Study of the Milky Way Halo using the OAJ surveys

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Background image credit:
Óscar Blanco

The Galactic halo: General Introduction

Composition

In situ + Ex situ (mergers)

Ex situ: records in the configuration space due to the large dynamical timescales

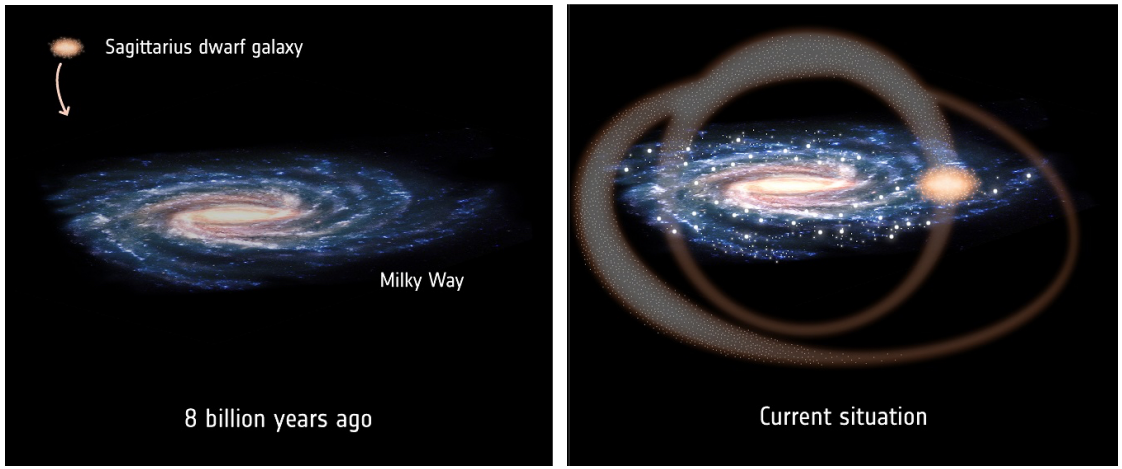
Ex.: Sgr dSph (Ibata et al. 1994), Gaia-Sausage (Berlokurov et al. 2018), Gaia-Enceladus (Helmi et al. 2018), ...

Gaia eDR3

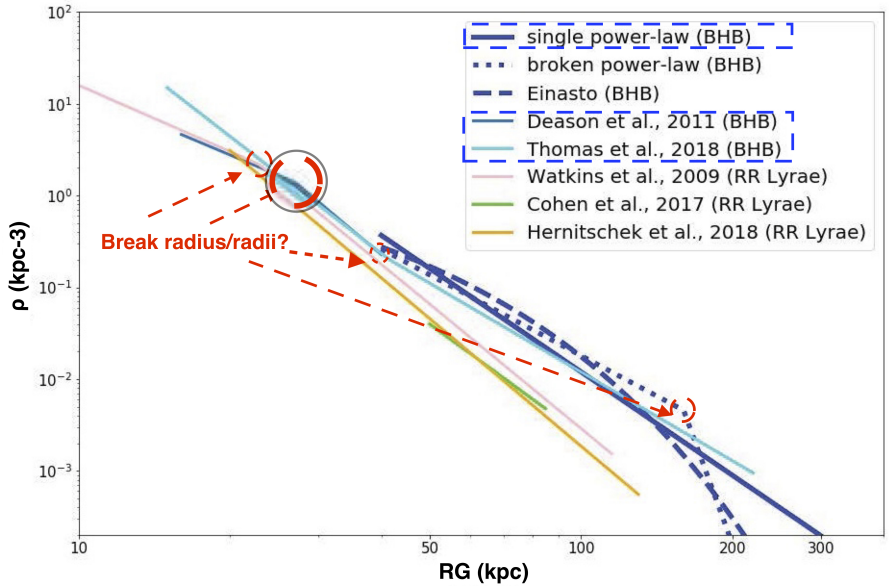
$0.02/\varpi = 0.2$ => $d \leq 10$ kpc

Open questions

Break radius, # events...



