Globular Cluster Candidates in Maffei 1

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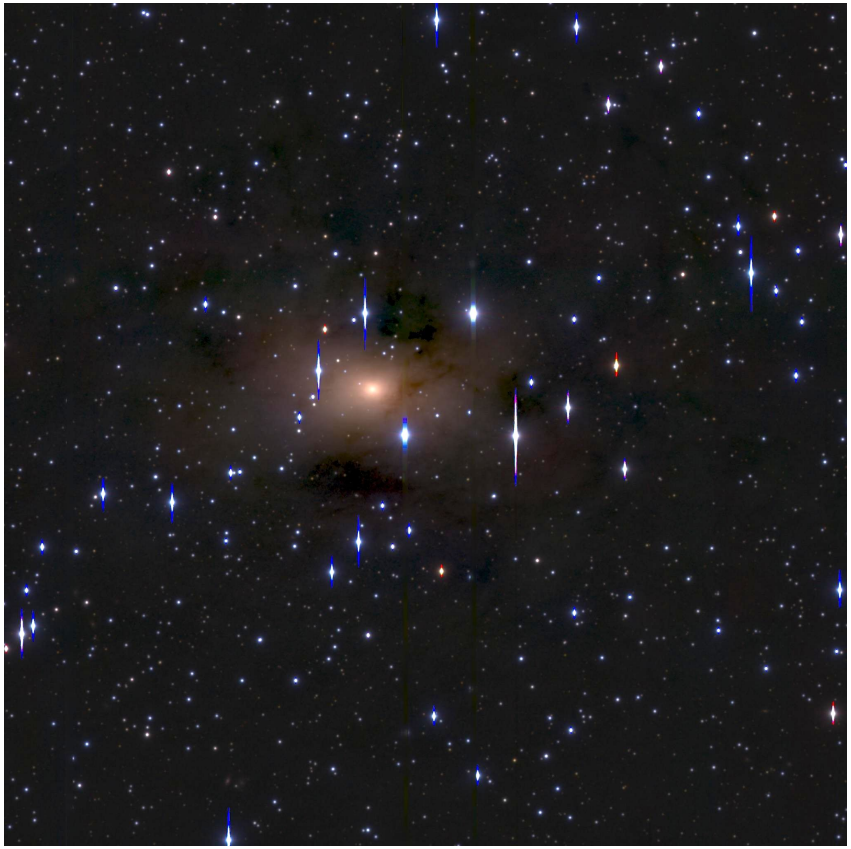
Motivations

- GCs are excellent tracers
- Maffei 1 is a giant elliptical, estimated to have over a thousand GCs
- Because it is the closest giant elliptical galaxy, at approximately 2.7 Mpc, we can partially resolve GCs

The aim of this project is to use imaging of Maffei 1 from the Subaru Telescope with SUPRIMECAM to select GC candidates for follow up.

