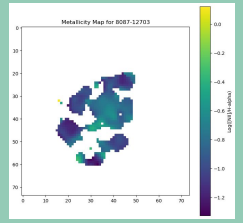


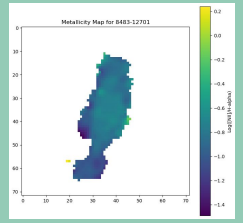


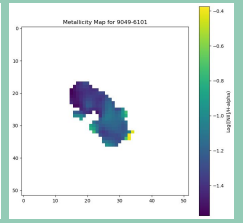


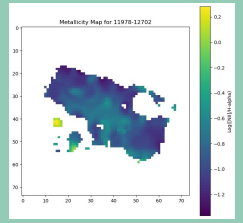


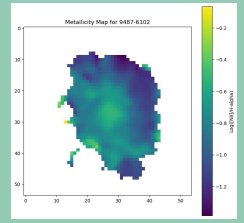


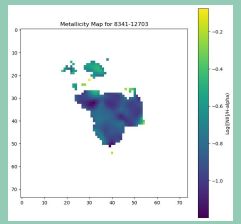


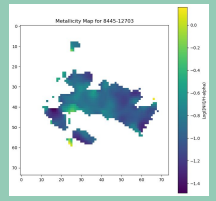


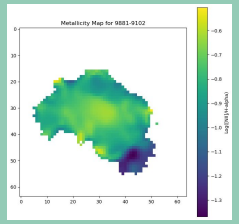


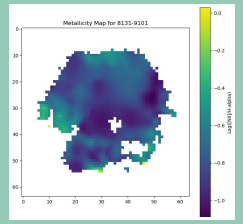


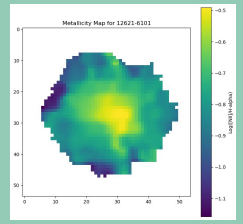


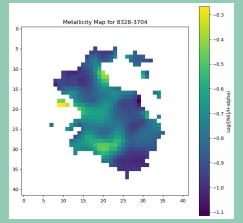


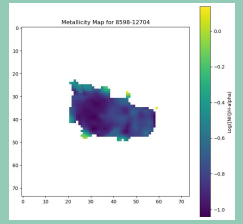


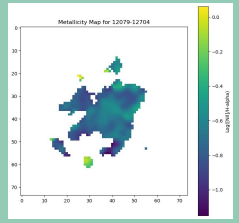


