The Giraffe Inner Bulge Survey (GIBS)

…and the Legacy Value of VVV

Manuela Zoccali

PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE

MILLENNIUM INSTITUTE OF ASTROPHYSICS

How did this form?

How did this form?

shape

How did this form?

shape
kinematics

How did this form?

shape
kinematics
density profile

How did this form?

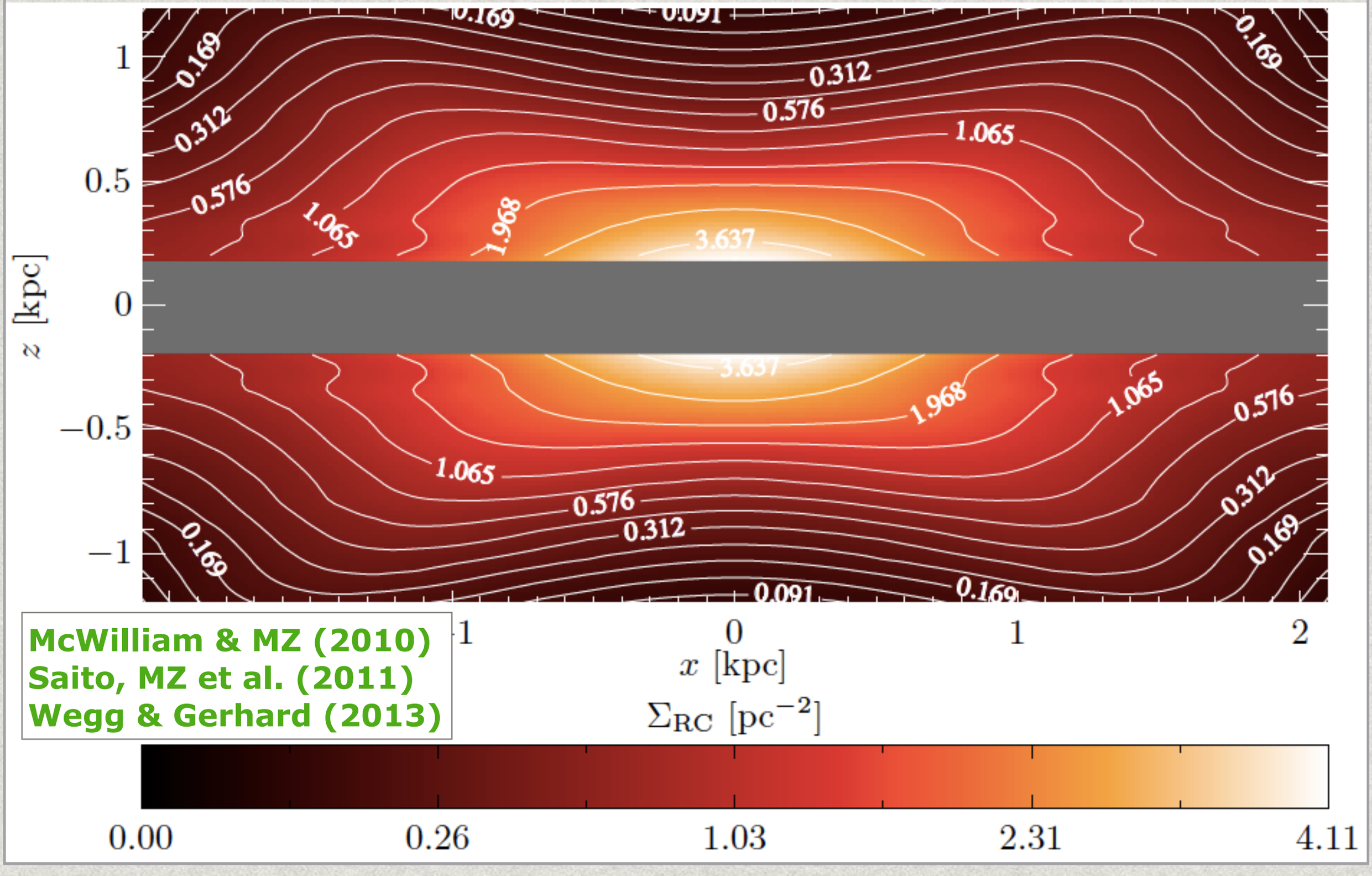
shape
kinematics
density profile
chemical composition

How did this form?

shape
kinematics
density profile
chemical composition
Star Formation History

The boxy/peanut Galactic bulge

…talk by Chris Wegg



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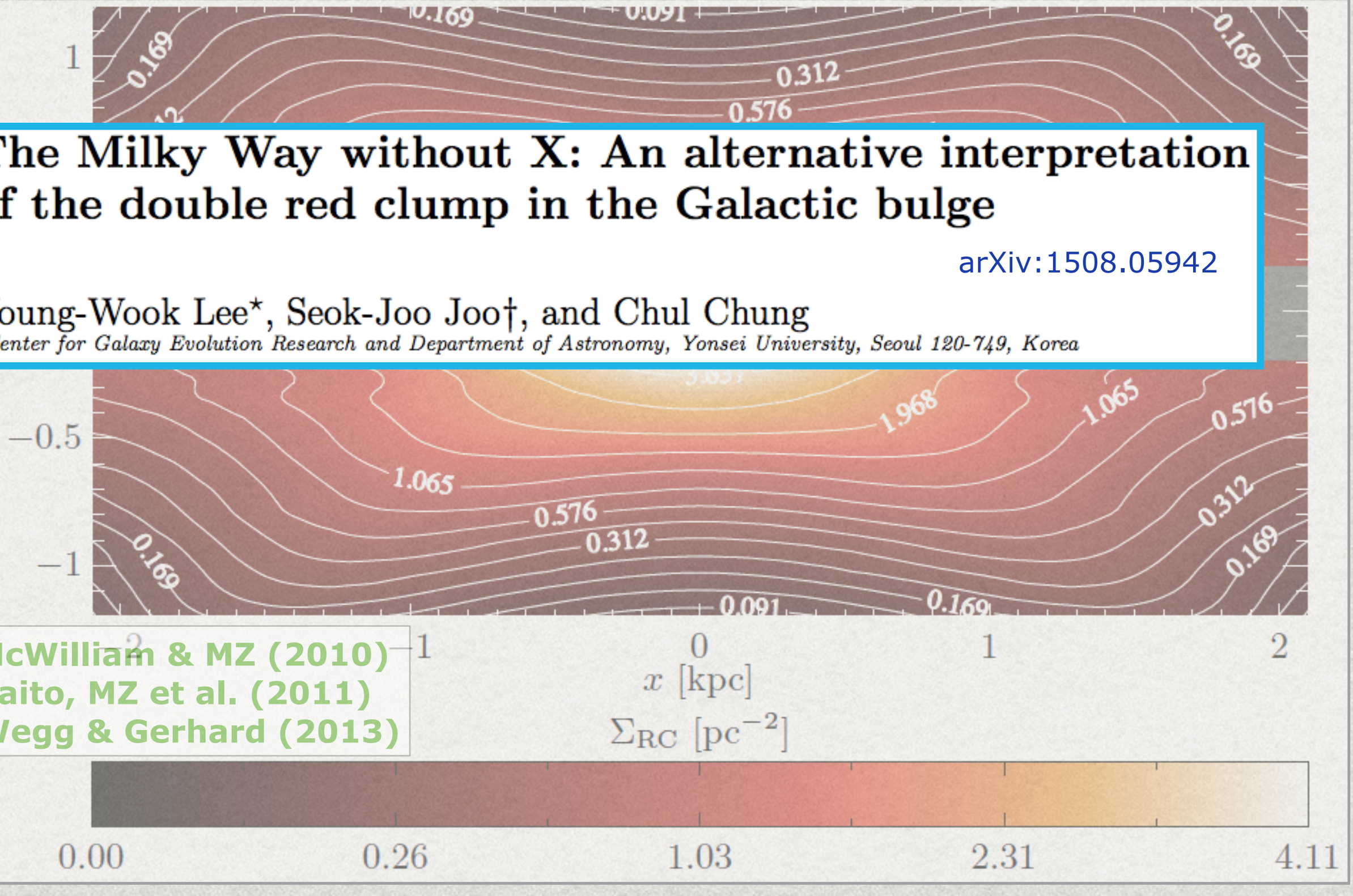
The Milky Way without X: An alternative interpretation of the double red clump in the Galactic bulge

arXiv:1508.05942

Young-Wook Lee*, Seok-Joo Joo†, and Chul Chung
Center for Galaxy Evolution Research and Department of Astronomy, Yonsei University, Seoul 120-749, Korea



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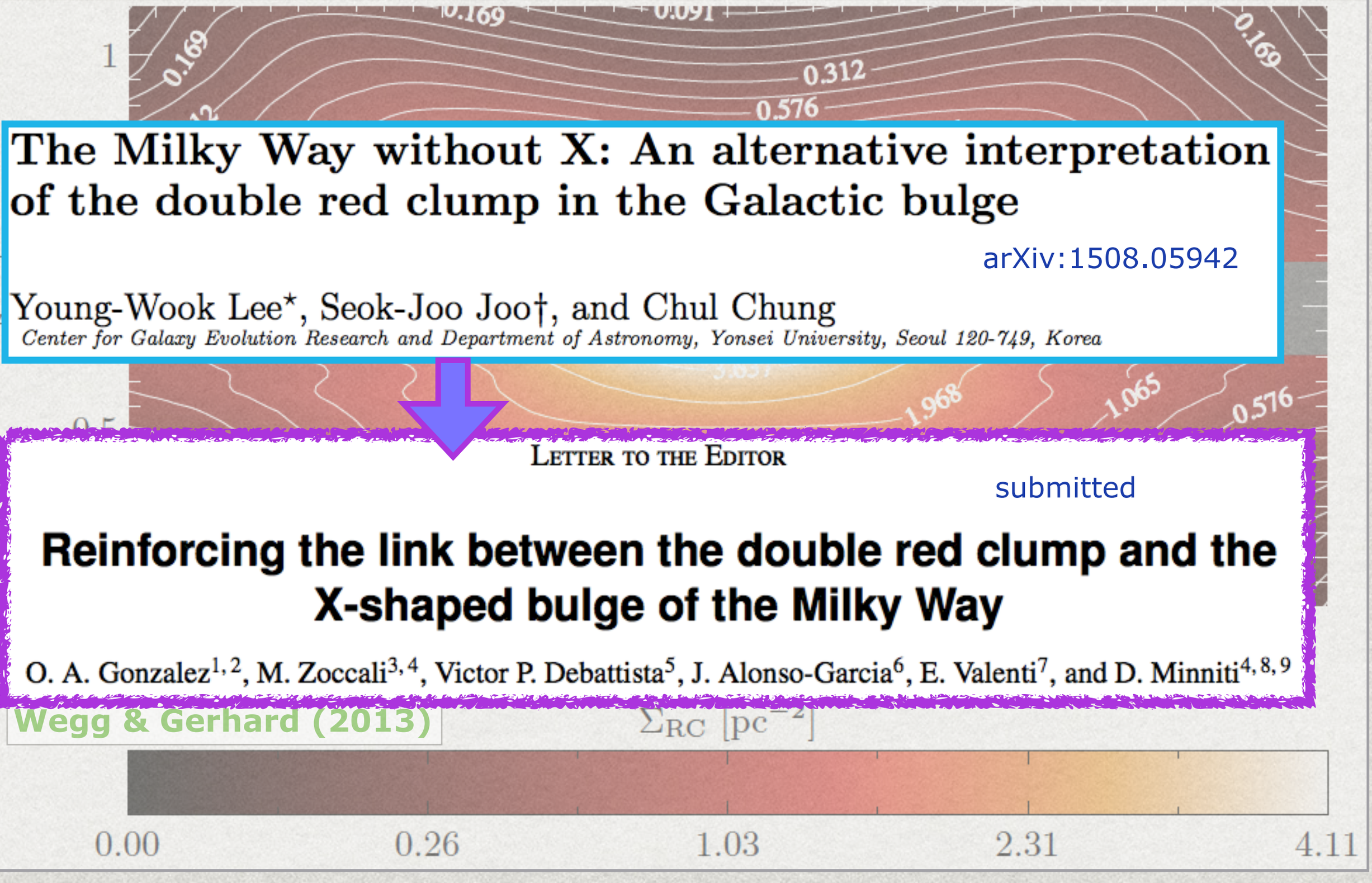
LETTER TO THE EDITOR

submitted

Reinforcing the link between the double red clump and the X-shaped bulge of the Milky Way

O. A. Gonzalez[1,2], M. Zoccali[3,4], Victor P. Debattista[5], J. Alonso-Garcia[6], E. Valenti[7], and D. Minniti[4,8,9]



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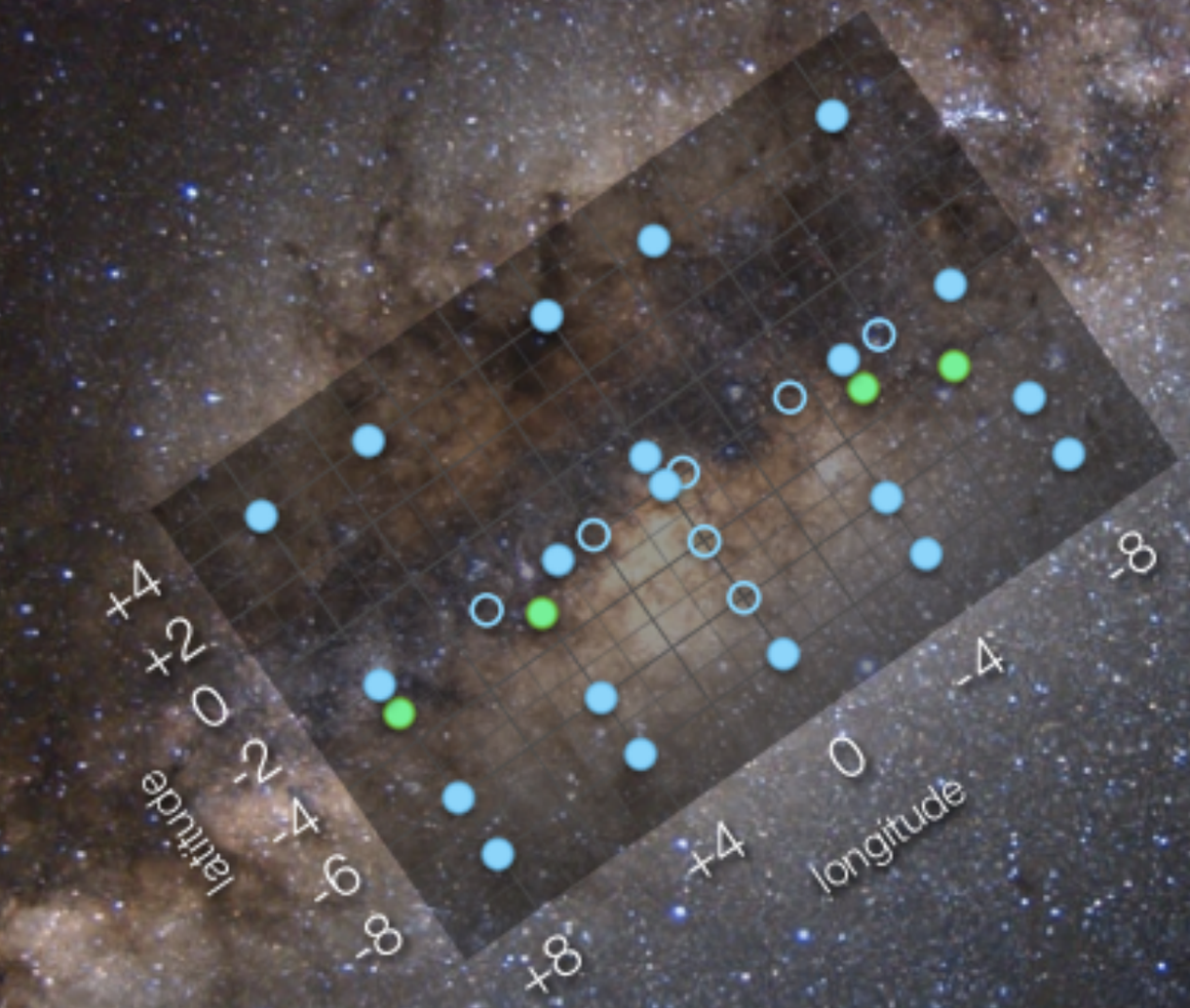
The Giraffe Inner Bulge Survey

PI: MZ



~6500 stars on CaT
+450 stars on HR13

LP 187.B-0909
130h with FLAMES

M. Zoccali, O. A. Gonzalez, S. Vasquez, V. Hill, M. Rejkuba, E. Valenti,
A. Renzini, A. Rojas-Arriagada, I. Martinez-Valpuesta,
C. Babusiaux, T. Brown, D. Minniti, and A. McWilliam

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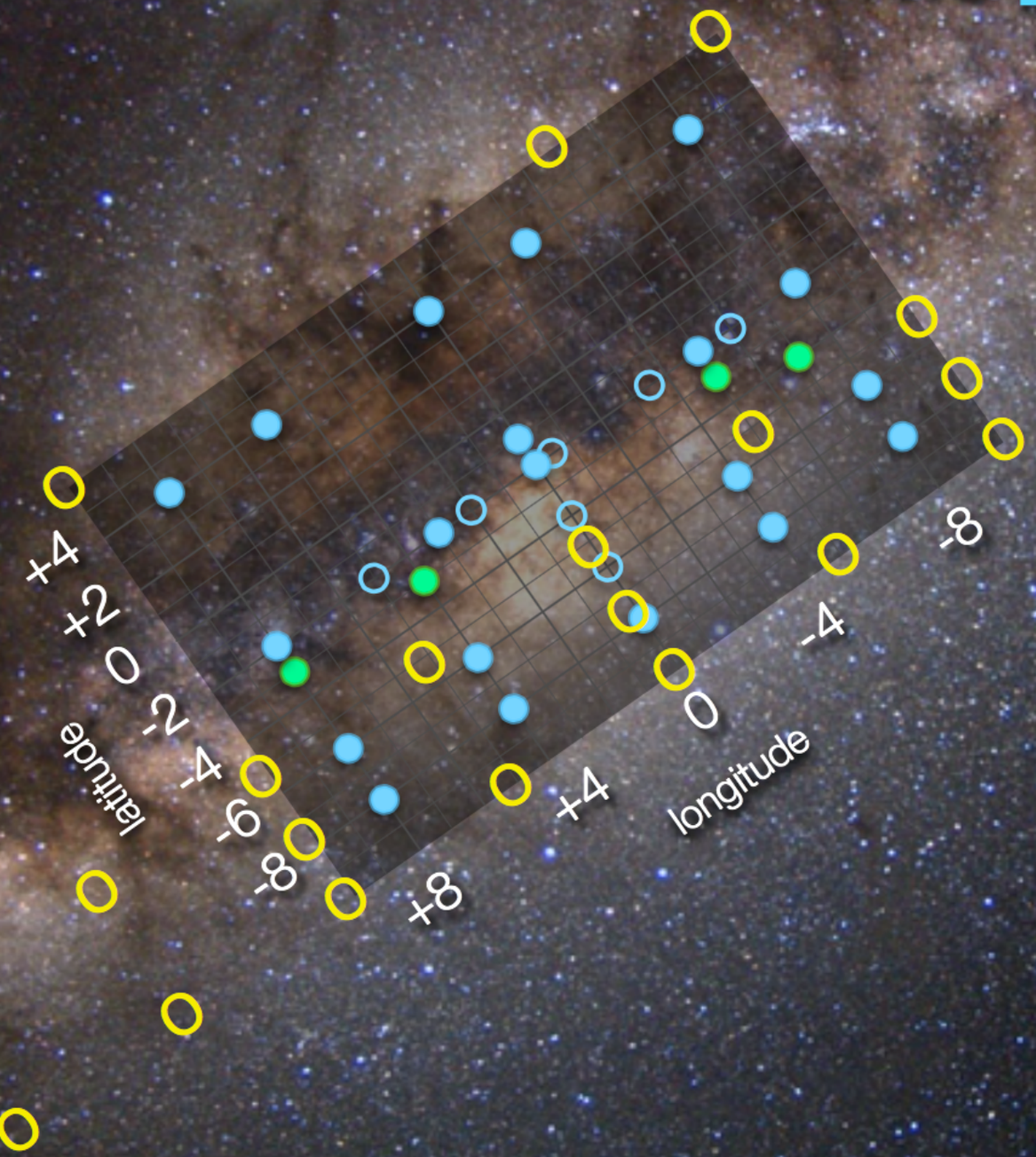


ARGOS fields

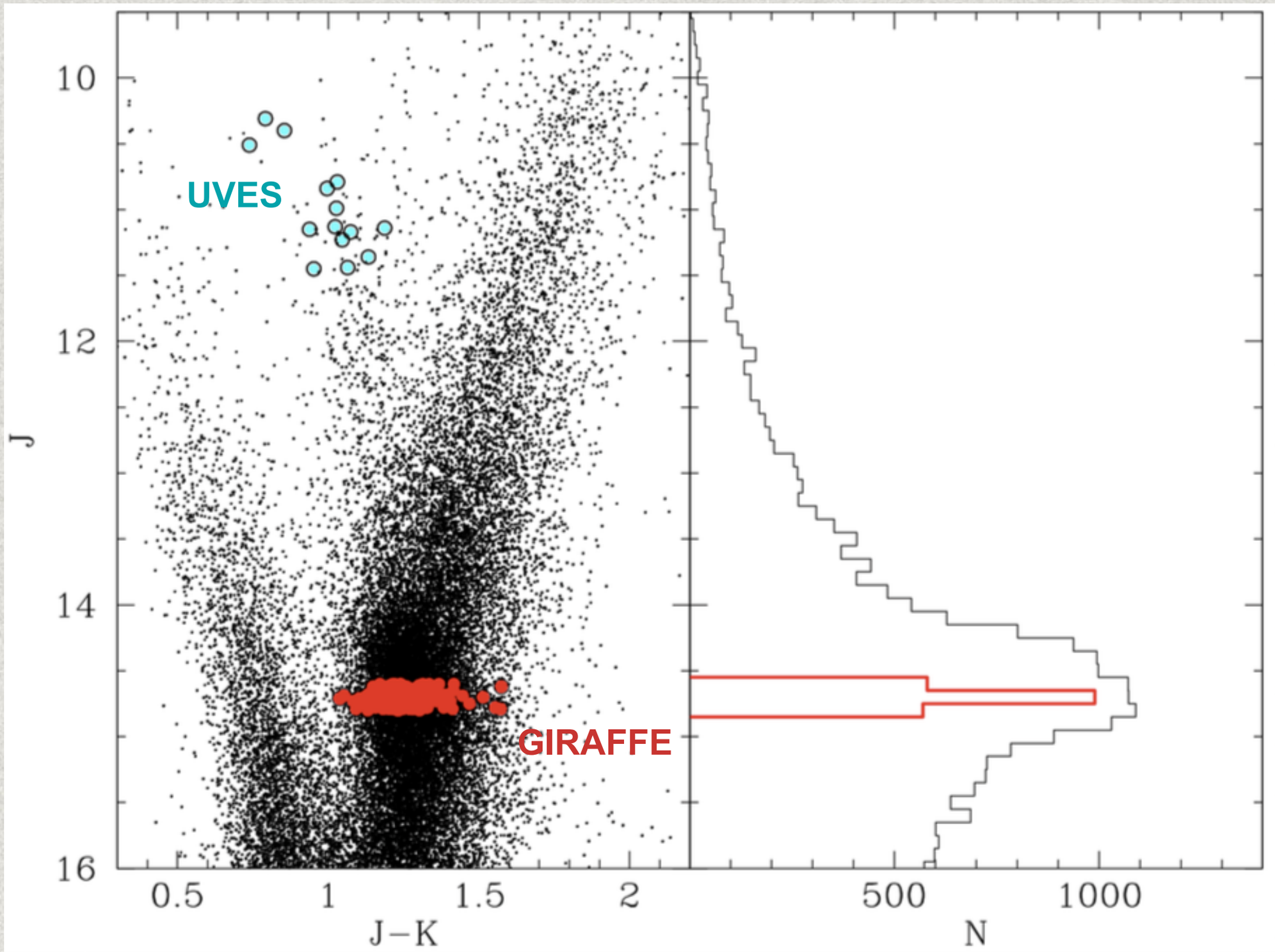
420h @AAT

LP 187.B-0909

130h with FLAMES

Giraffe Inner Bulge Survey (GIBS)

Targets: Red Clump (RC) stars, from **VVV** (+ optical, when available)



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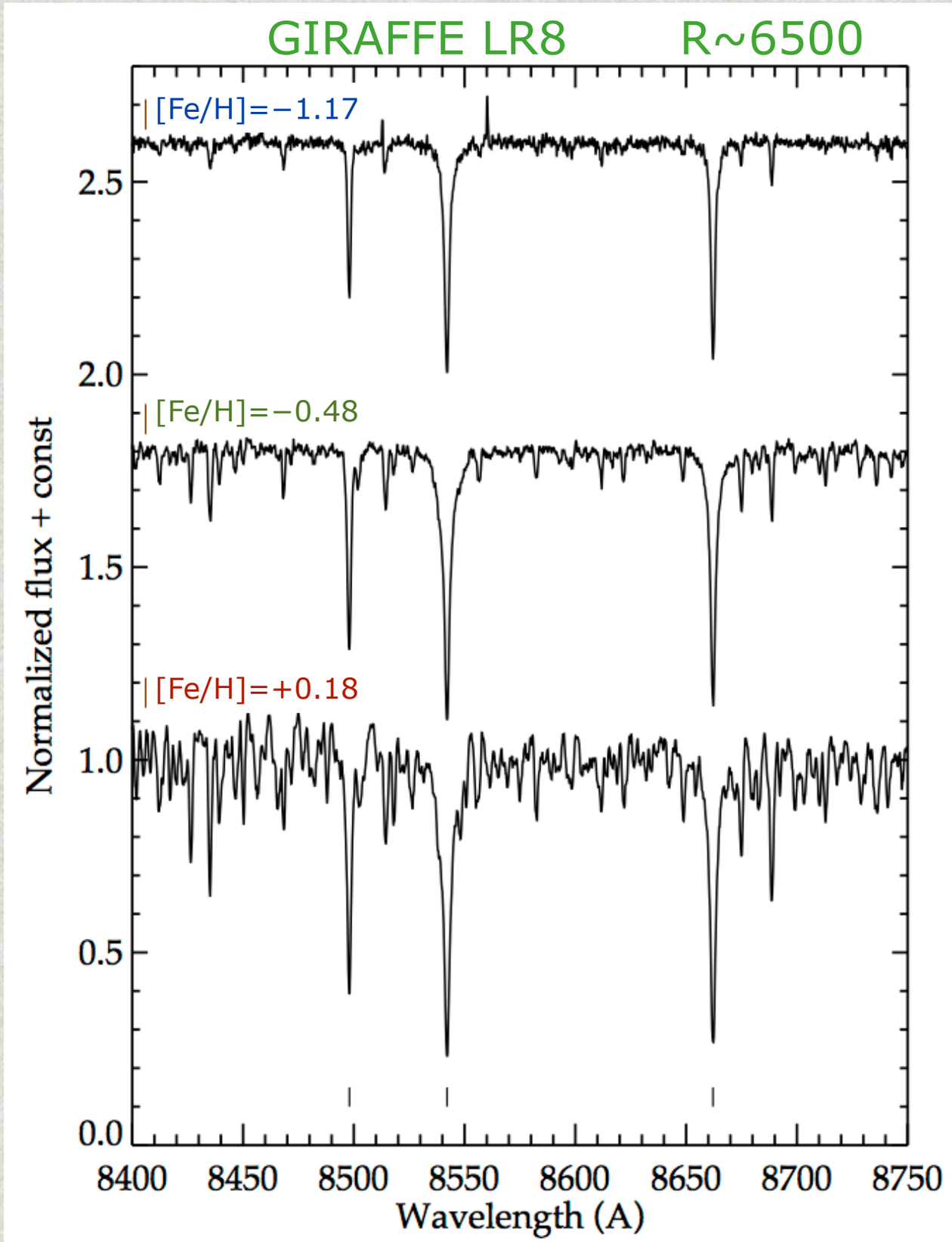

