CHASING CLUSTER MEMBERS IN THE GES CATALOG

Laura María Sampedro Hernández

sampedro@iaa.es

Thesis Advisors & Collaborators:

E. J. Alfaro Navarro (IAA-CSIC)

J. Peñarrubia (Edinburgh University, IAA-CSIC)

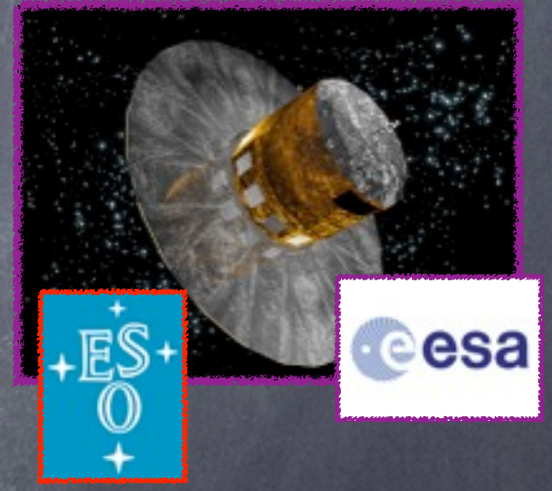
INTRODUCTION

Stellar Clusters are considered important laboratories for Astrophysical researches as Stellar Evolution, Star Formation and Galactic Structure and Evolution. (Gilmore et. al 2012)

Initial Problem:

The Membership Analysis ⟶ PROBABILISTIC NATURE

Used Variables: { Positions, Proper Motions, Radial Velocities, Metallicities, Parallaxes



Objective:

TO ESTIMATE THE MEMBERSHIP PROBABILITIES BASED ON AS MANY VARIABLES AS POSSIBLE MEASURED IN THE CLUSTER FIELD.

METHODOLOGY

Sampedro et. al 2013 in prep.

Metrical Method:

(Sampedro, Alfaro & Peñarrubia , 2013 in prep.)

N-Variables are more concentrated for the Cluster members than for the Field stars

Introducing the distance variable as an Euclidean distance in the N-D space

Hypothesis:

Distance distributions can be approximated by two 1-D gaussians

METHODOLOGY

Sampedro et. al 2013 in prep.

Procedure:

- Outlier Determination *(details in Cabrera-Caño & Alfaro, 1985)*

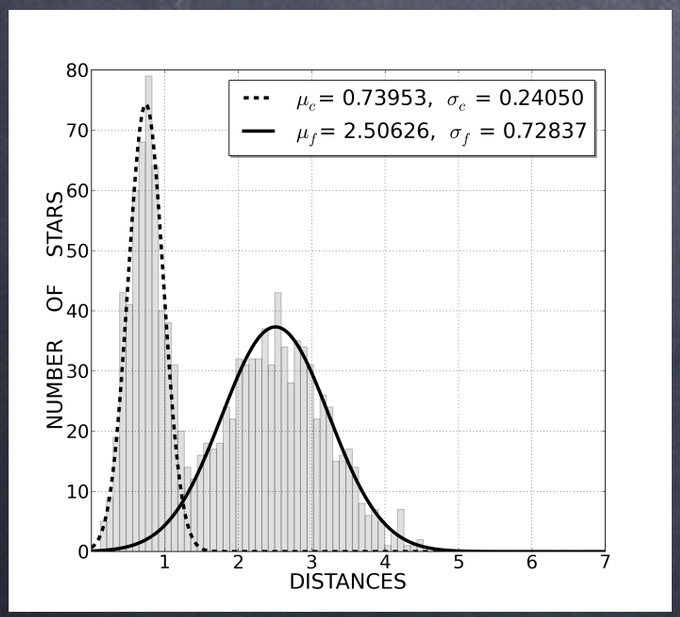
- Normalization of the N-variables:

$$X_i = \frac{x_i - x_0}{\sigma_x}$$

- Computation of the distances between every star and the cluster center in a N-D space:

$$dis_i = \sqrt{(X_{i,N})(T)(X_{i,N})}$$

- Estimation of the membership probabilities:



Distance distribution can be approached by a mixture of two 1-D gaussians

Bayes Theorem

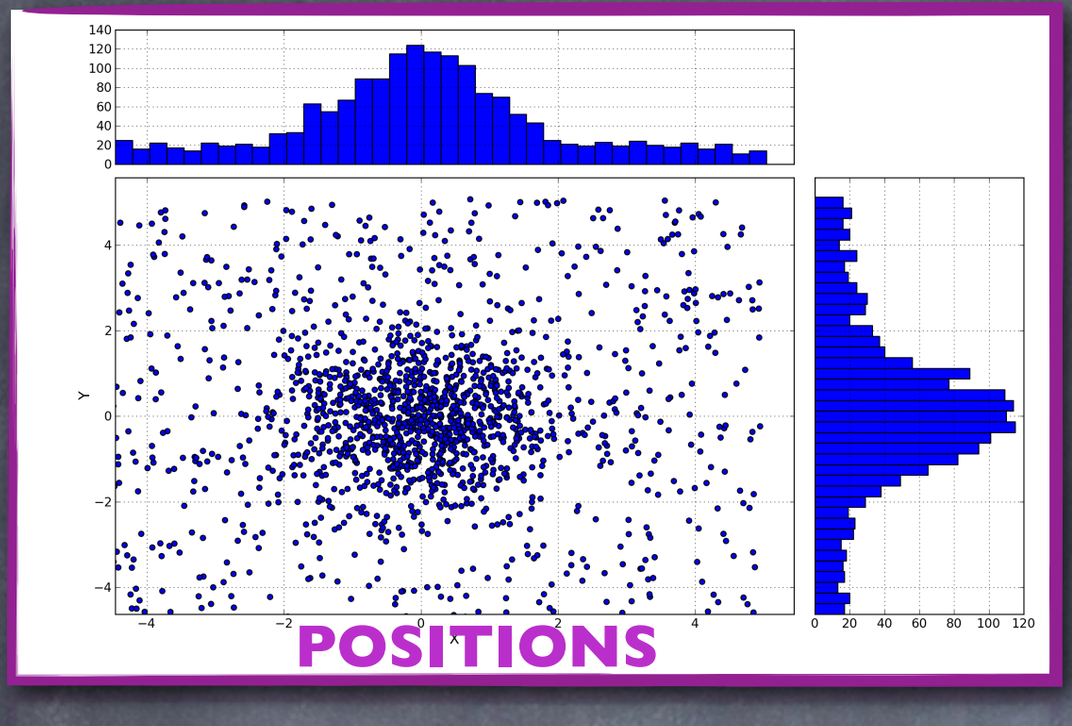
$$P(j/dis) = \frac{W j \phi_j(dis)}{\phi(dis)} \qquad j = c, f$$

P = 0.5

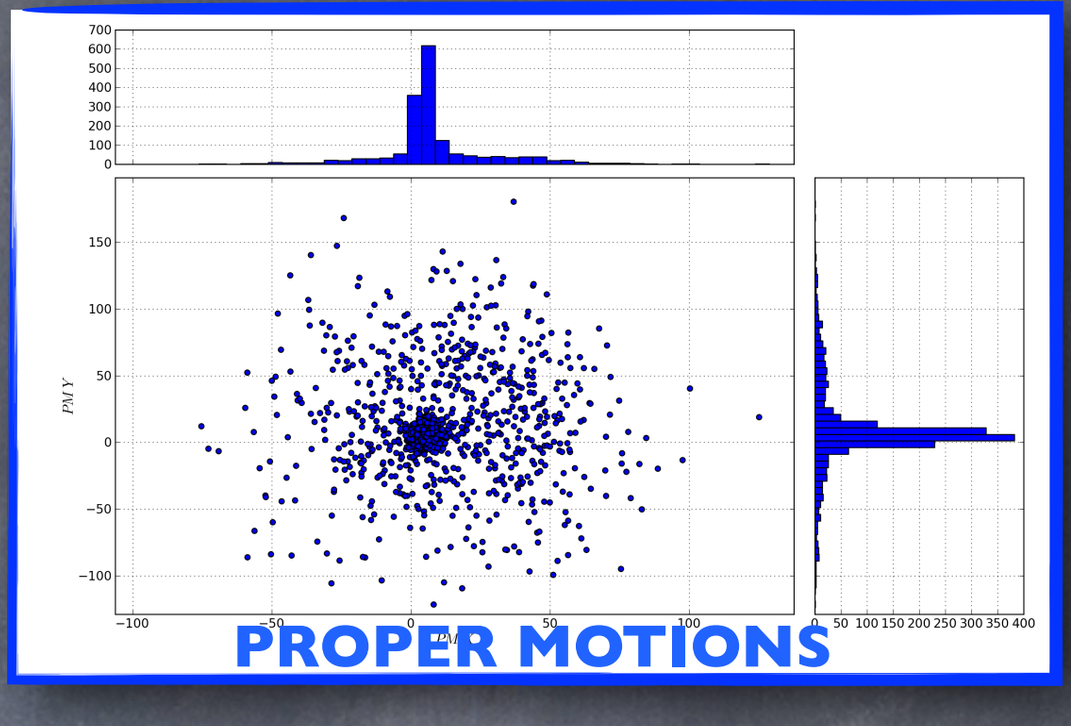
The Cluster Members!!

