CEMP Stars Near & Far: Examining the halo & disk using CEMP-no & CEMP-s stars

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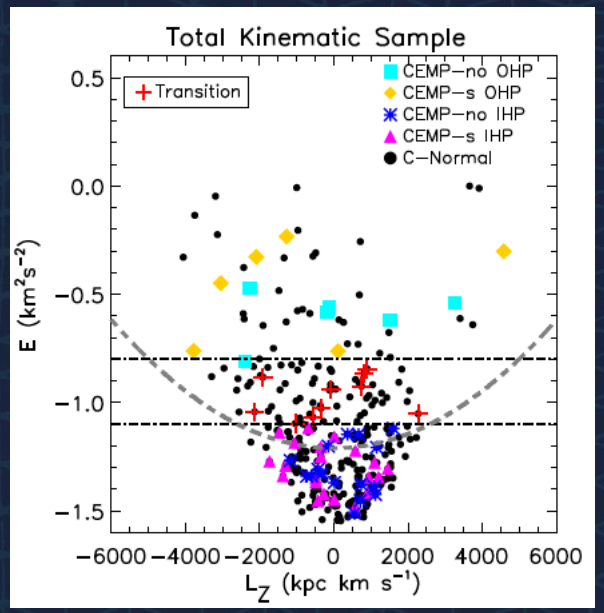
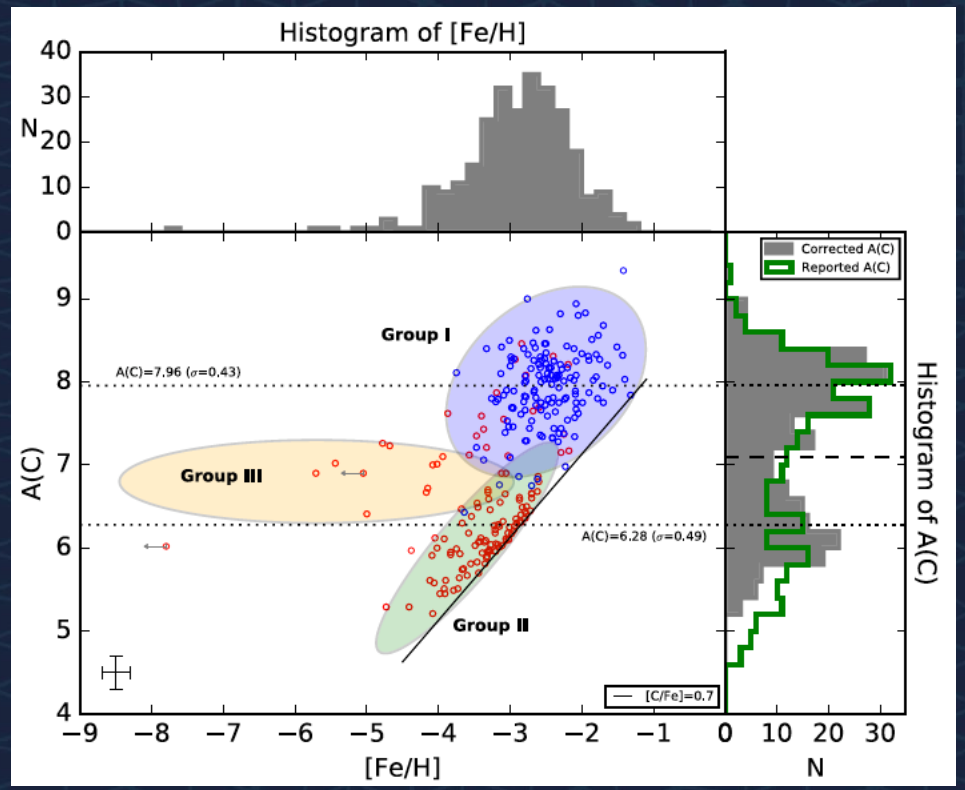
CEMP Stars Near & Far: Intro



Carollo et al. 2014

Interested in using CEMP-no & CEMP-s stars to examine structure in disk & halo

Previously had to use high-resolution samples to study CEMP-no & CEMP-s (Ba & Eu available), which were small by necessity



Yoon et al. 2016

Yoon et al. 2016 show CEMP-no & CEMP-s can be separate on basis of A(C) alone -> med-resolution data now available for CEMP-no vs. CEMP-s analyses

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CEMP Stars Near & Far: Data

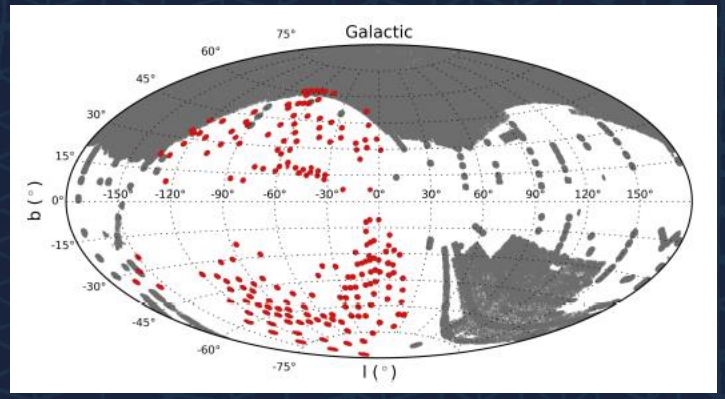
AEGIS (see Yoon et al. 2018):

R ~ 1300
~ 71,000 stars
~ 1600 (~ 1000 SG/G) CEMP stars
S hemisphere
Selected to study thick disk

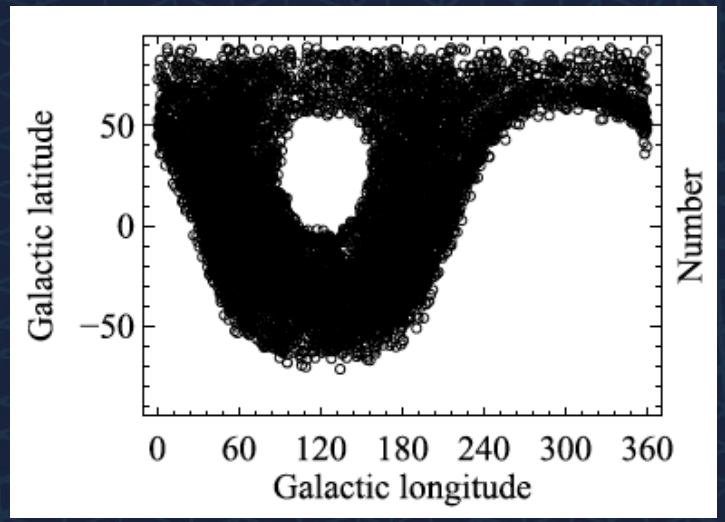
LAMOST DR3 VMP catalog (see Haining Li's talk):

R ~ 1800
~ 10,000 stars
~ 2500 (~ 1600 SG/G) CEMP stars
N hemisphere
Selected to be VMP stars

Note: selected SG/G CEMP stars only to avoid bias. At higher temperatures carbon more difficult to measure, so CEMP-no stars undercounted (see Tim Beers' talk).