Credit: ESA & Ruiz-Lara et al. 2020 (adapted)

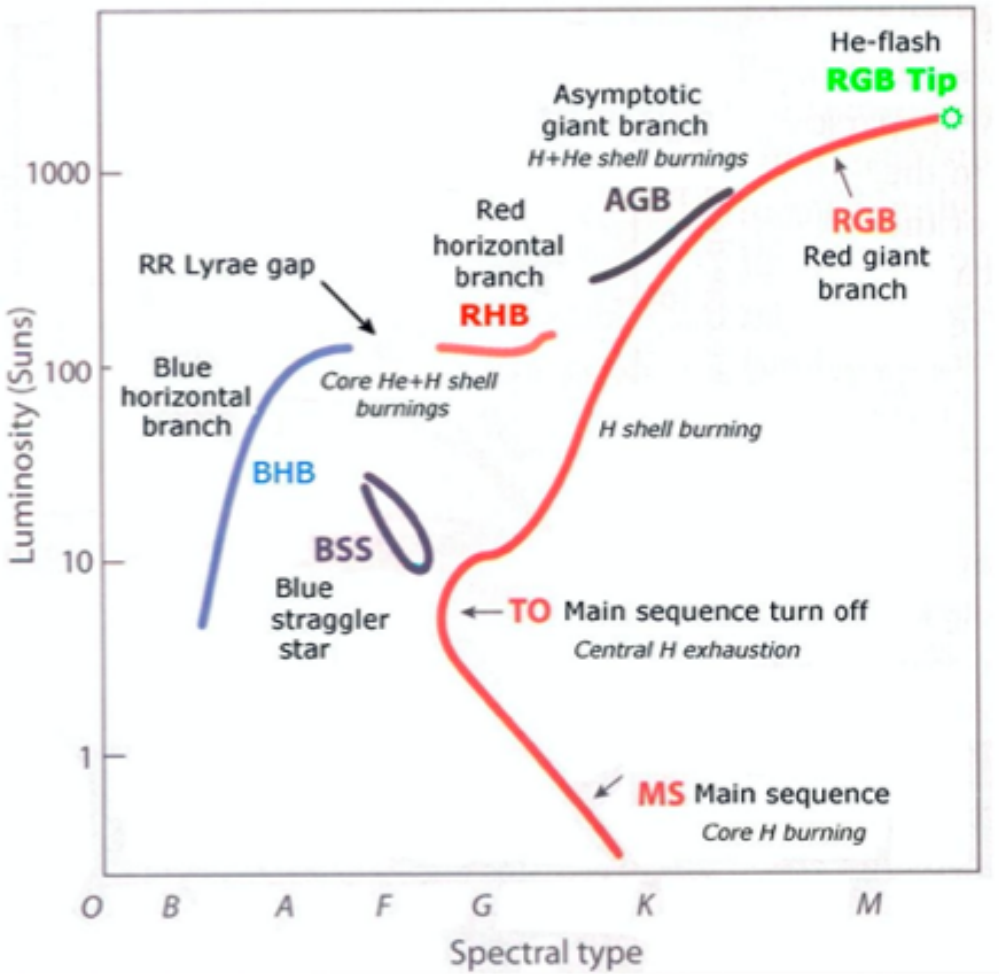


Credit: Adapted from Fukushima et al. 2019

The Galactic halo: Tracers & Methodologies

Different approaches to study the Halo:

- Stars:
  - HB stars (EBHB, BHB, RR Lyrae, RHB)
  - MSTO stars
  - K- and M-giants
  - Carbon stars, ...
- Other methods:
  - Overdensities
  - Kinematics
  - Metallicity, ...