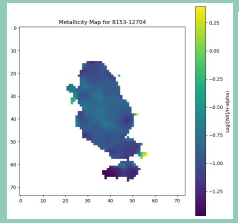


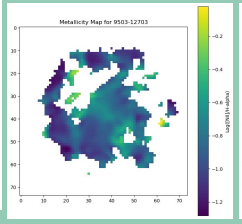


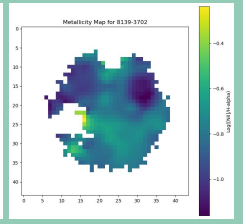


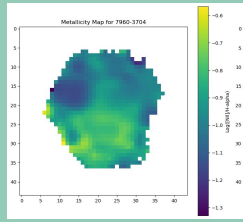


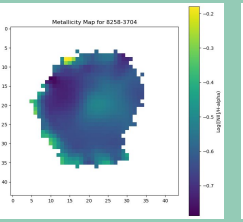


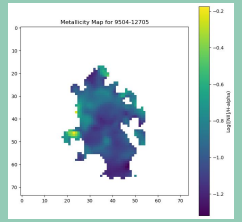


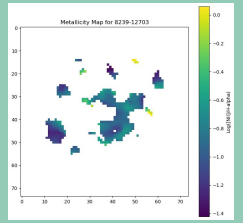


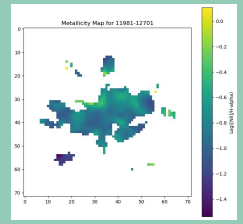












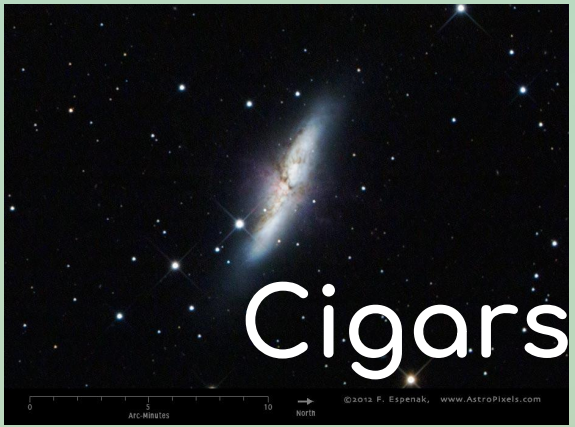
Metallicity Gradient Maps

Galaxy Groups

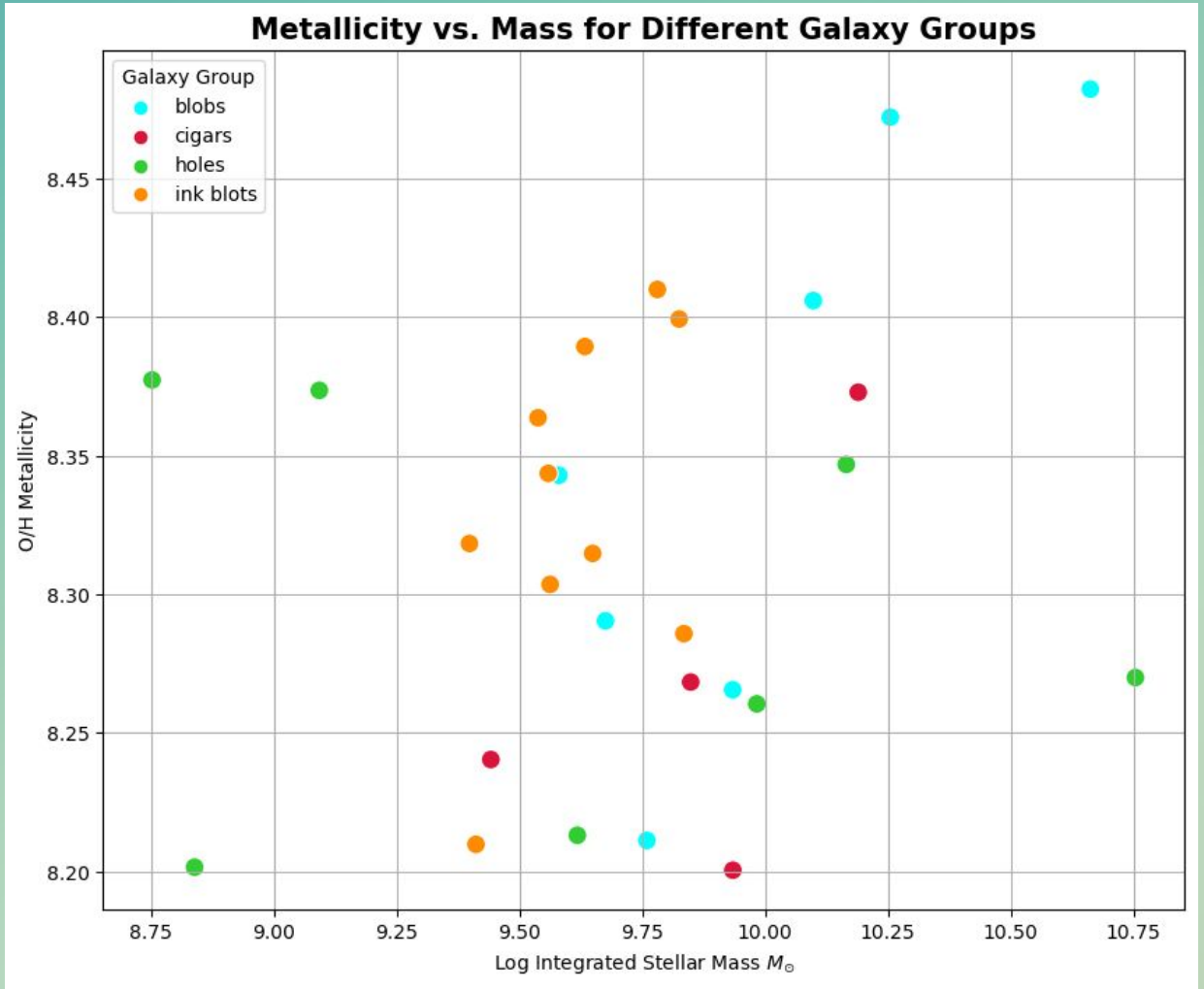
Blobs

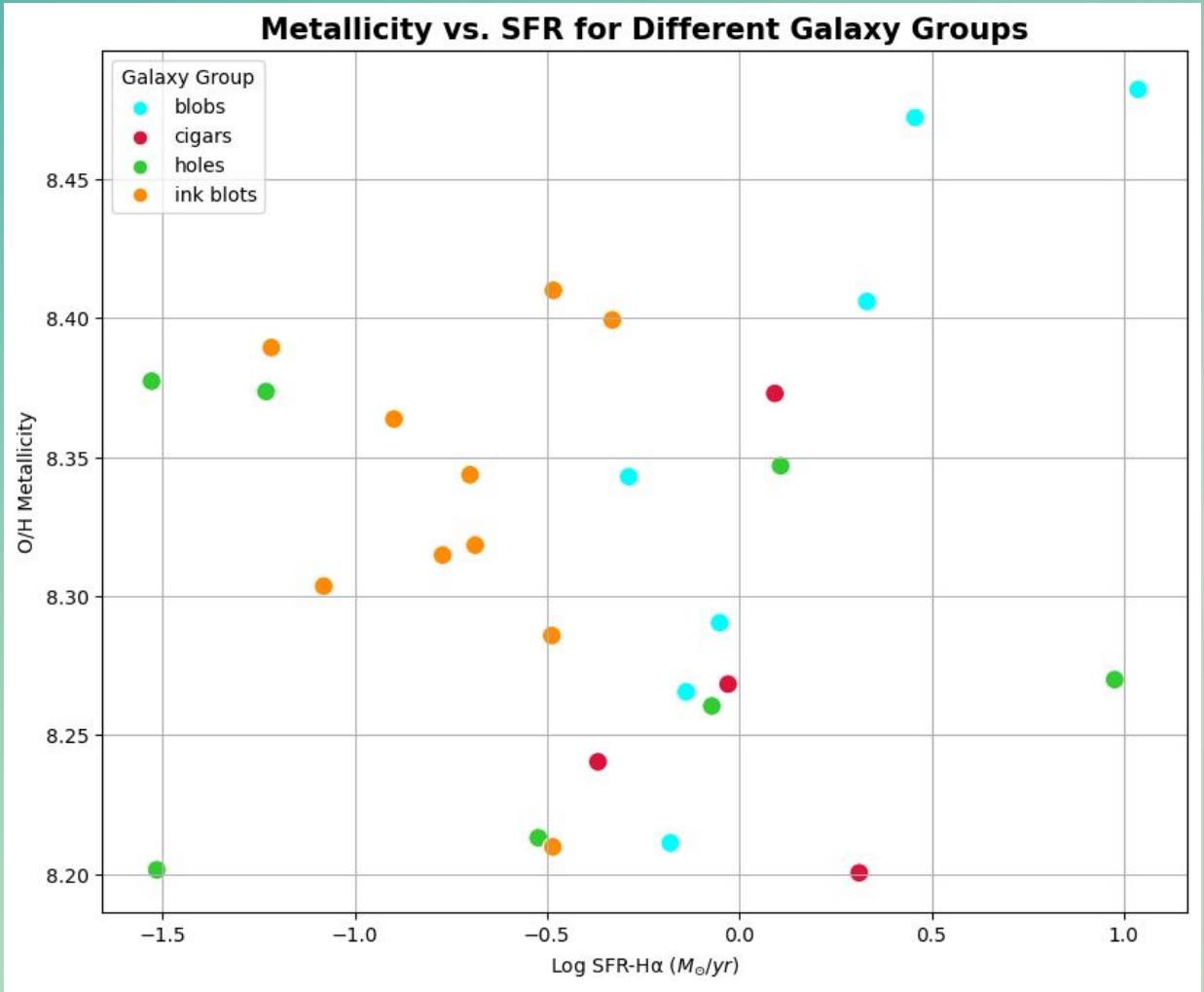
Inkblots

HOLES

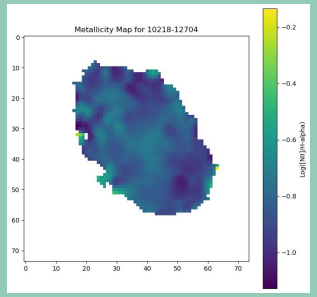