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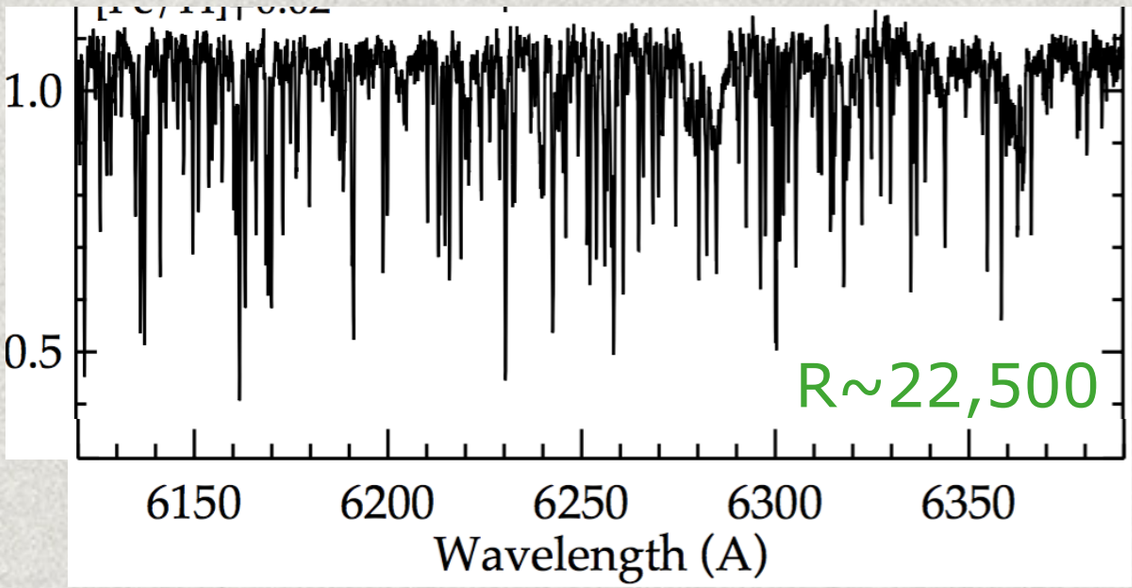
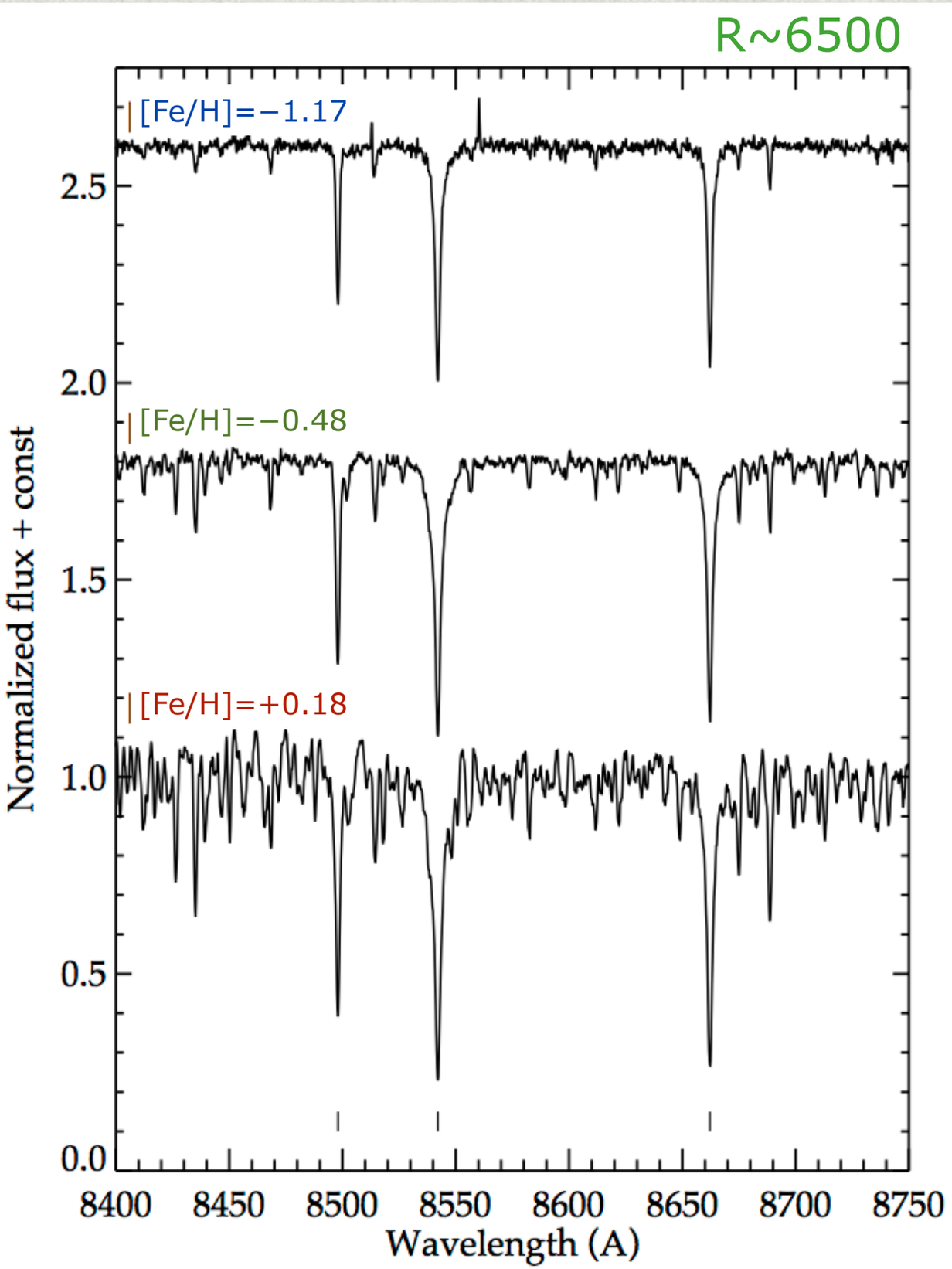
+ 450 stars with GIRAFFE HR13





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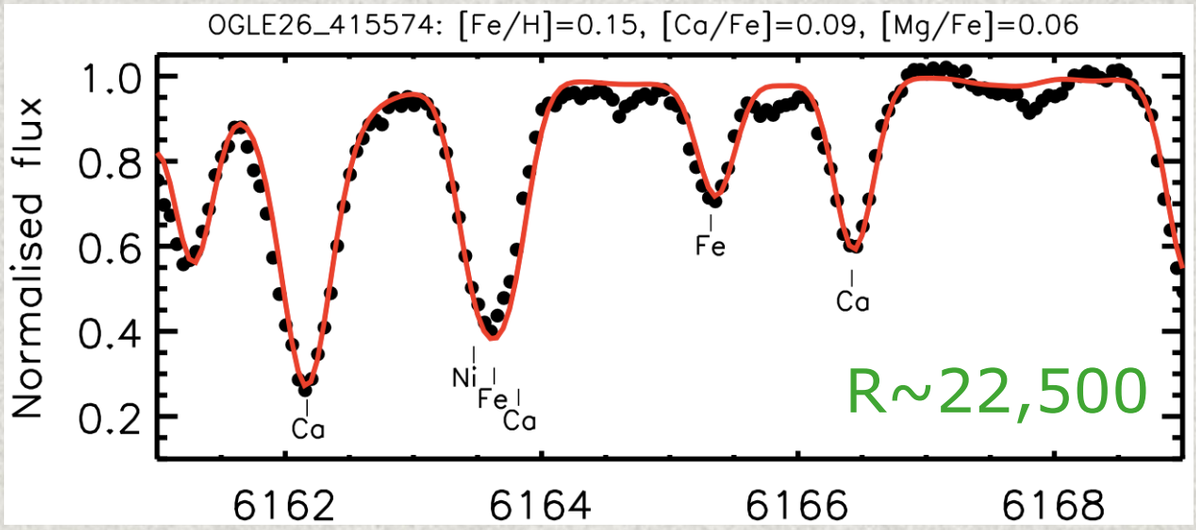

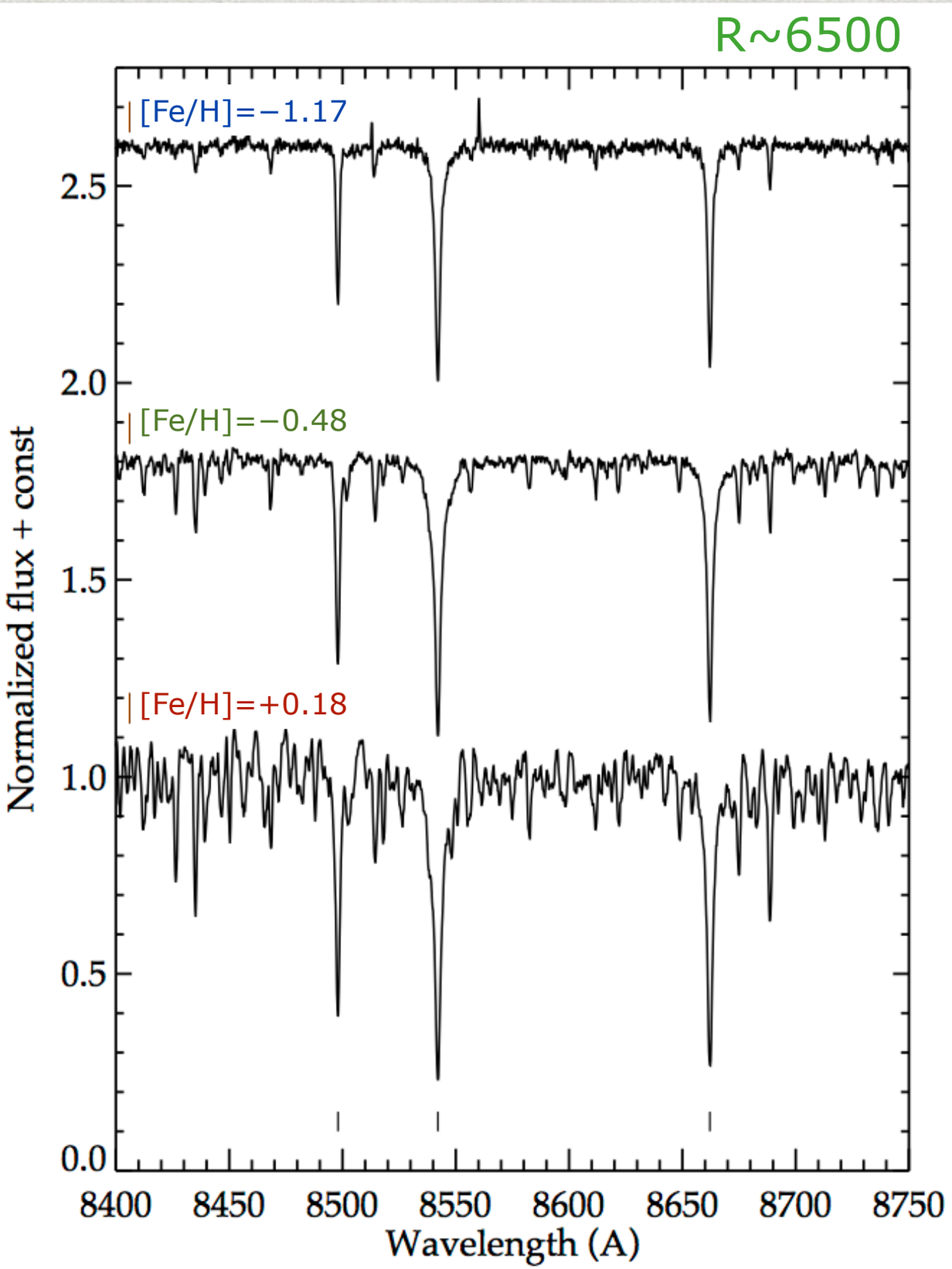

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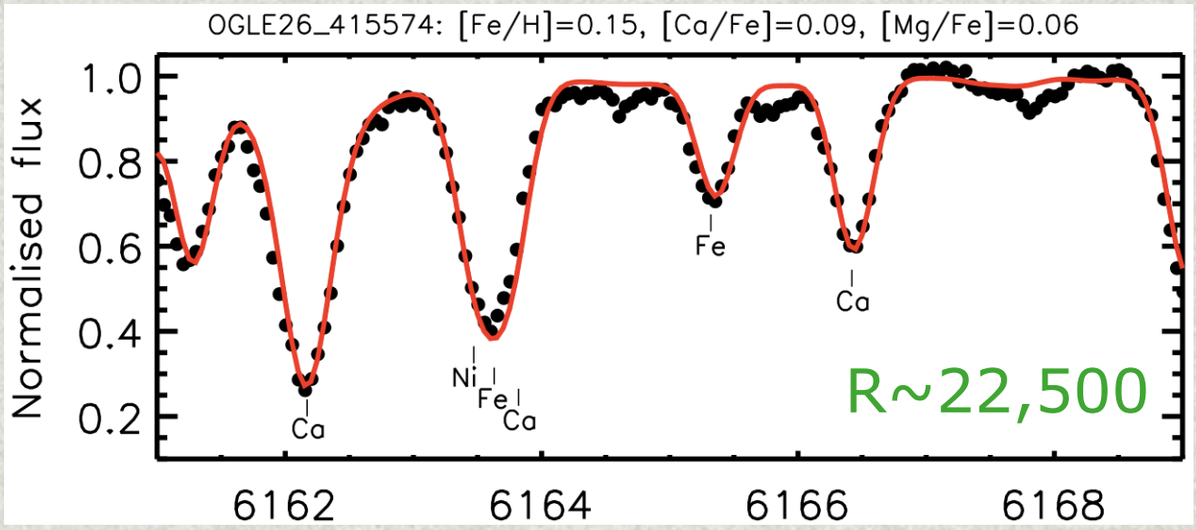
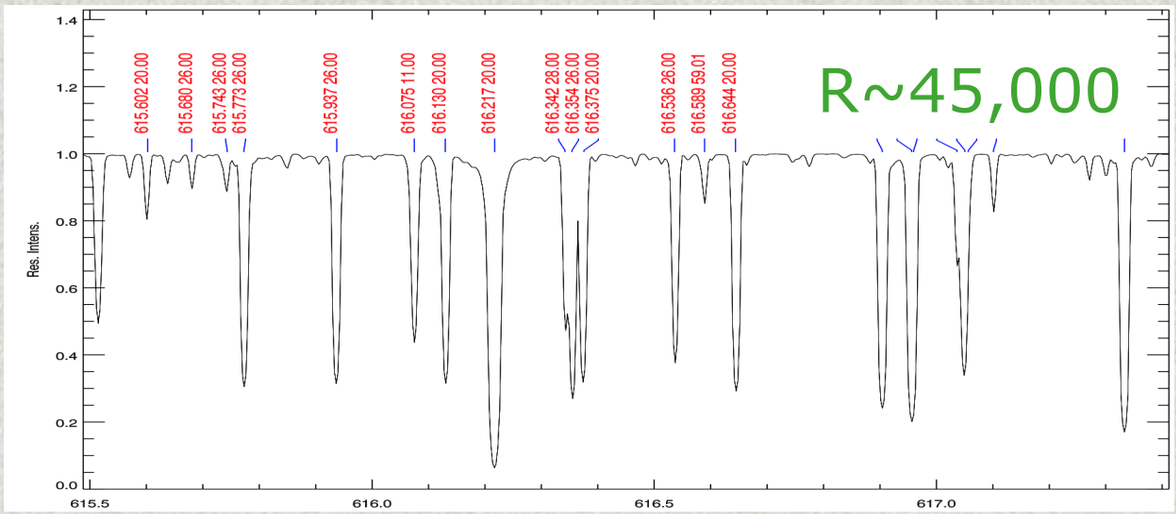
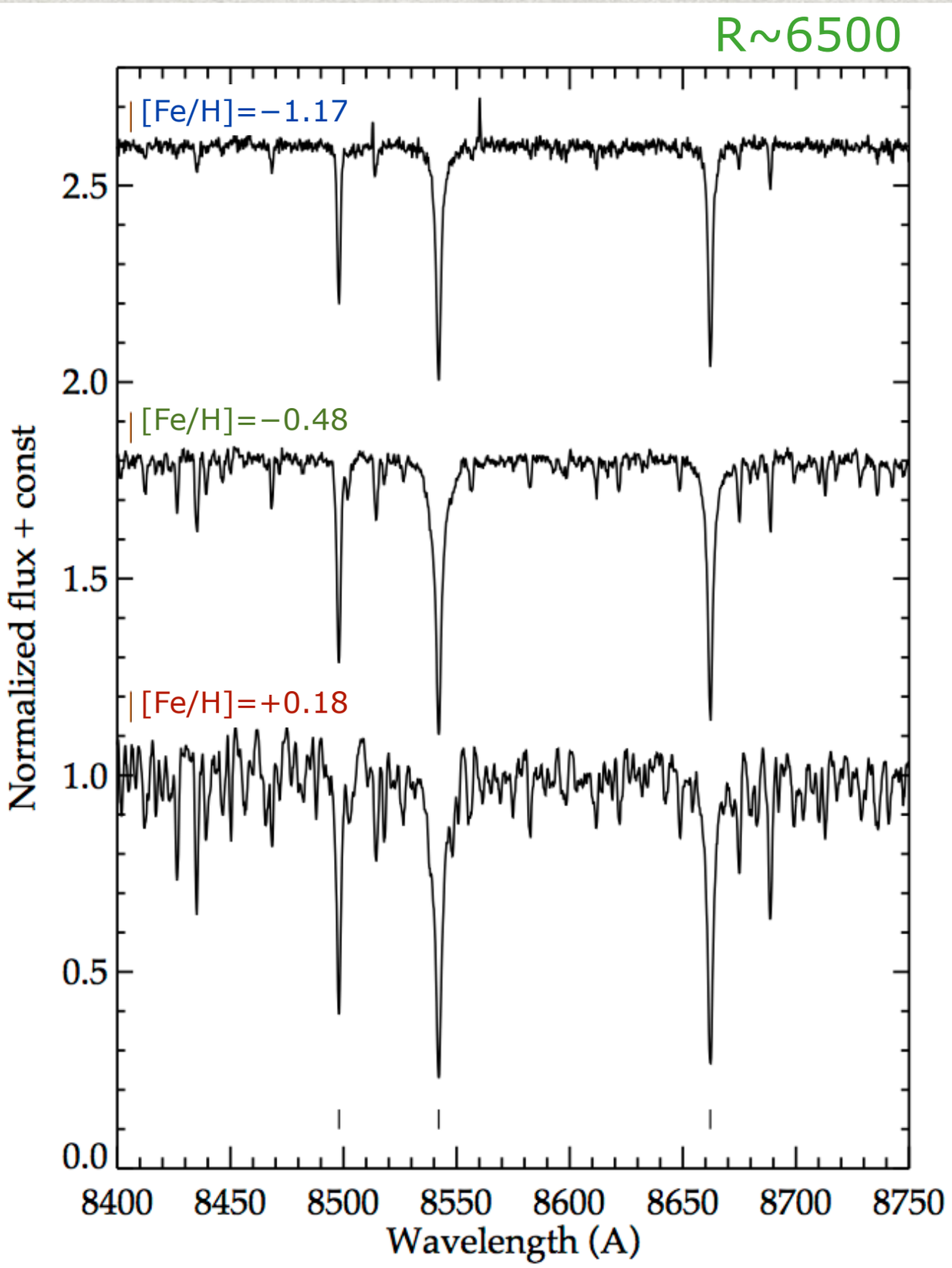