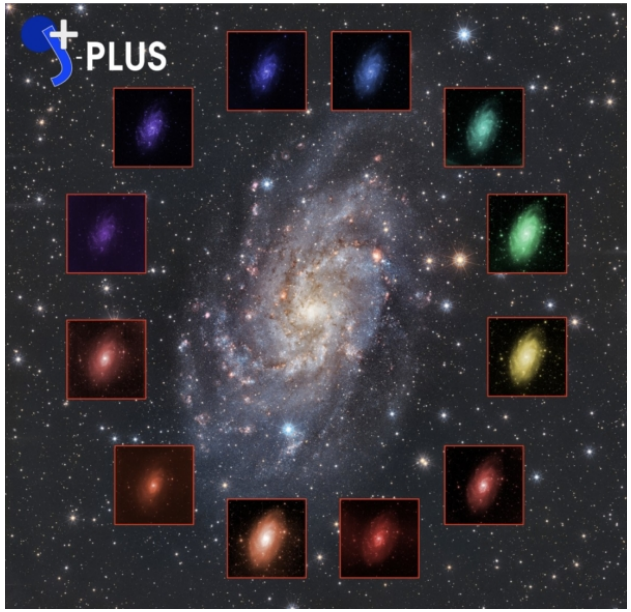


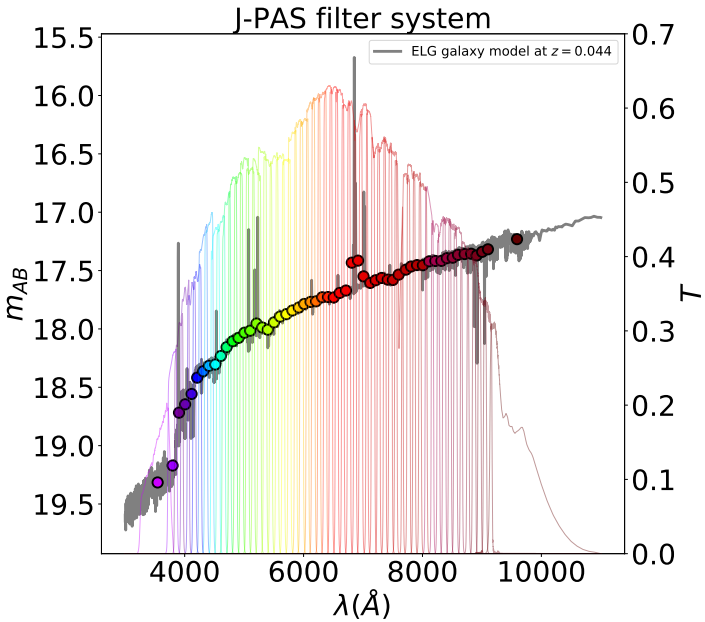
Credit: Murdin, 2001

Thesis objectives

The main goals of the present thesis project are:

- To study the radial density profile of the MW using a pure sample of BHB stars (J-PLUS, this talk).
- To study the spectral variation of RR Lyrae stars with the pulsation phase (J-PLUS, J-PAS).
- To study the radial density profile of the MW using RR Lyrae stars (J-VAR).

