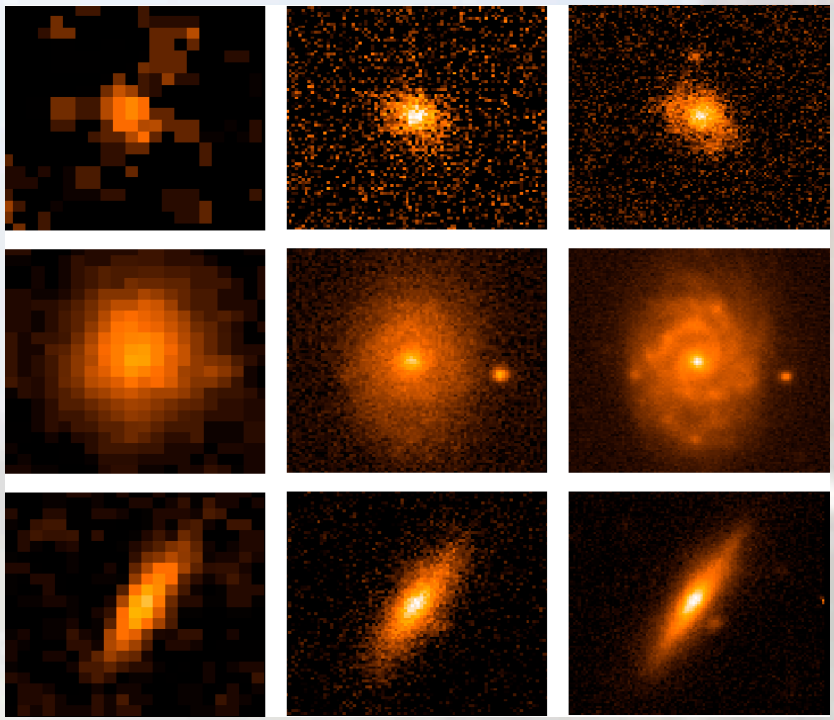
Tests of Extended Source Photometry for Bright (r=14-18) SAS galaxies

John Lucey (Durham)



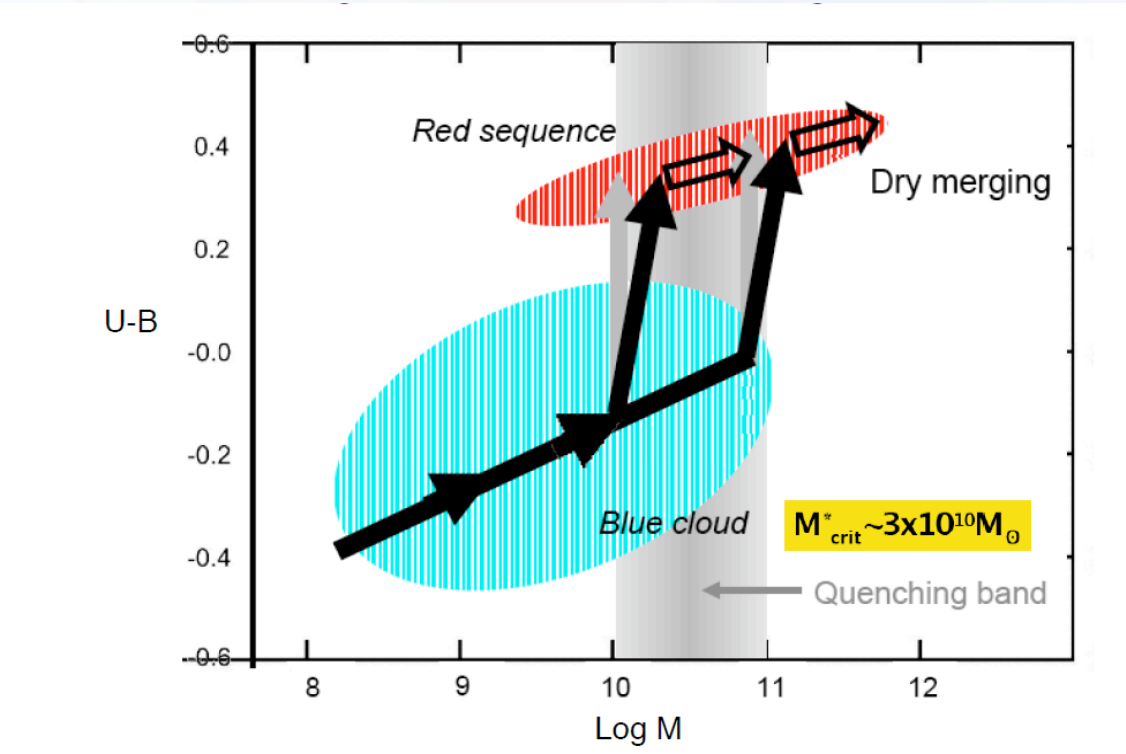
DSS SDSS Pan-STARRS?

Deeper and sharper images allow a new set of science projects to be carried out.

Outline

Science Background
SAS vs SDSS
Asymmetry etc parameters

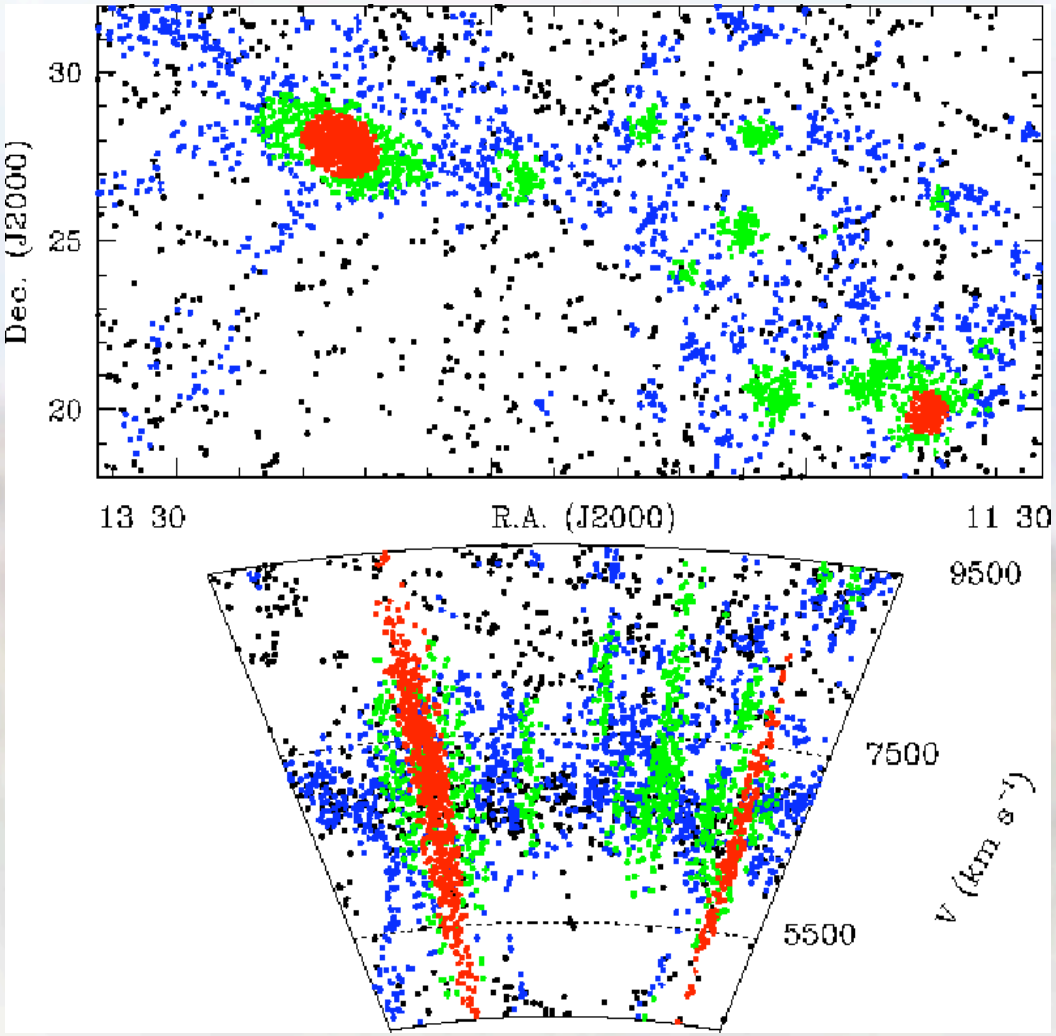
Stellar Populations (colour), Structural Parameters and Environment



What is the physical mechanism?
How long does the quenching process take?
Where/when does environmental quenching begin?
Mass dependence?

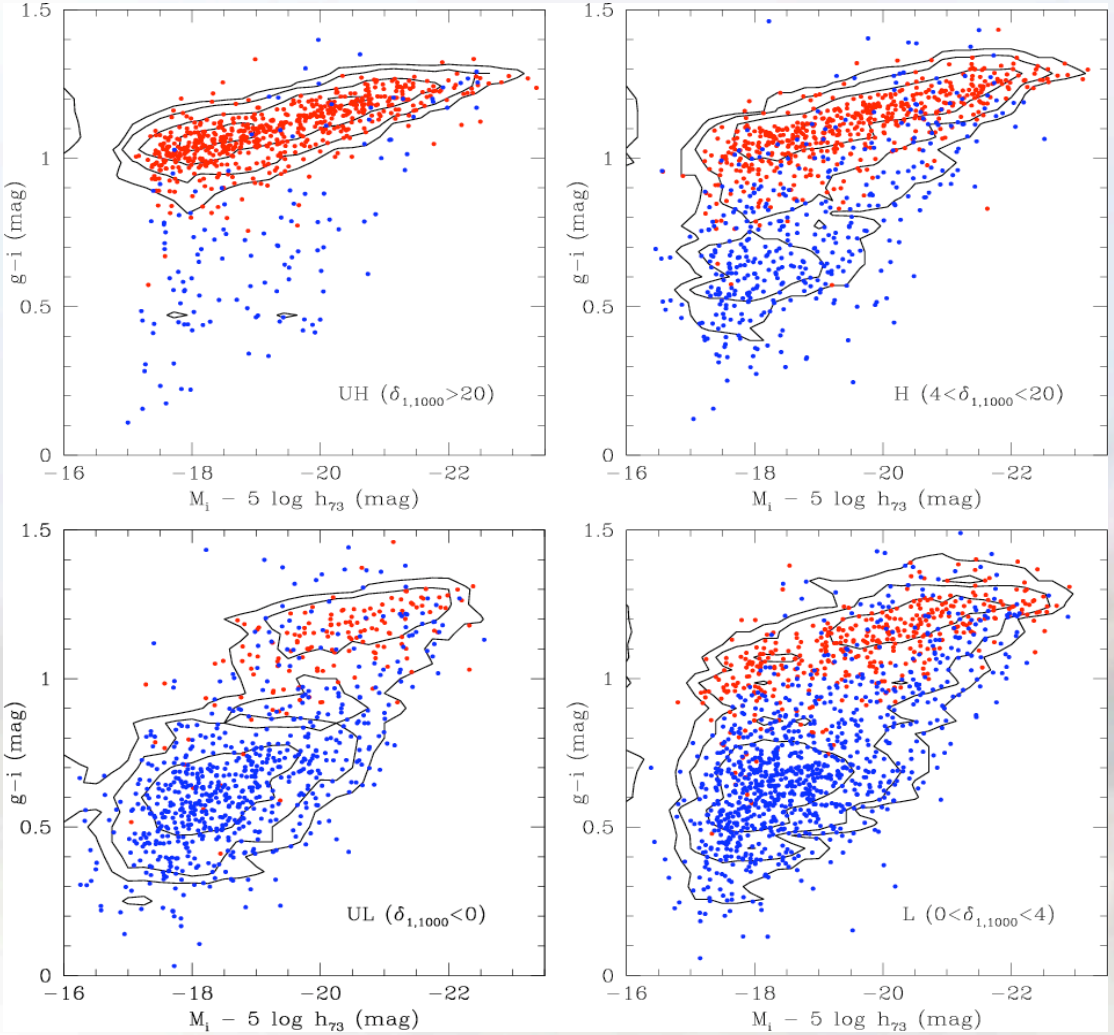
Secular bulge growth?
Disk fading?

Stellar Populations (colour), Structural Parameters and Environment



“A snapshot of galaxy evolution occurring in the Great Wall” Gavazz et al 2010

Stellar Populations (colour), Structural Parameters and Environment

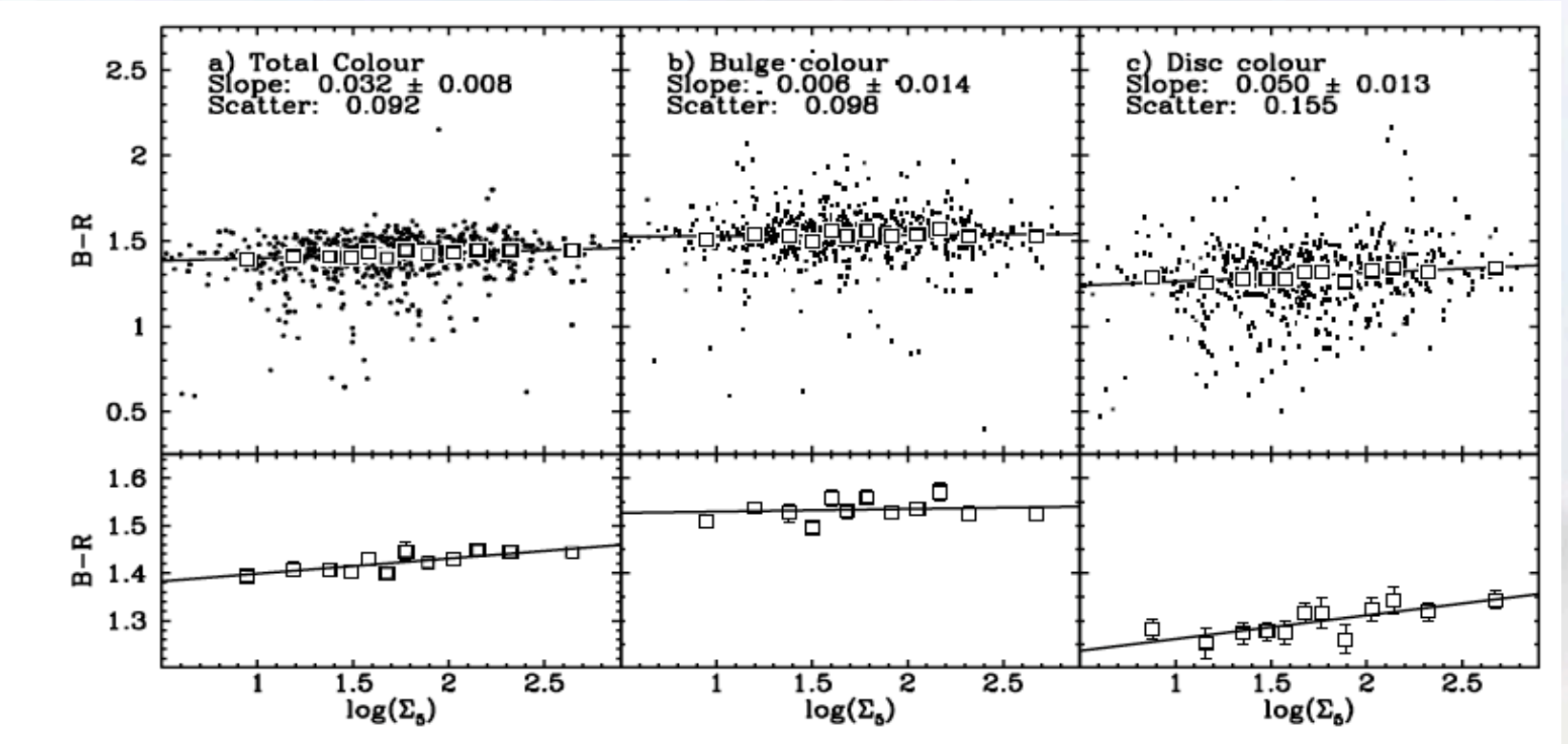


Global Colours!