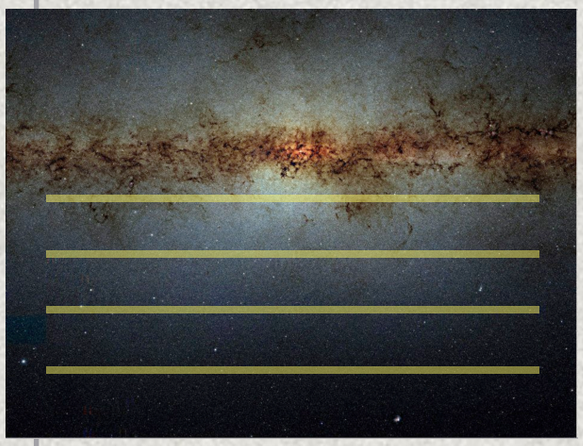
+ 100 **disk** stars with UVES



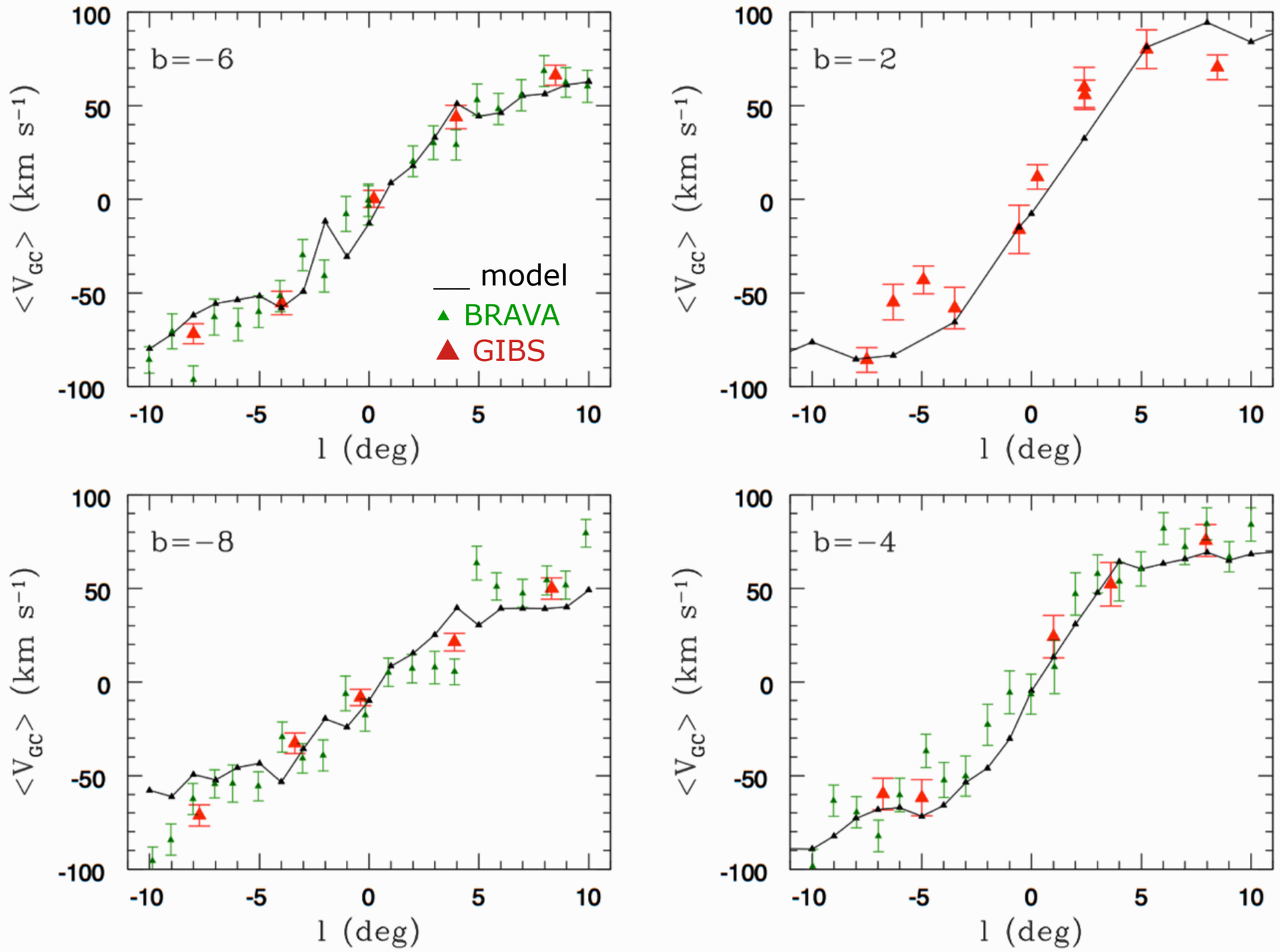


GIBS Kinematics: rotation curve

comparison with models : *cylindrical rotation confirmed*



MZ et al. (2014, A&A, 562, A66) Paper I



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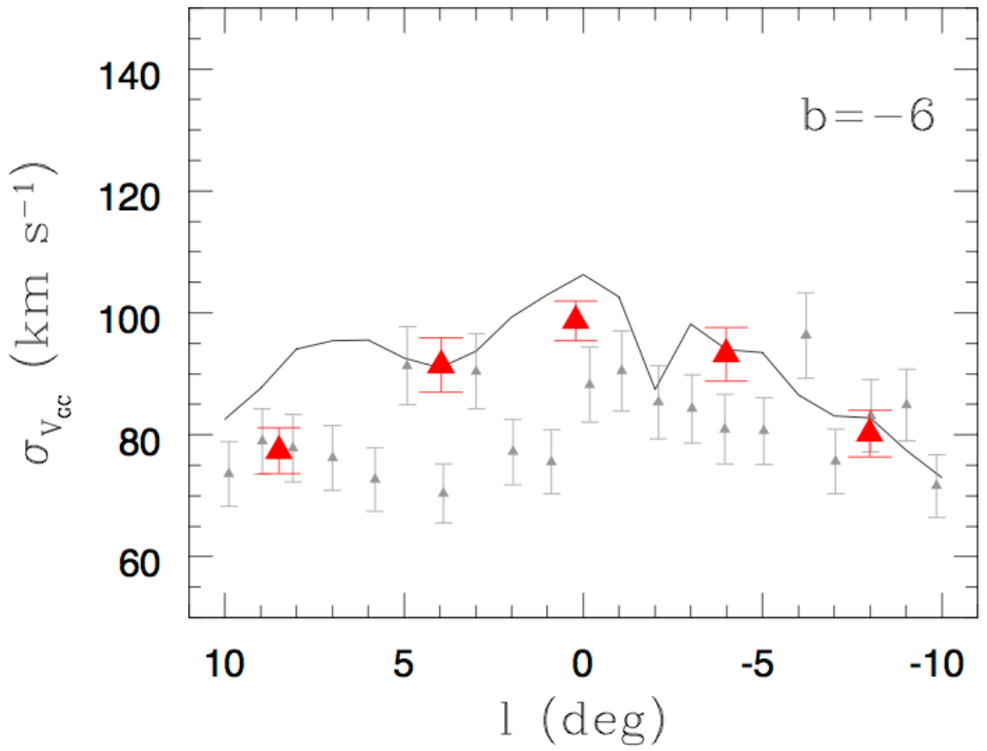
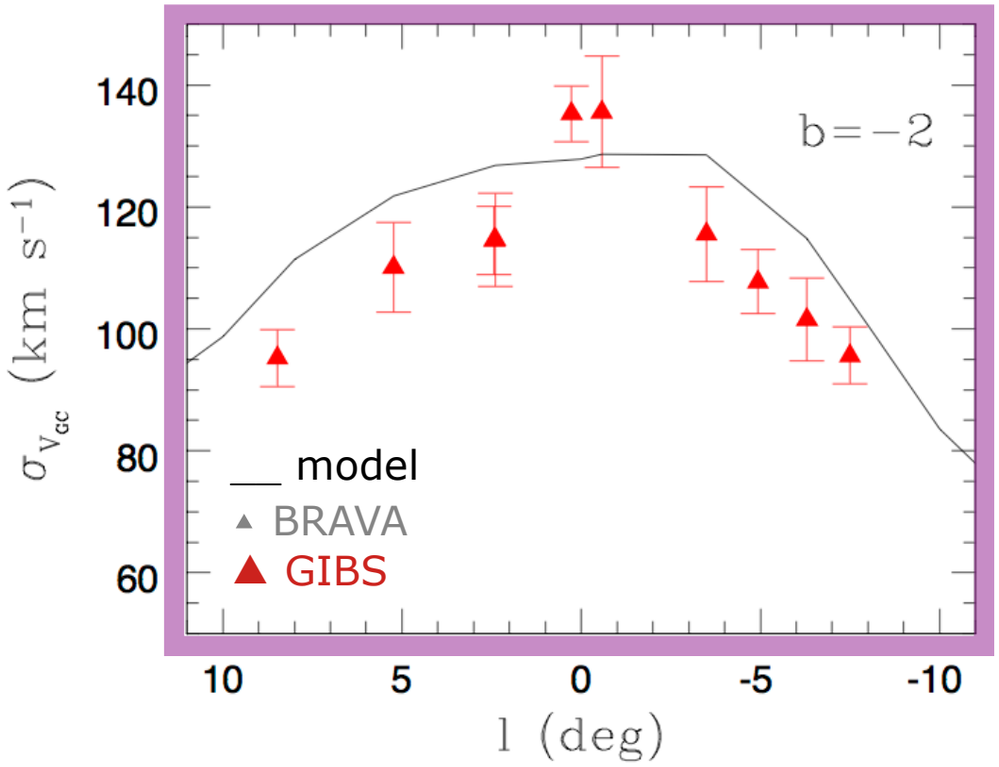
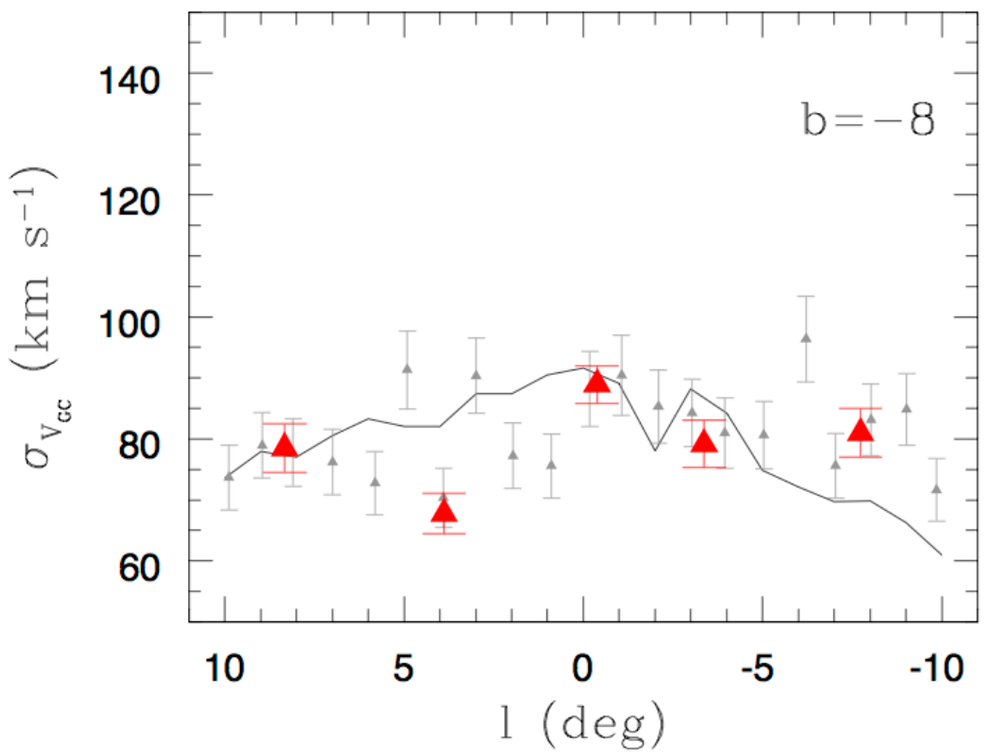
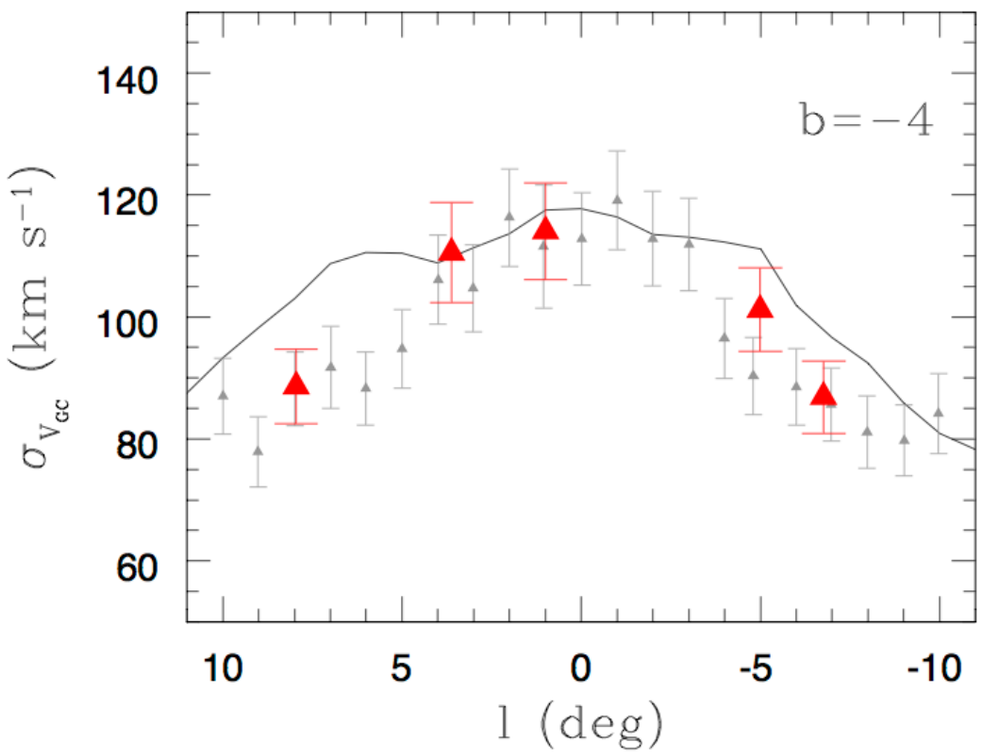
GIBS Kinematics: velocity dispersion

MZ et al. (2014, A&A, 562, A66) Paper I









GIBS: Kinematical maps

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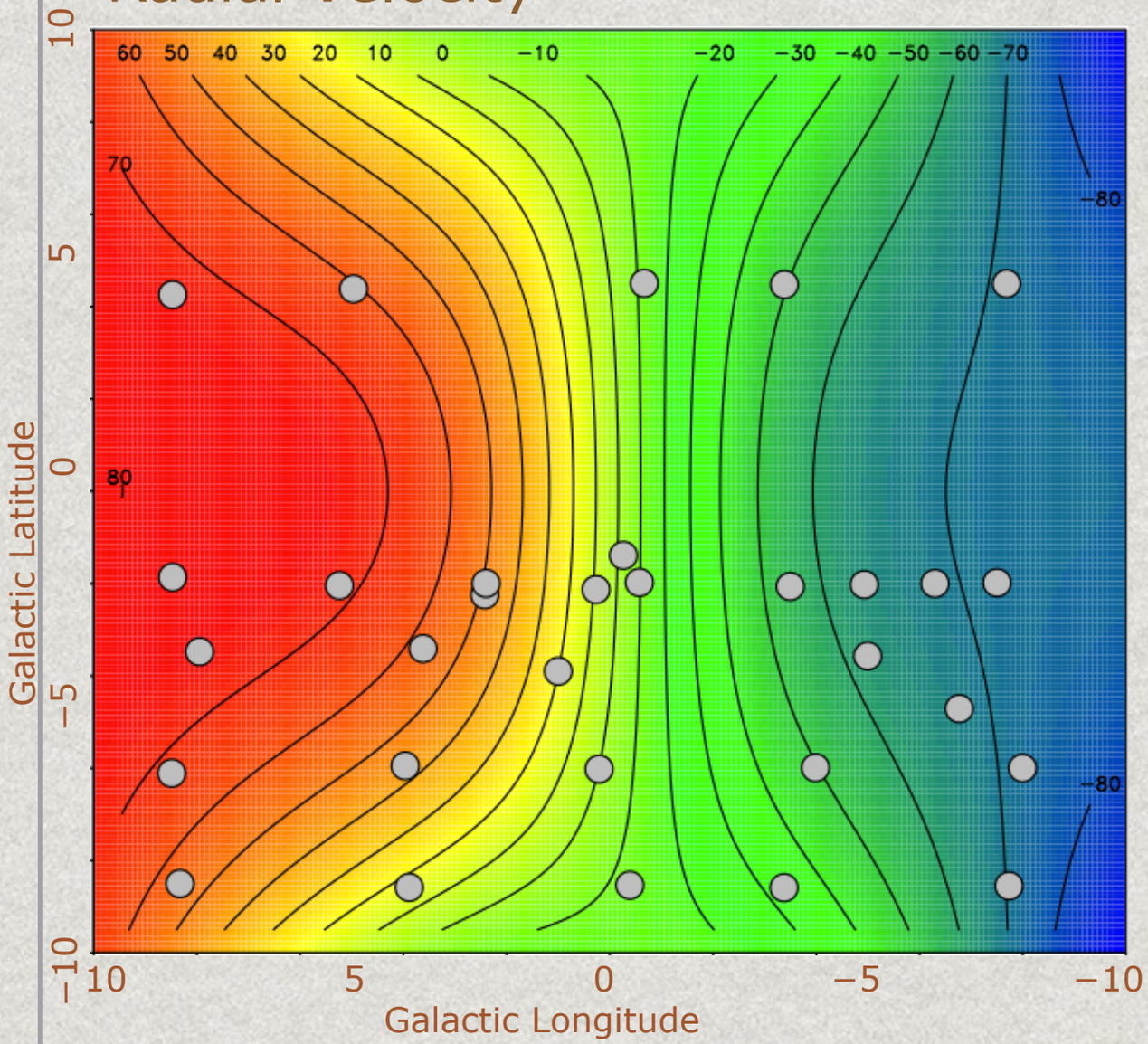
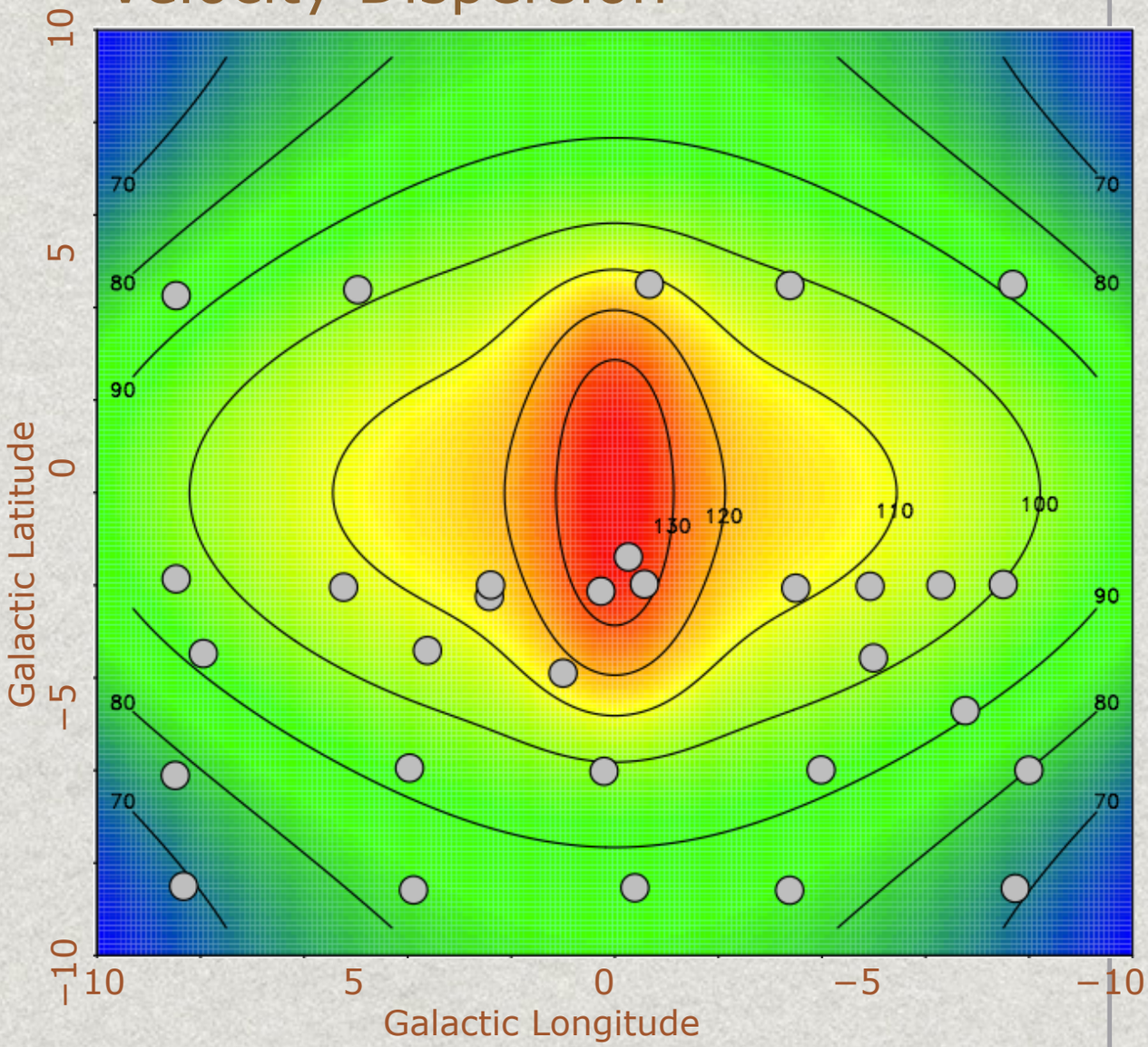
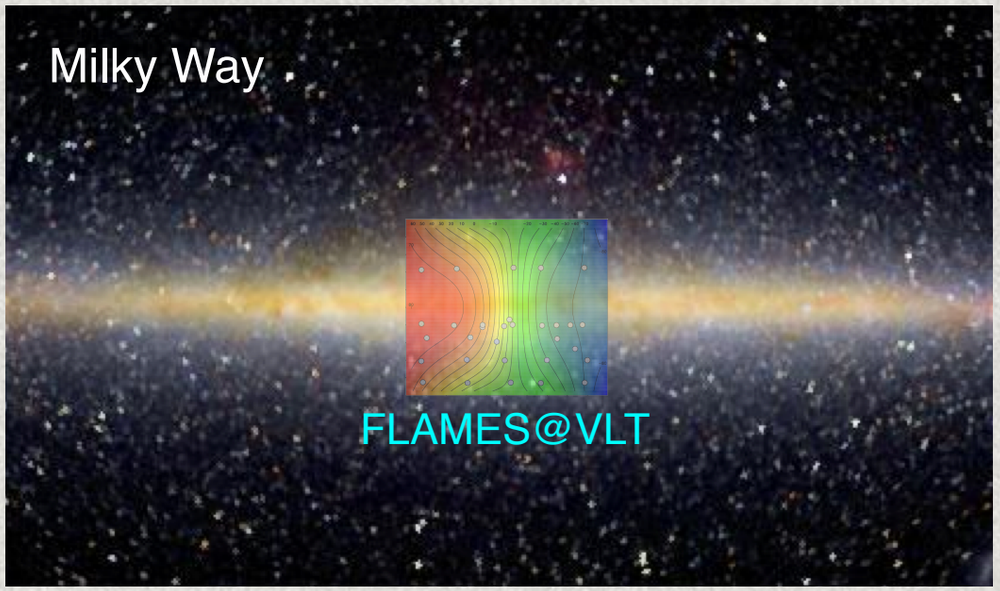
Radial Velocity

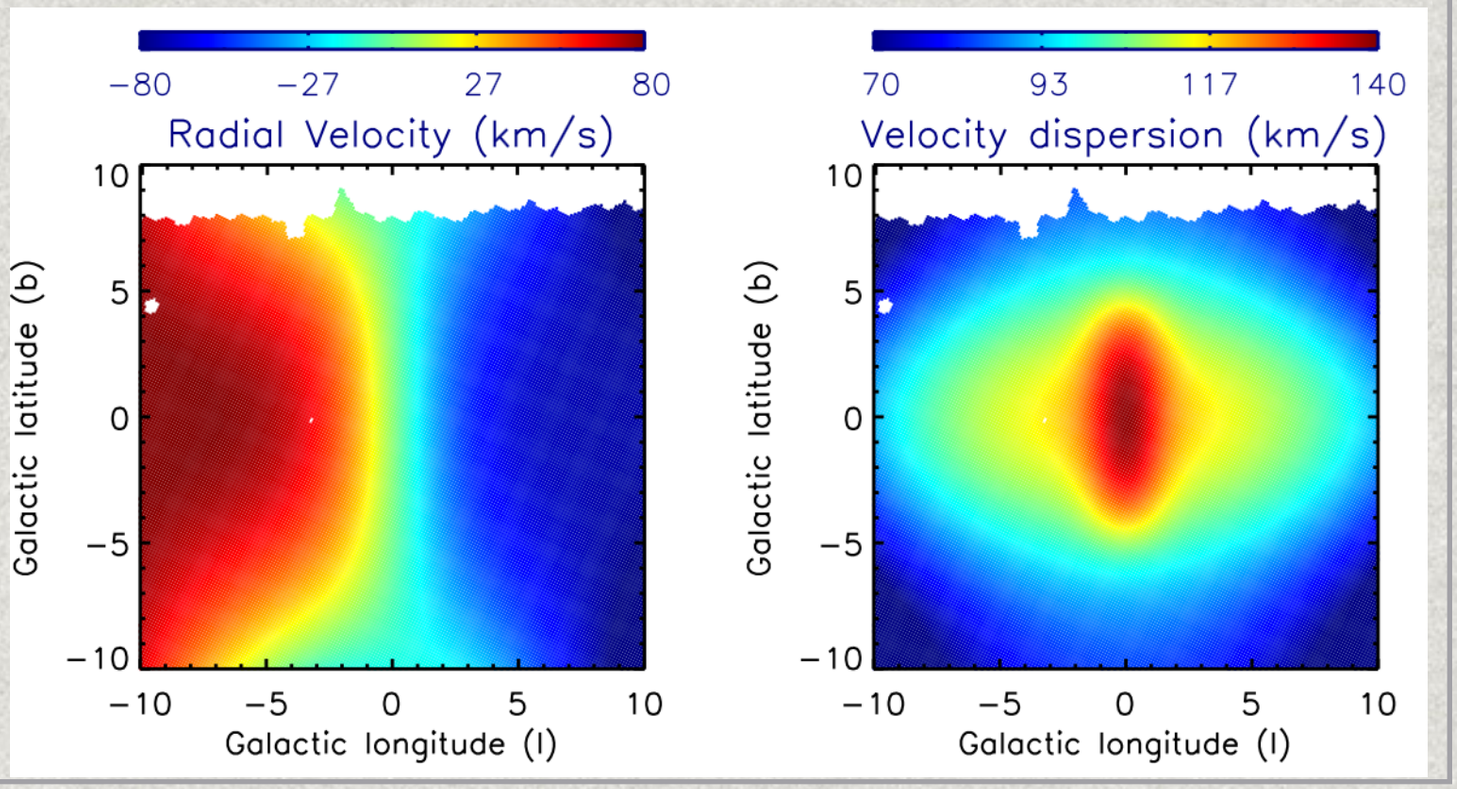


Velocity Dispersion



The Milky Way *vs* other Spirals





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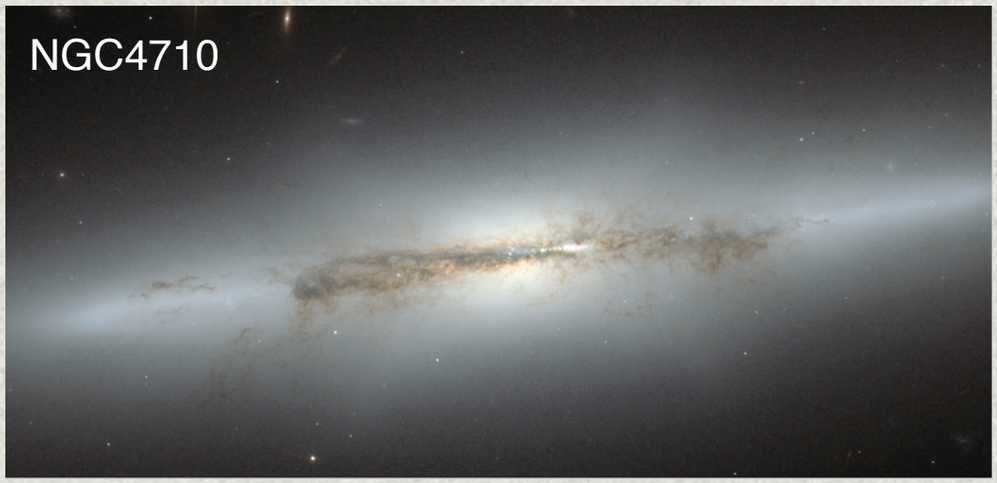

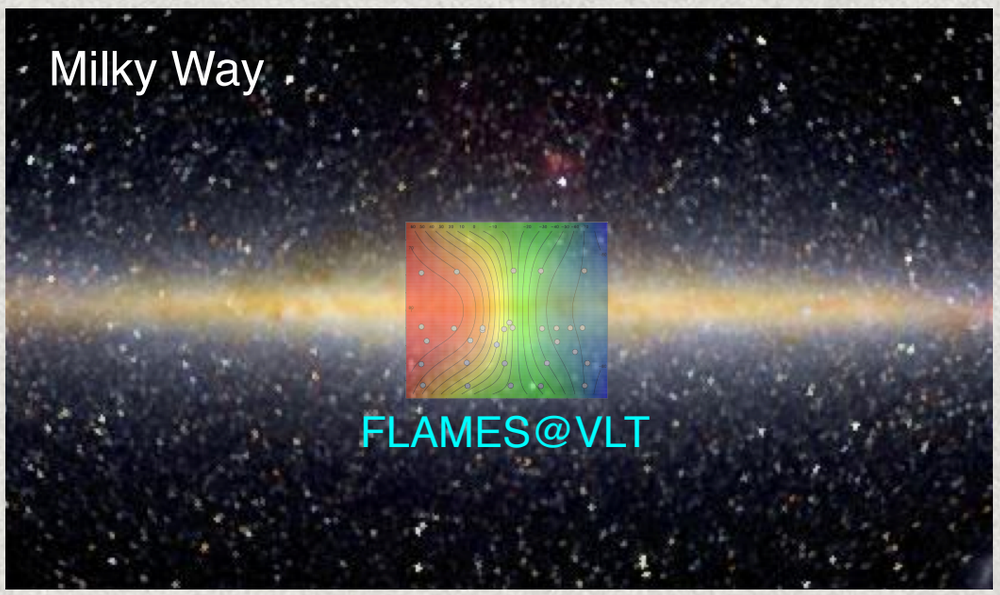

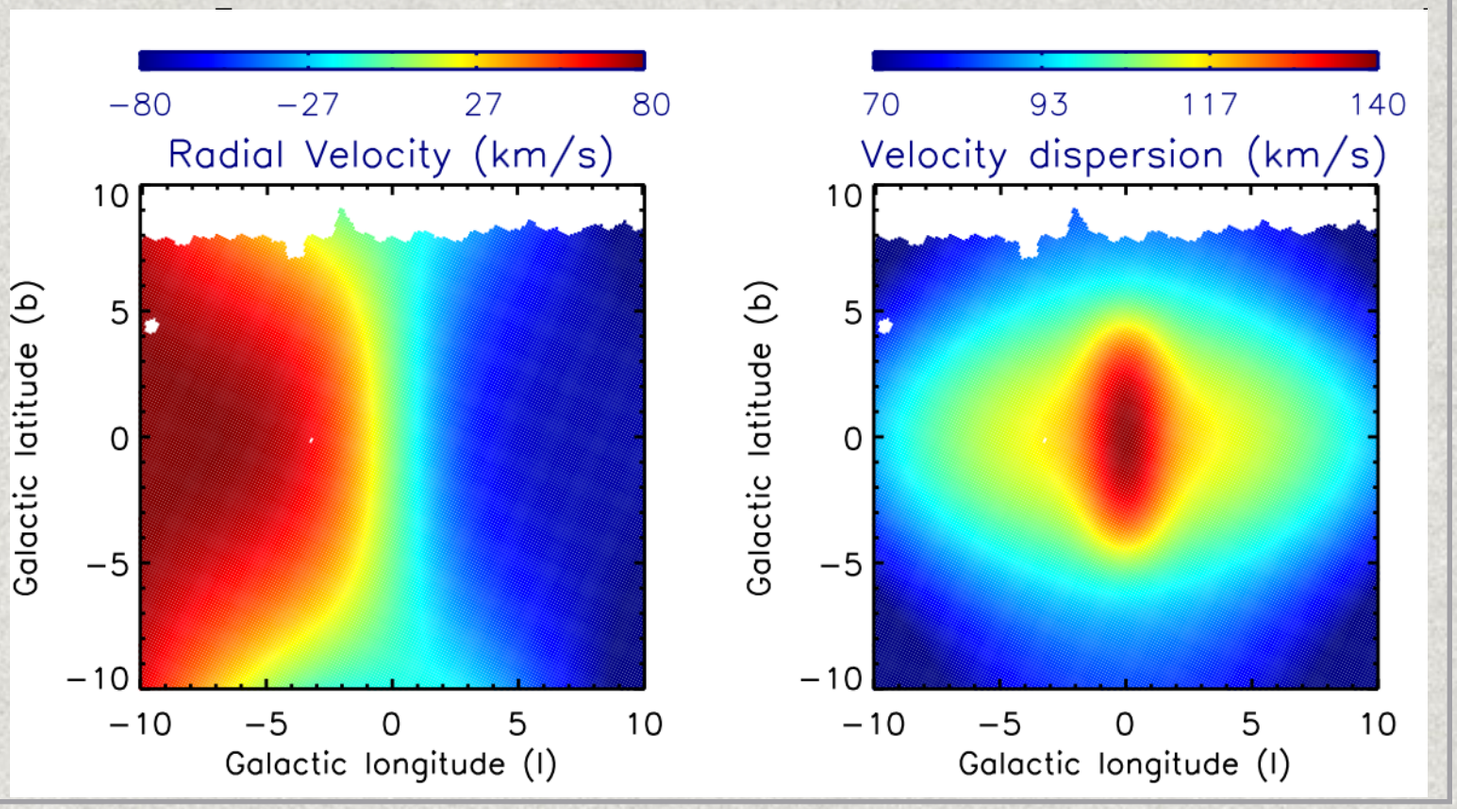

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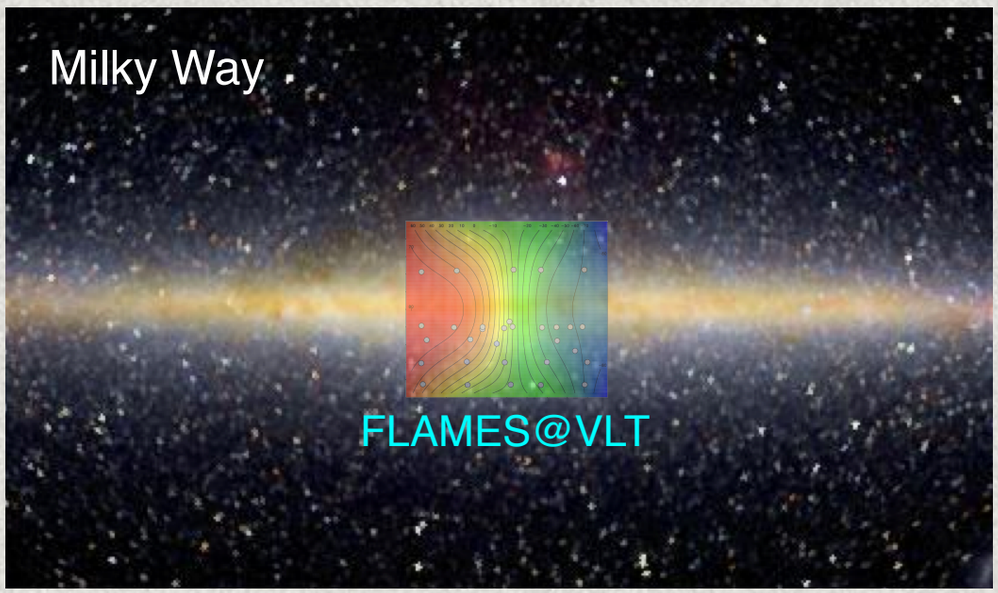

