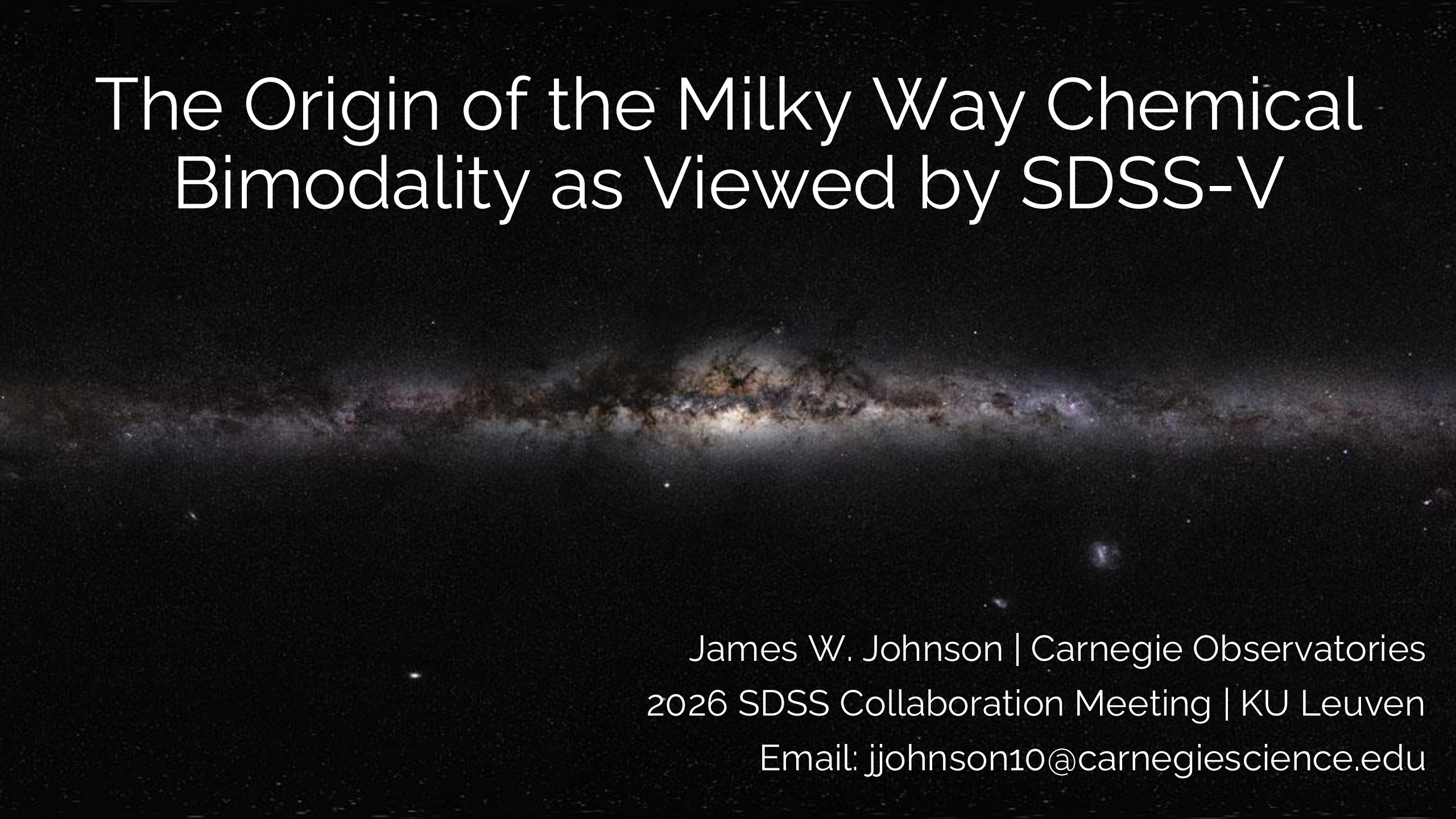
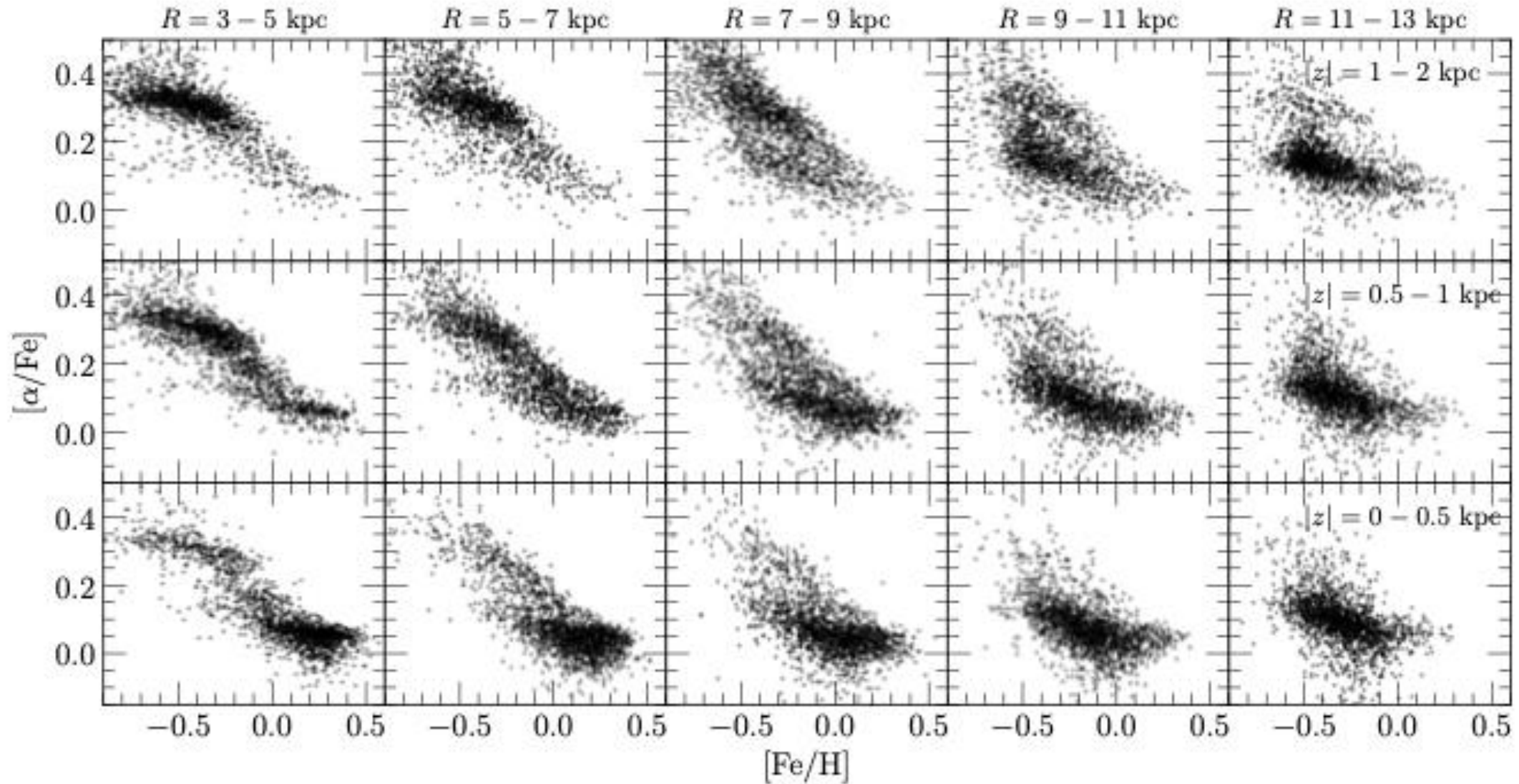