"A snapshot of galaxy evolution occurring in the Great Wall", Gavazz et al 2010

Stellar Populations (colour), Structural Parameters and Environment

Bulge-disk decomposition studies allow the details of the environmental quenching to be investigated, e.g. trends of the component colours with local density.



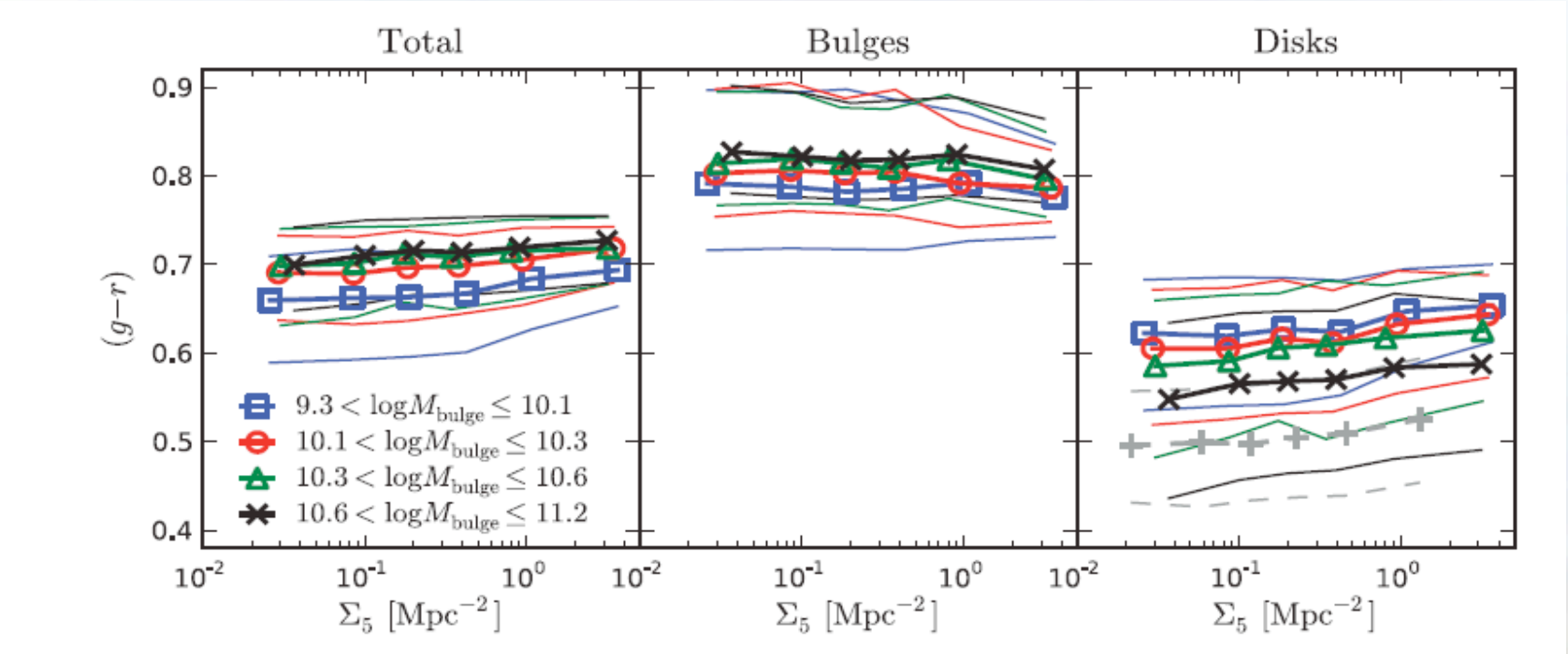
Hudson et al 2010

While the colours of bulge components do not depend on environment, the median colours of disks vary significantly, with disks in the cluster cores 0.10 mag redder than those at the virial radius.

Evidence for disk fading on infall ??

Stellar Populations (colour), Structural Parameters and Environment

Lackner & Gunn (2013) SDSS imagery



Taranu et al (2013) found from detailed modelling that “the environments of rich clusters must impact star formation rates of infalling galaxies on relatively long timescales - several times longer than a typical halo spends within the virial radius of a cluster.”

Minimum Requirements for Pan-STARRS Extended Source Photometry

Petrosian radii (R50 and R90) in all bands

Ellipticities and major axis position angles in all bands

Enclosed fluxes and colours vs. radius
(e.g. integrated growth curves)

Radial SB and colour profiles (e.g. differential)

2d psf convolved (Exponential, de Vac., Sersic) fits

Asymmetry/Smoothness/Clumpiness/Coarseness/Bumpiness

Can reliable extended source (structural) parameters be derived from Pan-STARRS, i.e. SAS quality imagery?

Extended Source Photometry

Relatively straightforward.

Many simple-to-use well-established packages, i.e. Sextractor, GALFIT, etc.

Issues

* sky determination
* deblending and masking
* region of fit, e.g. $r < 2\ R_{HALF}$
* choice of parametric form
* psf corrections to measured parameters

Data Sources for the Comparisons

~600 galaxies in SAS in the r-band magnitude range 14 to 18.

Extended source parameters from

SDSS DR8

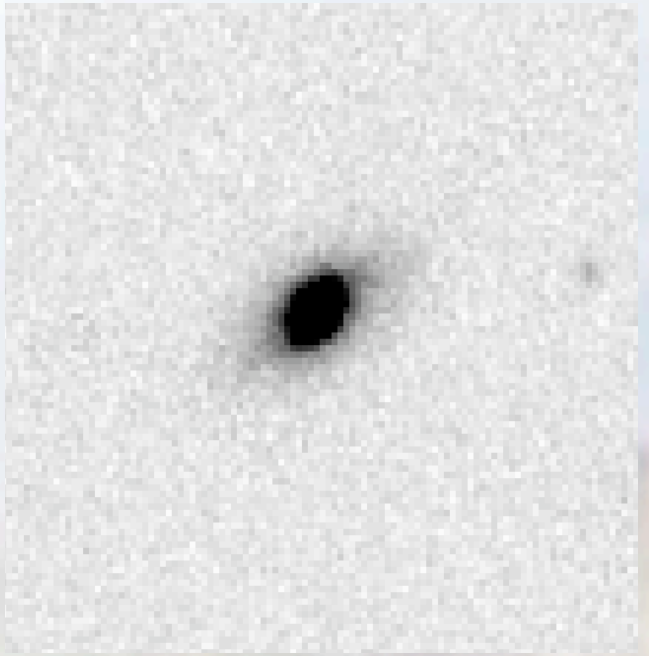
PSPS SAS11 release

SDSS GALFIT
(derived from postage stamps extracted from the DR8 tiles)

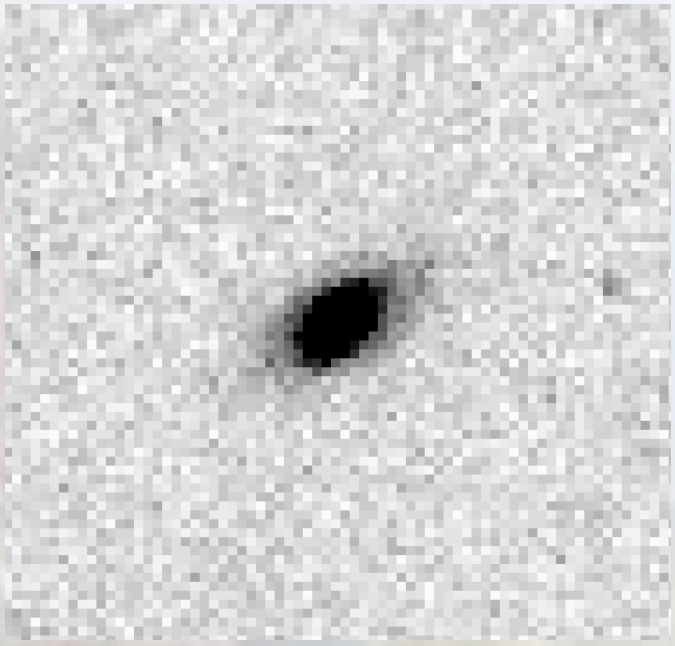
SAS GALFIT
(derived from postage stamps extracted by Peter Draper)

Initial comparisons exponential models only.

Pan-STARRS SAS



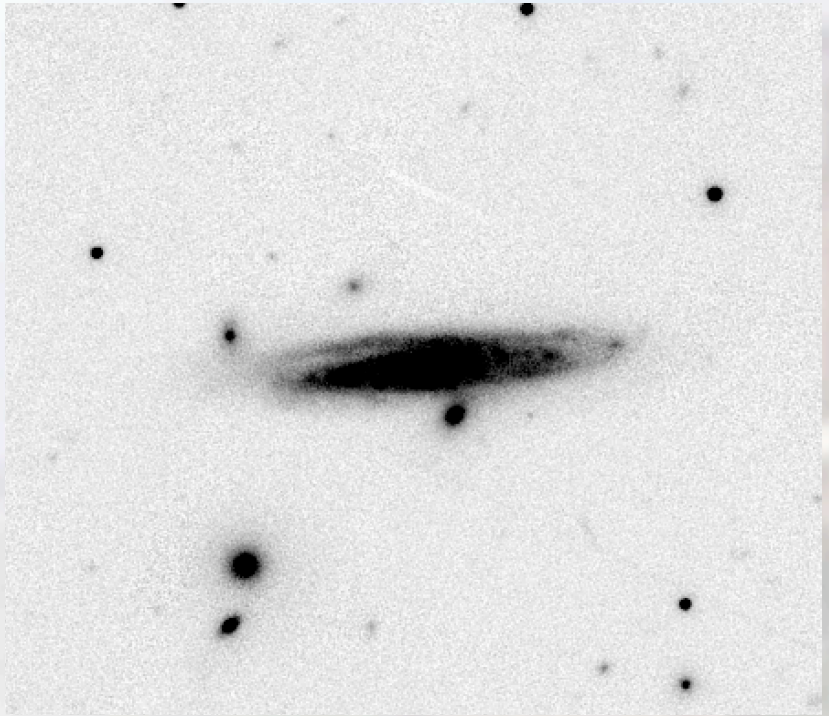
SDSS DR8



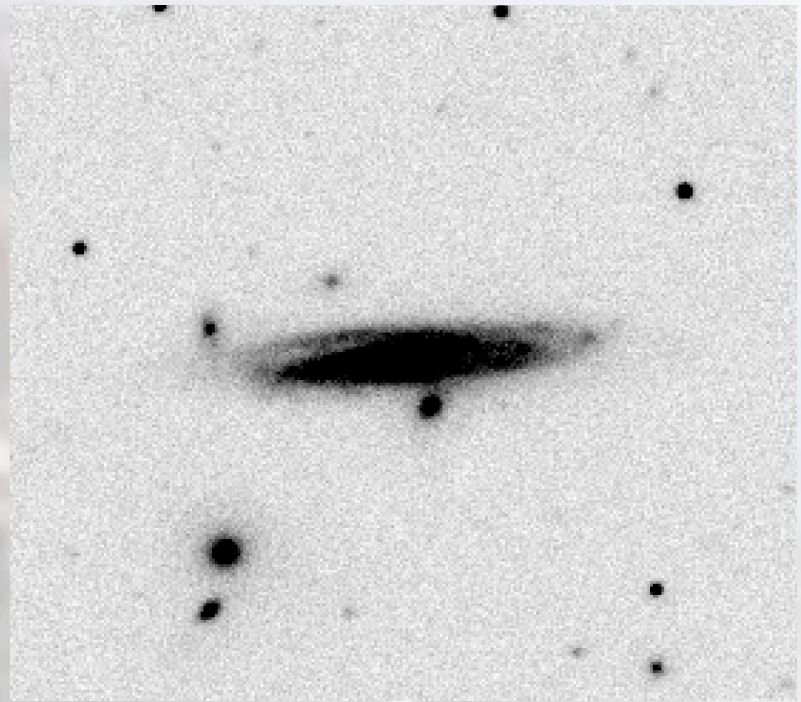
1237663542610755808

expMag_r = 18.01
expRad_r = 1.23”

Pan-STARRS SAS

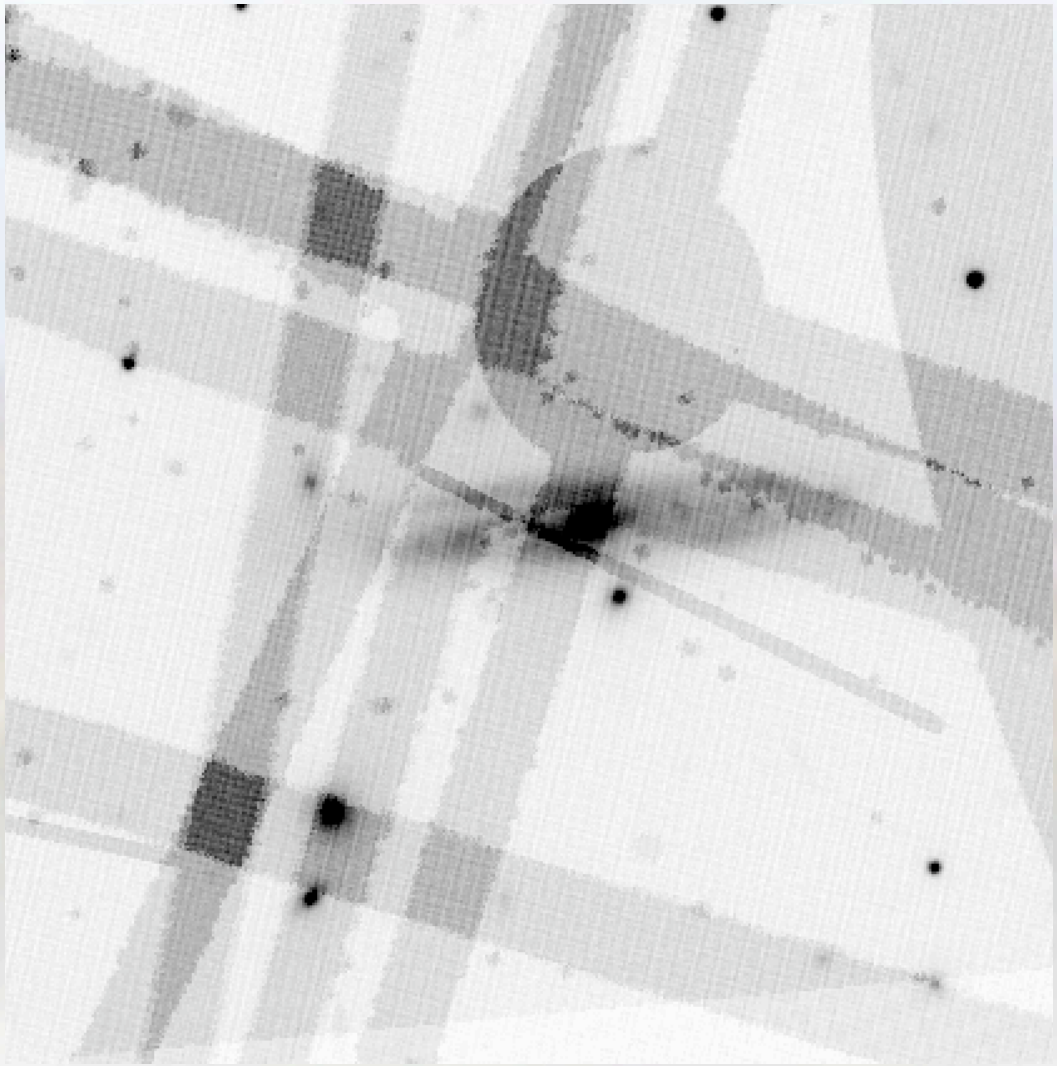


SDSS DR8



1237663542609707 30

expMag_r = 14.81
expRad_r = 9.94”