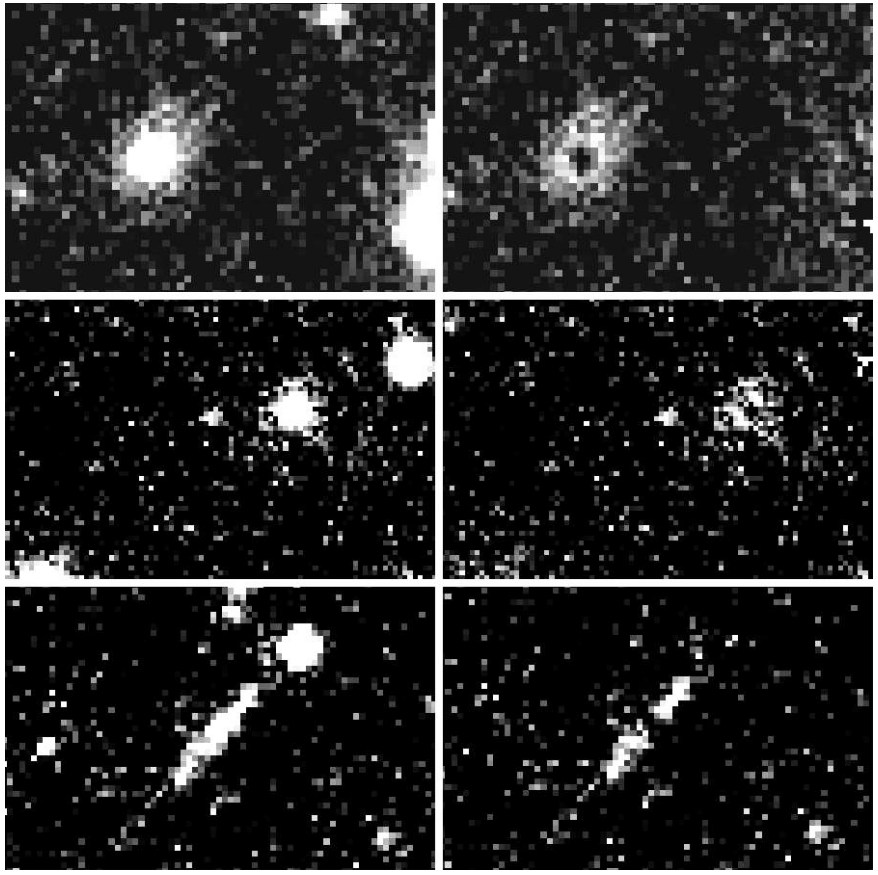
7’x7’ core of Maffei 1



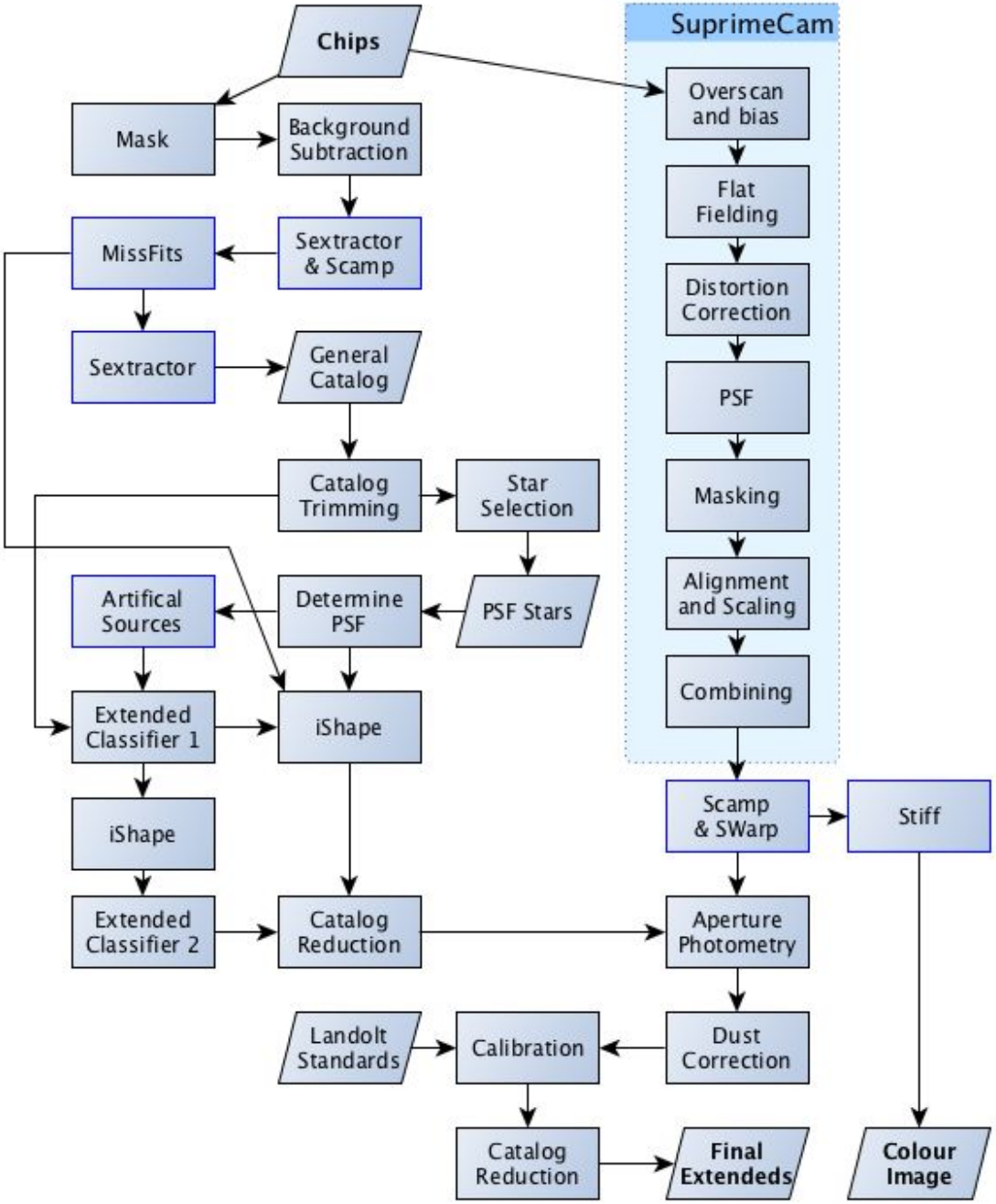
The failure of the naive solution

- Use PSF subtracted photometry to manually classify sources
  - Fairly simple to do
  - Time consuming, but still feasible
  - Except this method cannot determine at all the probability for detecting a source

- Need a solution that can be tested
  - Generate artificial images
  - Determine GCs
  - Use this to quantify probability of detection



Solution


Chips
SuprimeCam
Overscan and bias
Mask
Background Subtraction
Flat Fielding
MissFits
Sextractor & Scamp
Distortion Correction
Sextractor
General Catalog
PSF
Catalog Trimming
Star Selection
Masking
Artifical Sources
Determine PSF
PSF Stars
Alignment and Scaling
Extended Classifier 1
iShape
Combining
Scamp & SWarp
Stiff
iShape
Extended Classifier 2
Catalog Reduction
Aperture Photometry
Landolt Standards
Calibration
Dust Correction
Catalog Reduction
Final Extendeds
Colour Image