Yoon et al. 2018



Li et al. 2018

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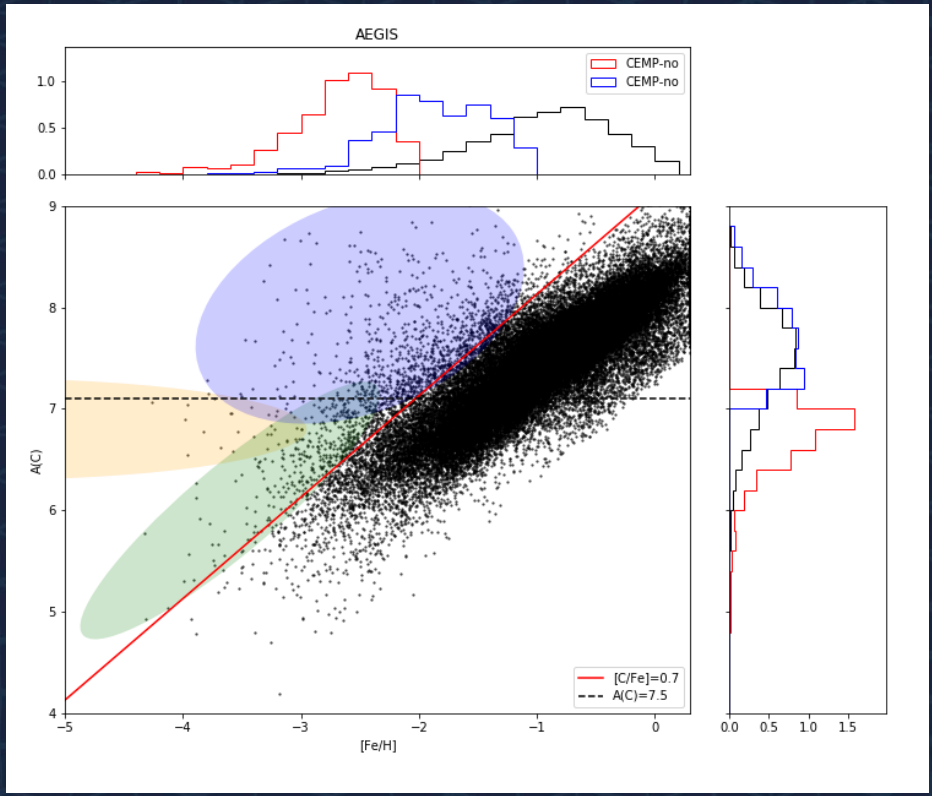
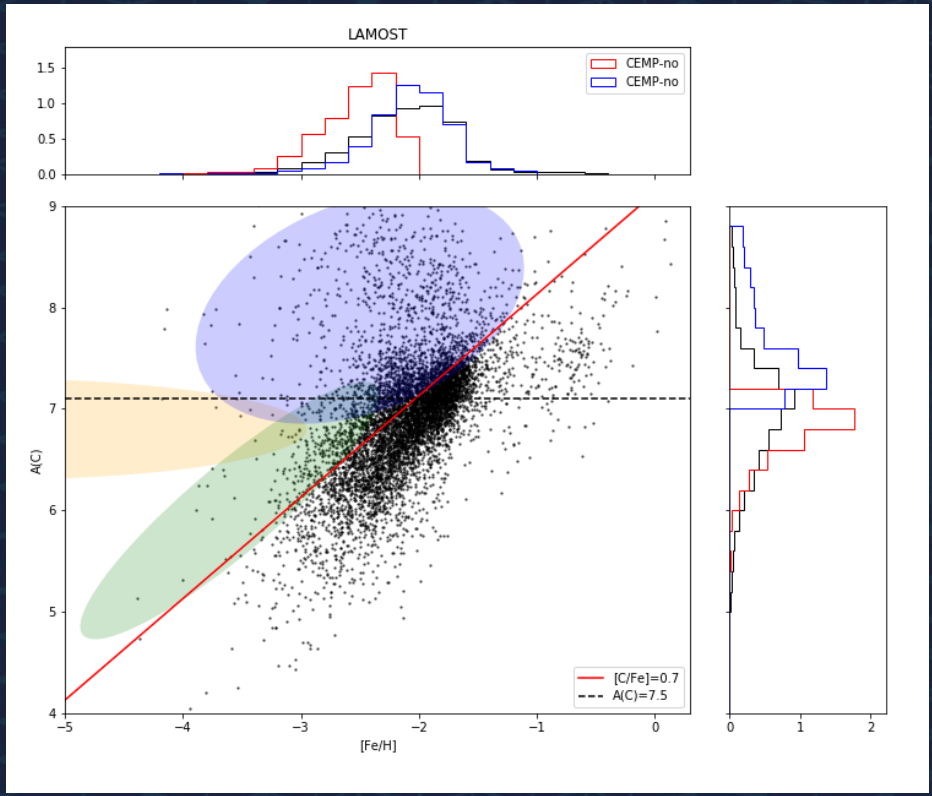
CEMP Stars Near & Far: Data

Populating Yoon-Beers diagram with samples



Dietz et al., in prep.



Dietz et al., in prep.

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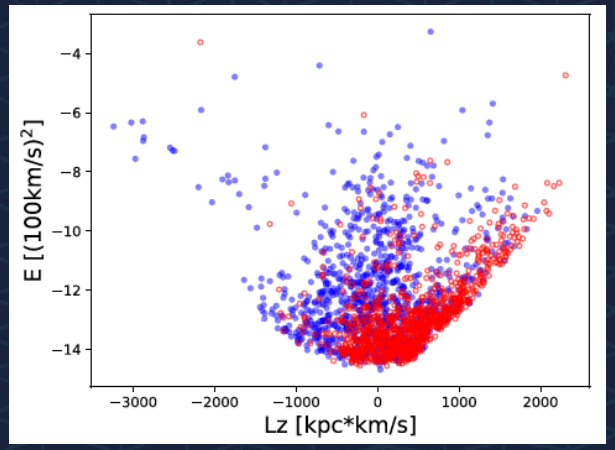
CEMP Stars Near & Far: Motivation

GE/“The Structure of Many Names”

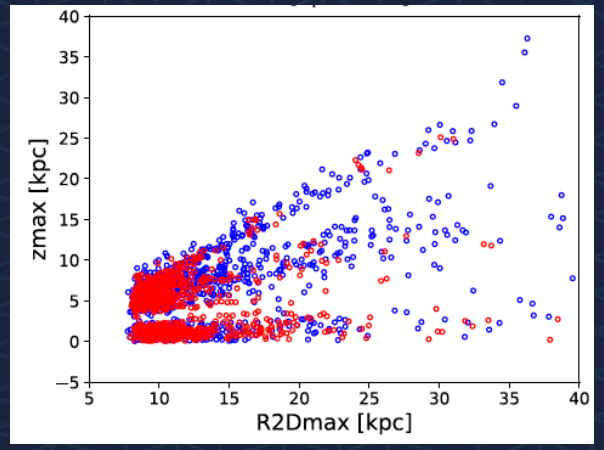
Origin of IH, heated thick disk?