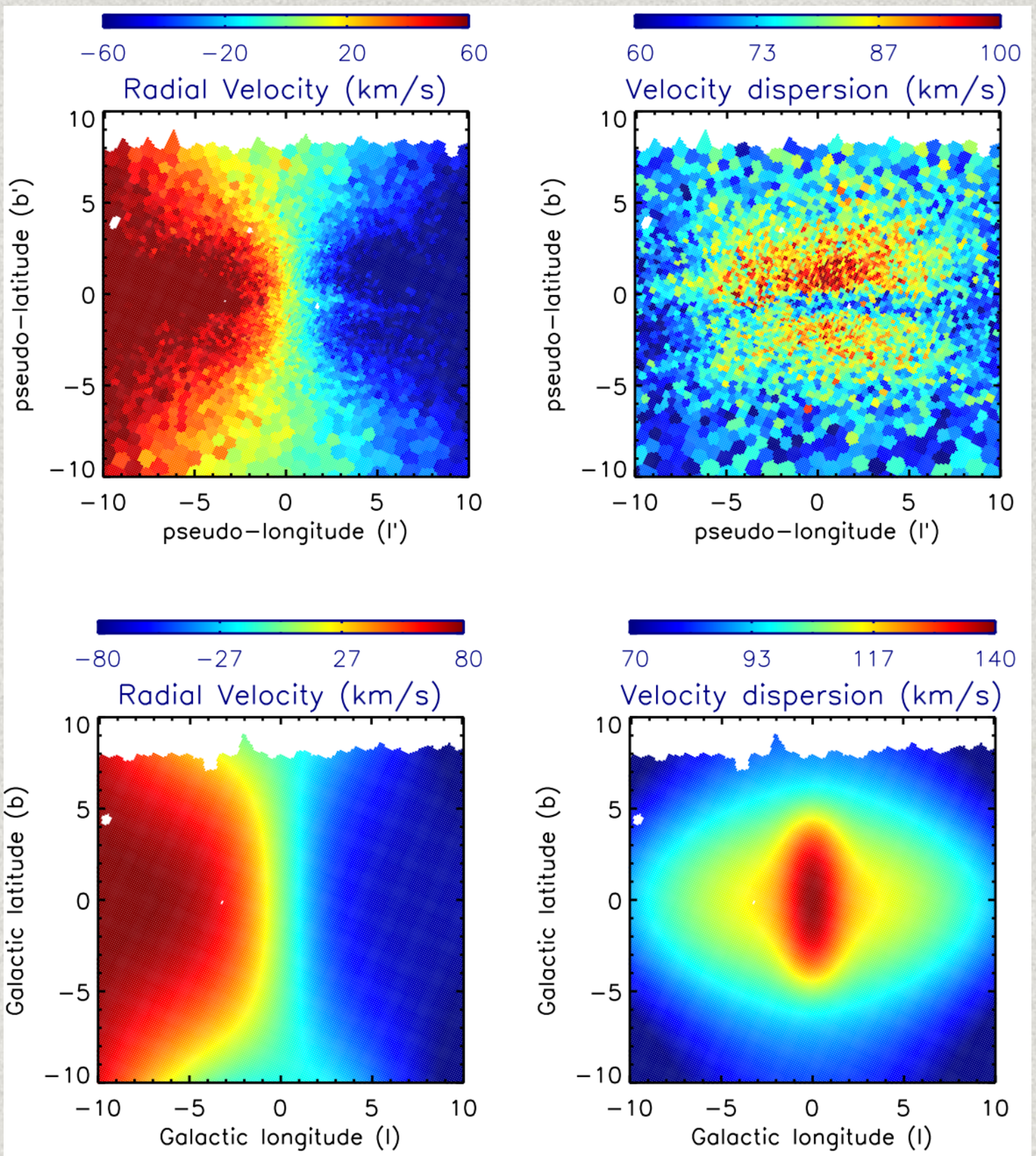

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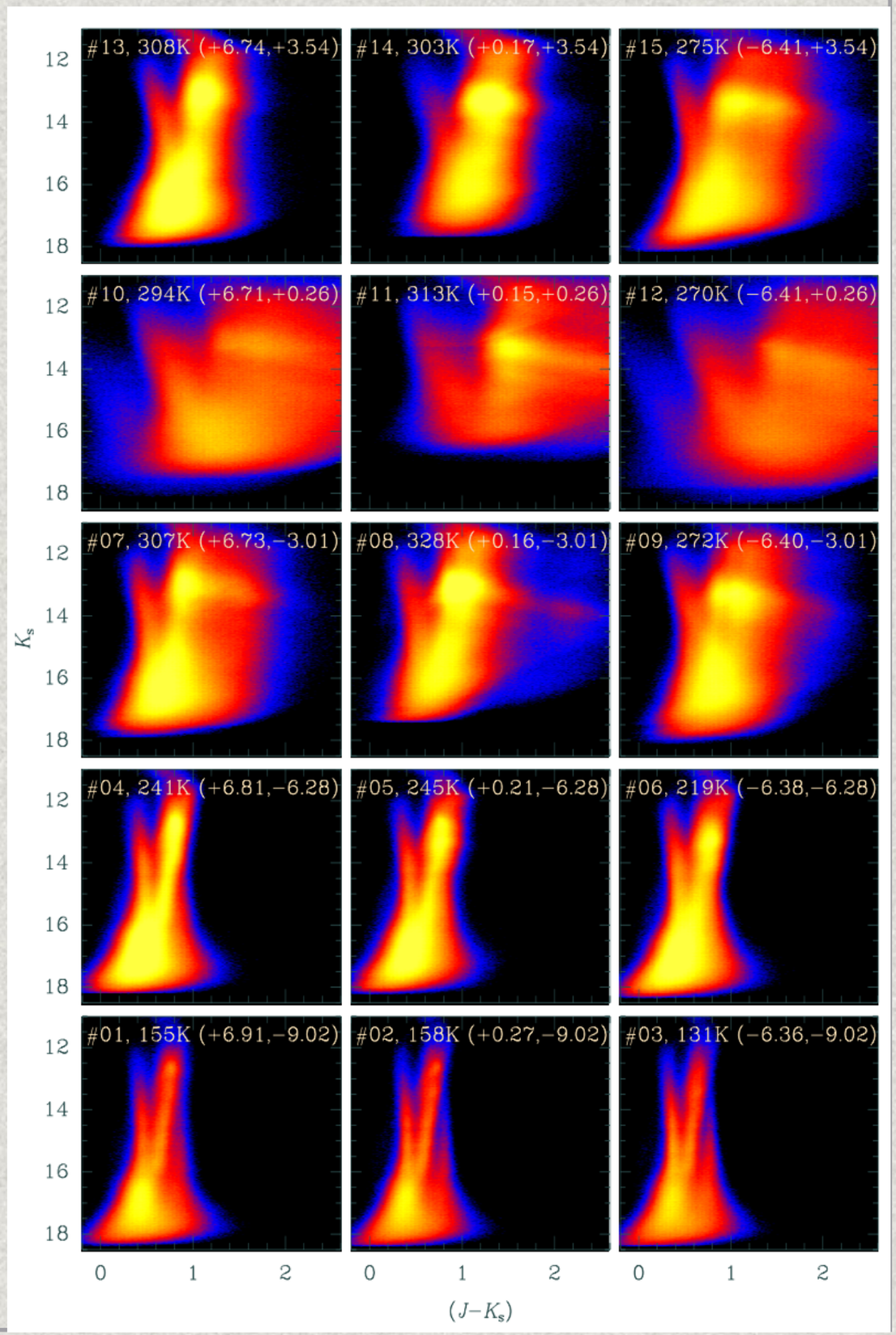
why ?

Milky Way demographics with the VVV Survey

160 million star CMD from CASU

Saito et al. (2012) DR1
Minniti et al. (2014)



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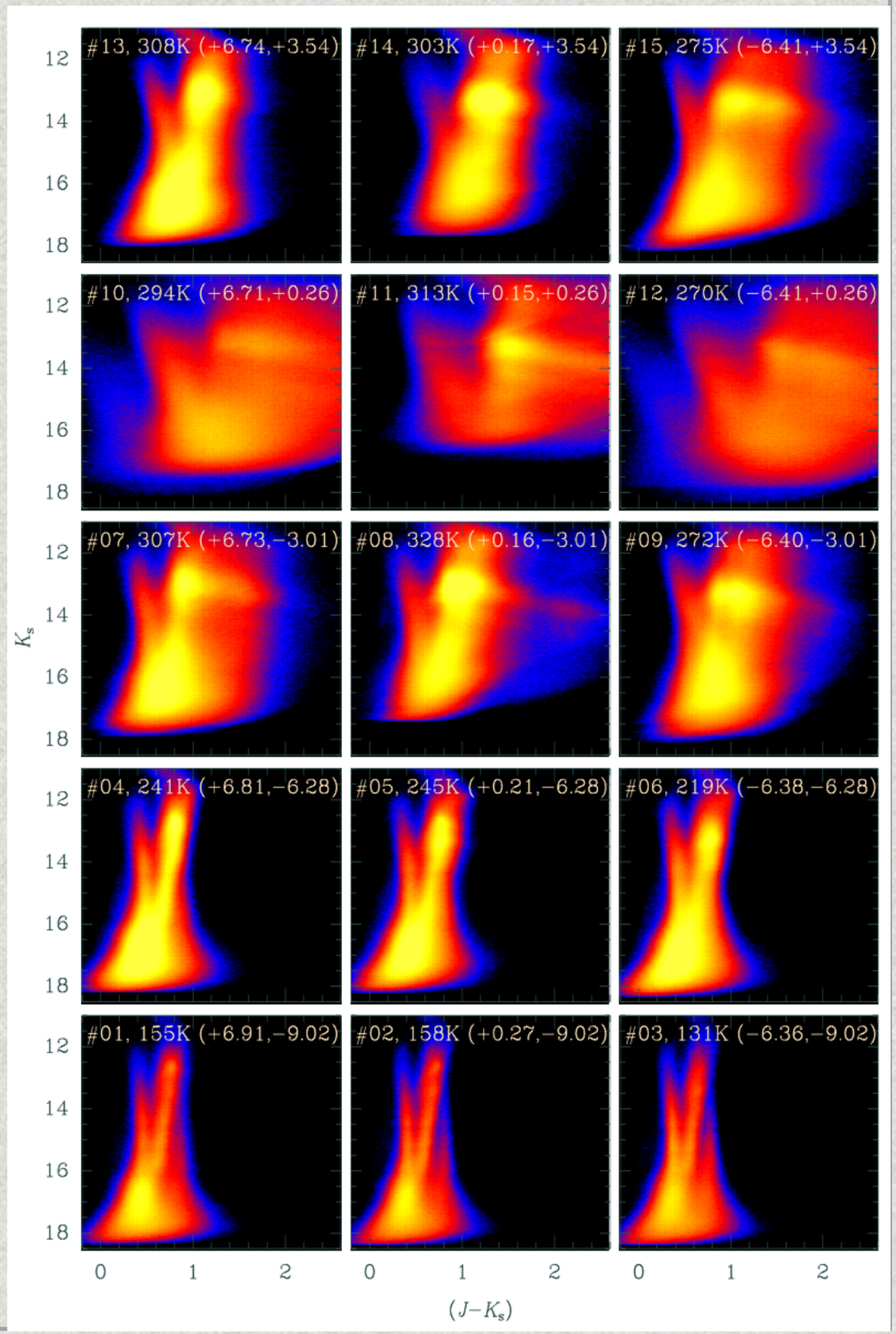

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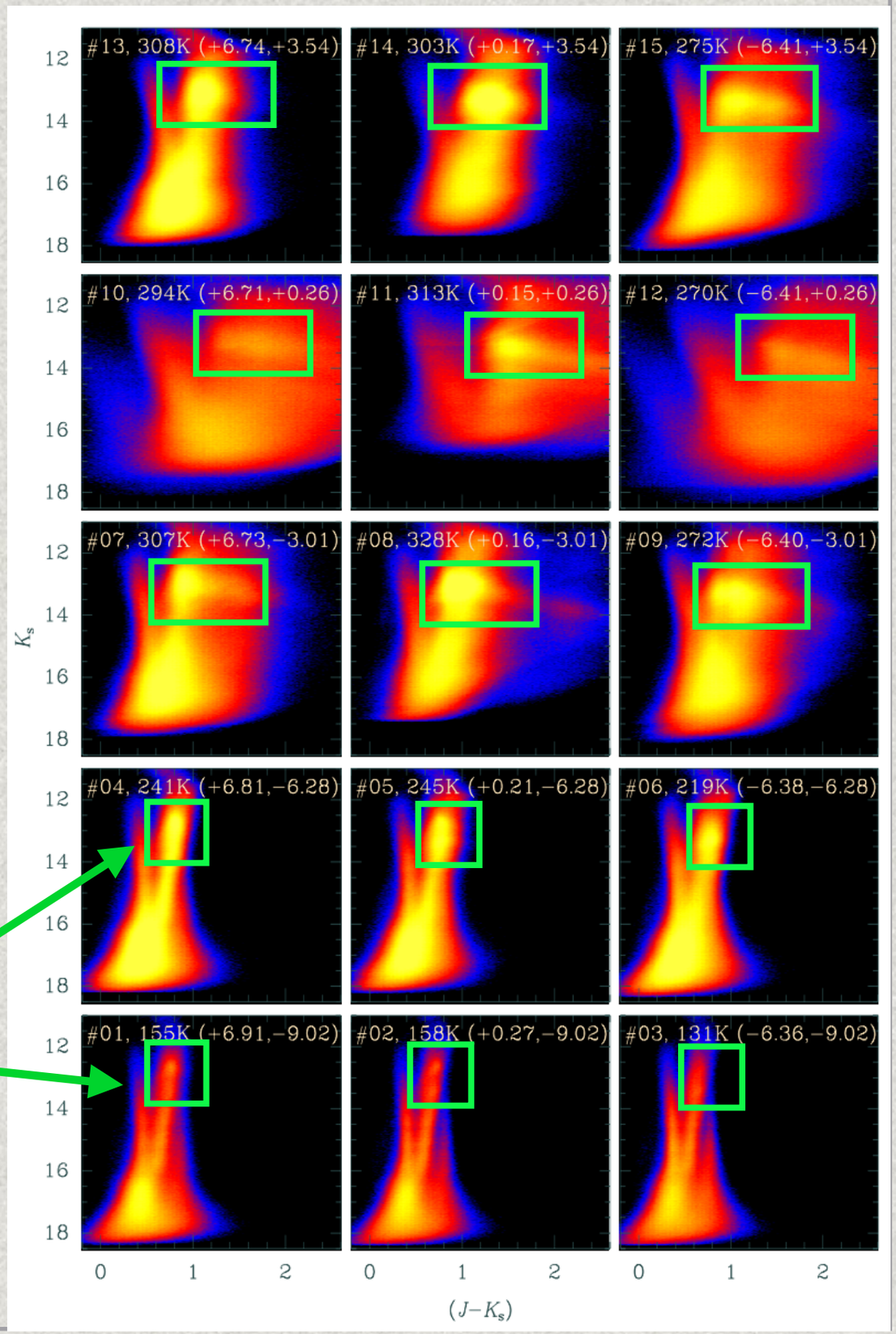
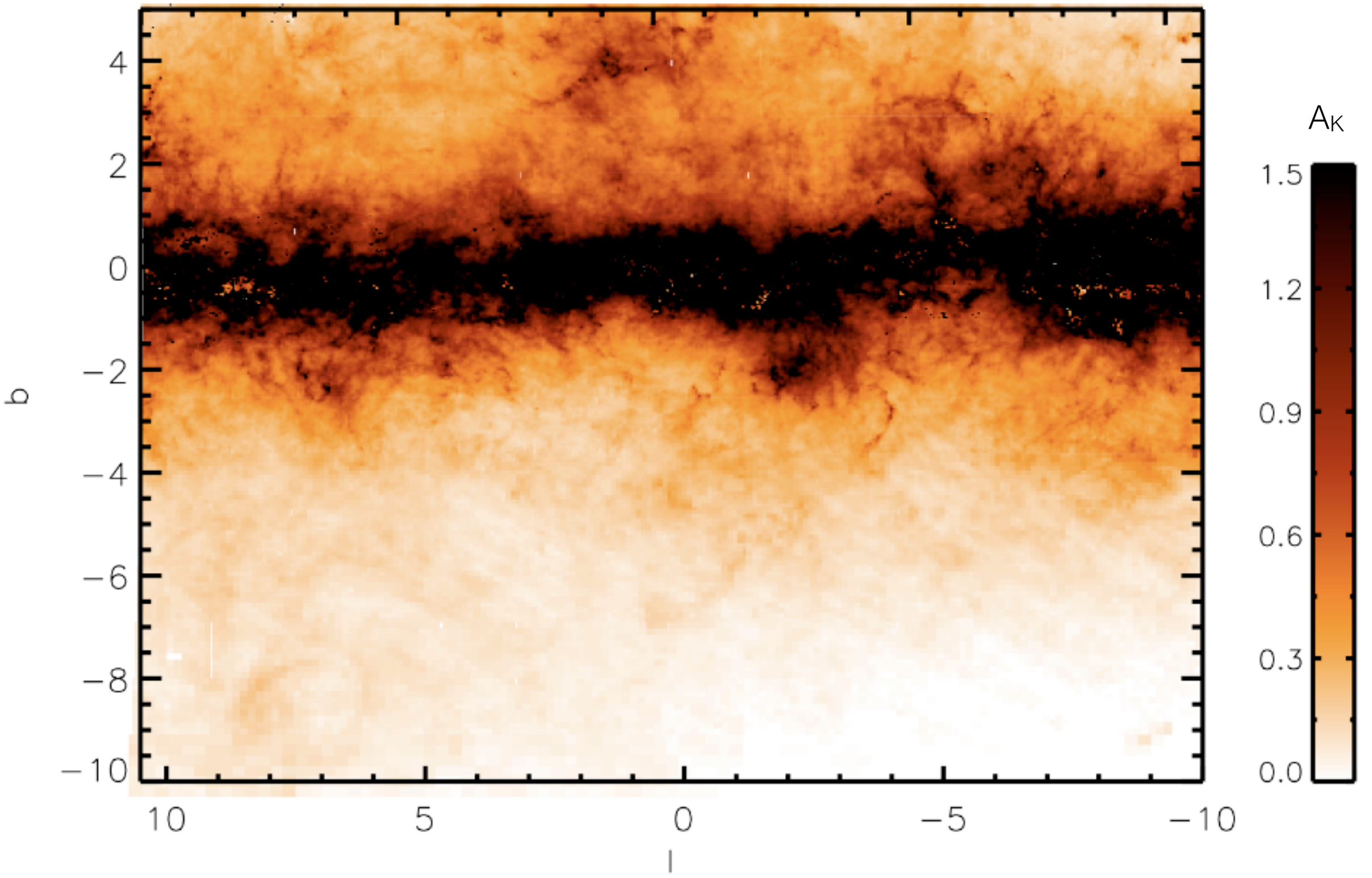
easy to count RC stars
even at b=0



The bulge extinction map

Gonzalez et al. (2012, A&A, 543, 13)



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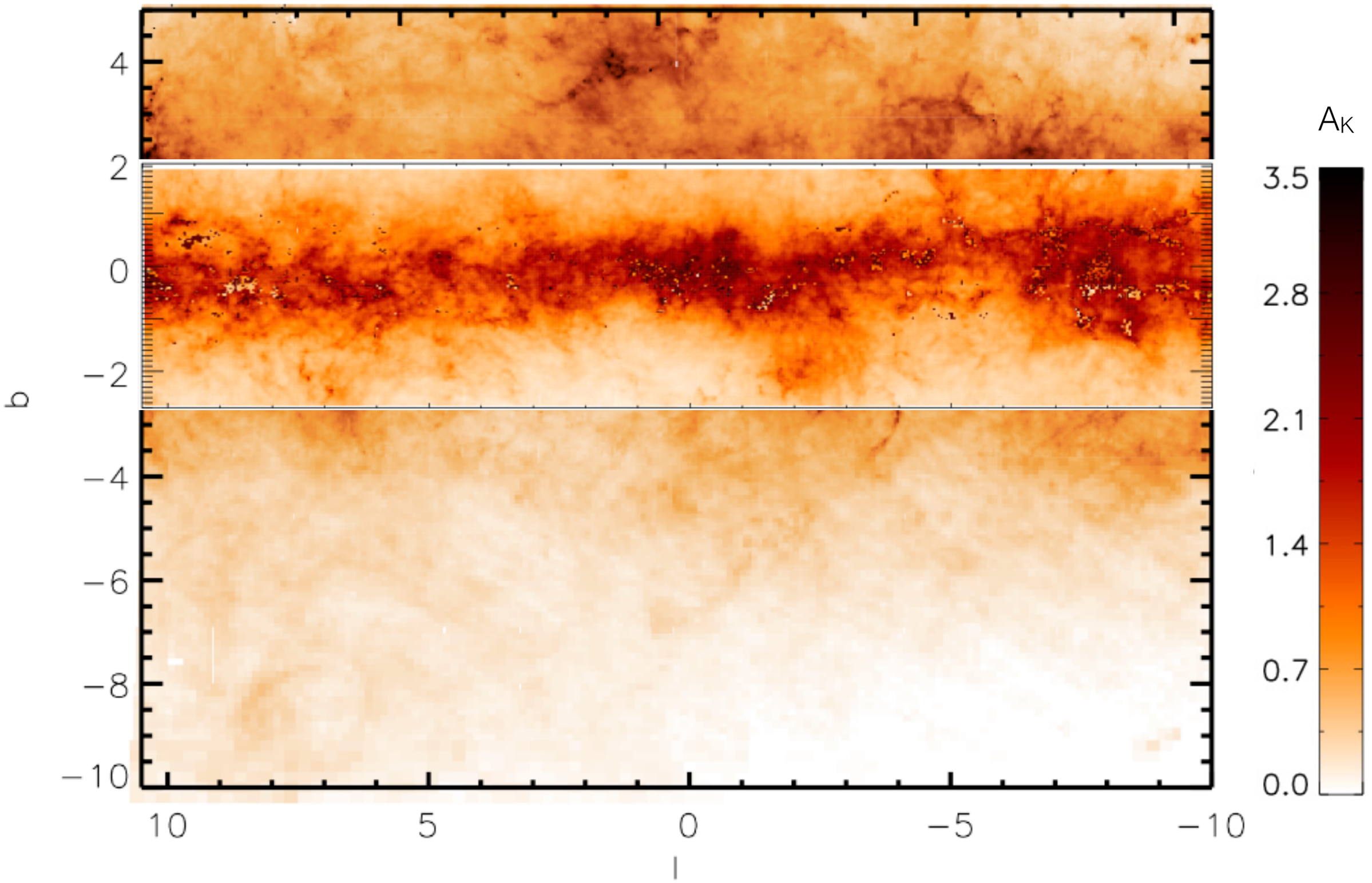
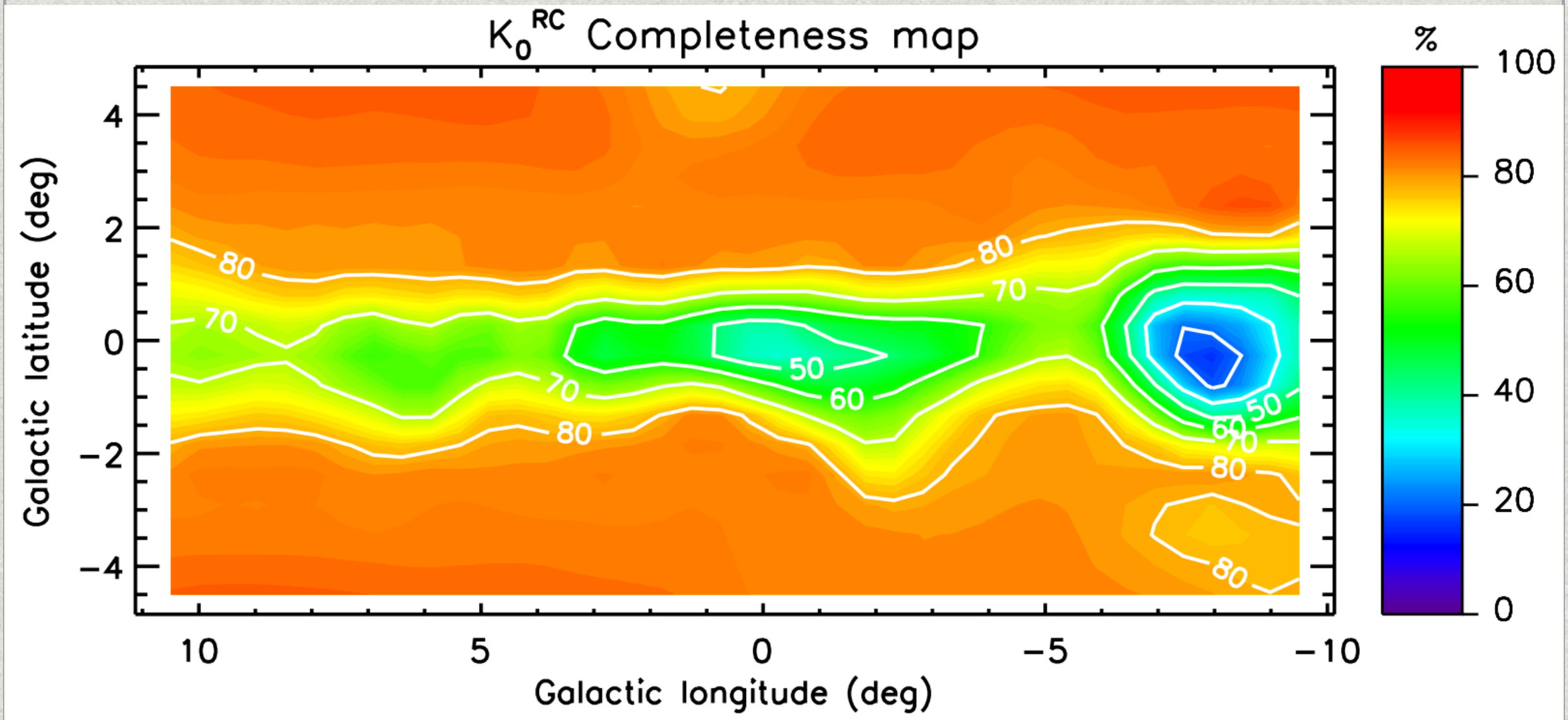


