From Planetary Architectures to Galactic Influences: Understanding our Sun's Unique(ish) Chemistry

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Know Thy Star, Know Thy Planet
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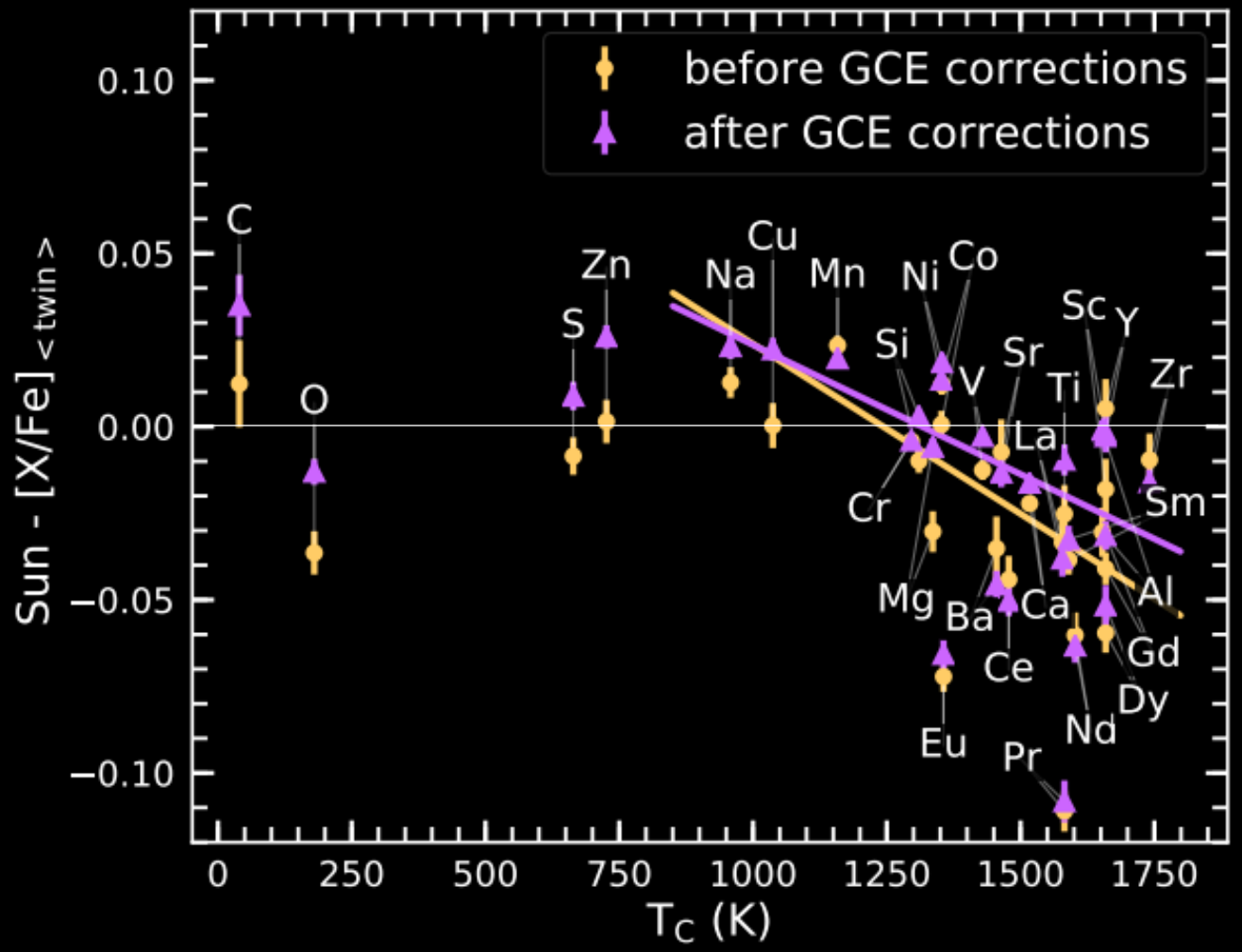
Our Sun's unique(ish) abundance pattern

compared to most other sun-like stars/solar analogs (stars that share similar T_{eff}, Log(g), [Fe/H])