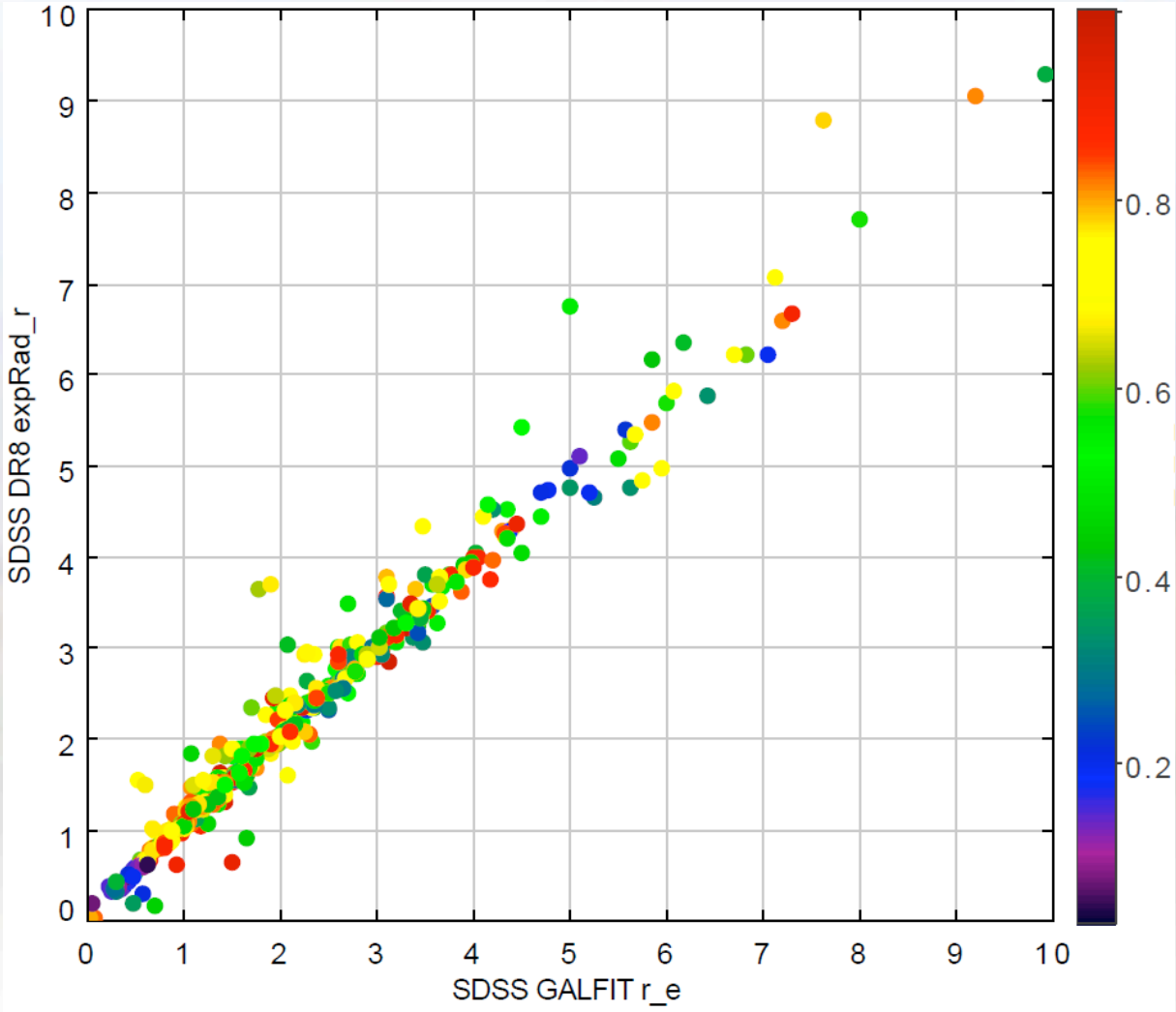


“Typical” Variance Map for a SAS Galaxy

SDSS DR8 vs SDSS GALFIT Exp. Fit. r_e

(indep. sky value, masking, deblending, range and method)

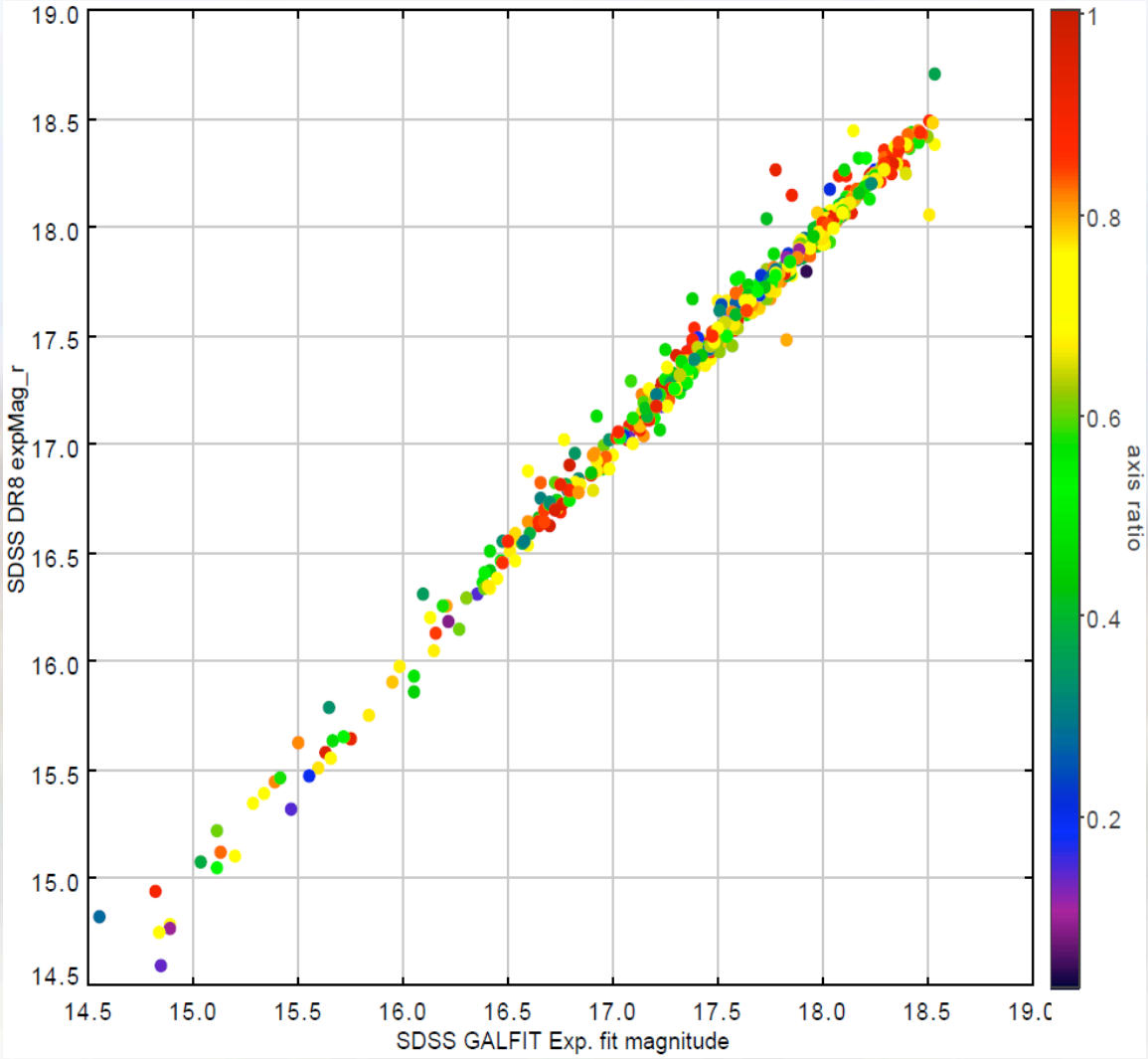
SDSS expRad_r



SDSS GALFIT r_e

SDSS DR8 vs SDSS GALFIT Exp. Fit. Magnitude

(indep. sky value, masking, deblending, range and method)

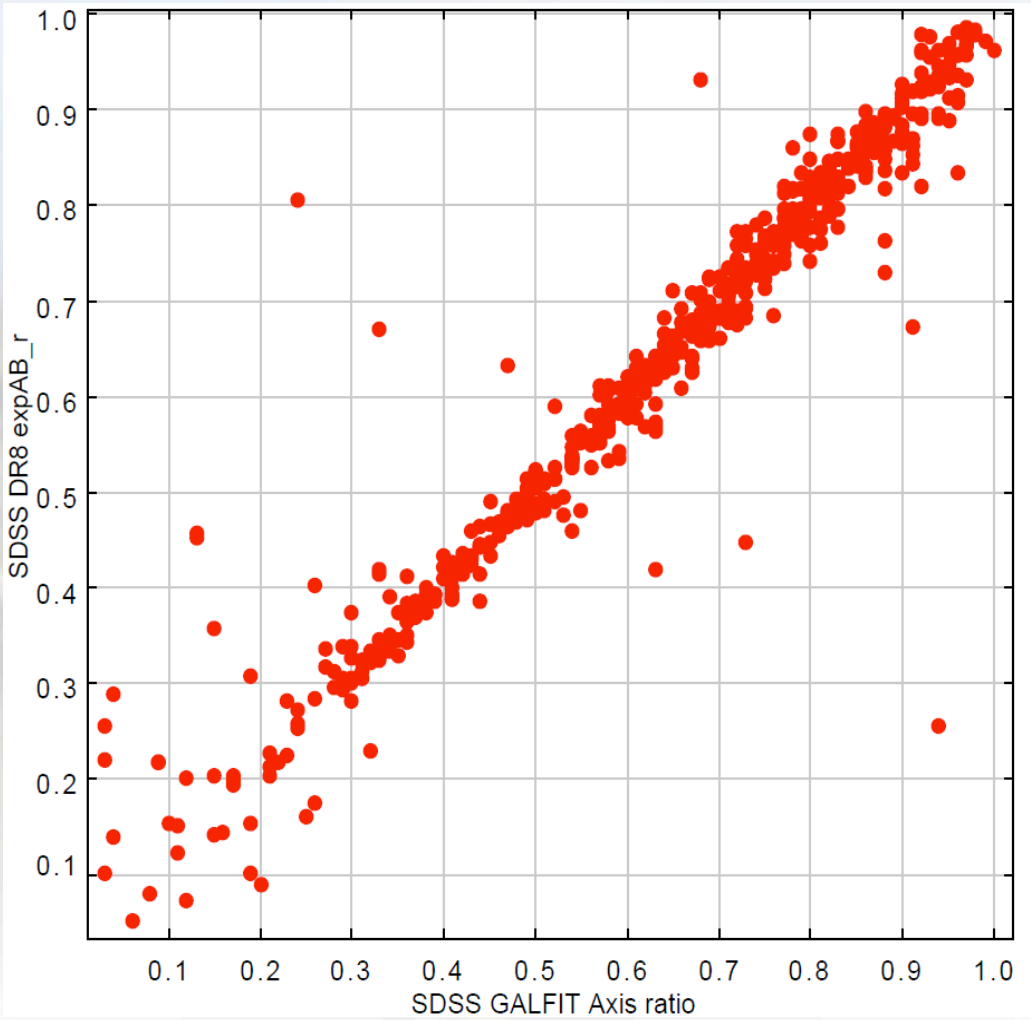


SDSS expMag_r

SDSS GALFIT Exp. Fit. Magnitude

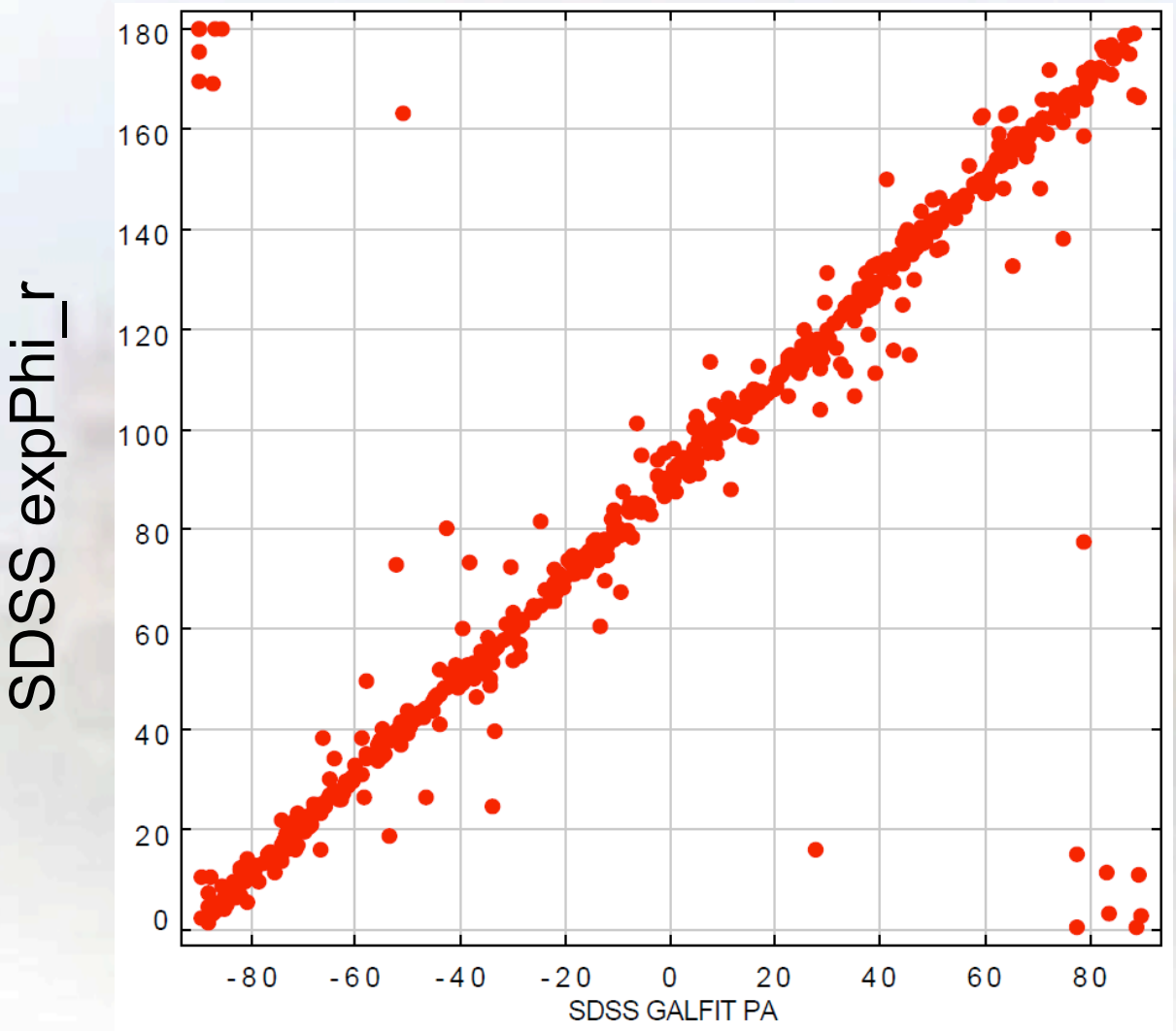
SDSS DR8 vs SDSS GALFIT Exp. Fit. Axis Ratio