The completeness map of the inner bulge at the RC mag

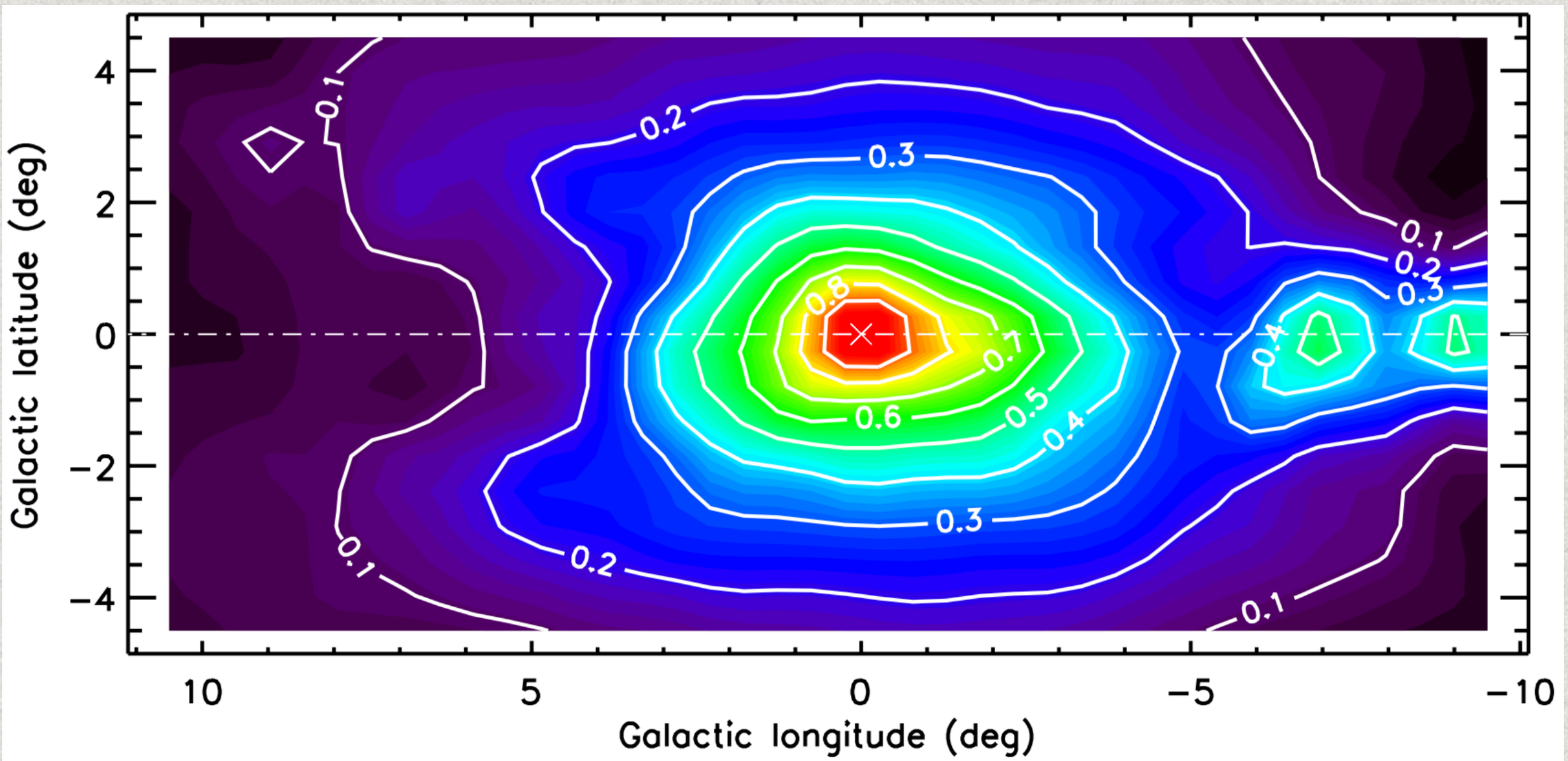
from PSF-fitting photometry (DoPHOT)



The Stellar Density of the inner bulge

based on RC stars from VVV

Valenti, MZ, et al. (2015, A&A submitted)



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stellar density follows velocity dispersion

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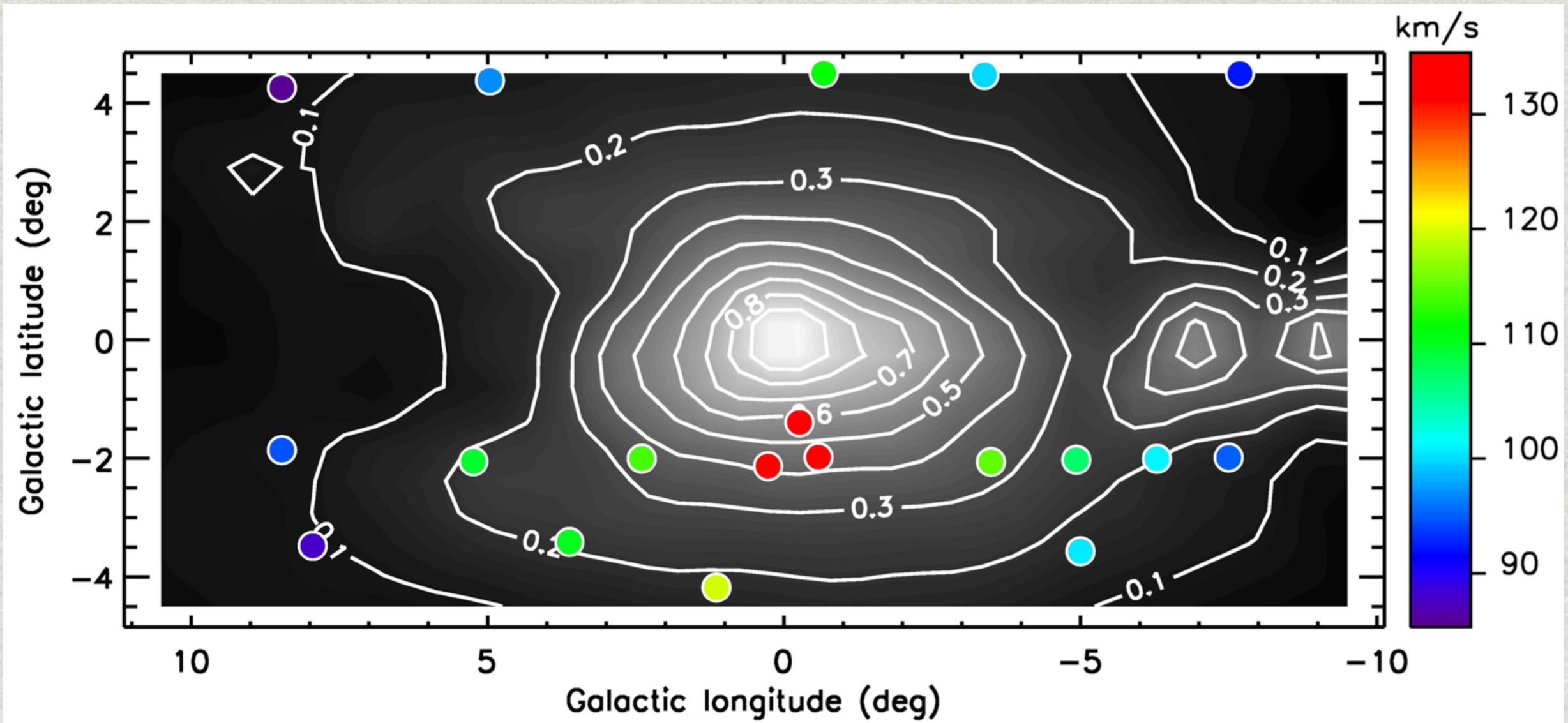
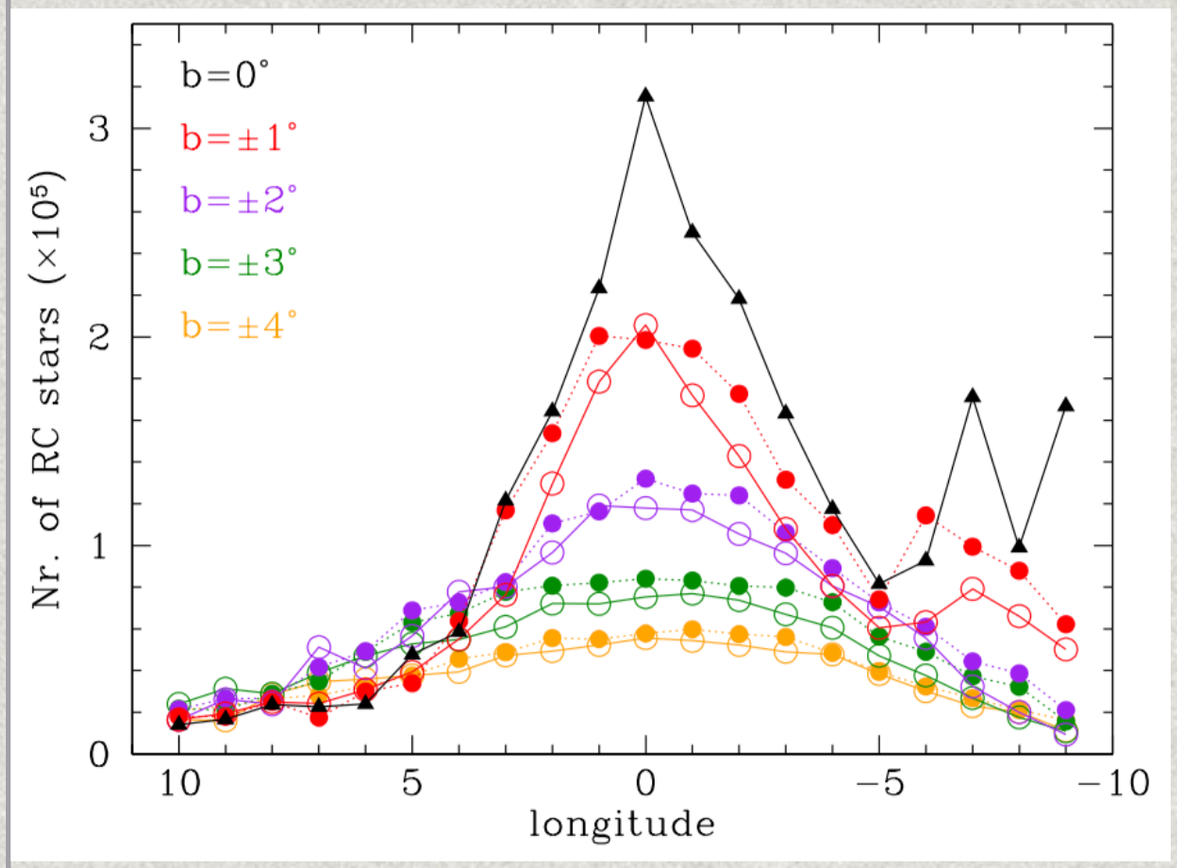


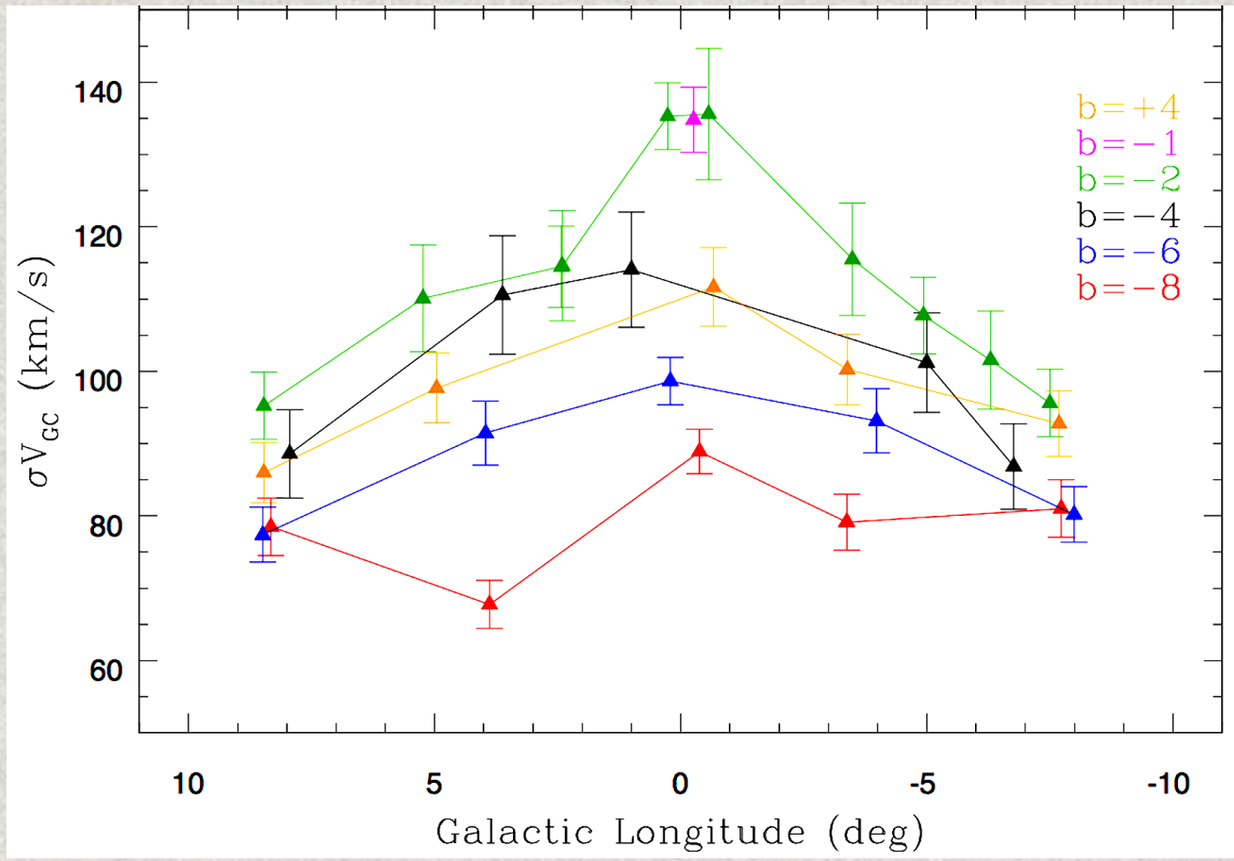
The Bulge Stellar Density Profile

Valenti, MZ, et al. (2015, A&A submitted)

Density Profile



sigma Profile



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it has a velocity dispersion peak at R<200 pc
…matched by a peak in stellar density

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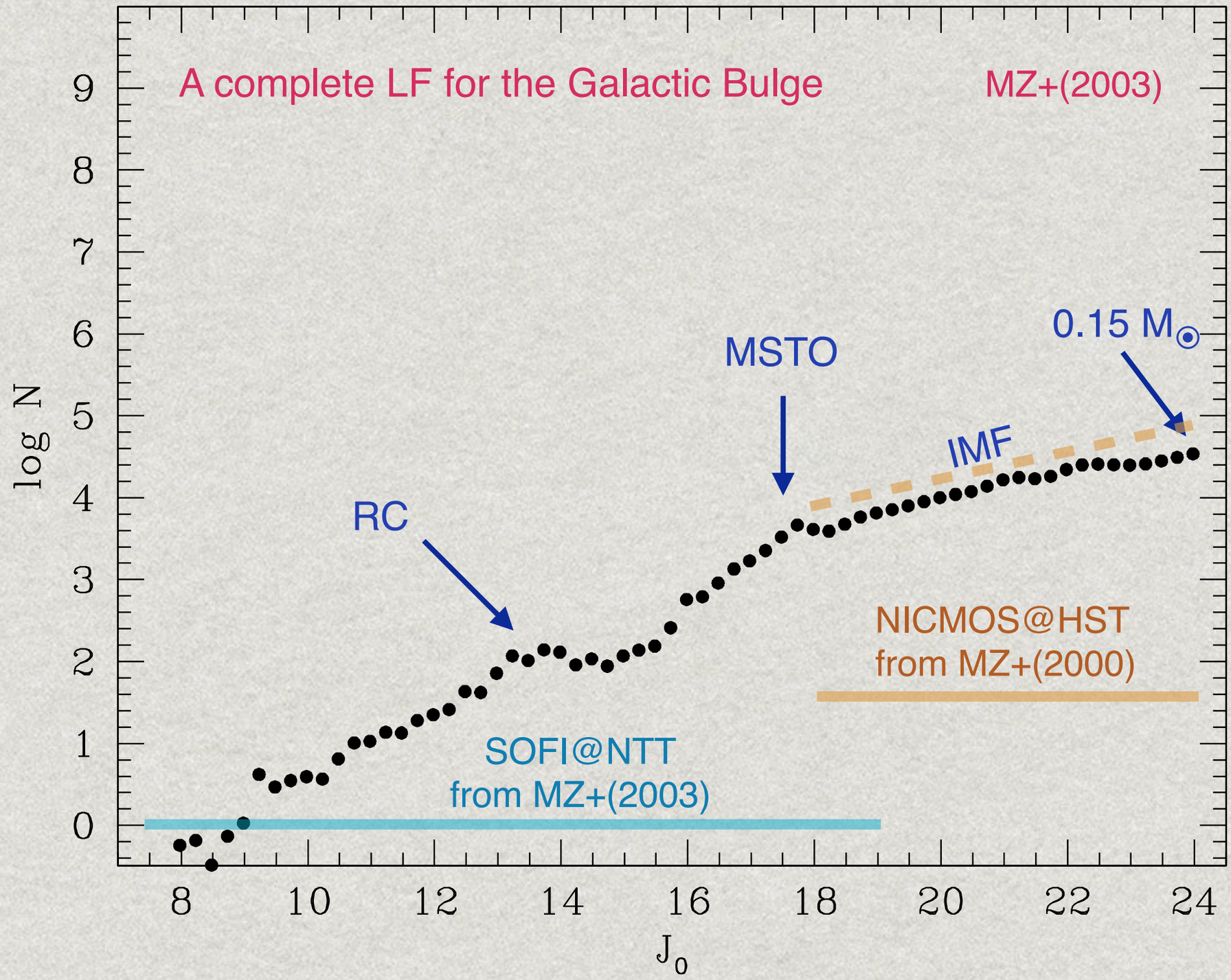
A fully empirical estimate of the bulge Stellar Mass



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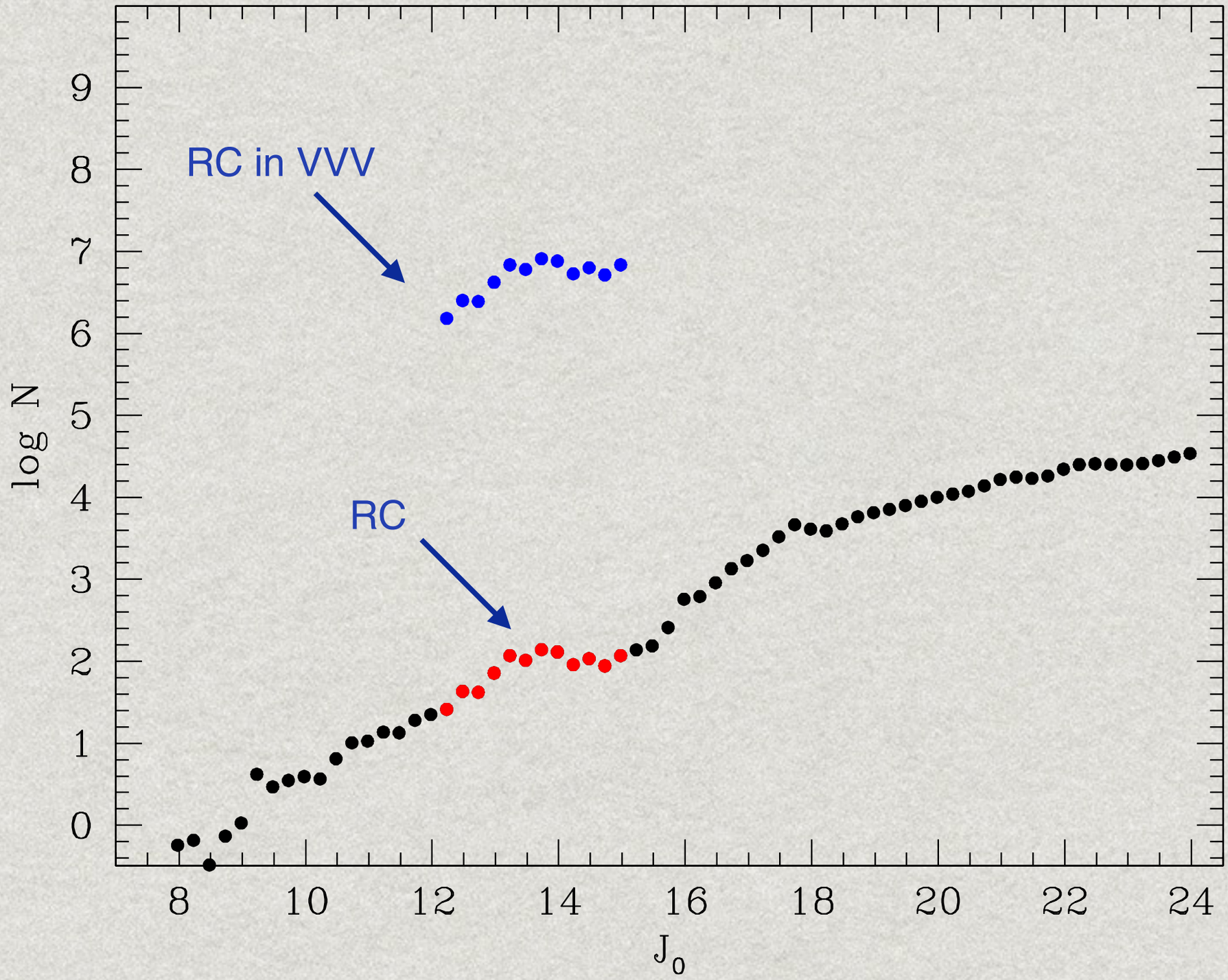

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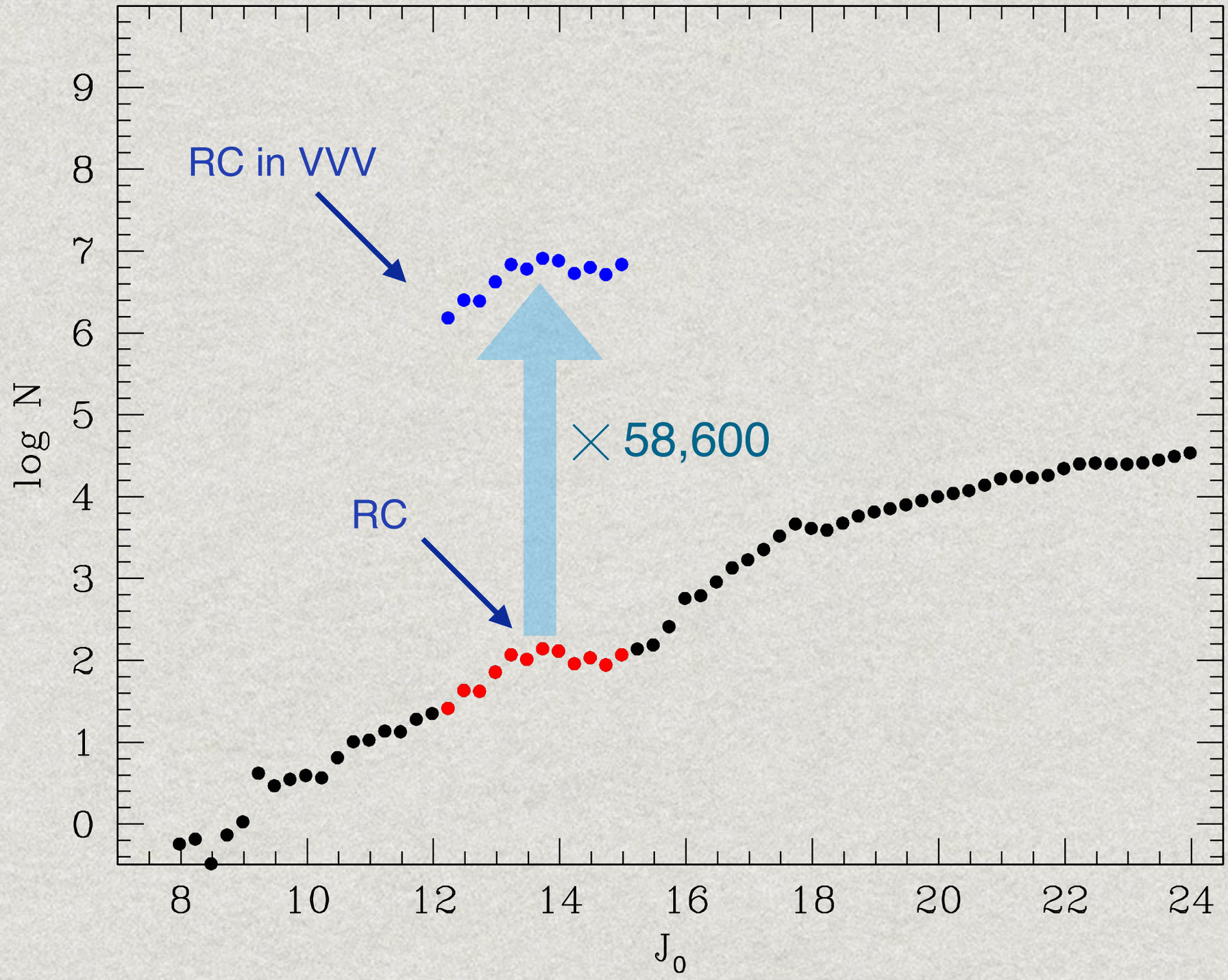