relative refractory* depletion trend compared to ~80% of other solar twins

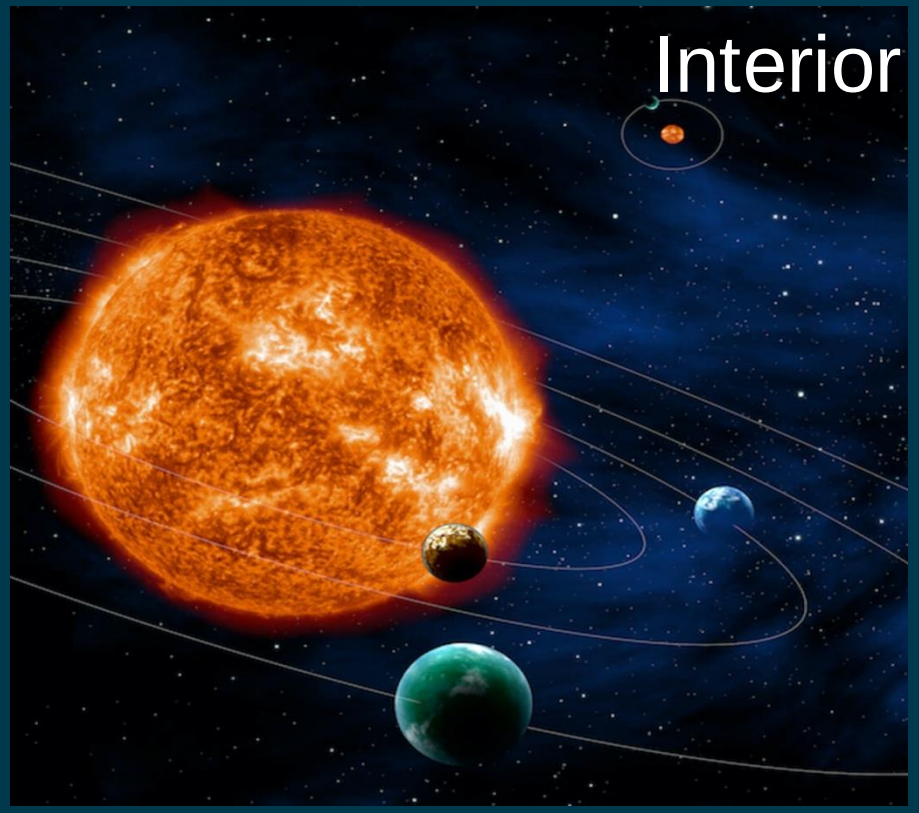
* Elements with high T_c that are hard to vaporize

T_c = Temperature at which 50% of element will condense from vapor to solid

Bedell+2018

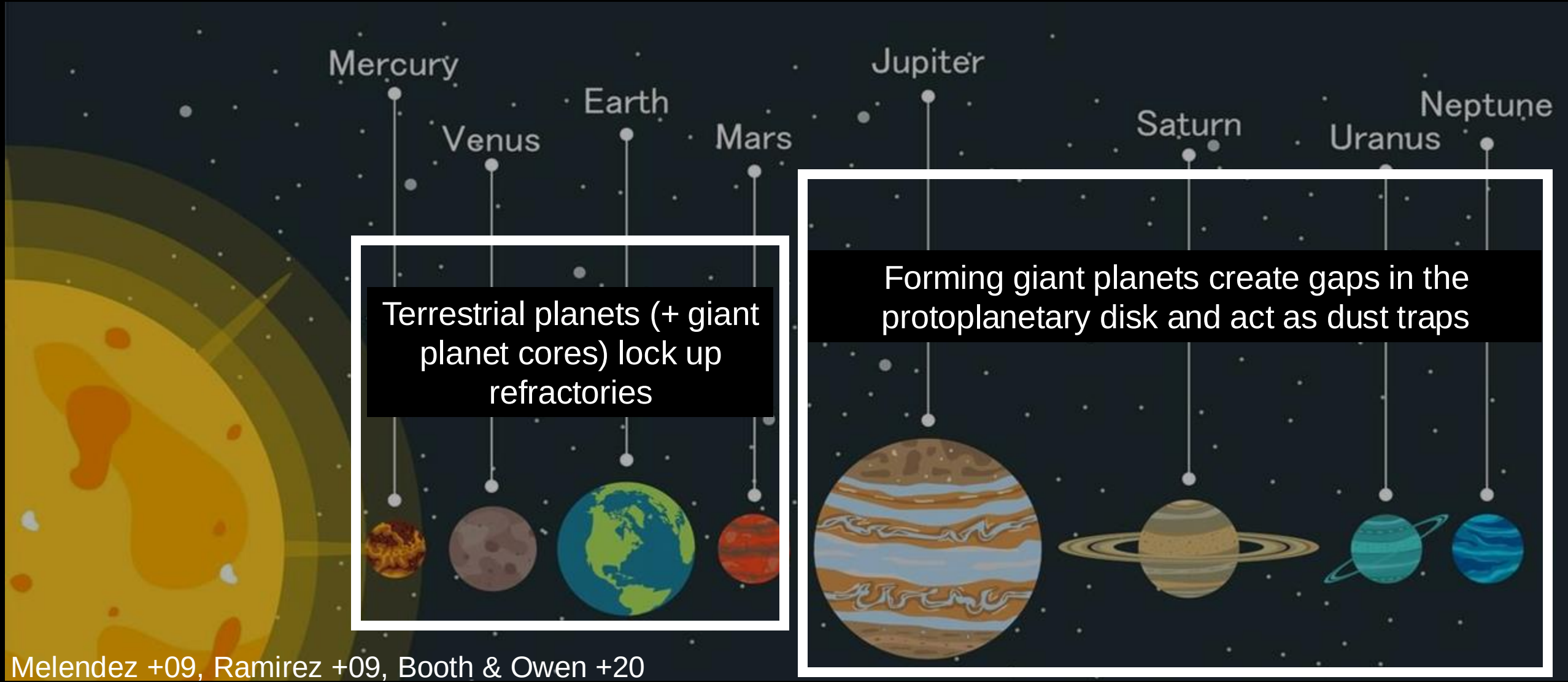
Is this due to an interior or exterior mechanism?

