

WINGS

Wide-field Nearby Galaxy-cluster Survey

Survey and Pipelines Overview

Benchmark for higher redshift studies

Average galaxy properties in nearby clusters

Photometry, mass, structure, morphology, stellar populations, star formation histories, scaling relations (e.g. FP and Kormendy), color-magnitude relation.

Global properties of nearby clusters

Photometry, structure, kinematics, morphological fractions, scaling laws, sub-structures, luminosity functions.

Cosmic variance of galaxy properties in nearby clusters

Relation between environment and galaxy properties, zero point for higher redshift studies.

People involved:

Padova Observatory (Italy)

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Per Kjeergard

School of Physics, University of New South Wales (Australia)

Warrik Couch
David Woods

Observatories of the Carnegie Institution of Washington, USA

Alan Dressler

Collaborations:

Study of Substructures in WINGS clusters

INAF - Trieste Observatory (Italy)

Andrea Biviano

Massimo Ramella

Armando Pisani

Study of Current Star Formation in WINGS' clusters

Instituto de Astrofísica de Andalucía (Spain)

Jorge Iglesias

Daniel Reverte Payá

José Manuel Vílchez

Bidimensional analysis of WINGS galaxies

Instituto de Astrofísica de Canarias (Spain)

José Alfonso López Aguirre

Rubén Sánchez Jansenn

WINGS-OPT

B and V wide field
photometry

COMPLETED!

INT 2.5m - WFC: (34'X34'; pix~0".33)

MPG 2.2m - WFI: (34'X34'; pix~0".24)

CORE PROJECT

Wide Field B/V imaging of 77 WINGS clusters

Stringent observational requirements: large field of view 1.6-2.6Mpc, photometric dept $V_T \sim 23.0$ ($\mu_V \sim 25.5$), high spatial resolution $\sim 1\text{kpc}$...

PRODUCTS: detailed photometry, surface photometry and morphological study

The cluster sample

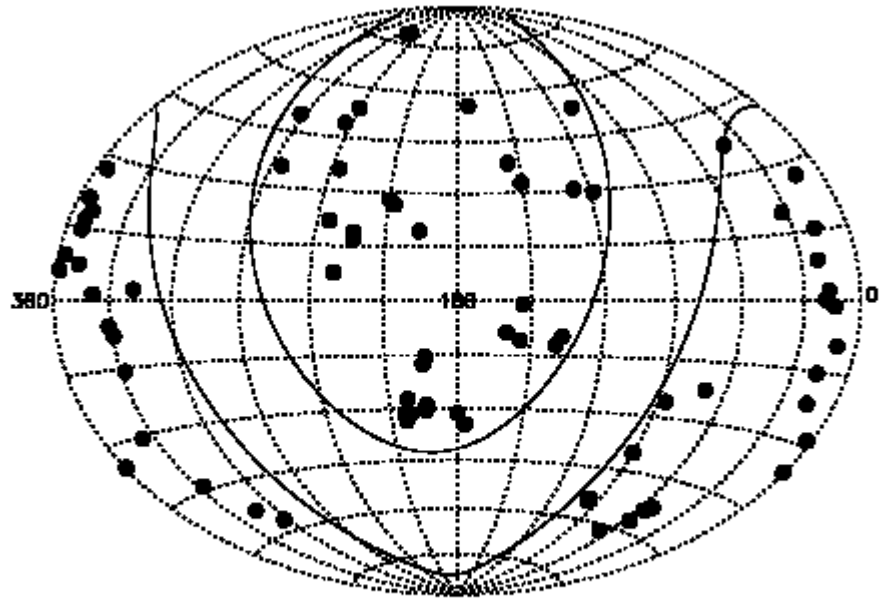
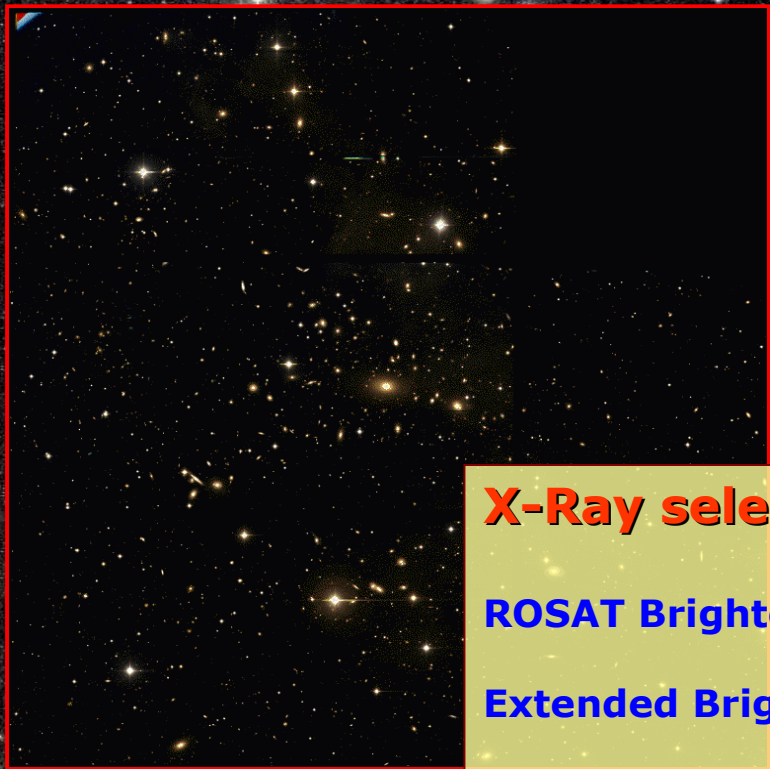


Fig. 1. All-Sky Aitoff map of the cluster sample (equatorial coordinates). Lines delimiting the region $|b| \leq 20$ are drawn.

X-Ray selection (ROSAT):

ROSAT Brightest Cluster Sample (Ebeling et al. 1998)

Extended Brightest Cluster Sample (2000)

X-ray brightest Abell-type Cluster Sample (Ebeling et al. 1996)

The cluster sample

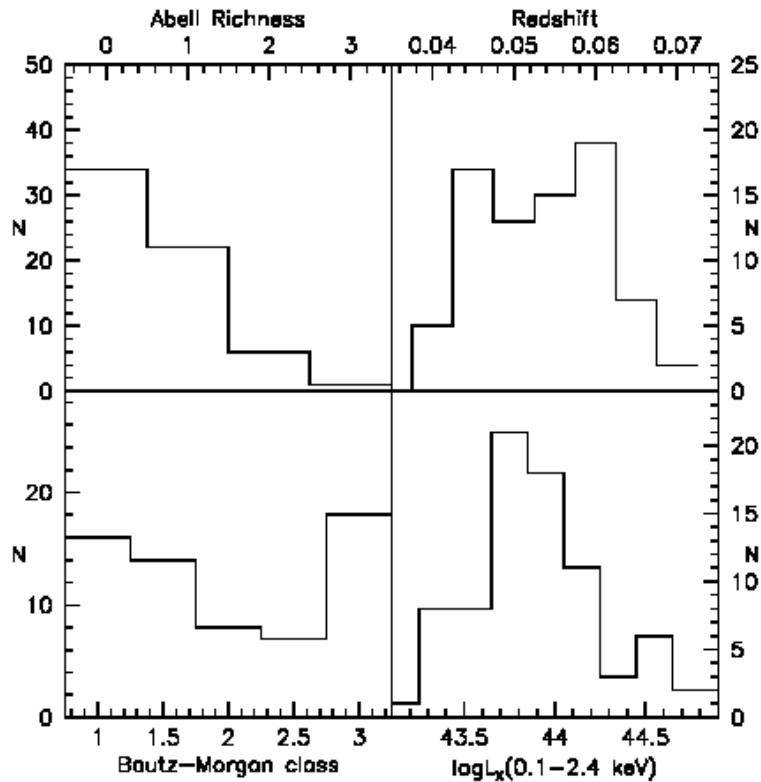


Fig. 2. Distribution of some cluster properties in the WINGS sample.