SDSS expAb_r



SDSS GALFIT Axis Ratio

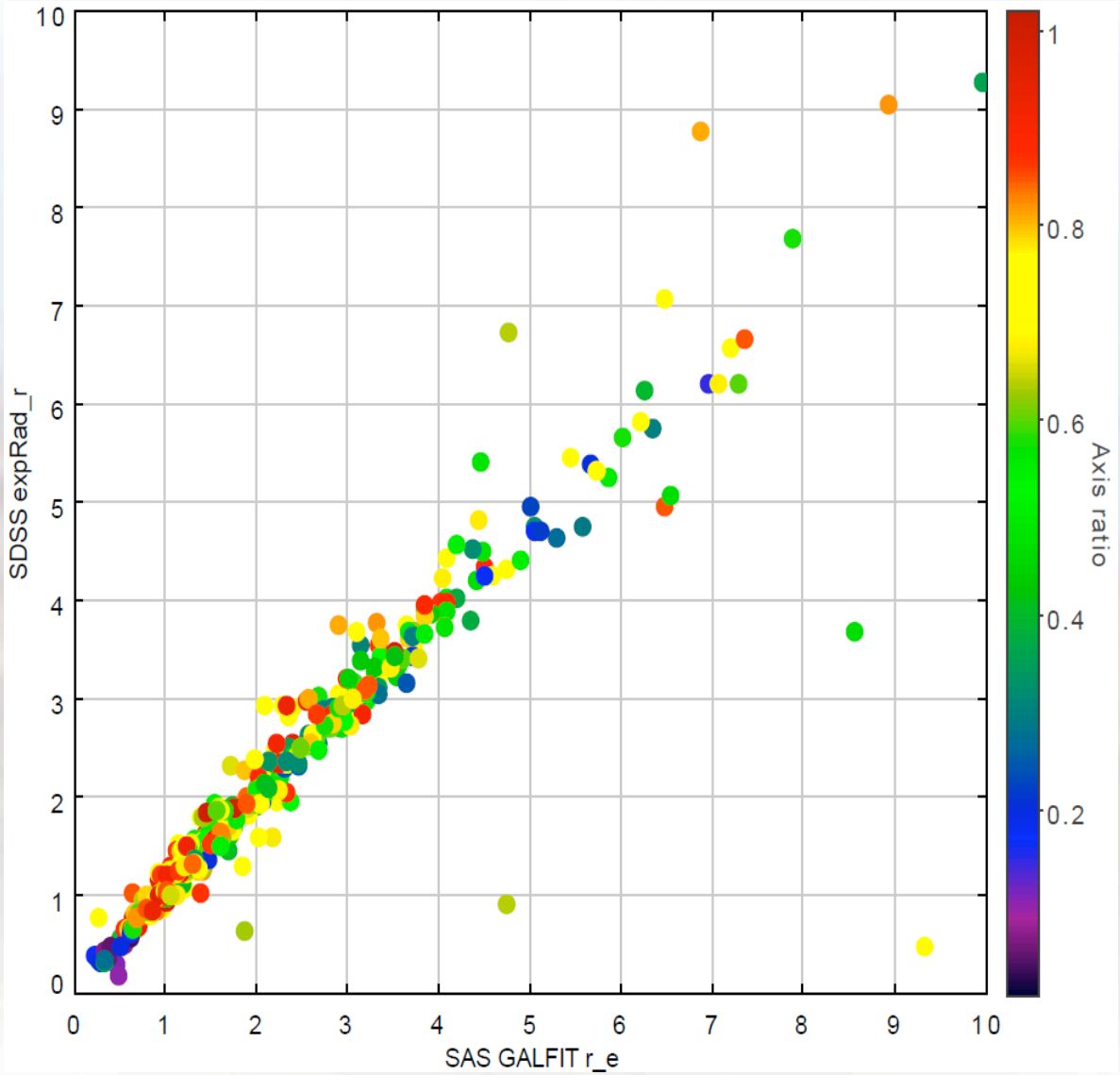
SDSS DR8 vs SDSS GALFIT Exp. Fit. PA



SDSS GALFIT PA

SDSS DR8 vs SAS GALFIT Exp. Fit. r_e

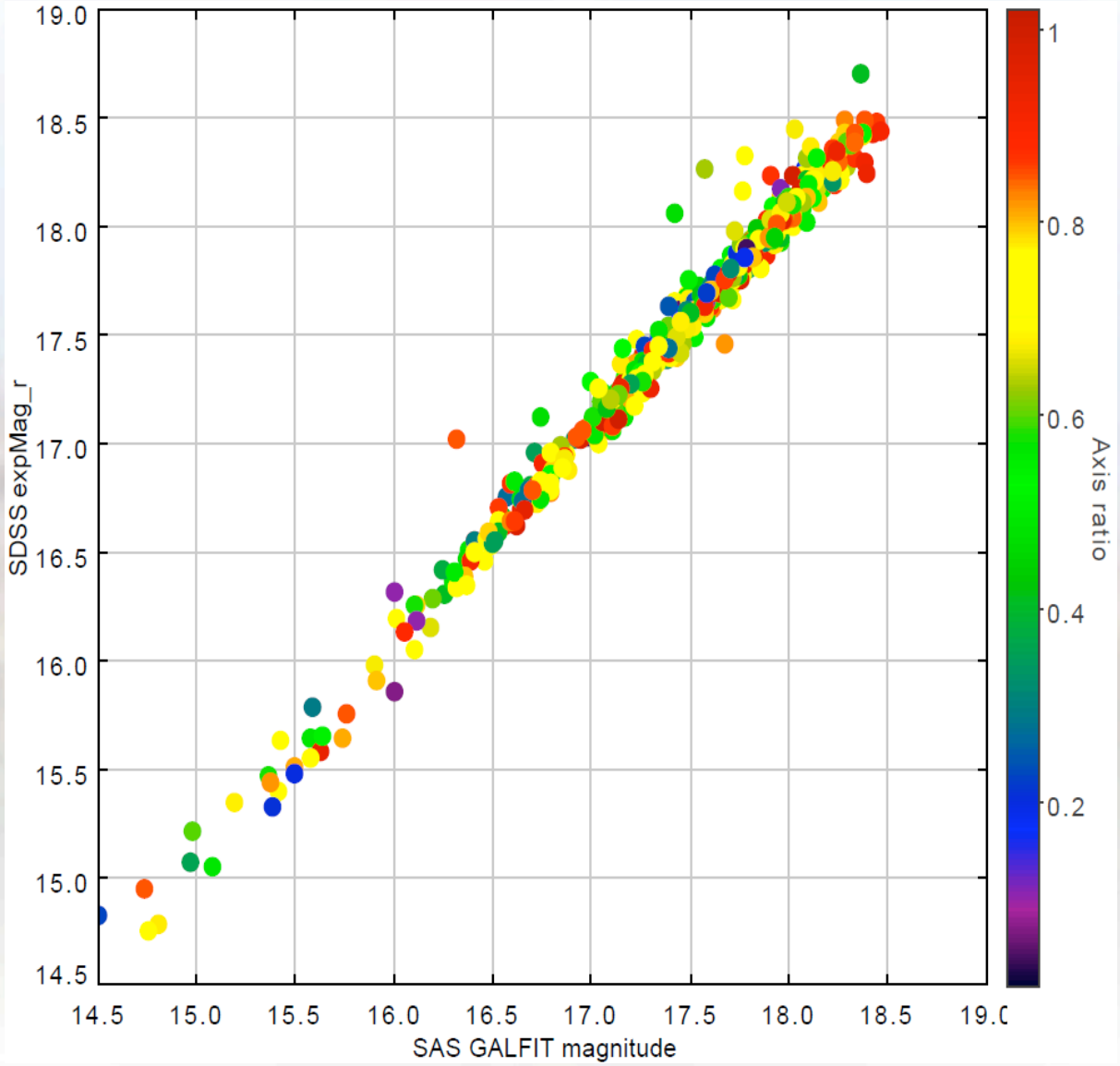
SDSS expRad_r



SAS GALFIT r_e

SDSS DR8 vs SAS GALFIT Exp. Fit. Magnitude

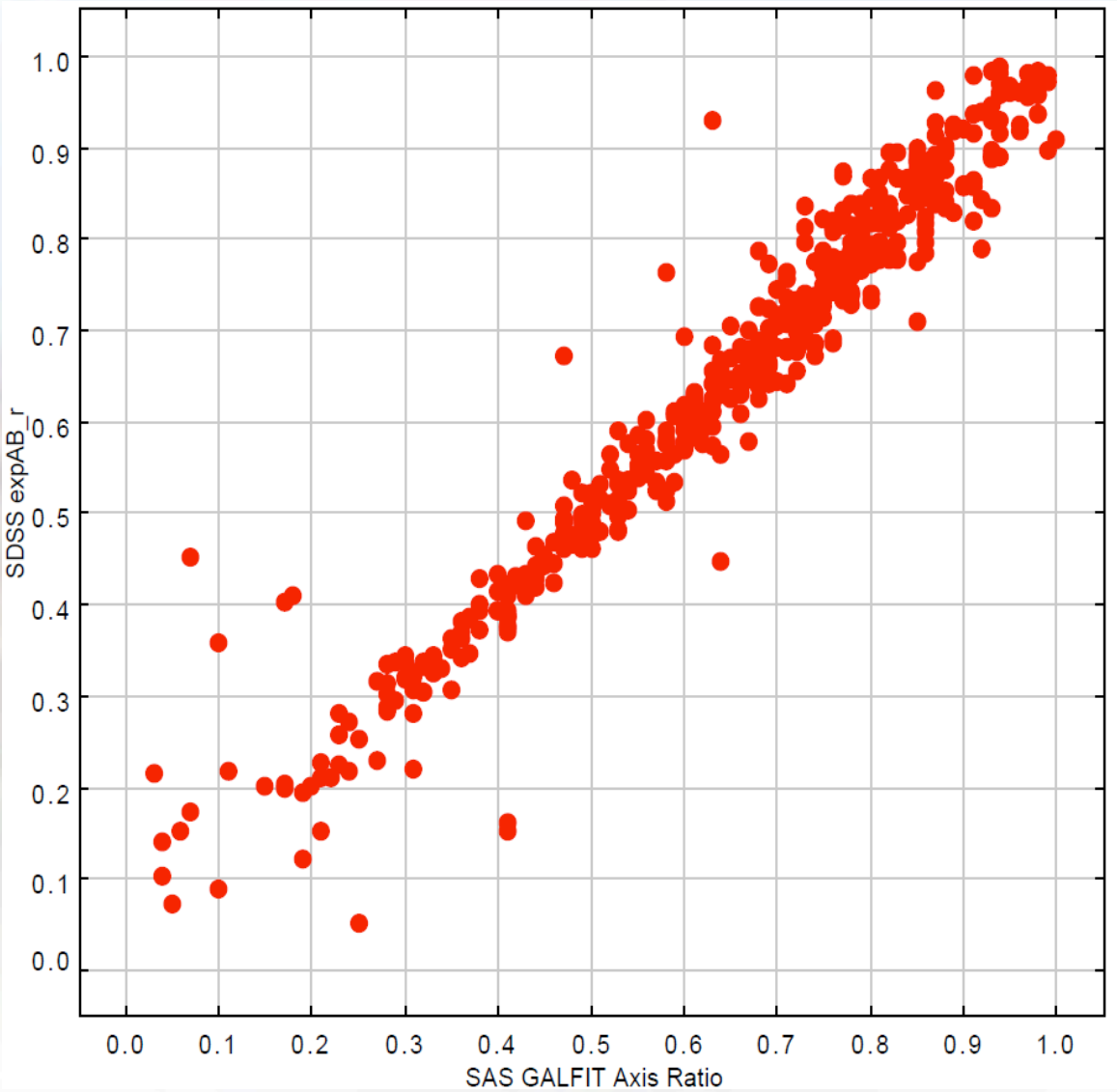
SDSS expMag_r



SAS GALFIT magnitude