ISM/Galactic



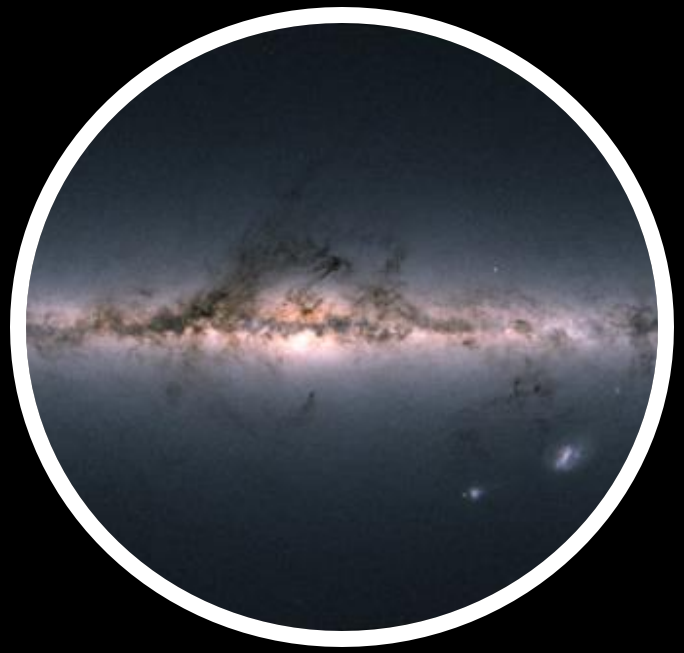
Planets/Solar system

Can terrestrial or giant planets explain deficit?