Number of clusters	77
Galactic Latitude Limits	$ b > 20^\circ$
Redshift range	0.040 - 0.069
$\log(L_x[0.1-2.4 \text{ keV}])$	43.48 - 45.05 [erg/s]
Number of Fields	
.... INT	46
.... ESO	31
Mean Seeing	
.... INT	1.22" \pm 0.20"
.... ESO	1.19" \pm 0.37"
Mean Field of View	
.... INT	0.279 deg ² 3.646 Mpc ² (h=0.75)
.... ESO	0.287 deg ² 3.358 Mpc ² (h=0.75)
Total Covered Area	21.275 deg ² 267.47 Mpc ² (h=0.75)
Mean linear resolution	
.... INT	1.17 \pm 0.27 kpc (h=0.75)
.... ESO	1.17 \pm 0.39 kpc (h=0.75)

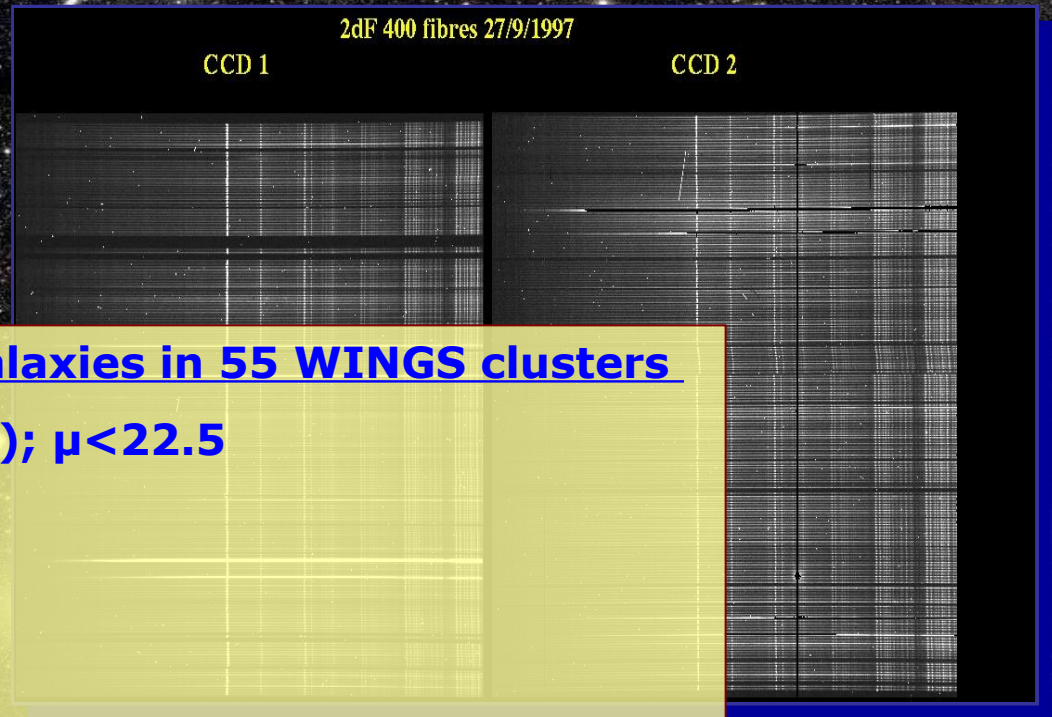
WINGS-SPE

Multifiber spectra of 55 clusters

COMPLETED!

WHT 4.2m - WYFFOS: (3800-7000 Å)

AAT 3.9m - 2dF: (3600-8000 Å)



Multifiber spectra of 100-300 galaxies in 55 WINGS clusters

- selection criteria: $V < 20$ (-16.5); $\mu < 22.5$
- intermediate resolution: $6 \div 9 \text{ \AA}$
- spectral range: $3800 \div 8000 \text{ \AA}$

PRODUCTS: redshifts, equivalent widths and line indices of emission and absorption lines for star formation histories and metallicity estimates, search for substructures

WINGS-NIR

J and K wide field
photometry

COMPLETED!

UKIRT 3.8m - WFCAM: (54'X54'; pix~0.20")

Abell 1069
K-band-3.8m
UKIRT-WFCAM

Wide Field J/K Imaging of 33 WINGS clusters

High quality UKIRT-WFCAM photometry

PRODUCTS: properties of cluster galaxies as a function of stellar mass, NIR structural parameters of galaxies, broad-band SED.

WINGS-UV

U wide field
photometry

ONGOING...

INT 4m - WFC: (34'X34'; pix~0".33)

BOK 2.2m - 90prime (70'X70'; pix~0".45)

LBT 8.4m - LBC: (23'X23'; pix~0".23)

Abell 2124
V-band-20m
WFC-INT

Abell 2124
U-band-5m
LBT-LBC

Wide Field U Imaging of 50 WINGS clusters

High quality U photometry and surface photometry...

22 clusters observed, further time allocated at LBC!

PRODUCTS: ongoing star formation studies, star formation distribution in galaxies and in clusters, large band SEDs.

WINGS-HAL

H α imaging

ONGOING...

INT 4m: WFC: (34'X34'; pix~0".33)

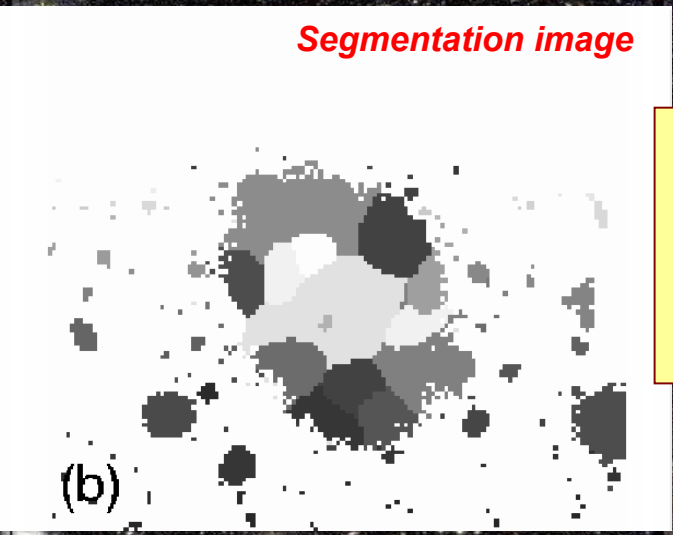
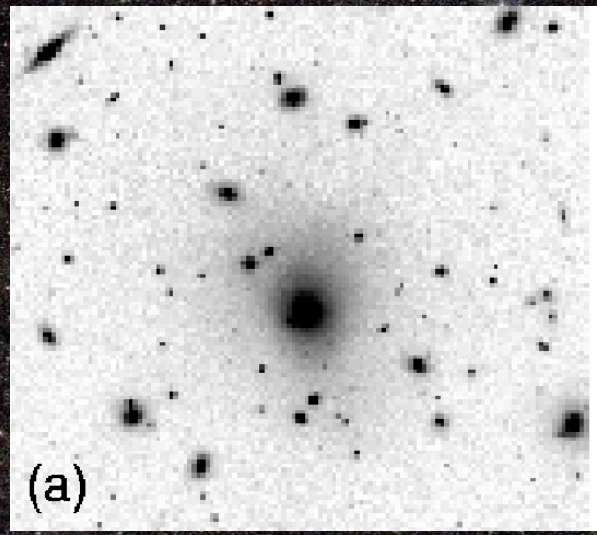
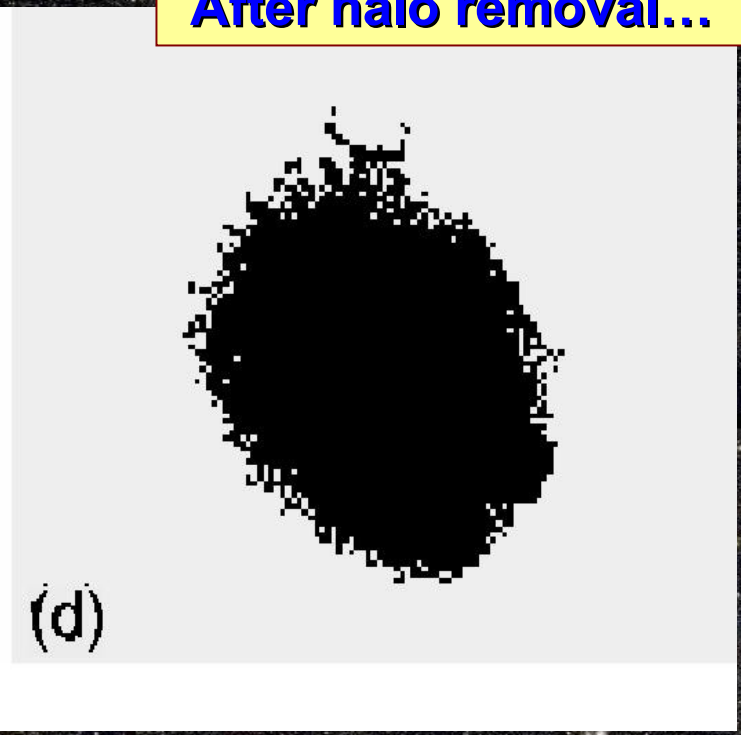
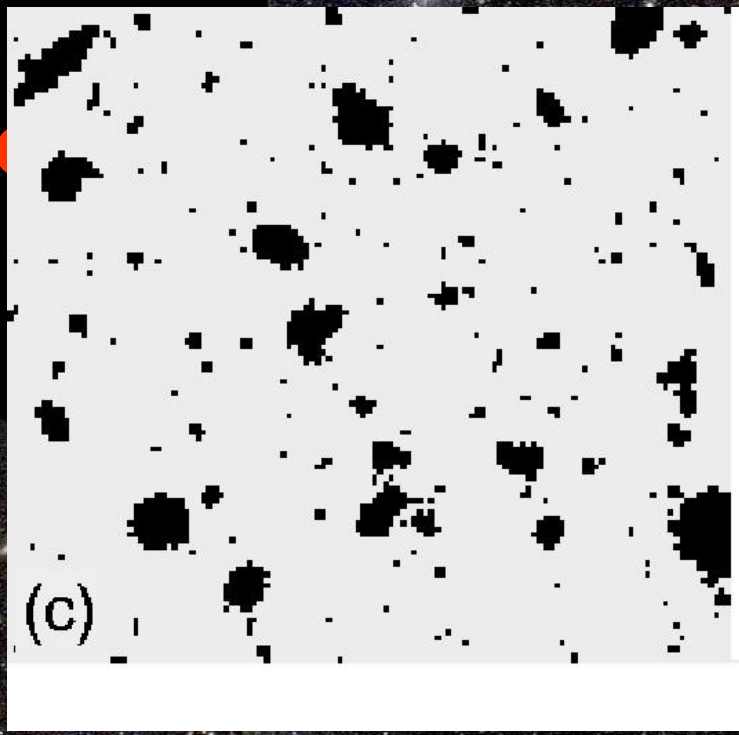
Wide Field H α Imaging 60'x60' mosaics