SDSS DR8 vs SAS GALFIT Exp. Fit. Axis Ratio

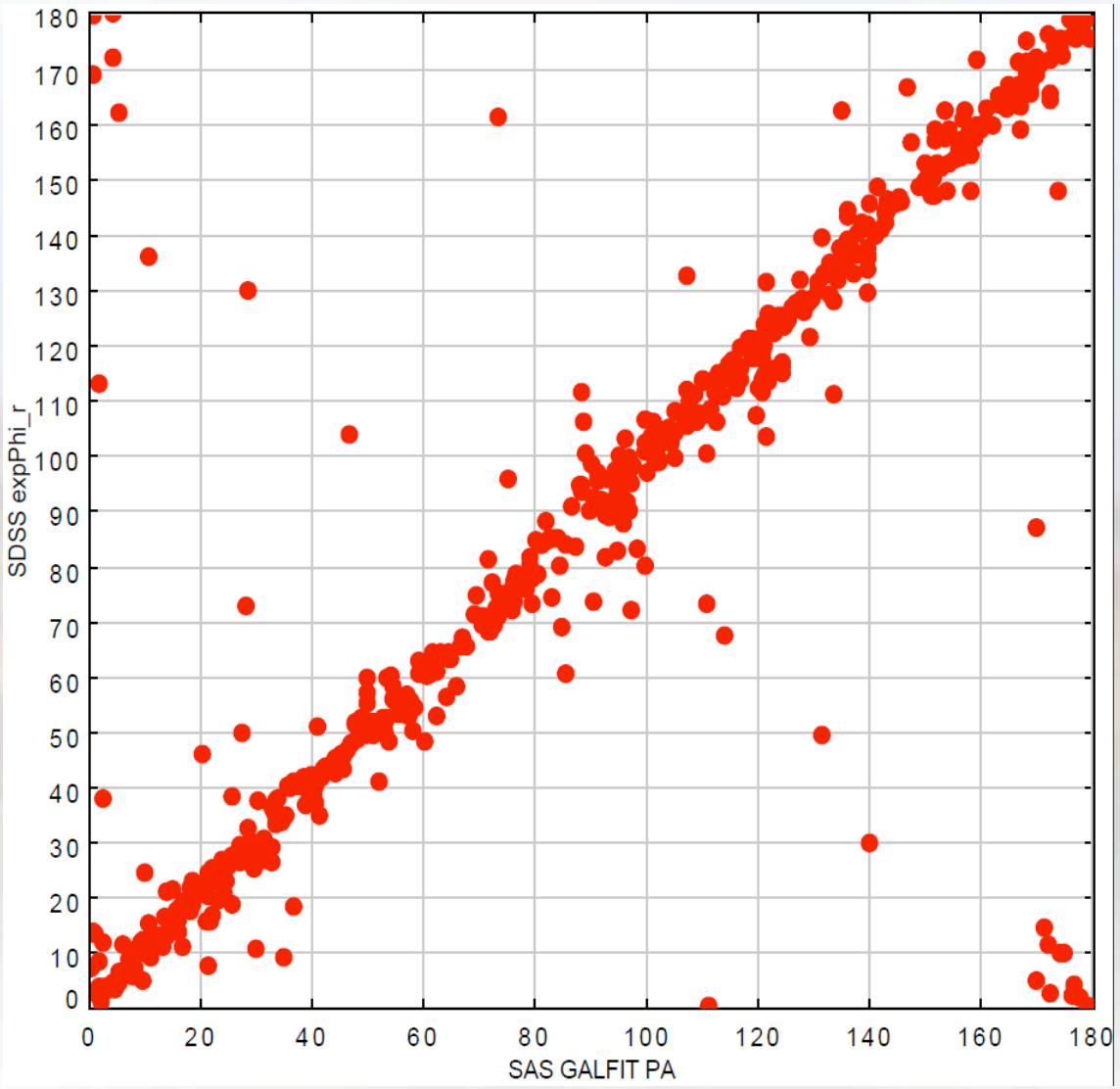
SDSS expAB_r



SAS GALFIT axis ratio

SDSS DR8 vs SAS GALFIT Exp. Fit. PA

SDSS expPhi_r

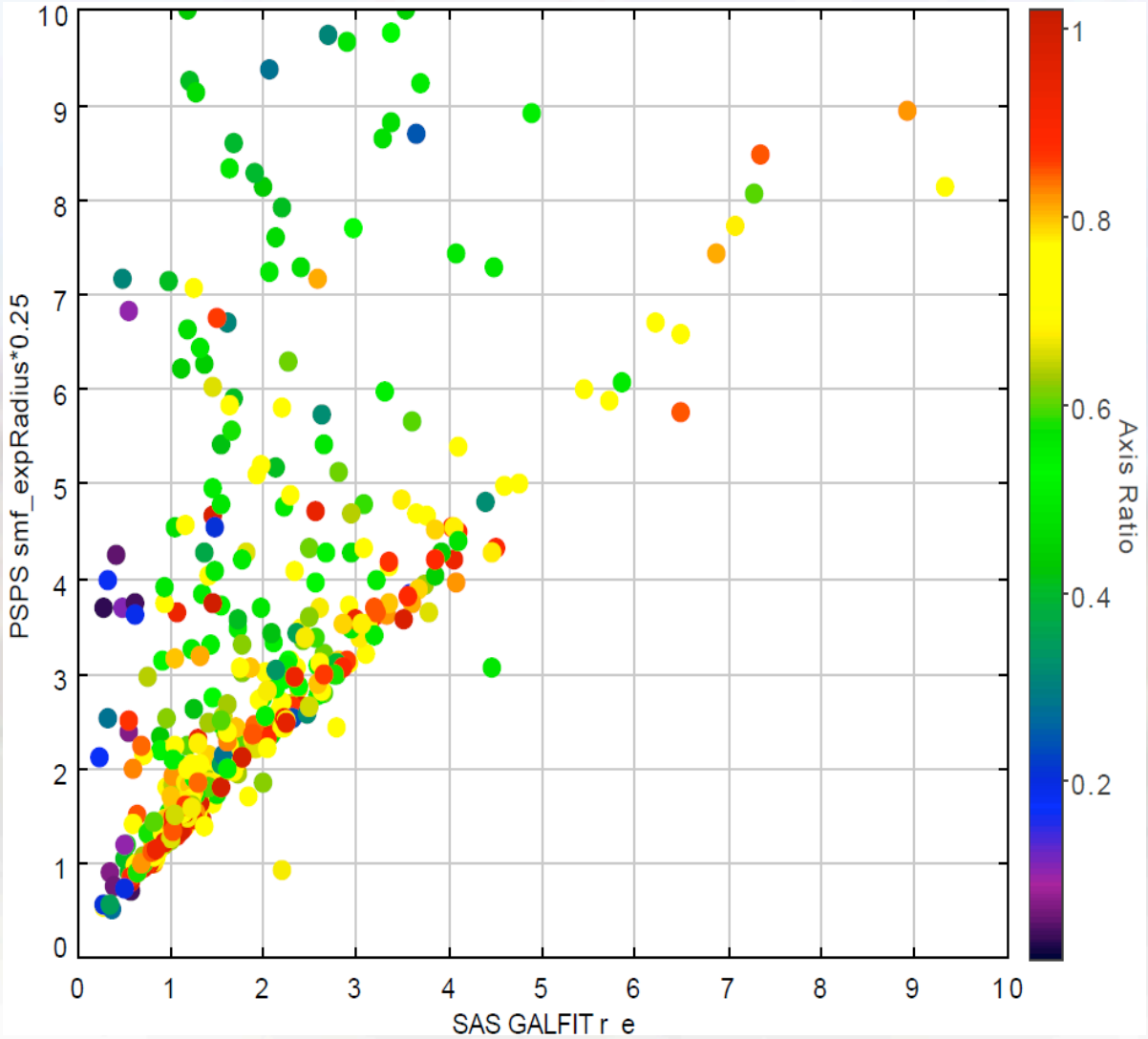


SAS GALFIT PA

SAS PSPS vs SAS GALFIT Exp. Fit. r_e

(indep. sky value, masking, deblending, range and method)

PSPS smf_expRadius

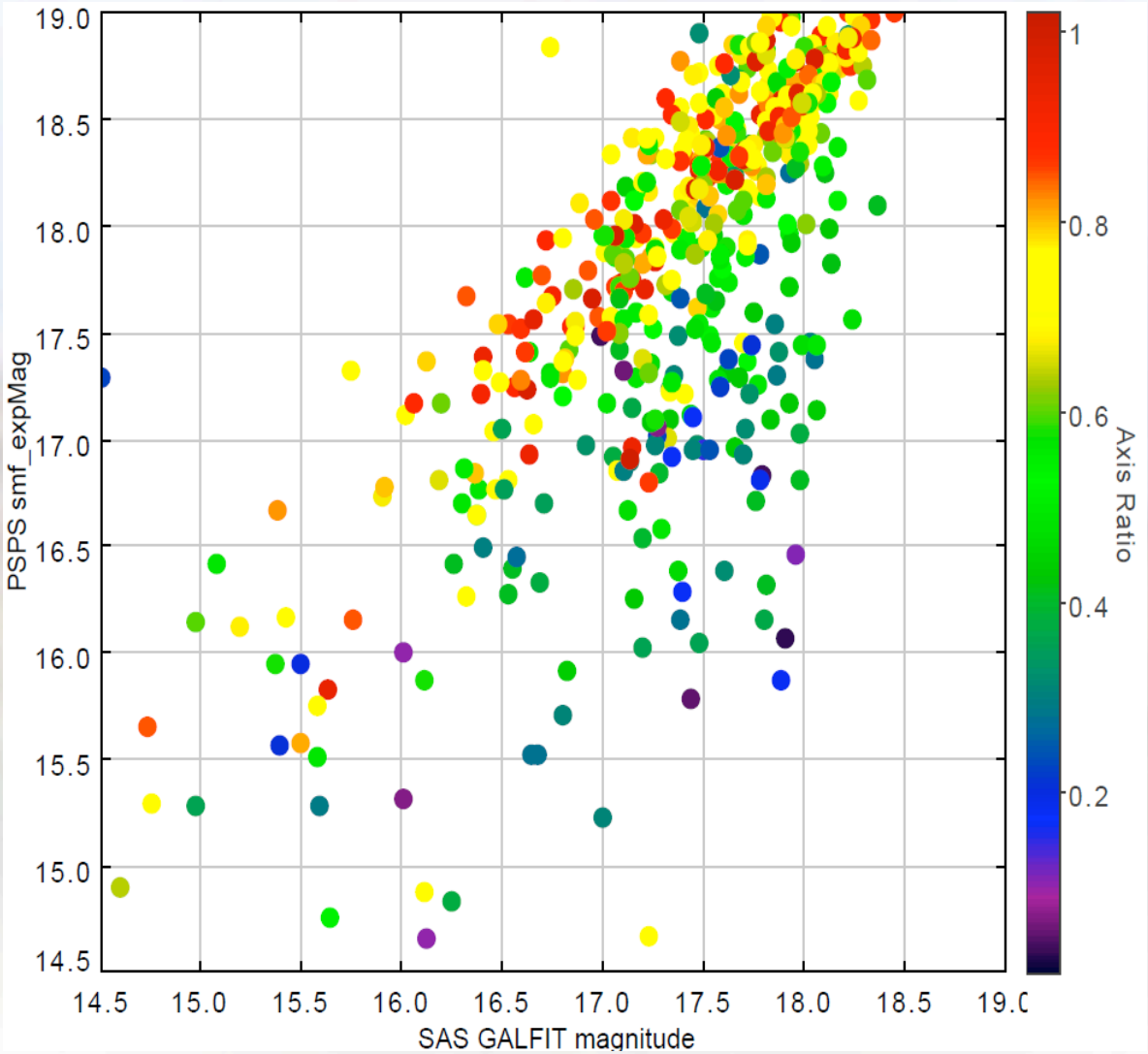


SAS GALFIT r_e

Ugh!!