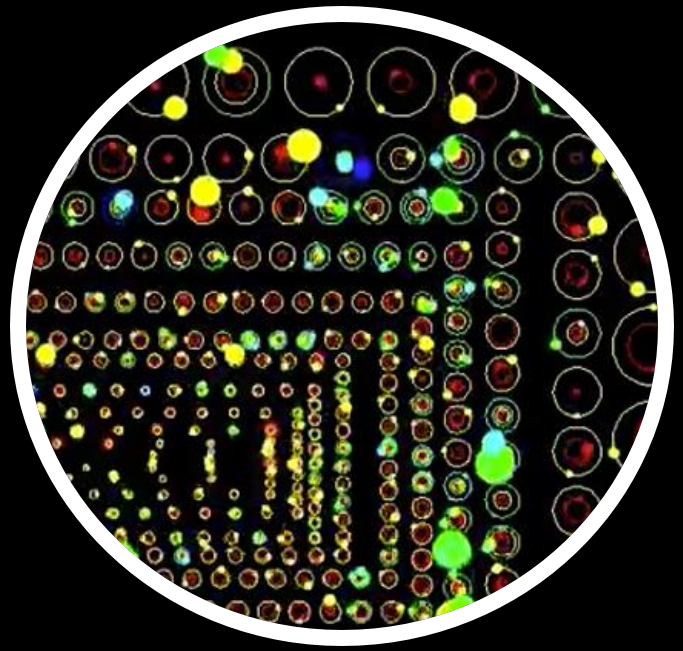


Melendez +09, Ramirez +09, Booth & Owen +20

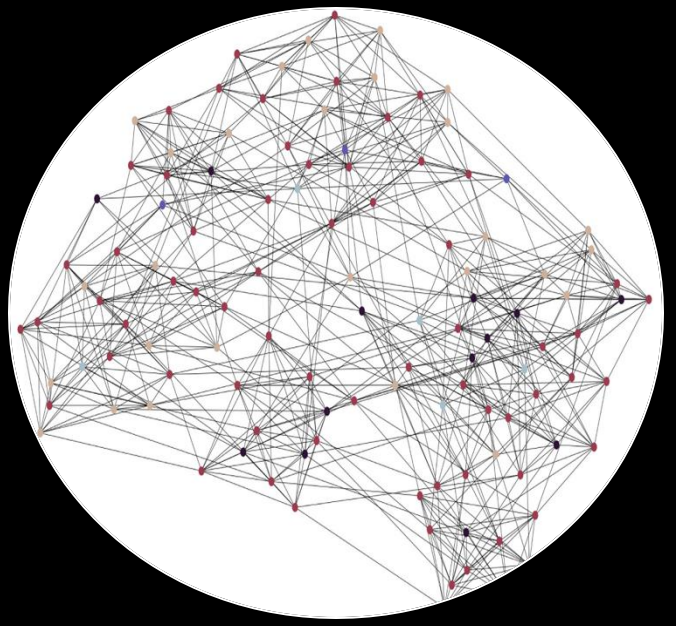
Let’s use Gaia and the current exoplanet population to compare abundance trends



DR3 includes 1 million RVS spectra (R = 11,200)



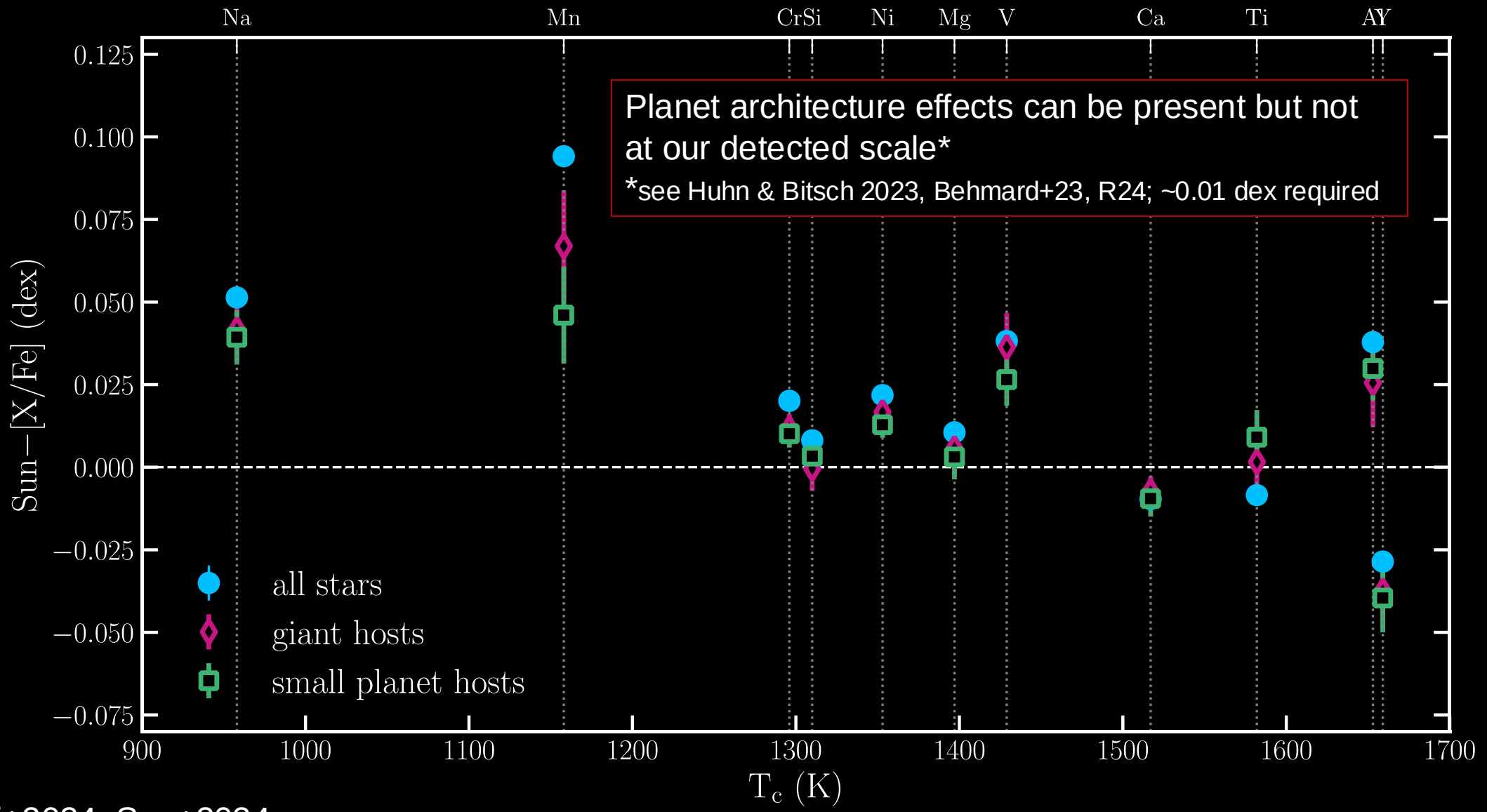
5000+ confirmed planets + 7000+ candidates



