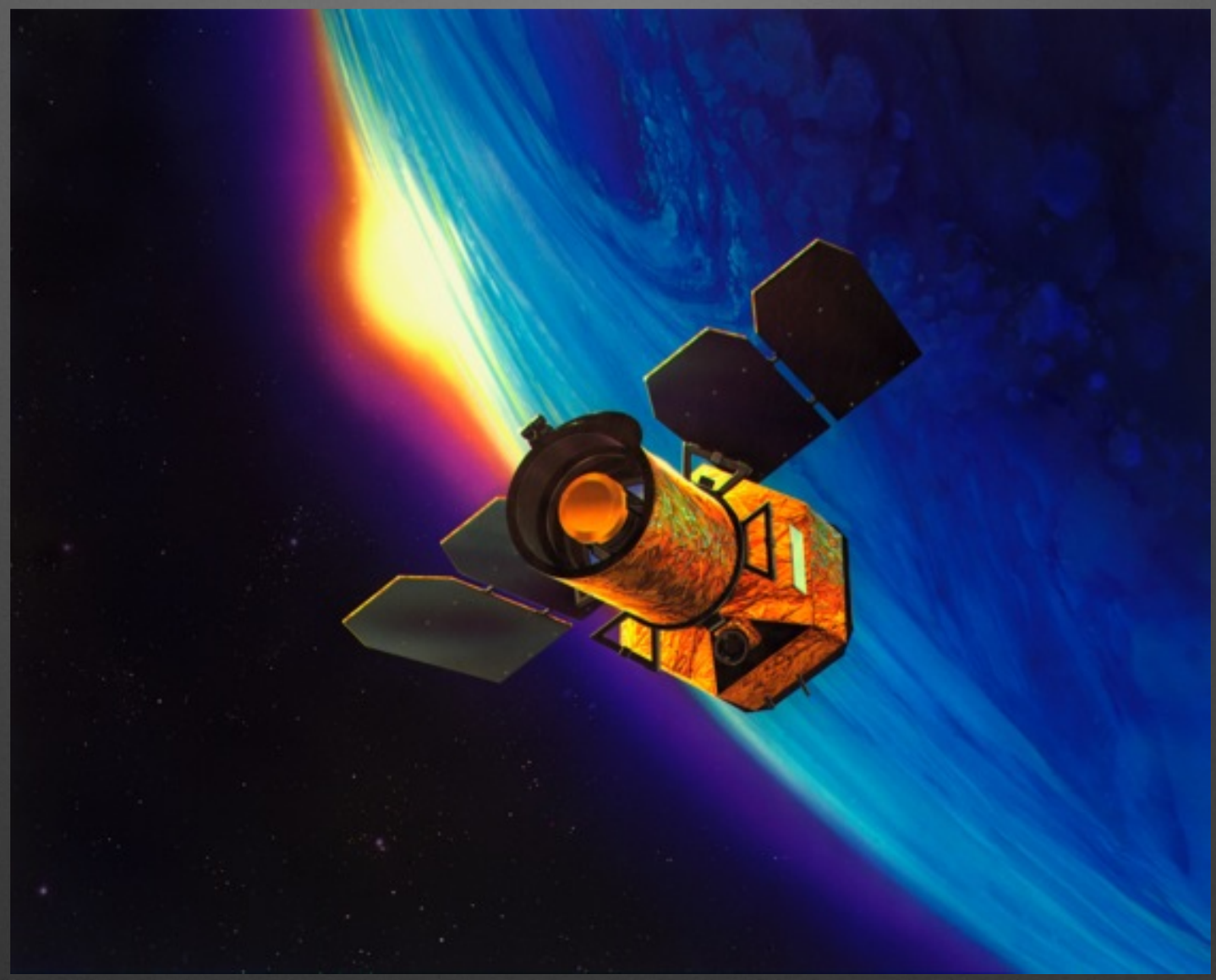
ASI Science Data Center

RR Lyrae in Galex



Giuliano Giuffrida

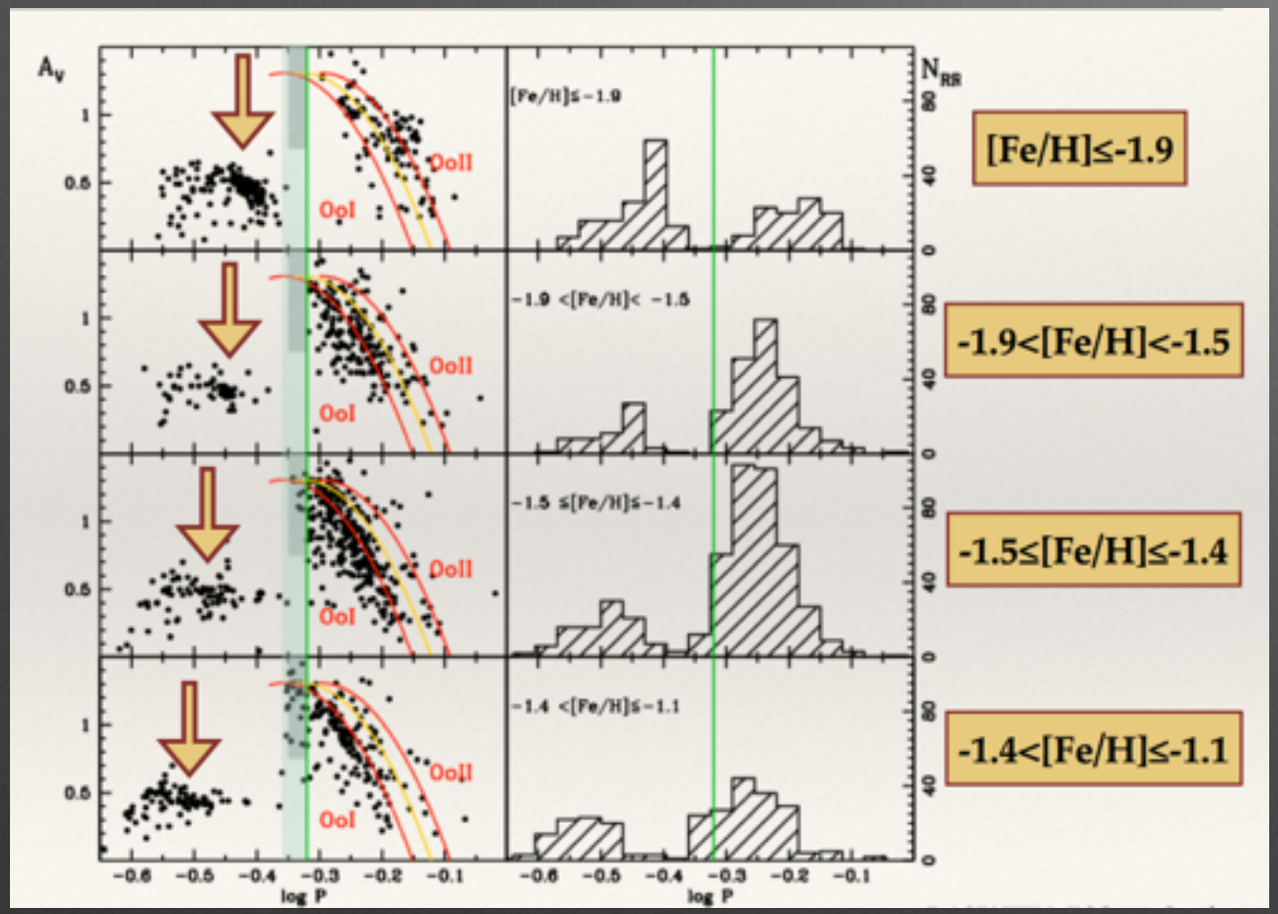
ASDC-INAF

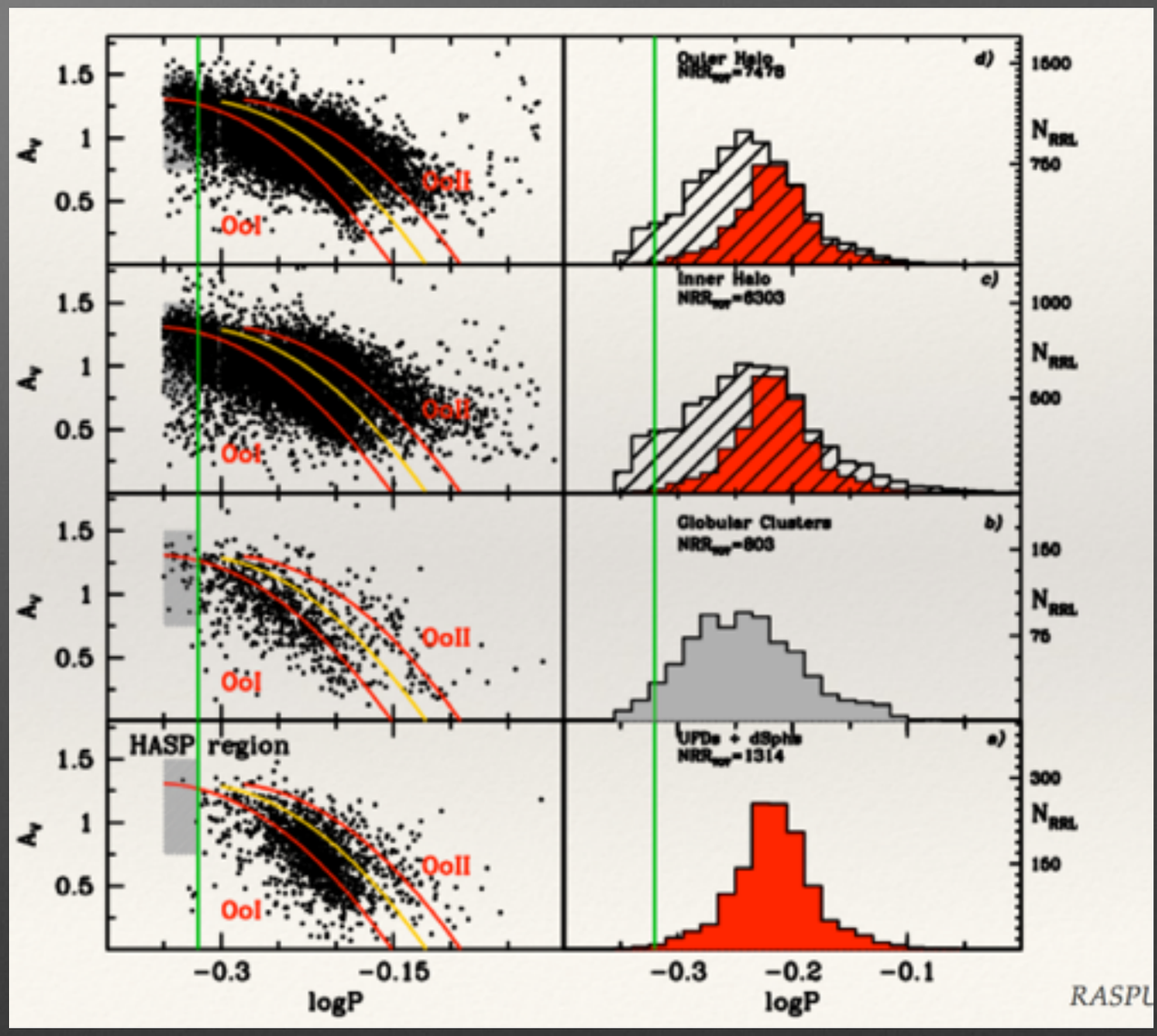
RASPUTIN

Resolved And unresolved Stellar PopUlaTIoNs

Giuseppe Bono (Univ. Tor Vergata Rome)
Vittorio Braga (Univ. Tor Vergata Rome)
Massimo Dall'Ora (INAF-OACN)
Francesco Verrecchia (ASDC-INAF)
Giacinto Iannicola (INAF-OAR)
Ivan Ferraro (INAF-OAR)
Roberto Buonanno (INAF-OACTe)