SAS PSPS vs SAS GALFIT Exp. Fit. Magnitude

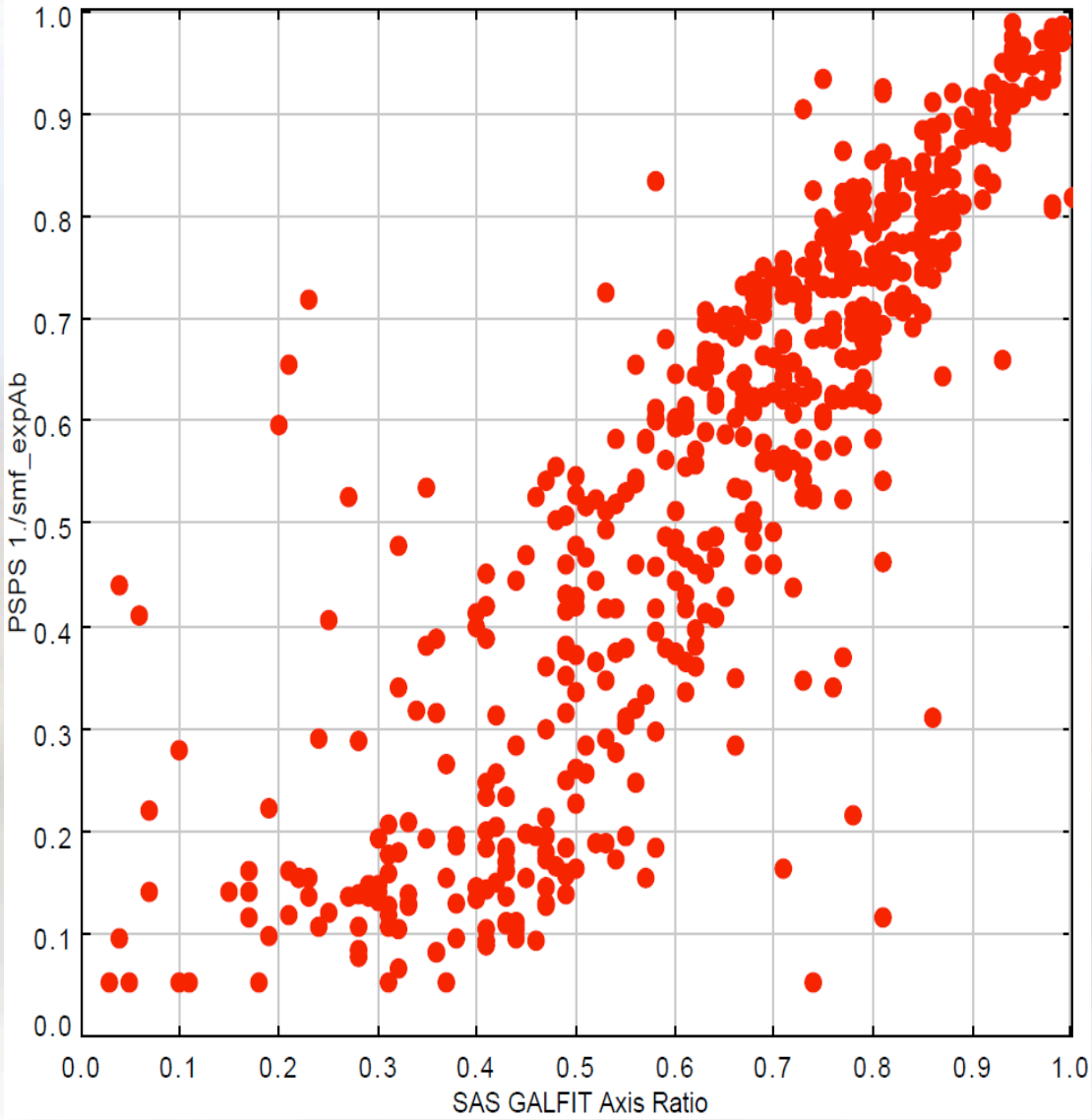
PSPS smf_expMag



SAS GALFIT magnitude

SAS PSPS vs SAS GALFIT Exp. Fit. Axis Ratio

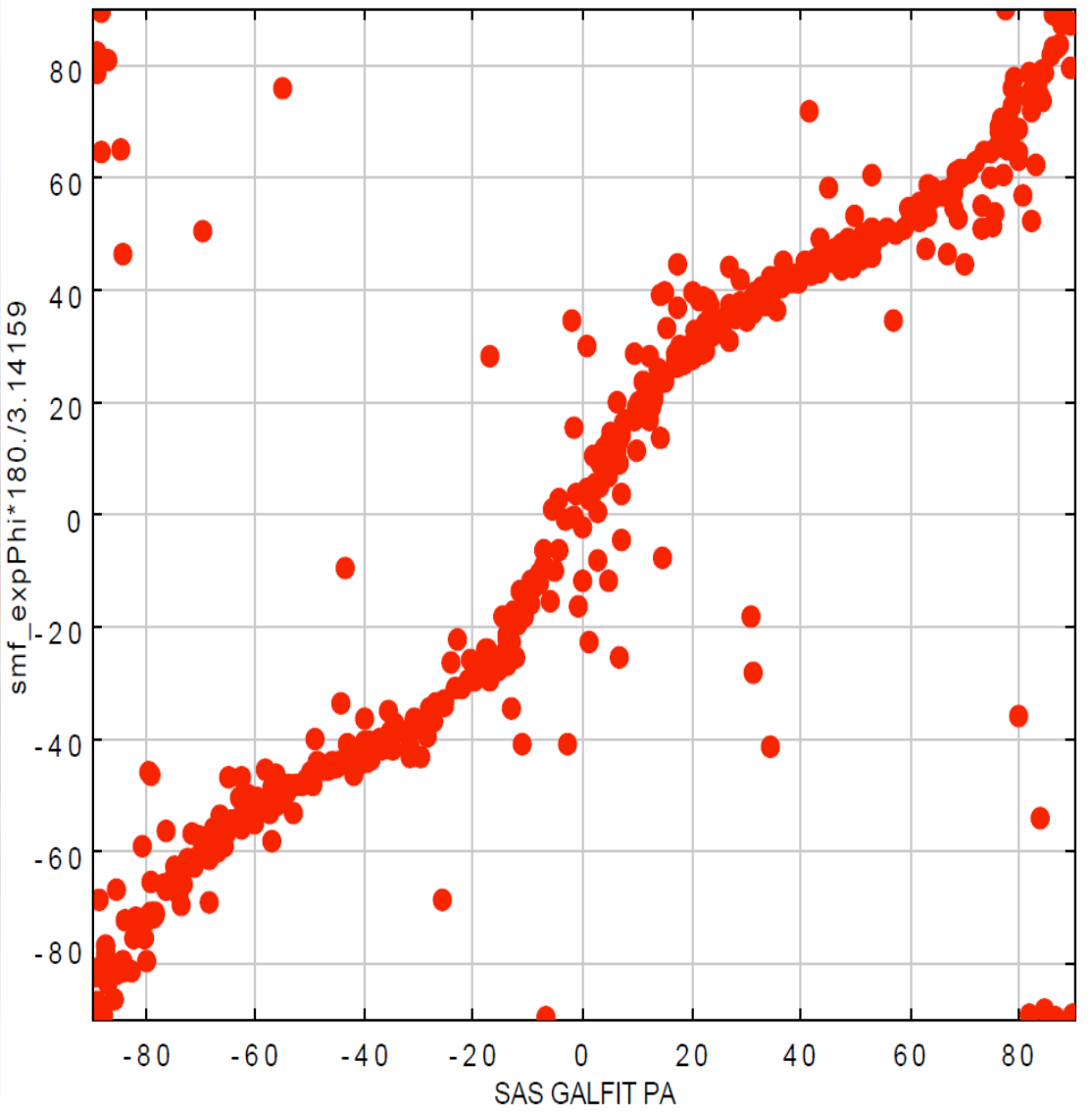
PSPS 1/smf_expAb



SAS GALFIT Axis Ratio

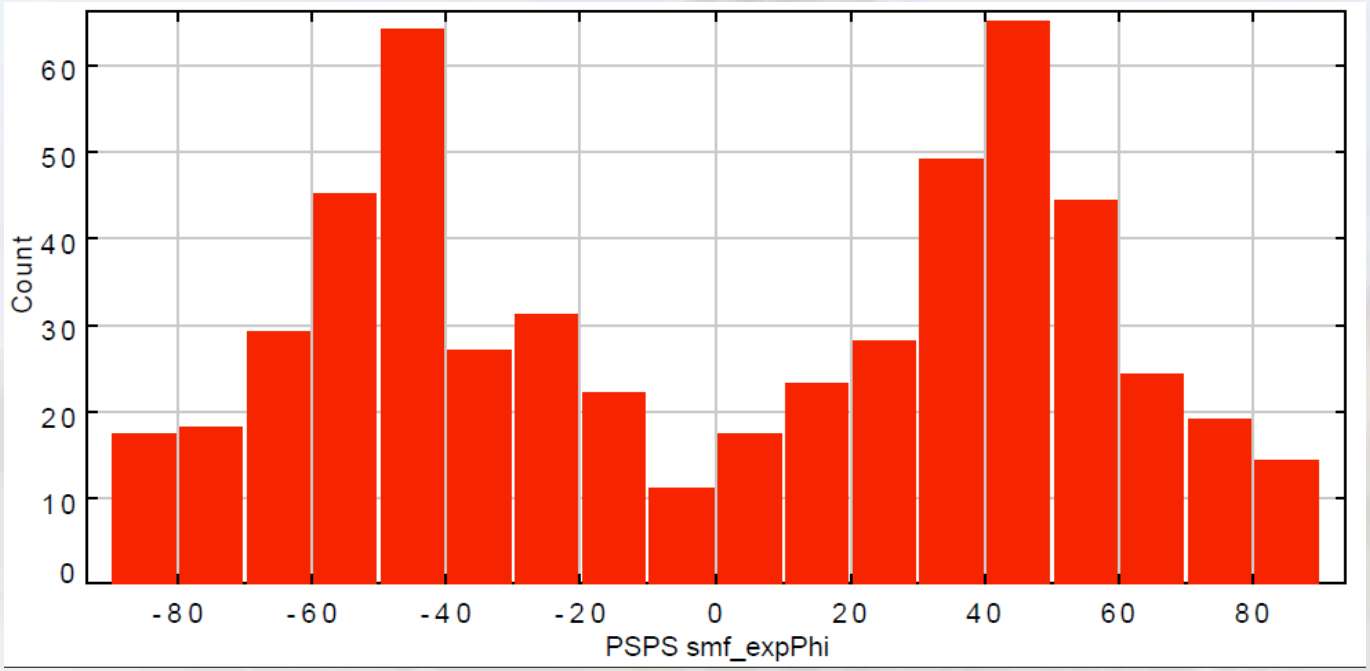
SAS PSPS vs SAS GALFIT Exp. Fit. PA

PSPS smf_expPhi



SAS GALFIT PA

SAS PSPS Exp. Fit. PA



PSPS smf_expPhi

Asymmetry, Smoothness, Clumpiness, Coarseness, Bumpiness

Many similar but equivalent definitions used

Following Im et al. (2002), we quantify the substructure contained within $r = 2r_{hl}$ and define it as

$$S = R_T + R_A. \quad (2)$$

From Simard et al. (2002) we have

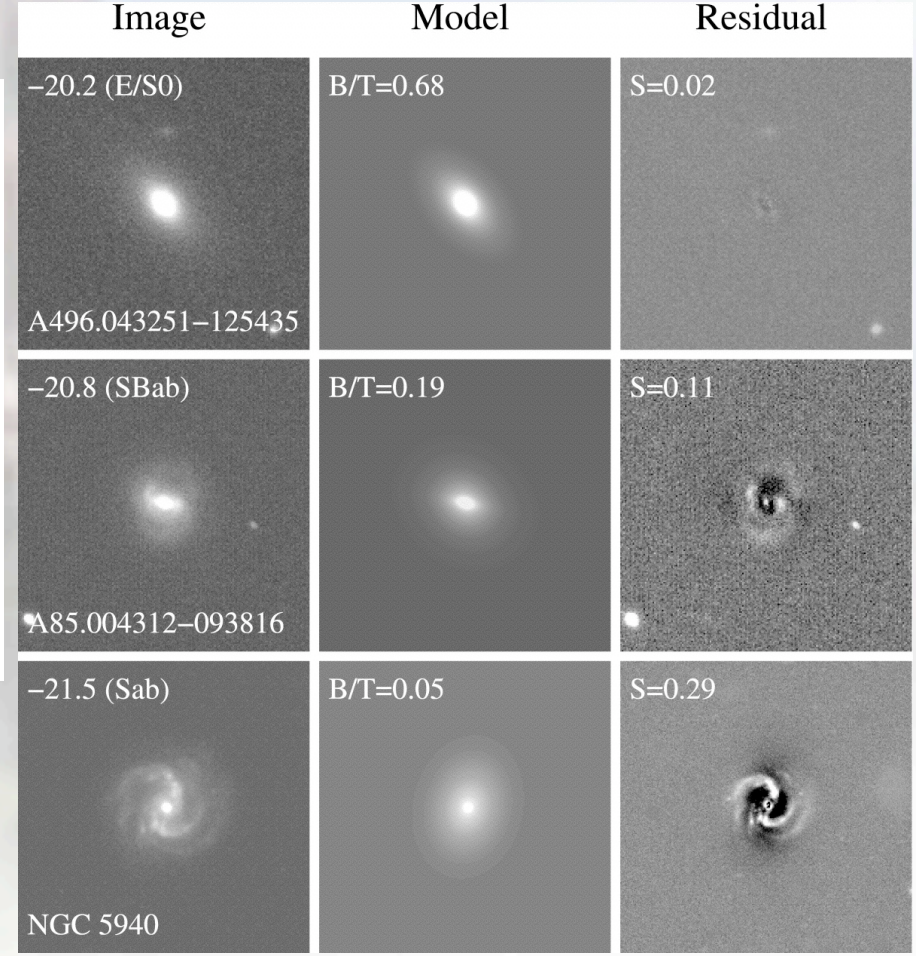
$$R_T = \frac{\Sigma(1/2)\left|R_{ij} + R_{ij}^{180}\right|}{\Sigma I_{ij}} - \frac{\Sigma(1/2)\left|B_{ij} + B_{ij}^{180}\right|}{\Sigma I_{ij}} \quad (3)$$

and

$$R_A = \frac{\Sigma(1/2)\left|R_{ij} - R_{ij}^{180}\right|}{\Sigma I_{ij}} - \frac{\Sigma(1/2)\left|B_{ij} - B_{ij}^{180}\right|}{\Sigma I_{ij}}. \quad (4)$$

R_T = total residual flux
R_A = asymmetric residual flux
S = R_T + R_A

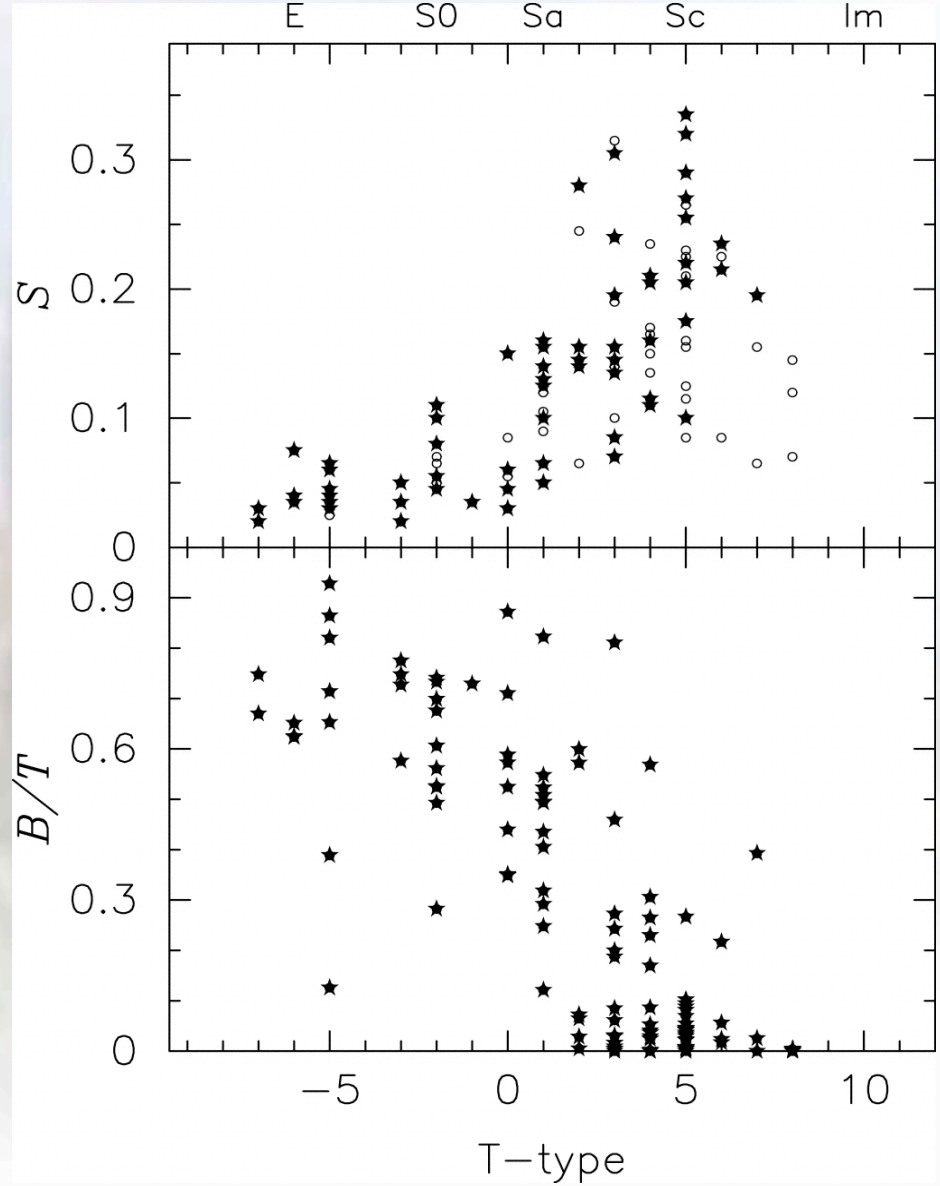
(see Schade et al 1995, GIM2D)



McIntosh, Rix, Caldwell (2004)