The Origin of the Milky Way Chemical Bimodality as Viewed by SDSS-V

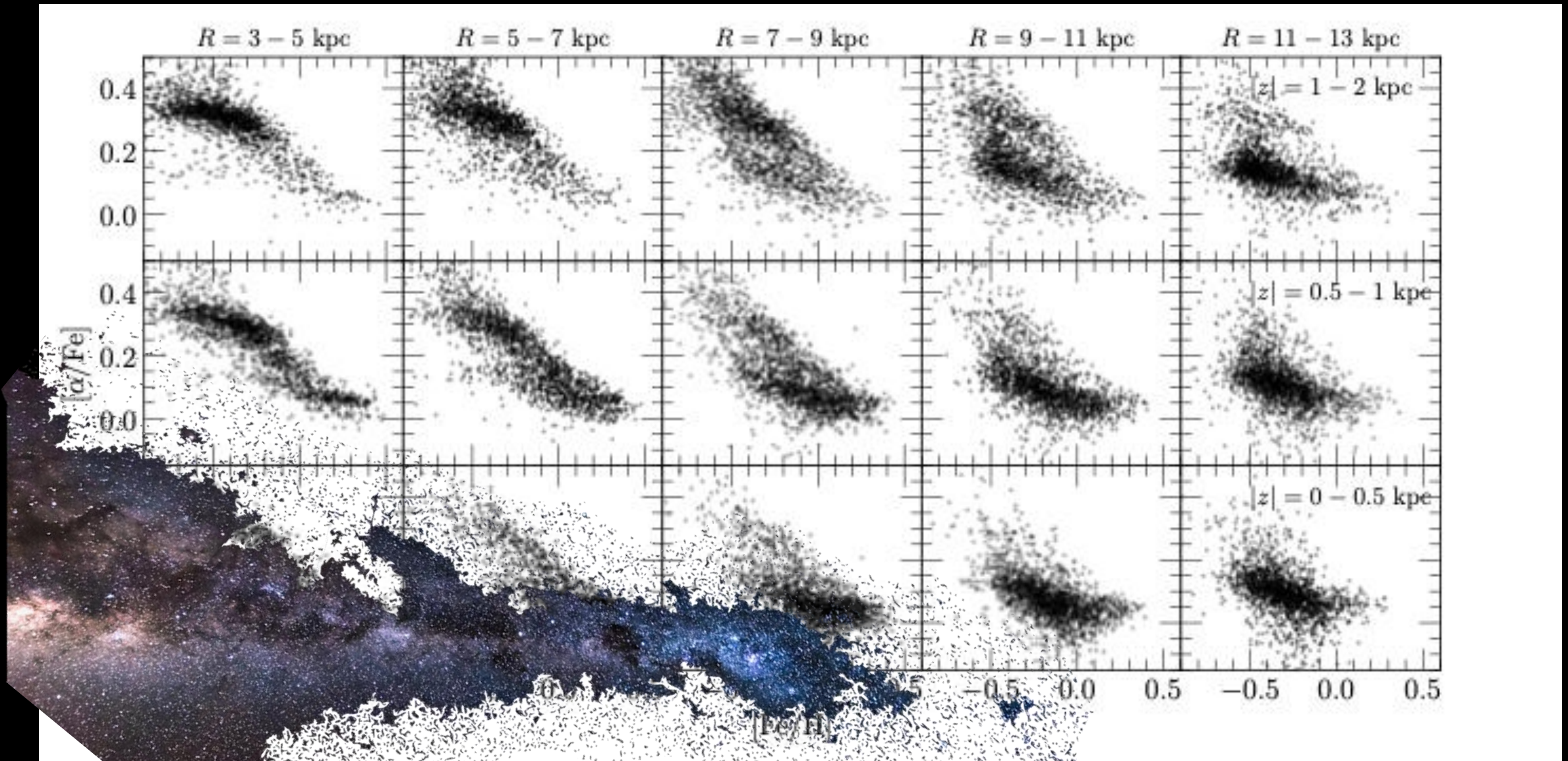


James W. Johnson | Carnegie Observatories
2026 SDSS Collaboration Meeting | KU Leuven
Email: jjohnson10@carnegiescience.edu

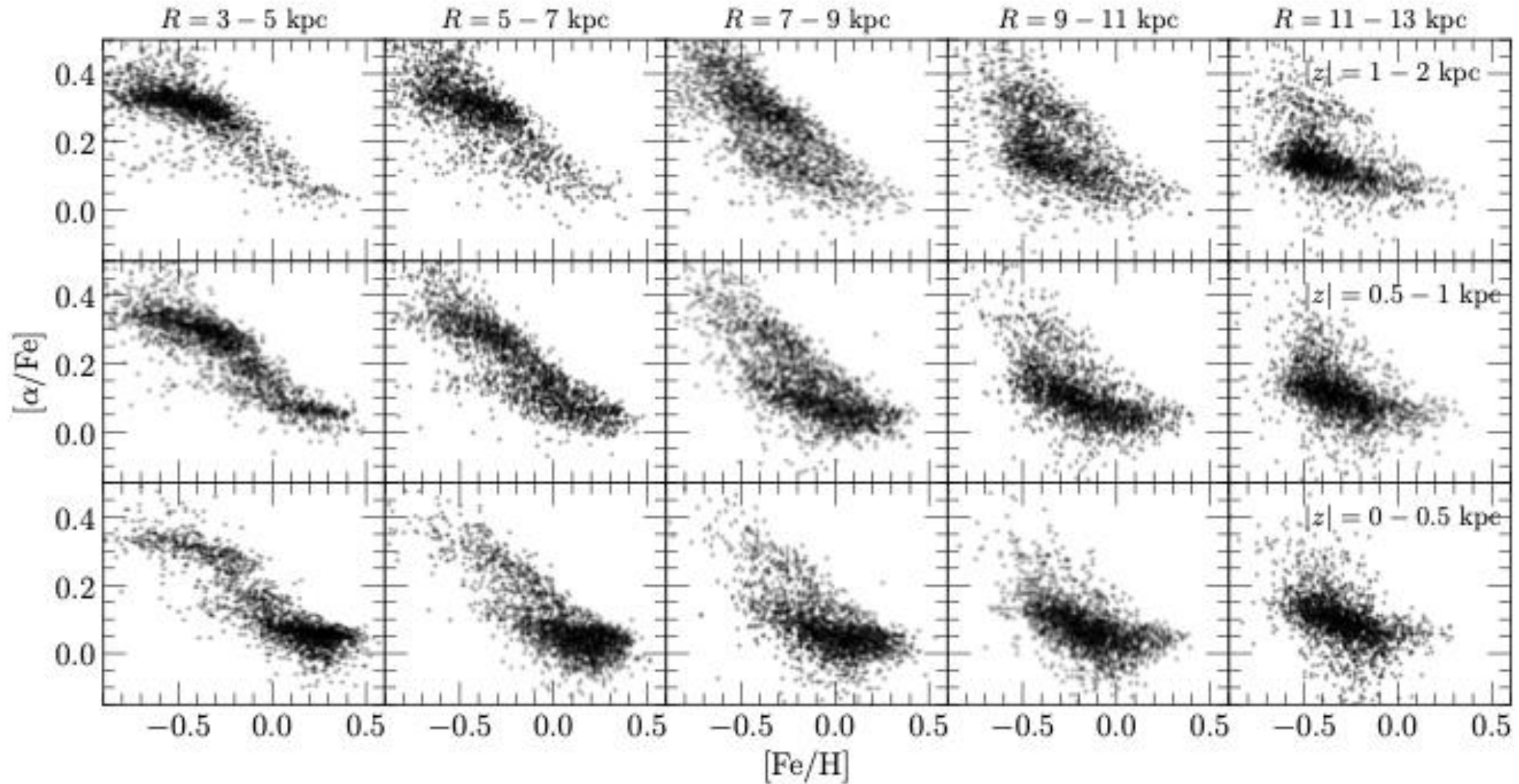
Two Stellar Populations in the Milky Way