PRODUCTS: post star-burst events studies, star formation activity over a wide range of masses and clustercentric distance.

B,V pipe

Varela et al.

After halo removal...



Segmentation image

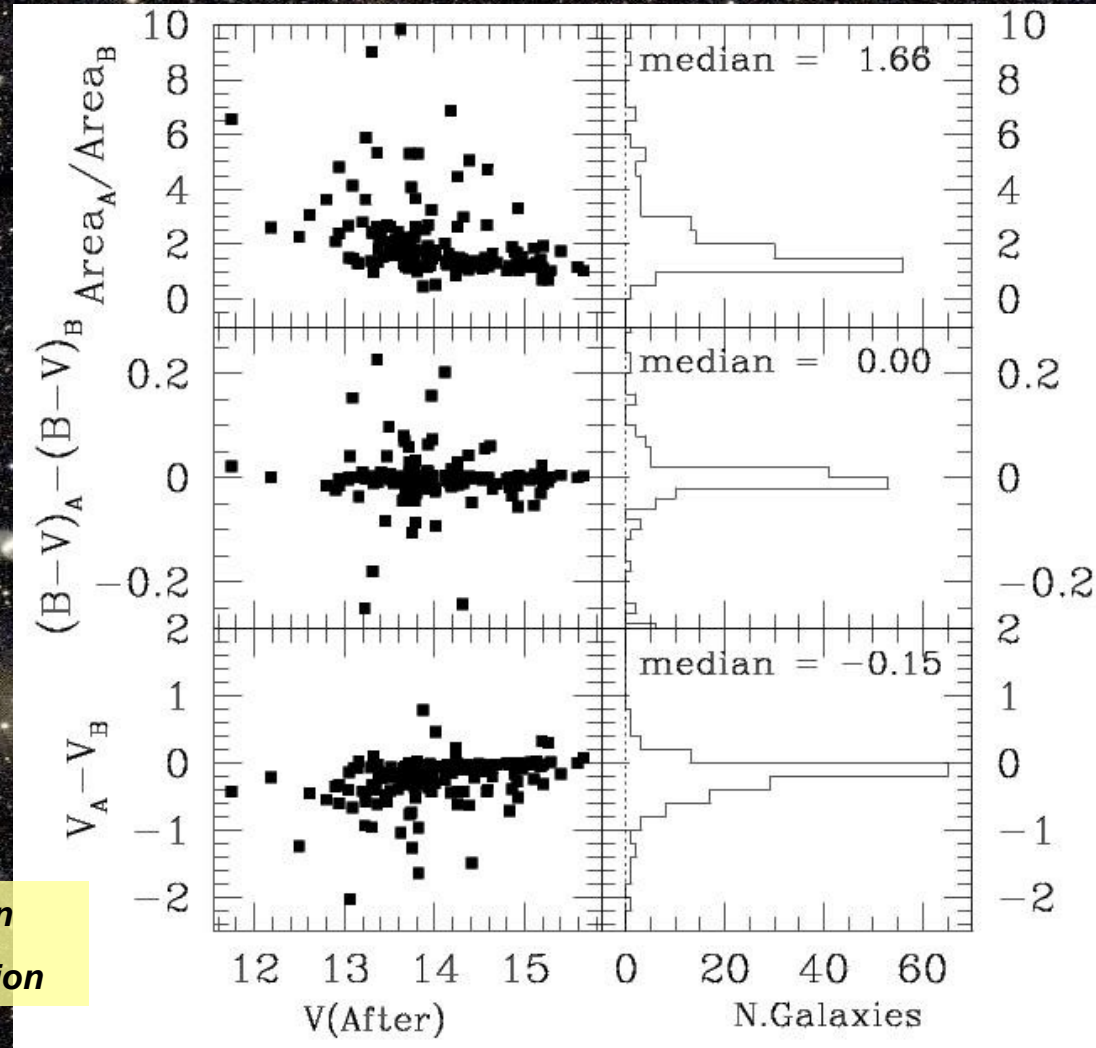
Halos of big galaxies (included BCG) and halos of stars affect photometry.

B,V pipeline

Varela et al. 2008

Special care for treating large extended galaxies (including the BCG): photometry on images in which large galaxies and halos of bright stars are removed.

Photometry for large galaxies GREATLY improved (up to 1mag difference) + detect 16% more objects around BCG



A=after correction

B=before correction

B,V pipeline

Varela et al. 2008

SExtractor positions, geometrical parameters, several total and aperture magnitudes.

Photometric catalogs 90% complete at $V \sim 21.7$, and 50% at $V \sim 23.2$

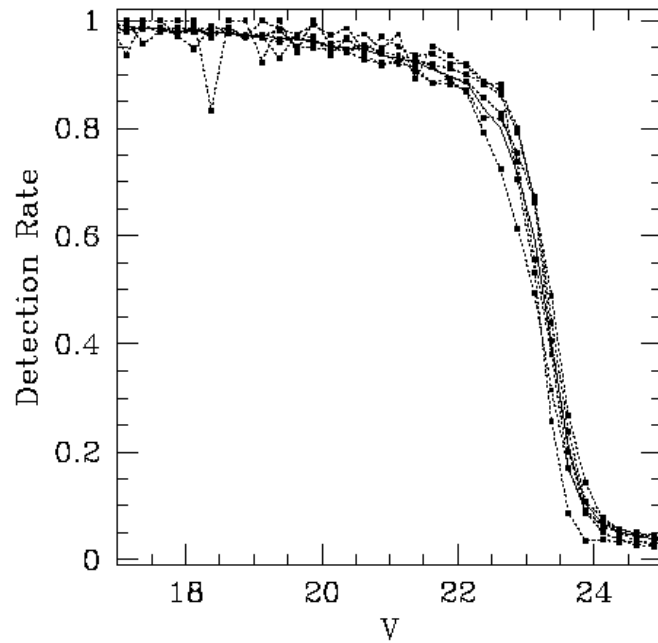
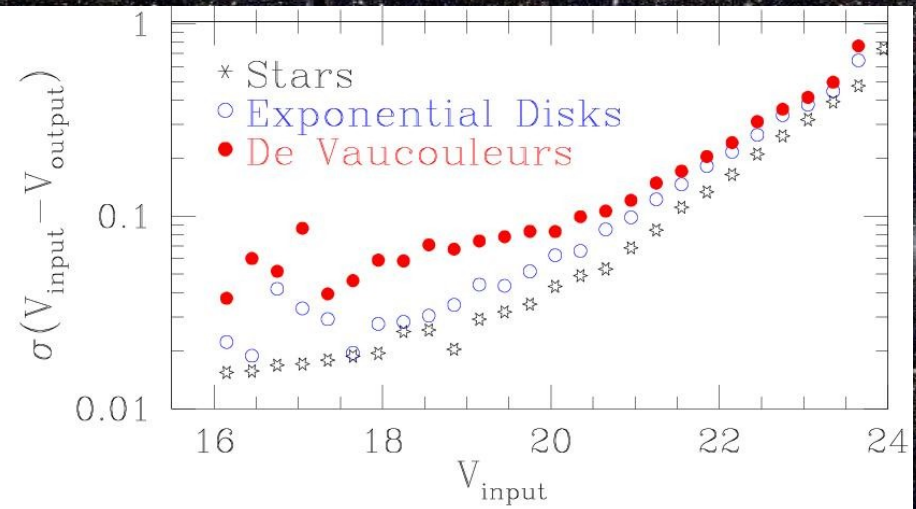


Fig. 5. Average detection rate in each observing run computed from simulations. The stronger black line is the detection rate averaged over the 77 fields.