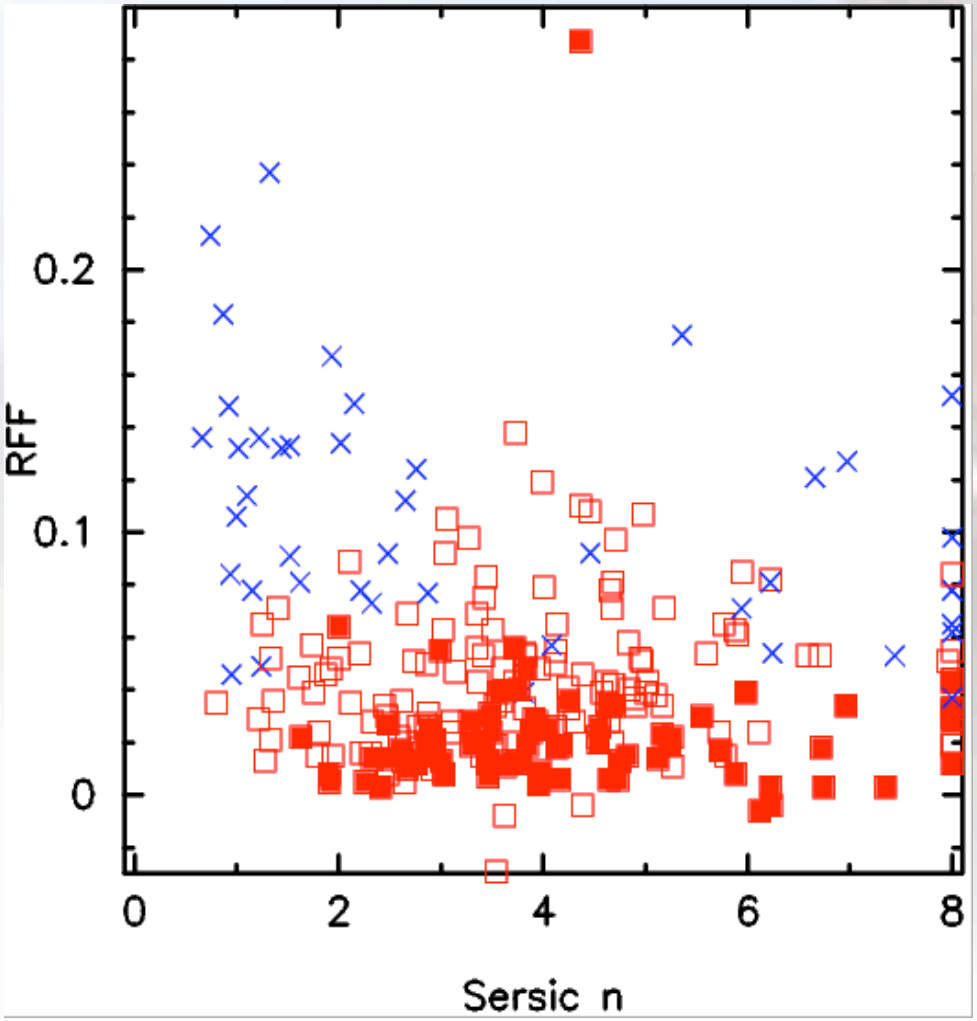
Smoothness, etc, closely related to morphological type

McIntosh, Rix, Caldwell (2004)

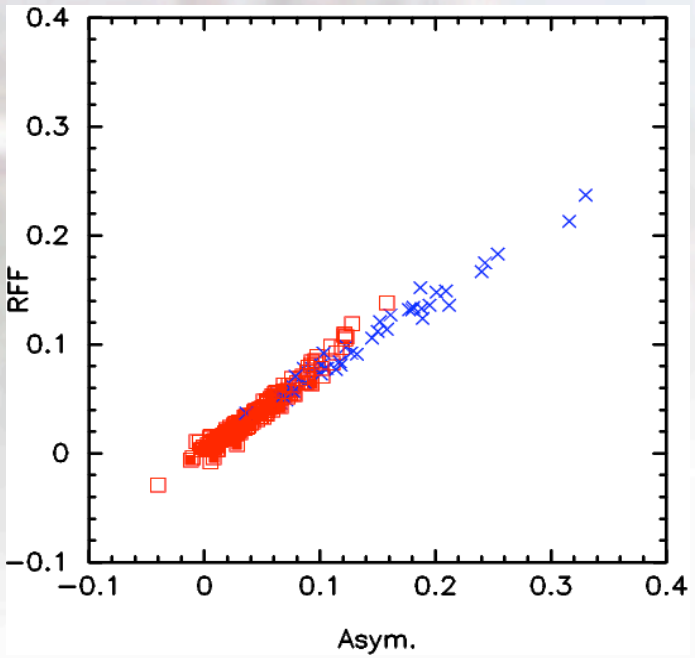


Smoothness, etc, closely related to morphological type

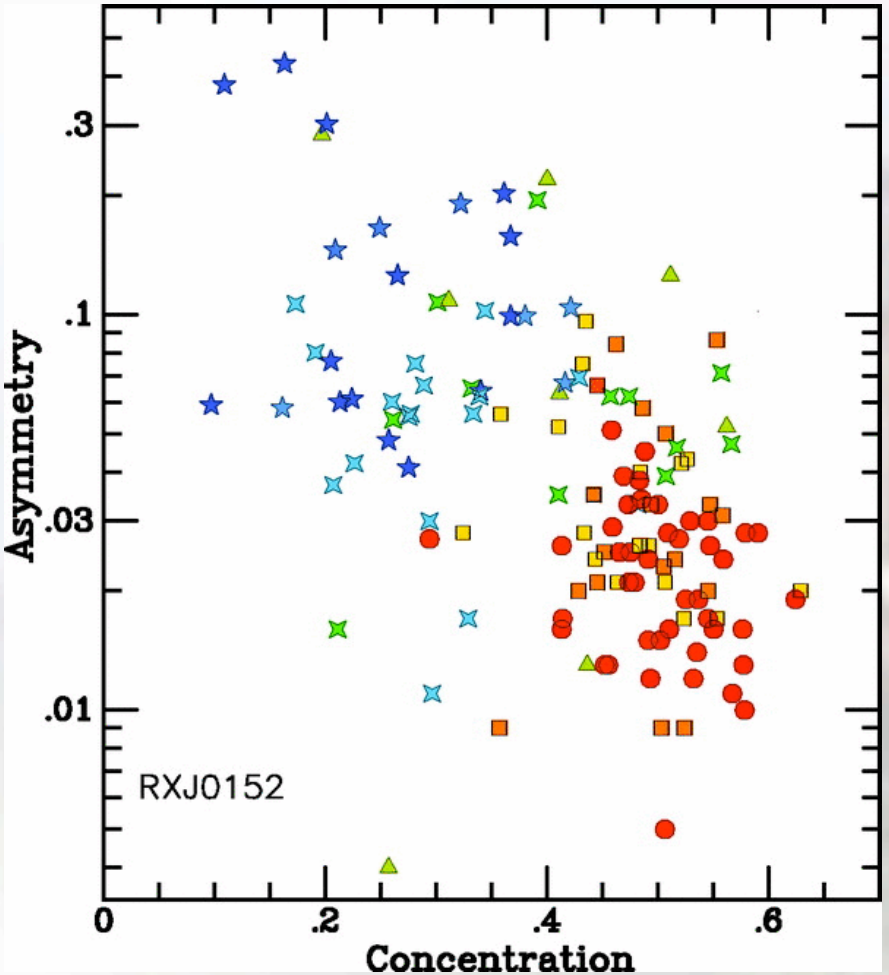
Morphological types for Coma cluster
Analysis of SDSS r-band images
Elliptical (filled squares), S0 (open squares), spirals (crosses)

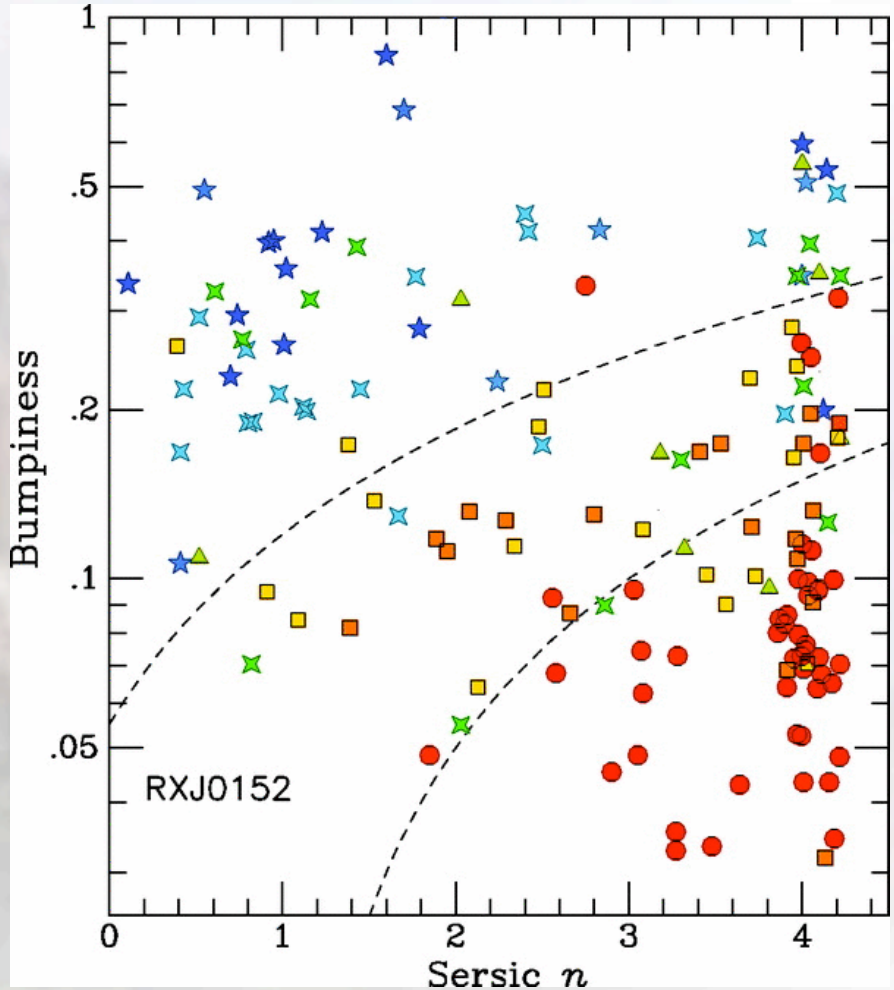


RFF = Residual Flux Fraction,
i.e. what is not accounted for with the best-fit Sersic model.
Very similar to the “standard” smoothness parameter.
(Hoyos et al 2001)



Asymmetry, Concentration, Sersic *n*, Bumpiness (Blakeslee et al 2006)

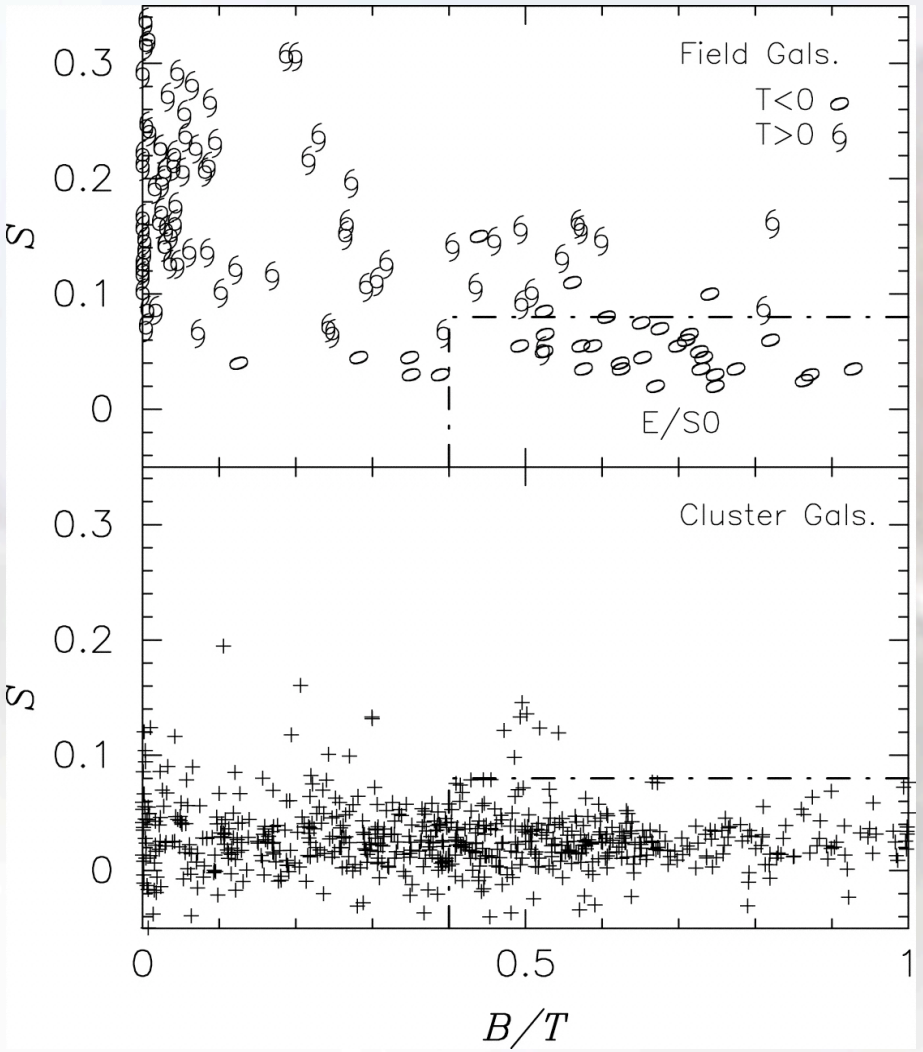




Elliptical (circles), S0 (squares), S0/a (triangles), spirals (4-pointed stars),
Irr (5-pointed stars)

"Bumpiness" parameter = ratio of the rms residuals after galaxy model subtraction

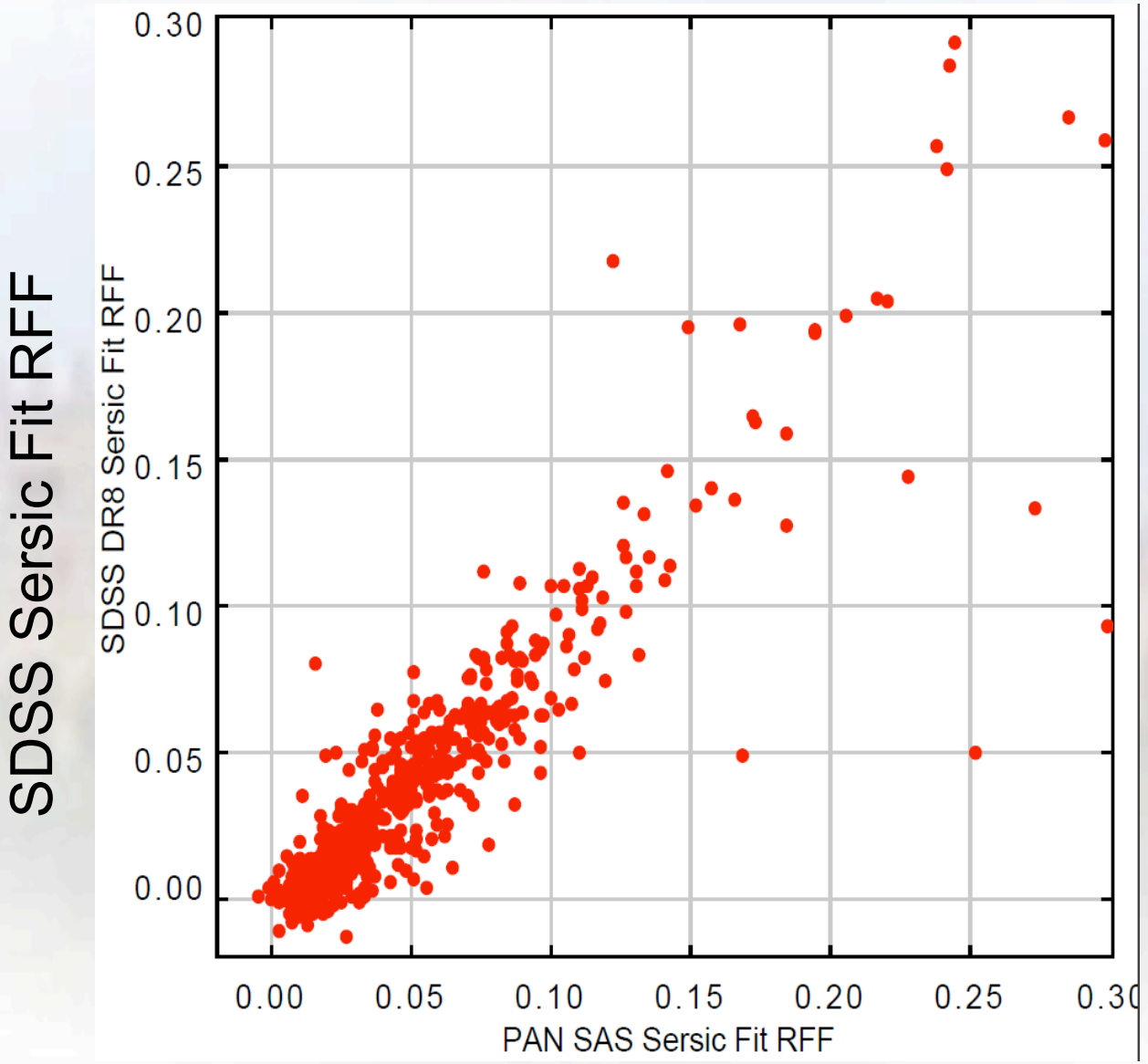
Internal structure closely related to environment



McIntosh, Rix, Caldwell (2004)

Little structure in cluster disk galaxies.