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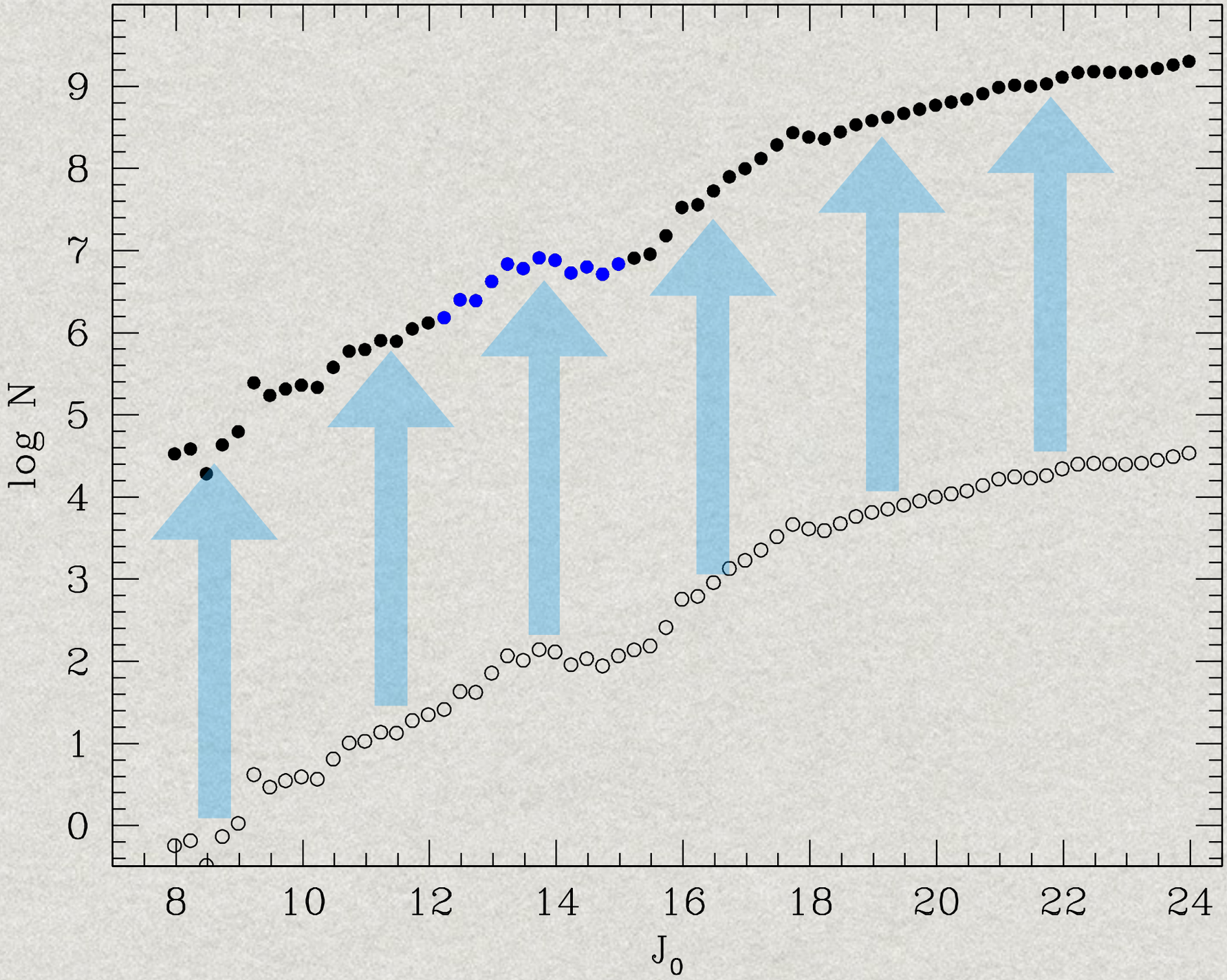

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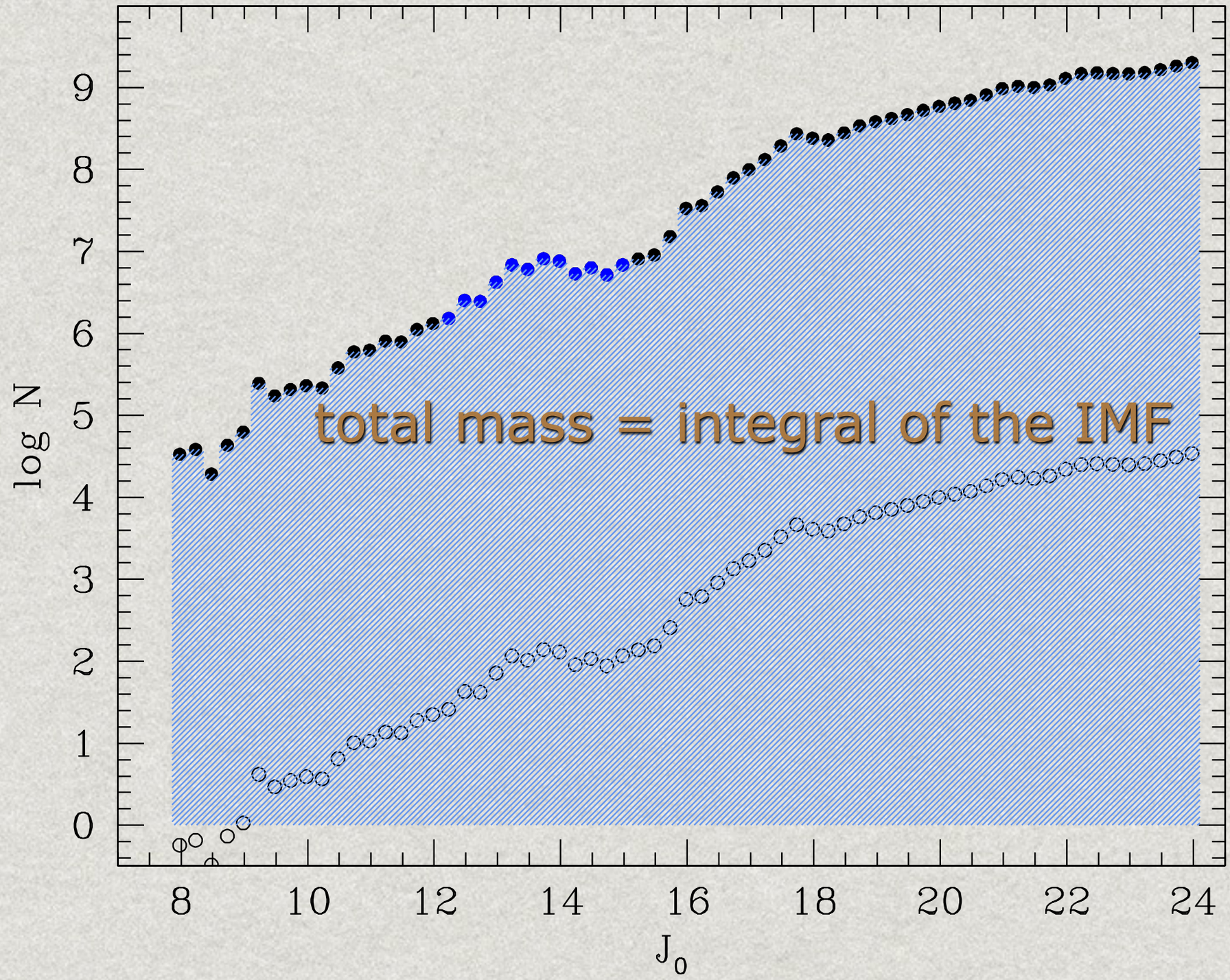


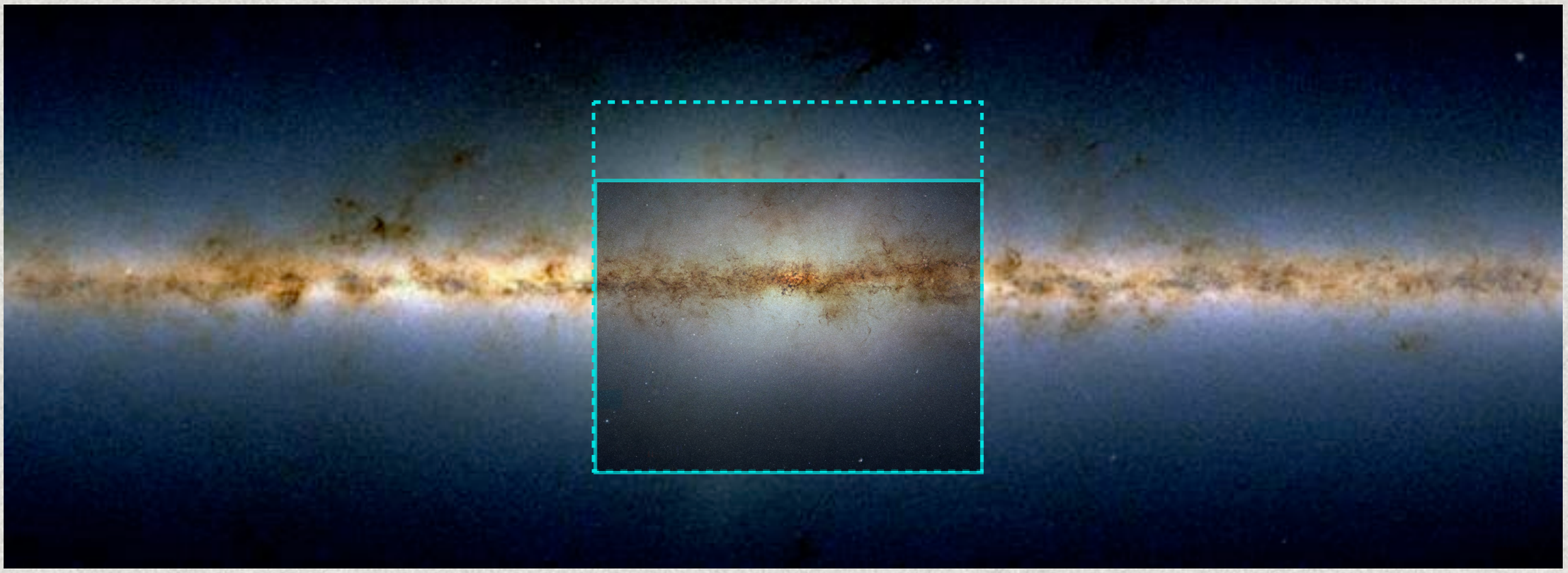
Stellar density profile and mass of the Milky Way Bulge from VVV data*

A&A submitted

E. Valenti,[1] M. Zoccali,[2,3] O. A. Gonzalez,[4,5] D. Minniti,[3,6,7] J. Alonso-García,[8,3] E. Marchetti,[1] M. Hempel,[2] A. Renzini,[9] M. Rejkuba,[1,10]

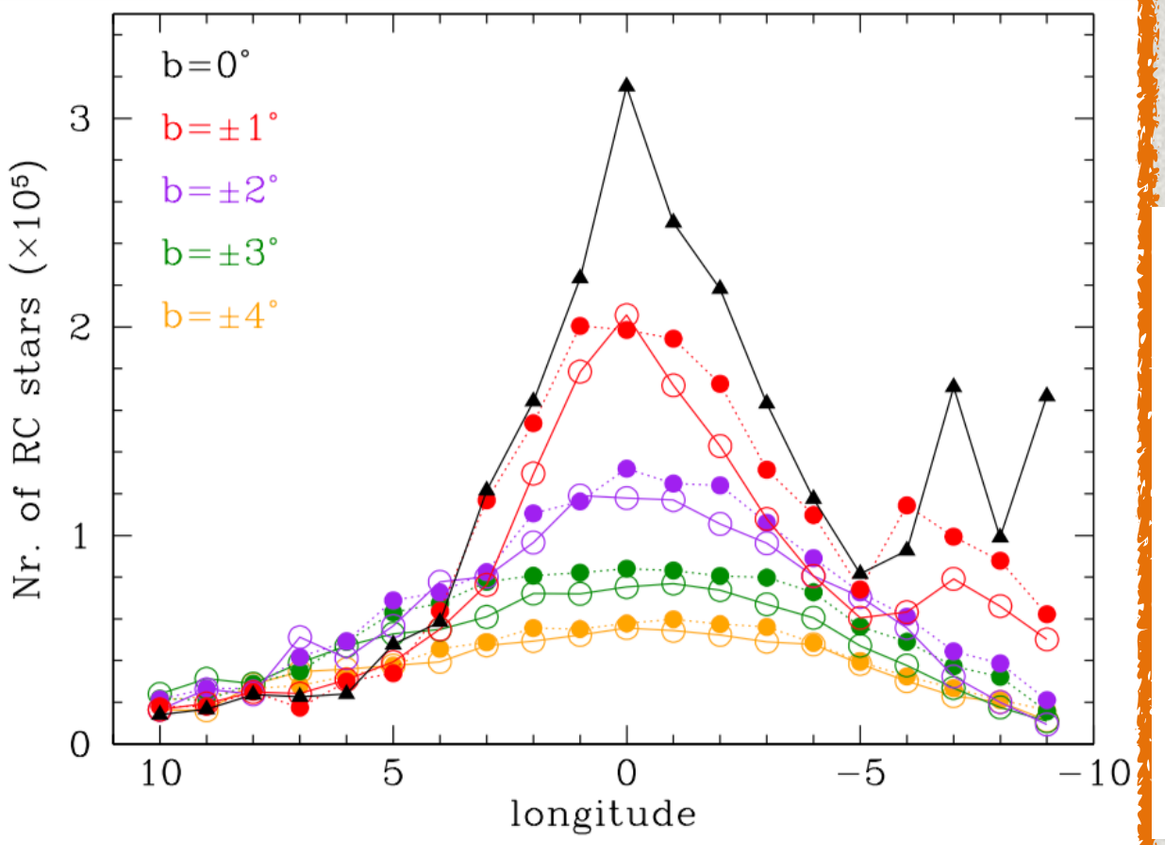
2 (±0.3) x 10^{10} $M_\odot$

in stars
and remnants

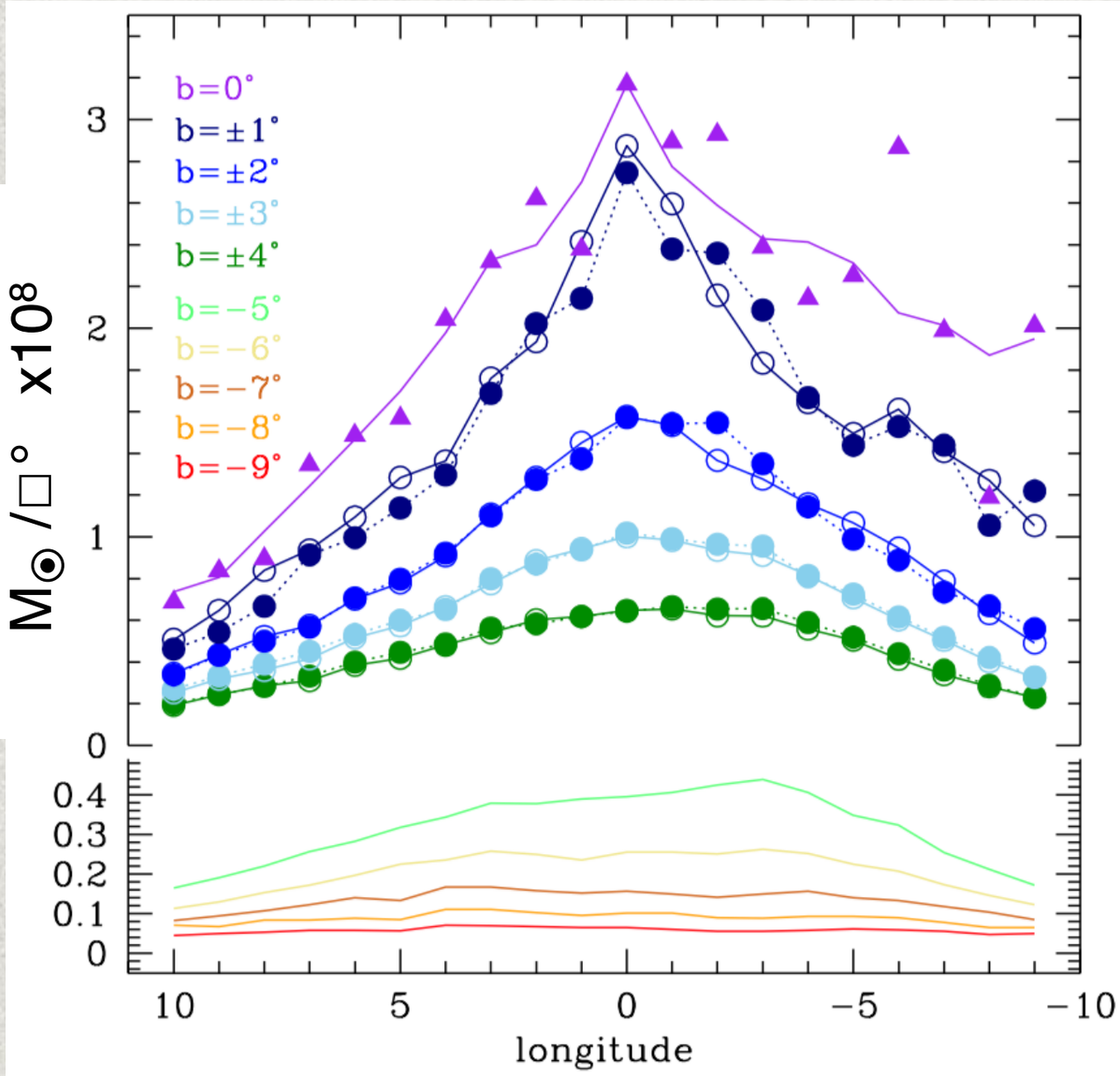


Valenti, MZ, et al. (2015, A&A submitted)

Density Profile



Mass Profile



The Galactic bulge

it is a bar, with a boxy/peanut shape

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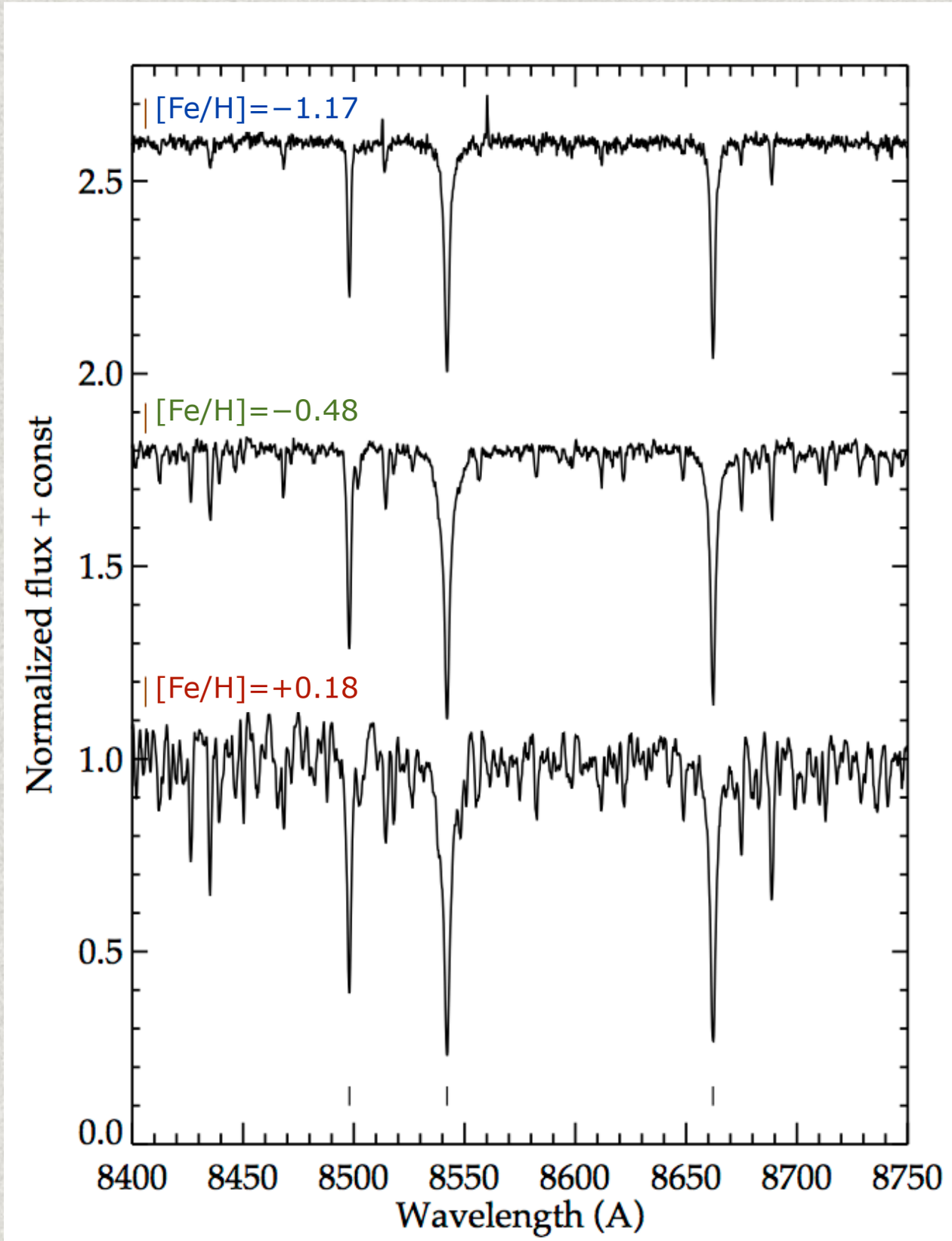
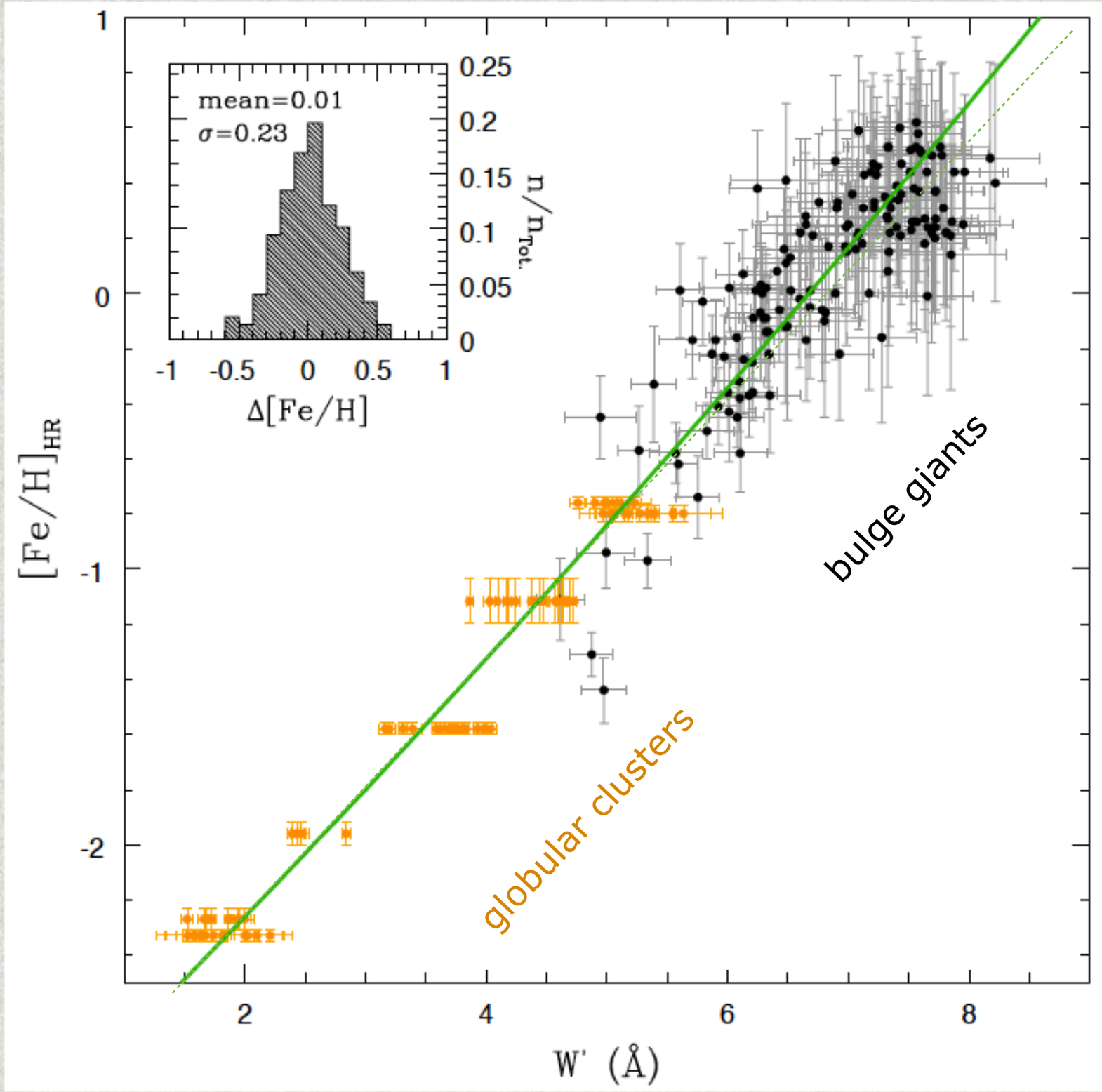
…back to the GIBS spectra

~ 6500 RC stars observed in **CaT**



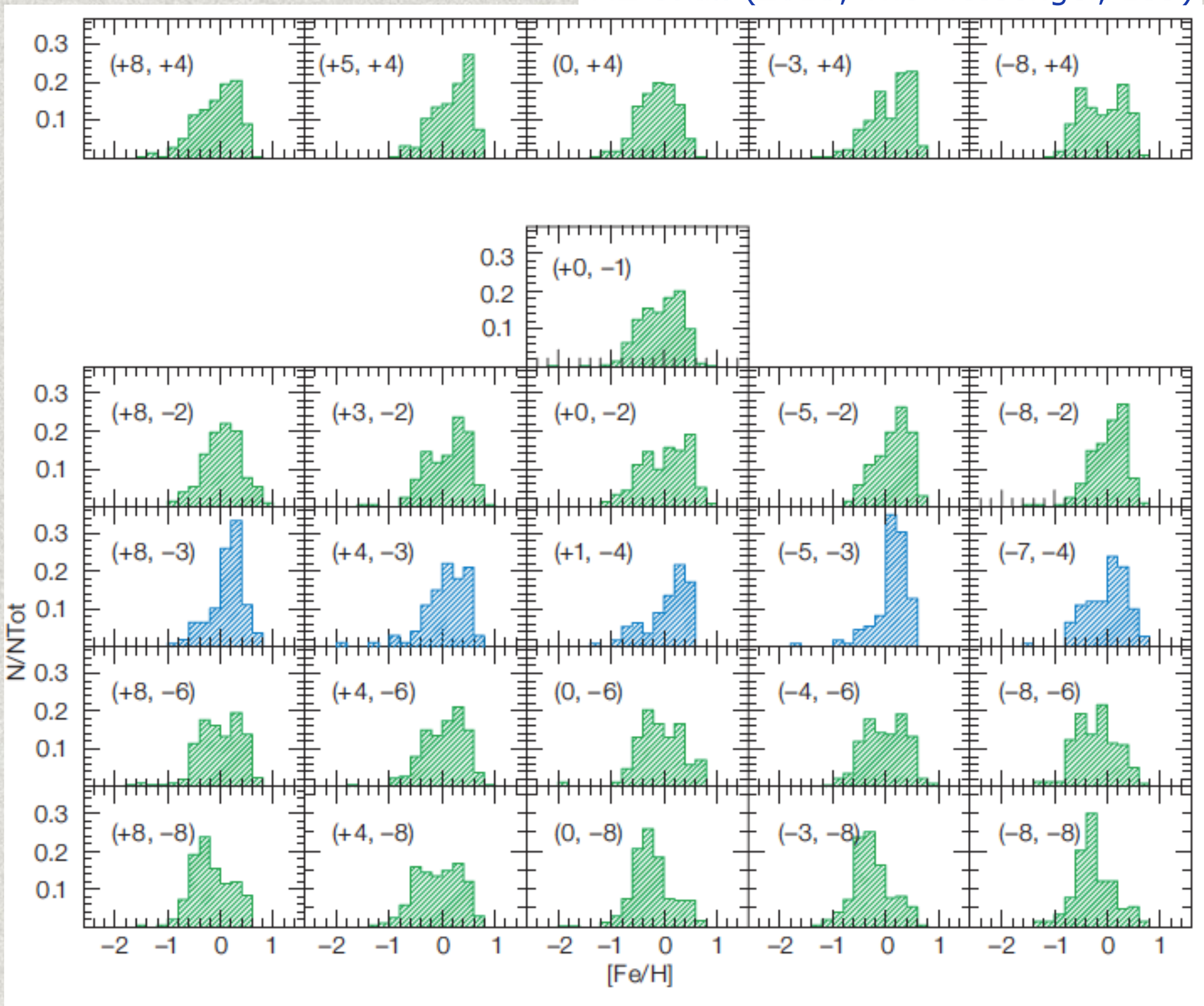
A new CaT–[Fe/H] calibration obtained from bulge giants