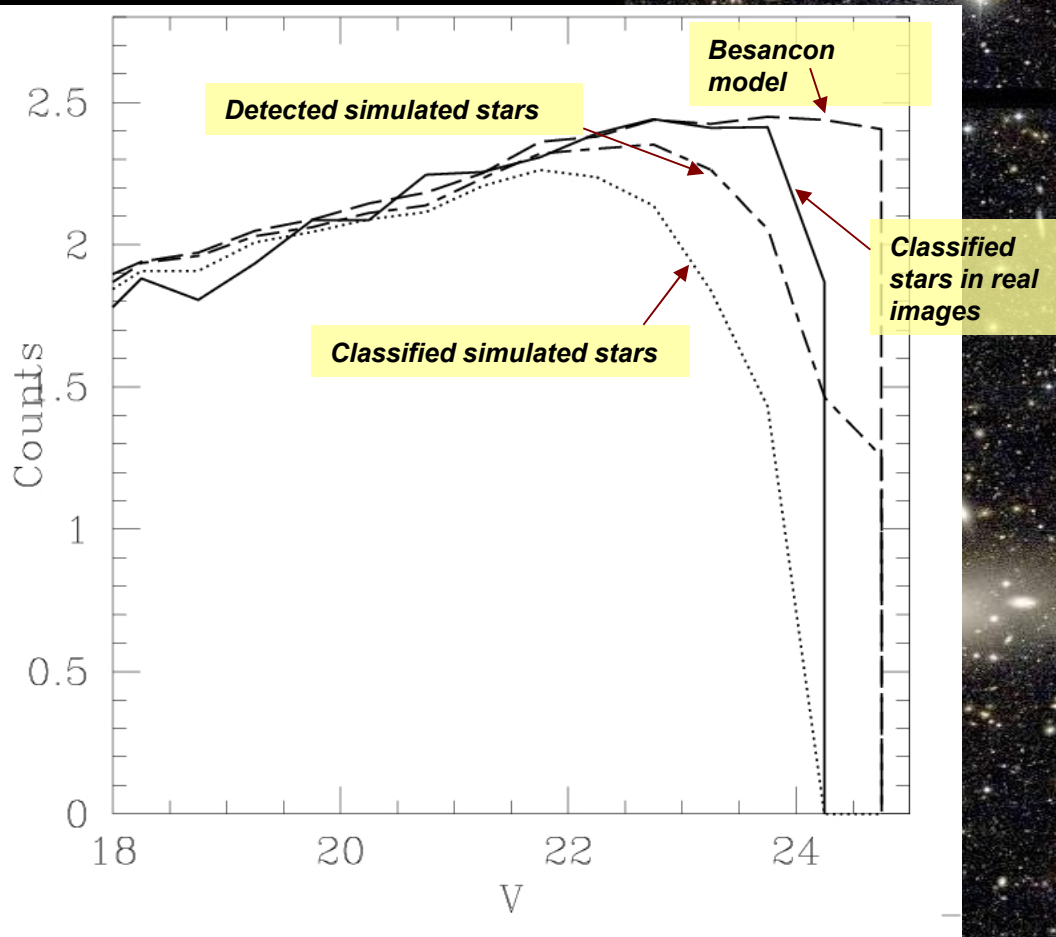
Errors from simulations



B,V pipeline

Varela et al. 2008

Know problem with IRAF-ARTDATA



Better star/galaxy separation and detection on real images than simulated ones...

J,K pipeline

Valentinuzzi et al. 2008



Images already reduced and calibrated in UK at CASU. They are stacked and ready to become a mosaic...

... go directly to the fun ☺!!!!

54 Mosaics of 33 WINGS clusters generated with MONTAGE

(NASA/IPAC Infrared Science Archive)

Very simple and direct usage...

Powerful overlapping fitting...

Uses ZPN projection...

Enormous amount of disk space needed (70Gbyte)

Need of lots of memory... (4Gbyte)

Time consuming (5 hours for 64 stacked images of 1 cluster)...

*Abell 1069
K-band-3.8m
UKIRT-WFCAM*

Sky subtraction with SExtractor

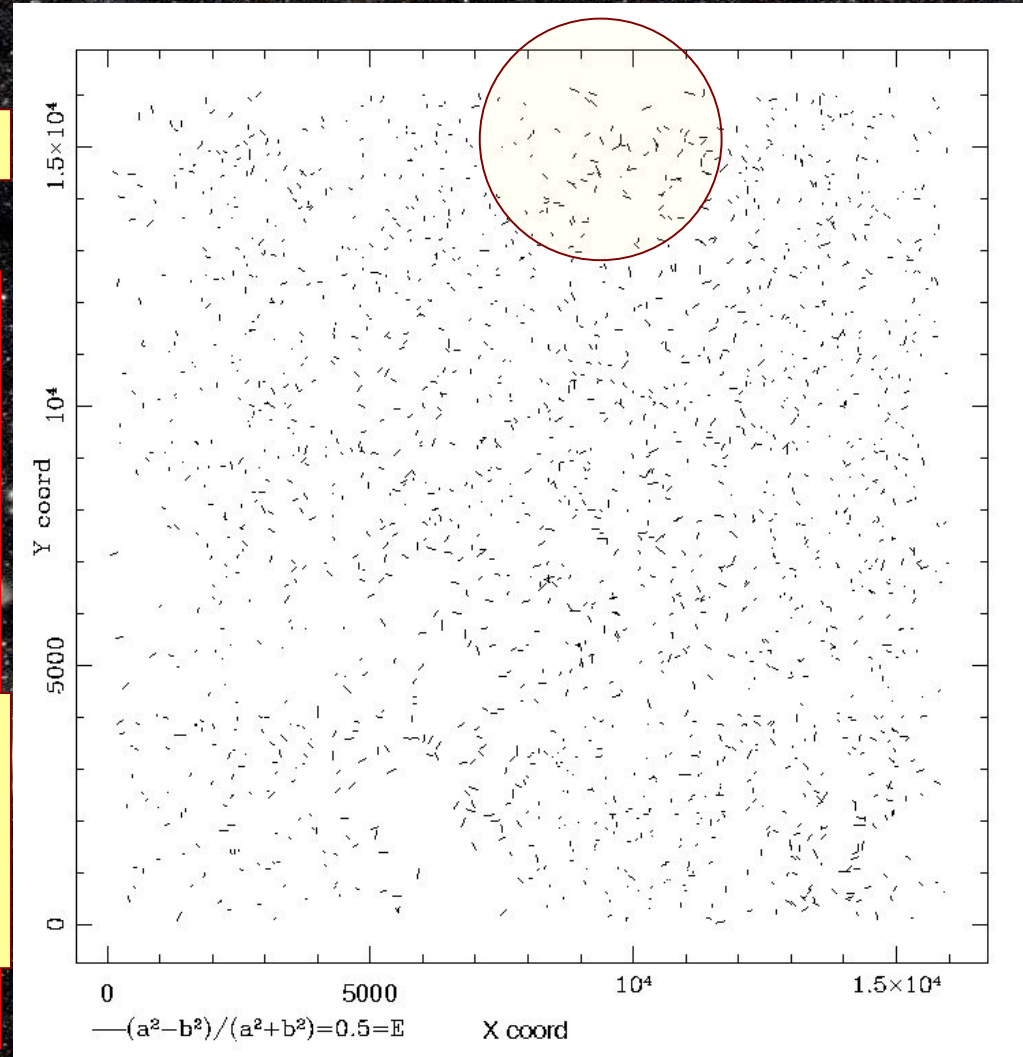
J,K pipeline

Valentinuzzi et al. 2008

PSF distribution analysis...

Check if PSF has been strongly affected by some stacked image, check of systematic distortion effects on the mosaic...