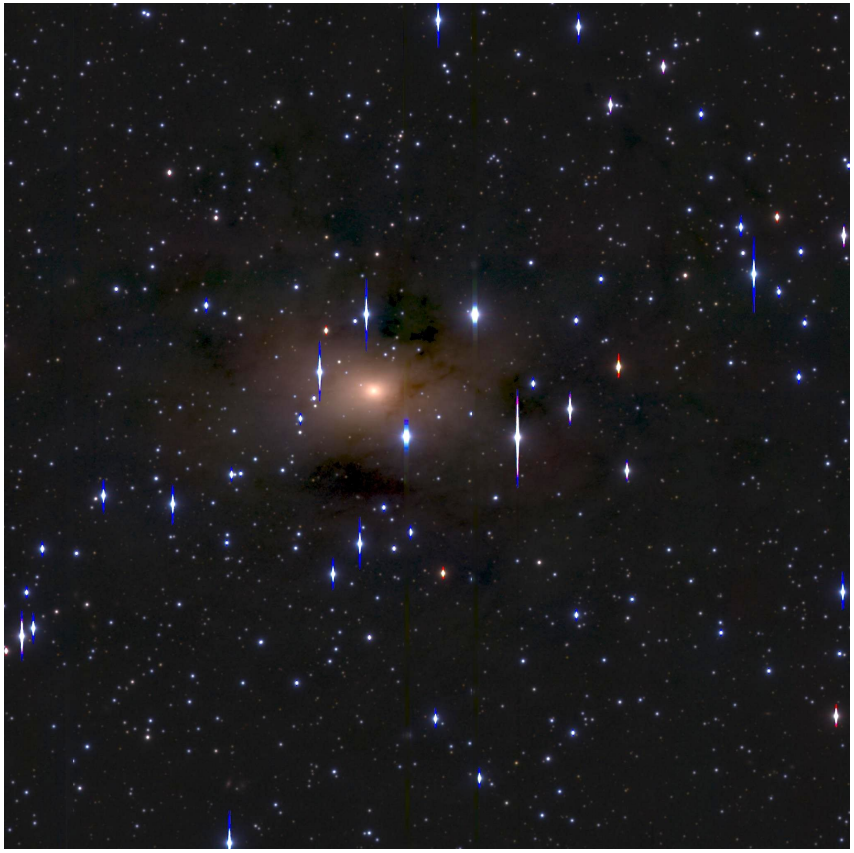
Data reduction

Mosaics and calibration data use the SDFRED2 pipeline. Output mosaics are Scamped and SWarped to give correct WCS.

Tiles for classification use the *z'* band image. Scamped to correct WCS. Sources trimmed.

Colour image produced using mosaics and Stiff.

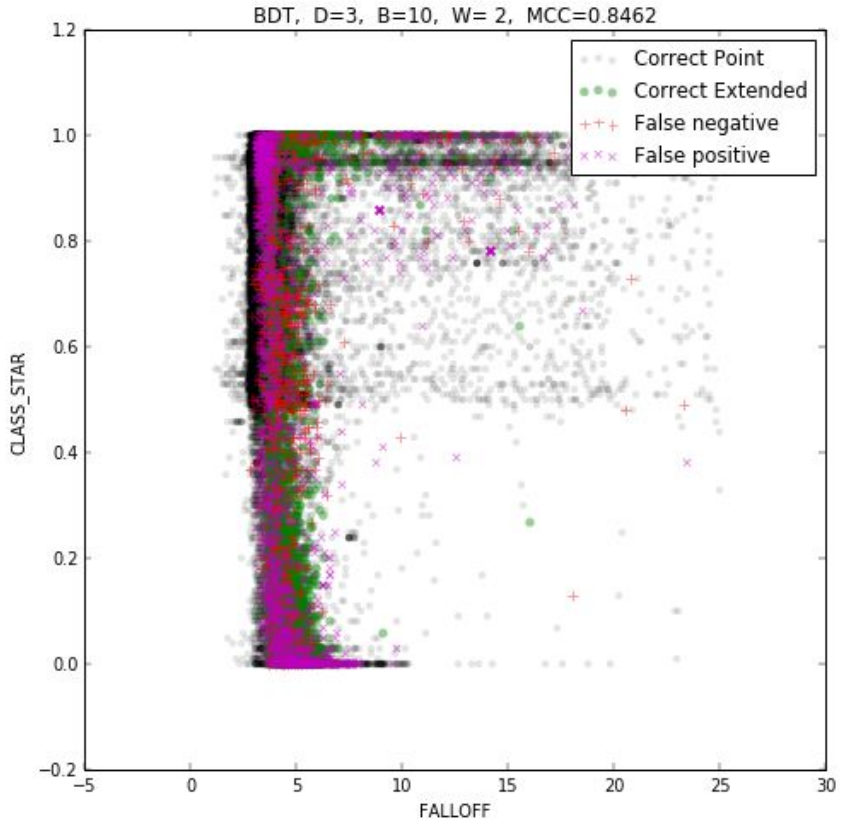
7'x7' core of Maffei 1...again



Classification System

- Data generated using automatically selected PSF stars and BAOlab's `mksynth`
- Machine learning classifier
  - 40% training, 35% test, 25% validation
- Uses 2 simple Boosted Decision Trees
  - Boost number, tree depth and training weights determined by Matthews Correlation Coefficient score against validation data.
  - One for SExtractor, one that also uses iShape

```
Matthews correlation corefficient: 0.8491
Extended correct: 90.2%
False negative: 9.8%
Point correct: 98.0%
False positive: 2.0%
Num True positive / Num Positive: 0.827
Num True positive / Num Actual Positive: 0.902
```