Vásquez, MZ et al. (2015, A&A, 580, 121)



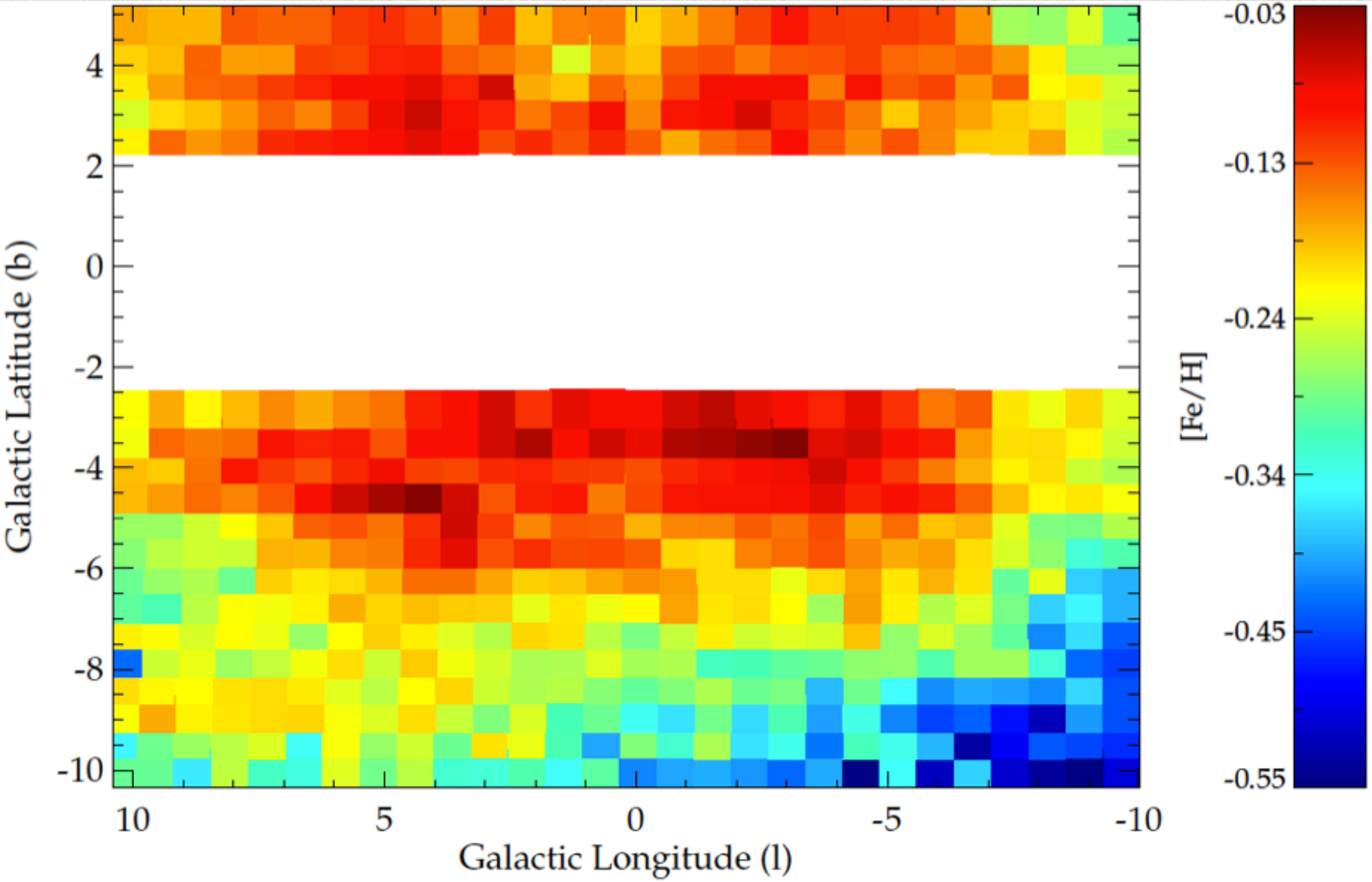
The Metallicity Distribution for 31 bulge fields

MZ et al. (2015, The Messenger, 159)



The Photometric Metallicity Map for VVV

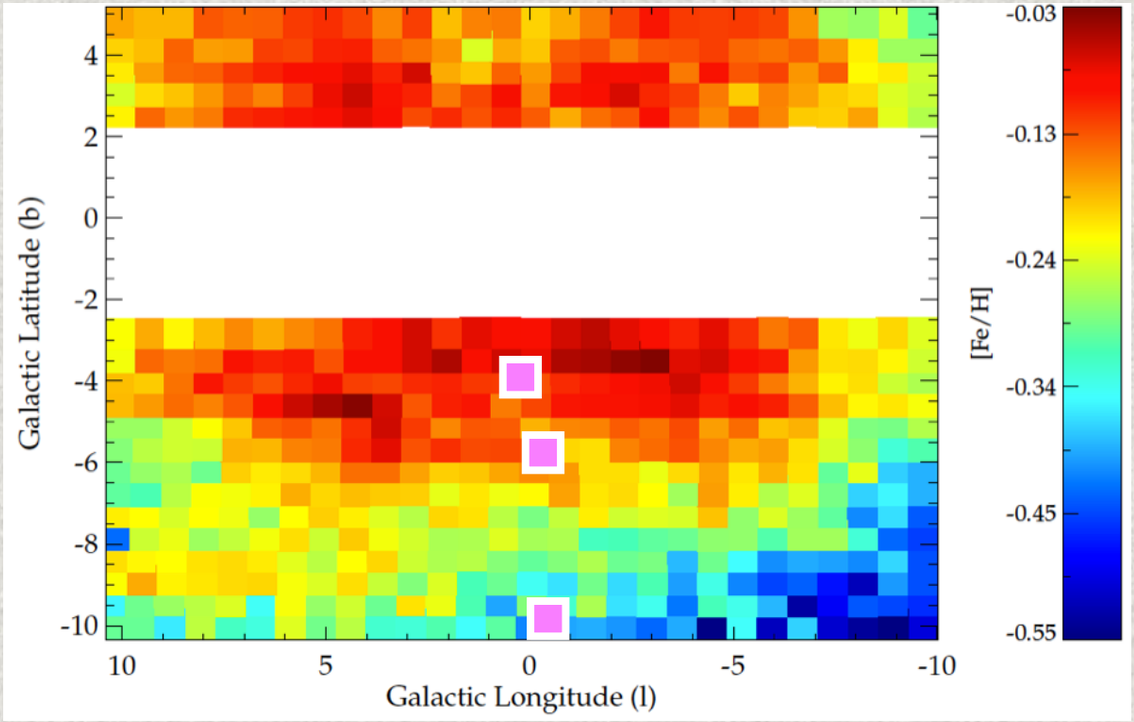
Gonzalez et al. (2013, A&A, 543, 13)



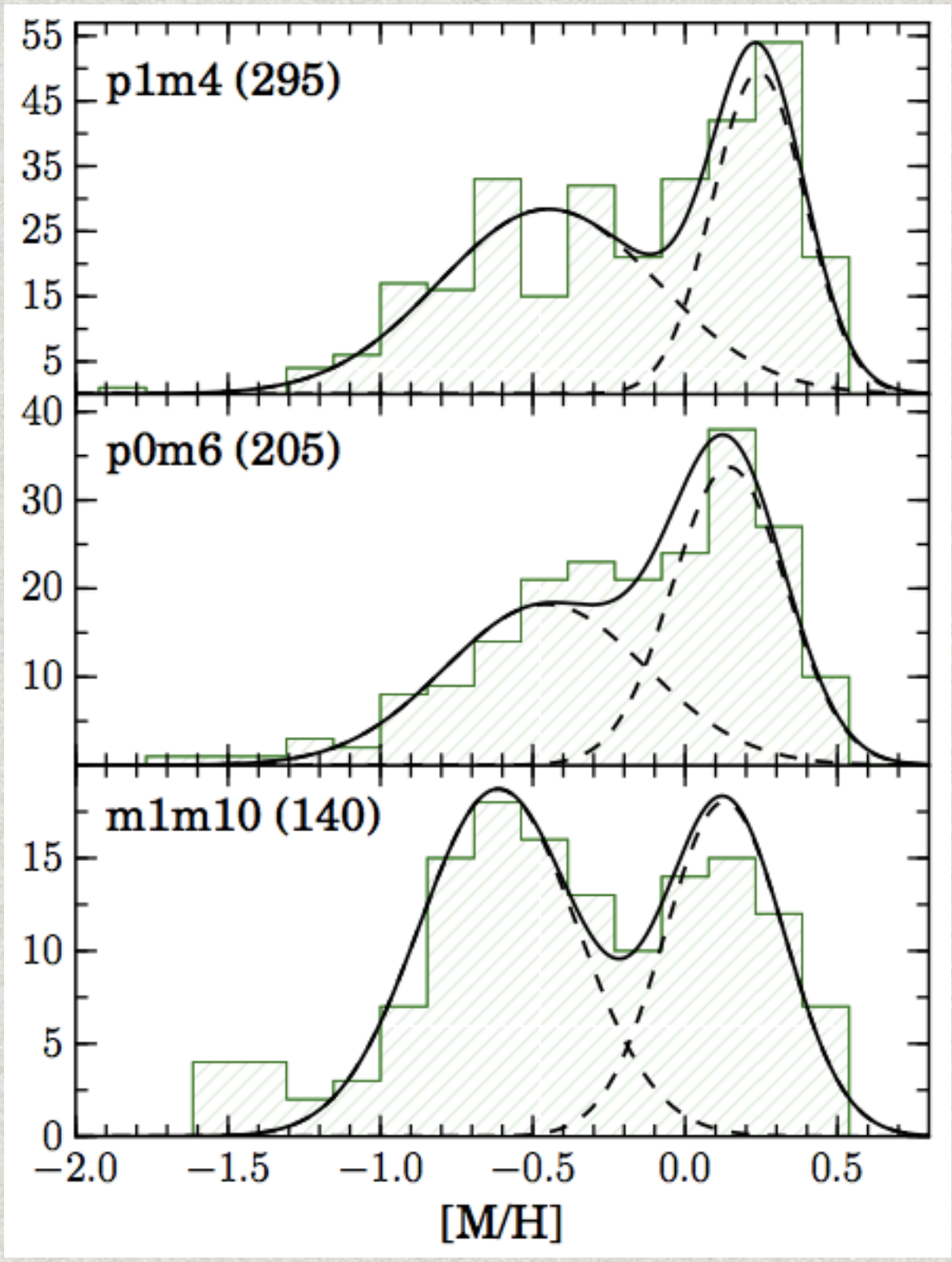
The origin of the bulge metallicity gradient

the gradient is due to a different proportion of two stellar components

see also:
MZ et al. (2008)
Babusiaux et al. (2010)
Hill et al. (2011)
Ness et al. (2013)



Rojas-Arriagada et al. (2014)….Gaia ESO

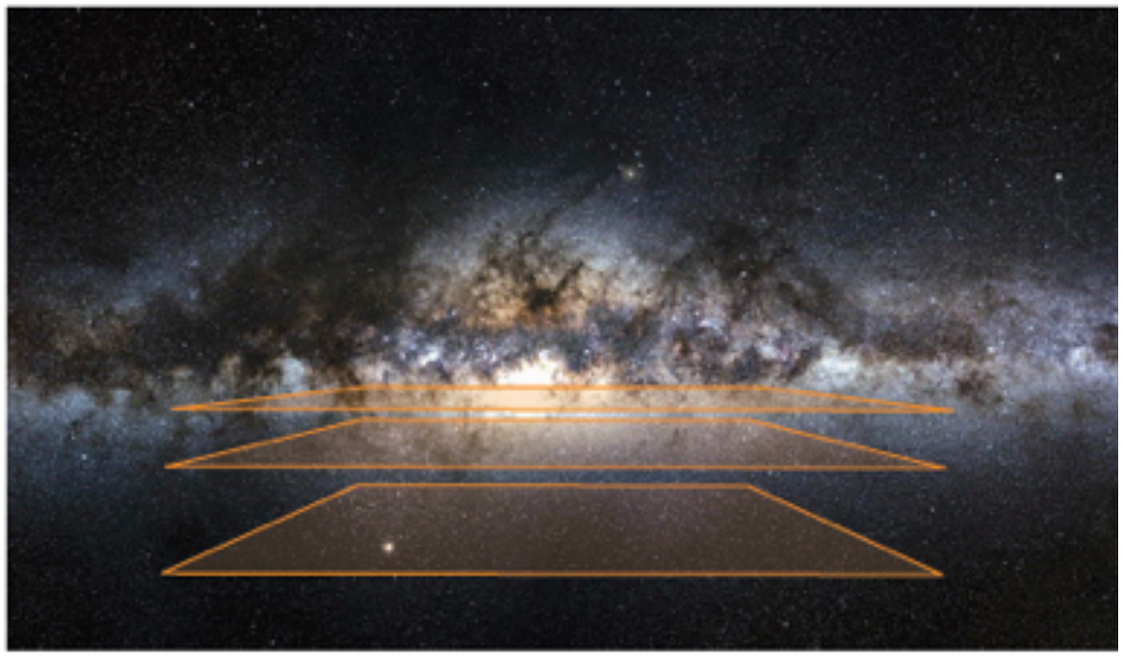


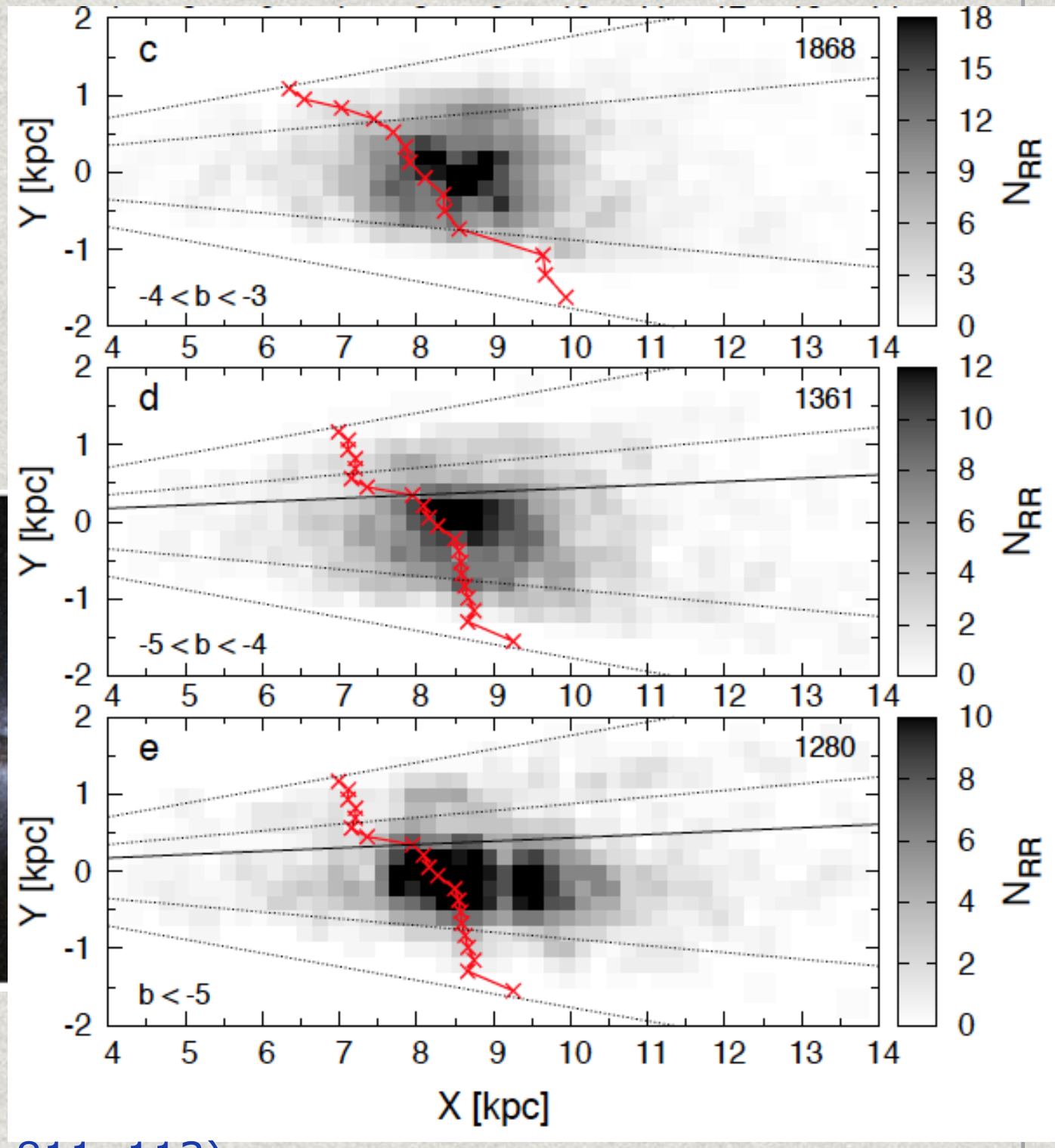
The bulge 3D map from RR Lyrae

RRL do not trace a bar

they have a spheroidal 3D distribution

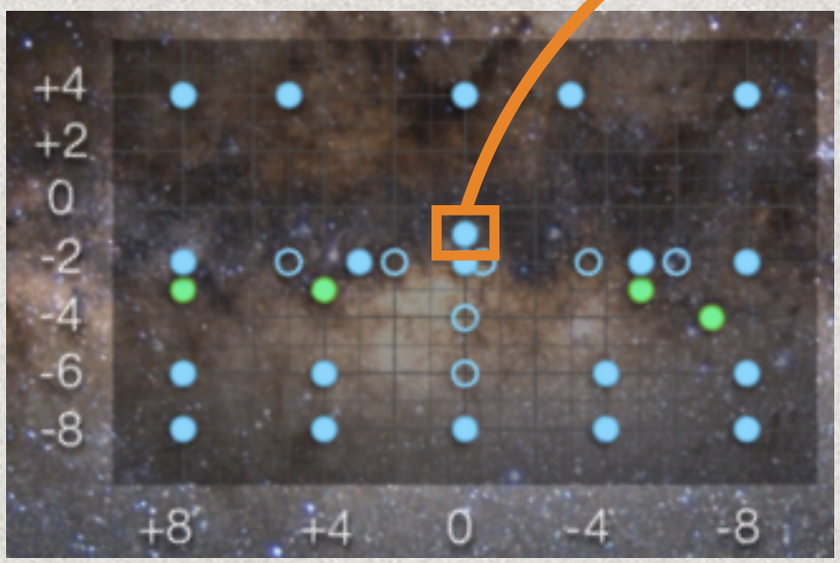
Dékány et al. (2013, A&A, 776, L19)

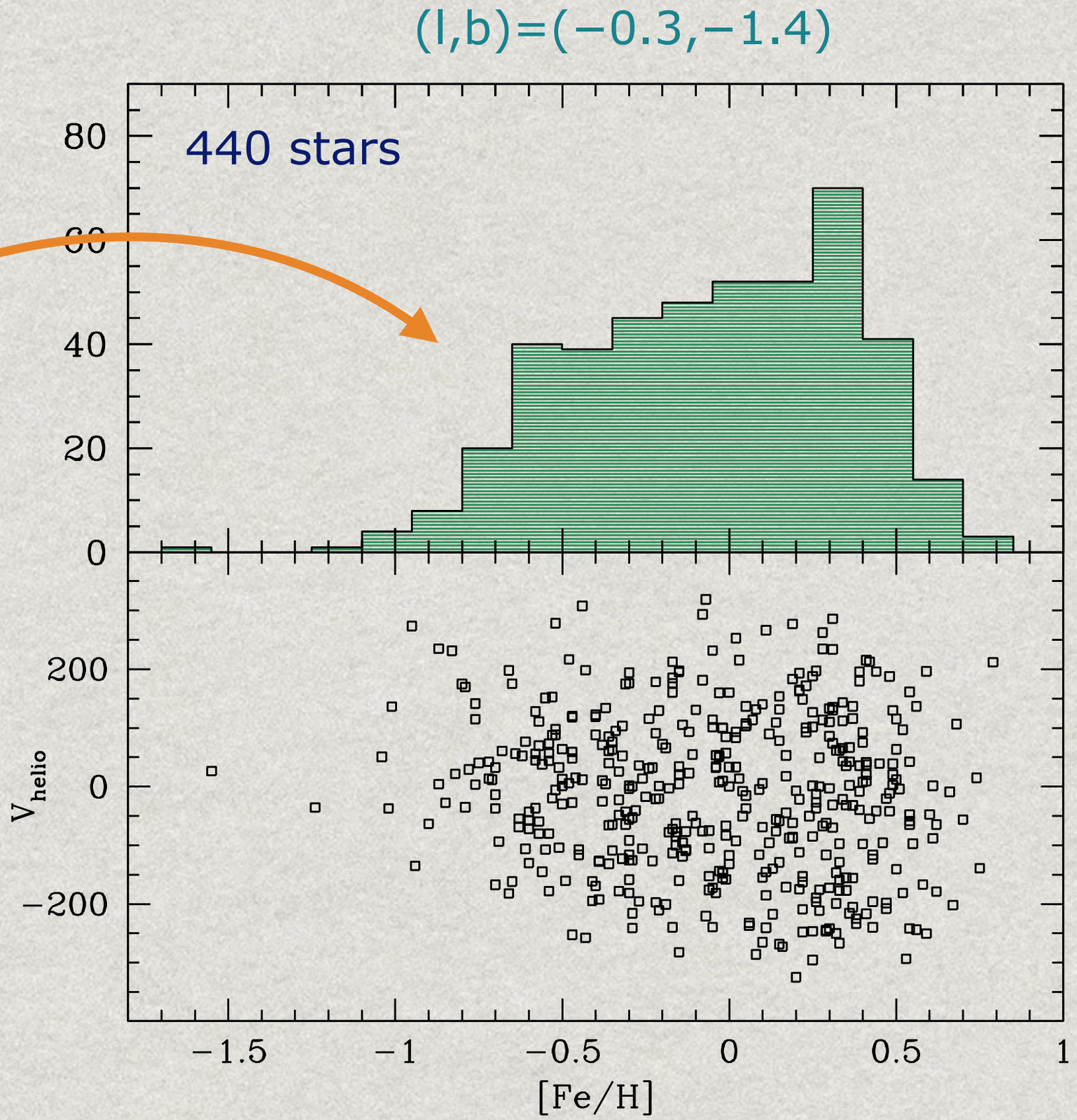




but see also Pietrukowicz+ (2015, ApJ, 811, 113)