CEMP-no/CEMP-s can be used to characterize diff pops in MW, since they are believed to have diff progenitor environs

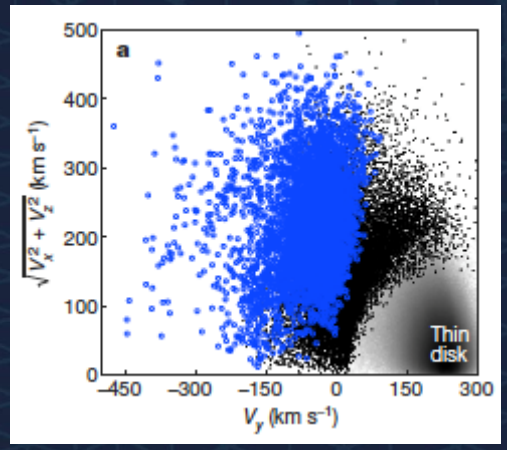
Have access to sample with many thick disk stars (AEGIS)



Haywood et al. 2018



Haywood et al. 2018



Helmi et al. 2018

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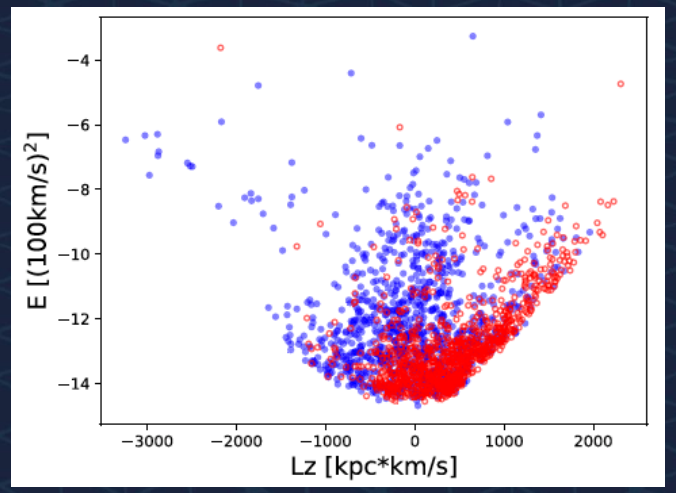
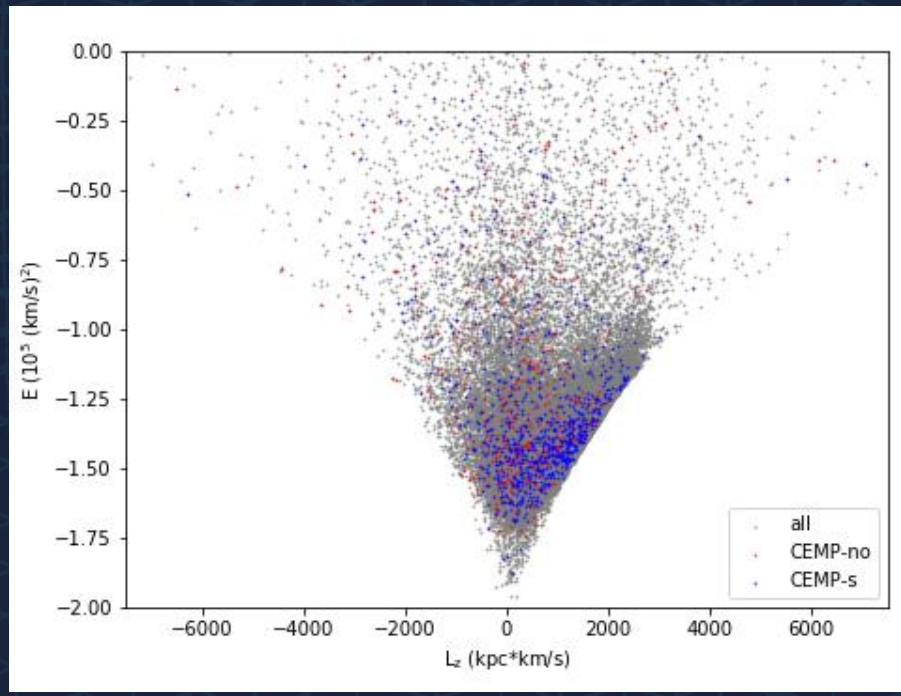
CEMP Stars Near & Far: Analysis



Haywood et al. 2018

AEGIS



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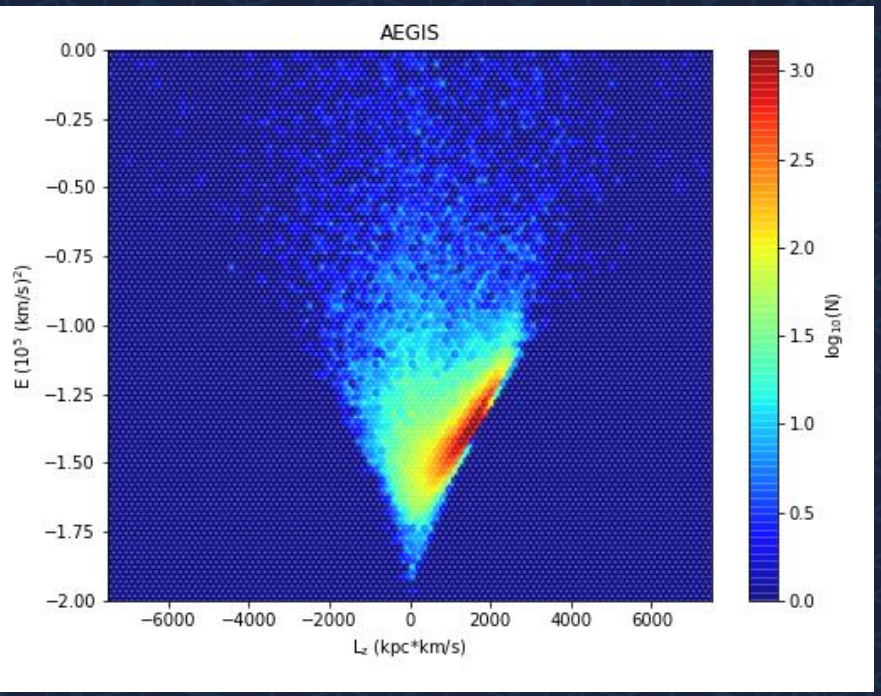