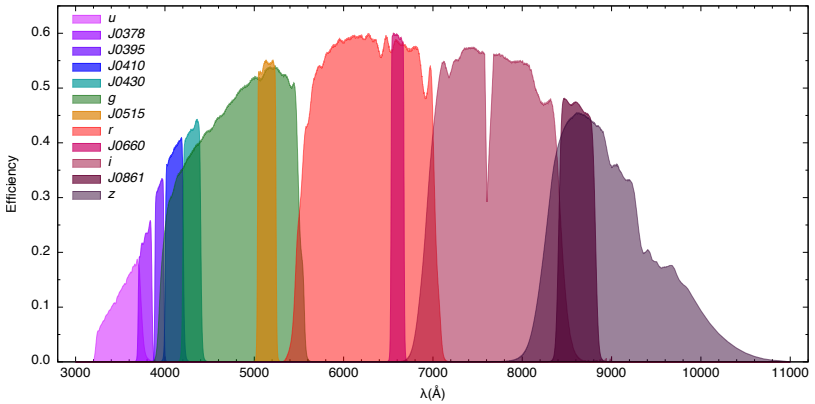




Credit: J-PLUS, and J-VAR collaborations and Martínez-Solaeche et al. 2019

OAJ surveys: J-PLUS, J-PAS & J-VAR

(a) JAST/T80



Credit: Cenarro et al. 2019 (b) J-PLUS filter set

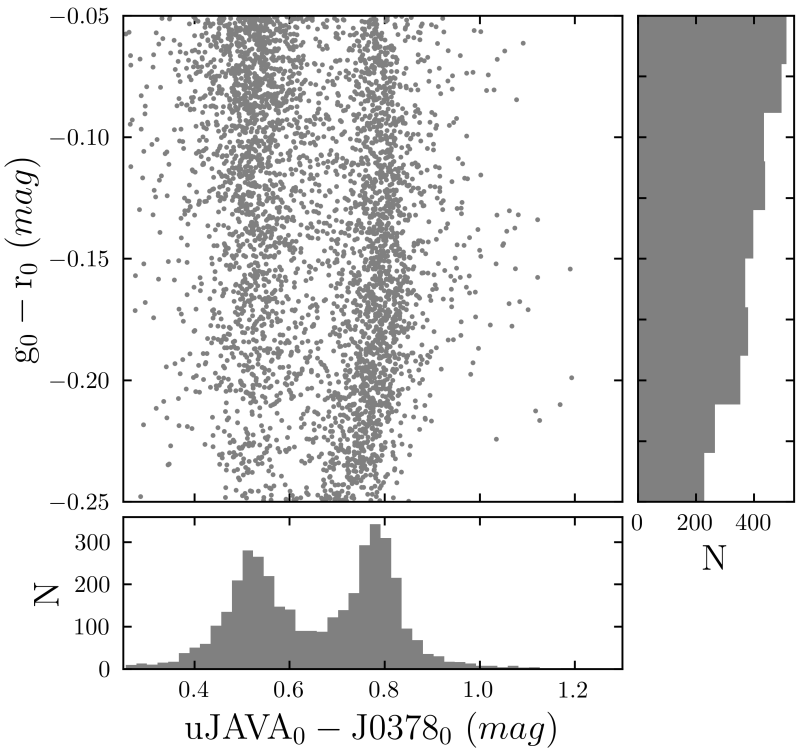
	J-PLUS	J-PAS	J-VAR
Telescope	JAST/T80	JST/T250	JAST/T80
FoV (deg^2)	2	4.2	2
Plate scale (arcsec deg^{-2})	0.55	0.23	0.55
Area surveyed (deg^2)	2176	1*	126 (>11 epochs)
Filters	12	56	7
Public	✓	✓	✗
Reference	Cenarro+19	Benítez+14 Bonoli+20	Ederoclite+21 (in prep)

*Pathfinder camera (FoV=0.3 deg^2)

BHB and BS loci: Color-color diagrams

Physical range

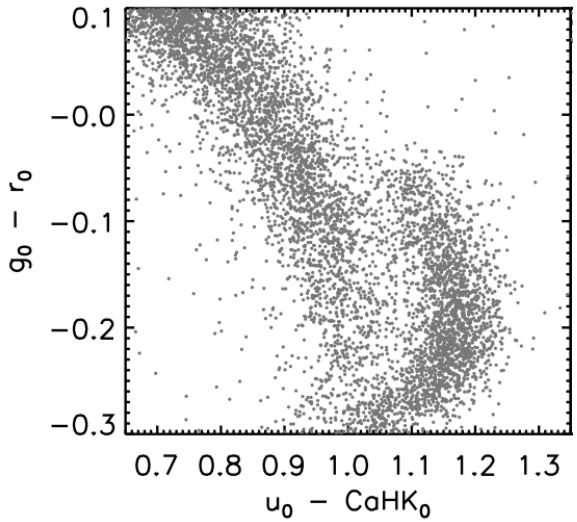
- log g (cm s^{-2}): BHB$\sim$2.75-3.75
  BS$\sim$3.75-5
- Teff (K): 7 500-10 000 ($\sim$ A-type stars)



Credit: This work (J-PLUS)

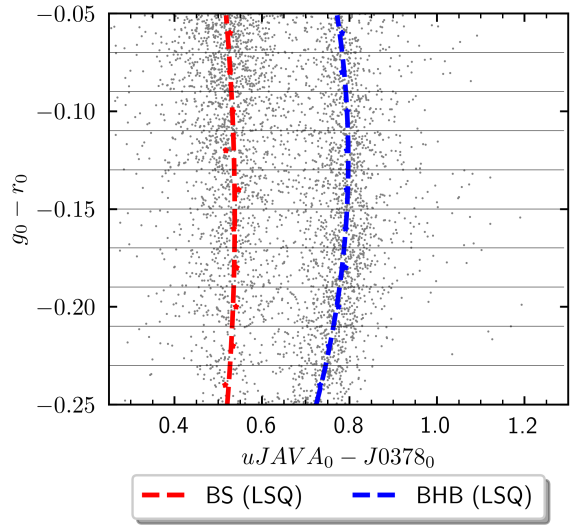
Other surveys with narrow filter/s in this range:

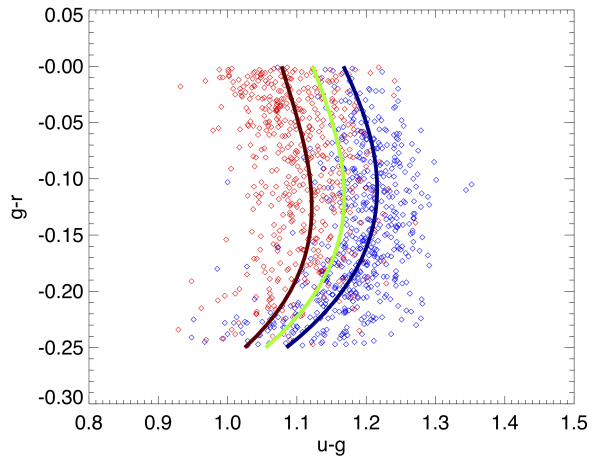
- Pristine: CaHK ($\sim$ J0395)
- Skymapper: v
- S-PLUS (Southern sky twin of J-PLUS)
- ...