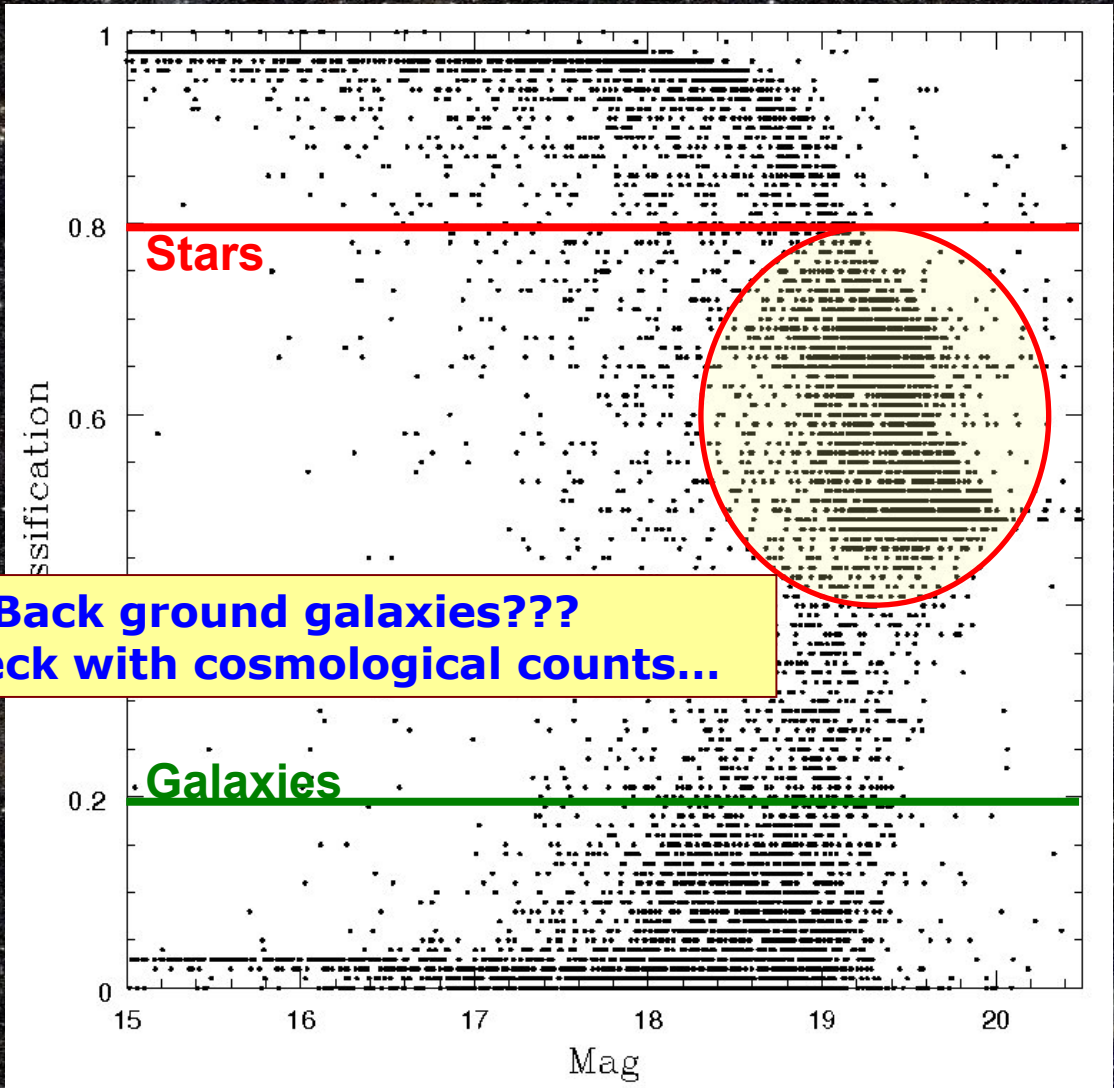
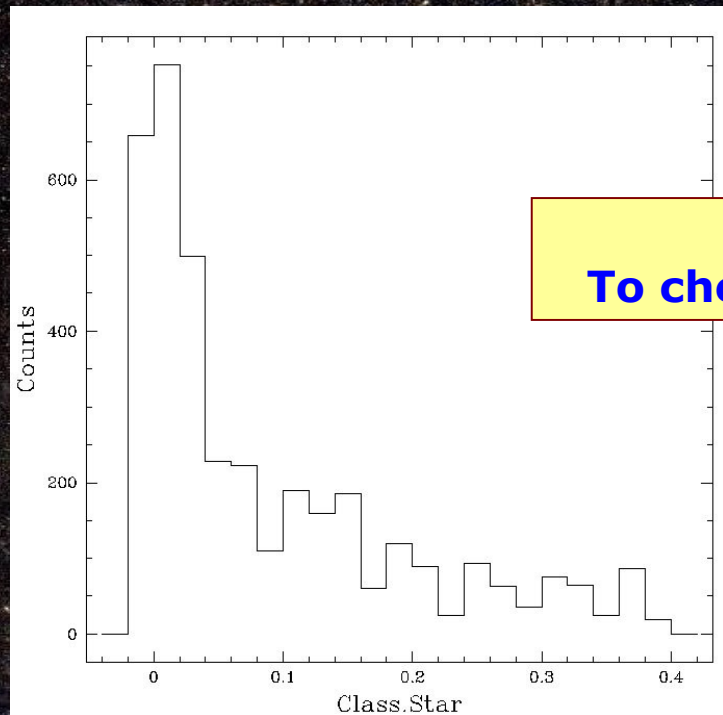
Preliminary analysis of mosaics...



J,K pipeline

Valentinuzzi et al. 2008

Star/galaxy classification check



Back ground galaxies???
To check with cosmological counts...

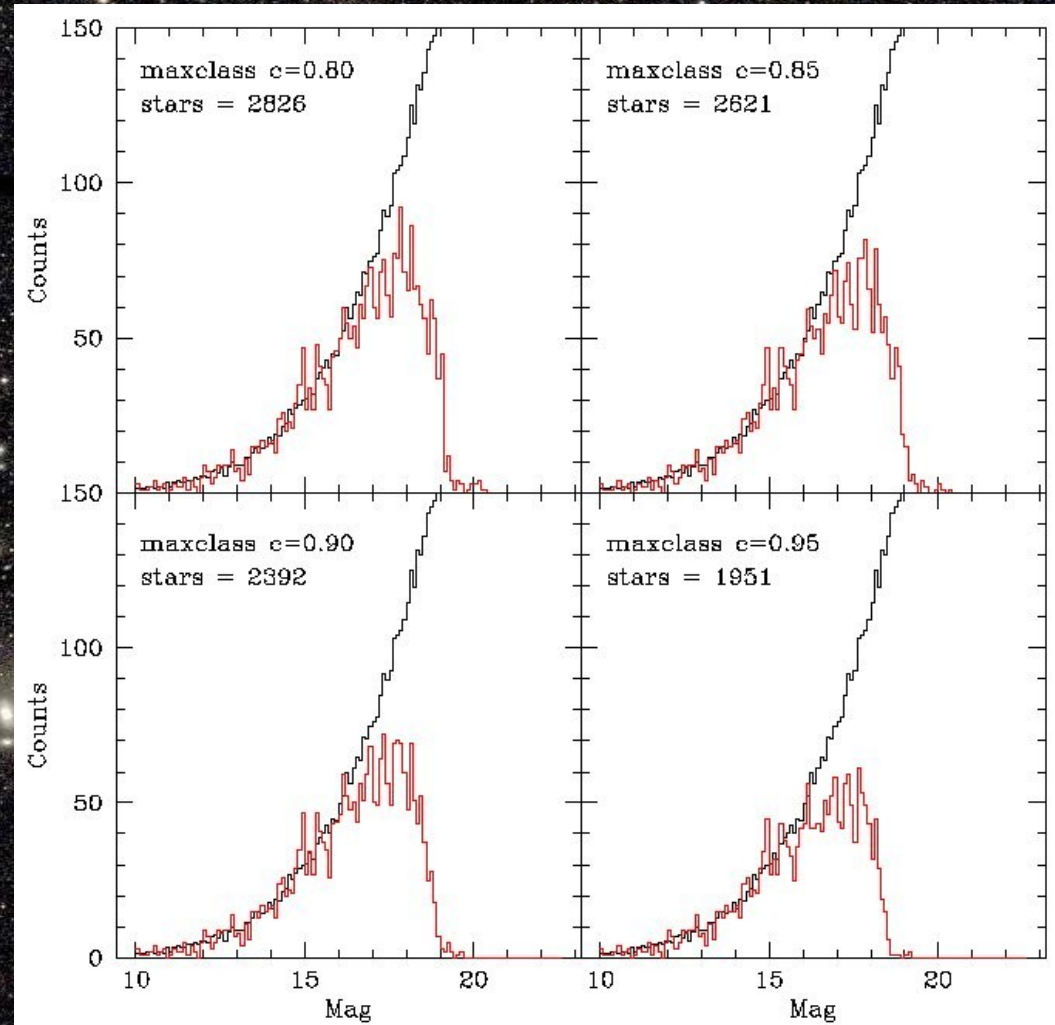
J,K pipeline

Valentinuzzi et al. 2008

Star counts check, using Trilegal as reference...