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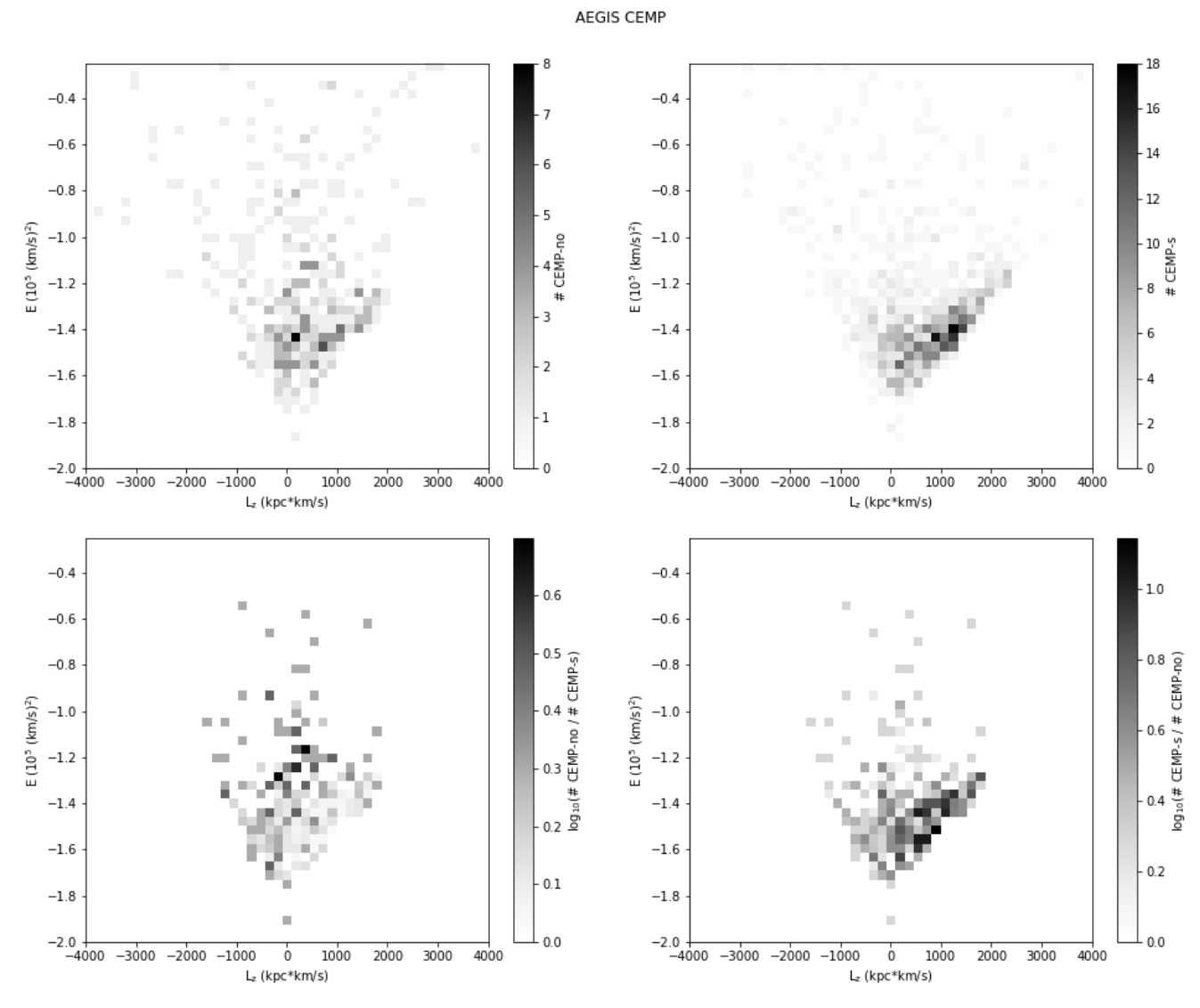

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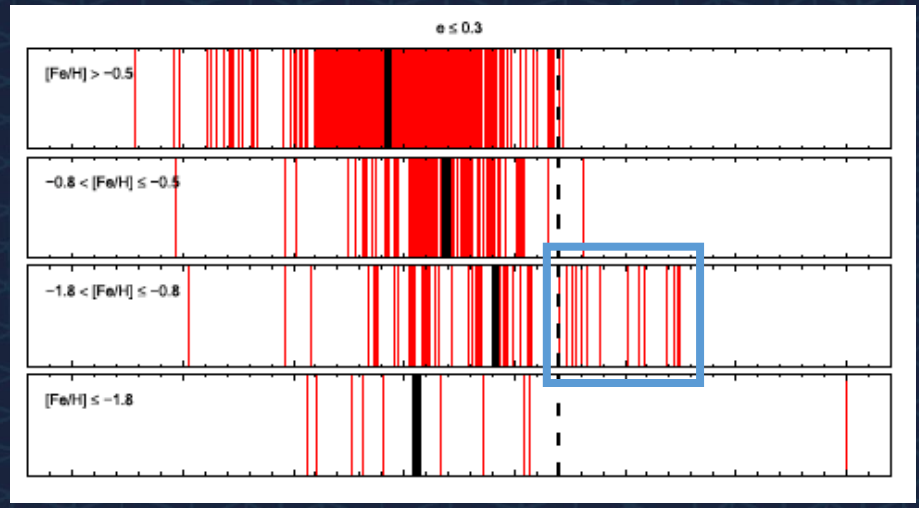

Beers et al. 2017

Many AEGIS CEMP-no in plume while most AEGIS CEMP-s concentrated in thick disk

52/48 % CEMP-s to CEMP-no in "GE" based on Helmi description of GE characteristics