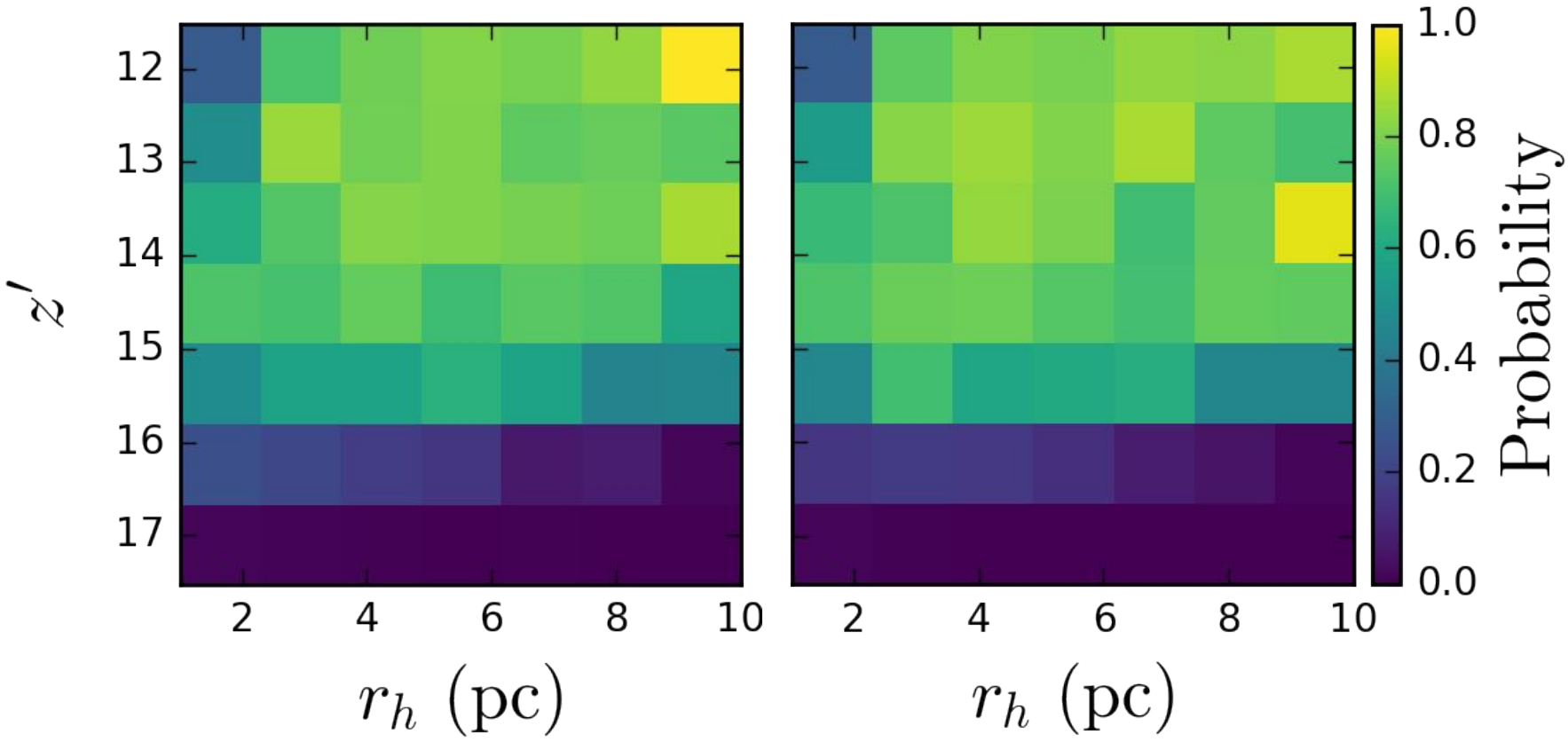
Classification System

Classifier 1 (SExtractor)

Contamination: 31%

Classifier 2 (+ iShape)

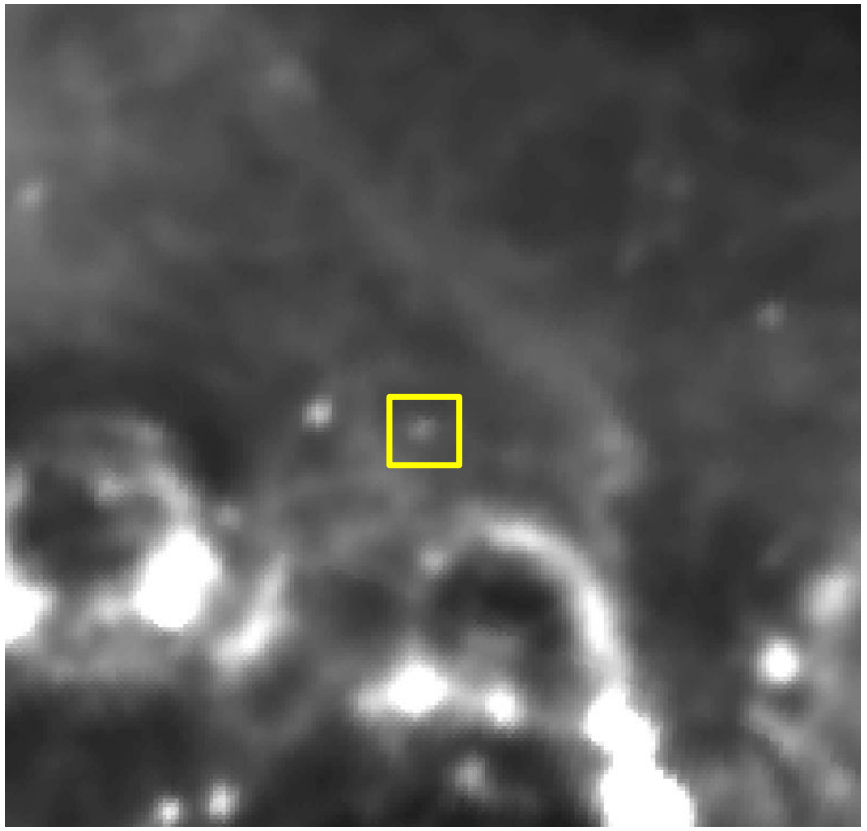
Contamination: 17%



Photometry

- Performed on final mosaics
- Dust extinction calculated from interpolated IRAS dust map for each target.
- Photometric calibrations calculated from Landolt standards transformed into SDSS bands.