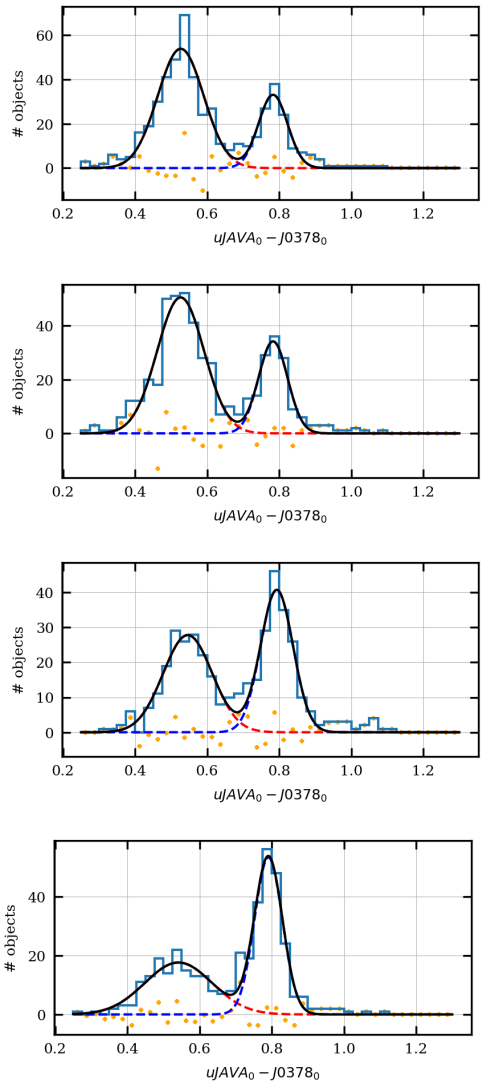
Credit: Starkenburg et al. 2019 (Pristine)

BHB and BS loci: Disentangling the relationships (I)

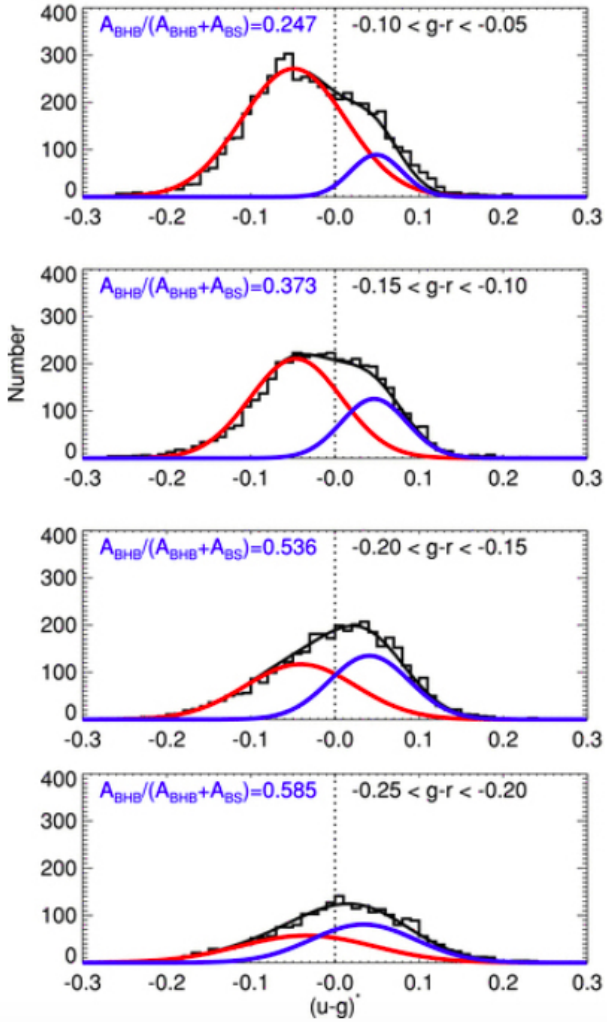




Credit: This work (top); Deason et al. 2011 (bottom)