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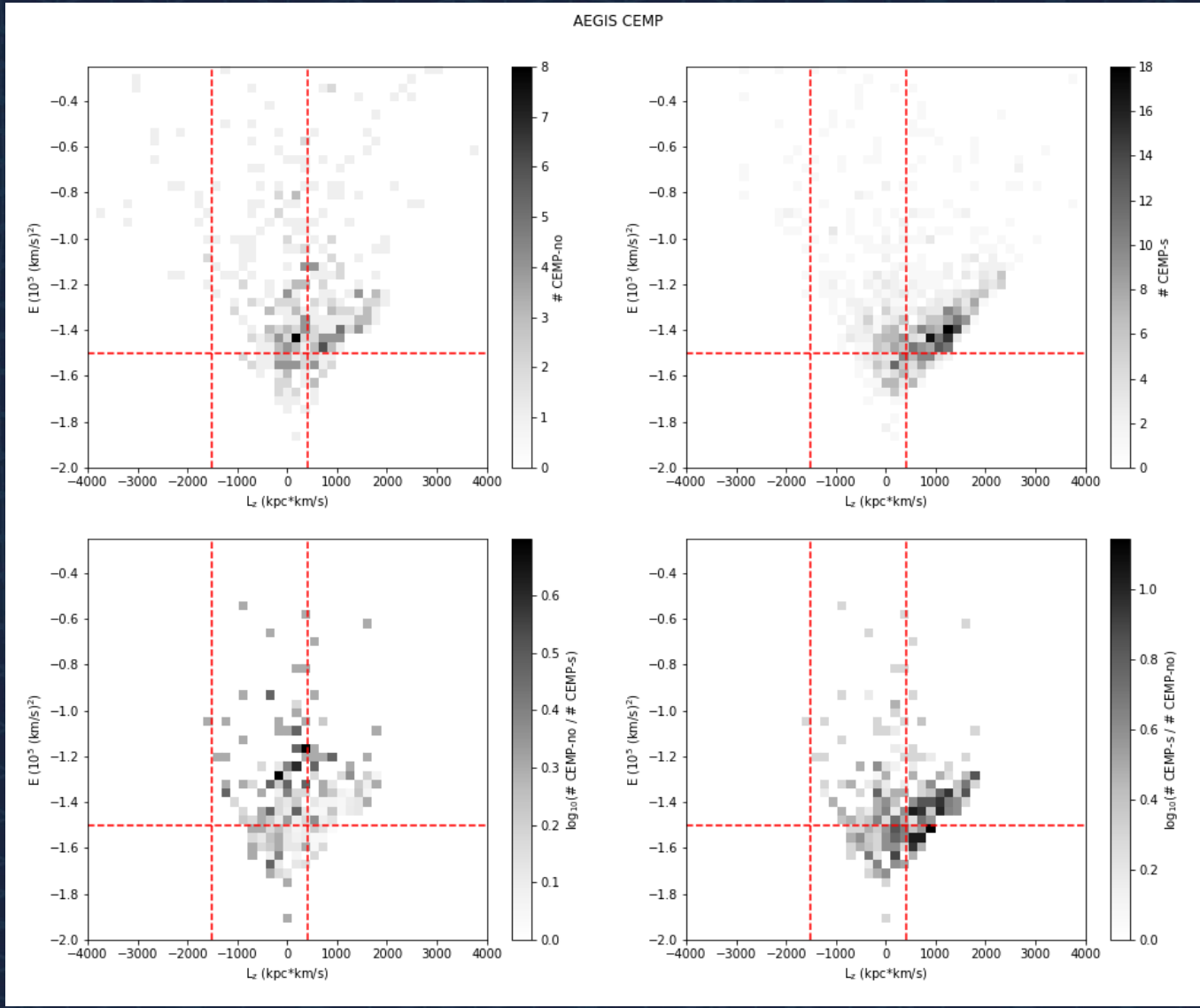
CEMP Stars Near & Far: Analysis



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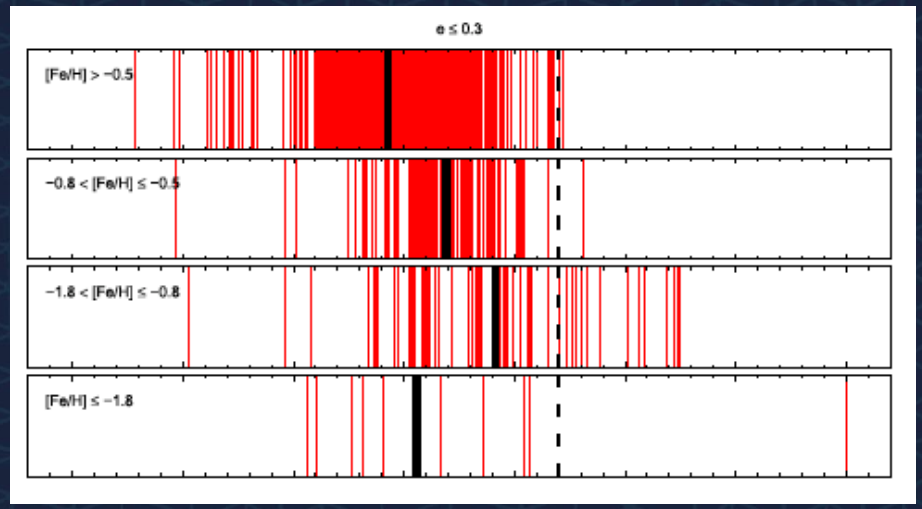

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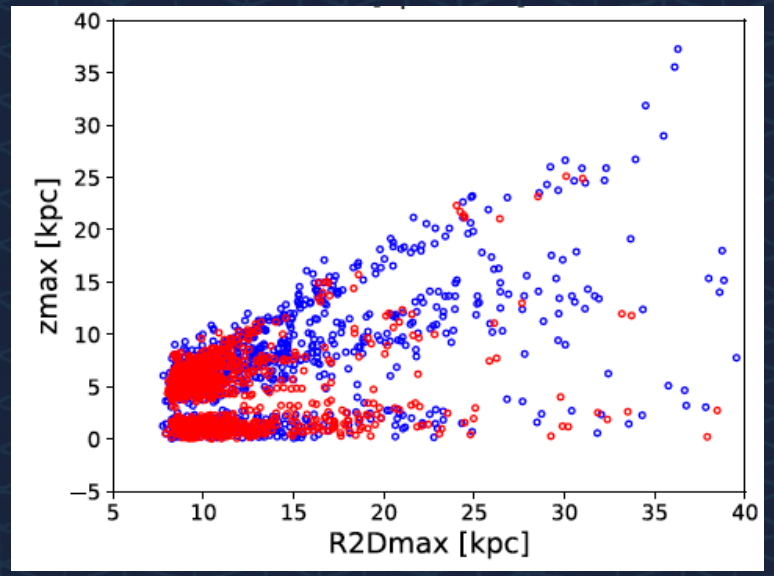
CEMP Stars Near & Far: Analysis

R_apo – Z_max GE “wedges”