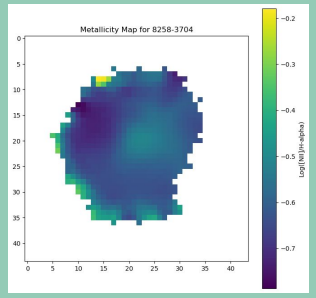
Cigars

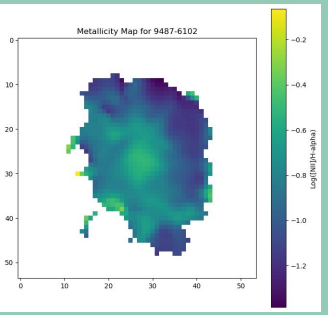

Metallicity vs. Mass for Different Galaxy Groups
Galaxy Group
blobs
cigars
holes
ink blots
O/H Metallicity
8.45
8.40
8.35
8.30
8.25
8.20
8.75
9.00
9.25
9.50
9.75
10.00
10.25
10.50
10.75
Log Integrated Stellar Mass $M_\odot$

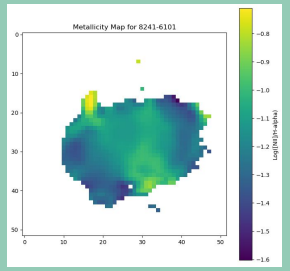

Metallicity vs. SFR for Different Galaxy Groups
Galaxy Group
blobs
cigars
holes
ink blots
O/H Metallicity
8.45
8.40
8.35
8.30
8.25
8.20
−1.5
−1.0
−0.5
0.0
0.5
1.0
Log SFR-Hα ($M_\odot/yr$)