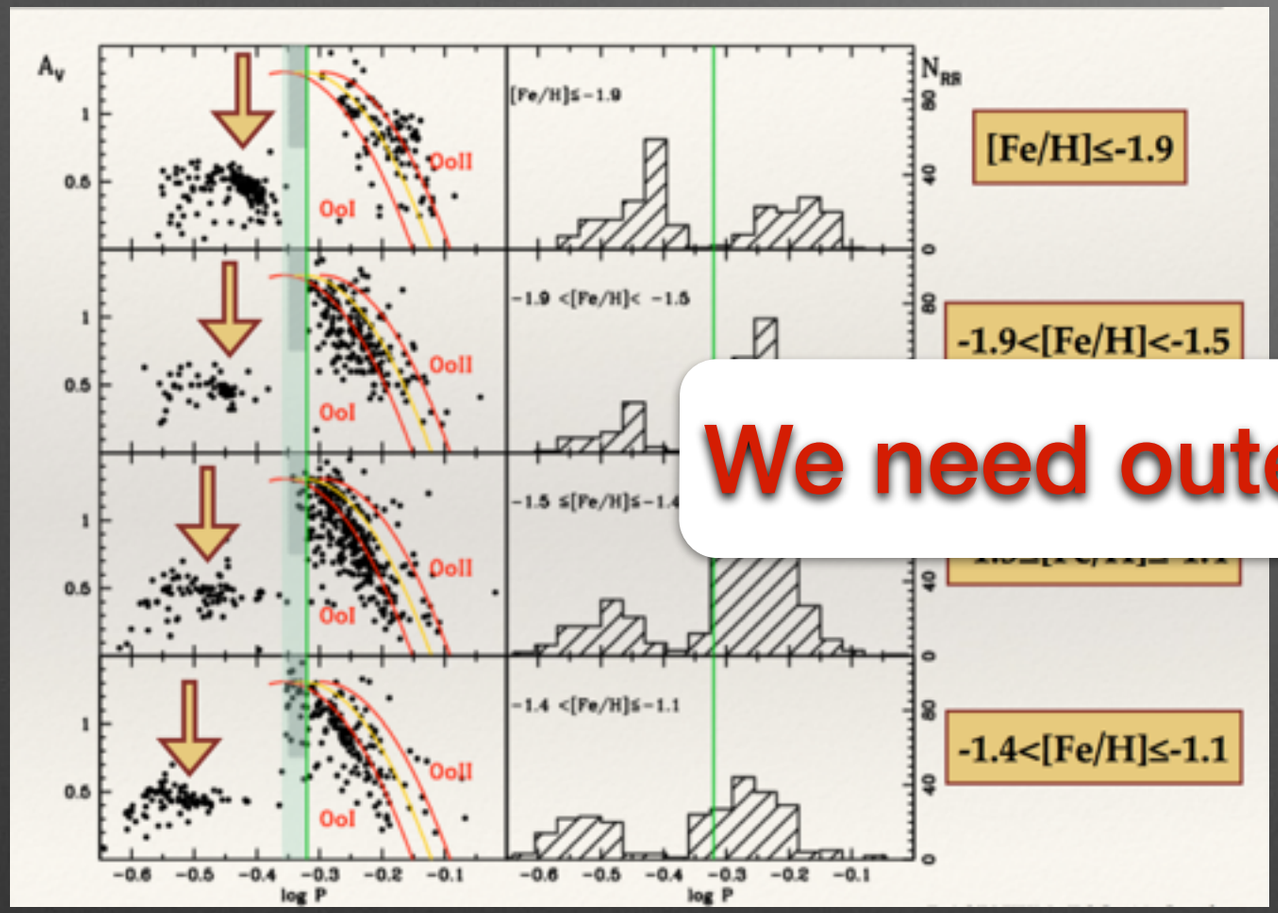
Fiorentino
Monday's talk

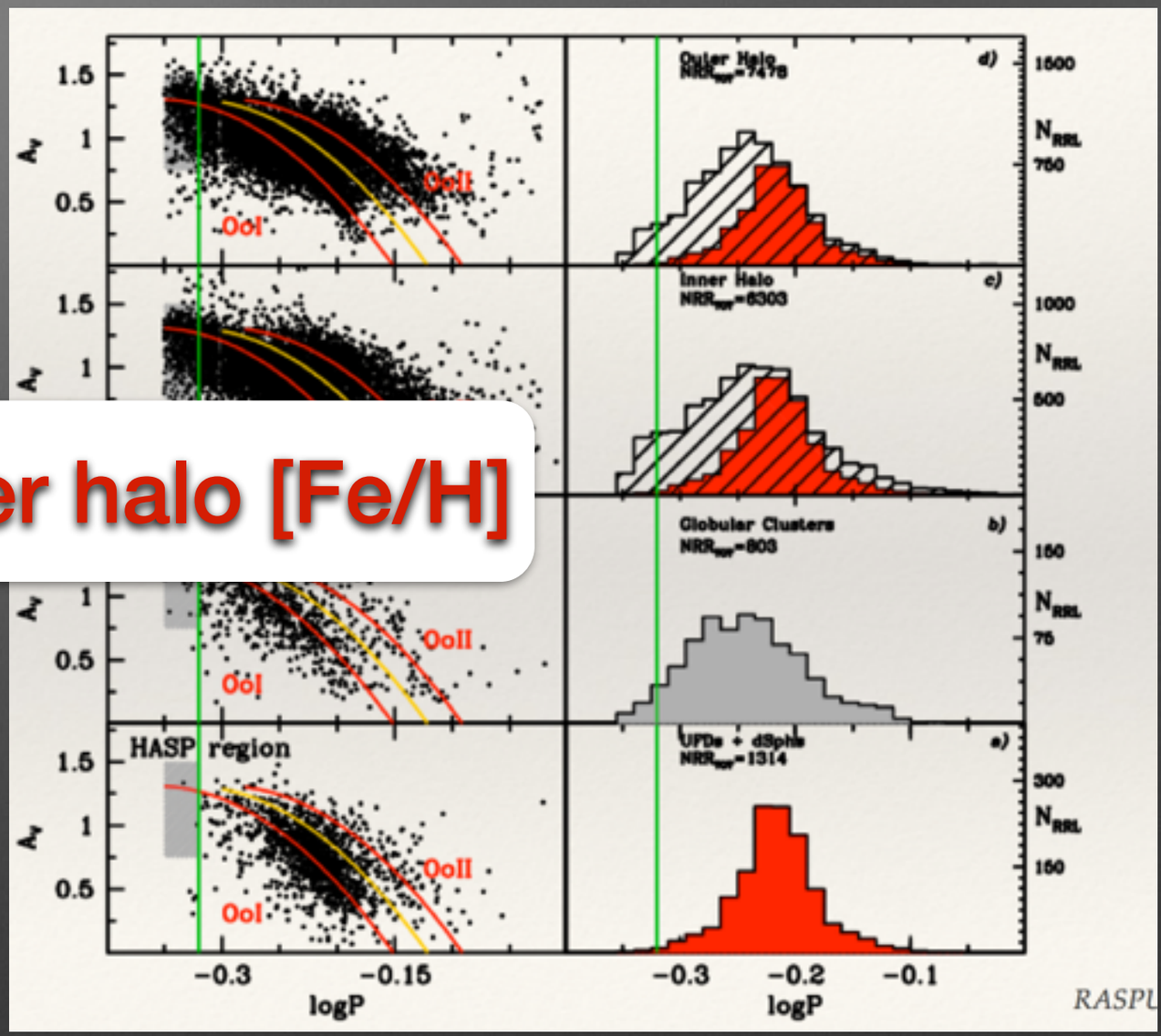




+ Gilmore Tuesday talk and others

Fiorentino
Monday's talk

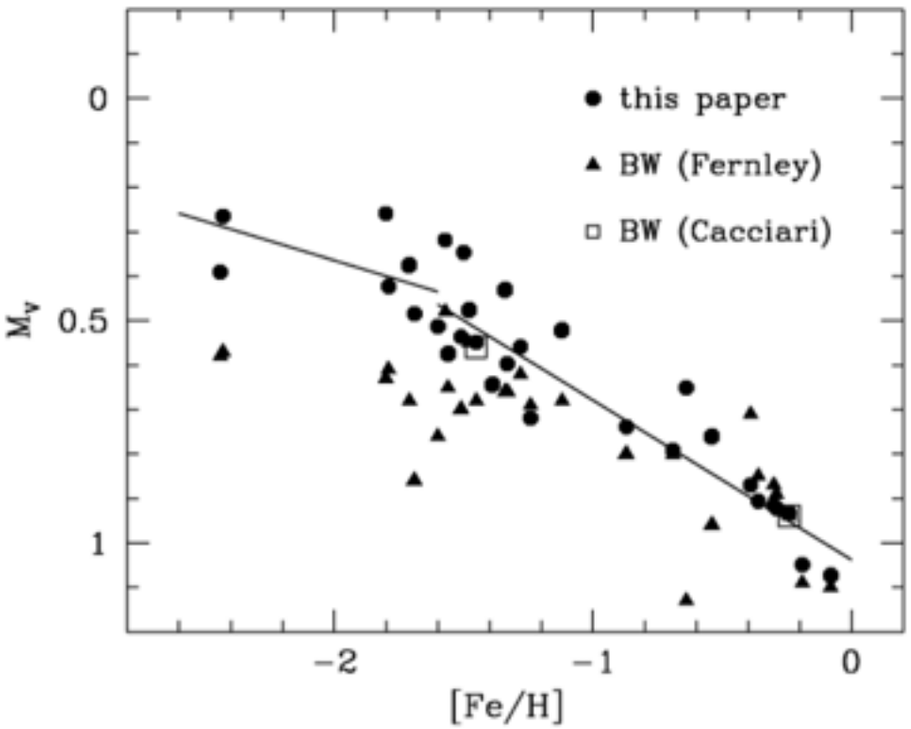


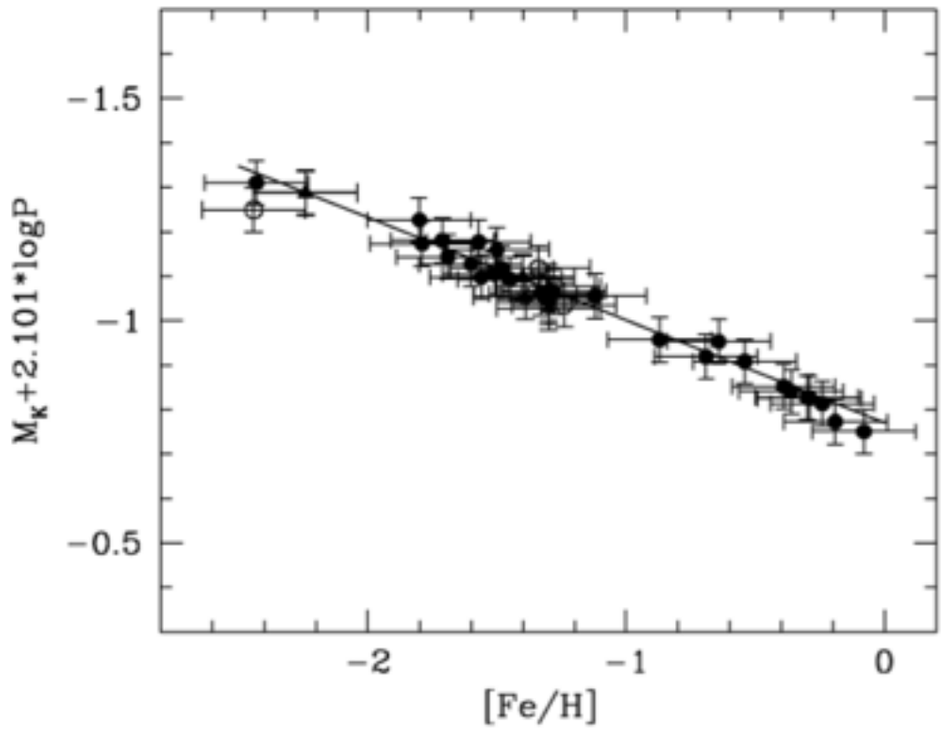


We need outer halo [Fe/H]

+ Gilmore Tuesday talk and others

RR Lyrae
Period-Luminosity-Metallicity





Bono et al 2003

MK=–0.770+ 0.231*[Fe/H] – 2.101*log(Pf)

MV= 0.718 + 0.177(±0.020)*[Fe/H] ([Fe/H]<= -1.6)

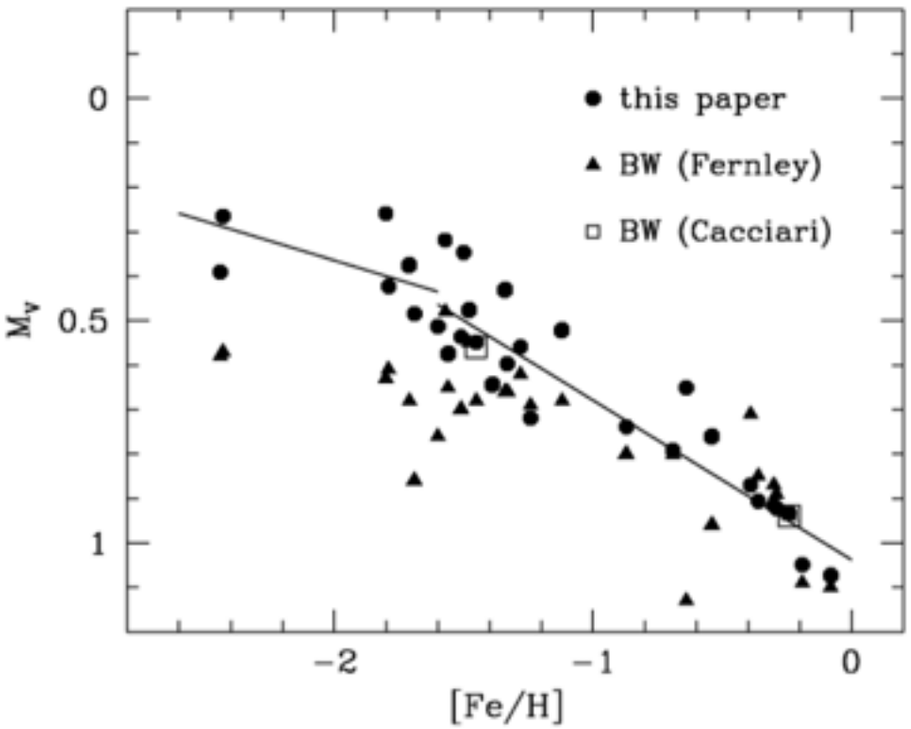
MV= 1.038 + 0.359(±0.020)*[Fe/H] ([Fe/H]> -1.6)

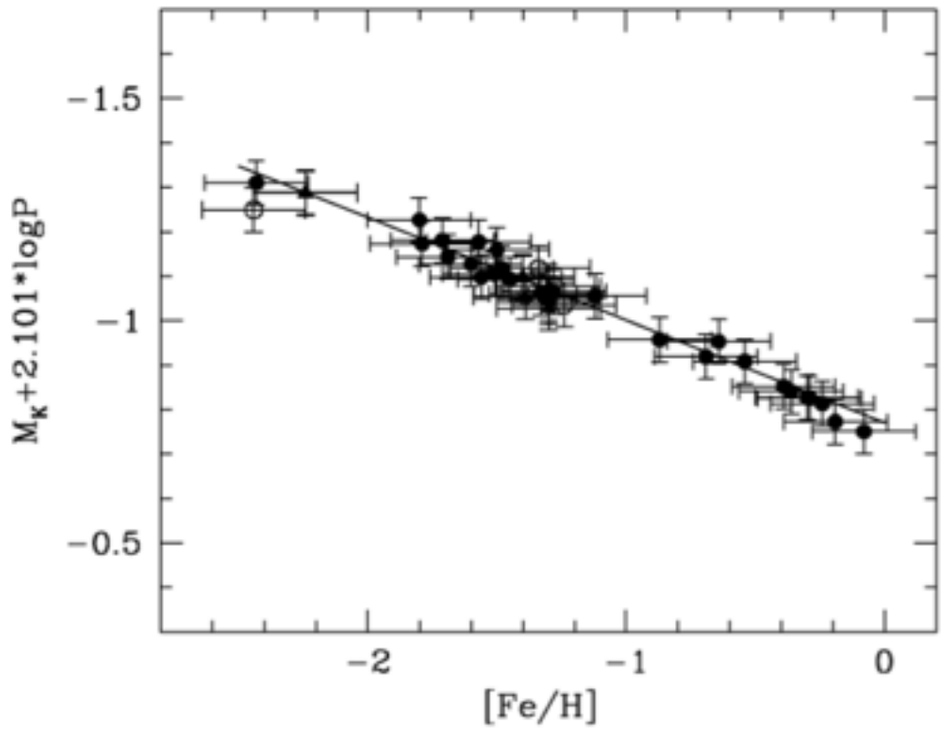
Dambis et al 2013

MK= –0.769(±0.088) + 0.088(±0.026)*[Fe/H] – 2.33*log(Pf)

MV= 1.094(±0.091) + 0.232(±0.020)*[Fe/H]

RR Lyrae
Period-Luminosity-Metallicity





Bono et al 2003

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MV= 1.038 + 0.359(±0.020)*[Fe/H] ([Fe/H]> -1.6)

UV?

Dambis et al 2013

MK= -0.769(±0.088) + 0.088(±0.026)*[Fe/H] – 2.33*log(Pf)

MV= 1.094(±0.091) + 0.232(±0.020)*[Fe/H]

Outline

- Galex data
- Period-Color-[Fe/H] on FUV-NIR
- [Fe/H] on Halo

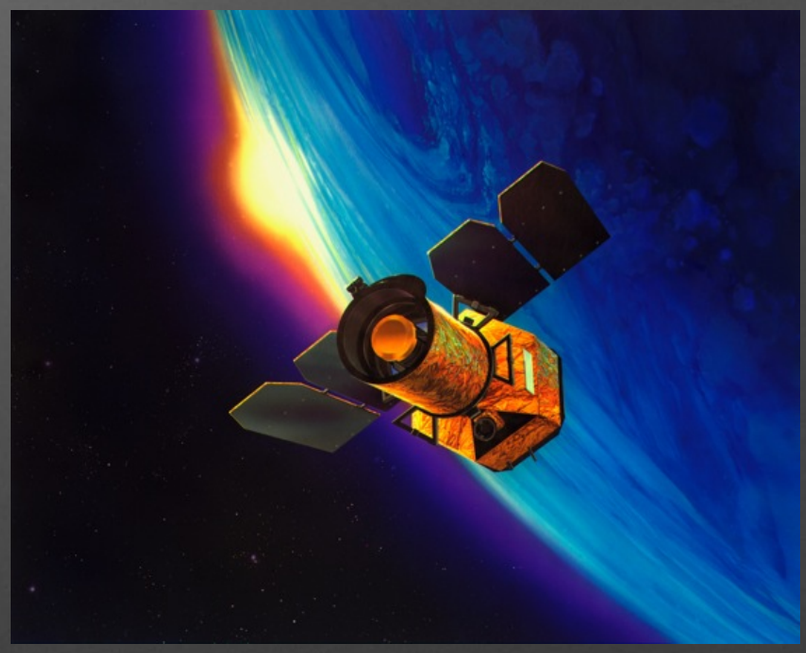
Galex

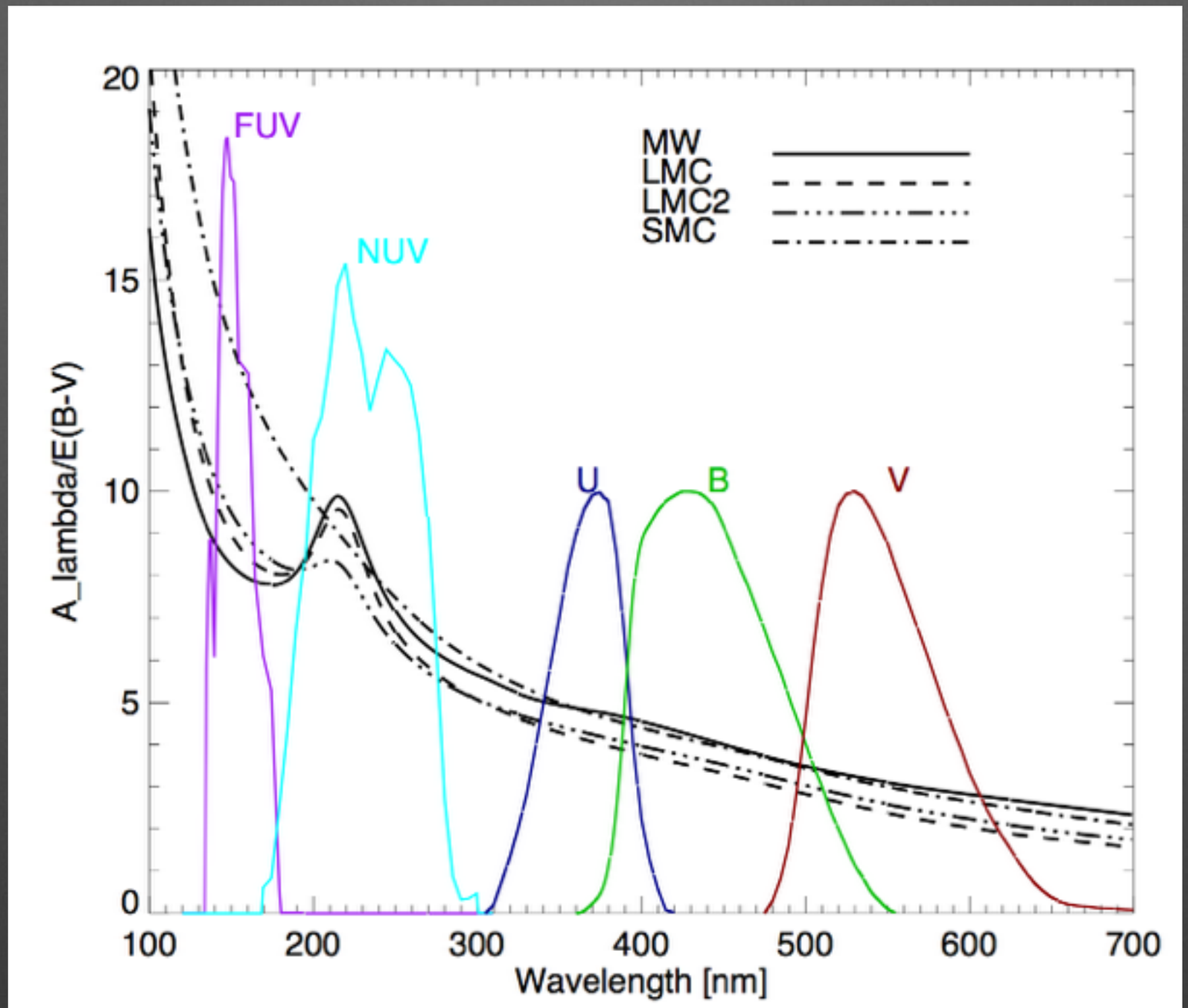
Launched in 2003

2 Filters FUV (135-175 nm)
NUV (175-275 nm)

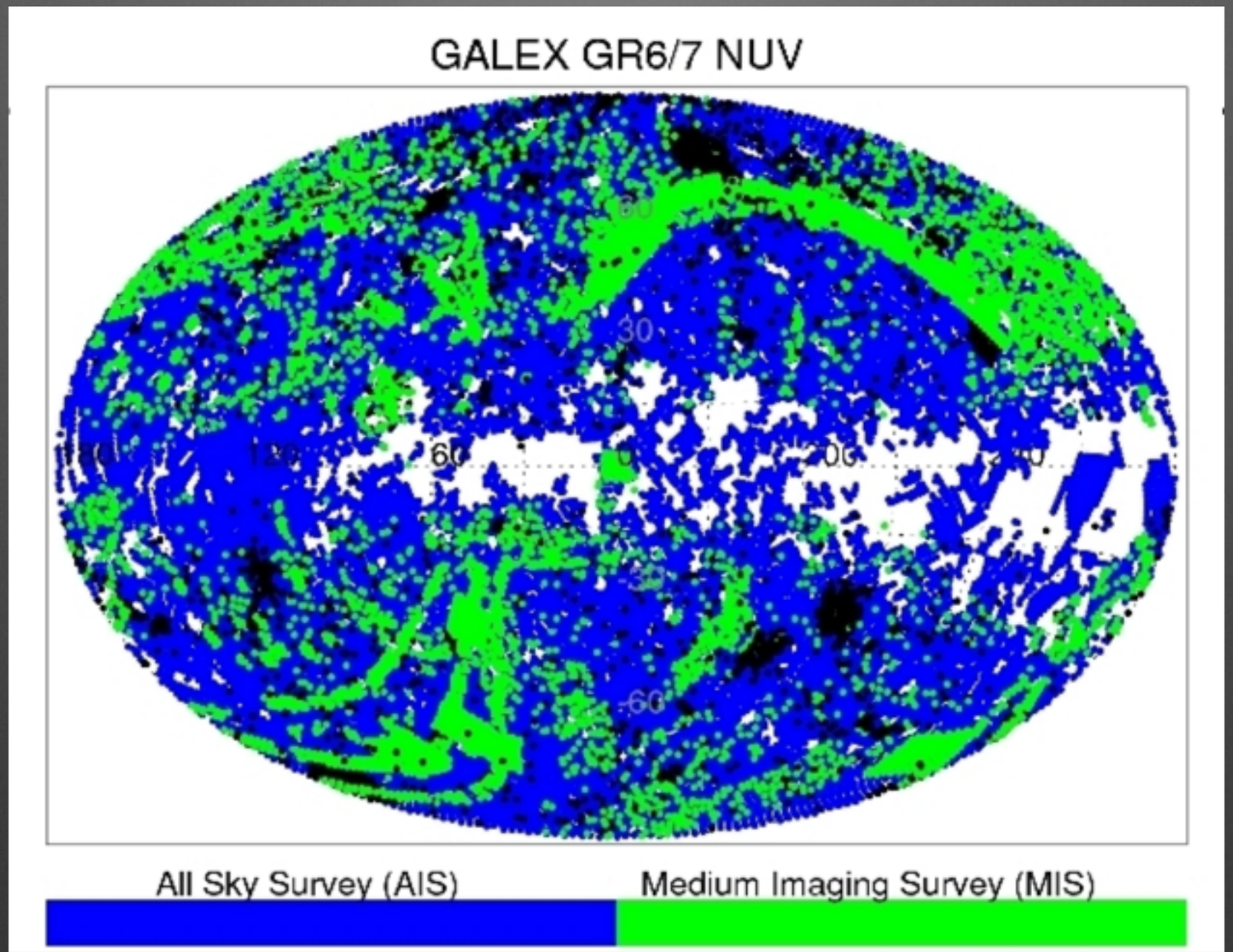
Field of view: 1.2 d (circular)

Angular resolution: 4.5” (FUV)
6.5” (NUV)





http://dolomiti.pha.jhu.edu/papers/Bianchi_GALEX_SF.pdf



Bianchi 2014

http://galex.stsci.edu/GR6/

145,755 fits
598 GB

762,339,557
Source measurements

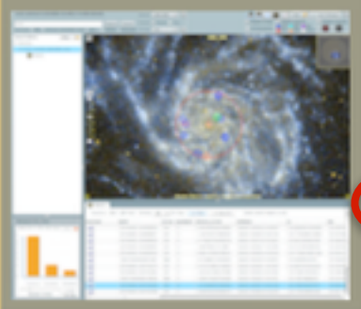
Barbara A. MIKULSKI ARCHIVE FOR SPACE TELESCOPES

MAST | STScI | Tools | Mission Search | Tutorial | Site Search | Follow Us

GALEX GR6/GR7 Home | About GALEX | Getting Started | GalexView | CASJobs | Scan Mode

- Search & Retrieval
- Guest Investigators
- Documentation
- Database Info
- Contributed Software
- Guest Investigator Site
- Related Sites
- Acknowledgments

GalexView:



CasJobs:

GALEX GR6/7 Data Release

GR6 Summary *GR7 Summary*
GR6 Pipeline Description *GR7 Pipeline Description*

MORE GR6 and NEW GR7 data now available, click for summary.