Data-driven abundance inference with the Cannon: more precise

Recio-Blanco + 2023, NASA Exoplanet Archive, Berger+2023, Ness+15

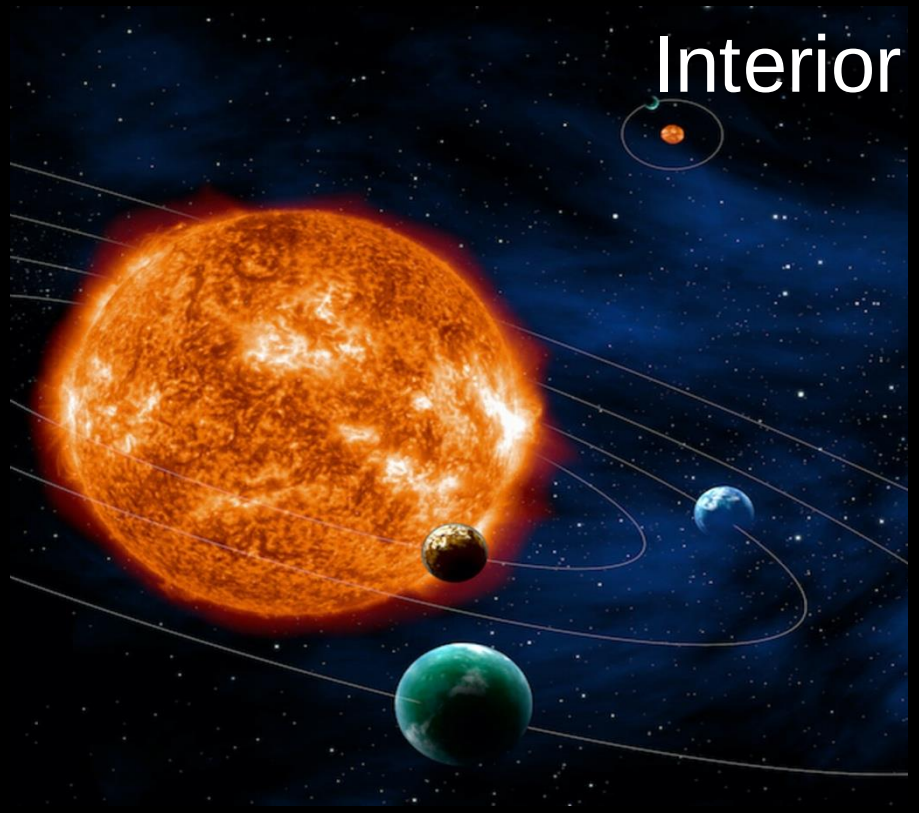
Sun's depletion persists regardless of planet type