Testing our Methodology *Sampedro et. al* 2013 in prep.

Simulations



POSITIONS



PROPER MOTIONS

FIXED PARAMETERS →
- *N_T = 1250 stars*
- *Cluster Standard Deviations*
- *Centroids of the cluster in positions and proper motions*

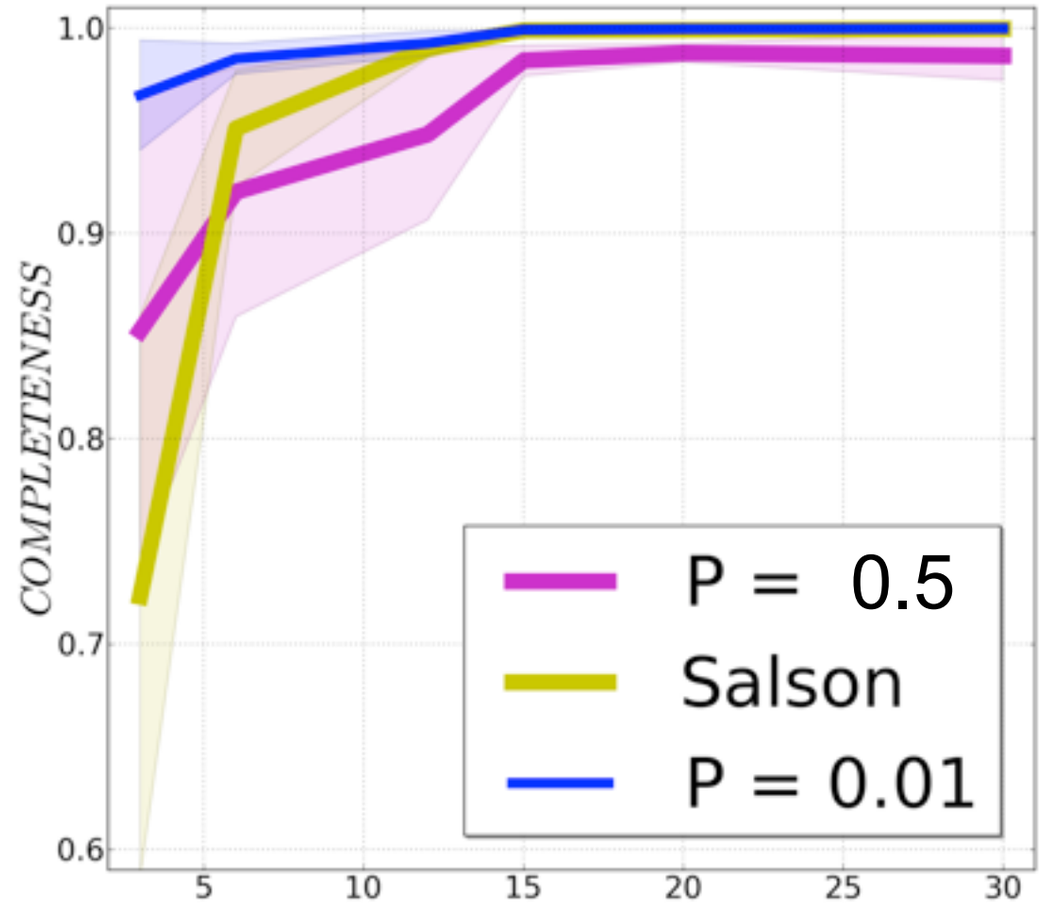
VARIABLE PARAMETERS →
- *Percentage of Cluster Members*
- *The relative distances between the cluster and the field centers in proper motions*
- *Field Stars Dispersion, Uncertainties*

A non-parametric Method (Salson) *(Cabrera-Caño & Alfaro 1990)*

Testing our Methodology

Sampedro et. al 2013 in prep.

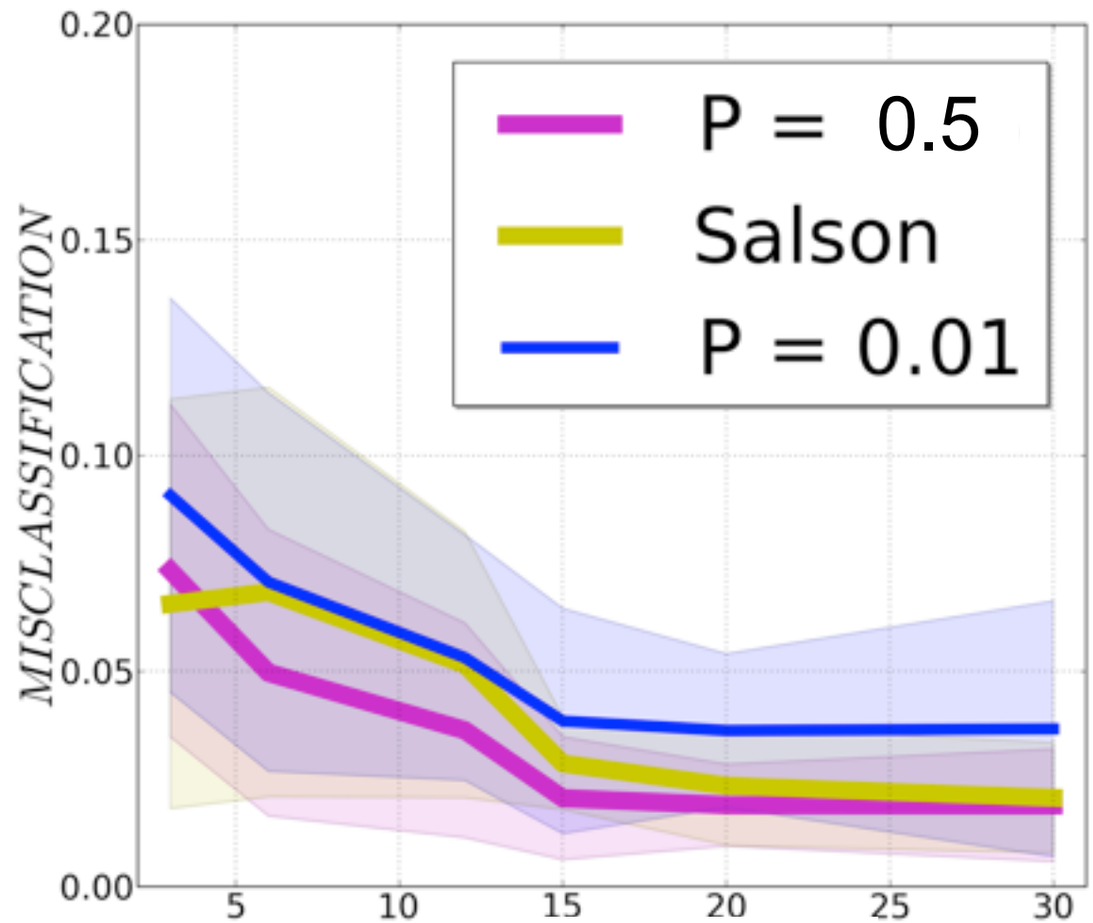
Completeness



$$\sigma_{\mu_f,y} = X\sigma_{\mu_c}$$

$$C = \frac{N^o_{*c,met}}{N^o_c}$$

Misclassification



$$\sigma_{\mu_f,y} = X\sigma_{\mu_c}$$

$$M = \frac{N^o_{*c\longmapsto f} + N^o_{*f\longmapsto c}}{N^o_T}$$

Application to GES-Data (gesiDR1): NGC 6705

SELECTION OF THE SAMPLE

```
SELECT
Spectrum.targetID, Target.targetID, Target.ra, Target.dec, Spectrum.rv, Spectrum.rvErr,
Spectrum.FeH, Spectrum.snr, Spectrum.specFrameID, SpecFrame.specFrameID ,
SpecFrame.instrument
FROM
Spectrum,  Target,  SpecFrame
WHERE
(Target.dec BETWEEN -6.87 AND -5.67) AND (Target.ra BETWEEN 282.17 AND 283.37)
AND (Spectrum.targetID=Target.targetID) AND
Spectrum.specFrameID=SpecFrame.specFrameID)
```

```
SELECT
RecommendedAstroAnalysis.targetID,Target.targetID,Target.ra,Target.dec,
RecommendedAstroAnalysis.vel, RecommendedAstroAnalysis.vrad,
RecommendedAstroAnalysis.vradErr, RecommendedAstroAnalysis.FeH,
RecommendedAstroAnalysis.FeHerr, RecommendedAstroAnalysis.snr,
RecommendedAstroAnalysis.Instrument
FROM
RecommendedAstroAnalysis, Target
WHERE
(Target.dec BETWEEN -6.87 AND  -5.67) AND (Target.ra BETWEEN 282.17 AND 283.37)
AND (RecommendedAstroAnalysis.targetID=Target.targetID)
```

Tables:

- Target
- Spectrum
- RecommendedAstroAnalysis

Variables:

- Right Ascension
- Declination

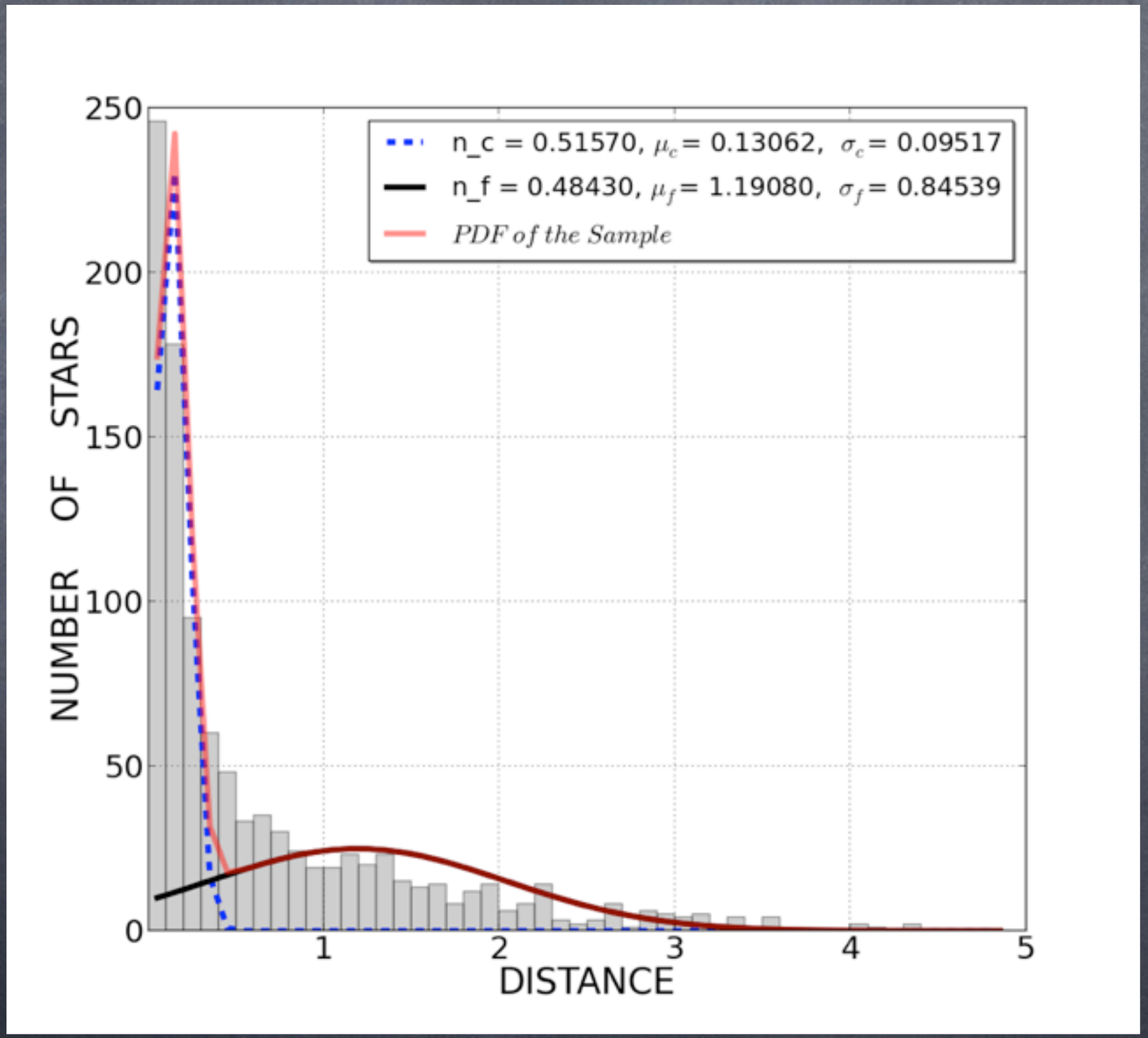
Objects:

- mean
- Variance < 10

Number of Stars in our Sample = 1031/211

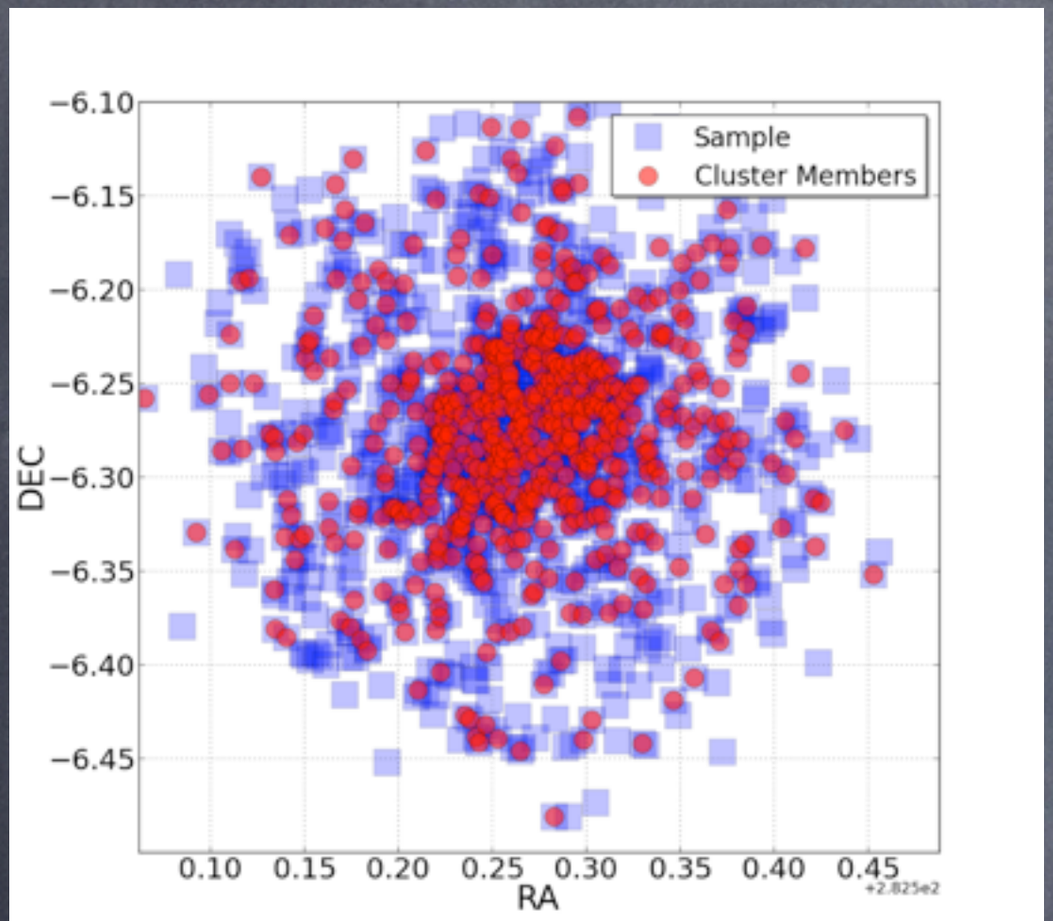
Application to GES-Data (gesiDR1): NGC 6705