Léo Girardi and Martin Groenewegen

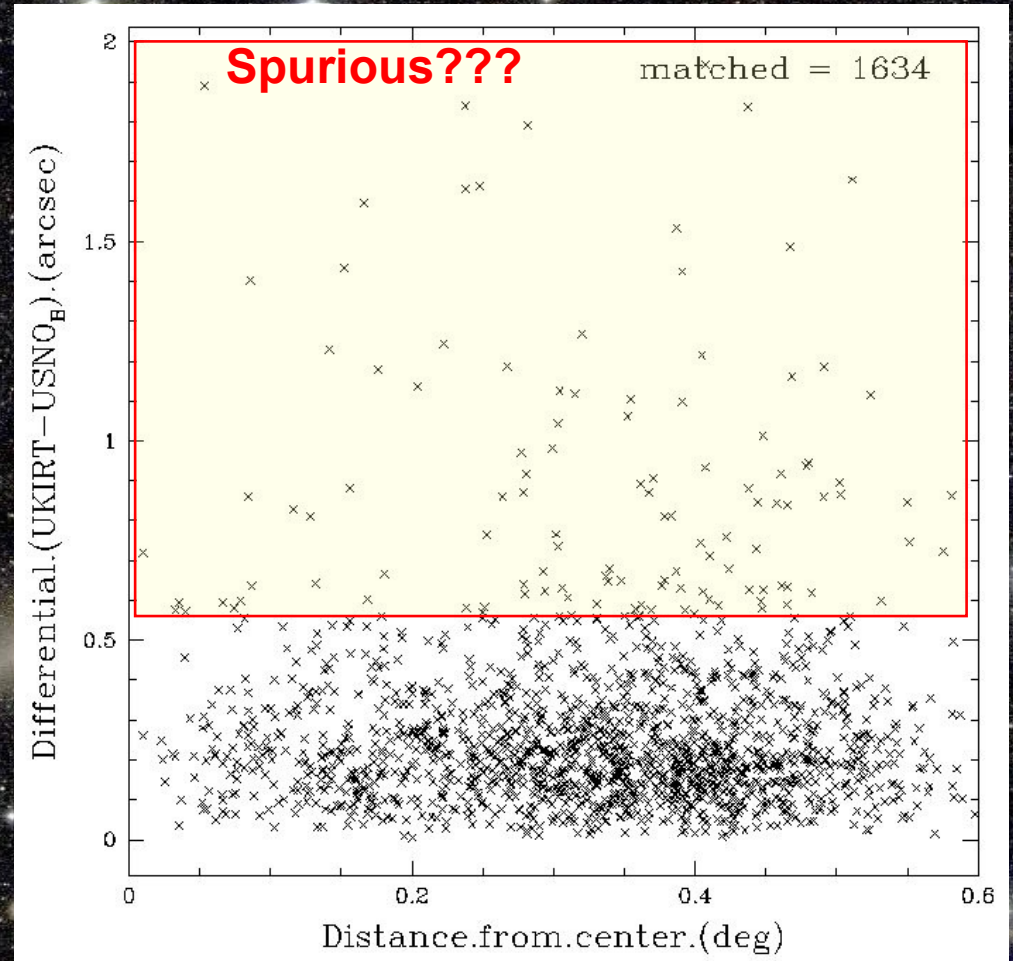
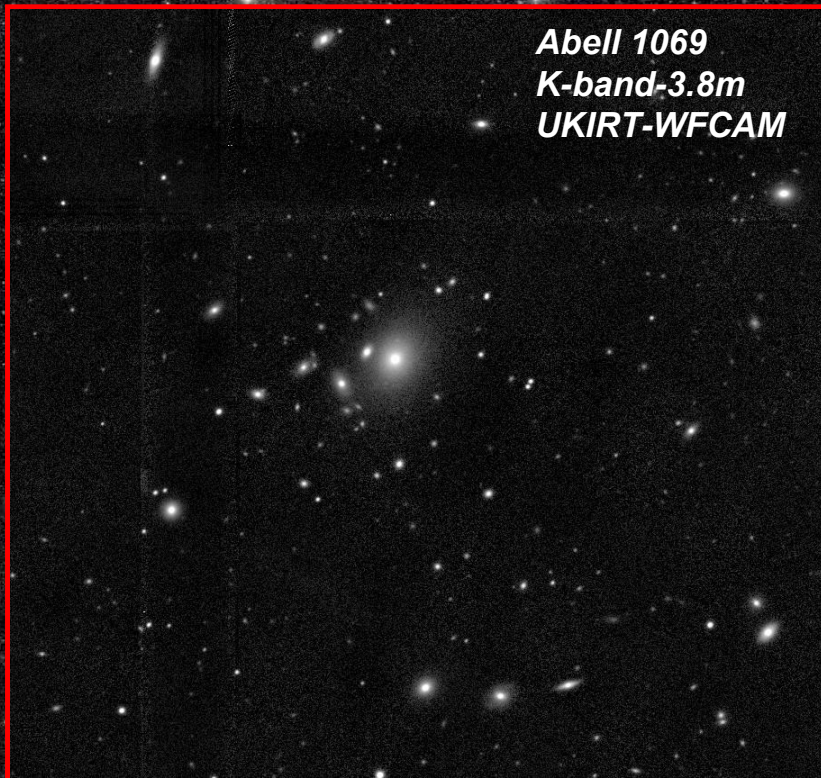
Abell 1069
K-band-3.8m
UKIRT-WFCAM