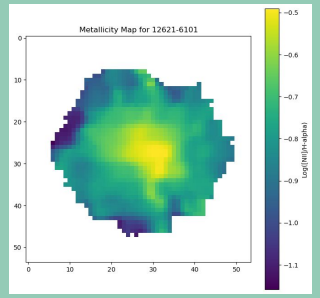
Meet the Blobs

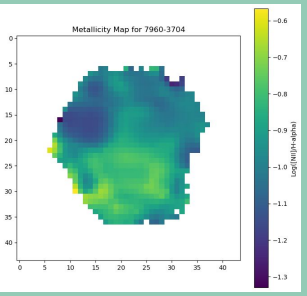


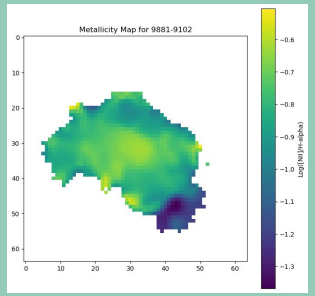






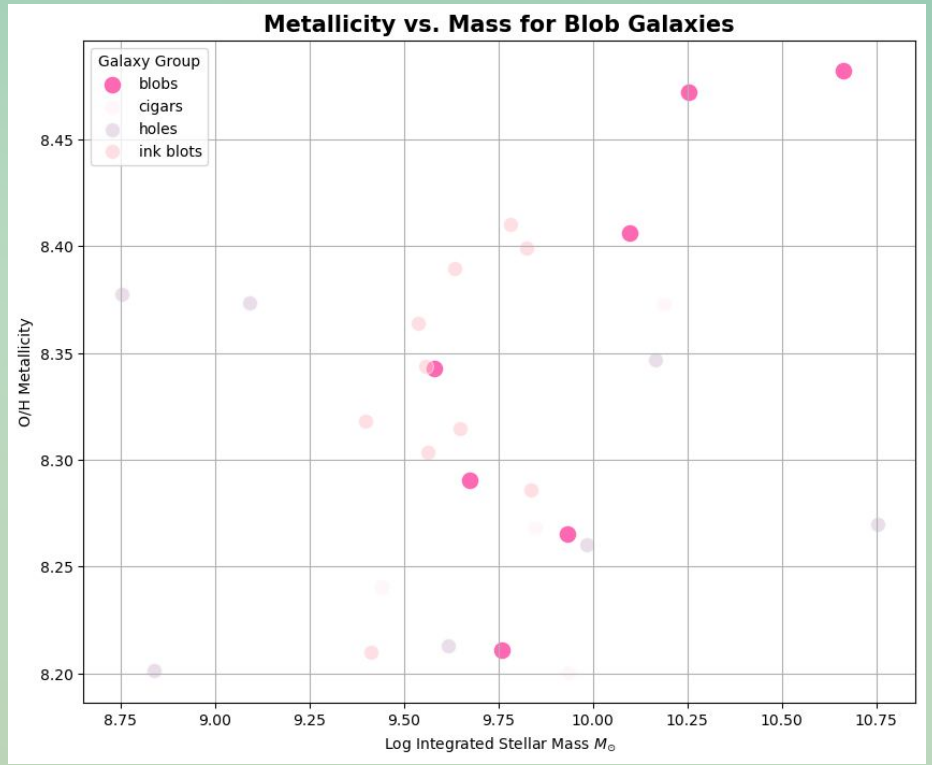


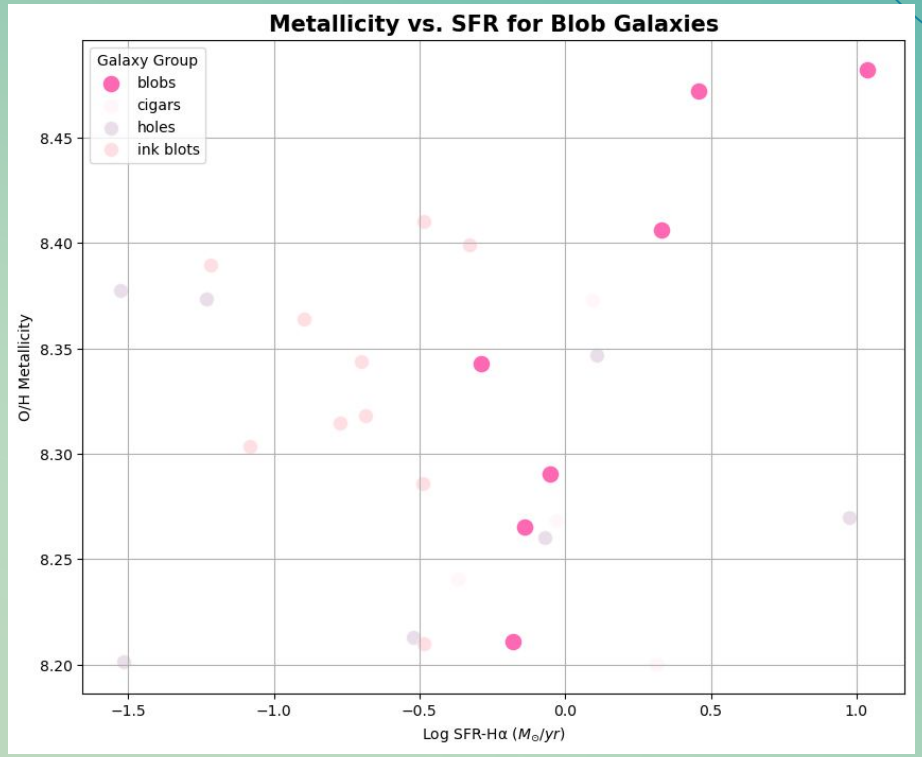




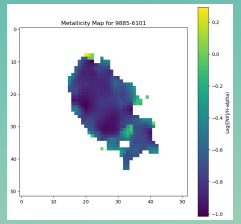
Average age: 248 Myr
Avg stellar mass surface ρ: 281 M⊙/pcˆ2
Avg v_stellar : 37 km/s