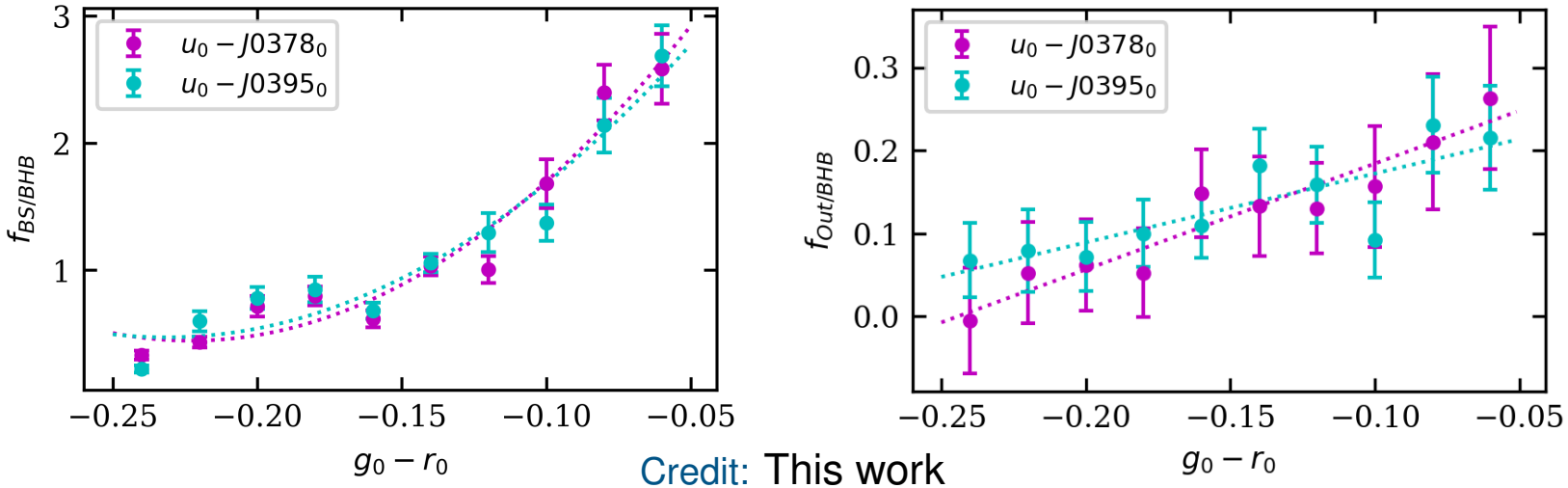


Credit: This work



Credit: Deason et al. 2011

BHB and BS loci: Disentangling the relationships (II)