J,K pipeline

Valentinuzzi et al. 2008

Astrometry check with USNO_B

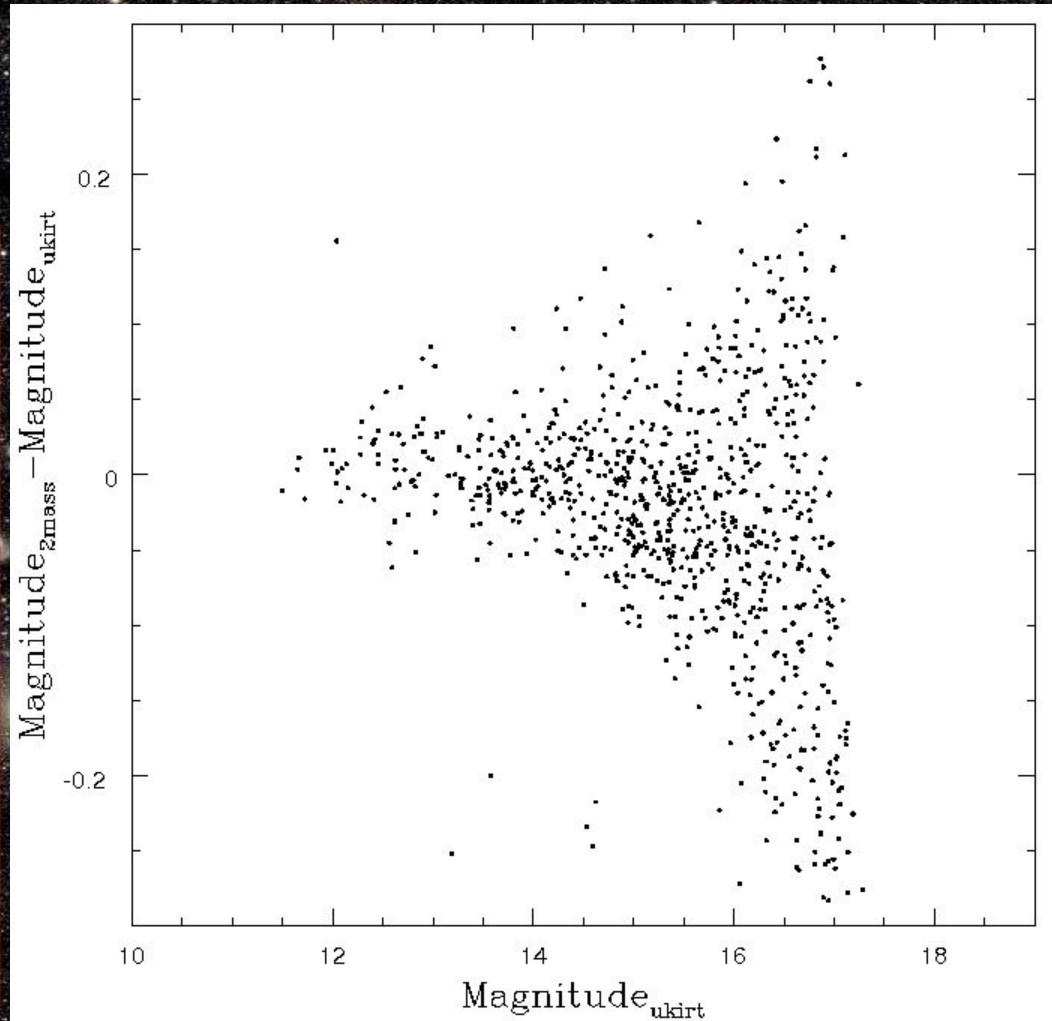


J,K pipeline

Valentinuzzi et al. 2008

Preliminary photometry check with 2MASS

Abell 1069
K-band-3.8m
UKIRT-WFCAM

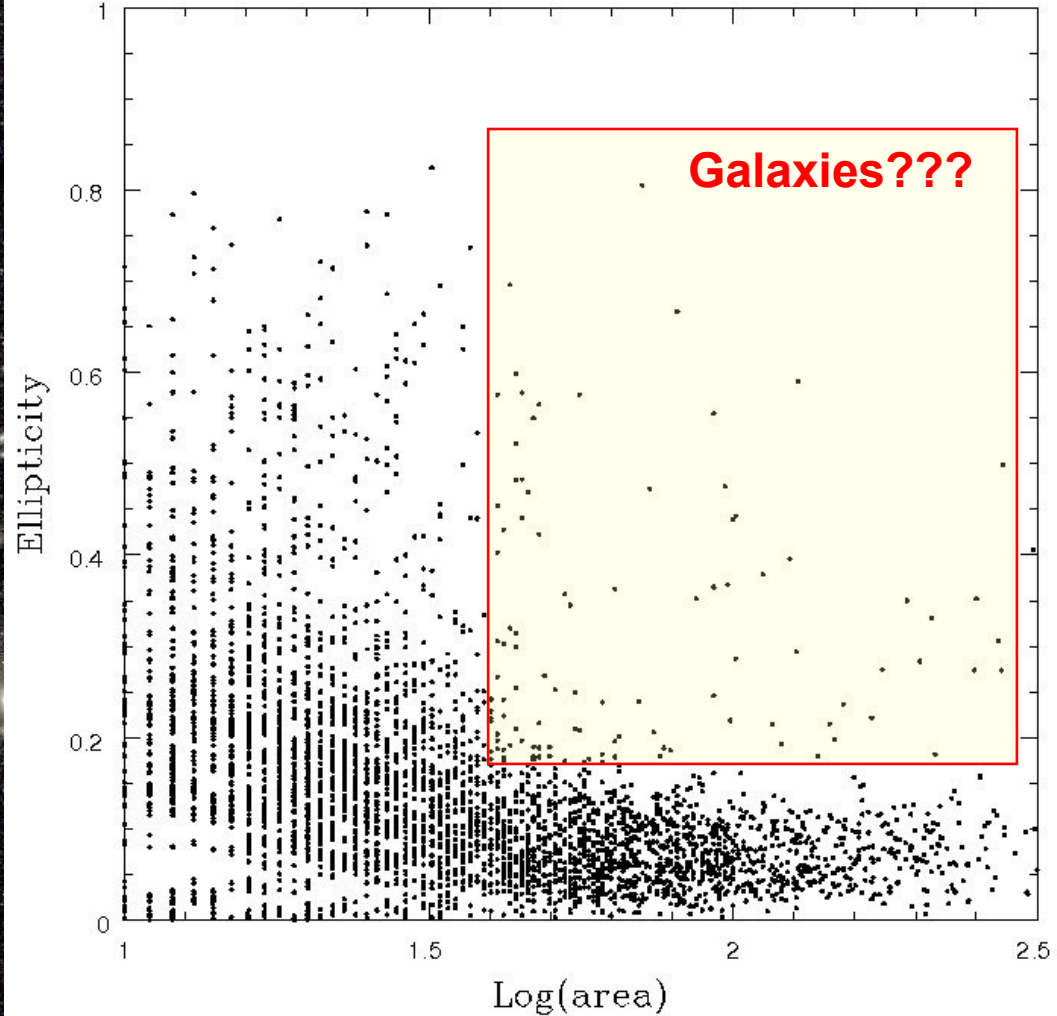


J,K pipeline

Valentinuzzi et al. 2008

Check of unidentified objects ...

Abell 1069
K-band-3.8m
UKIRT-WFCAM



J,K pipeline

Valentinuzzi et al. 2008

Result of this phase, improvement of SExtractor parameters choice, improvement of star/galaxy classification parameters choice...

Ready to run SExtractor in final mode...