5°x5° IRSA dust map centered on Maffei 1 @ 100μm



Classification Results

Add cuts to absolute magnitude, colour deviation, FWHM and χ^2 cuts.

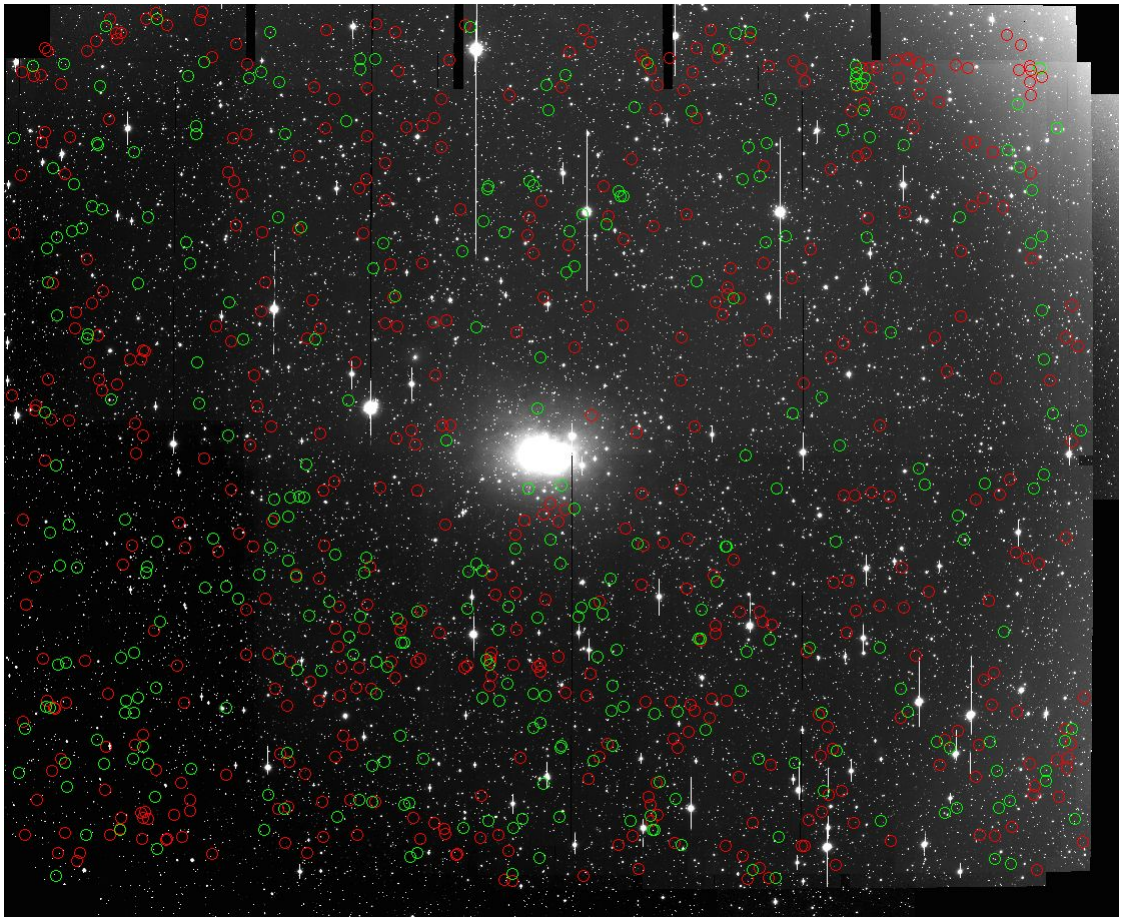
Location of final candidates around Maffei 1.