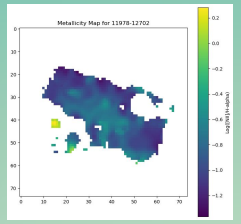
Blob Metallicity vs. Mass & SFR

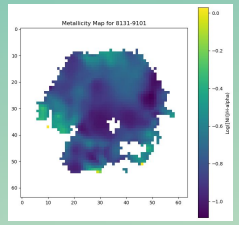


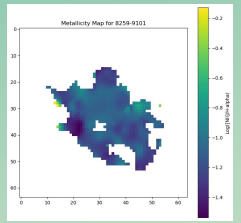


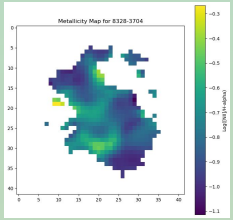
Meet the Holes

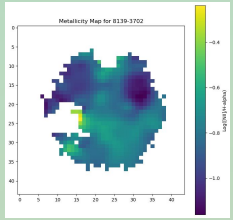


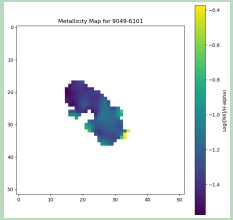






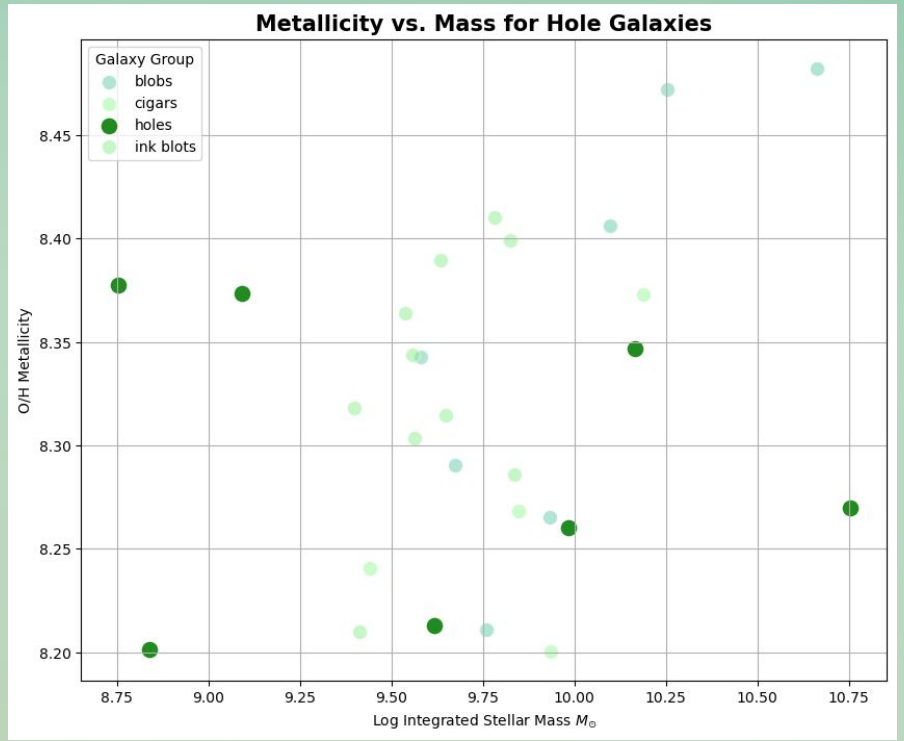


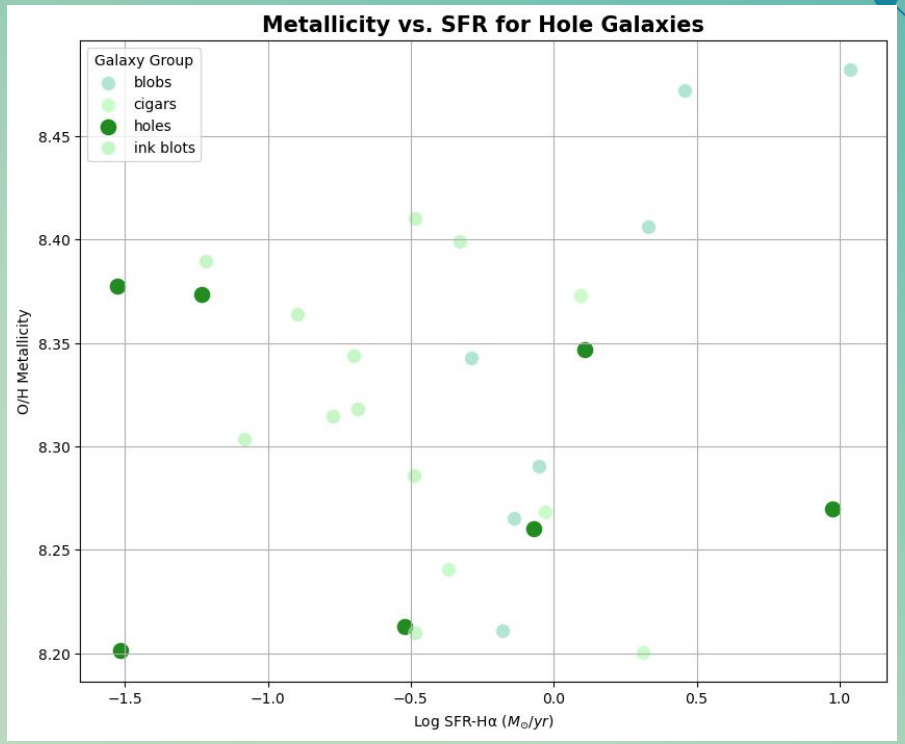




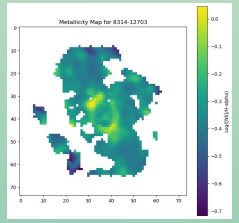
Average age: 223 Myr
Avg stellar mass surface ρ: 113 M⊙/pc^2
Avg v_stellar : 19 km/s