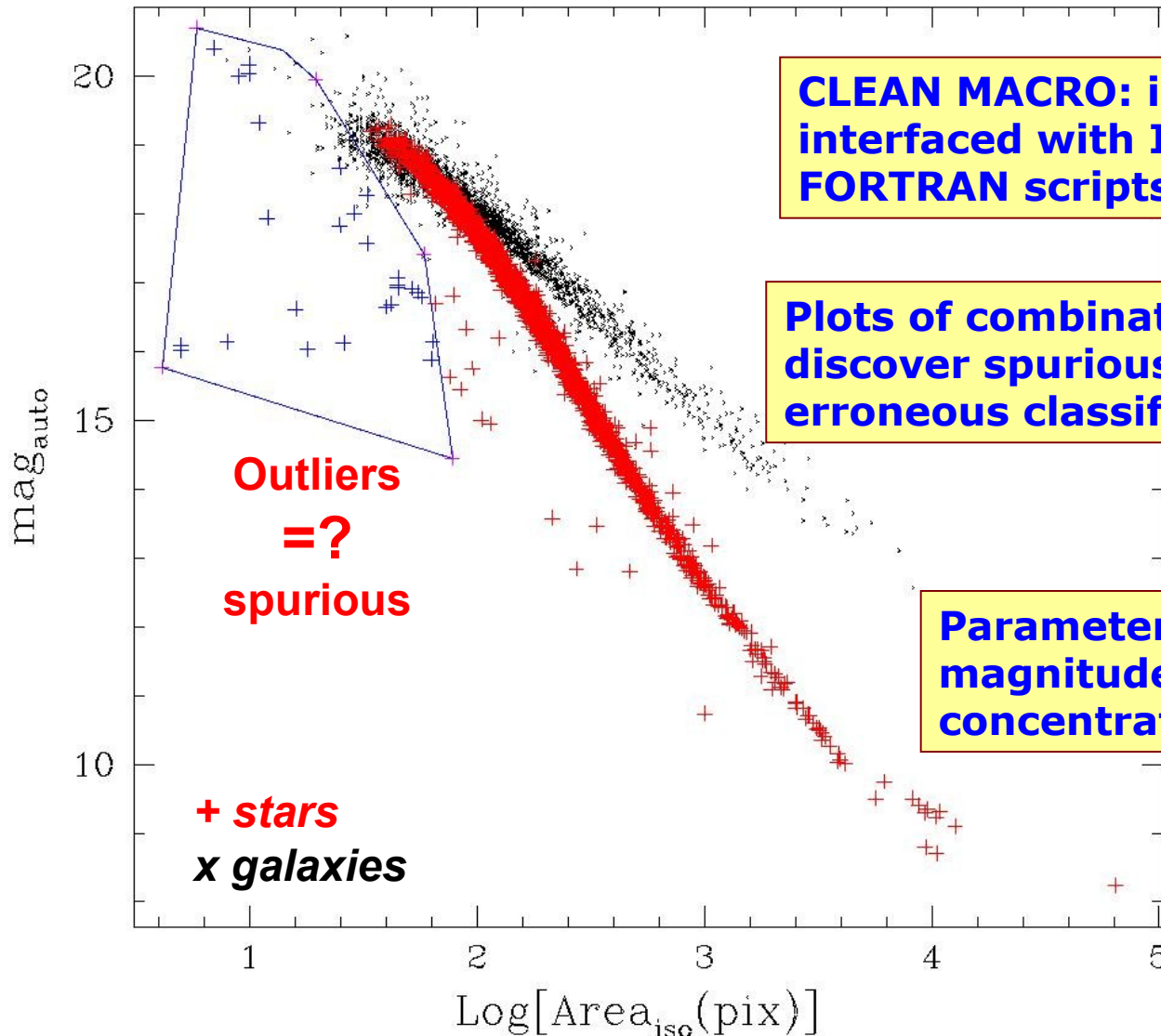
OUTPUT
3 main catalogs

- 4) Point sources catalog
- 2) Deep sources catalog
- 3) Unidentified sources catalog

```
# 1 NUMBER Running object number
# 2 X_IMAGE Object position along x [pixel]
# 3 Y_IMAGE Object position along y [pixel]
# 4 ALPHA_SKY Right ascension of barycenter (native) [deg]
# 5 DELTA_SKY Declination of barycenter (native) [deg]
# 6 XPEAK_IMAGE x-coordinate of the brightest pixel [pixel]
# 7 YPEAK_IMAGE y-coordinate of the brightest pixel [pixel]
# 8 ALPHAPEAK_SKY Right ascension of brightest pix (native) [deg]
# 9 DELTAPEAK_SKY Declination of brightest pix (native) [deg]
# 10 XWIN_IMAGE Windowed position estimate along x [pixel]
# 11 YWIN_IMAGE Windowed position estimate along y [pixel]
# 12 BACKGROUND Background at centroid position [count]
# 13 THRESHOLD Detection threshold above background [count]
# 14 ISDAREA_IMAGE Isophotal area above Analysis threshold [pixel**2]
# 15 KRON_RADIUS Kron apertures in units of A or B
# 16 A_IMAGE Profile RMS along major axis [pixel]
# 17 B_IMAGE Profile RMS along minor axis [pixel]
# 18 THETA_SKY Position angle (east of north) (native) [deg]
# 19 FWHM_IMAGE FWHM assuming a gaussian core [pixel]
# 20 ELLIPTICITY 1 - B_IMAGE/A_IMAGE
# 21 FLUX_RADIUS1 Fraction-of-light radii [pixel]
# 22 FLUX_RADIUS2 Fraction-of-light radii [pixel]
# 23 FLUX_RADIUS3 Fraction-of-light radii [pixel]
# 24 MU_MAX Peak surface brightness above background [mag * arsec]
# 25 MAG_ISO Isophotal magnitude [mag]
# 26 MAG_ISOCOR Corrected isophotal magnitude [mag]
# 27 MAG_APER1 Fixed aperture magnitude [mag]
# 28 MAG_APER2 Fixed aperture magnitude [mag]
# 29 MAG_APER3 Fixed aperture magnitude [mag]
# 30 MAG_APER4 Fixed aperture magnitude [mag]
# 31 MAG_APER5 Fixed aperture magnitude [mag]
# 32 MAG_APER6 Fixed aperture magnitude [mag]
# 33 MAG_AUTO Kron-like elliptical aperture magnitude [mag]
# 34 FLAGS Extraction flags
# 35 CLASS_STAR S/G classifier output
1573 44.718 13523.479 160.3838036 -8.3829543 45 13523 160.3838036 -8.3829543
9383 45.192 1156.265 160.3872244 -9.0713869 45 1156 160.3872244 -9.0713869
9959 46.160 144.966 160.3874522 -9.1276798 46 145 160.3874522 -9.1276798
3765 63.987 9781.516 160.3837606 -8.5912593 64 9782 160.3837606 -8.5912593
4196 66.511 9065.133 160.3838180 -8.6311386 66 9065 160.3838180 -8.6311386
2658 69.655 11666.849 160.3829169 -8.4863115 70 11667 160.3829169 -8.4863115
8959 81.928 1833.161 160.3849648 -9.0337181 82 1833 160.3849648 -9.0337181
5593 83.071 6932.266 160.3834794 -8.7498726 83 6932 160.3834794 -8.7498726
6058 83.127 6100.845 160.3837078 -8.7961550 82 6100 160.3837715 -8.7962017 82.492 6100.139
5290 87.187 7430.310 160.3831089 -8.7221493 87 7430 160.3831195 -8.7221665 87.125 7430.423
6912 88.602 4601.939 160.3838169 -8.8795949 89 4602 160.3837944 -8.8795916 88.276 4602.263
1174 89.348 14193.562 160.3811063 -8.3456664 89 14193 160.3811261 -8.3456976 89.295 14193.472
9744 92.383 508.130 160.3847450 -9.1074777 92 508 160.3847667 -9.1074849 92.365 508.197
4627 105.827 8319.449 160.3818118 -8.6726590 106 8319 160.3818022 -8.6726841 105.716 8319.341
1078 106.729 14353.225 160.3800842 -8.3367835 107 14353 160.3800690 -8.3367961 106.704 14353.563
4177 107.292 9089.195 160.3815152 -8.6298103 107 9089 160.3815317 -8.6298214 107.157 9089.055
6388 118.269 5480.262 160.3819010 -8.8307103 118 5480 160.3819162 -8.8307248 118.149 5480.344
```

J,K pipeline

Cleaning the catalogs ...



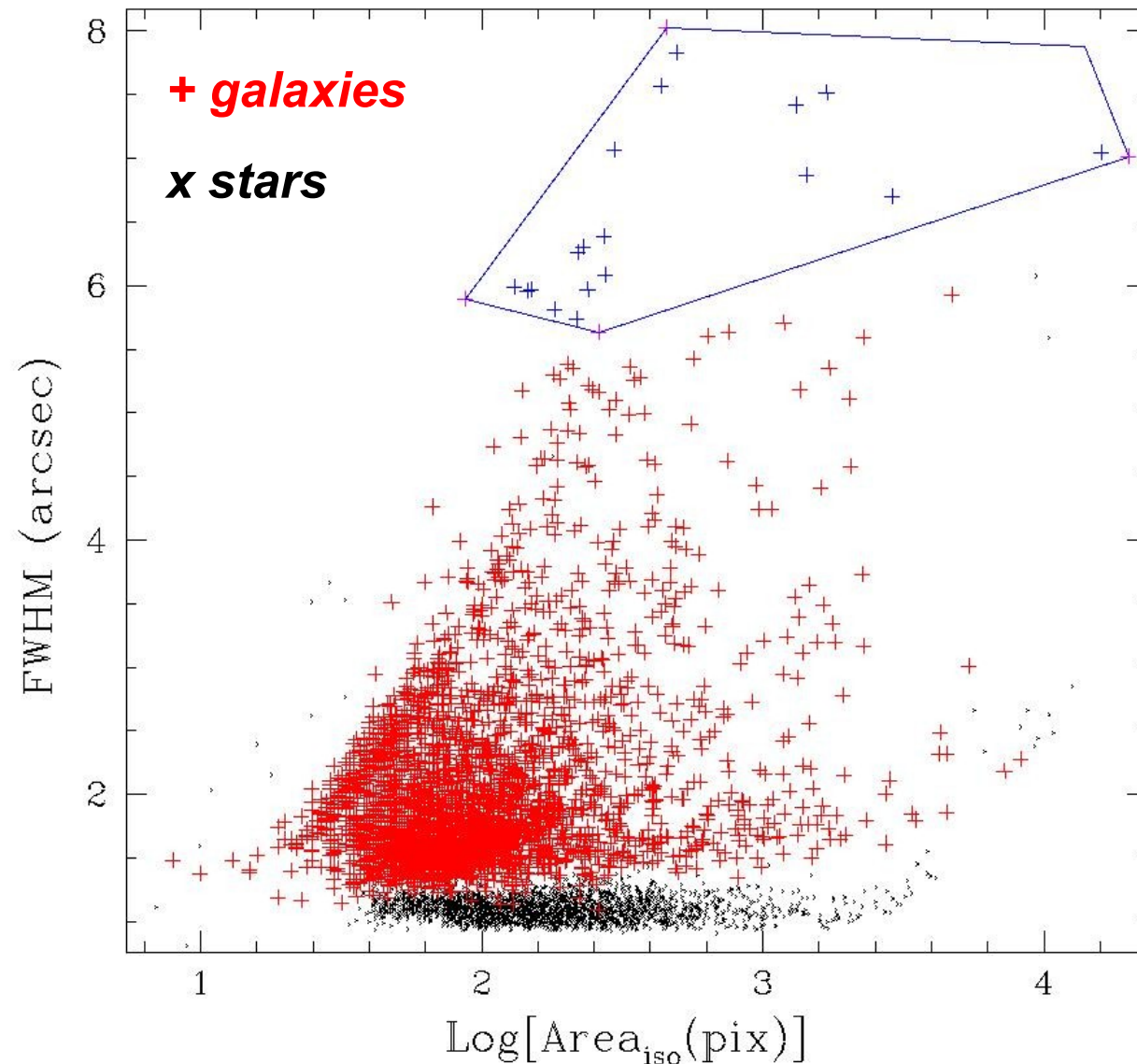
**CLEAN MACRO: interactive SM tool
interfaced with IRAF, ECLIPSE and
FORTRAN scripts.**

**Plots of combinations of parameters to
discover spurious detections and
erroneous classifications...**

**Parameters: dimension, area,
magnitude, 3 diff aperture phot,
concentration, FWHM...**

J,K pipeline

Cleaning the catalogs ...



- Interactive visual check:**
- 2) Delete from catalogs
 - 3) Change classification
 - 4) See NED info
 - 5) See SExtractor info
 - 6) Imexamine



**WINGS: a Wide-field Nearby Galaxy-cluster Survey. I:
Optical imaging**

G. Fasano¹, C. Marmo^{2,3}, J. Varela¹, M. D'Onofrio⁴, B.M. Poggianti¹, M. Moles⁵,
E. Pignatelli¹, D. Bettoni¹, P. Kjaergaard⁶, L. Rizzi⁷, W.J. Couch⁸, and A. Dressler⁹

**The catalog WINGS
are ready**
A Wide-Field Multi-wavelength Survey of Cluster Galaxies in the Local Universe

WINGS II

Deep optical photometry of 77 nearby clusters *

J. Varela^{1,3}, M. D'Onofrio², C. Marmo³, G. Fasano¹, D. Bettoni¹, E. Pignatelli¹, B.M. Poggianti¹, M. Moles⁴, P.
Kjaergaard⁵, W.J. Couch⁶, and A. Dressler⁷

If everything works 😊:

1) Clean SHARDS catalog...

2) Clean Deep catalog

3) Unknown objects catalog