GALEX Surveys

	AIS	DIS	MIS	NGS	GII	CAL	SPECTRA	TOTAL
GR1	3074	14	112	52	-	-	7	3259
GR2/GR3	15721	165	1017	296	288	20	41	17548
GR4/GR5	28269	292	2161	458	788	38	174	32180
GR6/GR7	34285	720	6964	716	2112	87	311	45195

Welcome to the GALEX Public Archive

- The GALEX Mission
- GALEX Surveys
- Public GALEX Releases
- Guest Investigator Program
- Close-out Deliverables (GR7)
- Scan Mode Data

The GALEX Mission

Welcome to the MAST public access site for browsing and retrieving GALEX Release 7 data products. The Galaxy Evolution Explorer (GALEX) satellite is a NASA mission led by the California Institute of Technology to investigate how star formation in galaxies evolved from the early Universe up to the present. GALEX uses microchannel plate detectors to obtain direct images

NEWS

Feb 27, 2013:
MORE GR6 and NEW GR7 data now available, click here to see a summary

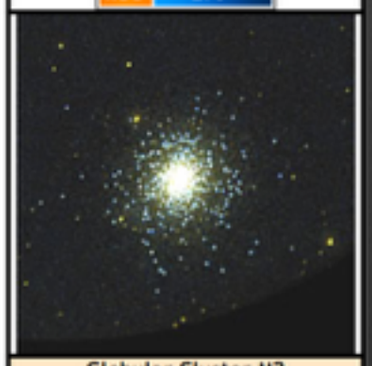
Oct 07, 2011:
GR6 Spectra are now available, click here to find out more

Oct 07, 2011:
GR6 addendum released, comprised of 12 DIS, 389 MIS and 66 GII tiles, click here to find out more

Mar 16, 2011:
Catalogs of GALEX UV unique sources and of UV-optical matched sources

Dec 21, 2010:
GALEX GR6 cross matched against SDSS DR7, available thru casjobs only. Click here for a tutorial

RSS 2.0



Globular Cluster M2

Halo RR Lyrae - Public catalogs

Position

Variability Parameters

- ASAS3
- Catalina
- Linear
- Loneos
- Quest
- ROTSE
- NSVS

[Fe/H]

Spectroscopic/Photometric

- Catalina SDSS
- Dambis
- HR
- Mateu

Wallerstein et al 2010
Hansen et al 2011
Lambert et al 1996
Clementini et al 1995
Kolenberg et al 2010

Pojmanski et al 2005 (ASAS3)
Drake et al 2013-2014 (Catalina)
Dambis et al 2013 (Dambis)
Mateu et al 2012 (Quest-low)
Sesar et al 2013 (Linear)
Miceli et al 2008 (Loneos)
Vivas et al 2004-2006 (Quest)
Akerlof et al 2000 (ROTSE)
Hoffman et al 2009 (NSVS)

Homogeneous Reddening and Distance

Schlafly
&
Finkbeiner
(2011)

PL relation

FU

M_j = -2.13557*Log(P)-0.79116
M_h = -2.40348*Log(P)-1.0591
M_k = -2.43557*Log(P)-1.11740
M_{w1}= -2.38*Log(P/0.55)-0.495

Braga et al 2014 (submitted)
Marconi et al (in preparation)
Klein et al 2014

FO

M_j = -2.34836*Log(P)-1.24632
M_h = -2.57585*Log(P)-1.49593
M_k = -2.59197*Log(P)-1.54985
M_{w1}= -1.64*Log(P/0.32)-0.231

A_V

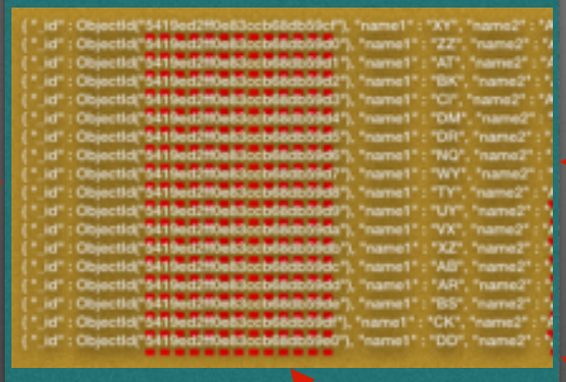
+

Distance

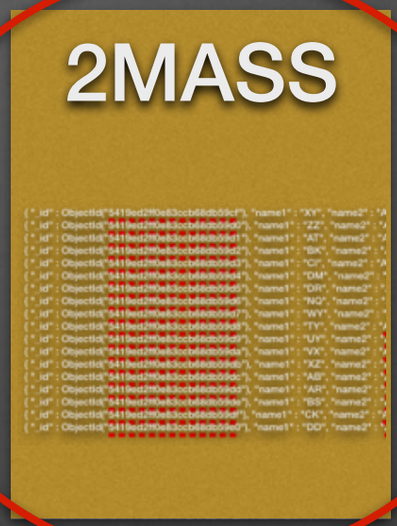
mongoDB

Java

RR Lyrae



2MASS



Galex

WISE

RR Lyrae Catalog

RR Surveys + 2MASS + WISE + Galex Obs

- ~30,000 RR Lyrae
- 1,502 with more than 10 Galex obs
- 19,759 with Kmag from 2MASS
- 1,977 with [Fe/H] (34 HR, 1415 Catalina/SDSS, 366 Dambis, 162 Mateu)

Galex RR Lyrae

My Drive - Google Drive [redacted] :8080/galexRR/galex1

Galex RRlyr Star id= 616 Distance(mag)=12.6564448501 per=0.5643341 FeH=-1.0994848408 ra= 219.47374 dec= 34.99012 l= 58.5985660396 b= 65.9718089276

Logout

Next

Select Star:

616-130

Invia

Or insert ID

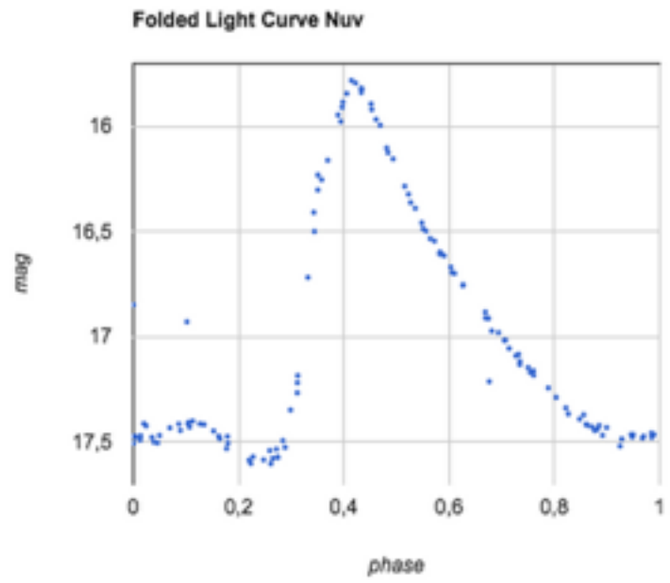
ID number

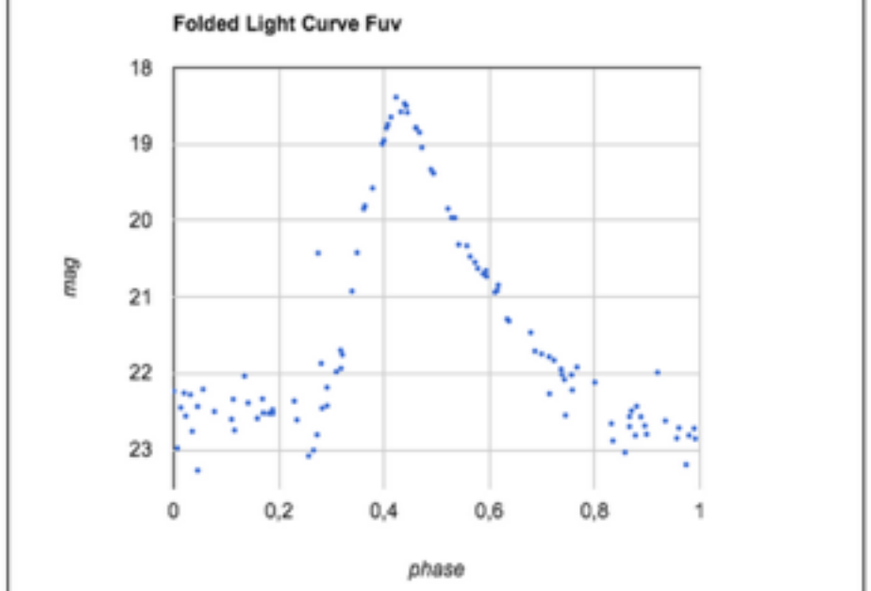
Invia

CSV Light Curve

Good
Not so good
Bad

Submit





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w1mpro	12.137
w1sigmpro	0.023
w2mpro	12.137
w2sigmpro	0.022
w3mpro	12.087
w3sigmpro	0.195
w4mpro	8.87
pmra	-36
sigpmra	32
pmdec	41
sigpmdec	32
ext_flg	0
var_flg	86nn
ph_qual	AABU
tmass_key	886742789
dist	0.29513540903857627

designation	14375371+3459241
j_m	12.358
j_msigcom	0.025
h_m	12.197
h_msigcom	0.032
k_m	12.147
k_msigcom	0.025
pts_key	886742789
htmID_6	57287
dist	0.36768263901107584

name	catalinaPaper1
CSS-ID	CSS_J143753.6+345924
ra	219.47374
decl	34.99012
V	13.401
per	0.5643341
Amp	0.68
Npts	236
Dist	3.56
Red	0.017
MJD-peak	53480.3738
CSS-ID-num	1135065025085
Av	0.0246
radius	-1

name	rotse
_r	89.11495639680726
recno	748
ROTSE1	J143753.84+345924.8
Type	rrab
q_Type	1
mag	13.78
e_mag	0.045
per	0.56432301
e_Period	5.765E-5
Amp	0.75
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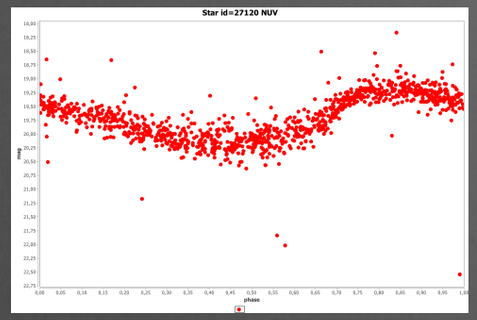
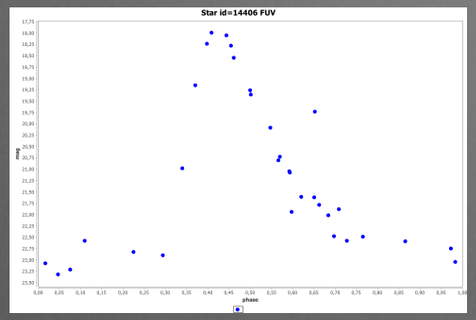
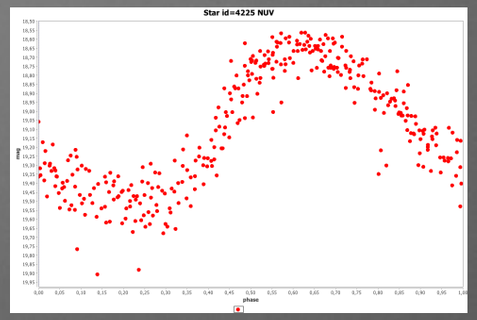
decl	34.99022305555555
Av	0.0246
radius	3