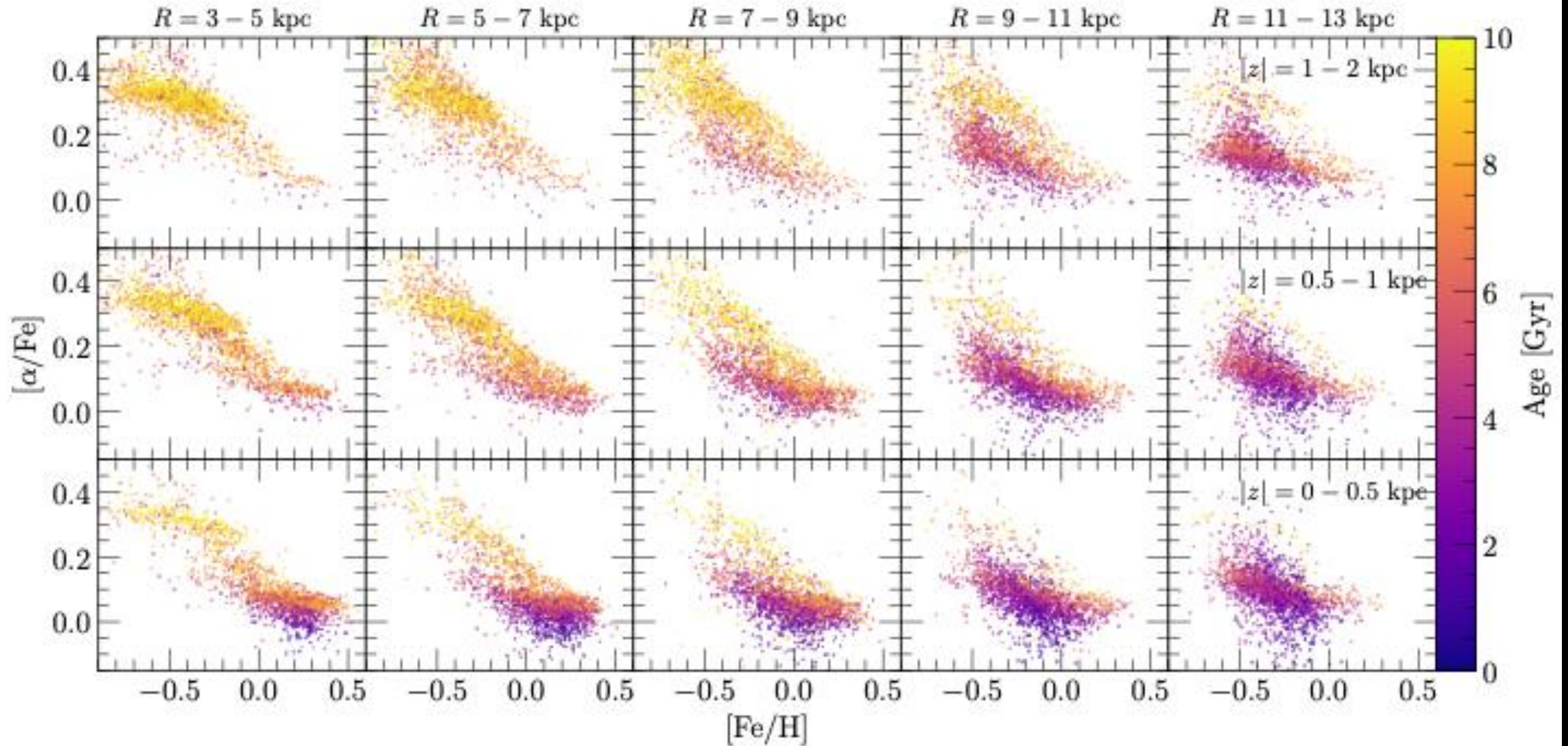
Two Stellar Populations in the Milky Way



Two Stellar Populations in the Milky Way



Two Stellar Populations in the Milky Way



Many Interpretations

Not necessarily complete, un-biased, mutually exclusive, correct/perfect

Dilution & Re-enrichment

- Spitoni+19,21
- Mackereth+18

Disk Compaction

- Grand+16
- Johnson+25

Radial Migration

- Kubryk+15
- Sharma+21
- Chen+23

Localized Starbursts at high- z

- Clarke+19
- Garver+23

Star Formation Hiatus

- Beane+25a,b

I'm probably missing $\geq 1...$

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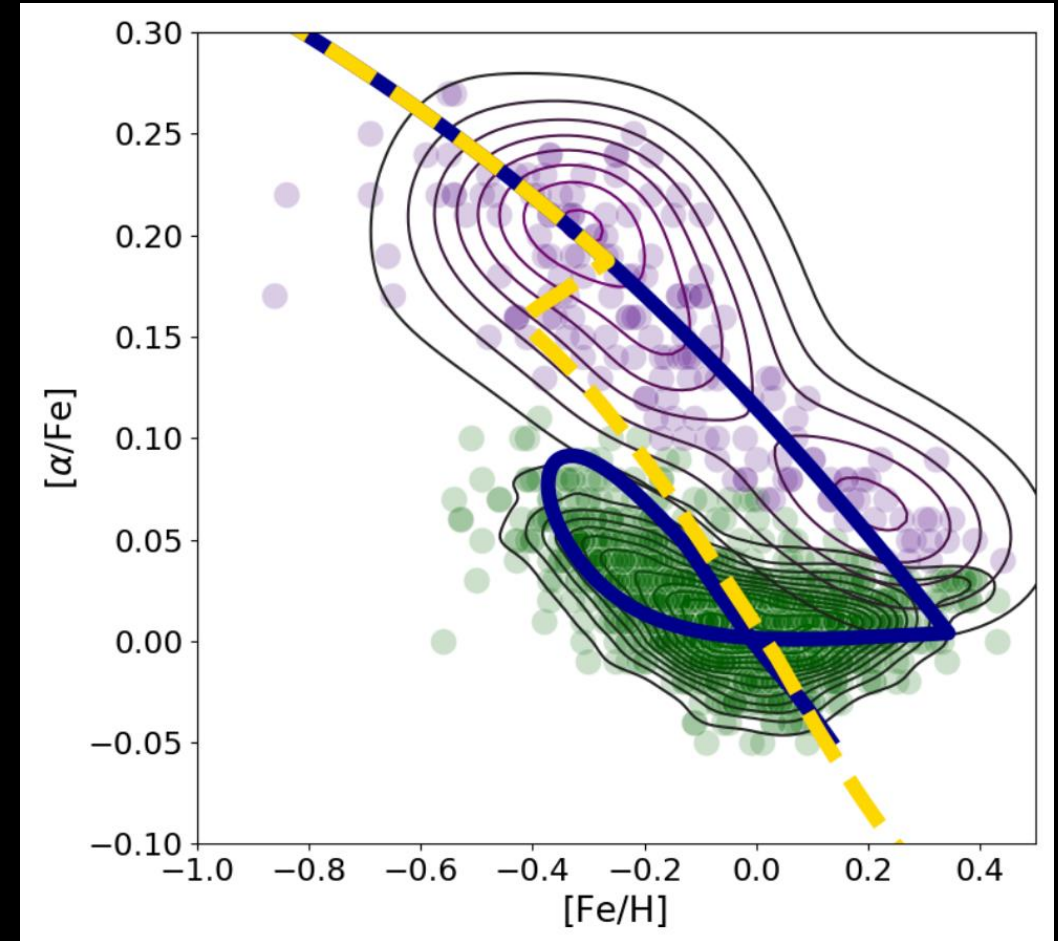
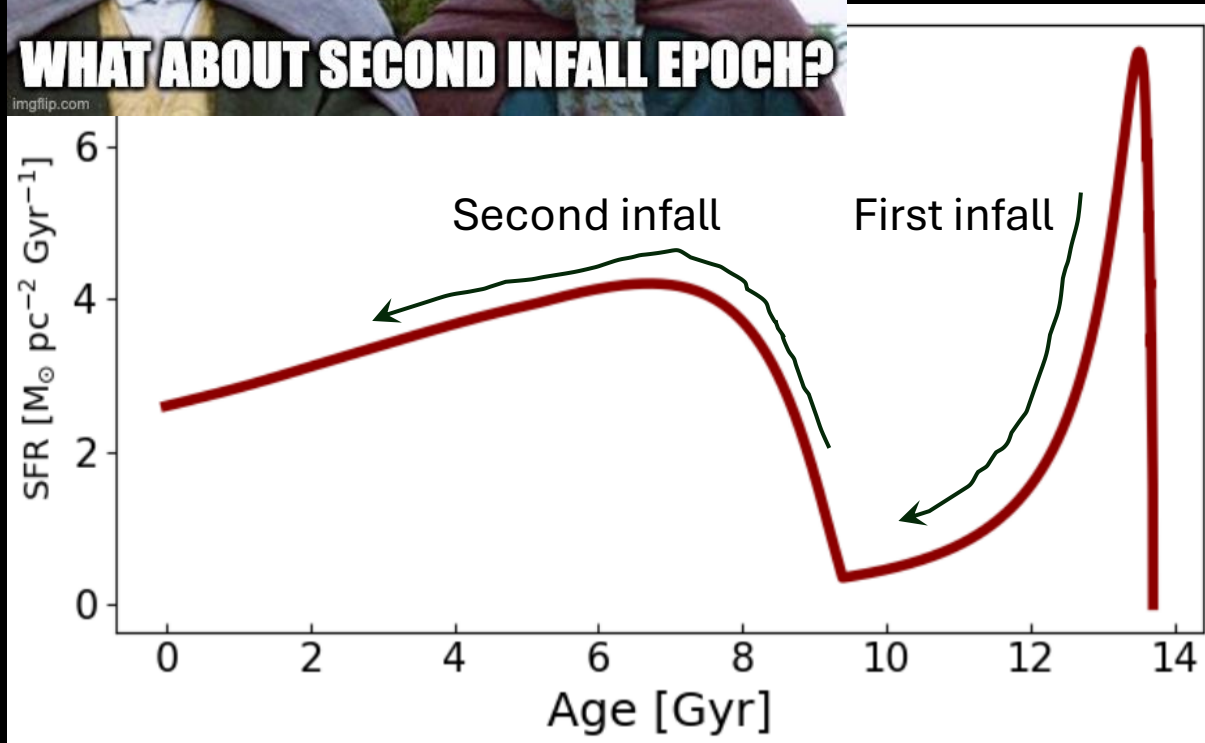
- Beane+25a,b