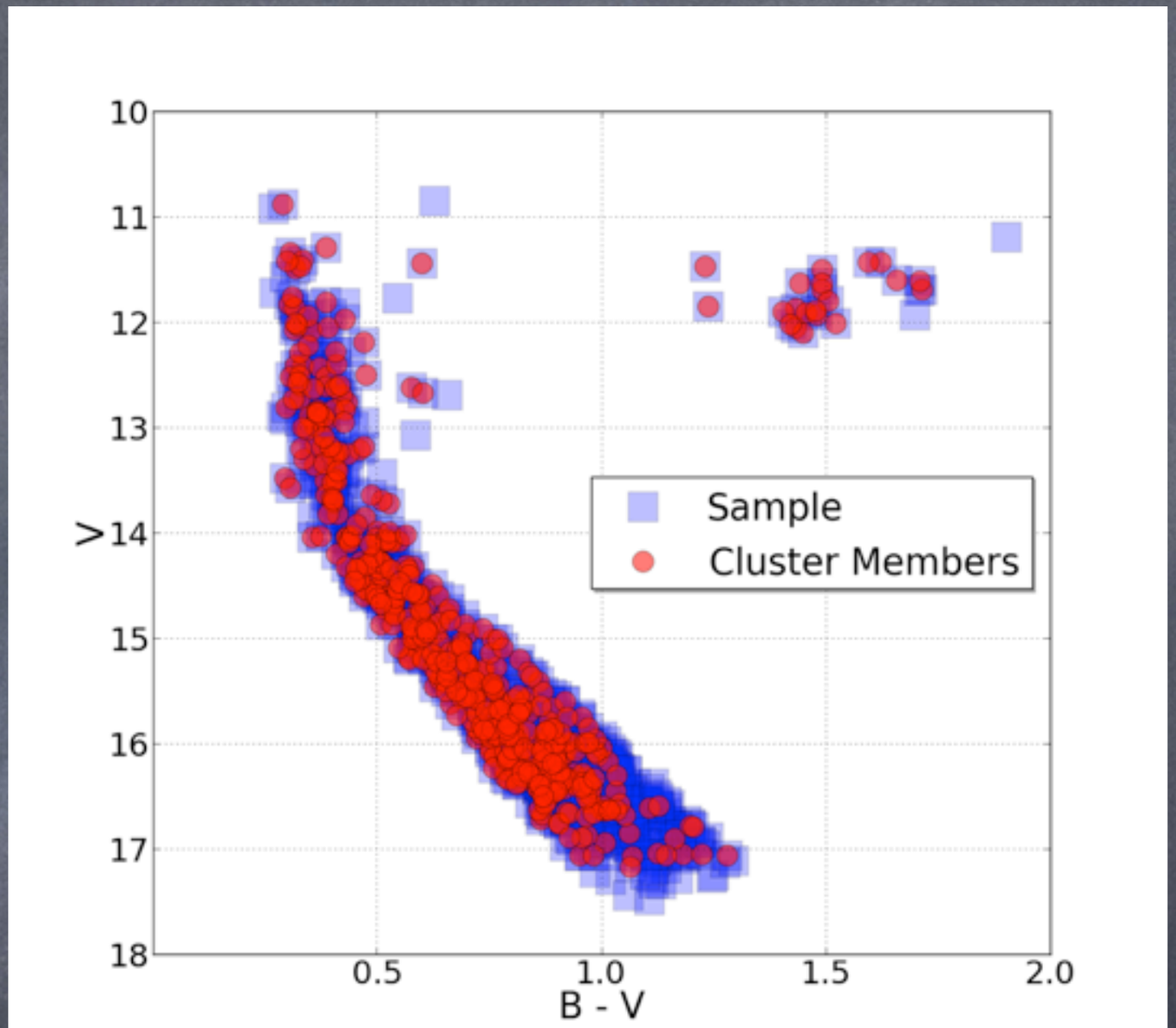
Radial Velocity (Spectrum)



Application to GES-Data (gesiDR1): NGC 6705

Radial Velocity (Spectrum)



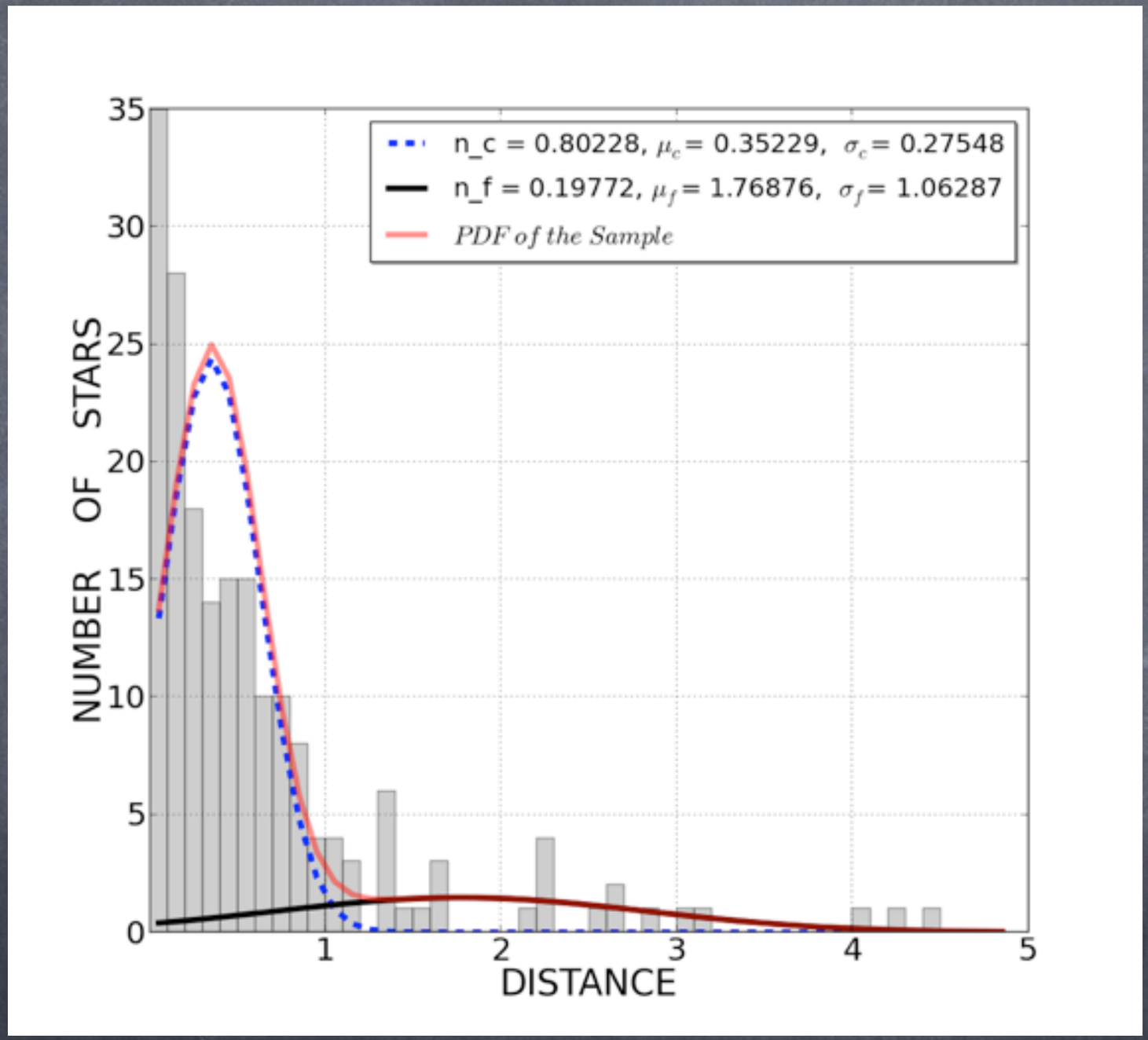


Mean Ra (deg)	282.7676
Std Ra (deg)	0.0635
Mean Dec (deg)	-6.2749
Std Dec (deg)	0.0616
Mean Vel (km/s)	35.6874
Std Vel (km/s)	3.5401

$N^{o}_{\text{cluster members}} = 557$

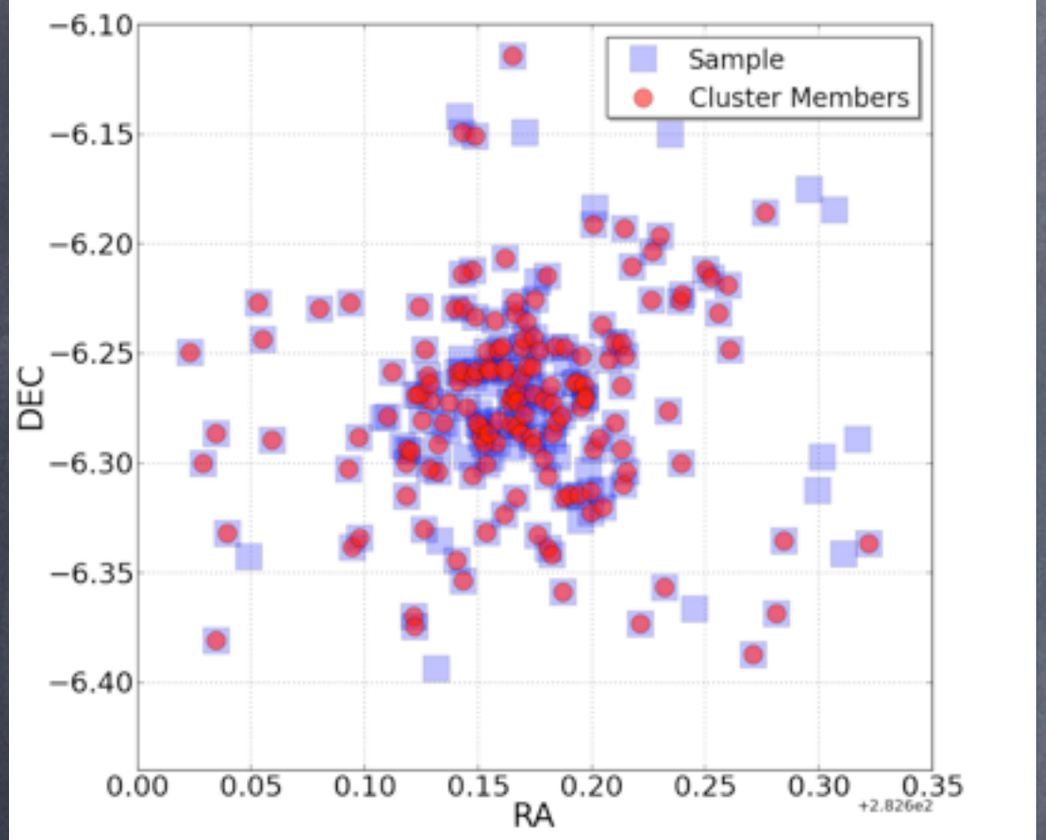
Application to GES-Data (gesiDR1): NGC 6705