Rampalli+2024, Sun+2024

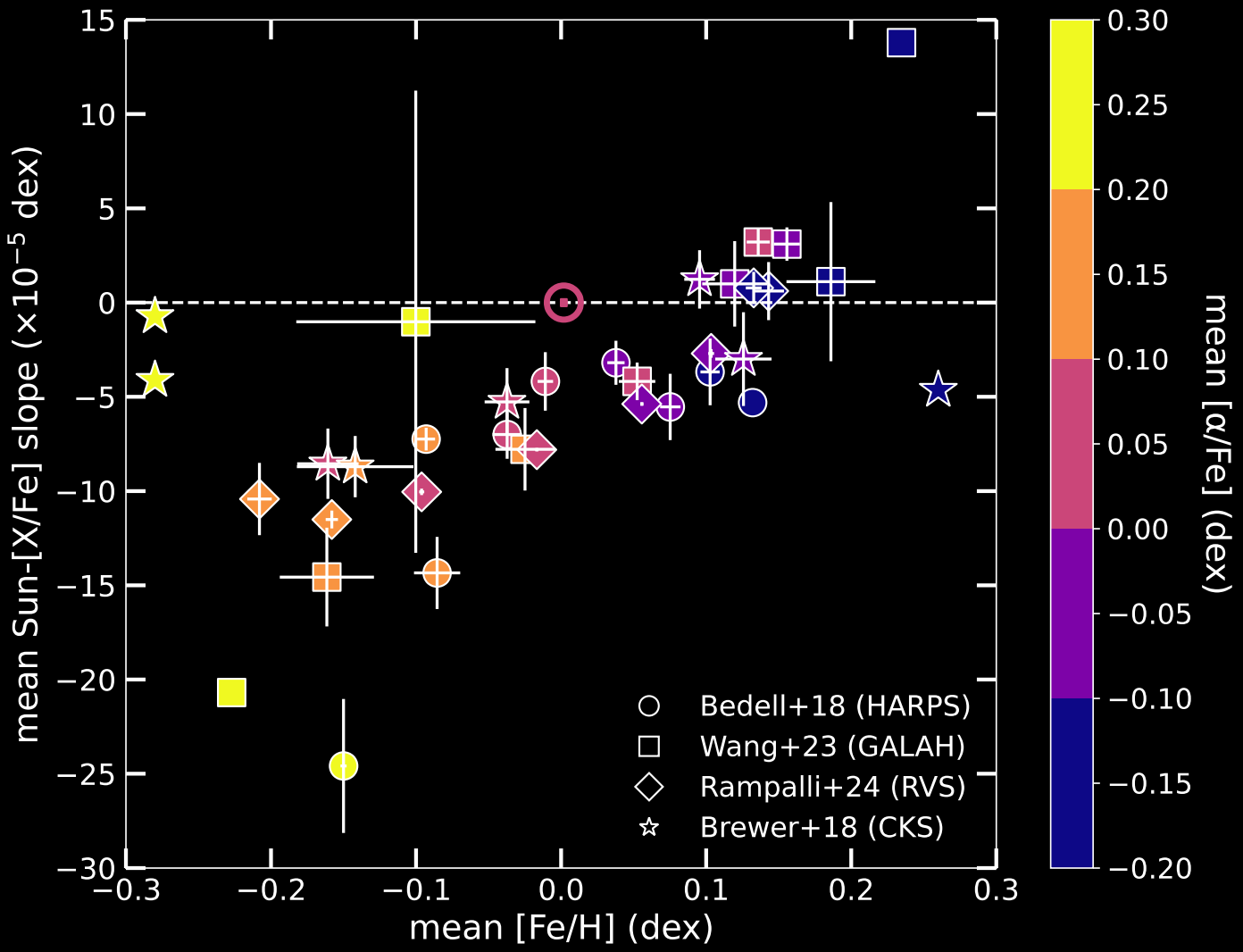
Back to the drawing board

ISM/Galactic



Planets/Solar system

Global [Fe/H] and [α/Fe]* (GCE) Trends in refractory-T_c space for Sun-like stars