Class A ≡ $(\chi^2_{DELTA}/\chi^2_{KING30}) > 1.5$

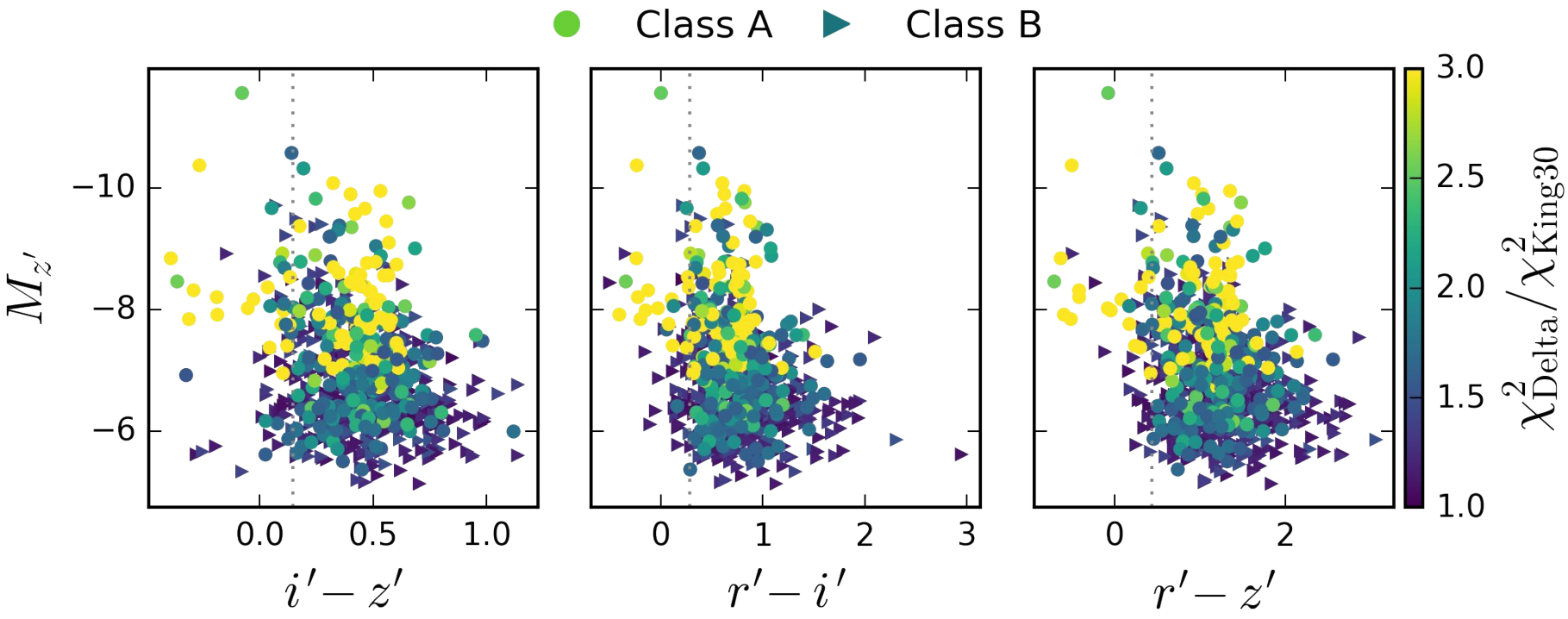
288 Class A candidates

432 Class B candidates

Maffei 1 and targets. Approx 34'x27'