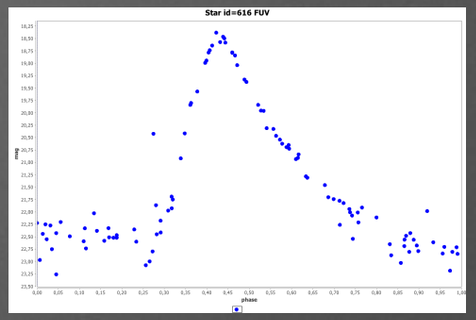
Galex RR Lyrae

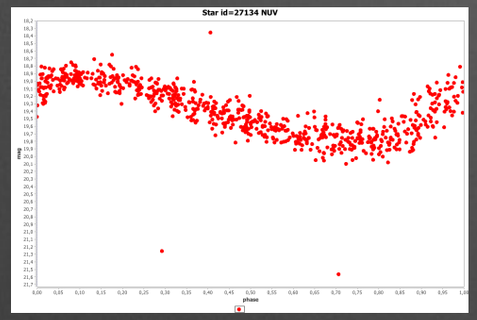
181 (NUV) + ~30 (FUV) light curves

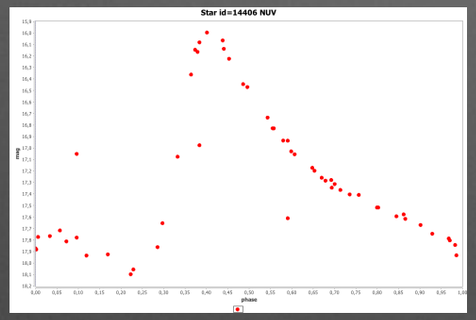


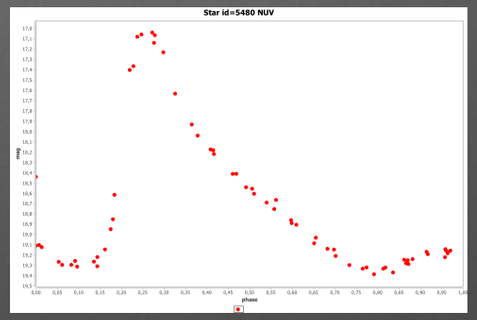


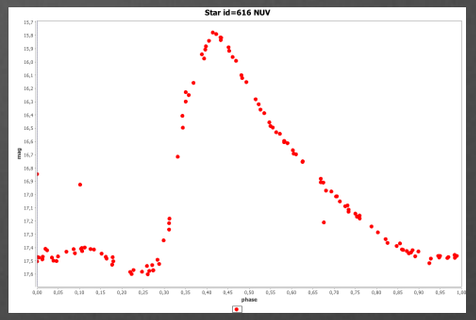


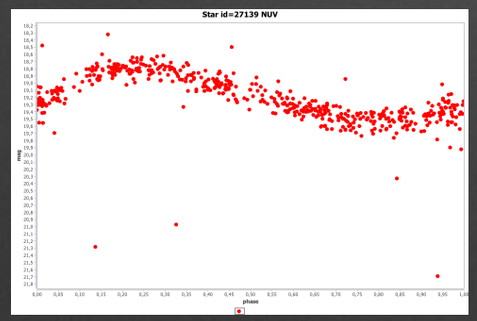


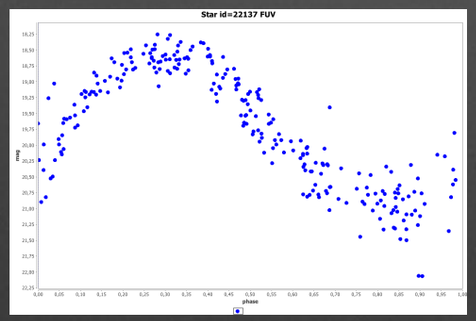


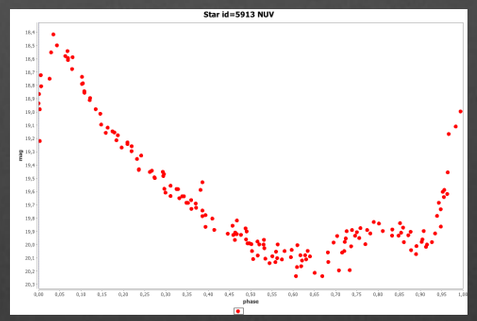


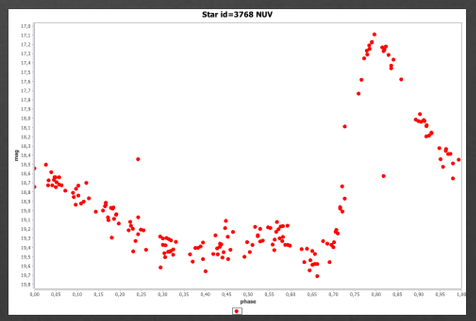


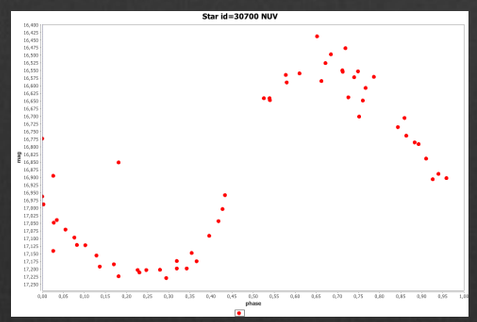


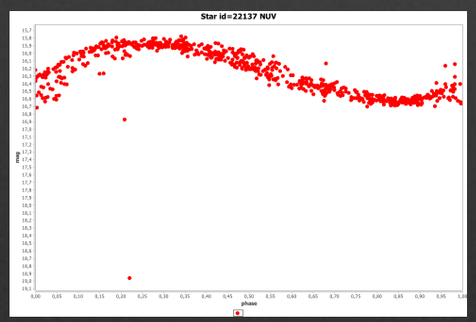


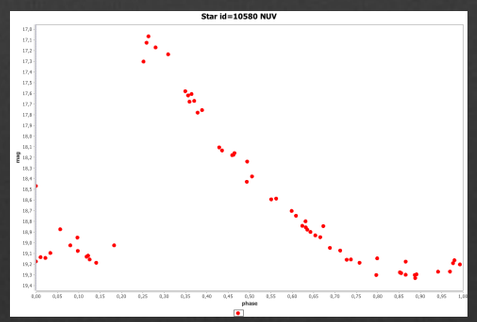


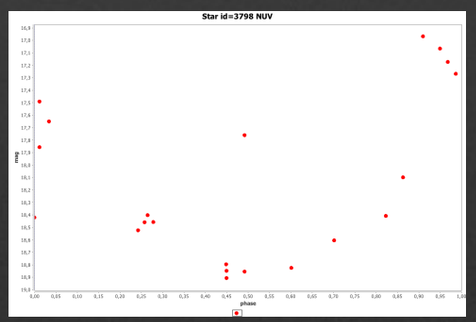


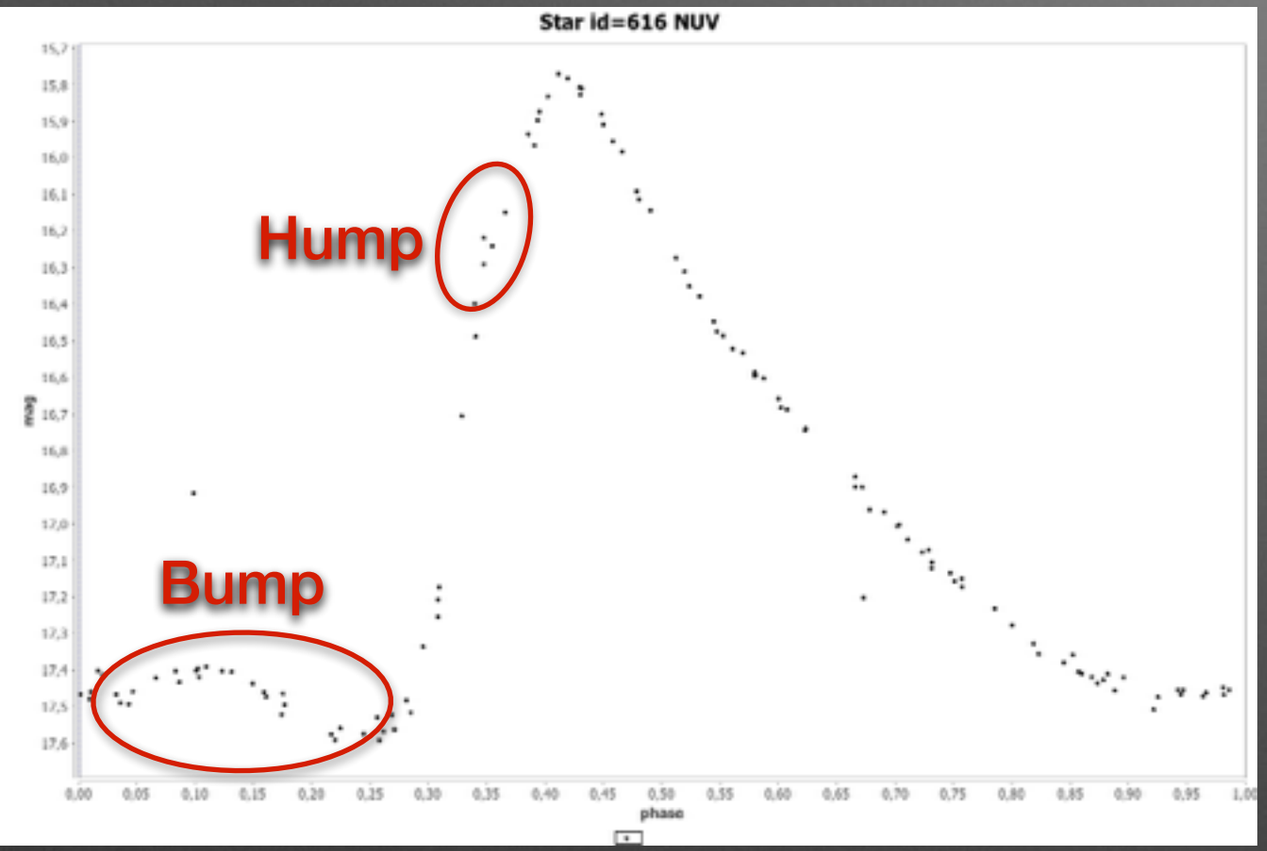


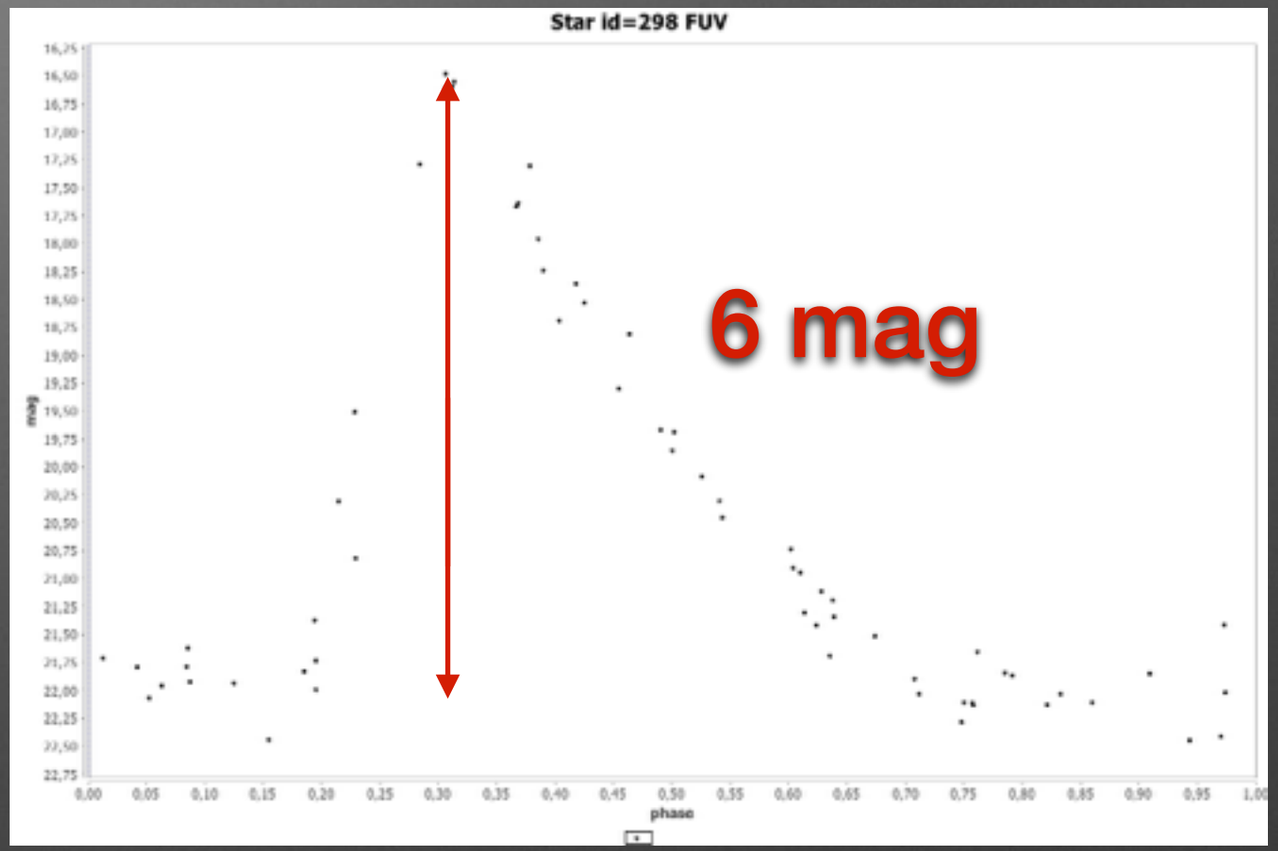









Star id=616 NUV
Hump
Bump
mag
phase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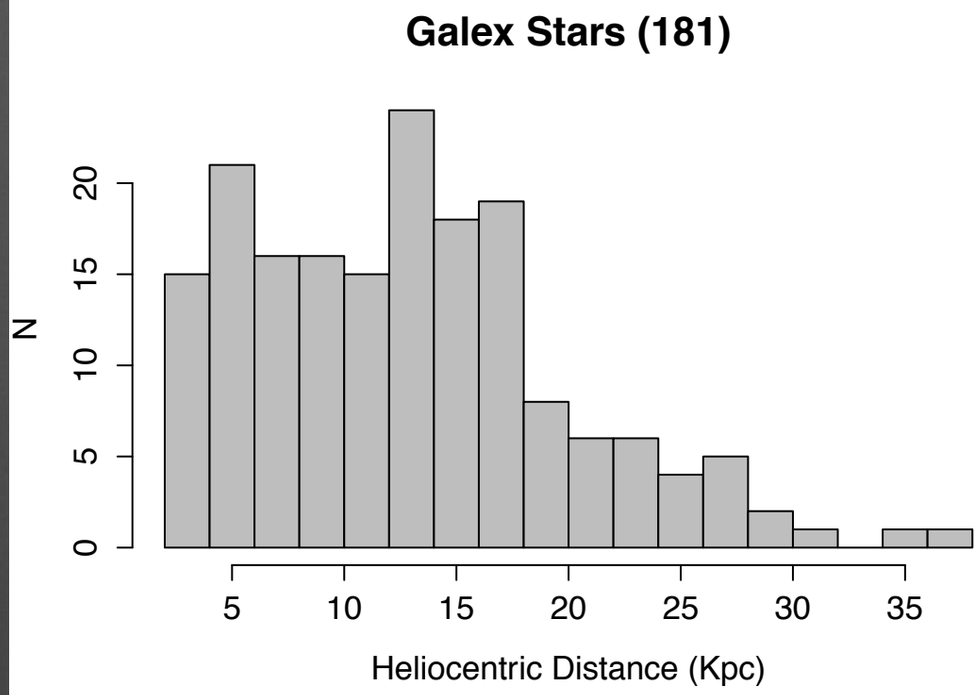
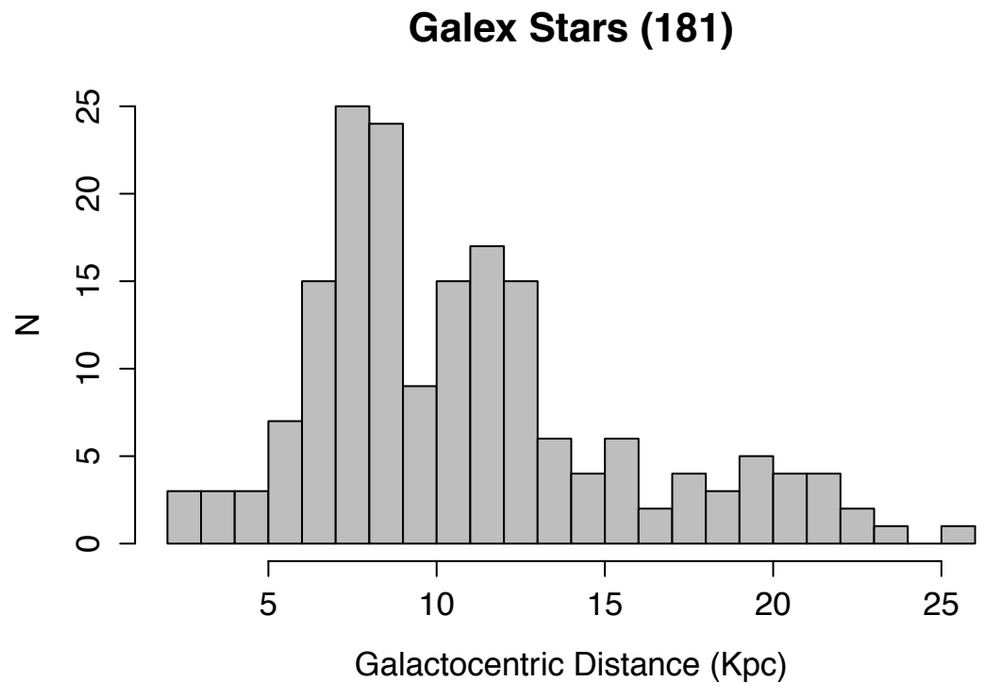
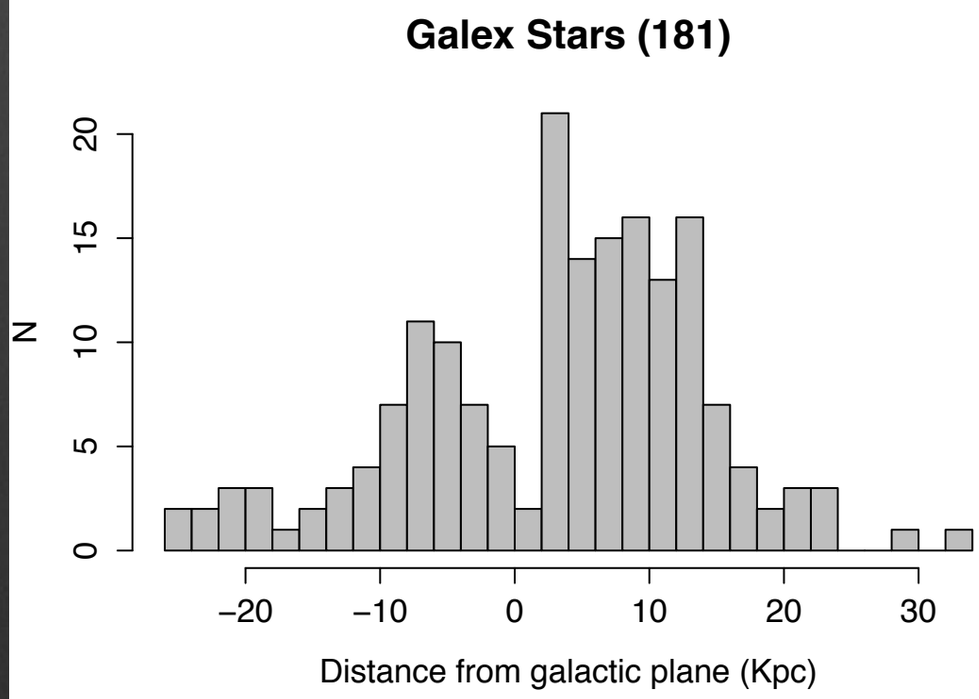
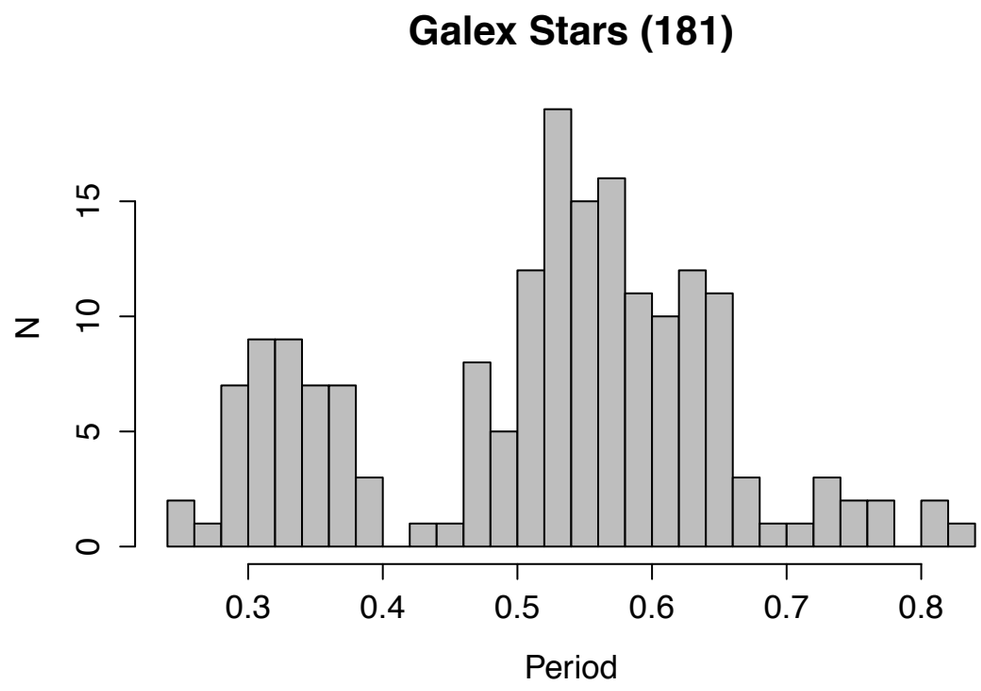
6 mag
mag
phase

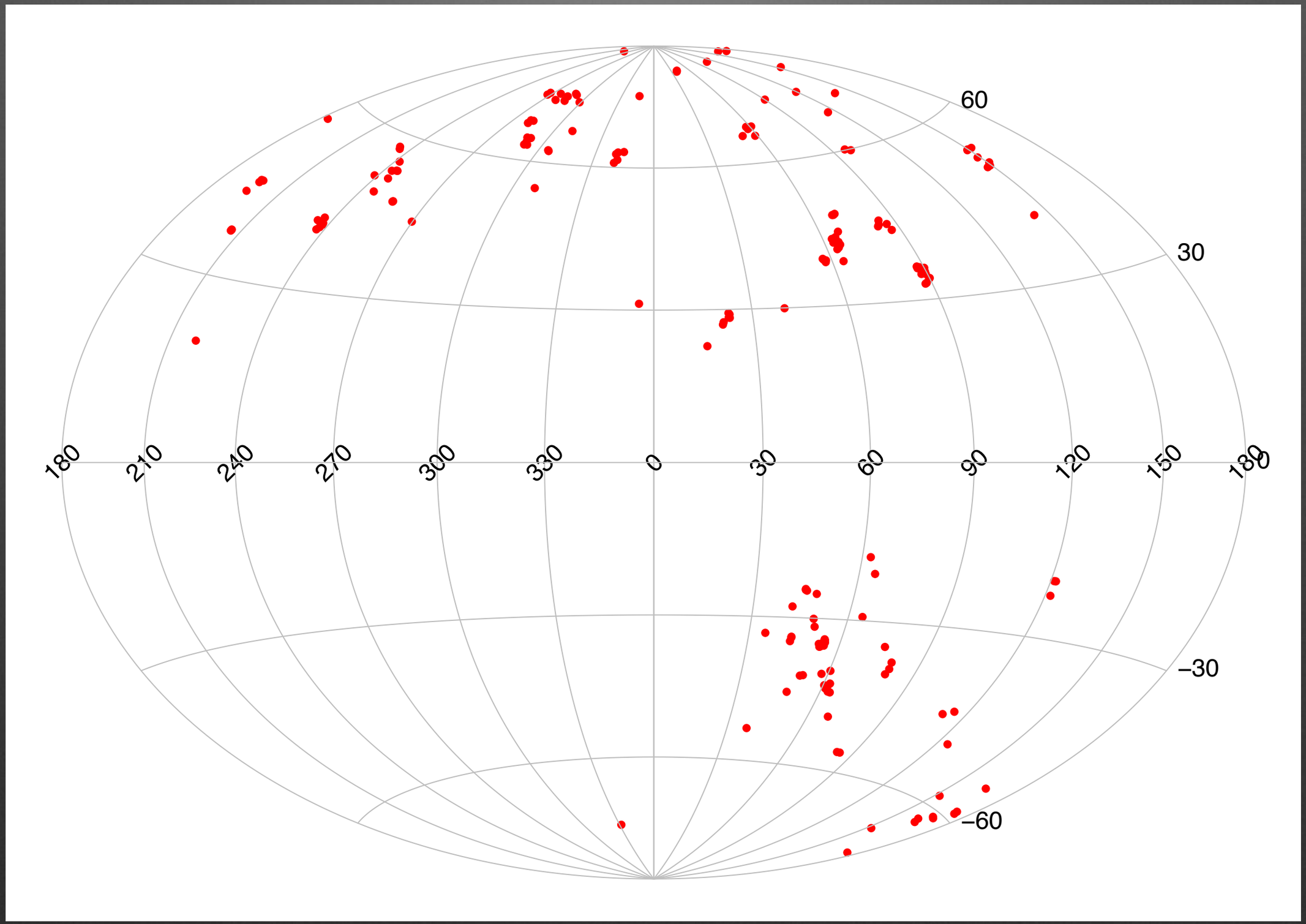

Galex Stars (181)
N
0
5
10
15
20
5
10
15
20
25
30
35
Heliocentric Distance (Kpc)


Galex Stars (181)
N
0
5
10
15
20
25
5
10
15
20
25
Galactocentric Distance (Kpc)


Galex Stars (181)
N
0
5
10
15
20
−20
−10
0
10
20
30
Distance from galactic plane (Kpc)