CEMP-s present in upper & lower wedge,
CEMP-no mainly in upper



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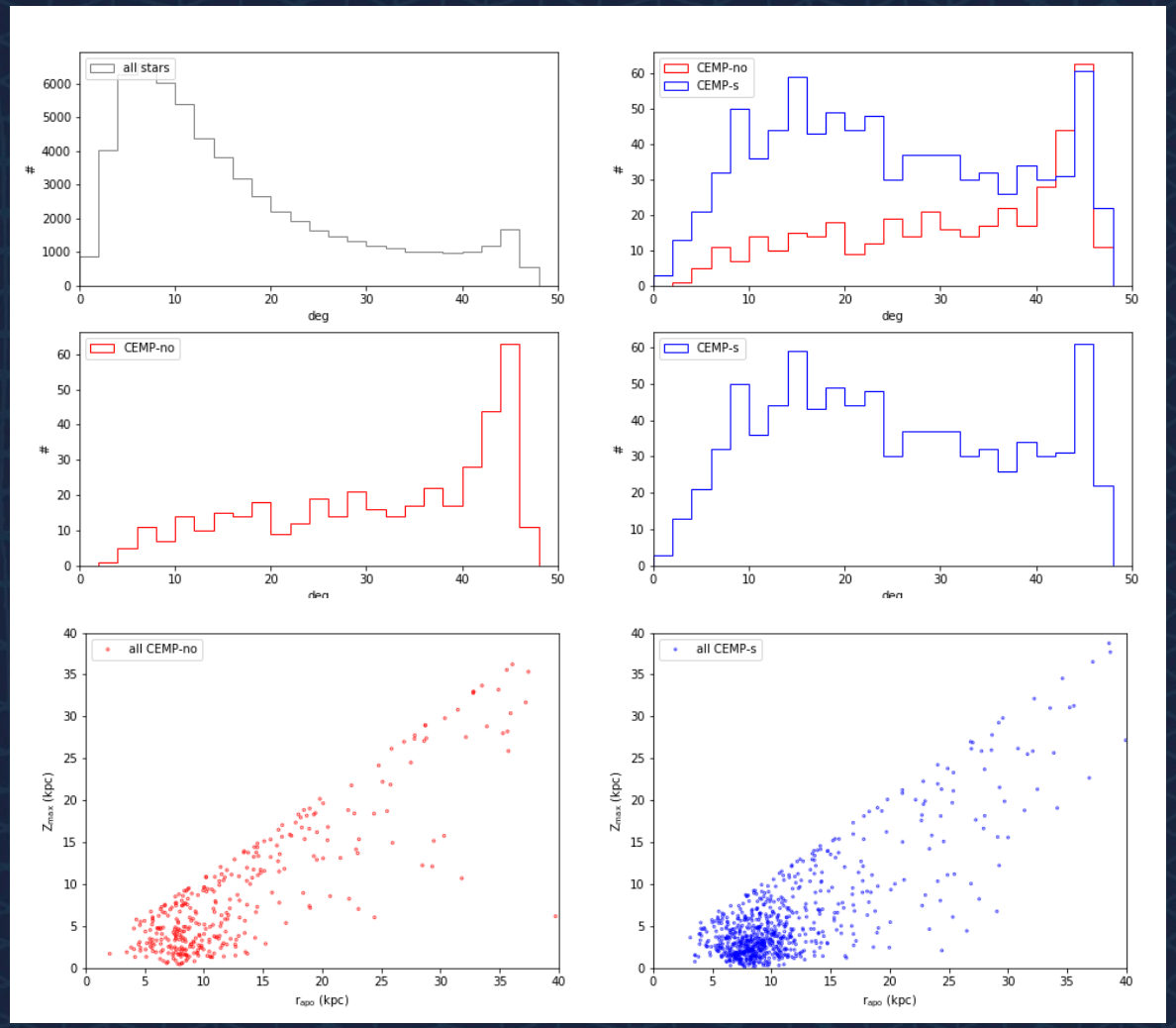

Dietz et al., in prep.

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CEMP Stars Near & Far: Implications

Reasonably consistent w/ Carollo et al. 2014 IH percentages

Presence of many CEMP-no stars in addition to high # of CEMP-s stars indicates GE may have experienced a combination of mergers of low & moderate mass MHs

High concentration of CEMP-s in disk?

Metallicity range of thin & thick higher than these CEMP-s stars (part of “MWTD”), maybe didn’t form in-situ here

Could be “donated” by GE. GE papers suggest GE merger heated disk leading to formation of thick disk, MWTD could be “donated” portion. So thick disk could be combo of in-situ disk & accreted disk.

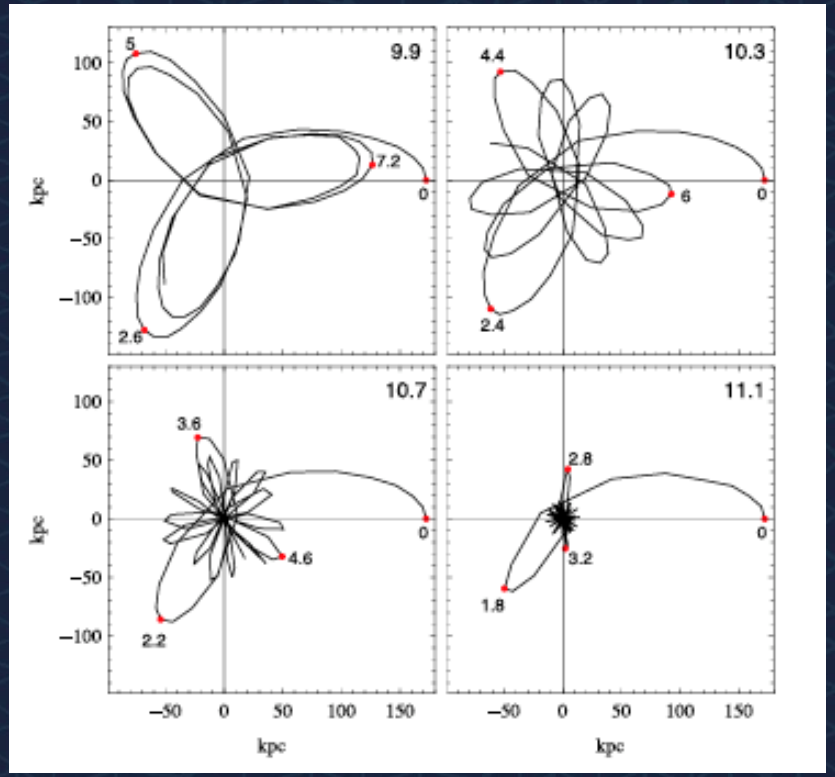
CEMP Stars Near & Far: Motivation

Want to contrast behavior of outermost halo with better-known inner & outer halo

Have reason to believe outermost halo would be heavily populated by CEMP-no stars