Comparison of RFF derived from SDSS and SAS



Conclusions

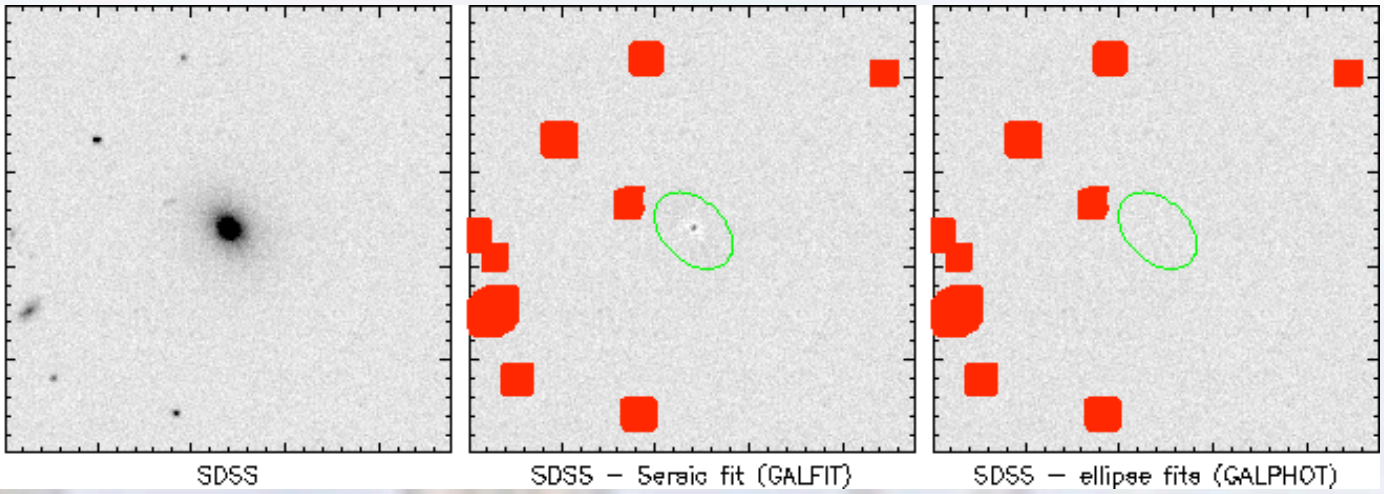
1. Reliable extended source parameters for galaxies in the r-band magnitude range 14 to 18 can be derived from SAS imagery.

2. Currently the PSPS extended source parameters are erroneous.

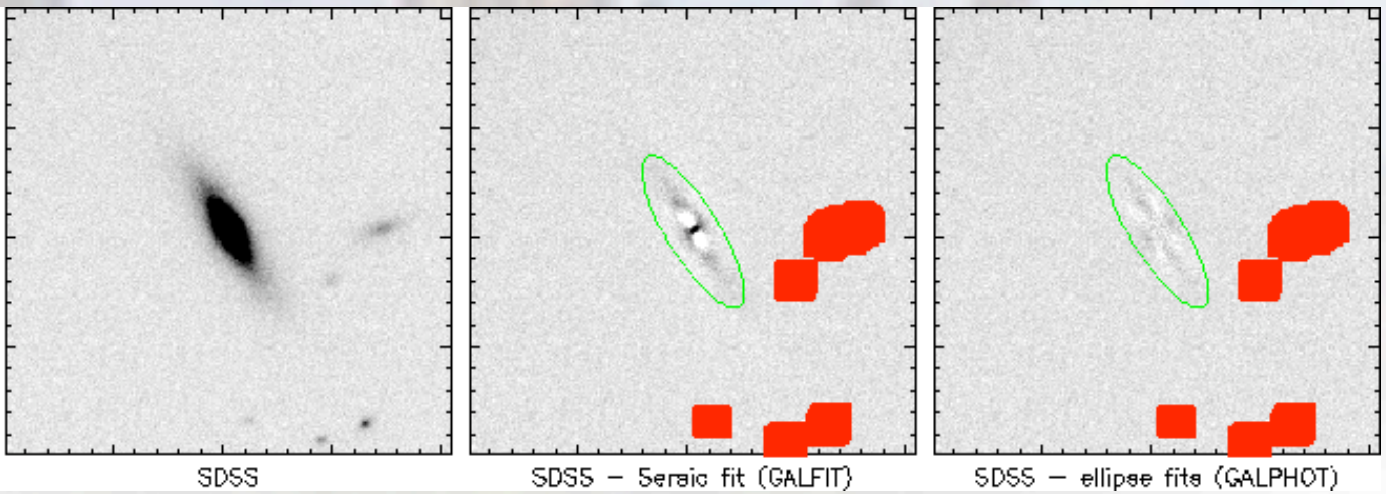
3. “Smoothness” derived from SDSS and SAS show good agreement.

Possible Additional Parameters II: Sersic fit residuals

587741722287014069
gmp2278
D010 E
(238x238)
n = 4.64
npix = 1238
Chi2 = 1.11
Residual flux = 0.014
sdss petro mag = 15.983
JRL petro mag = 15.898



587741602572992587
gmp1832
D036 S0
(204x204)
n = 2.24
npix = 1502
Chi2 = 2.20
Residual flux = 0.071
sdss petro mag = 15.430
JRL petro mag = 15.370



Possible Additional Parameters II: Sersic fit residuals

587741602572796090
gmp3238
D052 Sb
(376x376)
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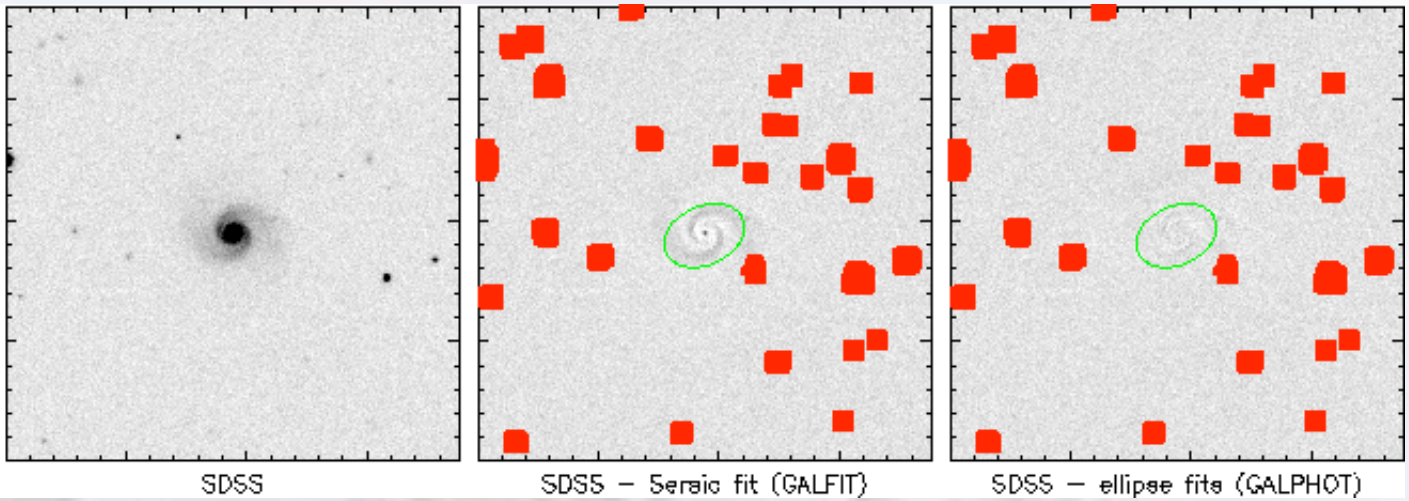
npix = 2663
Chi2 = 1.65
Residual flux = 0.076
sdss petro mag = 15.399
JRL petro mag = 15.307



587741723360886912
gmp1582
D202 Sd/I
(208x208)
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npix = 2263
Chi2 = 2.44
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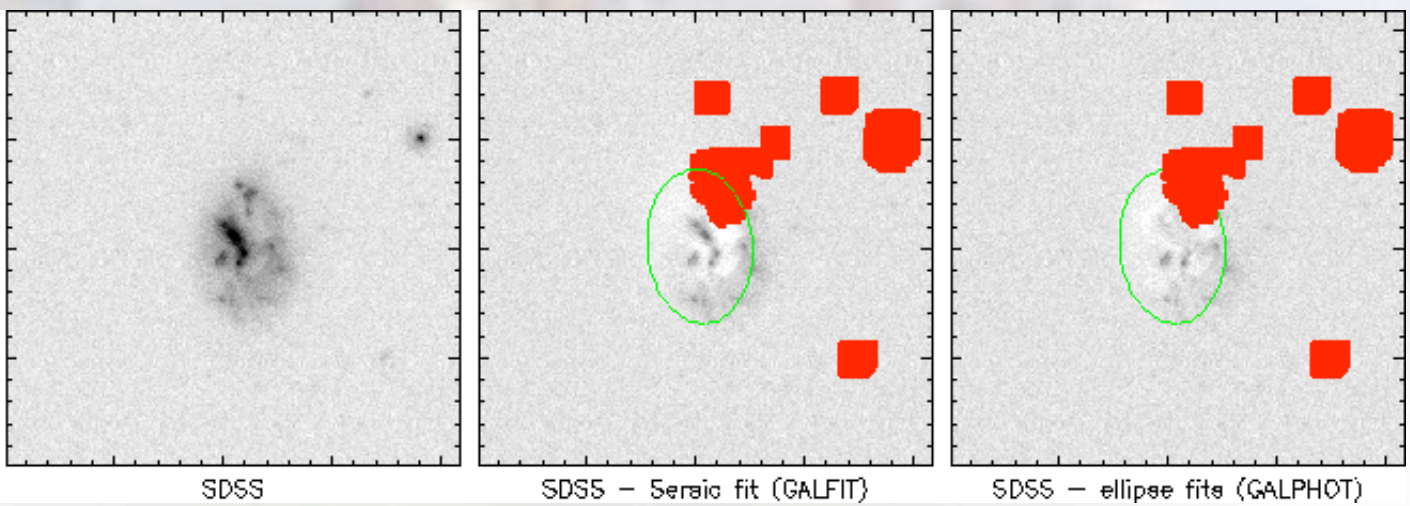
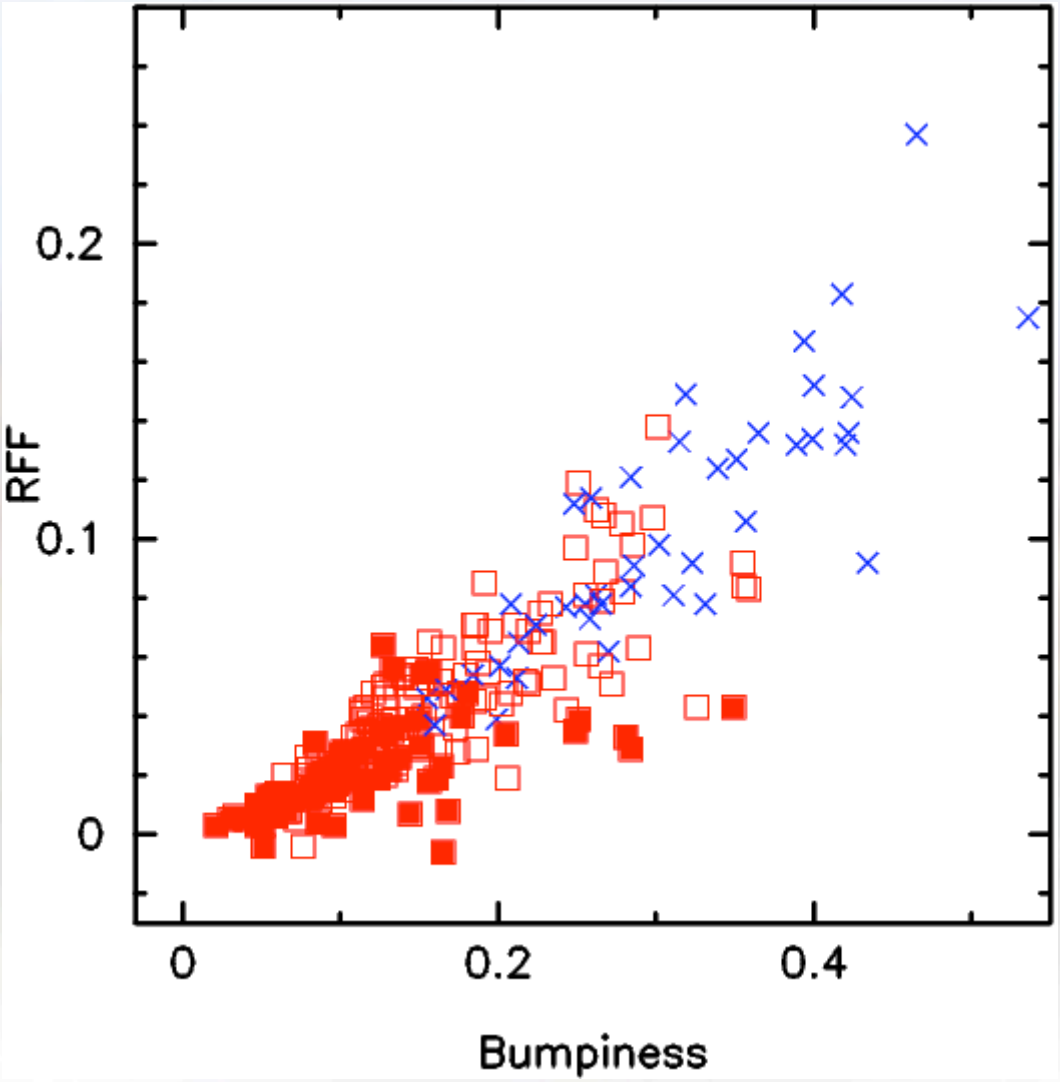
sdss petro mag = 16.299
JRL petro mag = 15.731




0.2
0.1
0
RFF
0
0.2
0.4
Bumpiness