Galex Stars (181)
N
0
5
10
15
0.3
0.4
0.5
0.6
0.7
0.8
Period

Galex RR Lyr - sky distribution



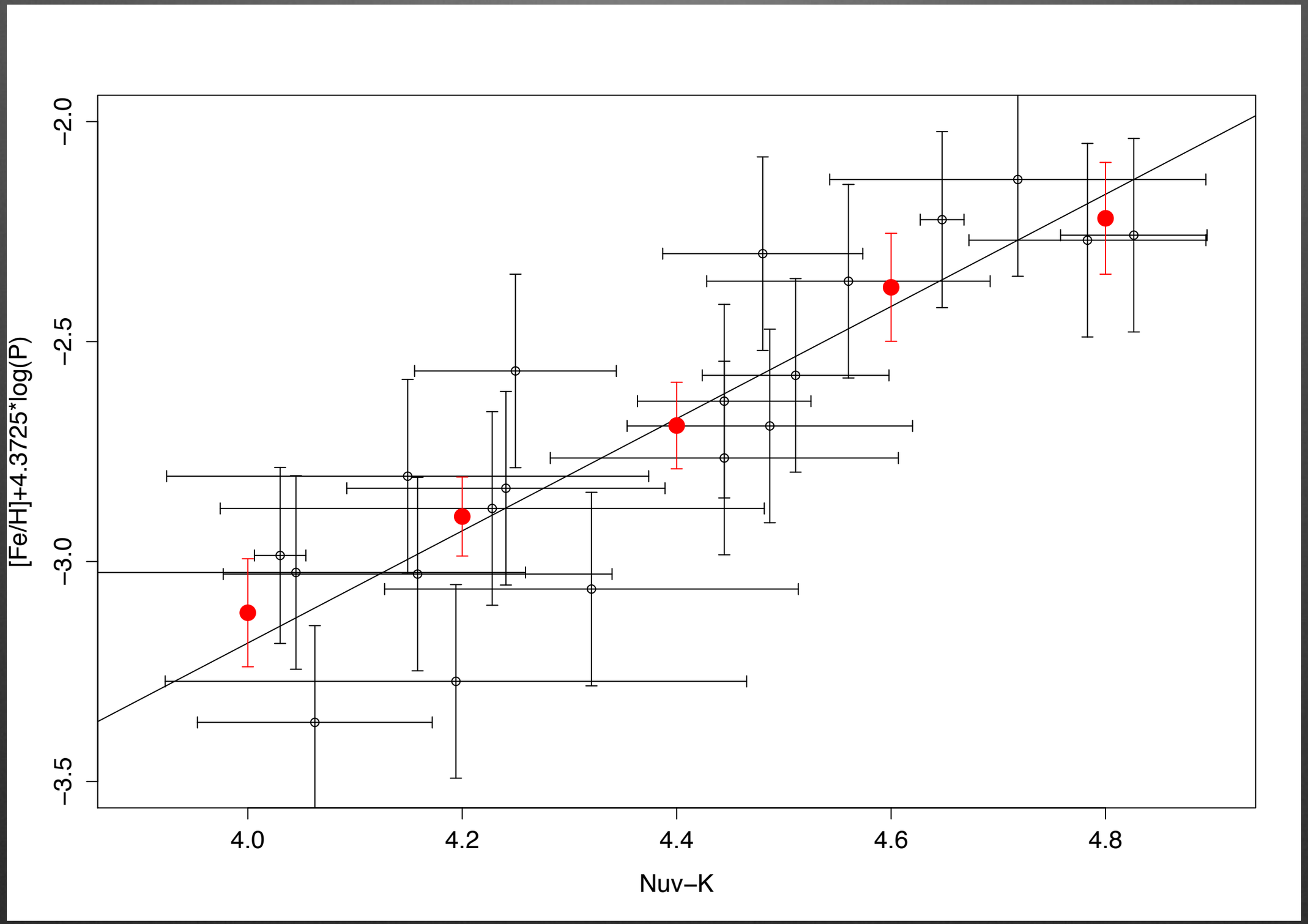
Outline

- Galex data
- Period-Color-[Fe/H] on FUV-NIR
- [Fe/H] on Halo

Galex RR Lyrae - [Fe/H]

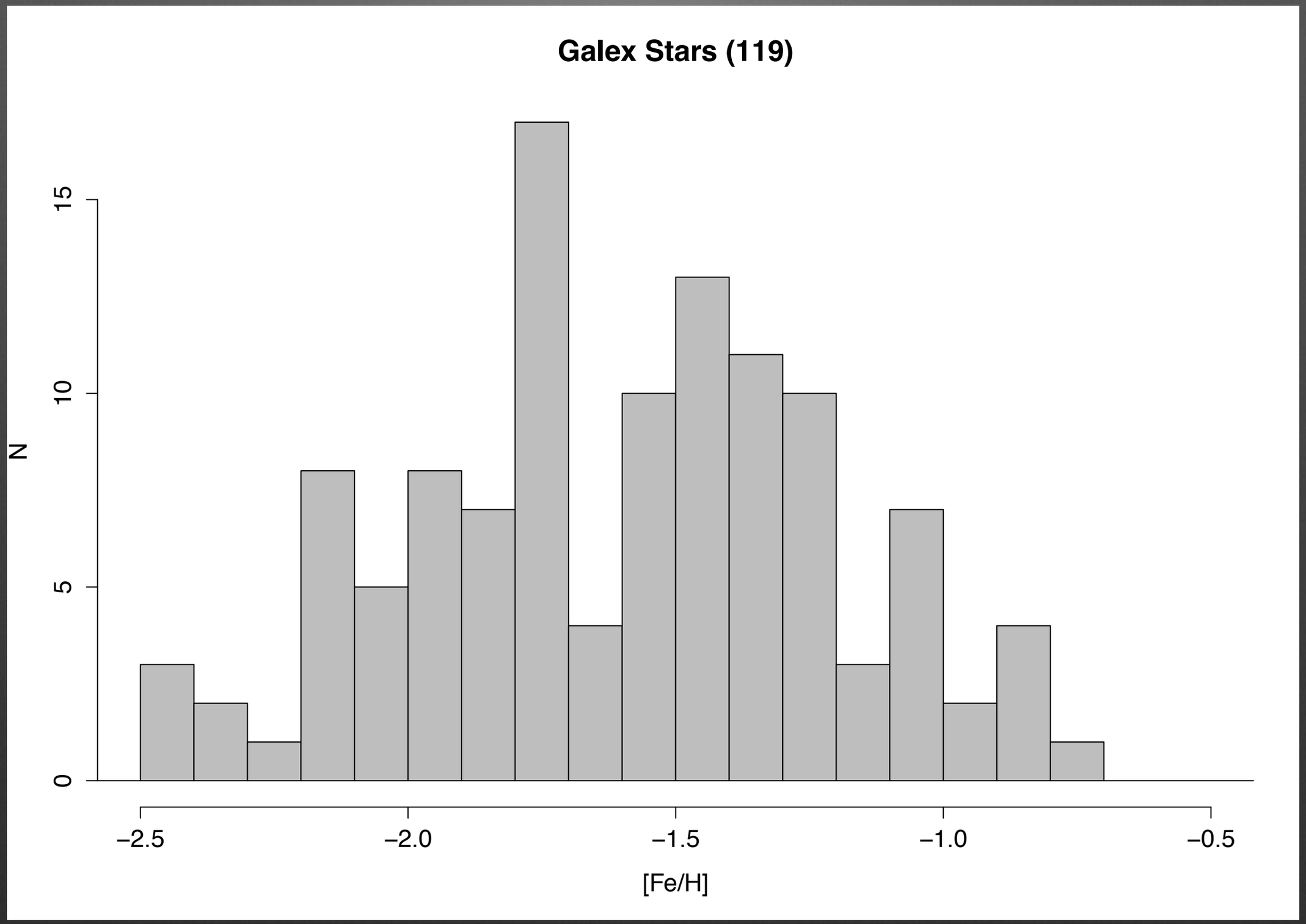
- 28 stars with [Fe/H] from Catalina/SDSS (Drake et al 2013)
  - 10 out of 28 stars without 2MASS K (95% confidence upper limit)
- 2 stars with [Fe/H] from Dambis (Dambis et al 2013)

[Fe/H] = -8.3 +1.3*(Nuv-K) -4.4*log(P)



Galex RR Lyr - [Fe/H]

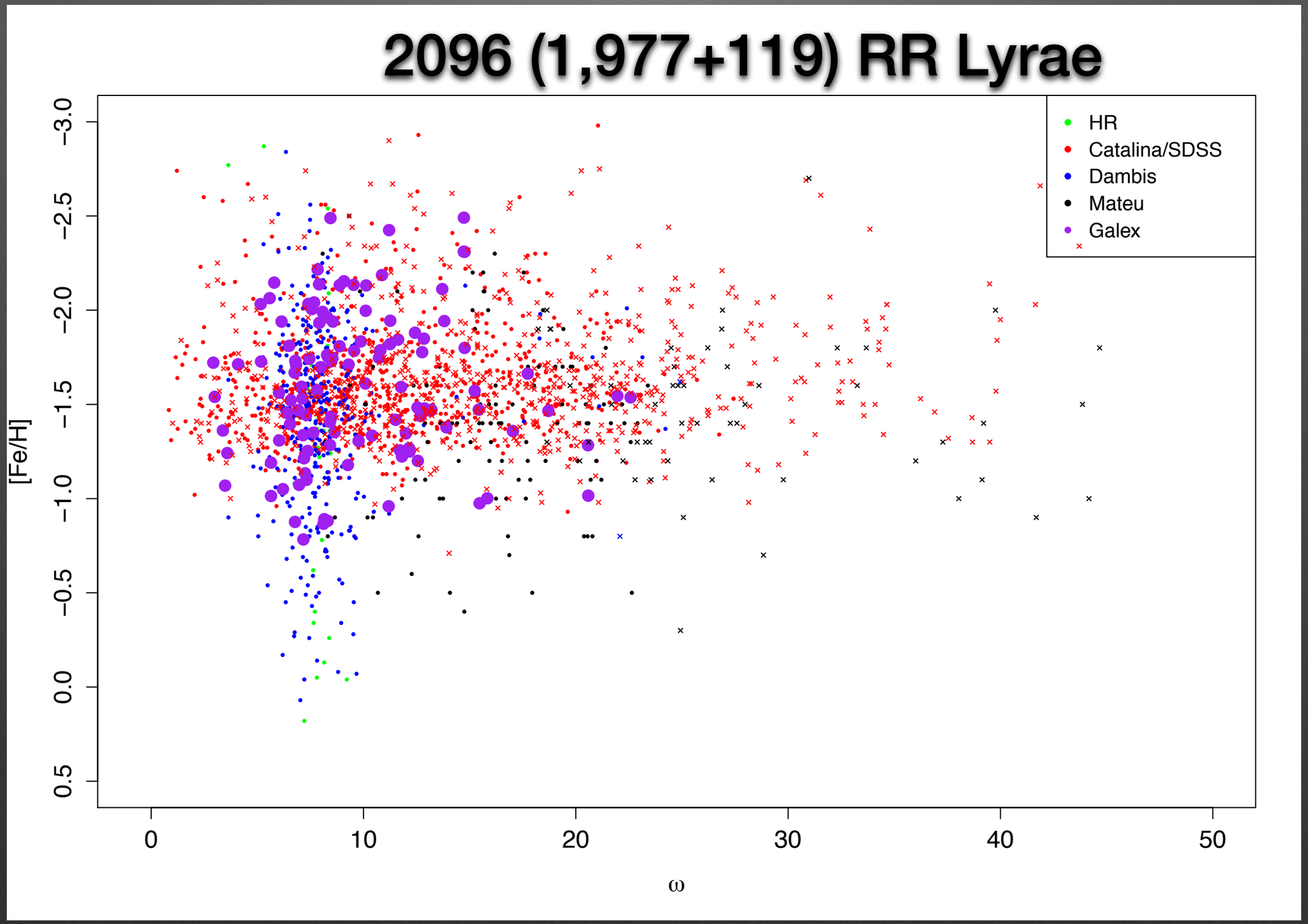
119 new [Fe/H]



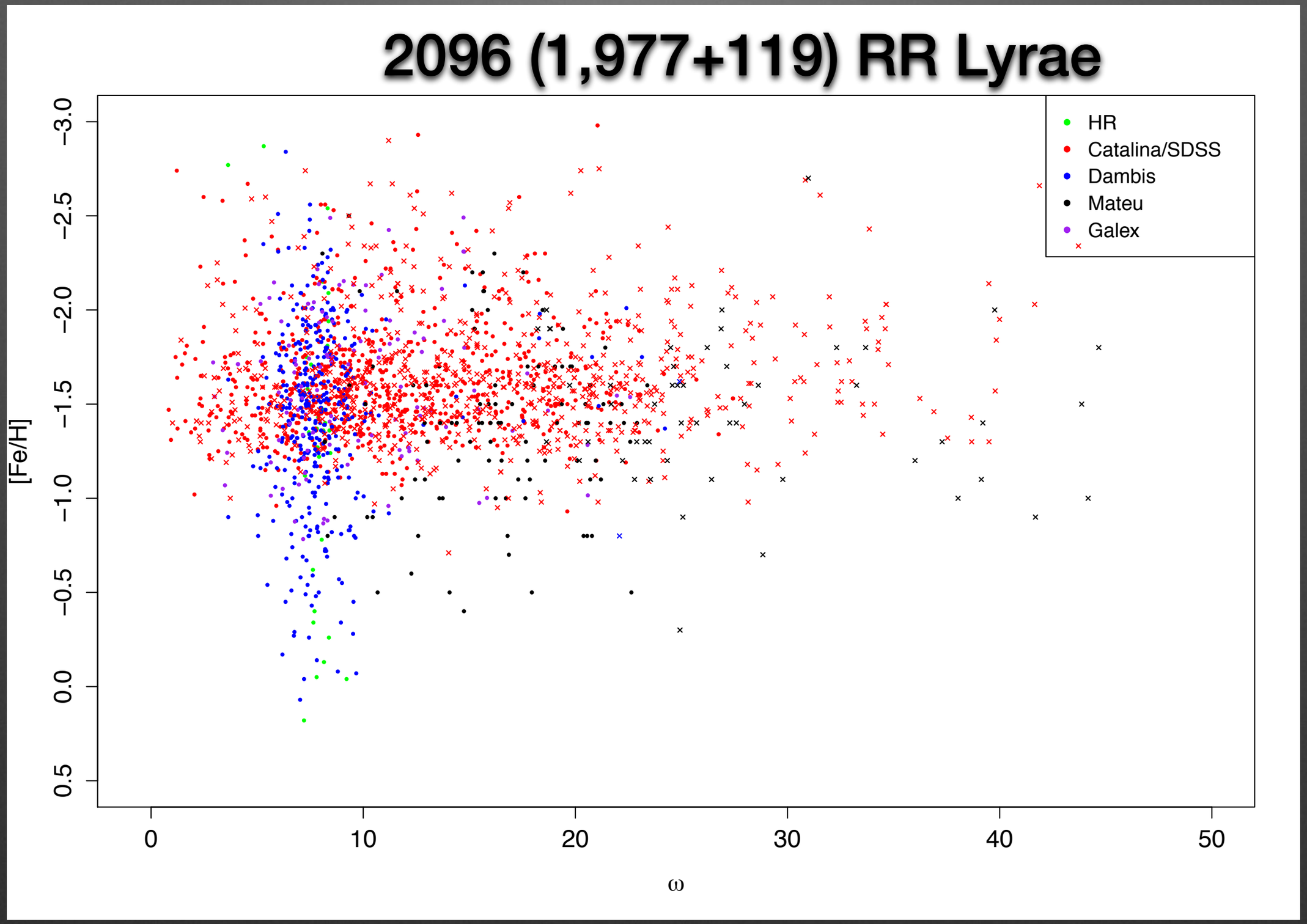
Outline

- Galex data
- Period-Color-[Fe/H] on FUV-NIR
- [Fe/H] on Halo

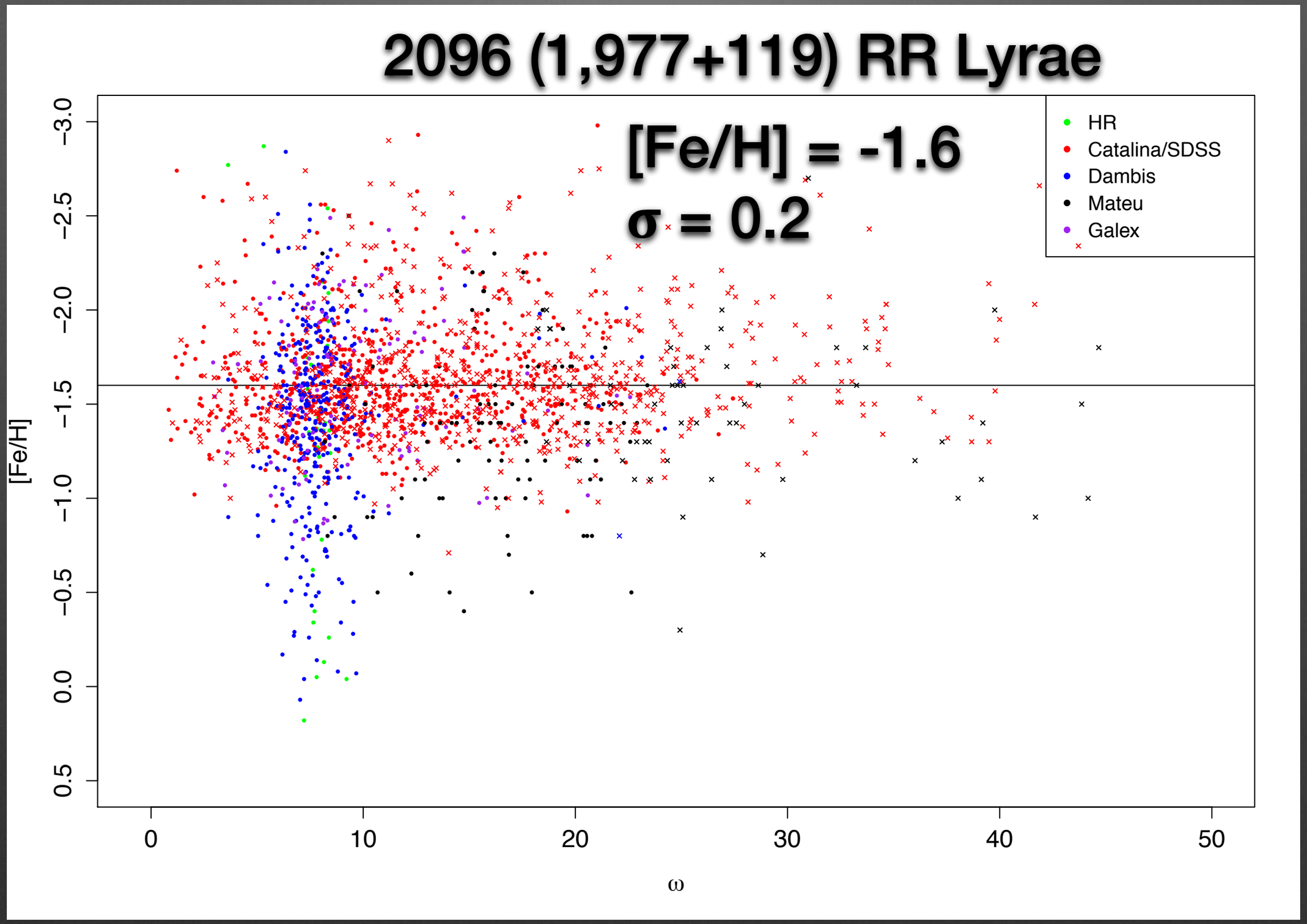
Galactocentric distance (projected onto the galactic plane)



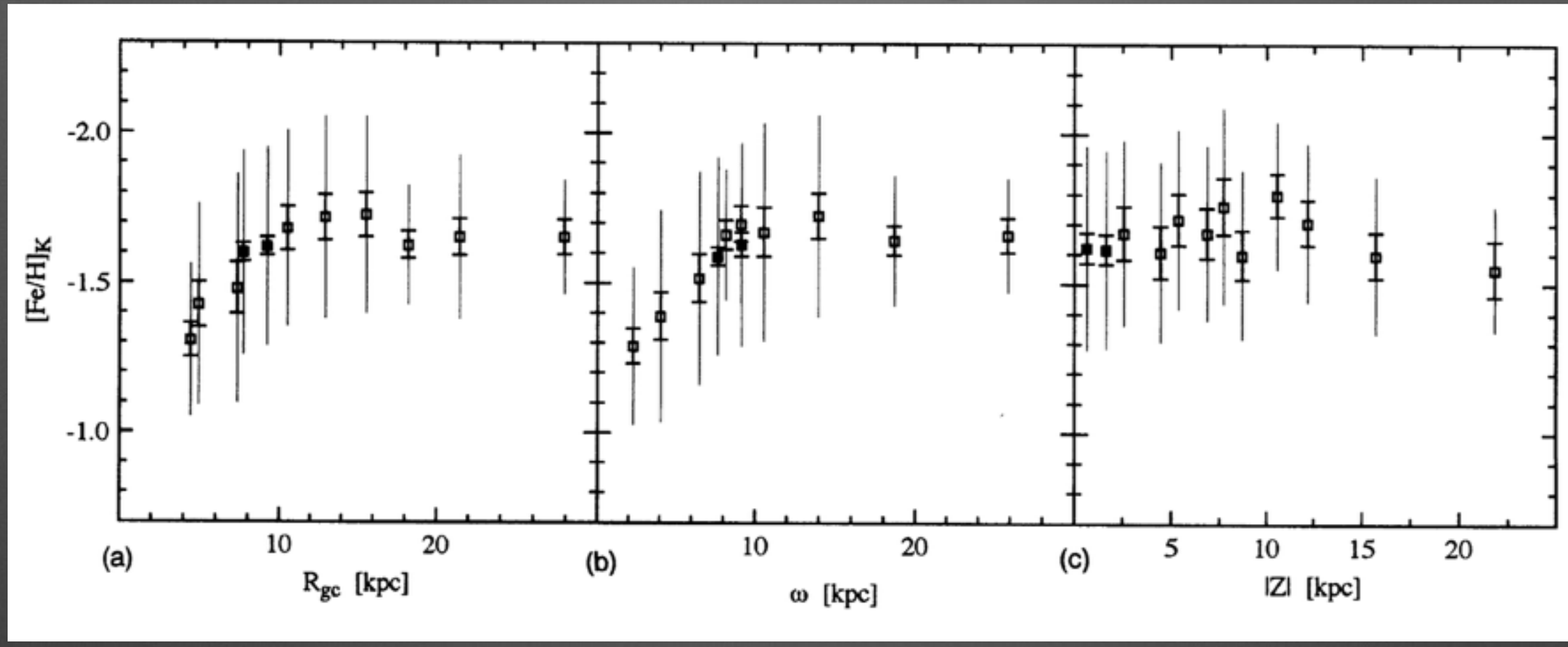
Galactocentric distance (projected onto the galactic plane)