Radial Velocity (RecommendedAstroAnalysis)

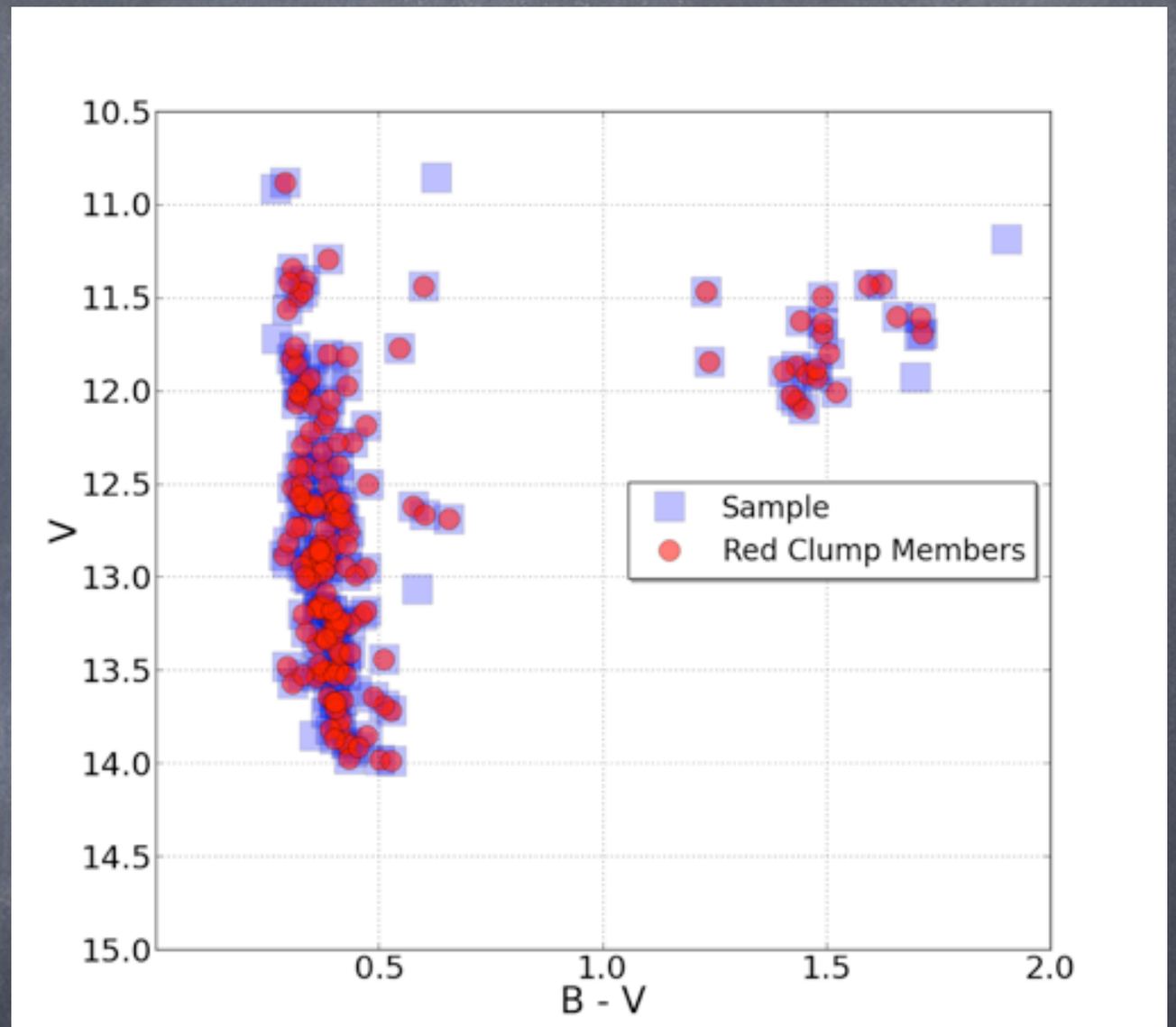


Application to GES-Data (gesiDR1): NGC 6705

Radial Velocity (RecommendedAstroAnalysis)



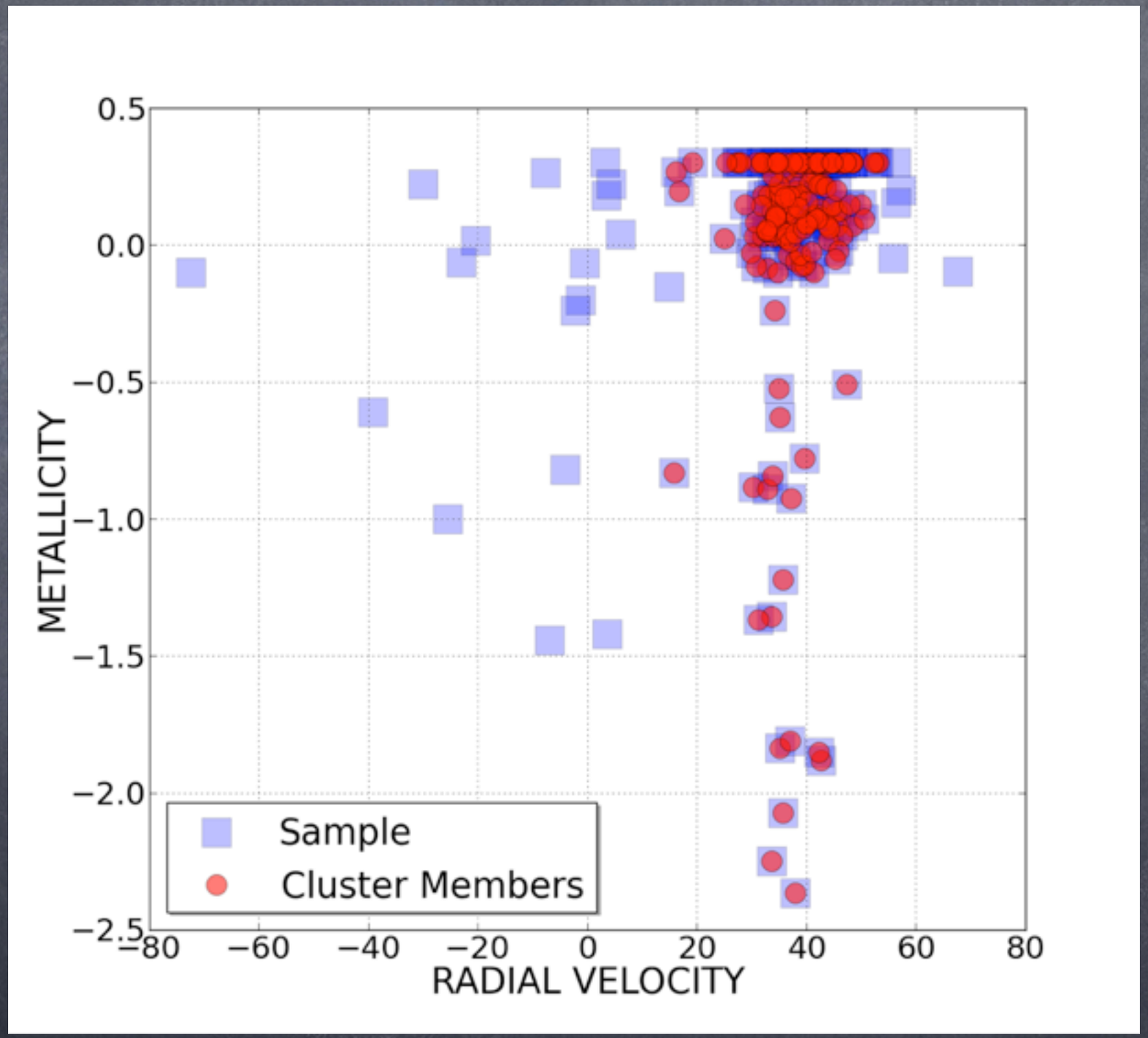
Mean Ra (deg)	282.768
Std Ra (deg)	0.0516
Mean Dec (deg)	-6.2713
Std Dec (deg)	0.0488
Mean Vel (km/s)	38.0075
Std Vel (km/s)	5.0105
Mean Met (dex)	-0.0036
Std Met (dex)	0.5290