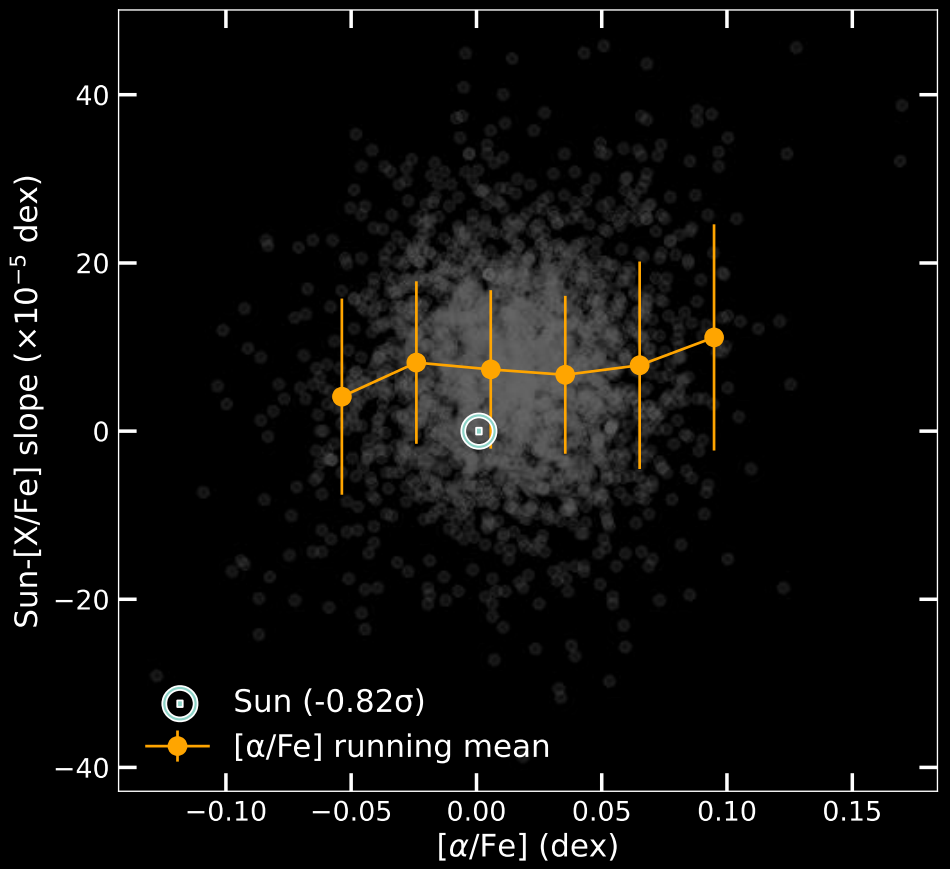


- *[α/Fe]: what kind of star-formation environment was star born in? SNII/SNIa proxy for star formation timescale
- Sun's abundance pattern more closely resembles metal-rich and alpha-depleted stars
- If we fix [Fe/H], does [α/Fe] trace refractory-T_c trends?

Rampalli+in prep

[α/Fe]

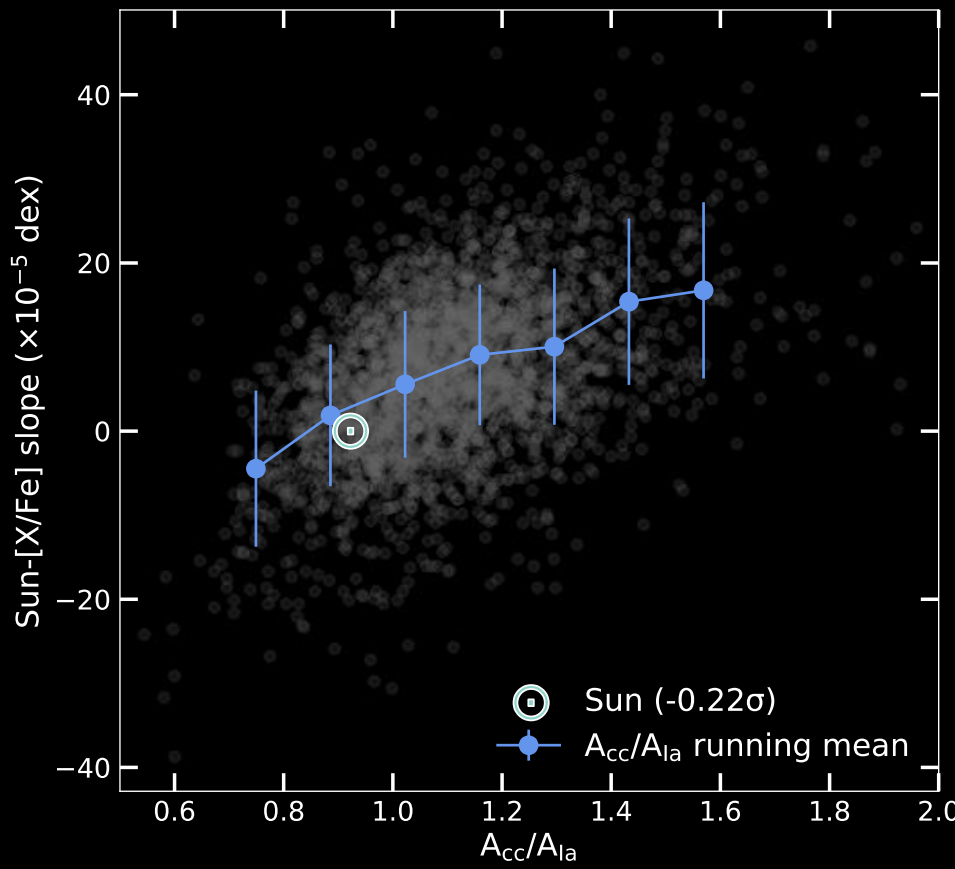
Elements approximated as either alpha-process (SNII/CC) or iron-peak (SNIa) based on the relative element amounts created from each nucleosynthetic source