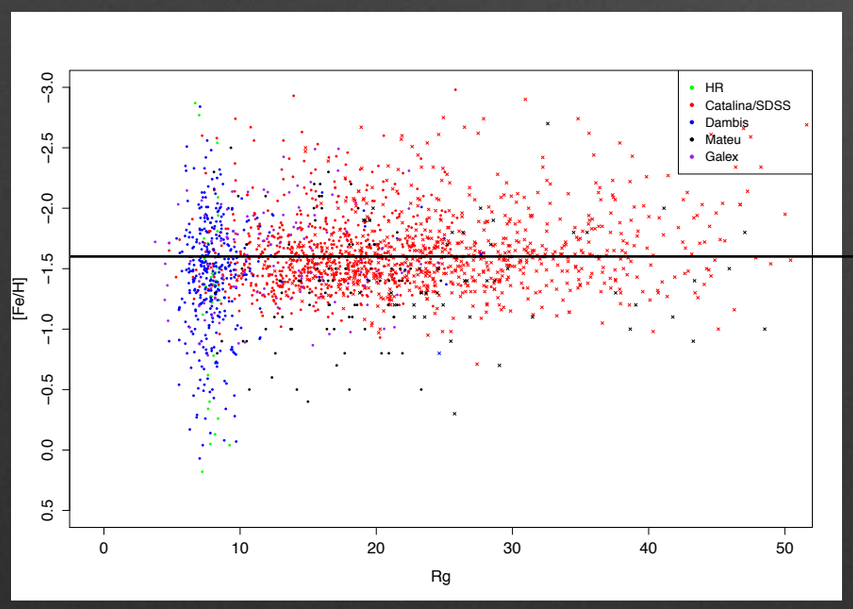


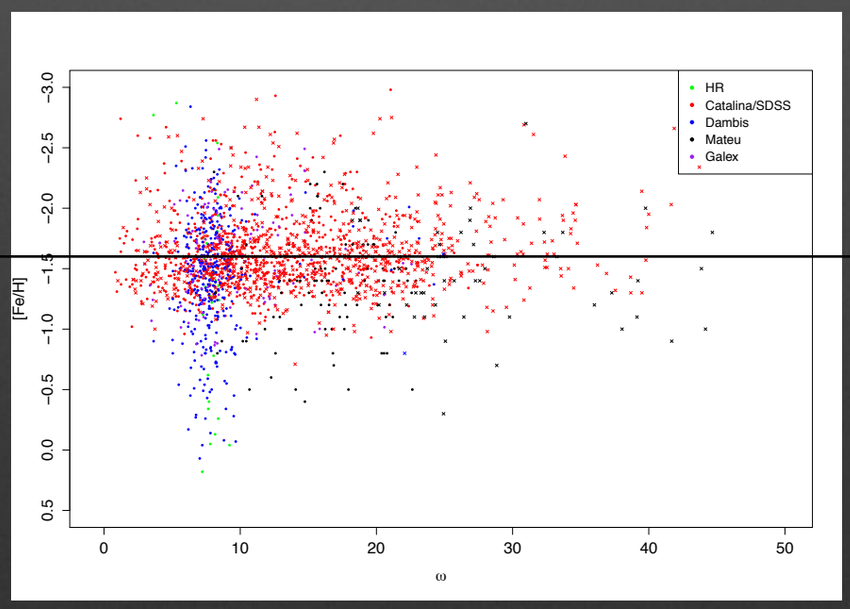
Galactocentric distance (projected onto the galactic plane)

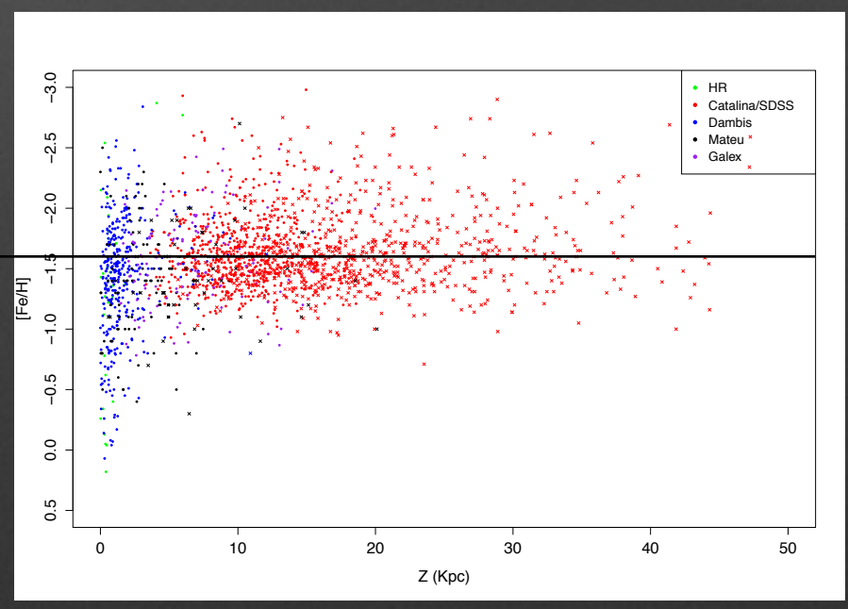


Comparison with Layden 1994









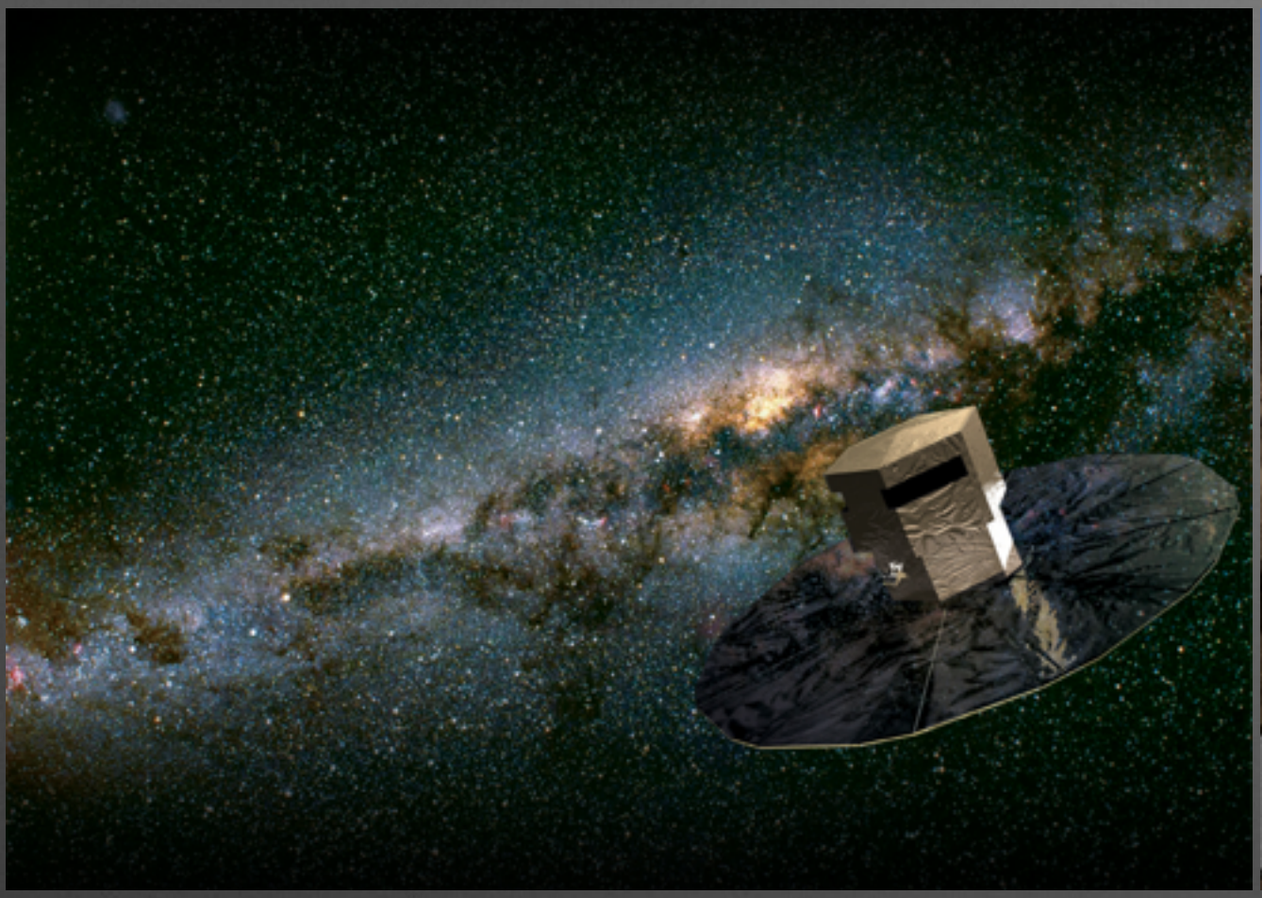
Conclusions

- We increase by a factor of 6 the Layden+Suntzeff sample of RR Lyrae with either spectroscopic or photometric [Fe/H] estimation
- The mean metallicity is relatively constant (-1.6 ±0.2 supporting Layden+Suntzeff)
- Evidence of a metal poor tail
- No evidence of a metal rich tail but the solar circle
- No evidence of clear separation between inner/outer halo

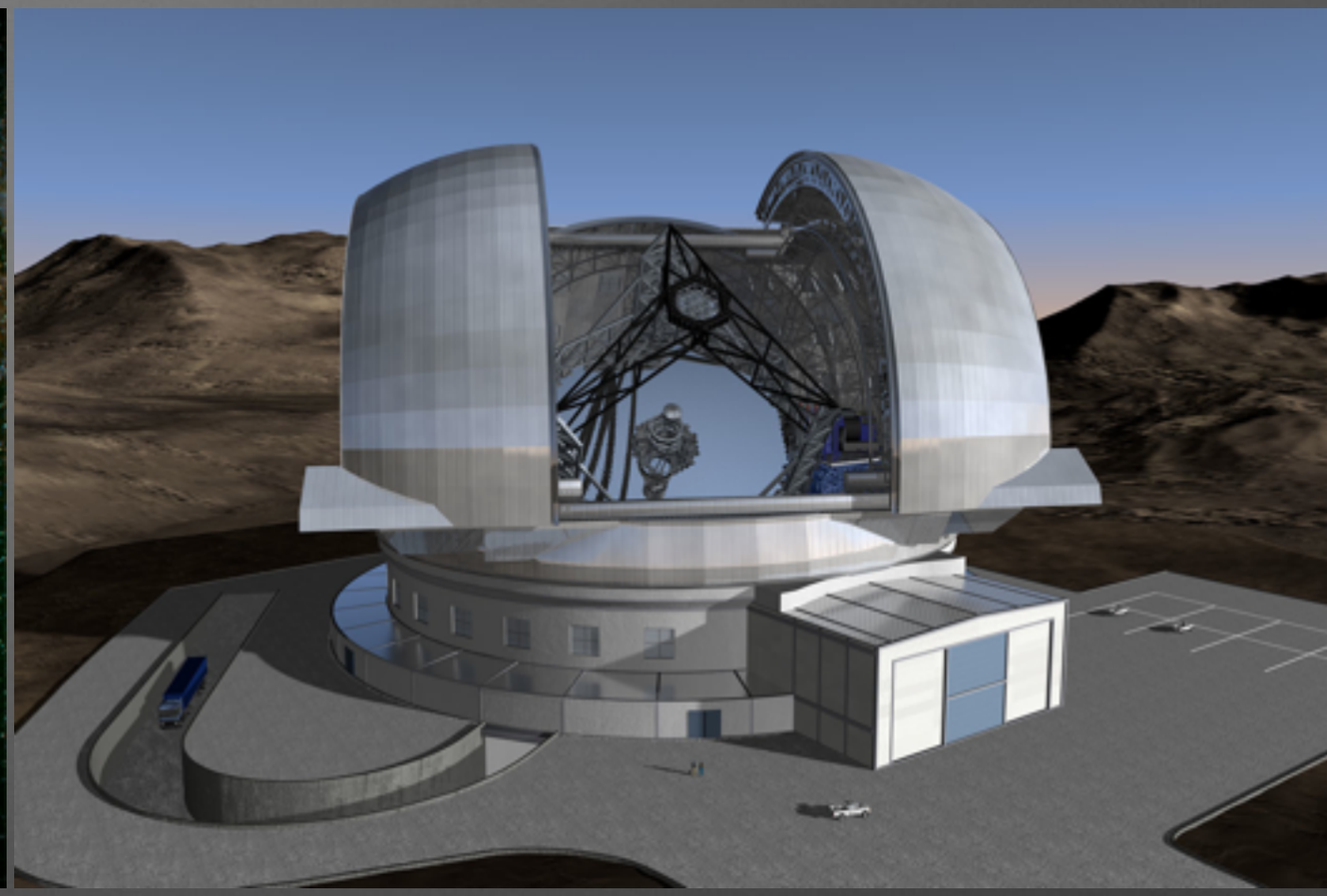
Next steps

- Accurate estimation of NUV and K mean mag
- Complete visual inspection of all Galex candidates
- A new spin of [FE/H] distribution on Halo RR Lyrae