$N^{o}_{\text{cluster members}} = 159$

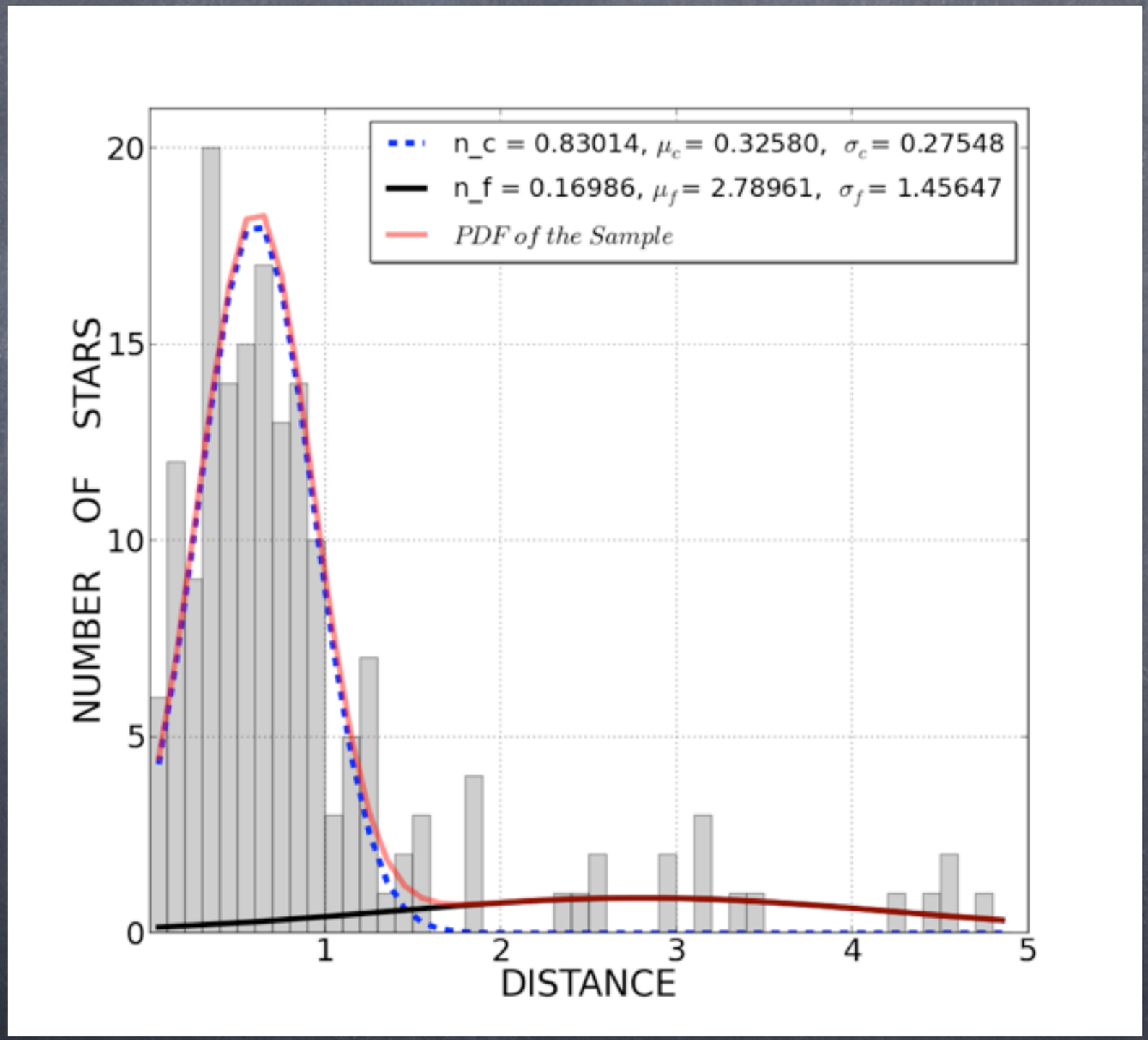
Application to GES-Data (gesiDR1): NGC 6705

Radial Velocity (RecommendedAstroAnalysis)



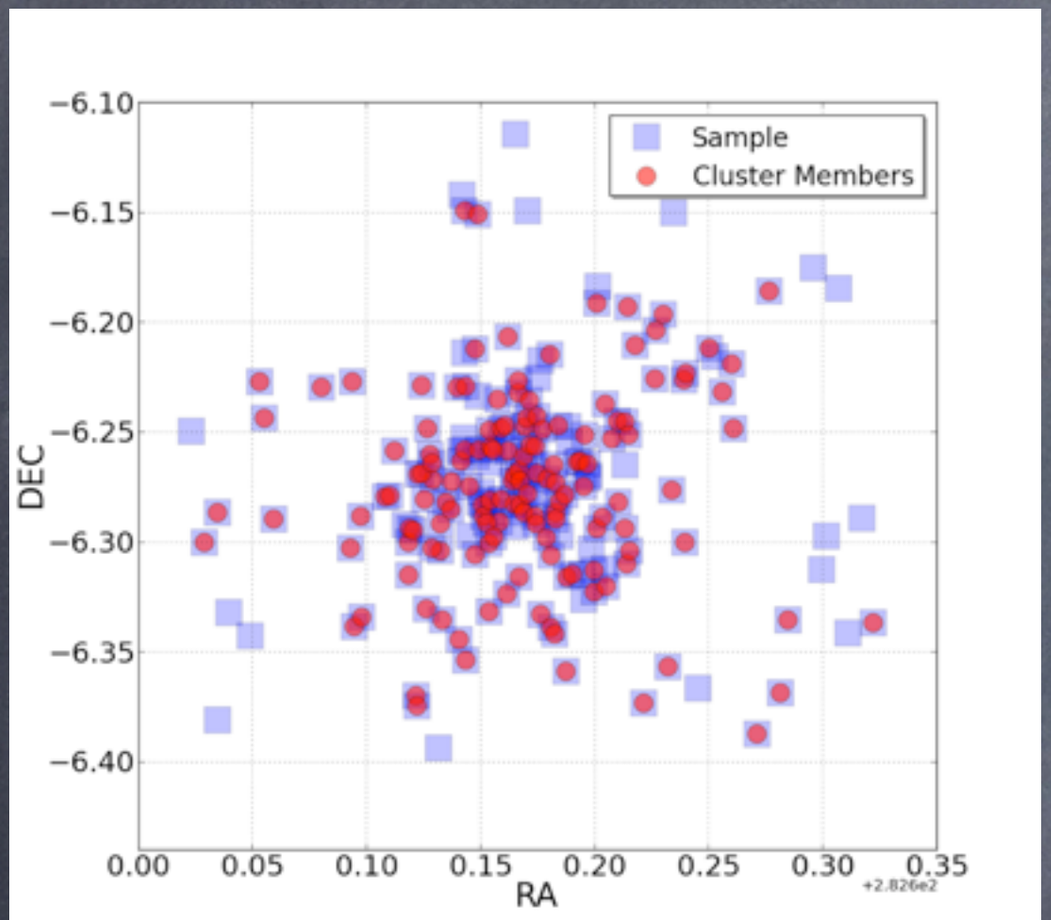
Application to GES-Data (gesiDR1): NGC 6705

Rad. Vel + Metall. (RecommendedAstroAnalysis)

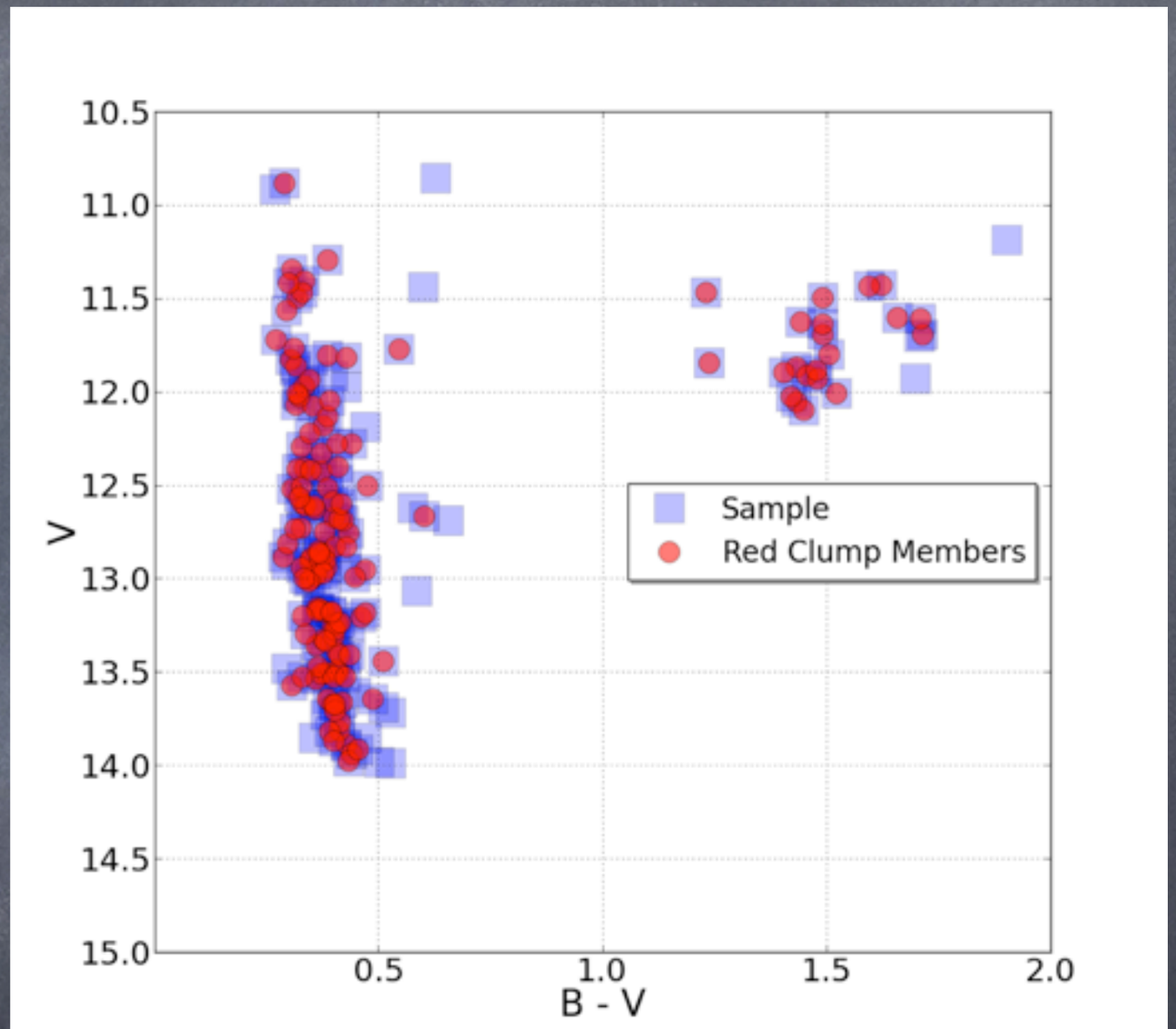


Application to GES-Data (gesiDR1): NGC 6705

Rad. Vel + Metall. (RecommendedAstroAnalysis)