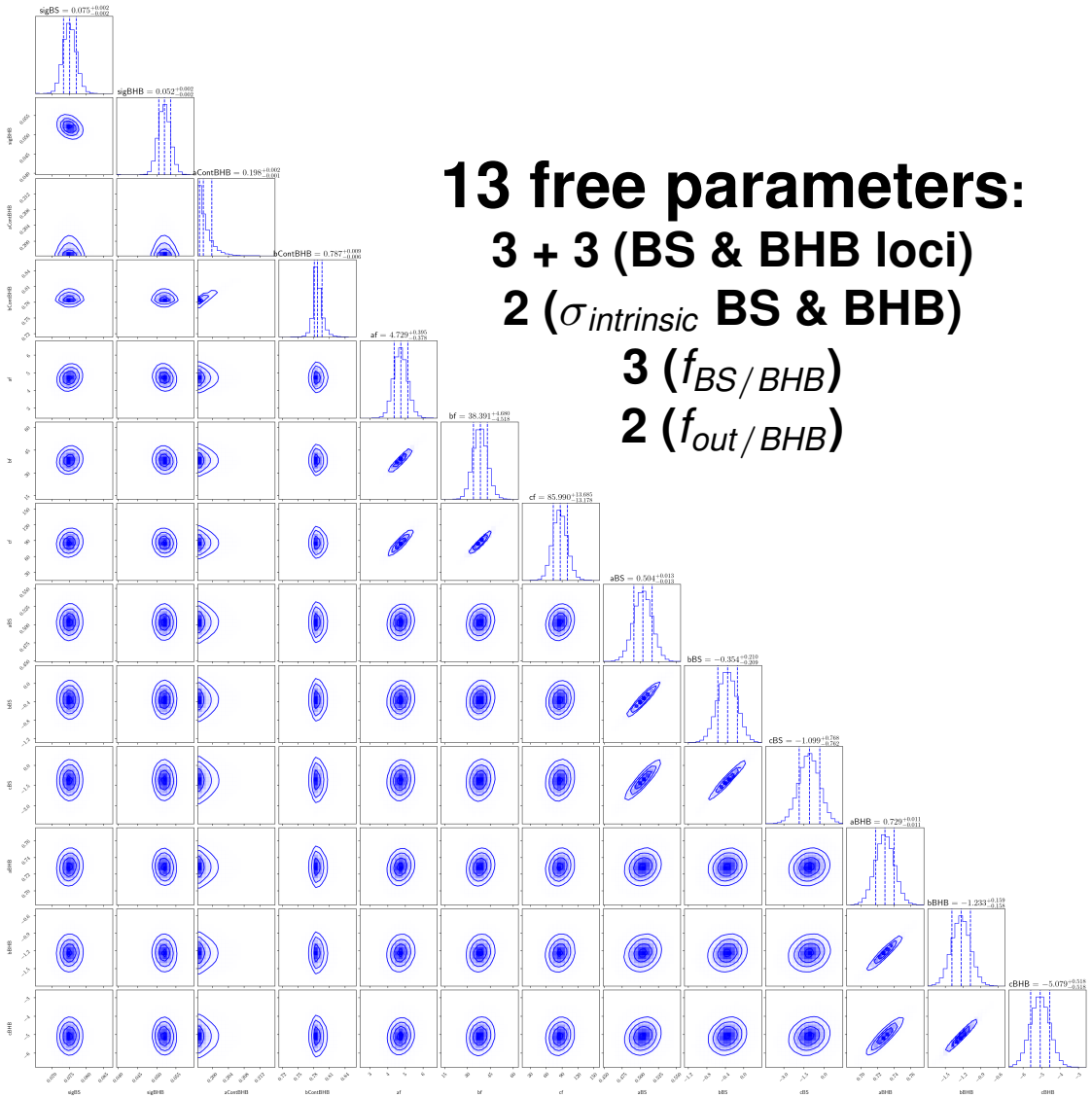


Credit: This work

Following a similar approach as in López-Sanjuan et al. 2019c, 2021, we can define the "real", combined distribution in the color C as:

$$D_{BHB+BS+Out}(C^{real}|\theta_{BHB},\theta_{BS},\theta_{Out},(g-r)_0) =$$
$$[f_{BHB}(f_{\frac{BS}{BHB}},f_{\frac{Out}{BHB}}) \times P_G(C^{real}|\langle C^{real}\rangle_{BHB},\sigma^{int}_{BHB})] +$$
$$[f_{BS}(f_{\frac{BS}{BHB}},f_{\frac{Out}{BHB}}) \times P_G(C^{real}|\langle C^{real}\rangle_{BS},\sigma^{int}_{BS})] +$$
$$[f_{Out}(f_{\frac{BS}{BHB}},f_{\frac{Out}{BHB}}) \times \mathcal{U}]$$

BHB and BS loci: MLE + MCMC



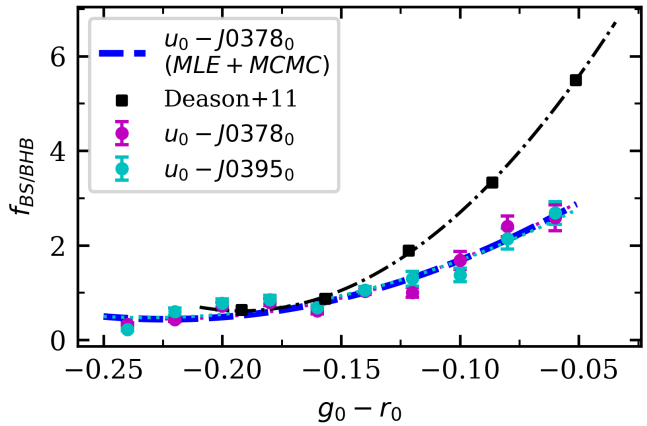
13 free parameters:

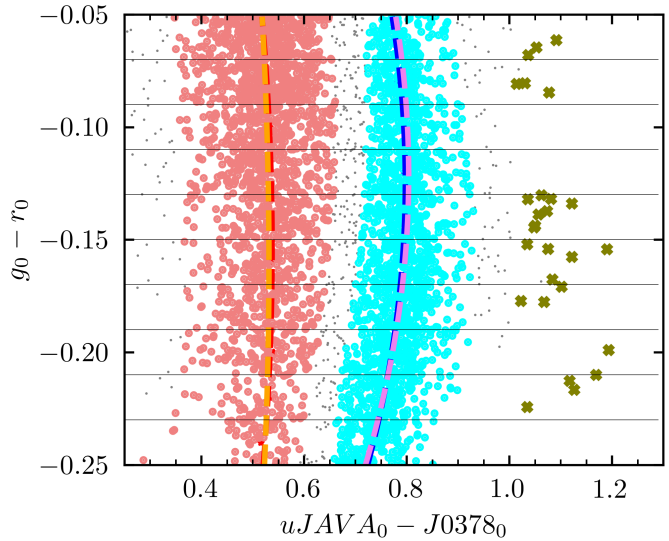
3 + 3 (BS & BHB loci)

2 ($\sigma_{intrinsic}$ BS & BHB)

3 ($f_{BS/BHB}$)

2 ($f_{out/BHB}$)





Credit: This work; emcee (Foreman-Mackey et al. 2013)

Purity, Completeness and SEDs

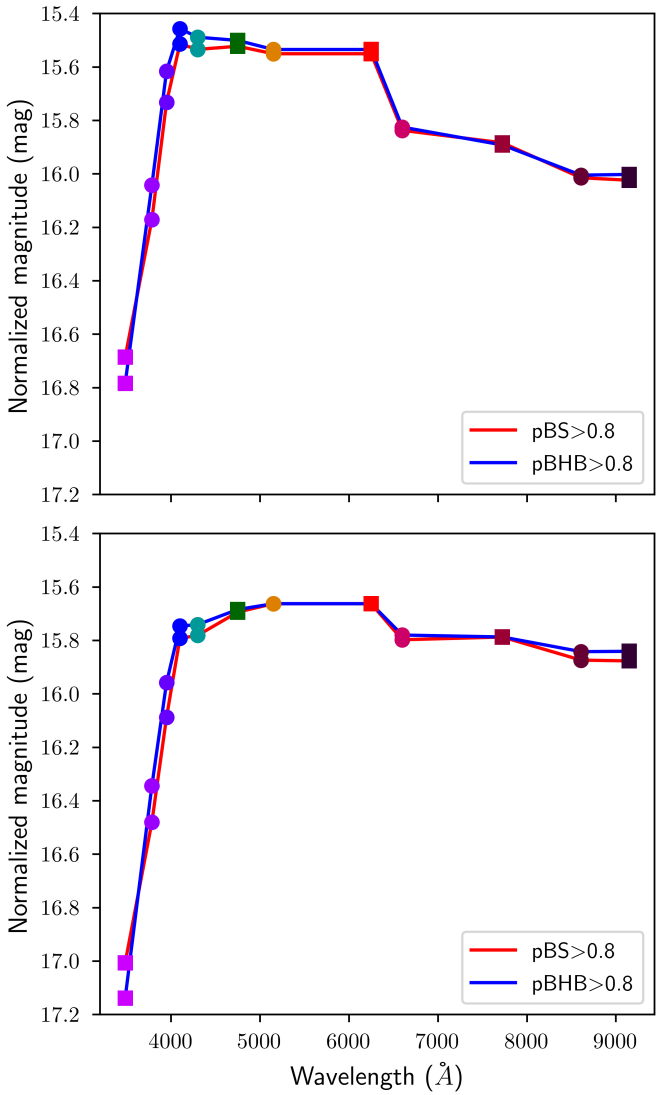
Purity

	BHB (P>0.8) (this work)	BS (P>0.8) (this work)
BHB (Xue+08)	97.5%	2.5%
BS + MS (Xue+08)	90.2%	9.8%

Completeness

	Xue+08
BHB (P>0.8) (this work)	82.4%
BS (P>0.8) (this work)	94.5%

Credit: This work



Conclusions & Future work

Conclusions:

- Taking advantage of the capabilities of the bluer filters of J-PLUS, we have collected a high purity sample of BHB stars.
- We are obtaining the radial profile of the Galactic halo using a Bayesian method.
- The preliminary results are in good agreement with those given in the literature.

Future work:

- To iterate N times to refine the results presented, and apply them to the faint sample, paying special attention to identify and remove star overdensities.
- Tackling the tasks related to RR Lyrae stars and the other OAJ surveys (J-PAS and J-VAR).