E-ELT + Gaia

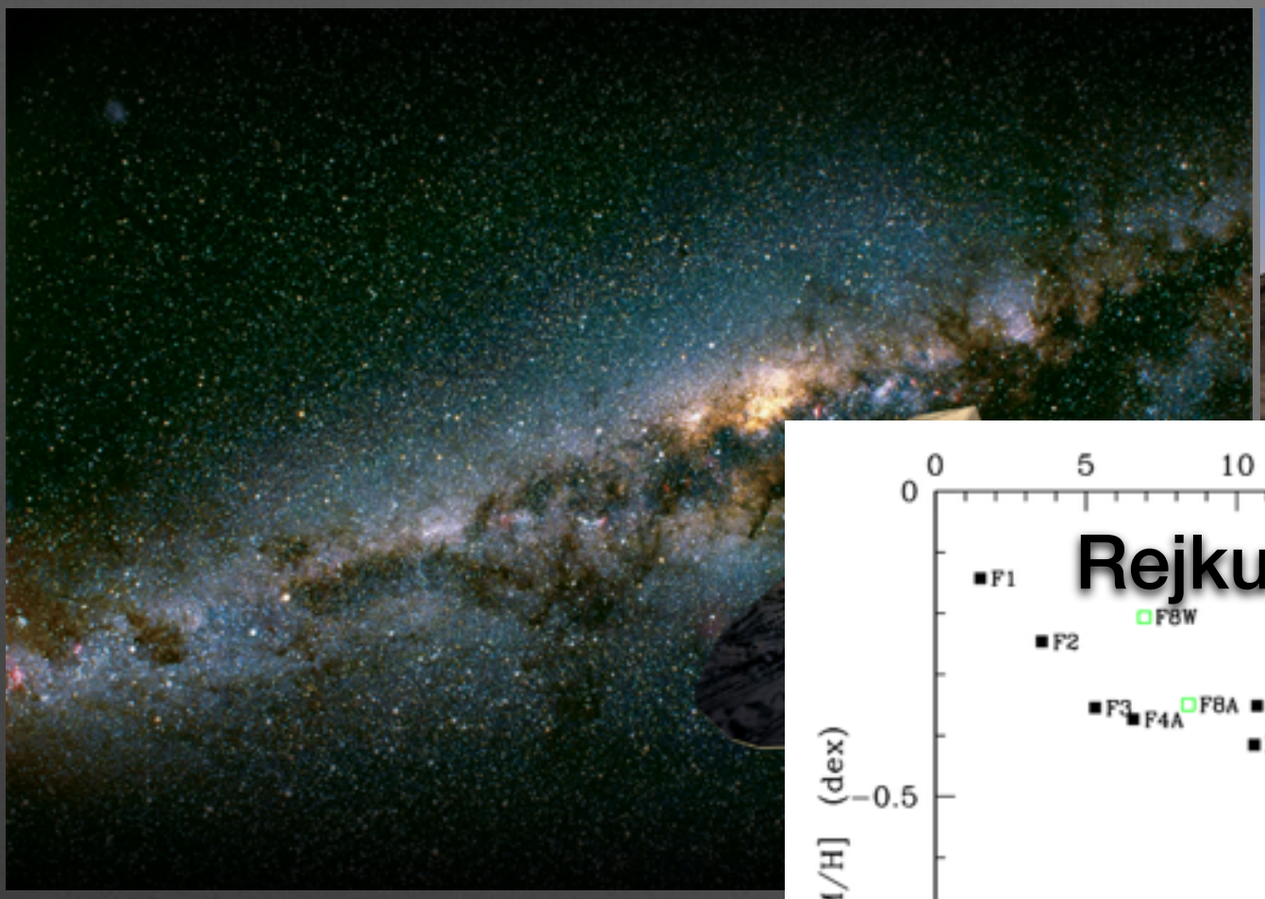


Trigonometric Parallax
+
Galex

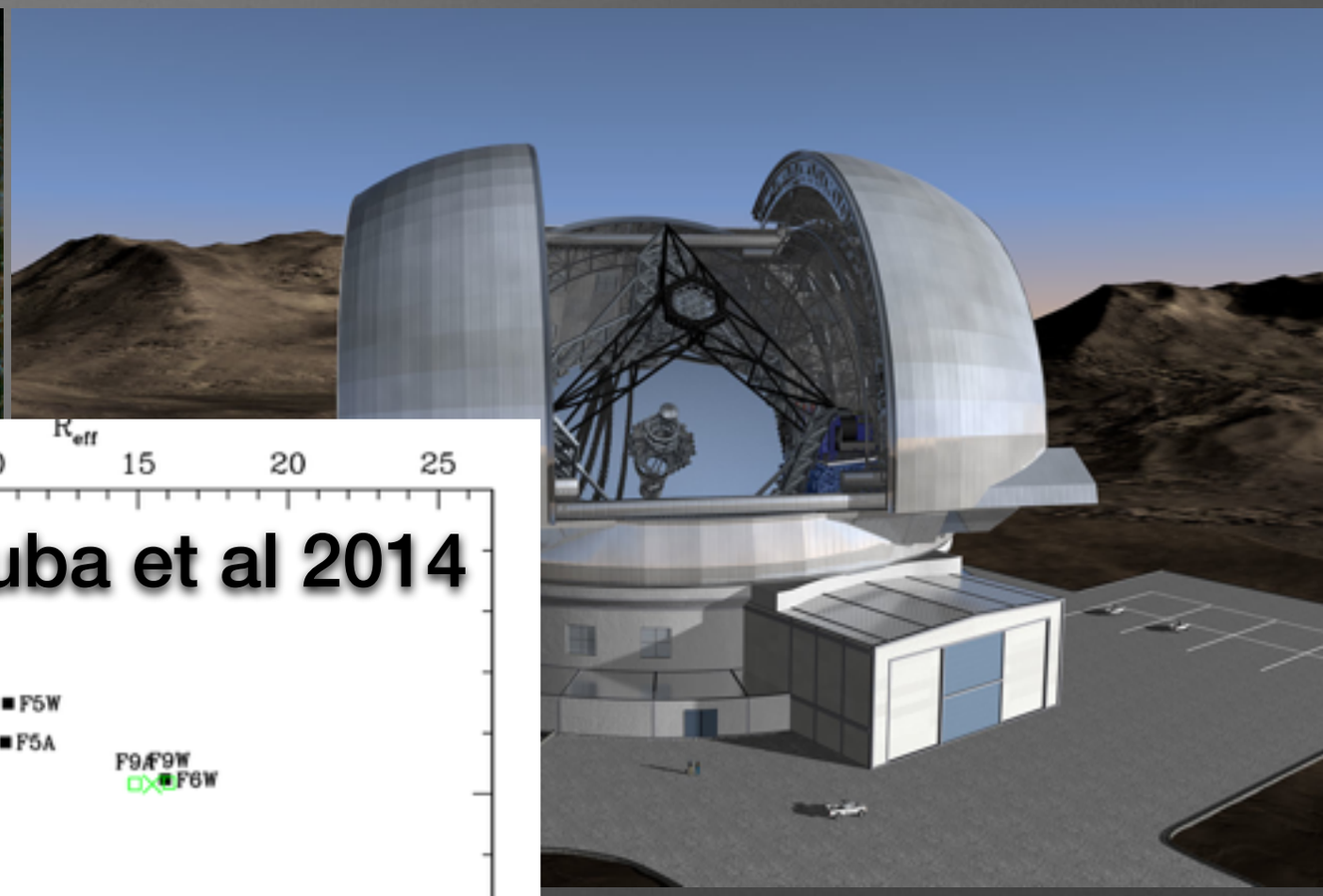


MOSAIC@E-ELT
Virgo Cluster

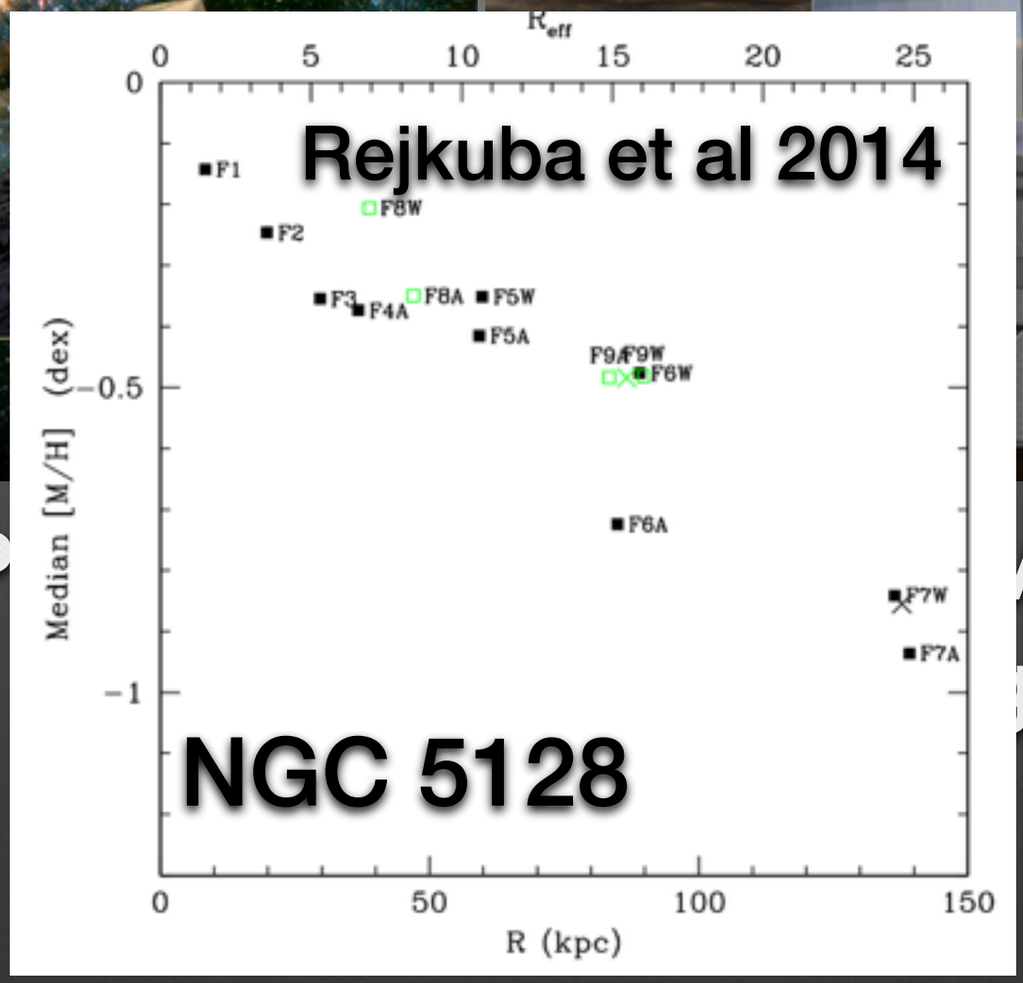
E-ELT + Gaia



Trigonometric P
+
Galex

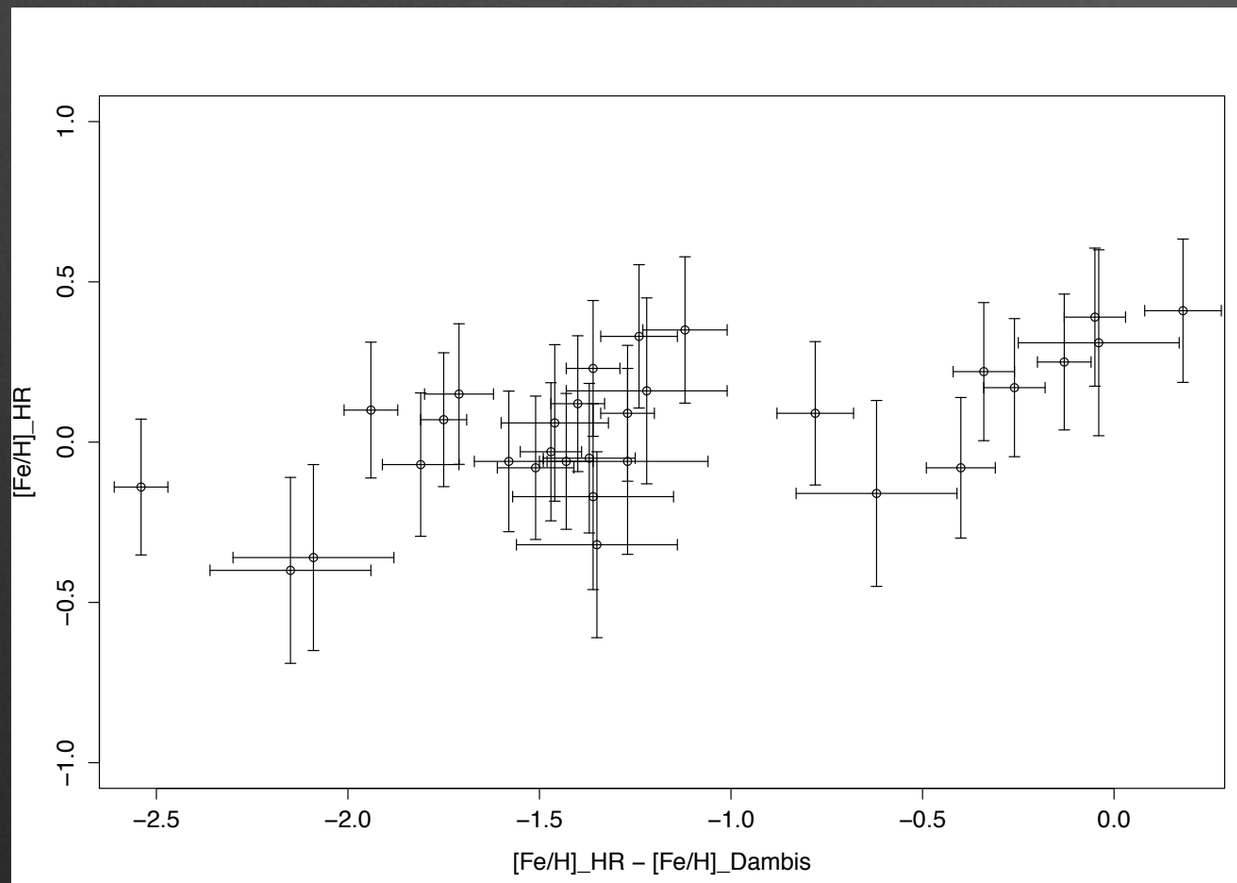


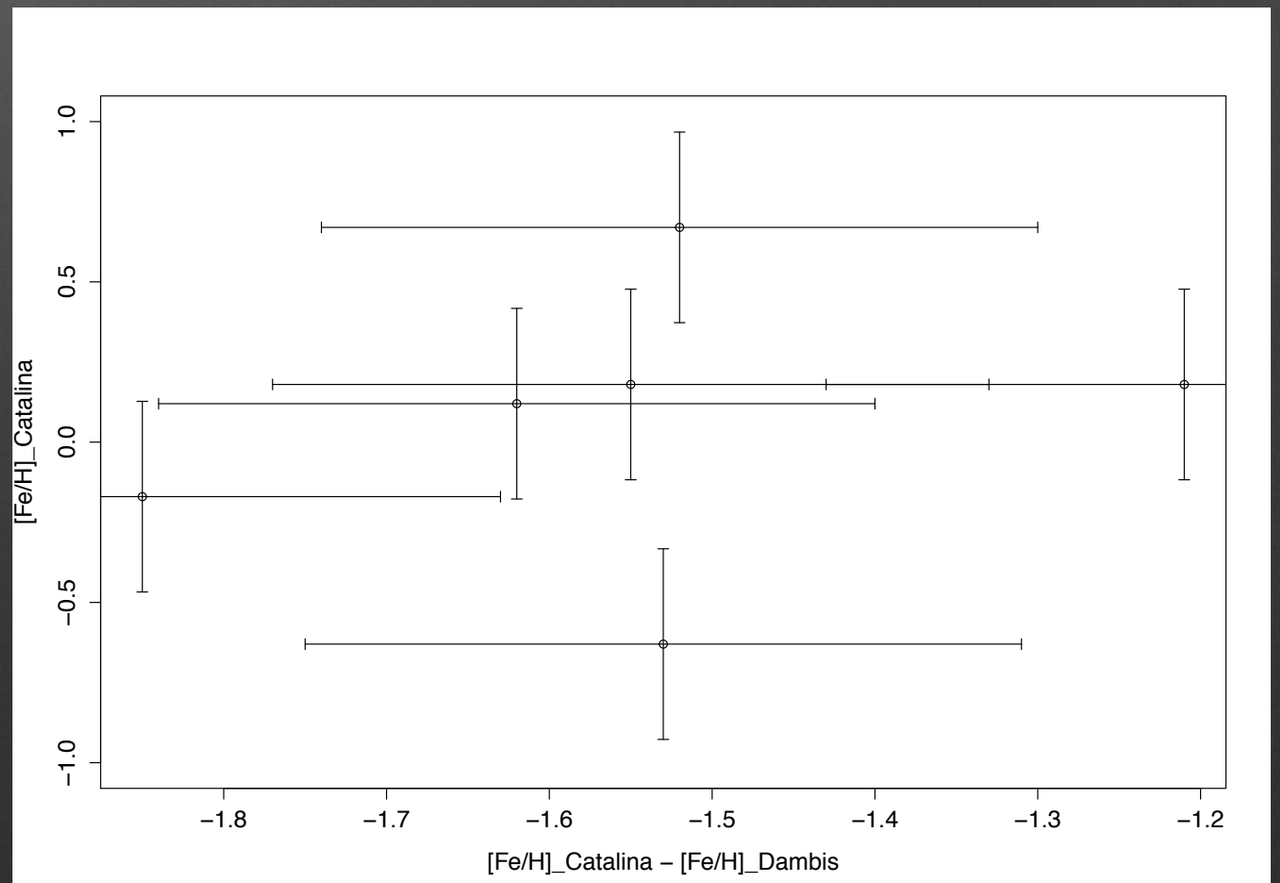
AIC@E-ELT
go Cluster

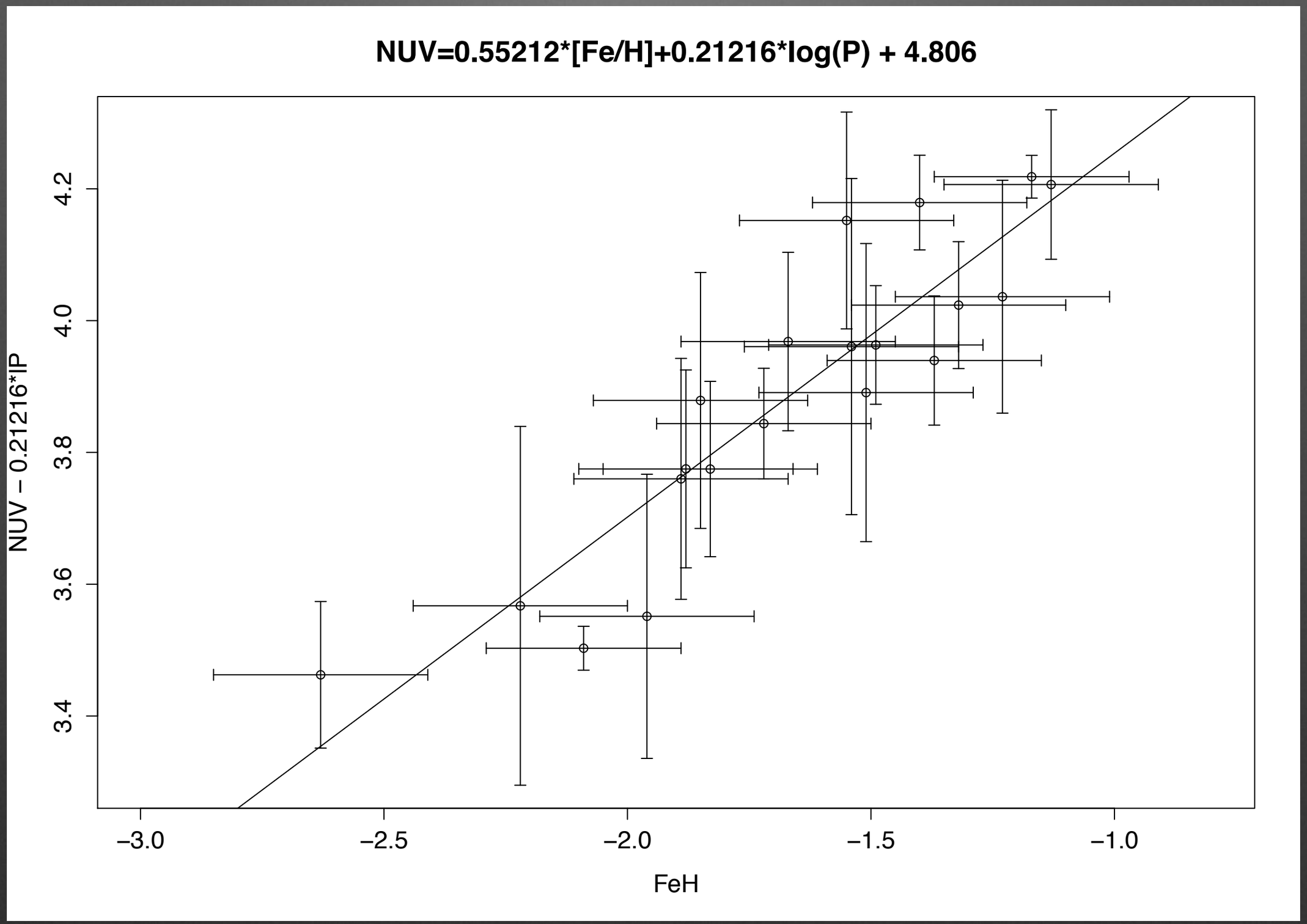


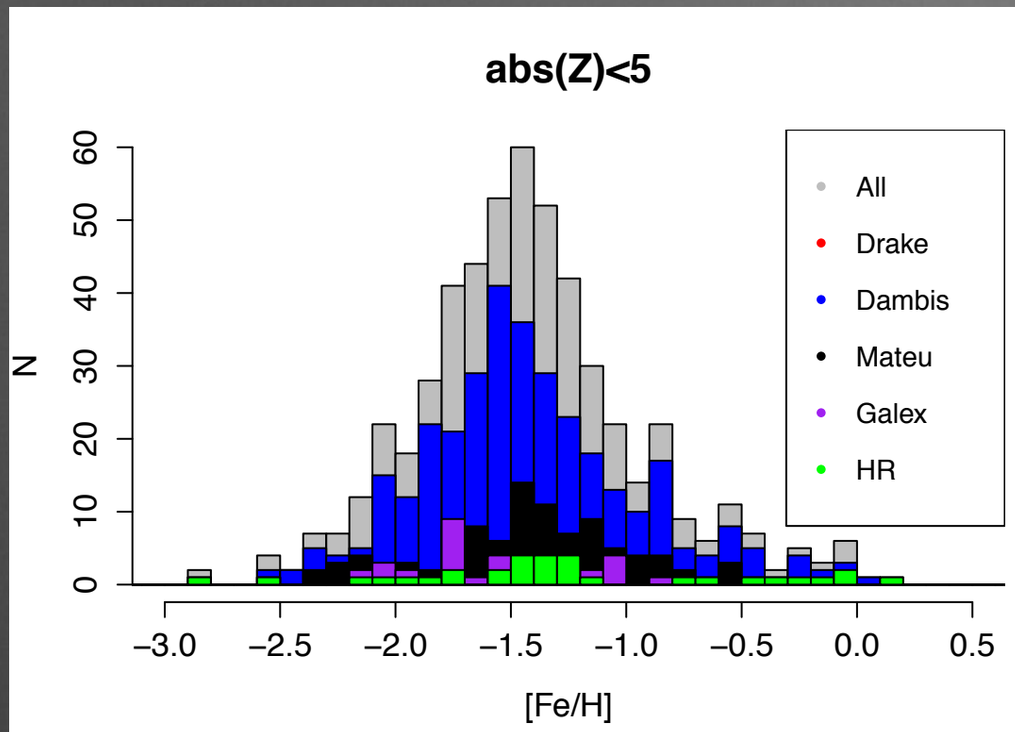
[Fe/H] comparison

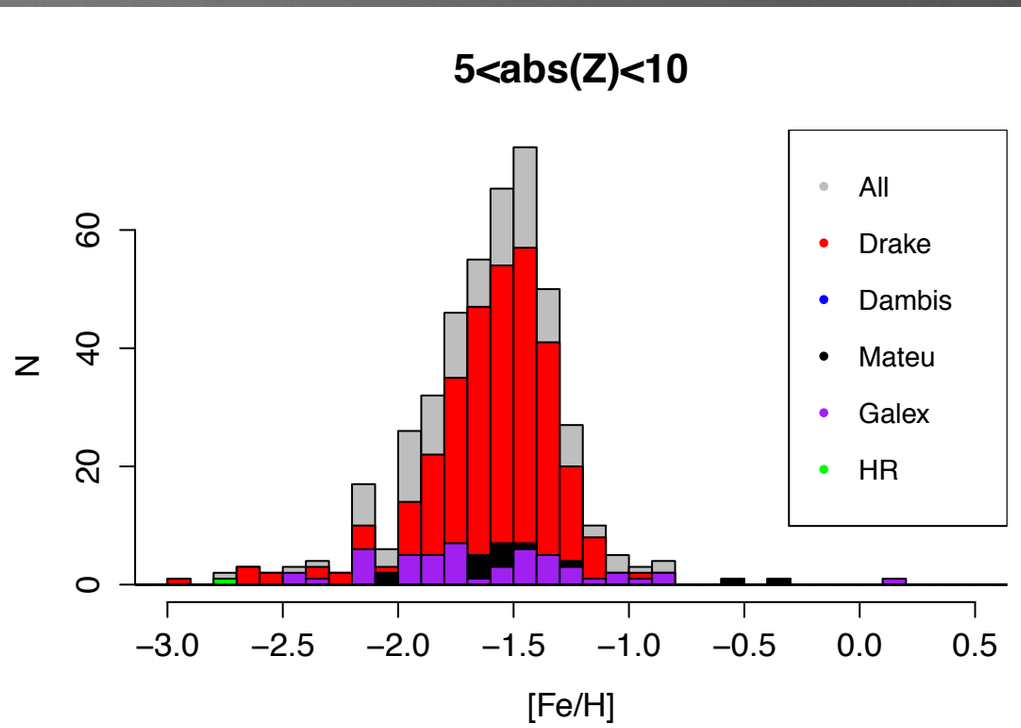
- HR-Dambis : 31 match d[Fe/H] = -0.02 σ=0.13
- Catalina-Dambis 6 match d[Fe/H] = 0.06 σ=0.39
- Catalina-Mateu 1 match d[Fe/H] = 0.03