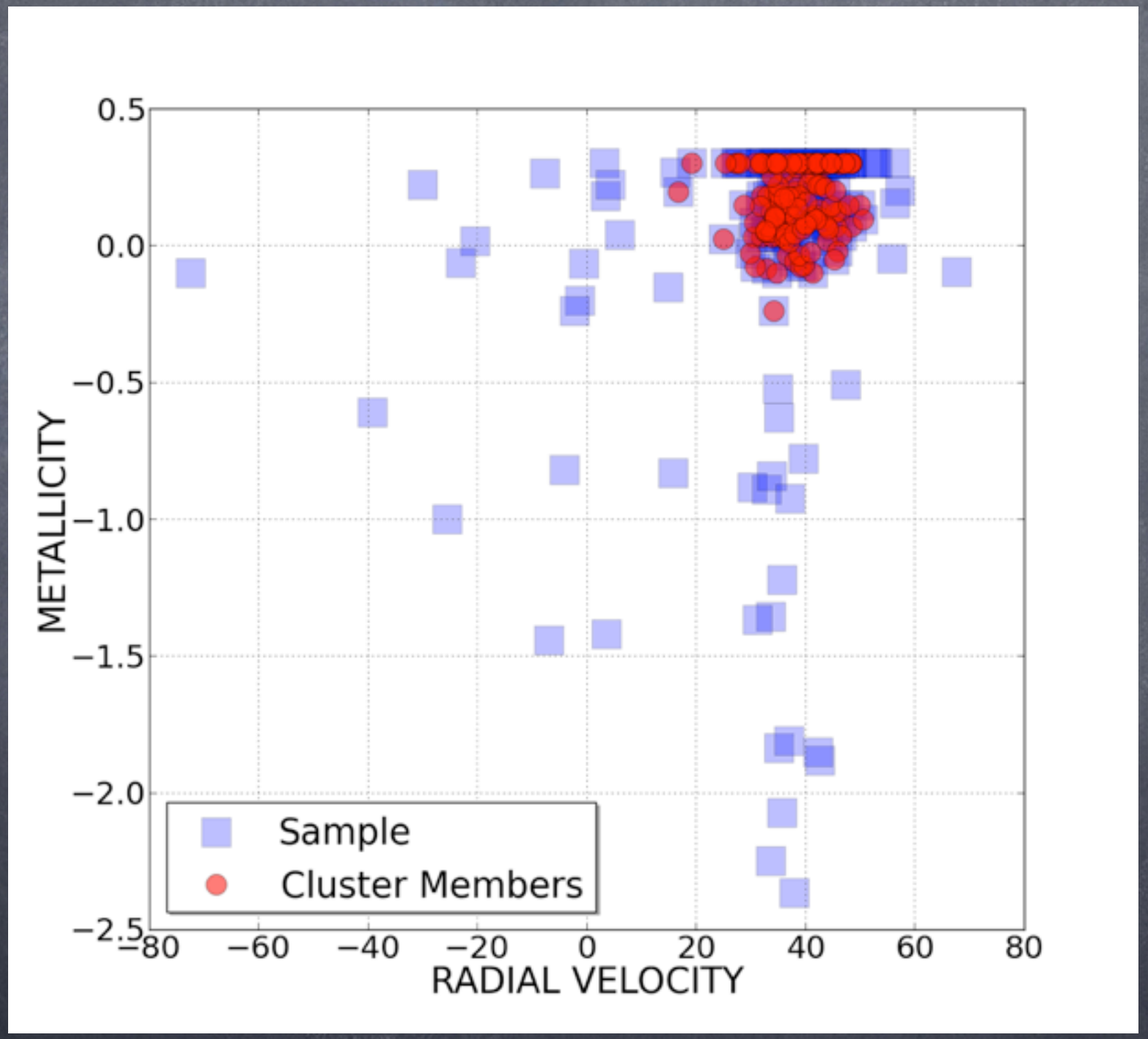
Mean Ra (deg)	282.7720
Std Ra (deg)	0.0533
Mean Dec (deg)	-6.2744
Std Dec (deg)	0.0275
Mean Vel (km/s)	34.411
Std Vel (km/s)	2.1006
Mean Met (dex)	0.0923
Std Met (dex)	0.0693



$N^{o}_{\text{cluster members}} = 147$

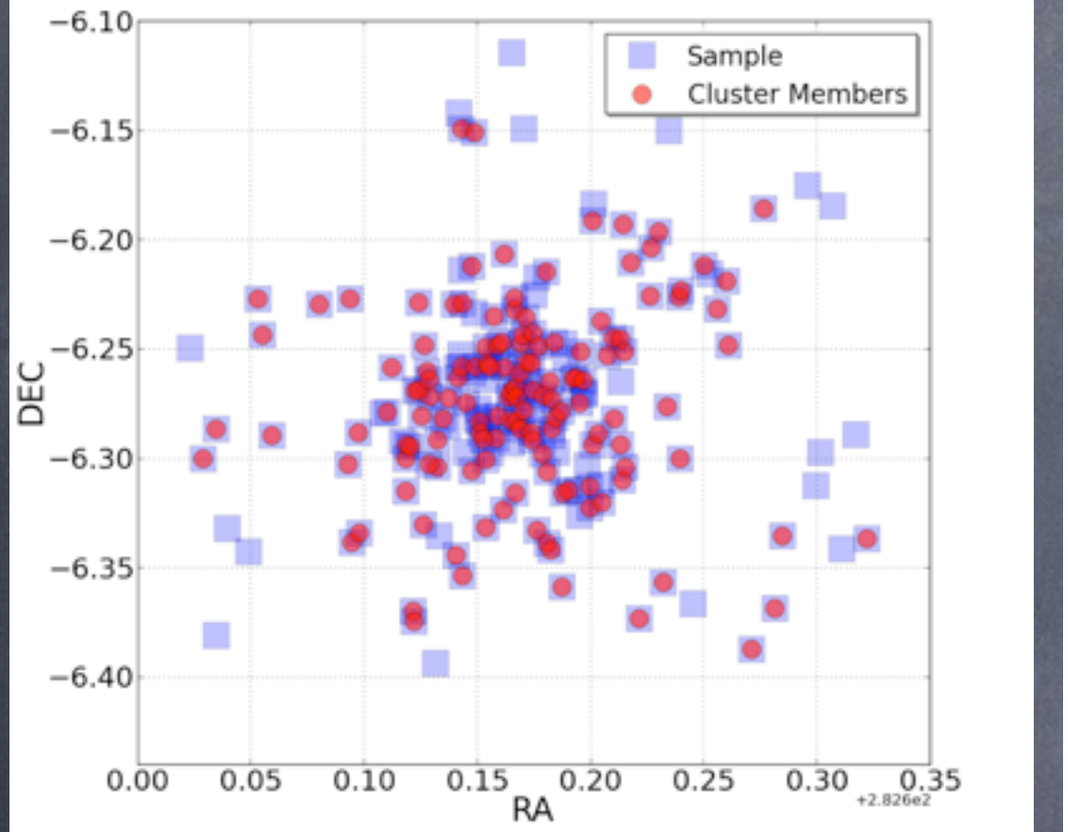
Application to GES-Data (gesiDR1): NGC 6705

Rad. Vel + Metall. (RecommendedAstroAnalysis)

