Morphological classification of compact and extended sources by PDF analysis

Carlos López San Juan
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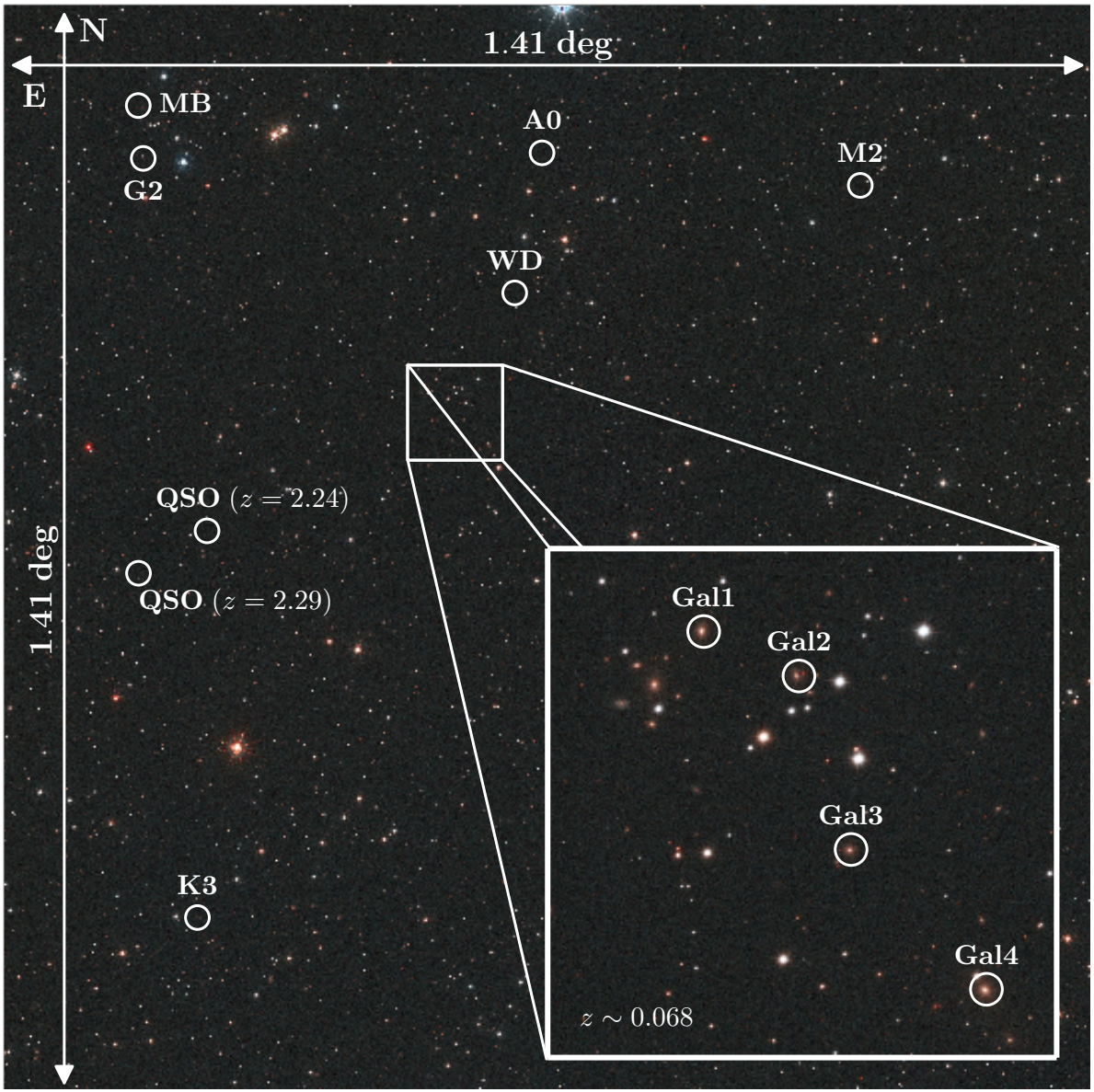
K. Viironen & the J-PLUS collaboration

Centro de Estudio de Física del Cosmos de Aragón

J-PLUS EDR RIA meeting / 2nd October 2017

Funding agencies :