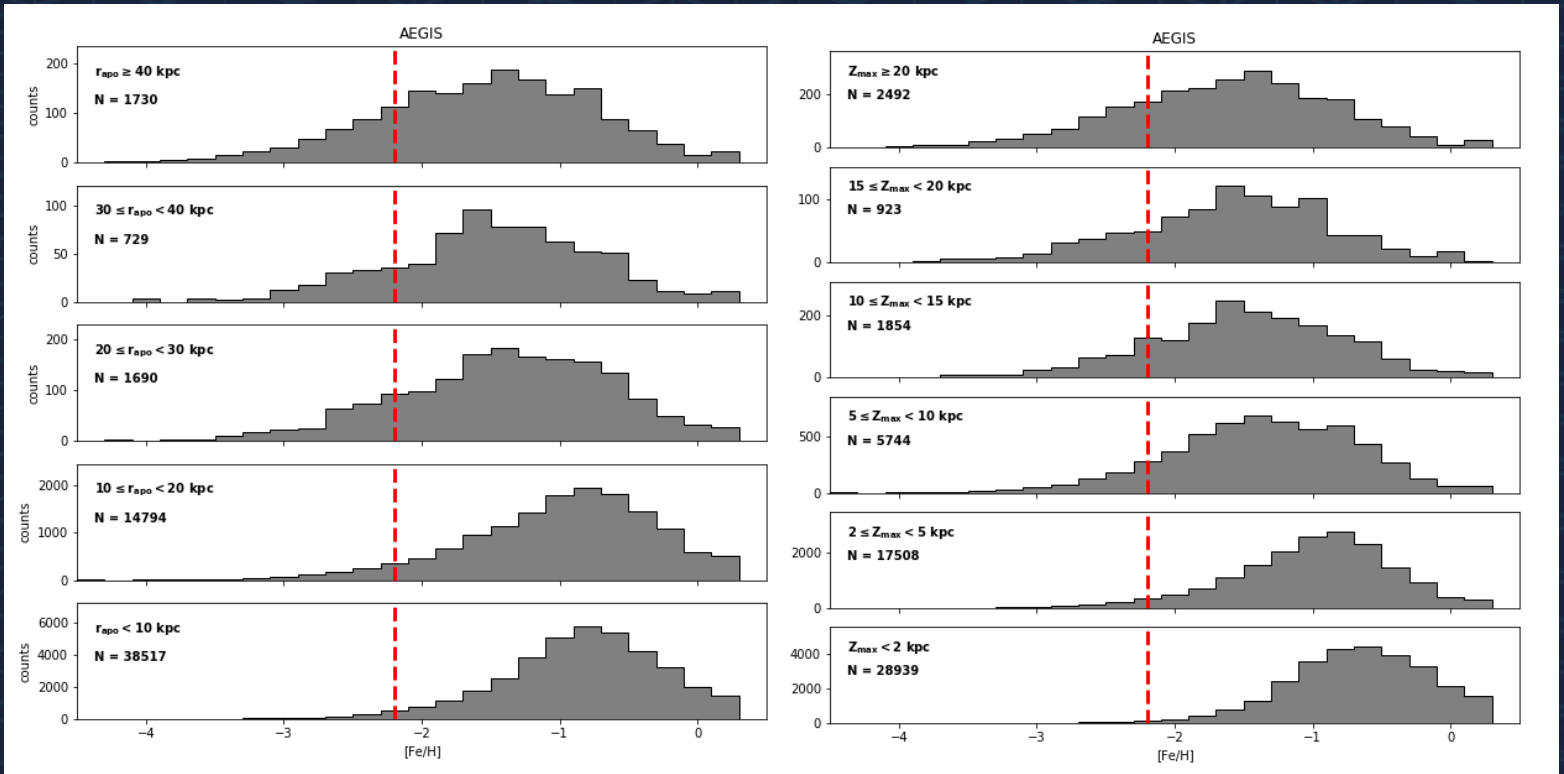
Lower-mass MHs fall less deeply into the potential wells of their host galaxies (Amorisco 2017)

CEMP-no stars likely to form on low-mass MHs with limited supply of gas, where star formation was quenched early on



Amorisco 2017

CEMP Stars Near & Far: Analysis



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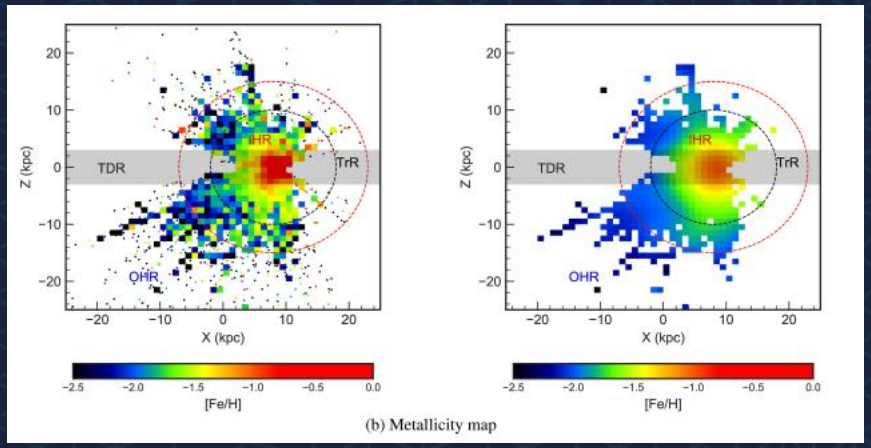

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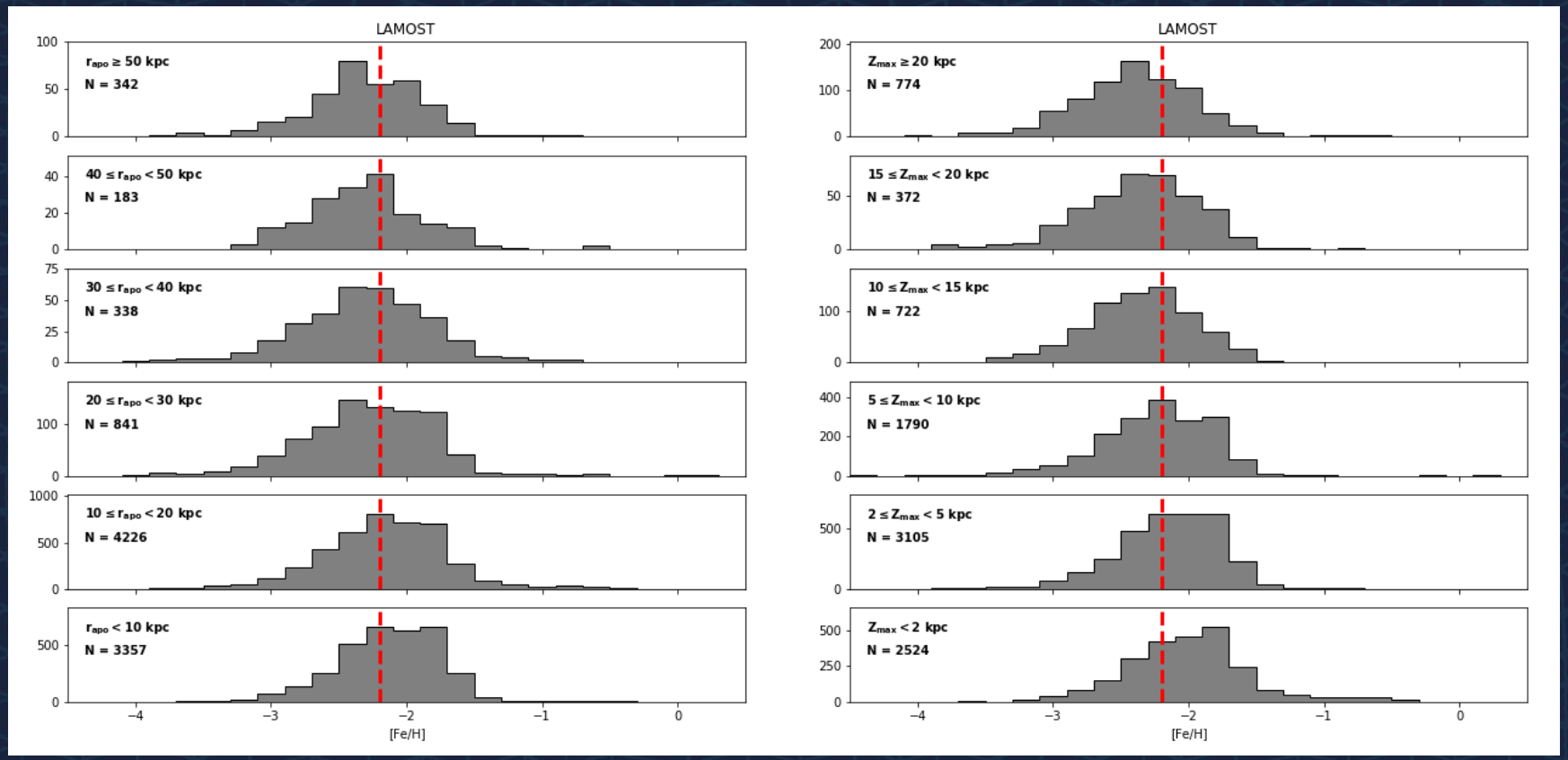

Dietz et al., in prep.