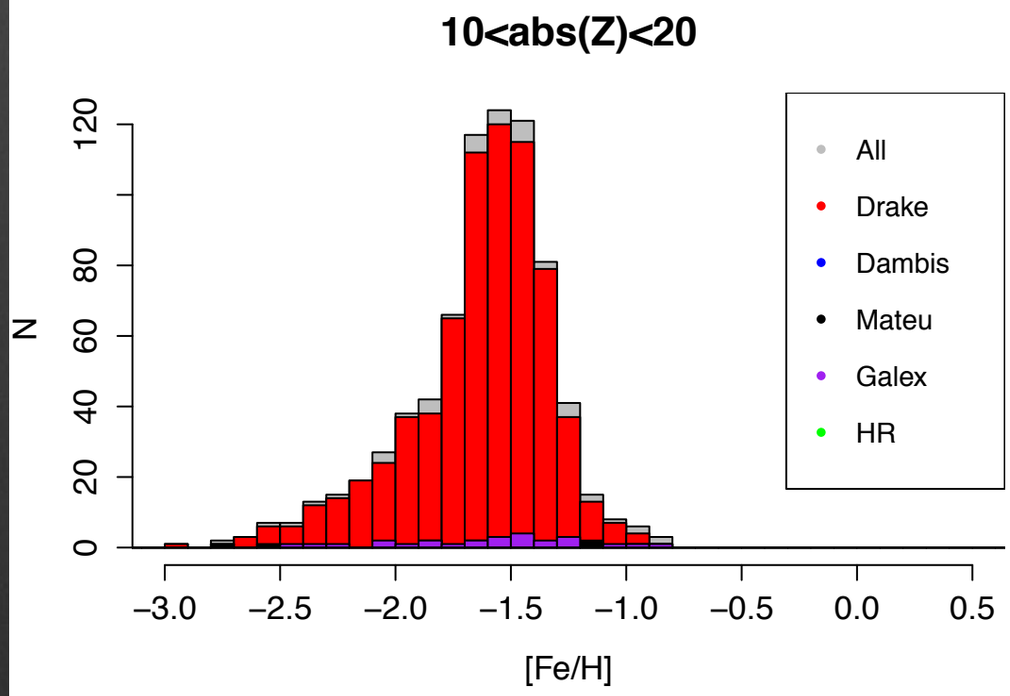


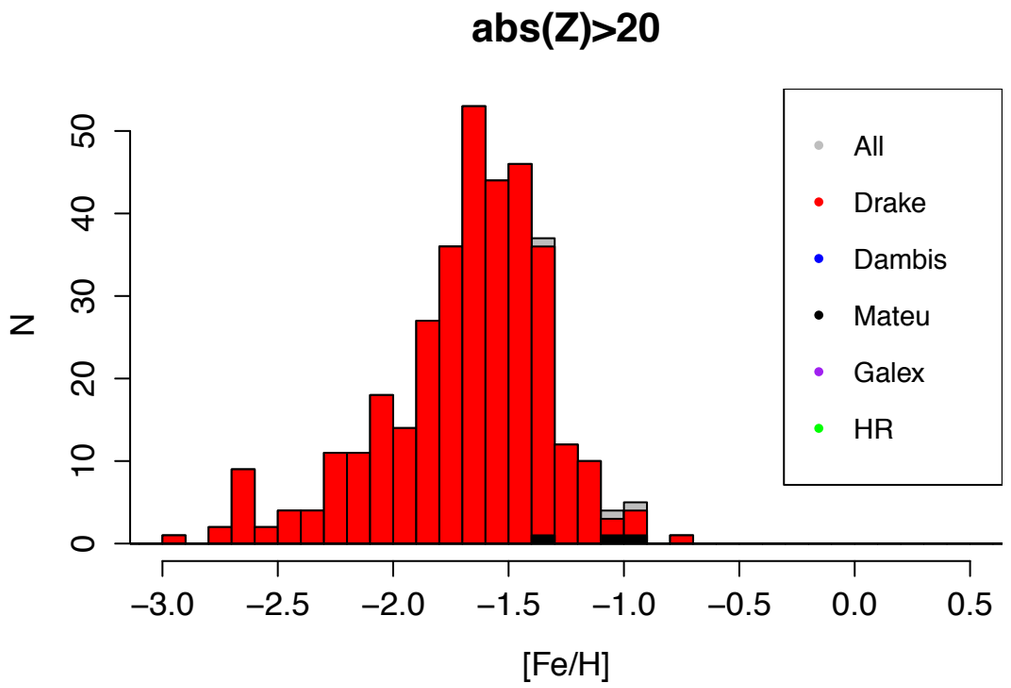


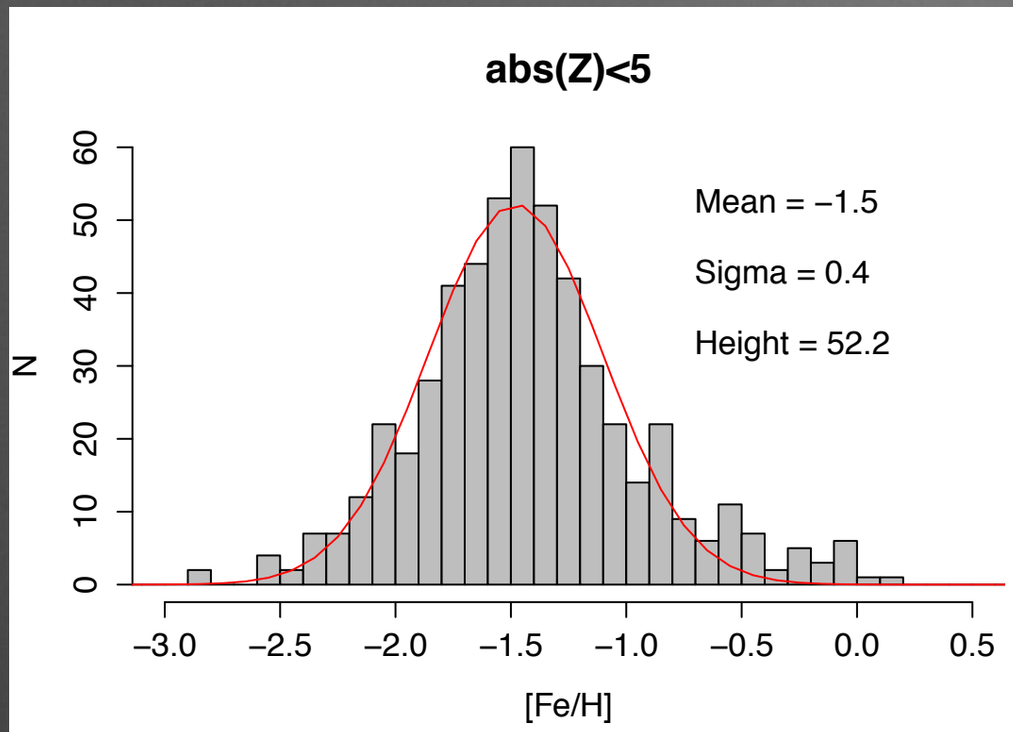

NUV=0.55212*[Fe/H]+0.21216*log(P) + 4.806
NUV – 0.21216*IP
4.2
4.0
3.8
3.6
3.4
–3.0
–2.5
–2.0
–1.5
–1.0
FeH

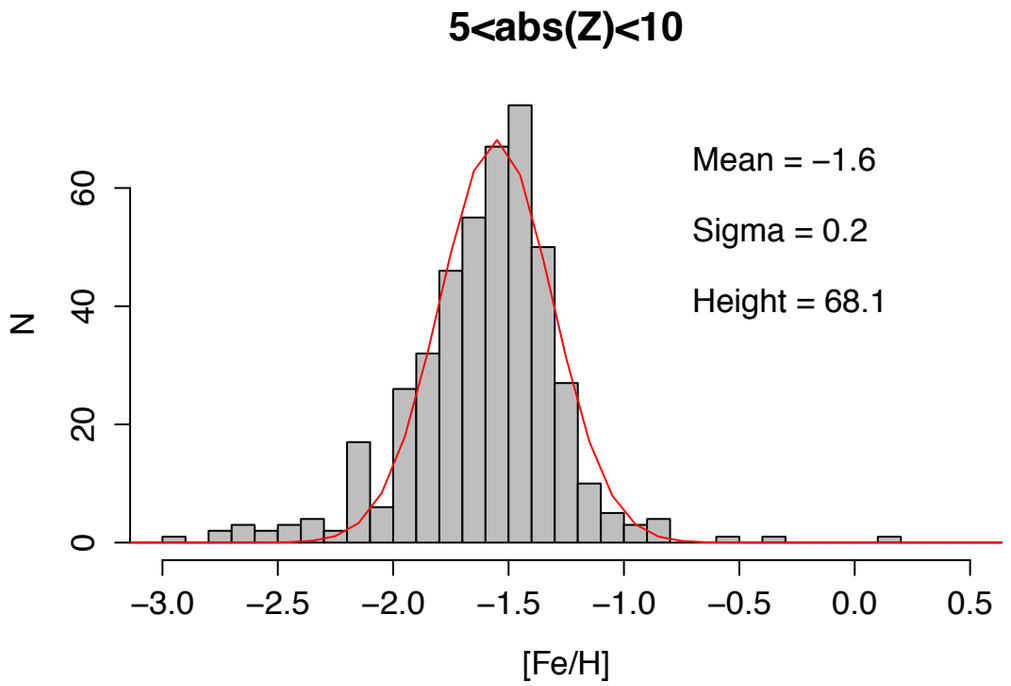

abs(Z)<5
N
0
10
20
30
40
50
60
–3.0
–2.5
–2.0
–1.5
–1.0
–0.5
0.0
0.5
[Fe/H]
All
Drake
Dambis
Mateu
Galex
HR

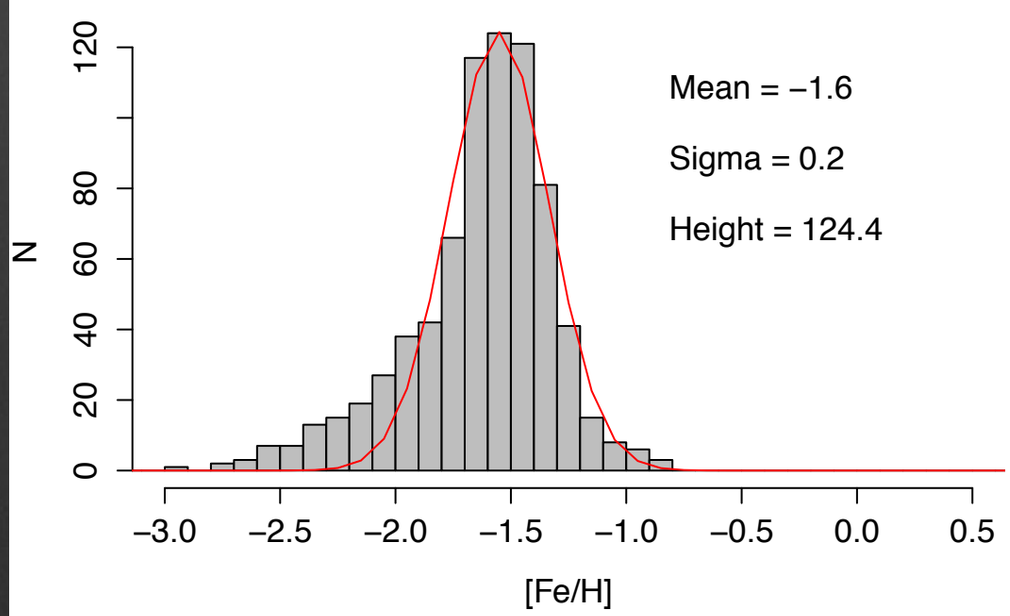

5<abs(Z)<10
N
0
20
40
60
–3.0
–2.5
–2.0
–1.5
–1.0
–0.5
0.0
0.5
[Fe/H]
All
Drake
Dambis
Mateu
Galex
HR

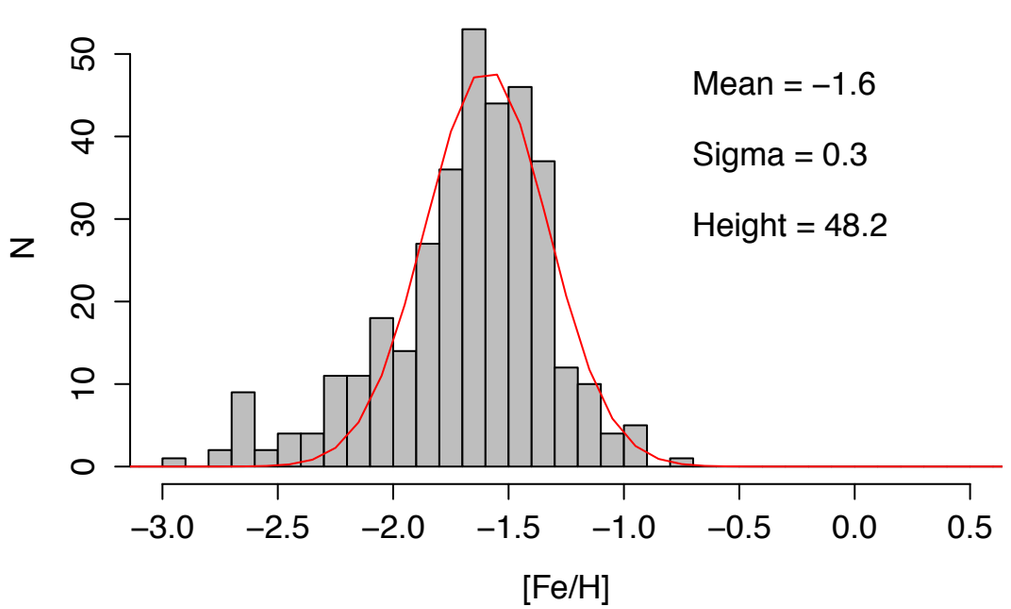

10<abs(Z)<20
N
0
20
40
60
80
120
–3.0
–2.5
–2.0
–1.5
–1.0
–0.5
0.0
0.5
[Fe/H]
All
Drake
Dambis
Mateu
Galex
HR

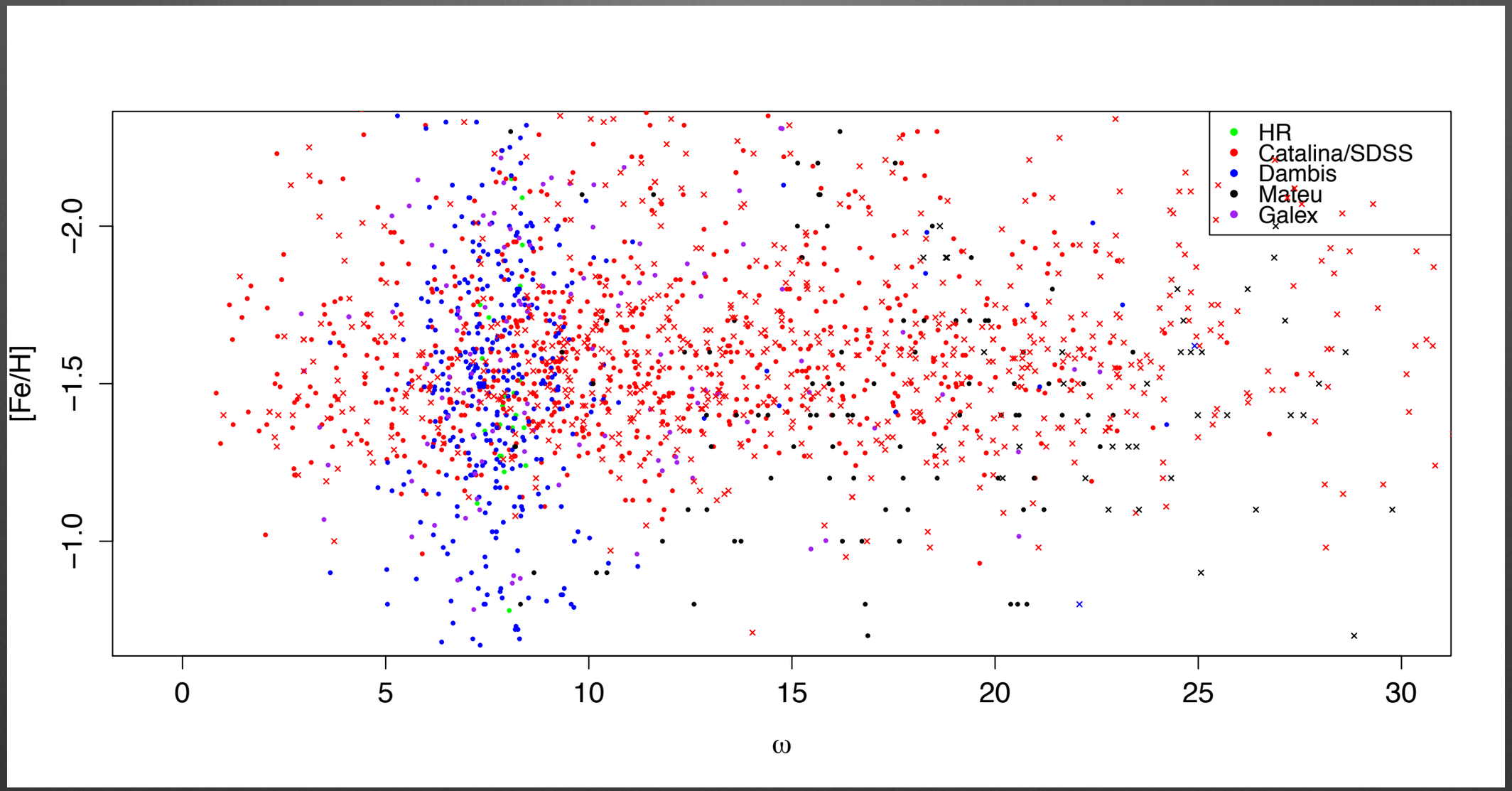

abs(Z)>20
N
0
10
20
30
40
50
–3.0
–2.5
–2.0
–1.5
–1.0
–0.5
0.0
0.5
[Fe/H]
All
Drake
Dambis
Mateu
Galex
HR


abs(Z)<5
N
0
10
20
30
40
50
60
Mean = −1.5
Sigma = 0.4
Height = 52.2
−3.0
−2.5
−2.0
−1.5
−1.0
−0.5
0.0
0.5
[Fe/H]


5<abs(Z)<10
N
0
20
40
60
Mean = −1.6
Sigma = 0.2
Height = 68.1
−3.0
−2.5
−2.0
−1.5
−1.0
−0.5
0.0
0.5
[Fe/H]


10<abs(Z)<20
N
0
20
40
60
80
120
Mean = −1.6
Sigma = 0.2
Height = 124.4
−3.0
−2.5
−2.0
−1.5
−1.0
−0.5
0.0
0.5
[Fe/H]


abs(Z)>20
N
0
10
20
30
40
50
Mean = −1.6
Sigma = 0.3
Height = 48.2
−3.0
−2.5
−2.0
−1.5
−1.0
−0.5
0.0
0.5
[Fe/H]


HR
Catalina/SDSS
Dambis
Mateu
Galex
[Fe/H]
−2.0
−1.5
−1.0
0
5
10
15
20
25
30
ω