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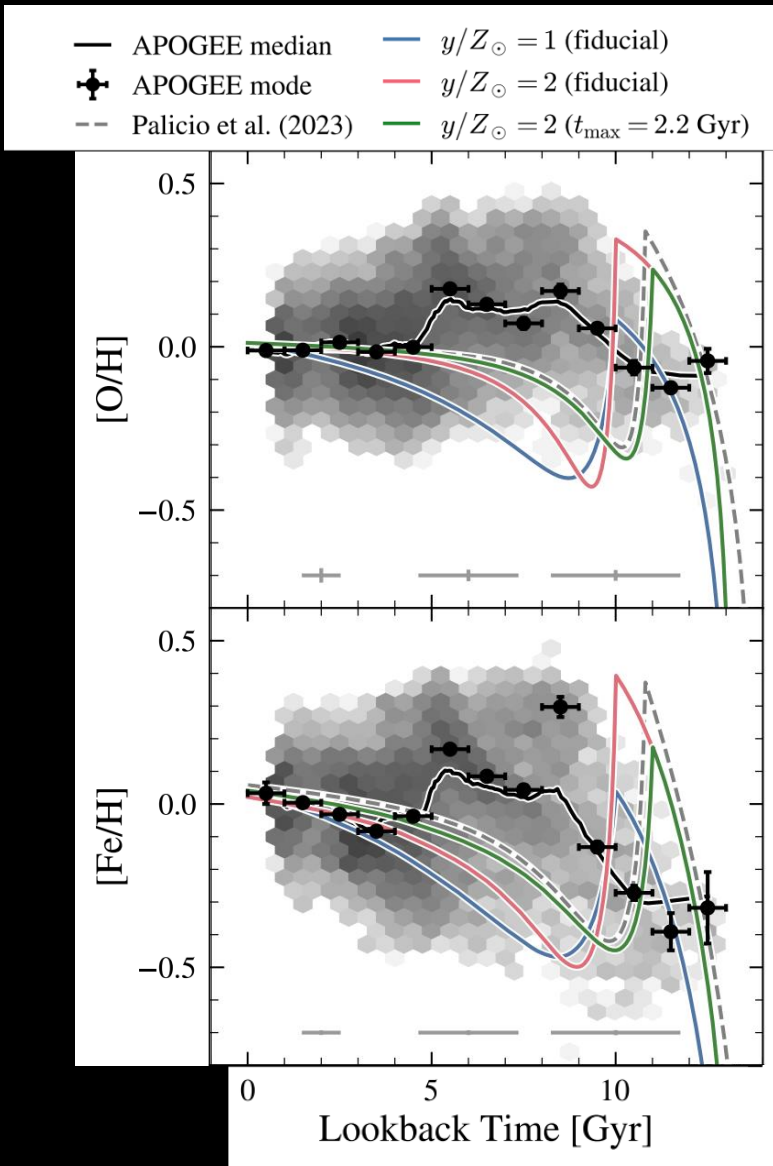
Dilution & Re-Enrichment: Two-Infall Scenario



Chiappini+97
Spitoni+19,21
Palla+20,22



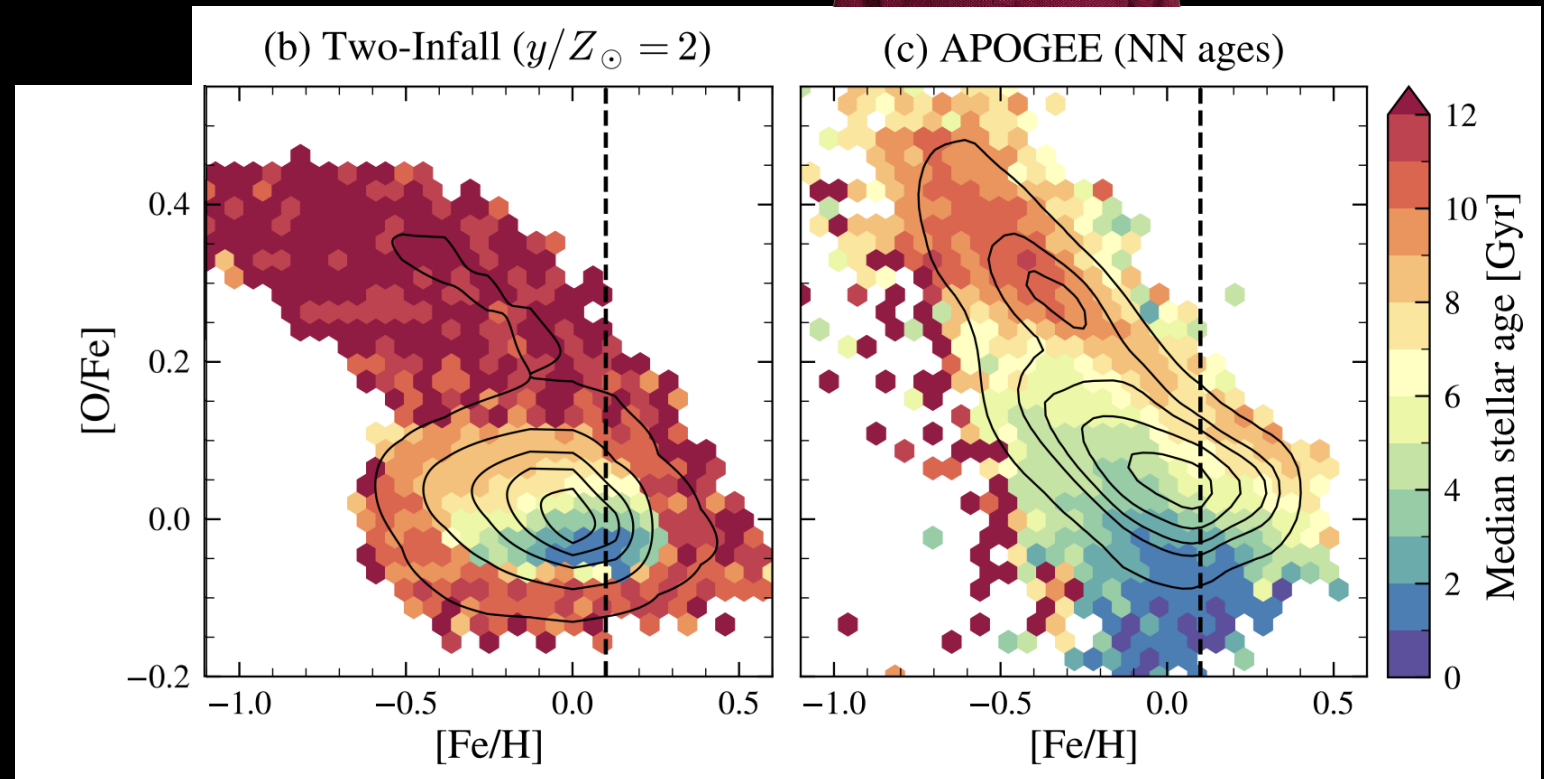
Dilution & Re-Enrichment: Where Are You?