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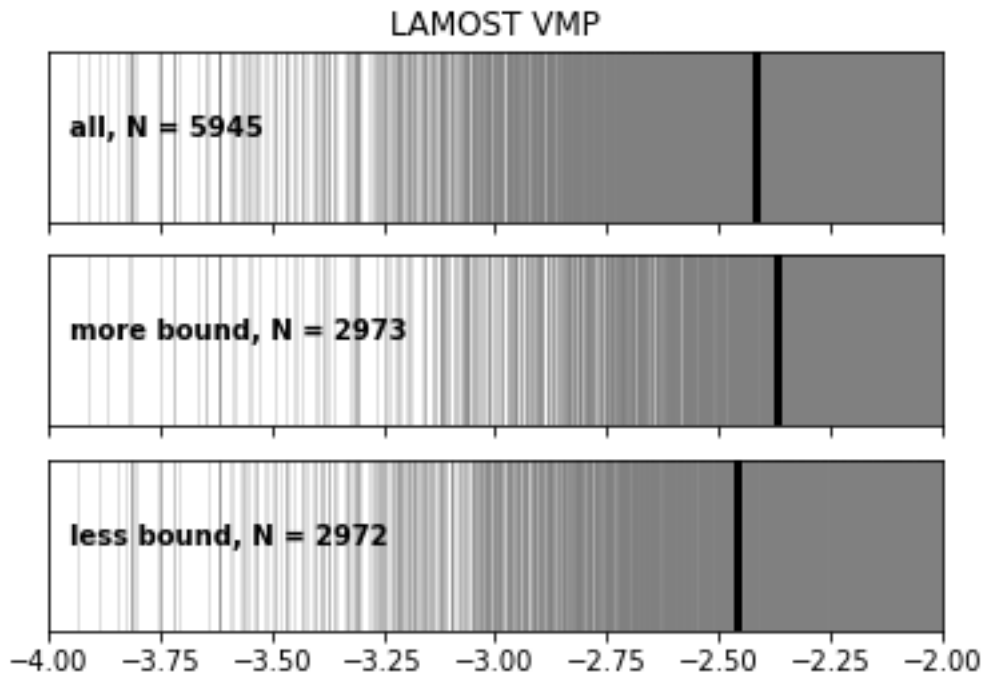
CEMP Stars Near & Far: Analysis

2-sample KS-test: more/less bound stars not drawn from same parent population

->difference in the metallicity distributions of VMP stars in our halo as we move out to examine less-bound stars



Dietz et al., in prep.

Implications:

Outskirts of outer-halo best place to look for metal-poor, ancient stars, populate Group III

Seen in simulations previously (Salvadori et al. 2010, Starkenburg et al. 2017, & more)

CEMP Stars Near & Far: Summary & Future Work

"GE" CEMP-no/CEMP-s ratios ~ consistent with IH characteristics

GE may have experienced low-mod mass MH mergers

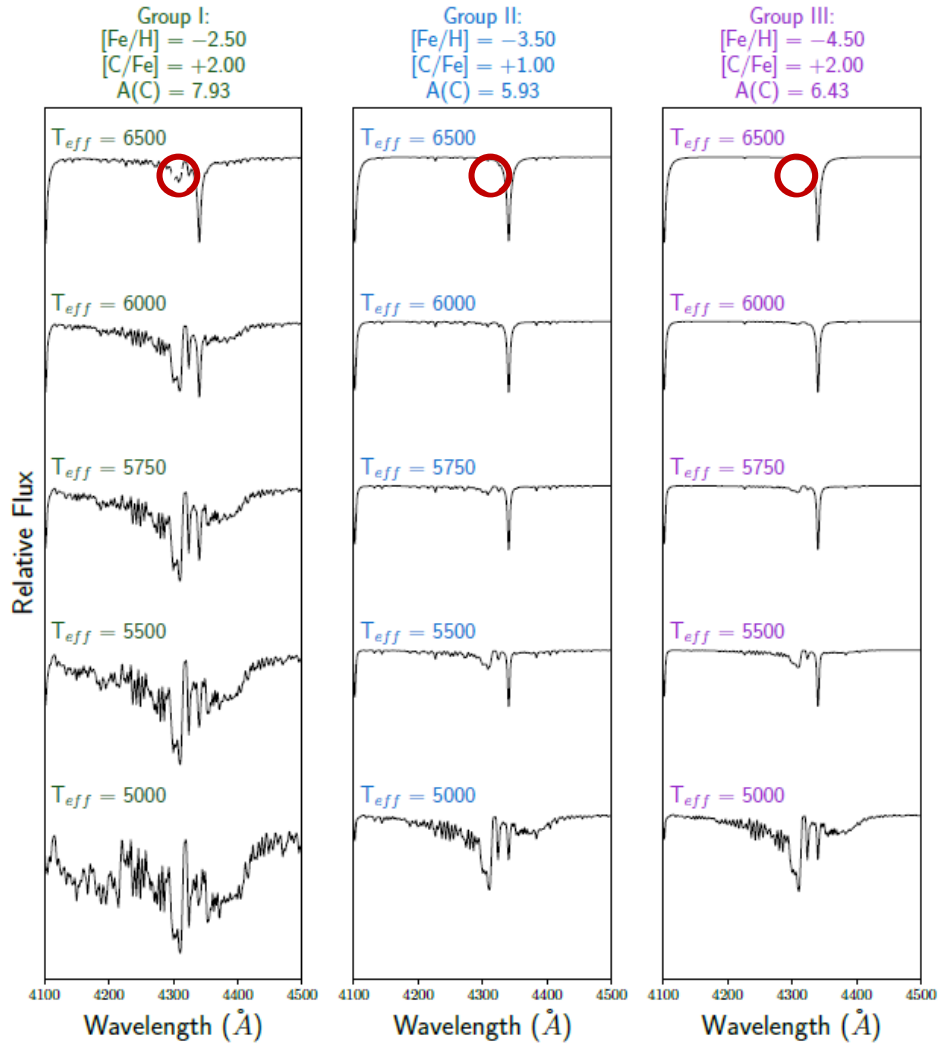
High amount CEMP-s in thick disk -> could have been imported
Thick disk may have in-situ component & ex-situ component (MWTD) from GE

Simulators: is amount of CEMP-s stars we find in thick disk consistent with an "imported" portion from GE? Are observed kinematics consistent?

OH gradient: best place to look for most metal-poor stars is OH, consistent with simulations

Want to take advantage of this to target UMP stars

Appendix: Effect of Temp. on C-detection



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