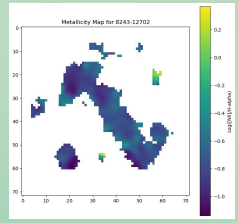
Hole Metallicity vs. Mass & SFR

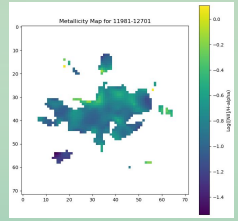


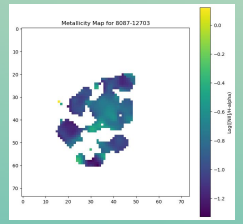


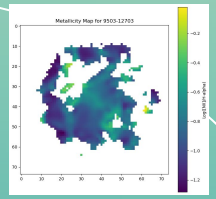
Meet the Inkblots

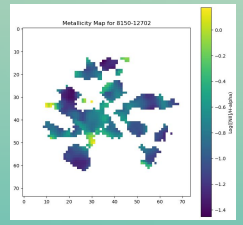


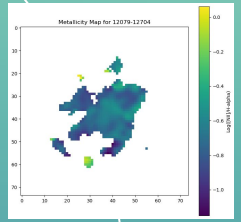


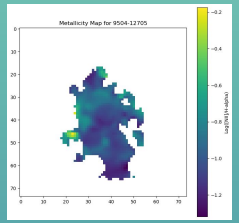


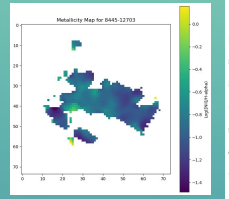


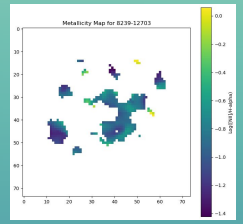




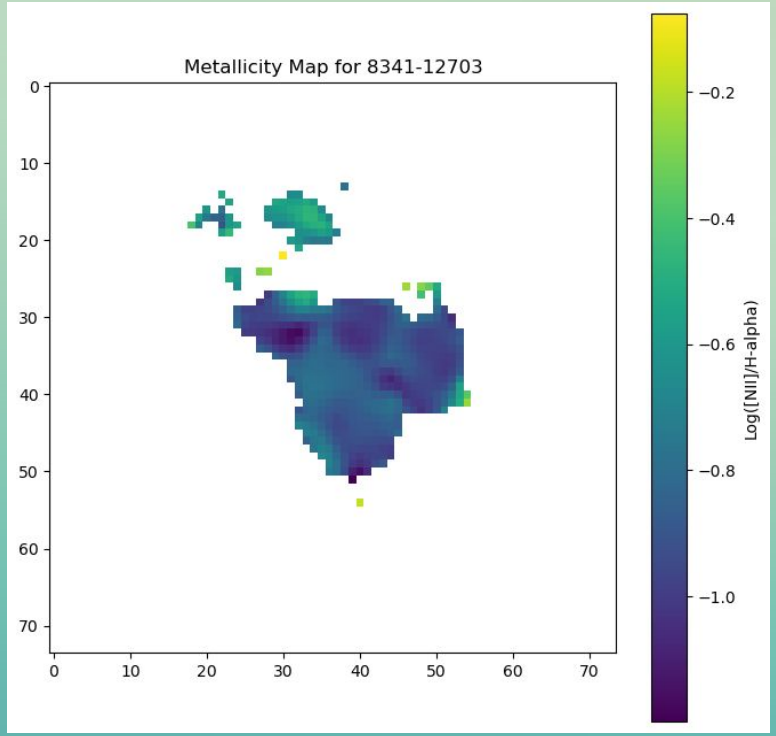








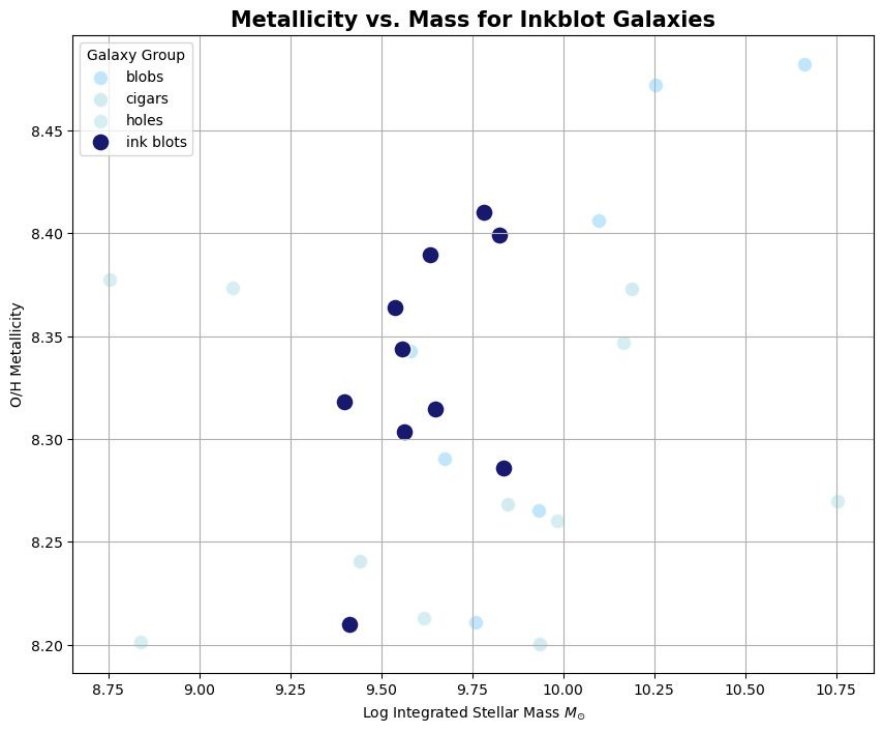
Avg age: 211 Myr
Avg stellar mass surface ρ: 99 M⊙/pcˆ2
Avg v_stellar :77 km/s