Observational
signatures not
found in age data



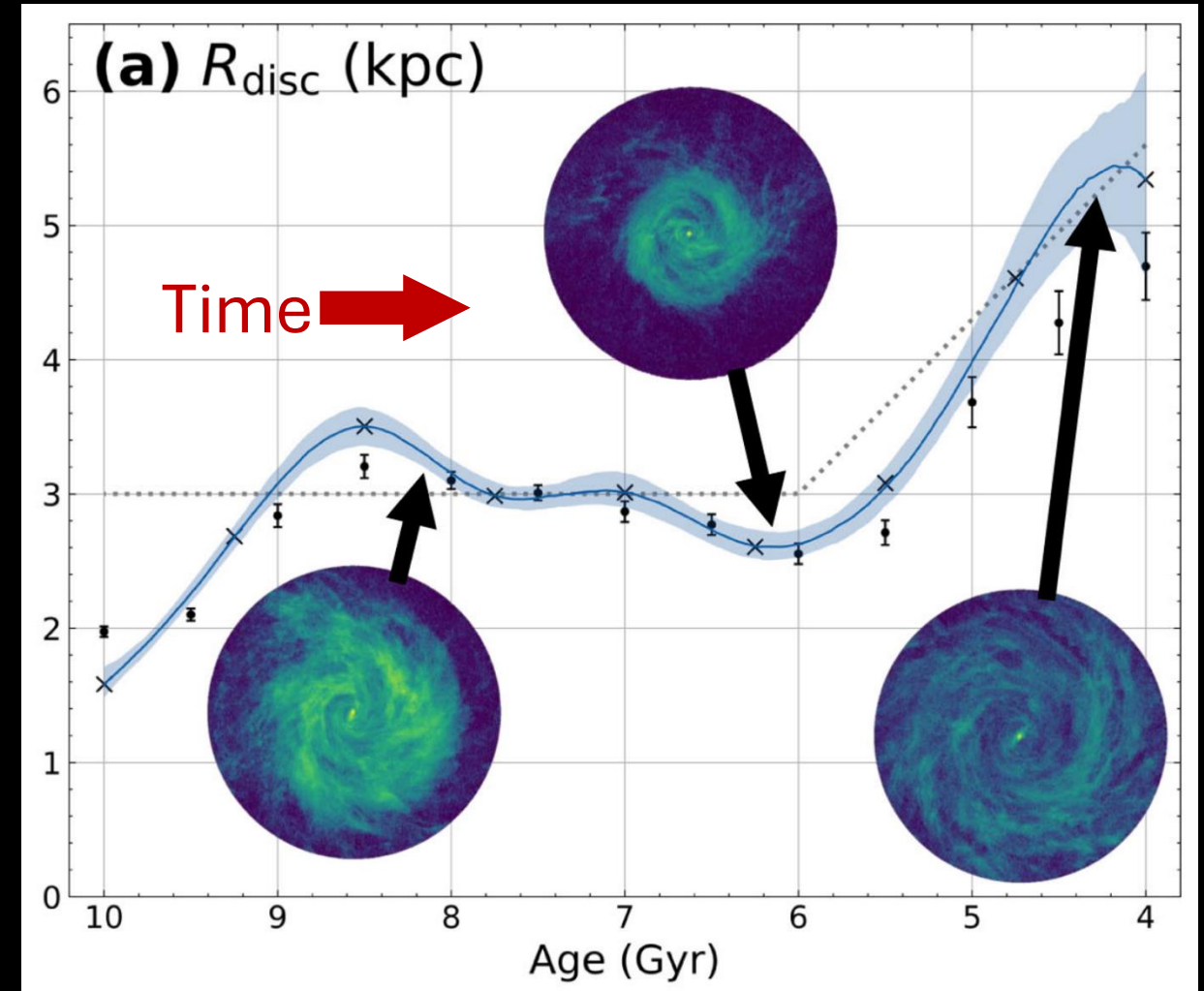
Liam Dubay
Ohio State



Disk Compaction: Gaia-Sausage-Enceladus?

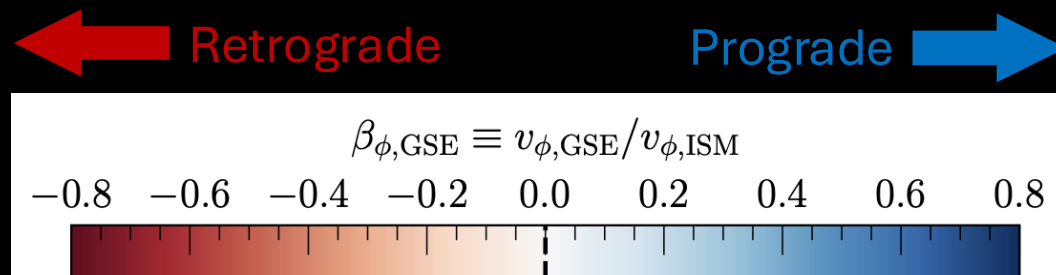
Retrograde merger trajectory should cause gas to sink toward Galactic center

- ~3:1 mass-ratio
- Redshift $z \sim 2$
- Retrograde
- Helmi+18, Belokurov+18, Bonaca+20, Xiang&Rix22, ...