GIBS: …the innermost field





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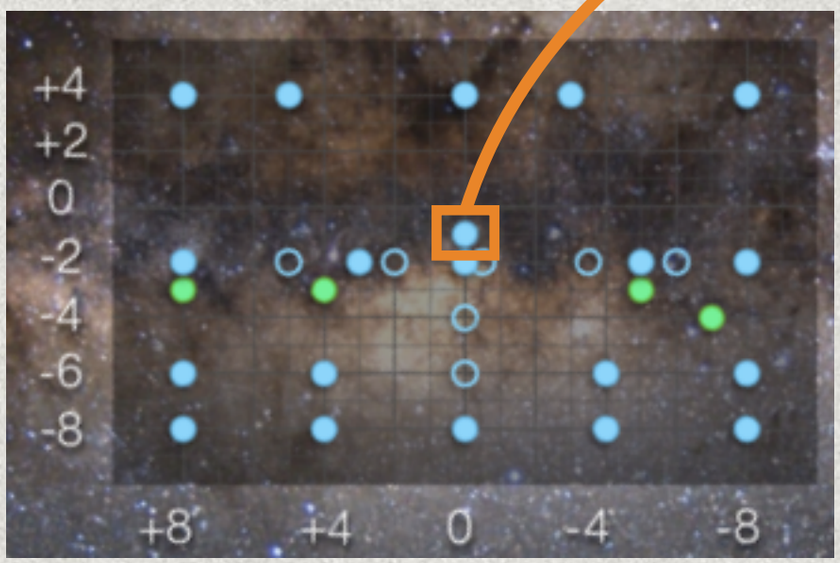
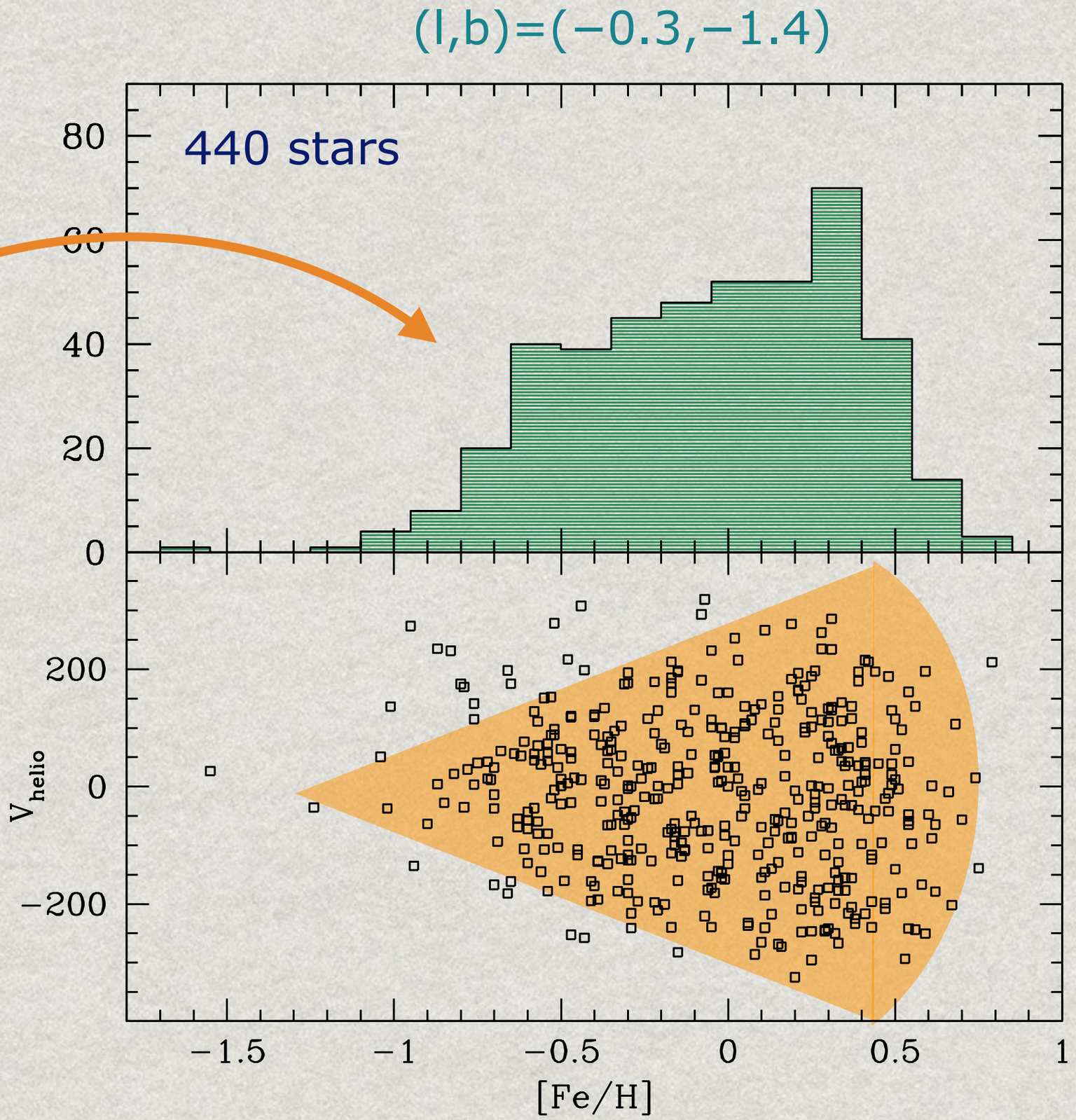
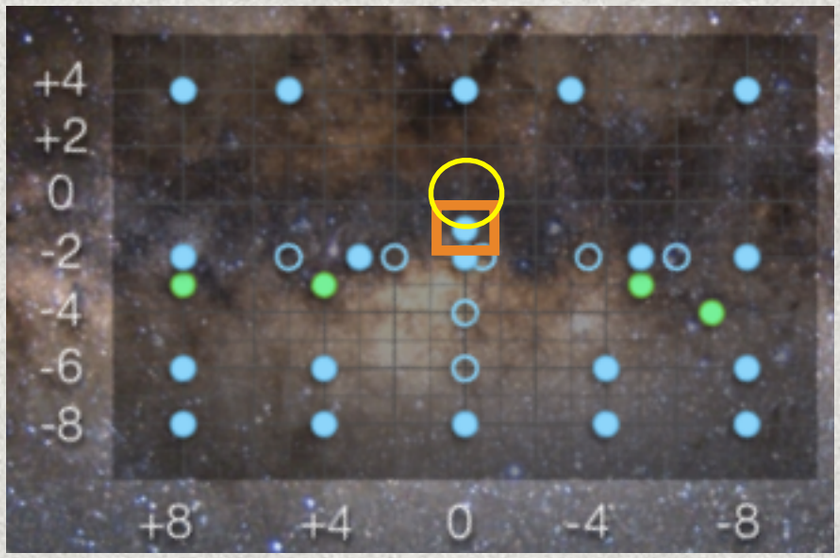
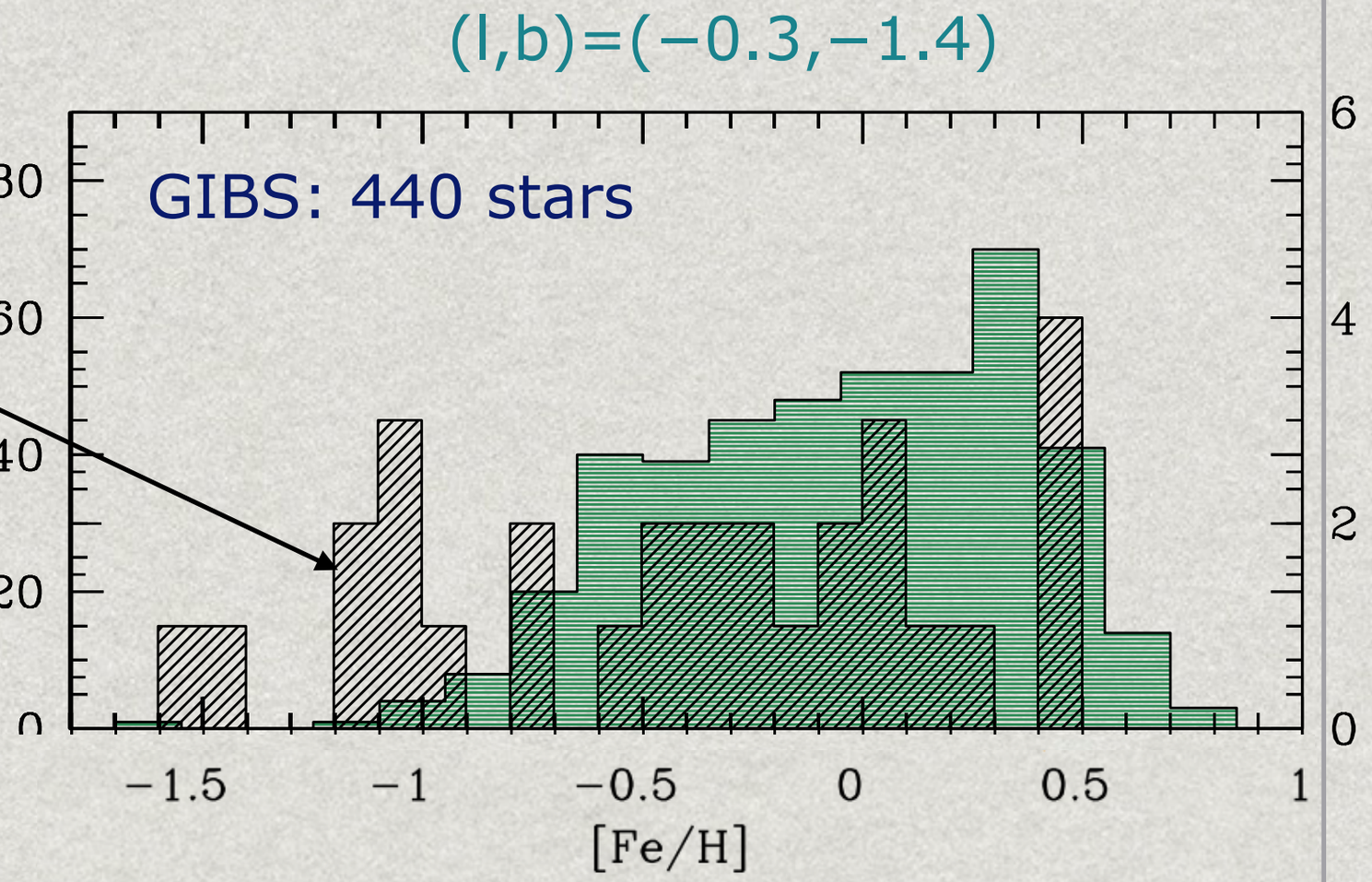




…the innermost field

Schultheis et al. (2015)
apogee: 33 stars





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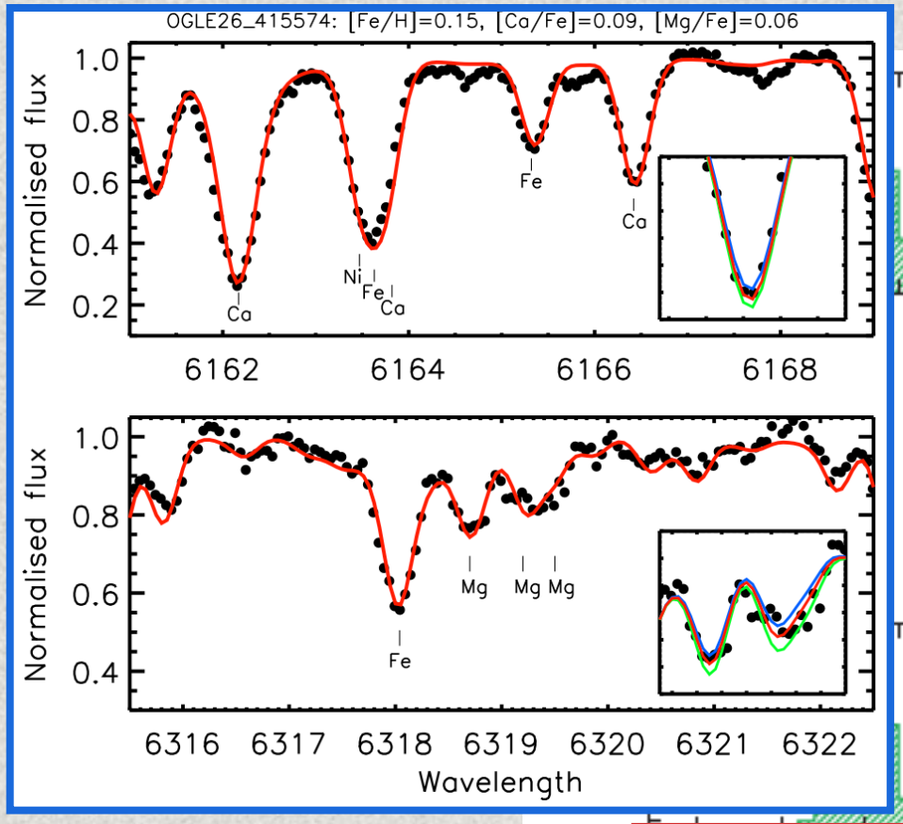
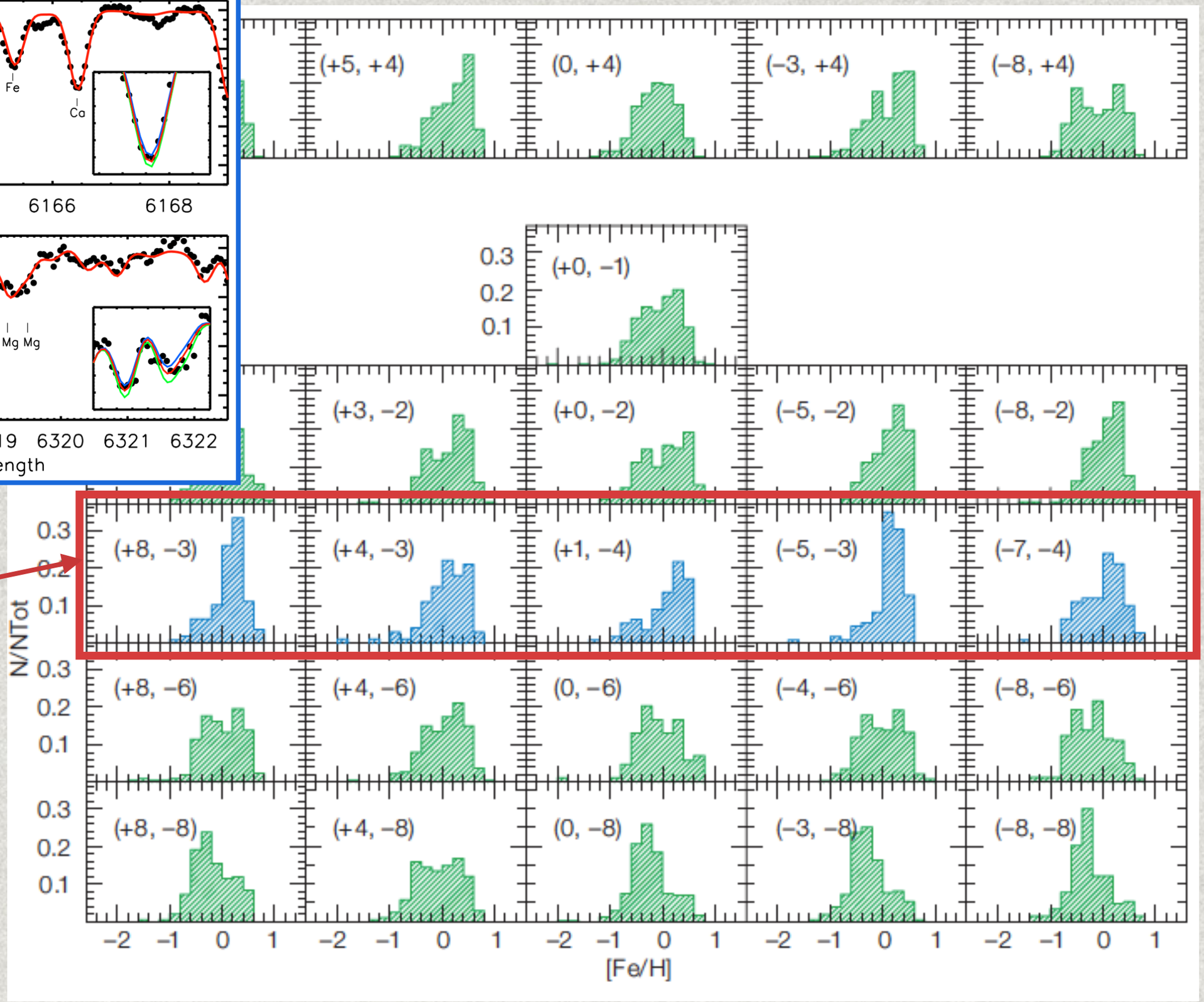
The MDF at high-resolution in 5 fields (GIRAFFE-HR)



high-res spectra



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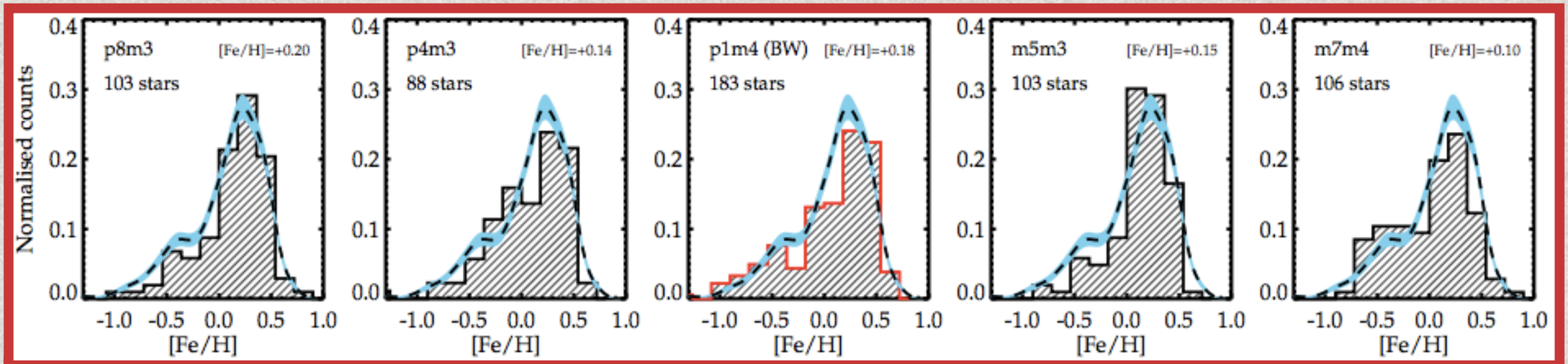

Gonzalez, MZ et al. (A&A in press, arXiv:1508.02576)

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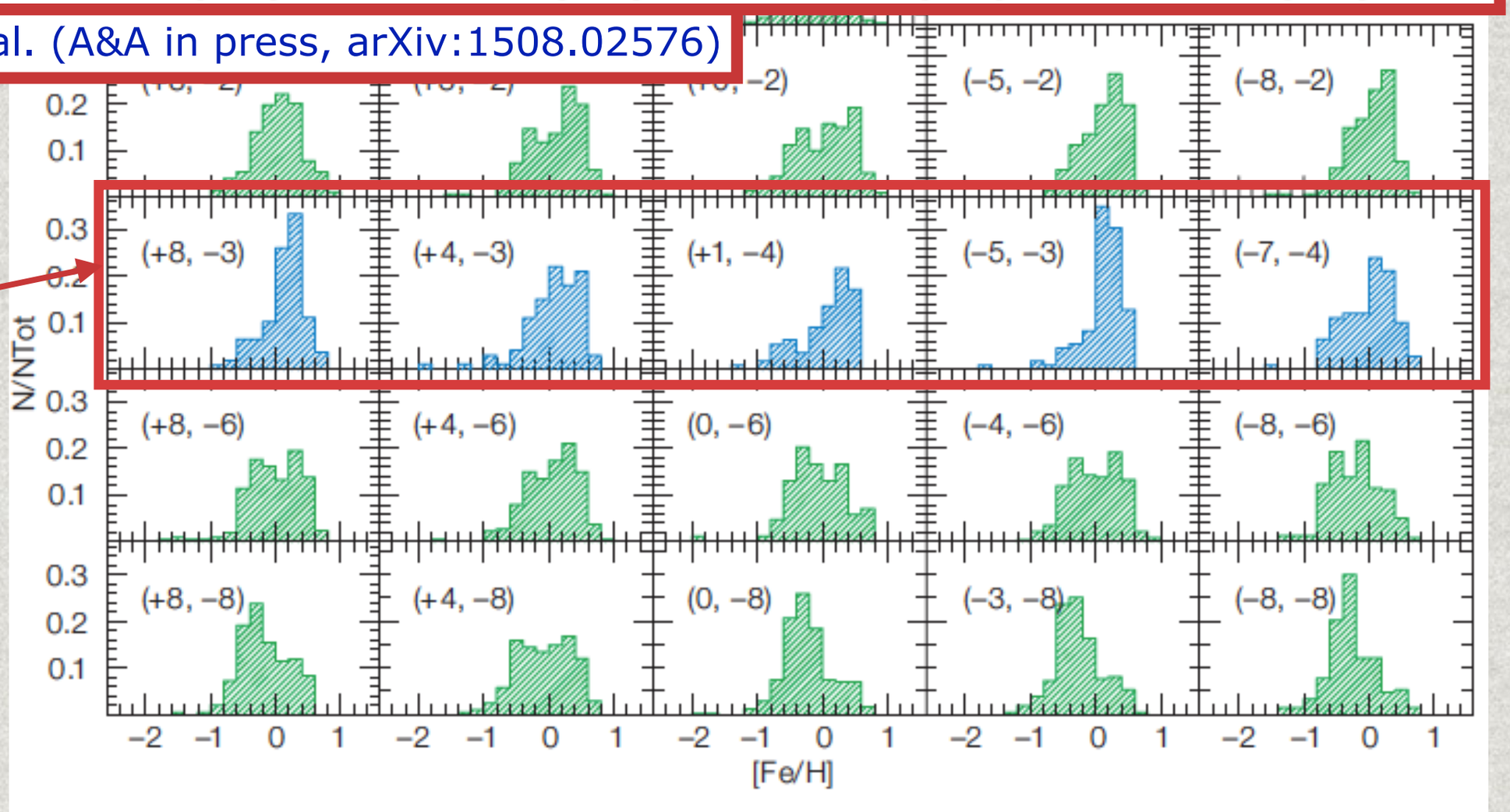

The Giraffe Inner Bulge Survey (GIBS) II. Metallicity distributions and alpha element abundances at fixed Galactic latitude ⋆

O. A. Gonzalez[1], M. Zoccali[2,3], S. Vasquez[2,3], V. Hill[4], M. Rejkuba[5,6], E. Valenti[5], A. Rojas-Arriagada[7], A. Renzini[8], C. Babusiaux[9], D. Minniti[3,10,12], and T. M. Brown[11]

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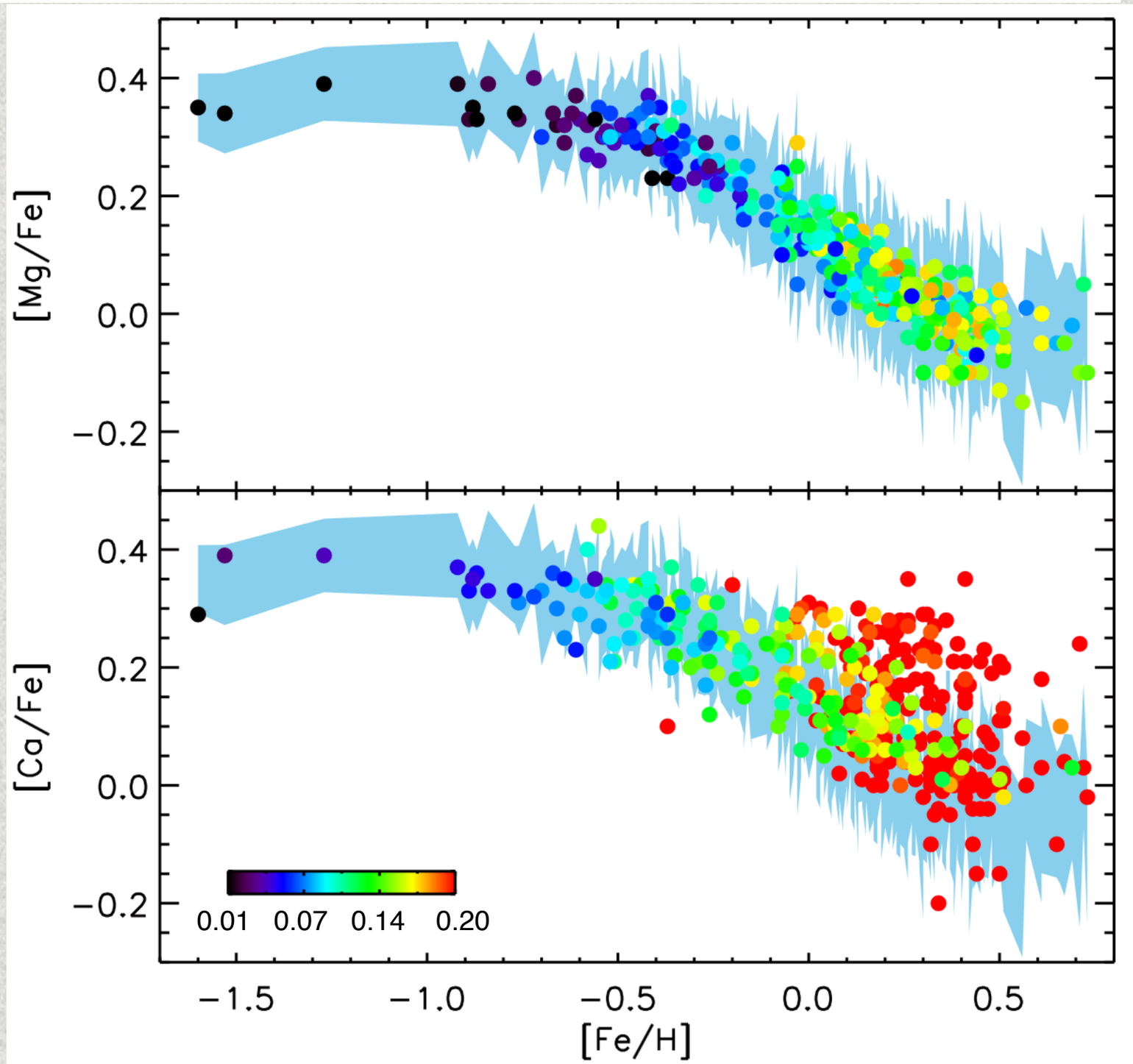

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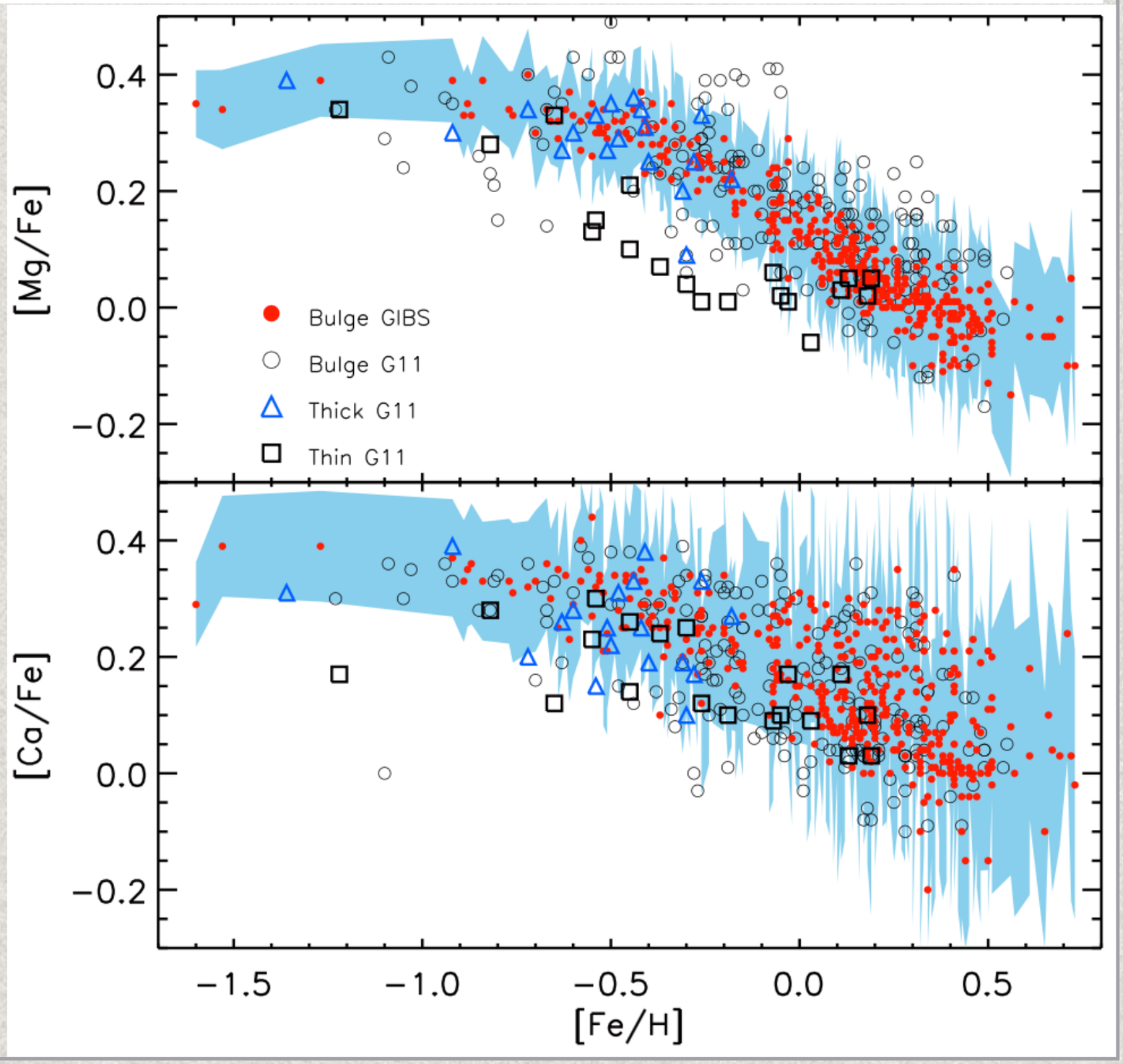

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alpha element ratios similar to thick disk but extending to much higher metallicities

[.....]
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