Objects classification



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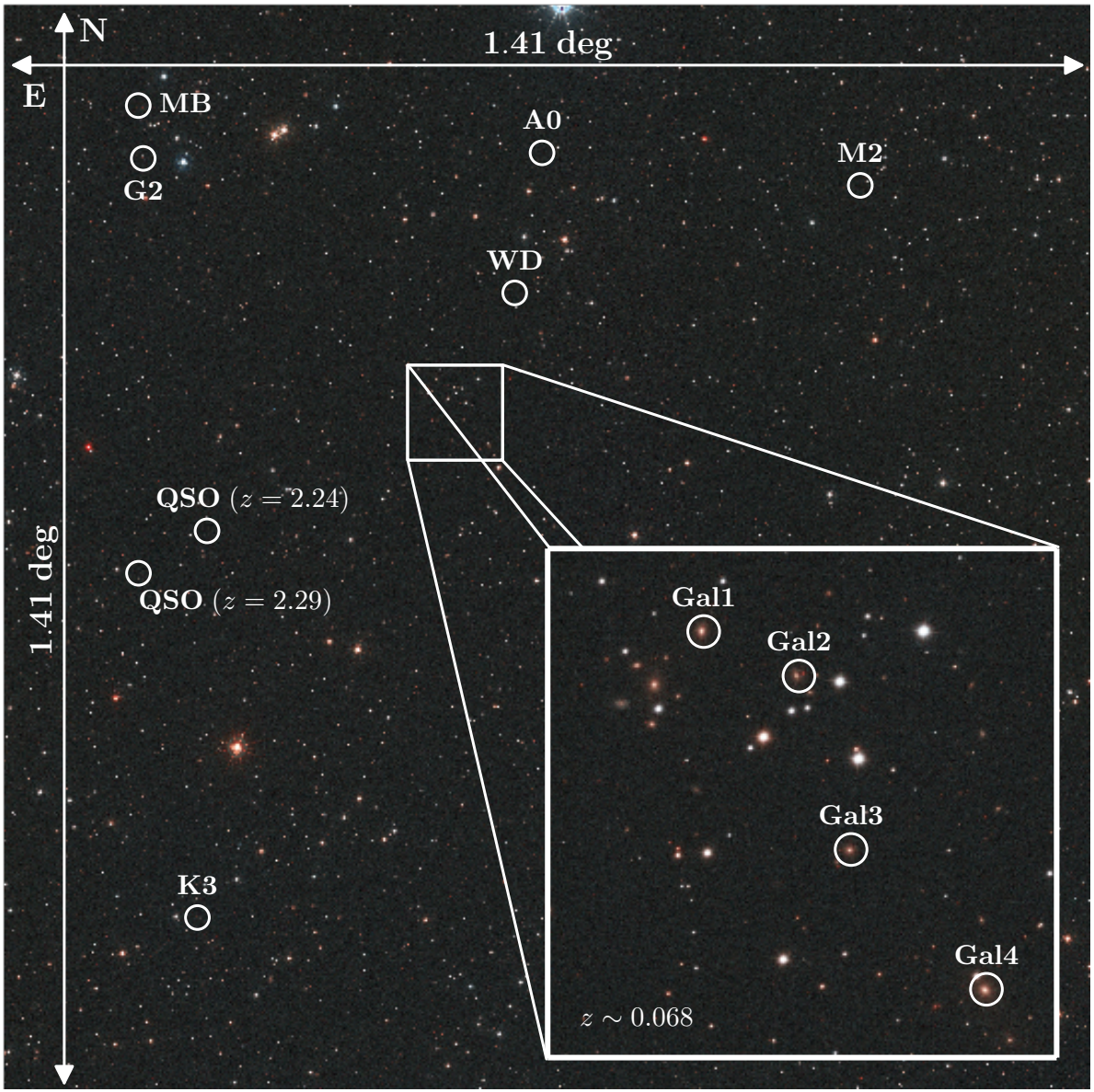