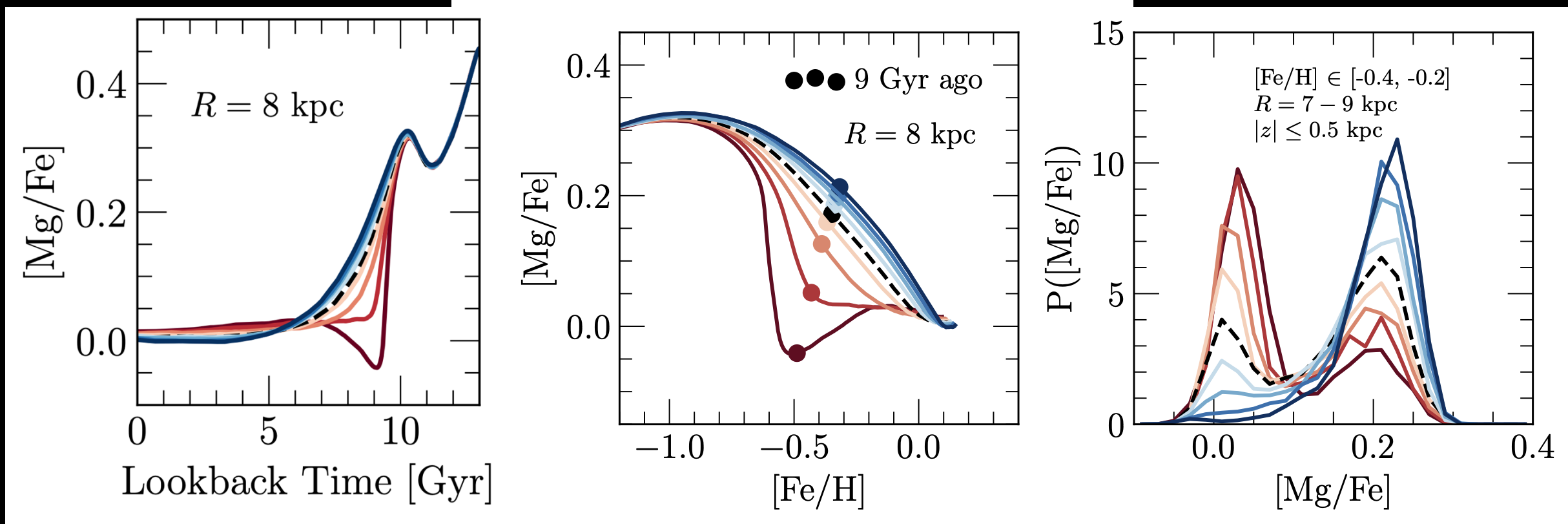


Trajectory Alone Can Account for Bimodality

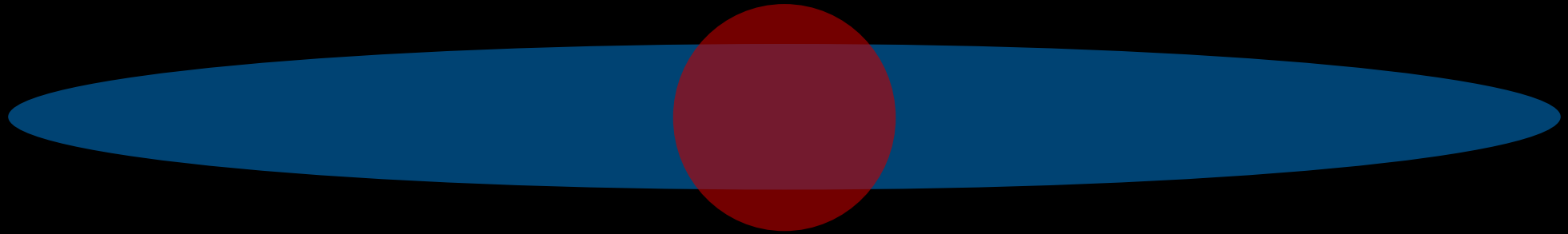
Expedites decline
in $[\alpha/\text{Fe}]$



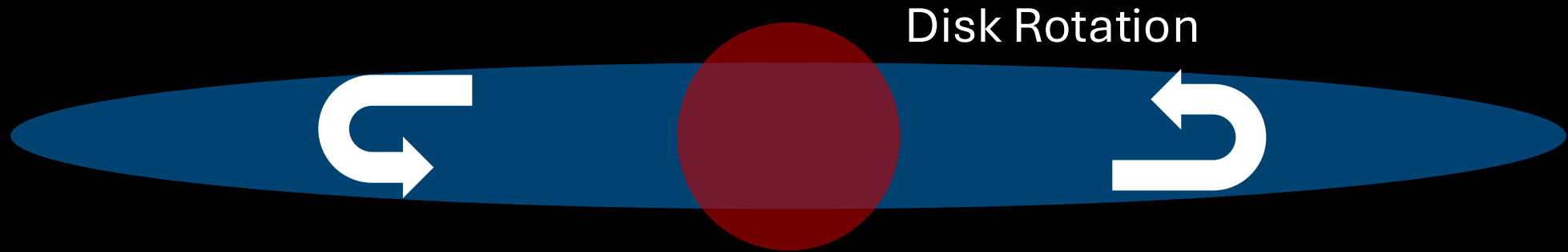
Adjusts frequency
of populations



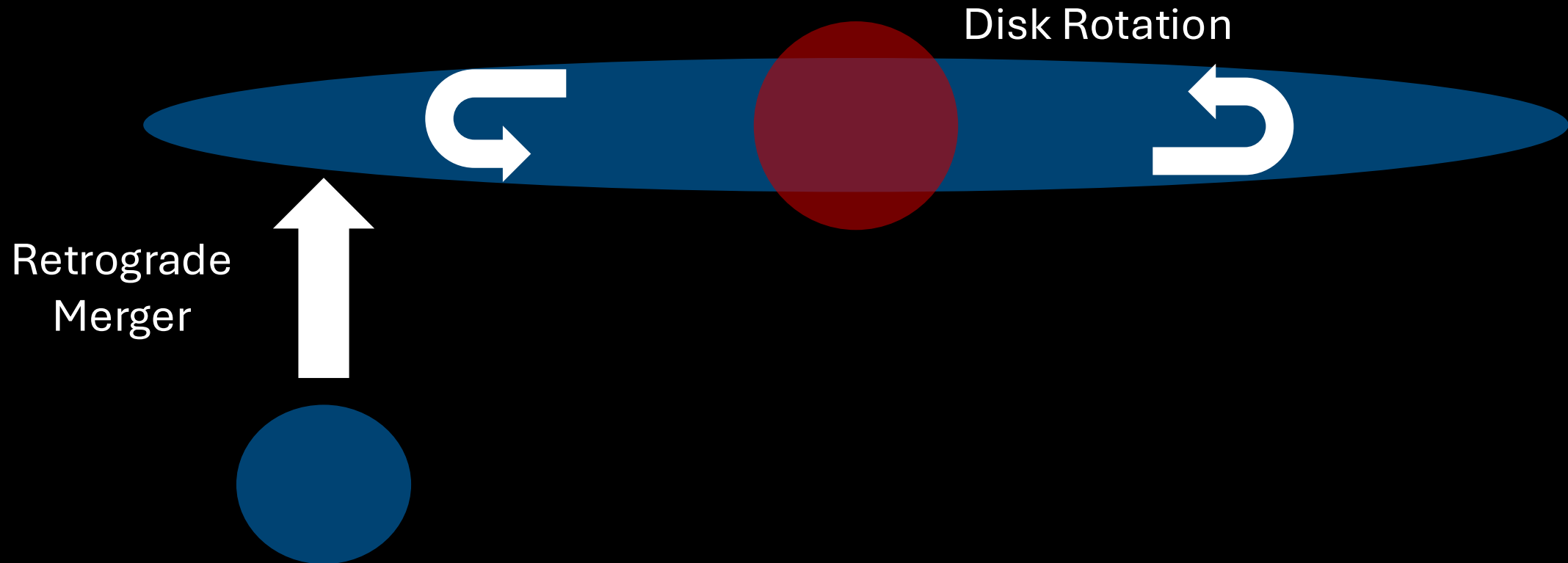
Why Does This Happen?