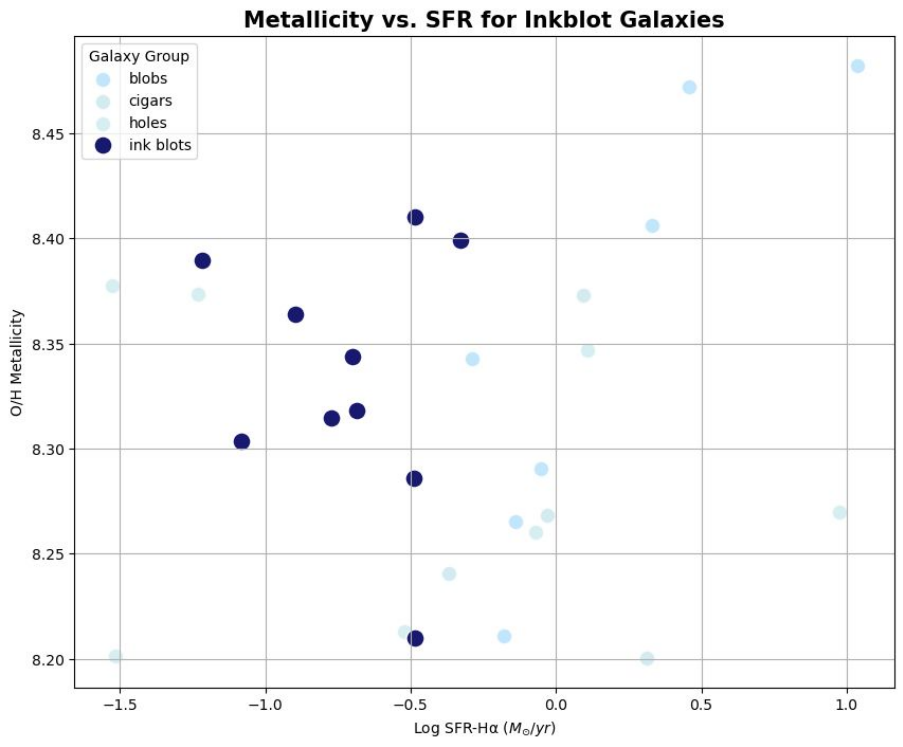


Outlier

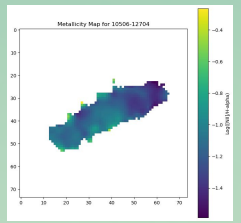
Highest log_Mass

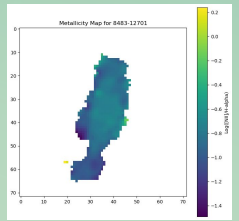
Inkblot Metallicity vs. Mass & SFR

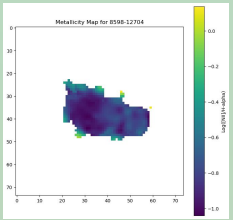


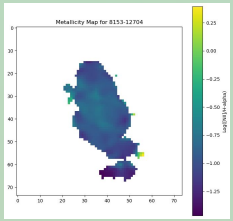


Meet the Cigars



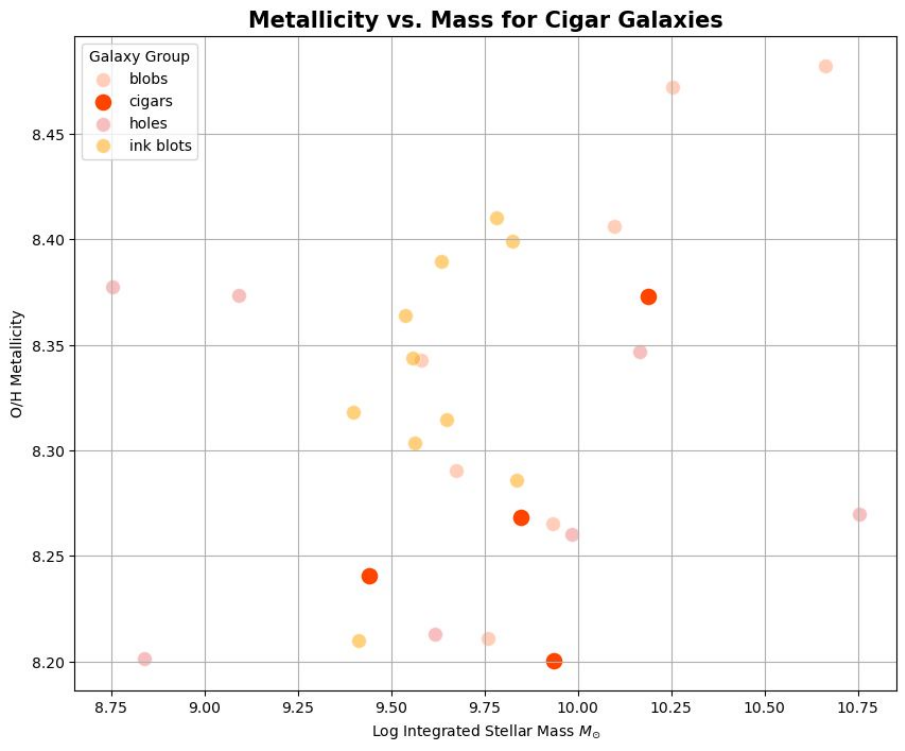


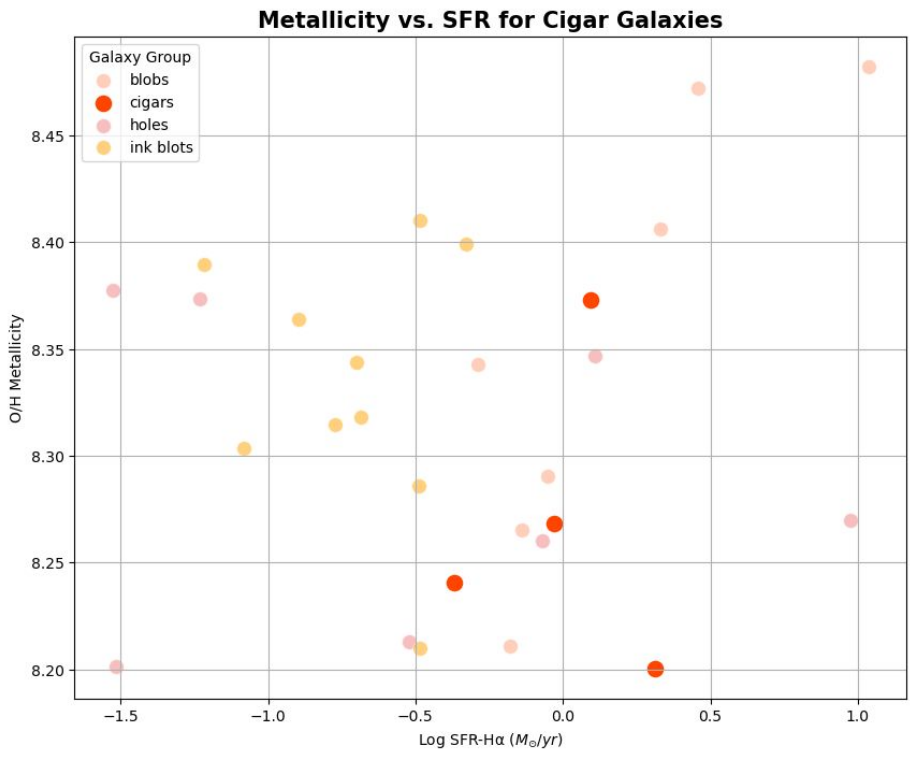




Average age: 209 Myr
Avg stellar mass surface ϱ: 51 M⊙/pcˆ2
Avg v_stellar : 140 km/s

Cigar Metallicity vs. Mass & SFR





Takeaways?

(Youngest) (Least dense) Cigars → Inkblots → Holes → Blobs (Oldest) (Most dense)

Cigars: fastest
Holes: slowest

Implications & Further Research

More support for young sFMR
- Larger sample size
- Simulations
- Follow up observations
- Different metallicity measurement methods

Galactic kinematics, gas content

Longitudinal studies & further spectroscopy, detailed spaxel analysis

Massive galaxies

Thank You! :)

Questions?