$[A_{cc}/A_{Ia}]$

data driven [α/Fe]: model abundances as a sum of a prompt process (A_{cc} from SNII/CC) + delayed process (A_{Ia} from SNIa) vectors to avoid binary nucleosynthetic designations (Griffith+24)

$[A_{cc}/A_{Ia}]$ is a better predictor for refractory-T_c trends, and the Sun is (even) less of an outlier in this parameter space



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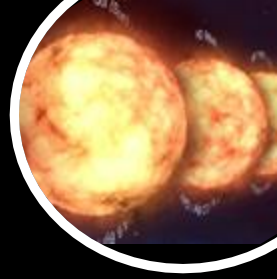
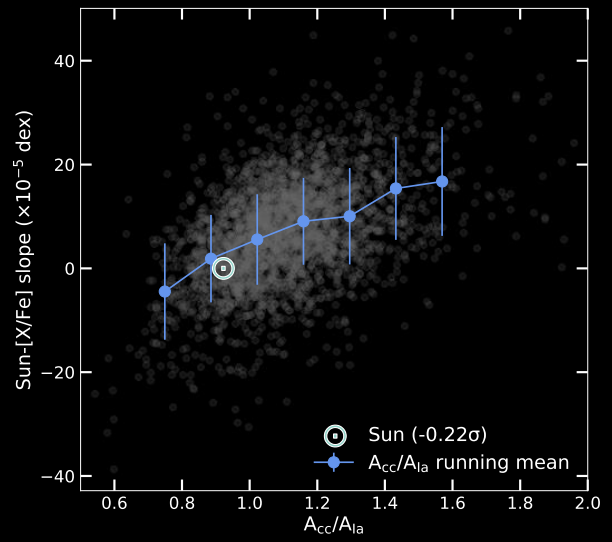
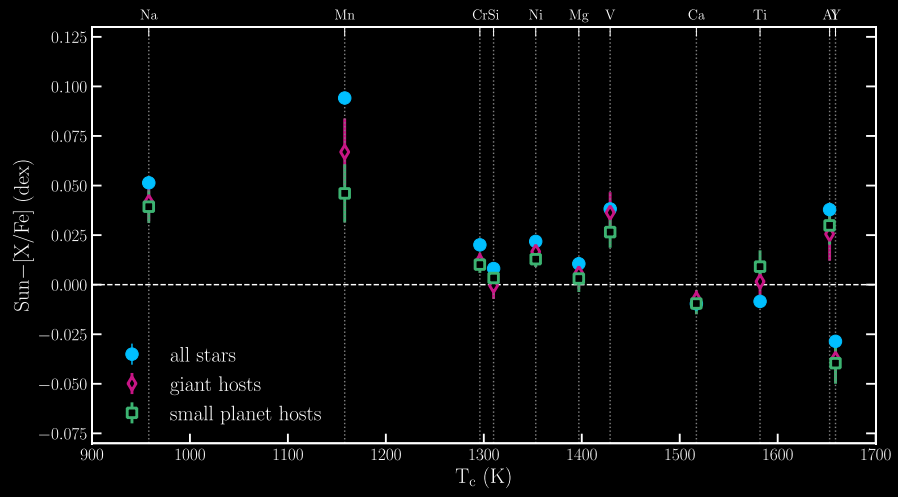
The Sun's Not So Unique Chemistry



- Data-driven Galactic chemical evolution shows the Sun is chemically ordinary compared to previous analyses
- Planet architectures may influence the Sun's chemistry but isn't dominant here
- Choice of parameters matter when analyzing subtle trends from planets, GCE, and disentangling the two





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