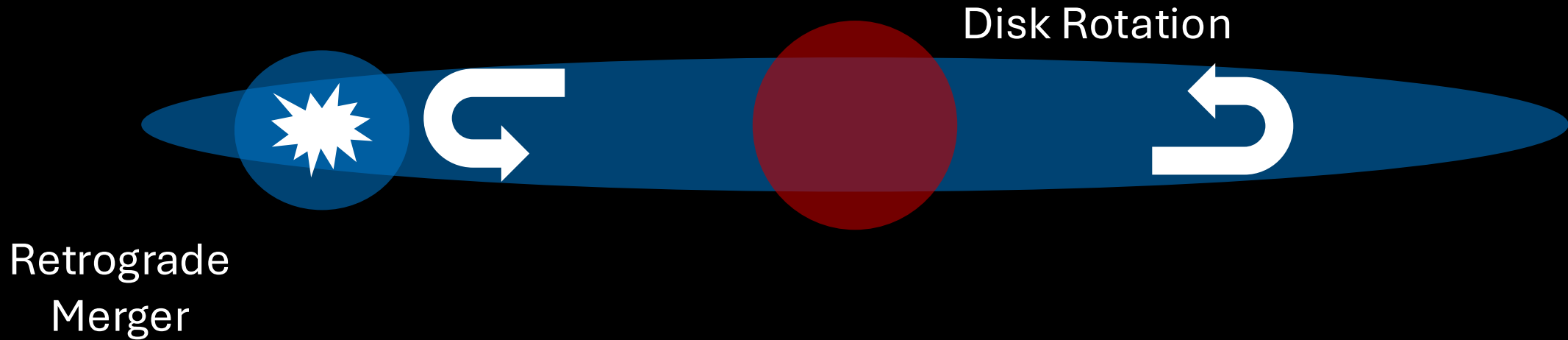
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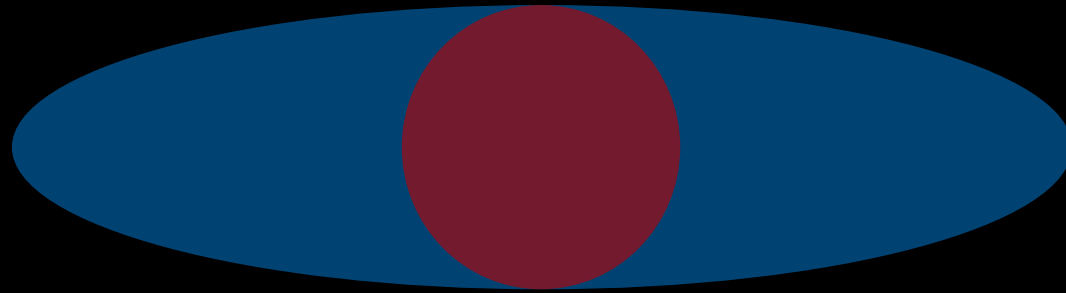
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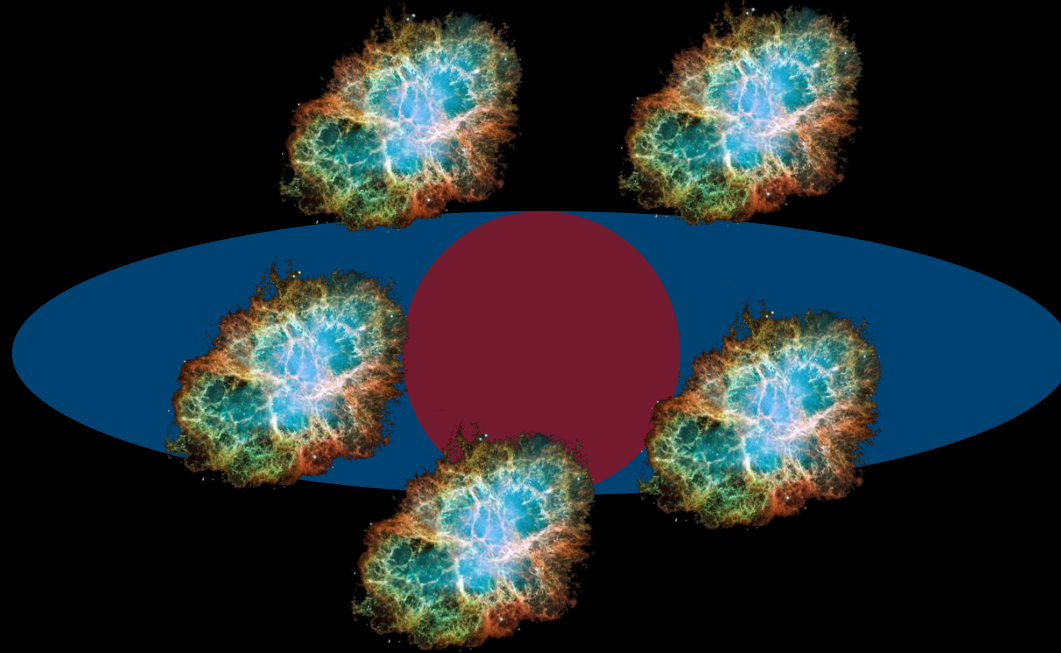
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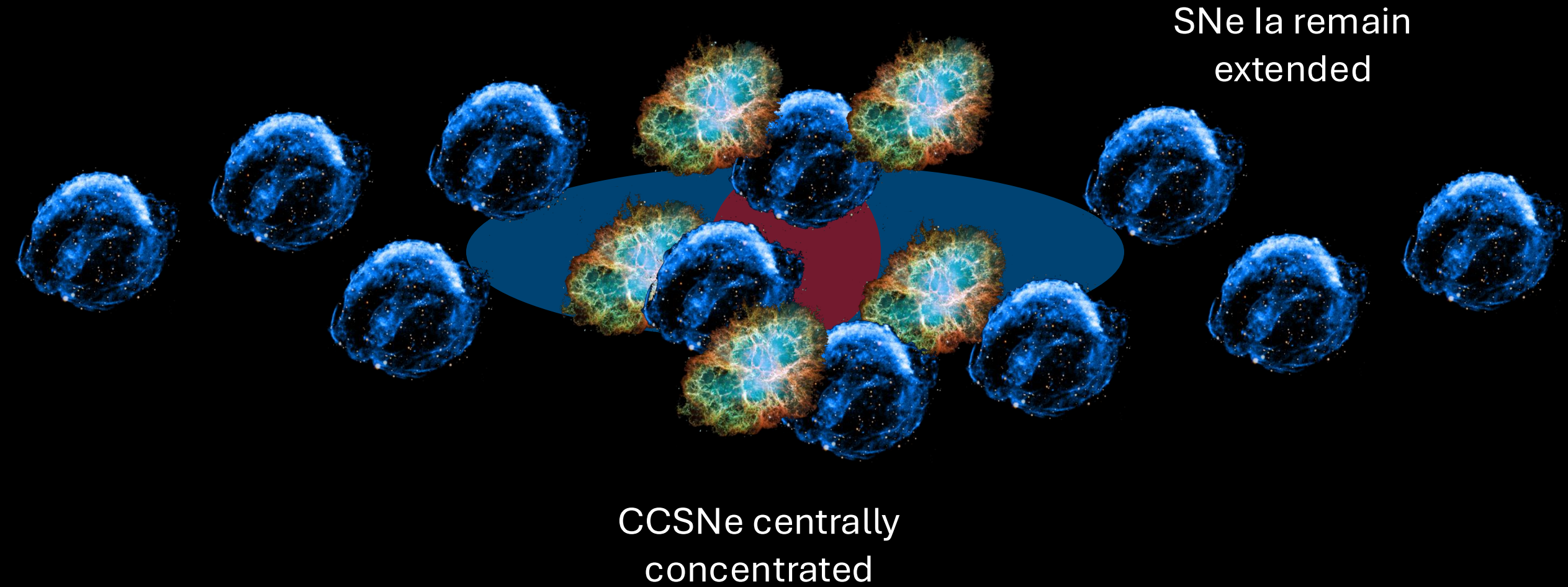


Why Does This Happen?