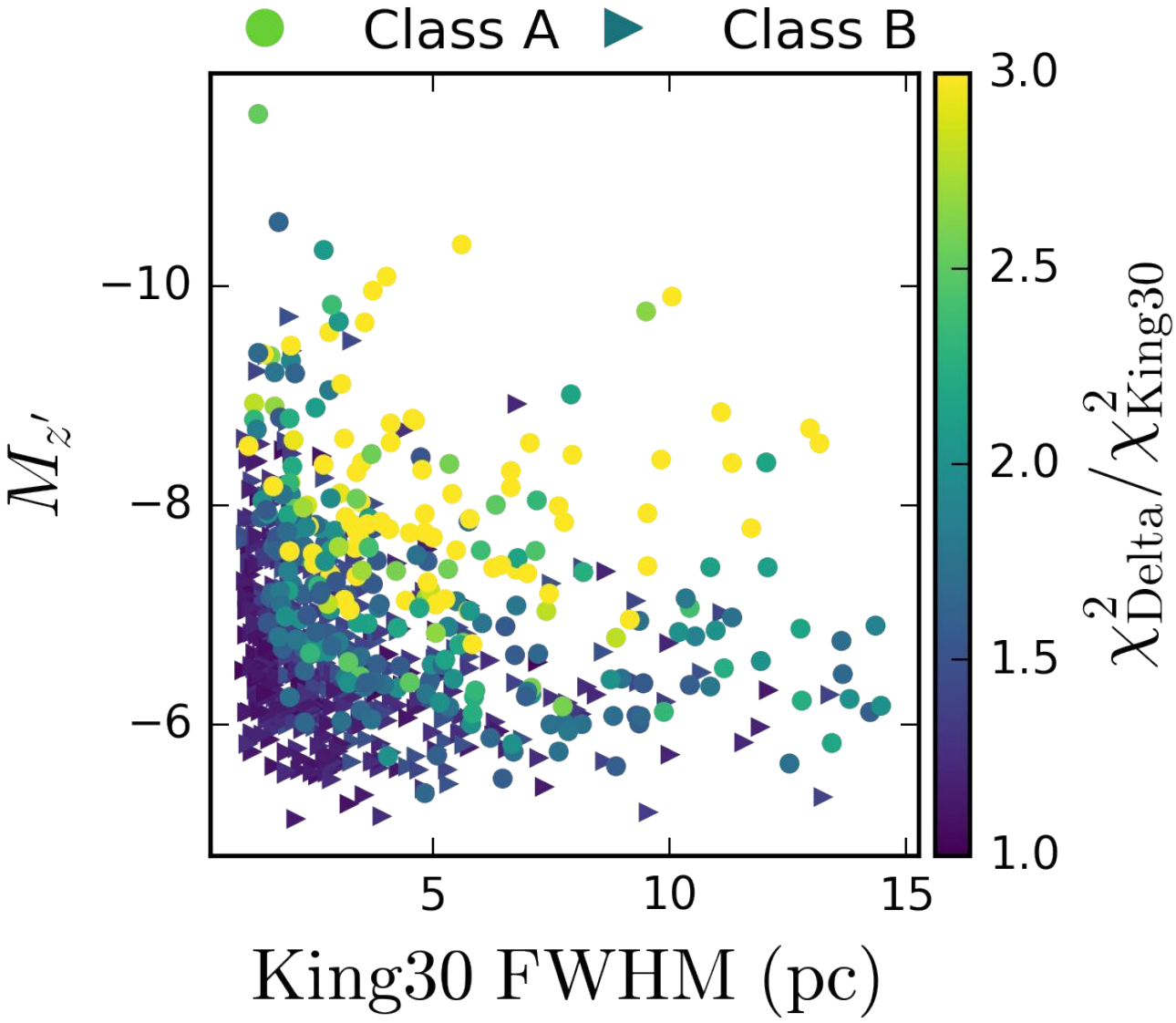


Classification Results

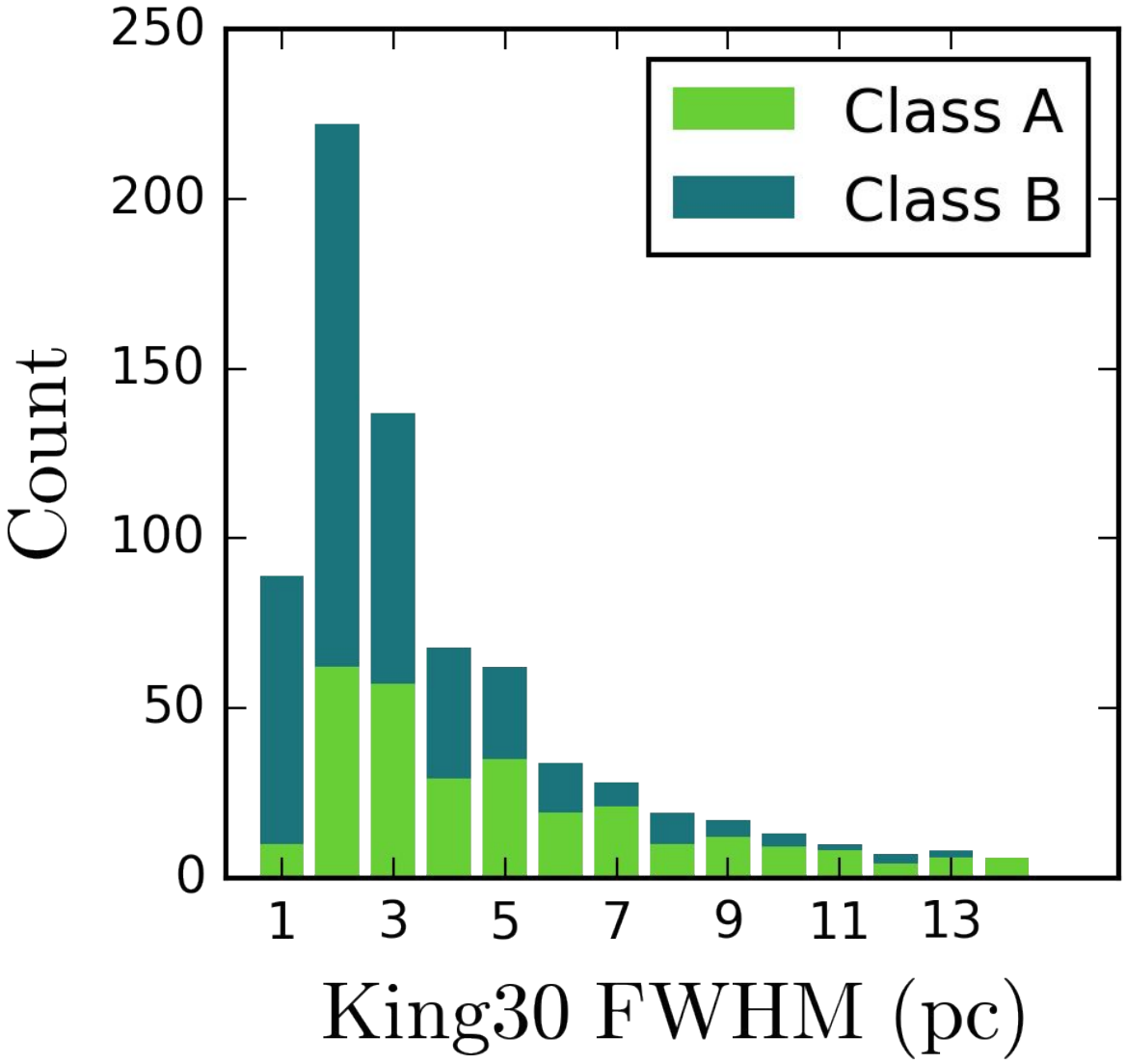


Mean colours from Vanderbeke (2014) shown as dotted line.

Classification Results



Classification Results



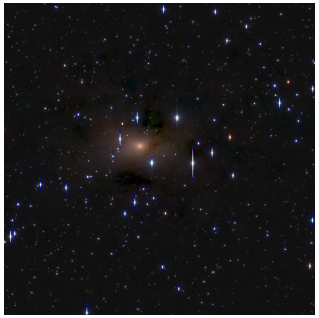
Final Product

288 Class A objects, and 432 Class B objects for spectroscopic follow up.
Prior Maffei 1 study by Buta & McCall (2003) gave 20 candidates in 3'x3'