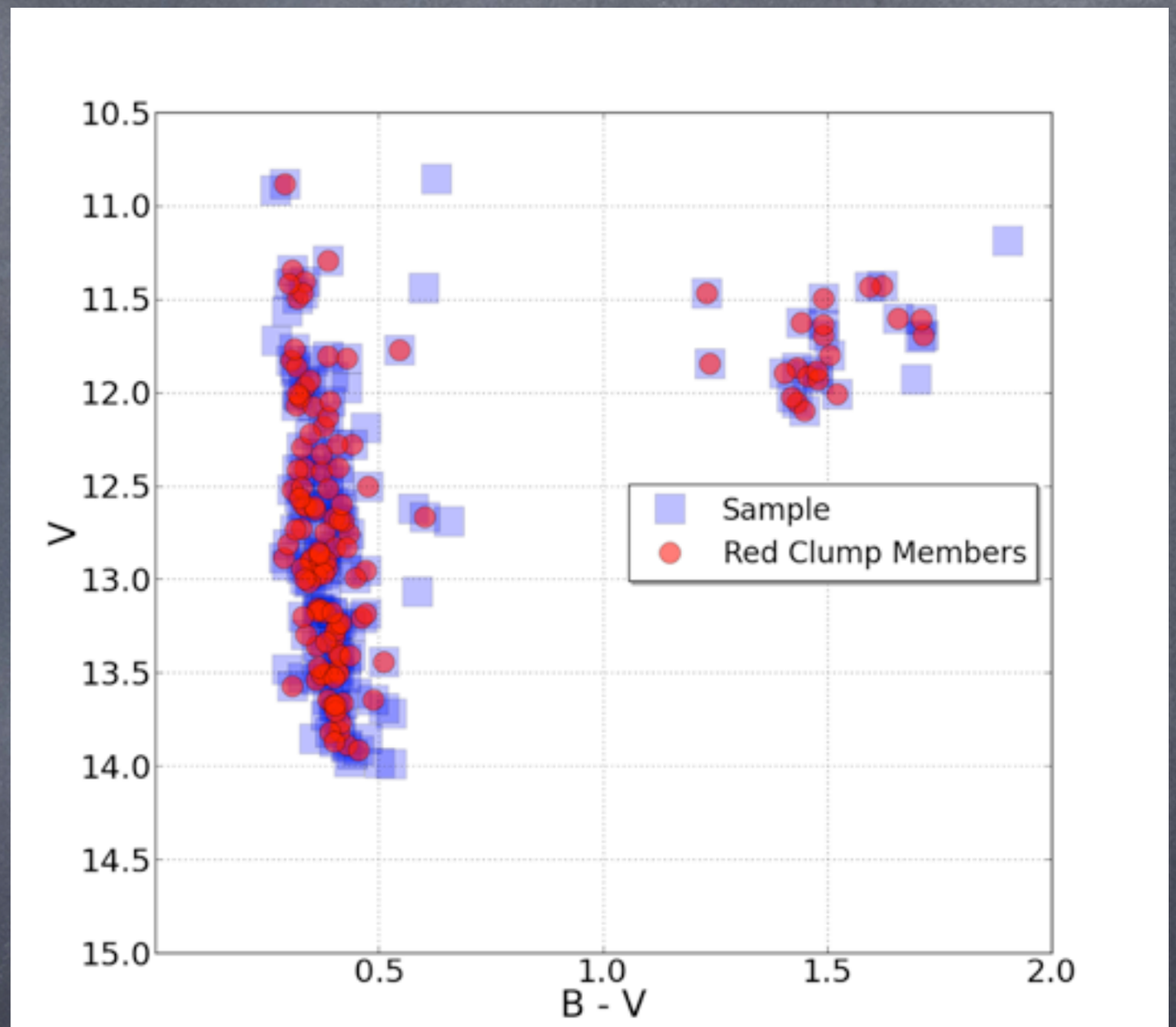


Application to GES-Data (gesiDR1): NGC 6705

Common Members for both Analysis (RecommendAstro.)



Mean Ra (deg)	282.7682
Std Ra (deg)	0.0498
Mean Dec (deg)	-6.2721
Std Dec (deg)	0.0476
Mean Vel (km/s)	38.2102
Std Vel (km/s)	5.0752
Mean Met (dex)	0.1661
Std Met (dex)	0.1240

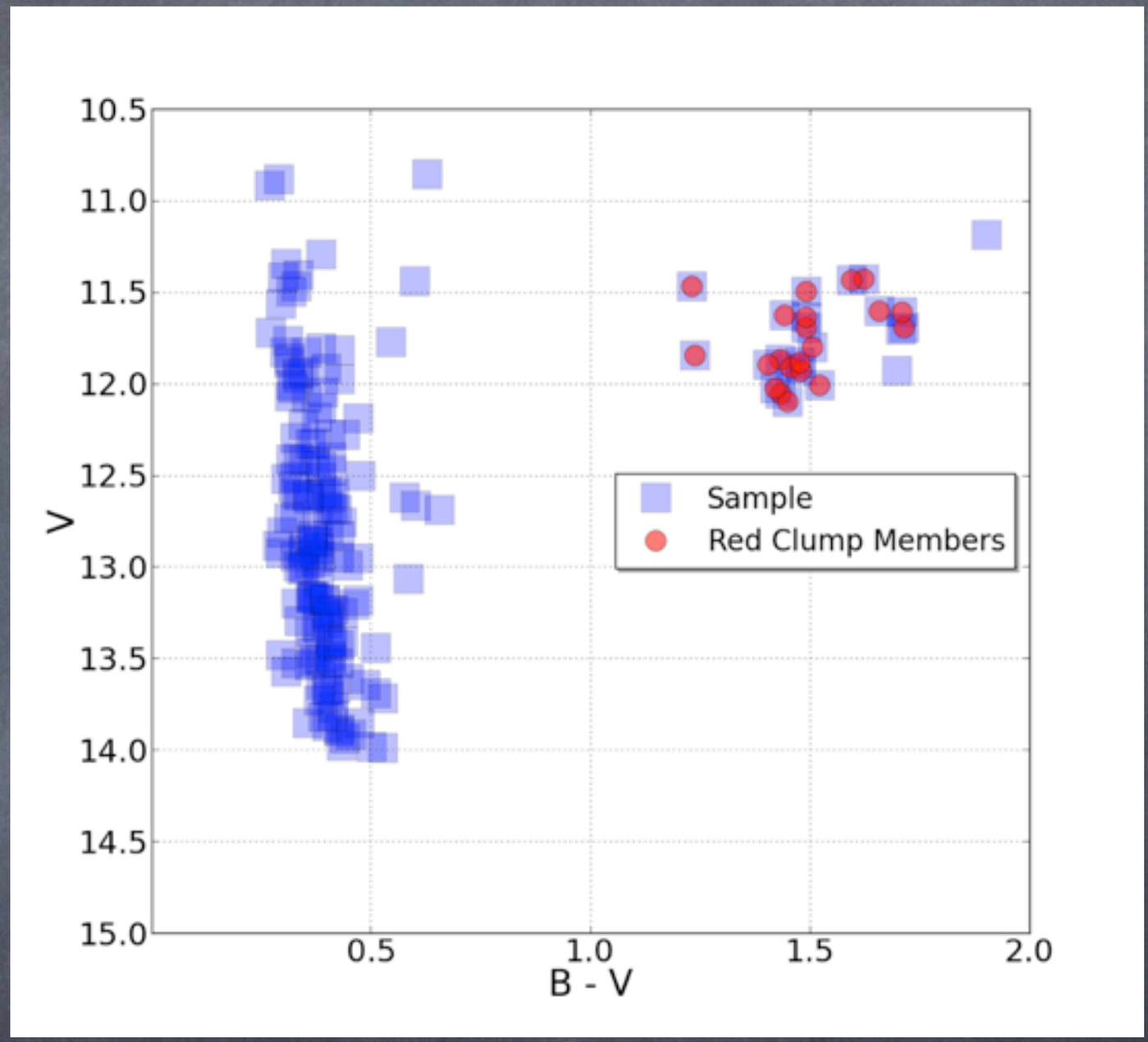


N° Cluster Members = 141

Application to GES-Data (gesiDR1): NGC 6705

$N^{o}_{\text{red clump members}} = 22$

Mean Vel (km/s)	**34.4110**
Std Vel (km/s)	**2.1006**
Mean Met (dex)	**0.0923**
Std Met (dex)	**0.0693**



Conclusions and Results

- Good results in the simulations
- Our Methodology can improve, in some aspect, existing ones
-

	Rad. Vel	Rad. Vel	Rad. Vel + Metall	Common
Num. of Members	557	159	147	141
Mean Ra (deg)	282.7676	282.768	282.7720	282.7682
Std Ra (deg)	0.0635	0.0516	0.0533	0.0498
Mean Dec (deg)	-6.2749	-6.2713	-6.2744	-6.2721
Std Dec (deg)	0.0616	0.0488	0.0275	0.0476
Mean Vel (km/	35.6874	38.0075	34.411	38.2102
Std Vel (km/s)	3.5401	5.0105	2.1006	5.0752
Mean Met (dex)	--	-0.0036	0.0923	0.1661
Std Met (dex)	--	0.5290	0.0693	0.1240

Conclusions and Results

	Red Clump
Num. of Members	**22**
Mean Vel (km/s)	**34.4110**
Std Vel (km/s)	**2.1006**
Mean Met (dex)	**0.0923**
Std Met (dex)	**0.0693**

- It is a very flexible tool let us deal with different physical variables to estimate membership probabilities.

THANK YOU

sampedro@iaa.es