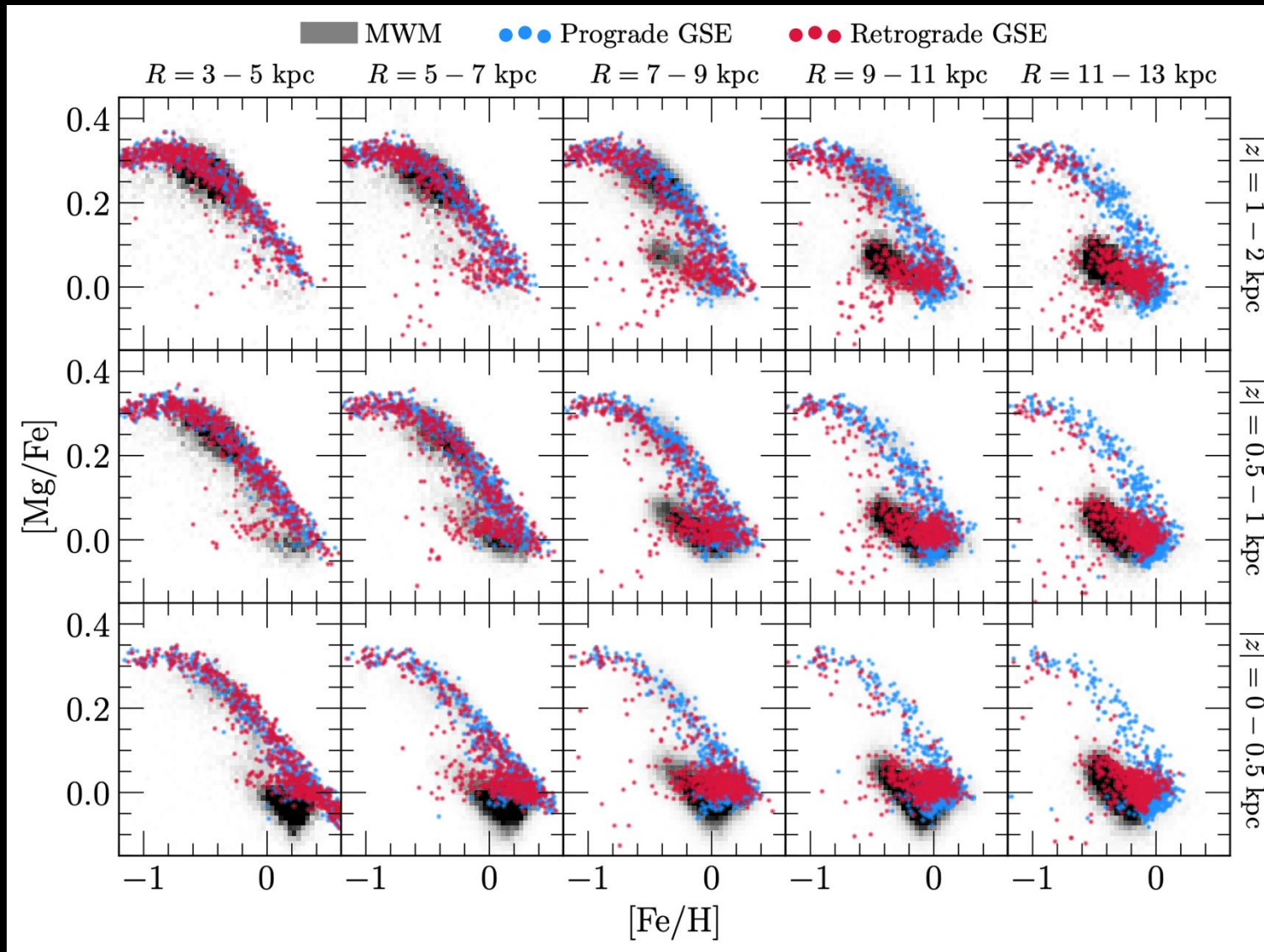


CCSNe centrally
concentrated

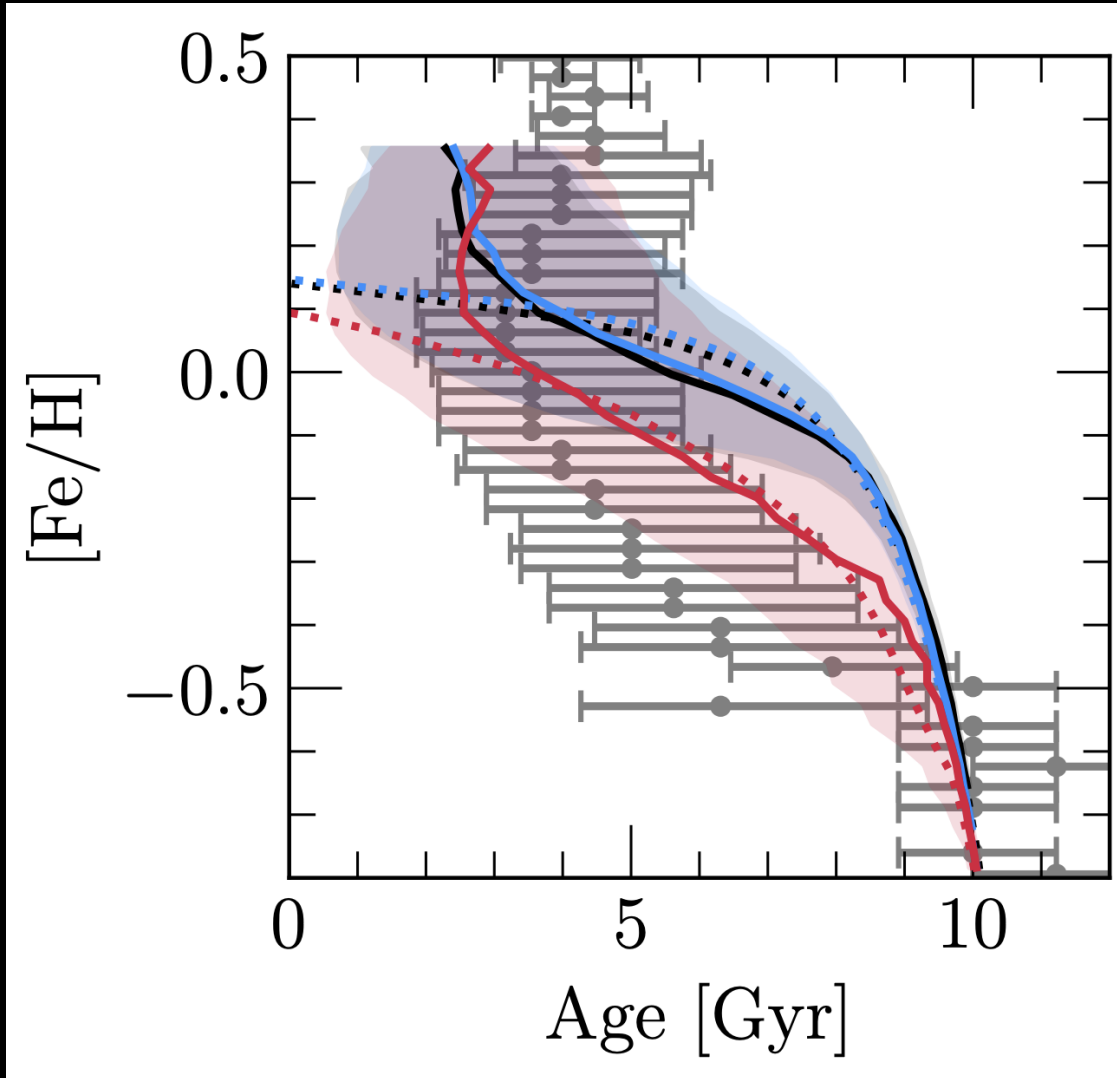
Why Does This Happen?



Free Model for the Spatial Dependence



Compaction: Alleviates Some Age Issues



Alleviates some but not all tension with age data

- Feuillet et al. (2019)
- No Burst
- $\beta_{\phi,\text{GSE}} = +0.8$
- $\beta_{\phi,\text{GSE}} = -0.8$

Diane Feuillet
U. of Uppsala



Summary

No obvious signatures of substantial dilution and re-enrichment in SDSS age-metallicity data

GSE: a $\sim 3:1$ mass-ratio retrograde merger

- $\Delta \log_{10} Z = -0.11$ if completely metal-free $\Rightarrow$ not substantially diluting
- Can produce bimodality instead through influence of gas dynamics on relative CCSN / SN Ia rates

Presence or lack of bimodality in M31 important test of this scenario

- Gibson+24: 80%/20% of MW light from high/low-alpha – opposite in M31
 - Missing high-redshift retrograde merger? Prograde merger instead?

Free Model for the Spatial Dependence