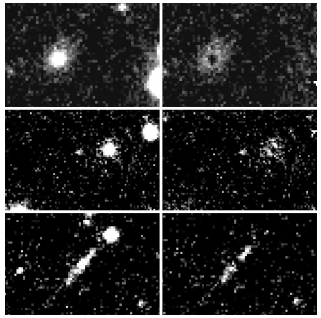
ID	RA	DEC	ϵ	$M_{z'}$	$m_{z'}$	$r' - z'$	King_{30} FWHM (pc)
A1	$2^h\ 38^m\ 35.3^s$	$59°\ 53'\ 40.45''$	0.14	-8.604	18.552	0.878	2.05
A2	$2^h\ 38^m\ 8.8^s$	$59°\ 52'\ 29.39''$	0.10	-7.399	19.757	1.473	4.88
A3	$2^h\ 38^m\ 54.9^s$	$59°\ 52'\ 15.67''$	0.22	-9.129	18.028	1.198	2.80
A4	$2^h\ 38^m\ 12.9^s$	$59°\ 52'\ 0.73''$	0.07	-8.487	18.670	1.363	7.04
A5	$2^h\ 37^m\ 56.5^s$	$59°\ 51'\ 57.60''$	0.25	-8.708	18.449	1.410	4.10
A6	$2^h\ 38^m\ 36.6^s$	$59°\ 51'\ 36.72''$	0.17	-7.123	20.033	1.004	3.64
A7	$2^h\ 38^m\ 10.6^s$	$59°\ 50'\ 18.02''$	0.20	-7.194	19.963	1.281	3.84
A8	$2^h\ 38^m\ 10.7^s$	$59°\ 50'\ 1.18''$	0.24	-8.158	18.999	1.413	6.64
A9	$2^h\ 38^m\ 59.8^s$	$59°\ 49'\ 49.22''$	0.24	-7.544	19.613	0.985	2.71
A10	$2^h\ 38^m\ 37.2^s$	$59°\ 49'\ 41.20''$	0.10	-7.116	20.041	1.513	5.48
A11	$2^h\ 38^m\ 37.0^s$	$59°\ 49'\ 37.06''$	0.16	-6.685	20.471	1.459	10.54
A12	$2^h\ 38^m\ 27.5^s$	$59°\ 49'\ 23.63''$	0.17	-8.271	18.886	1.115	11.32
A13	$2^h\ 38^m\ 49.2^s$	$59°\ 48'\ 49.93''$	0.11	-8.477	18.680	0.920	9.81
A14	$2^h\ 38^m\ 43.5^s$	$59°\ 48'\ 17.57''$	0.18	-7.249	19.908	1.413	4.85
A15	$2^h\ 38^m\ 38.6^s$	$59°\ 47'\ 33.18''$	0.20	-7.096	20.061	2.325	2.19

Questions?

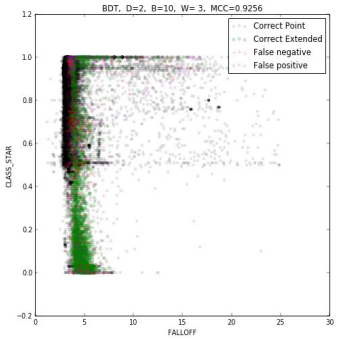
A



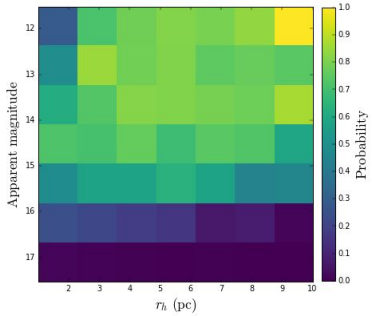
B



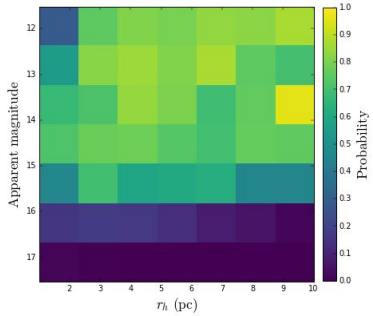
C



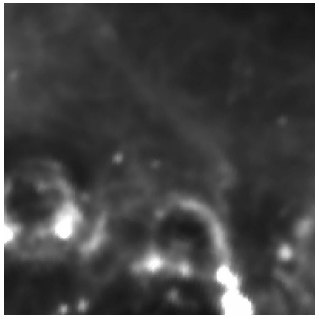
D



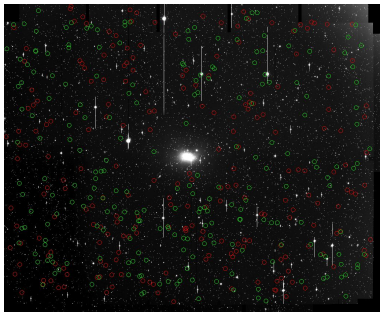
E



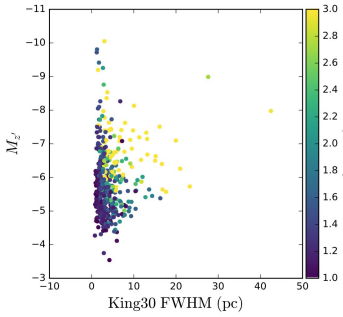
F



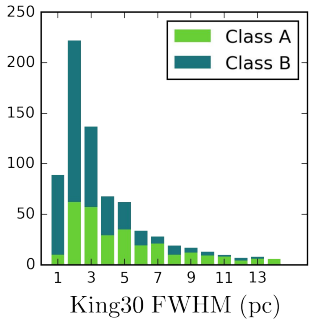
G



H



I



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