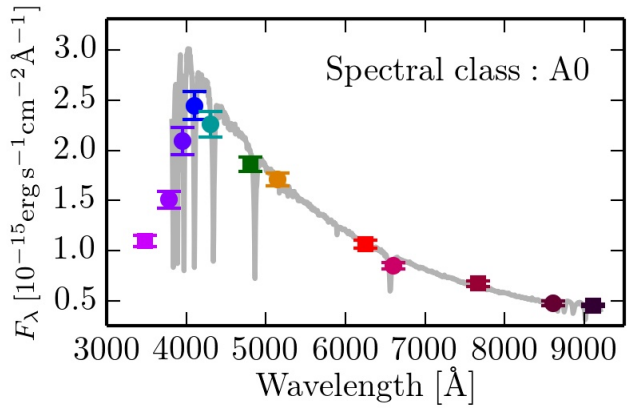

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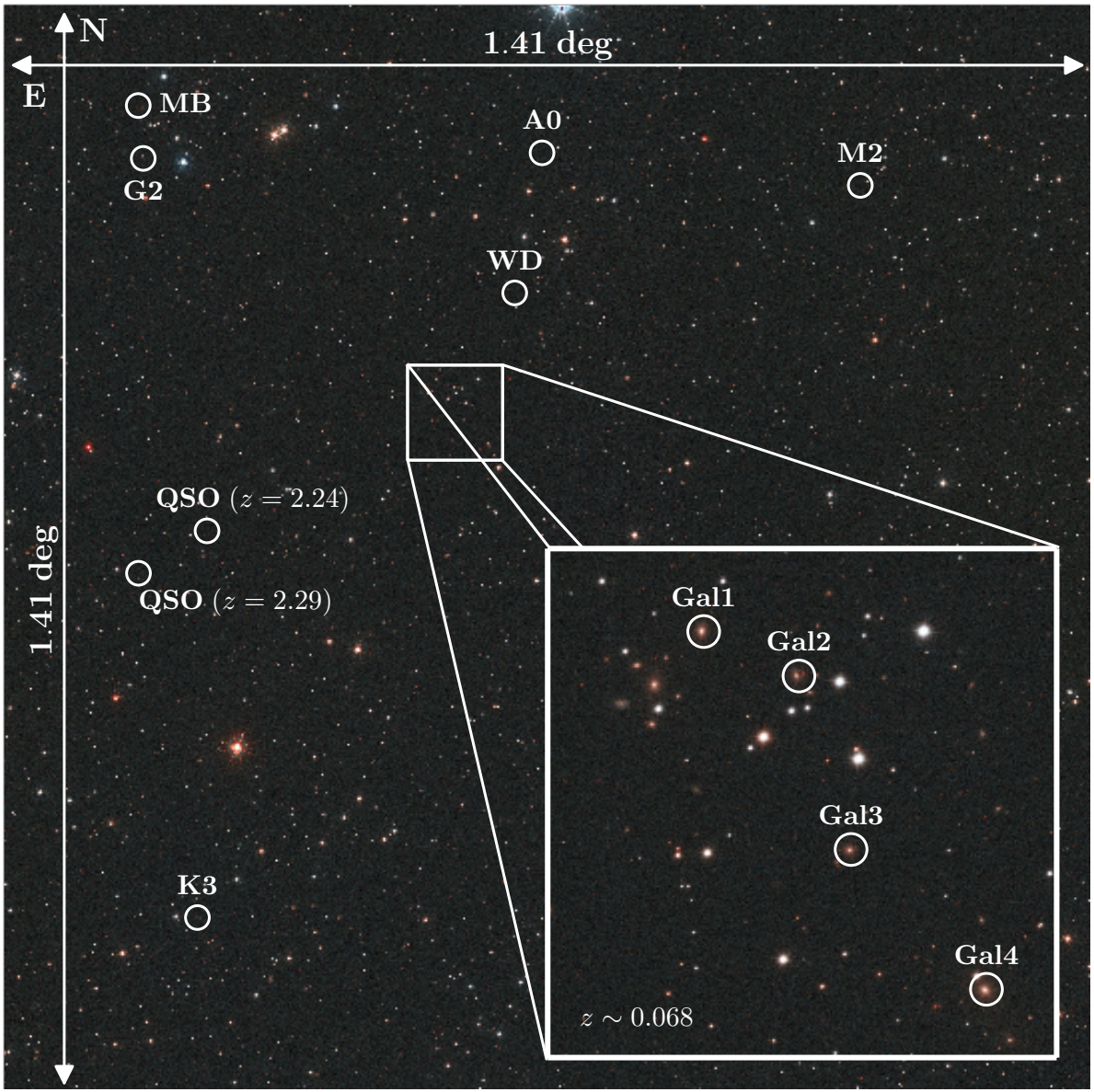

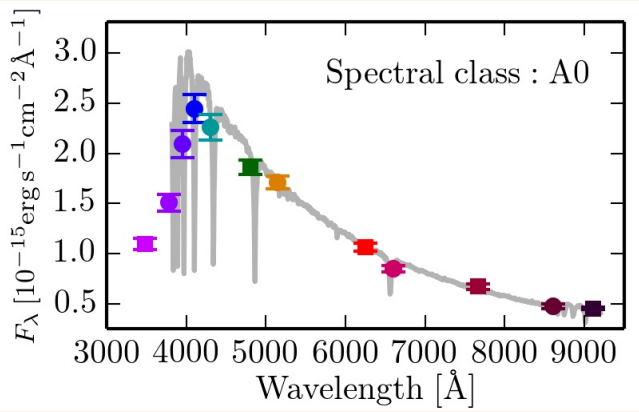

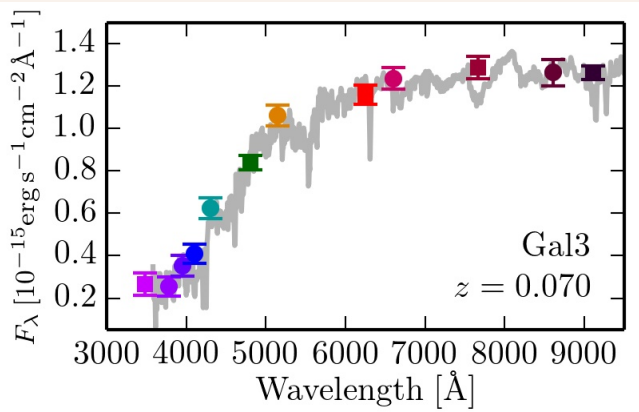

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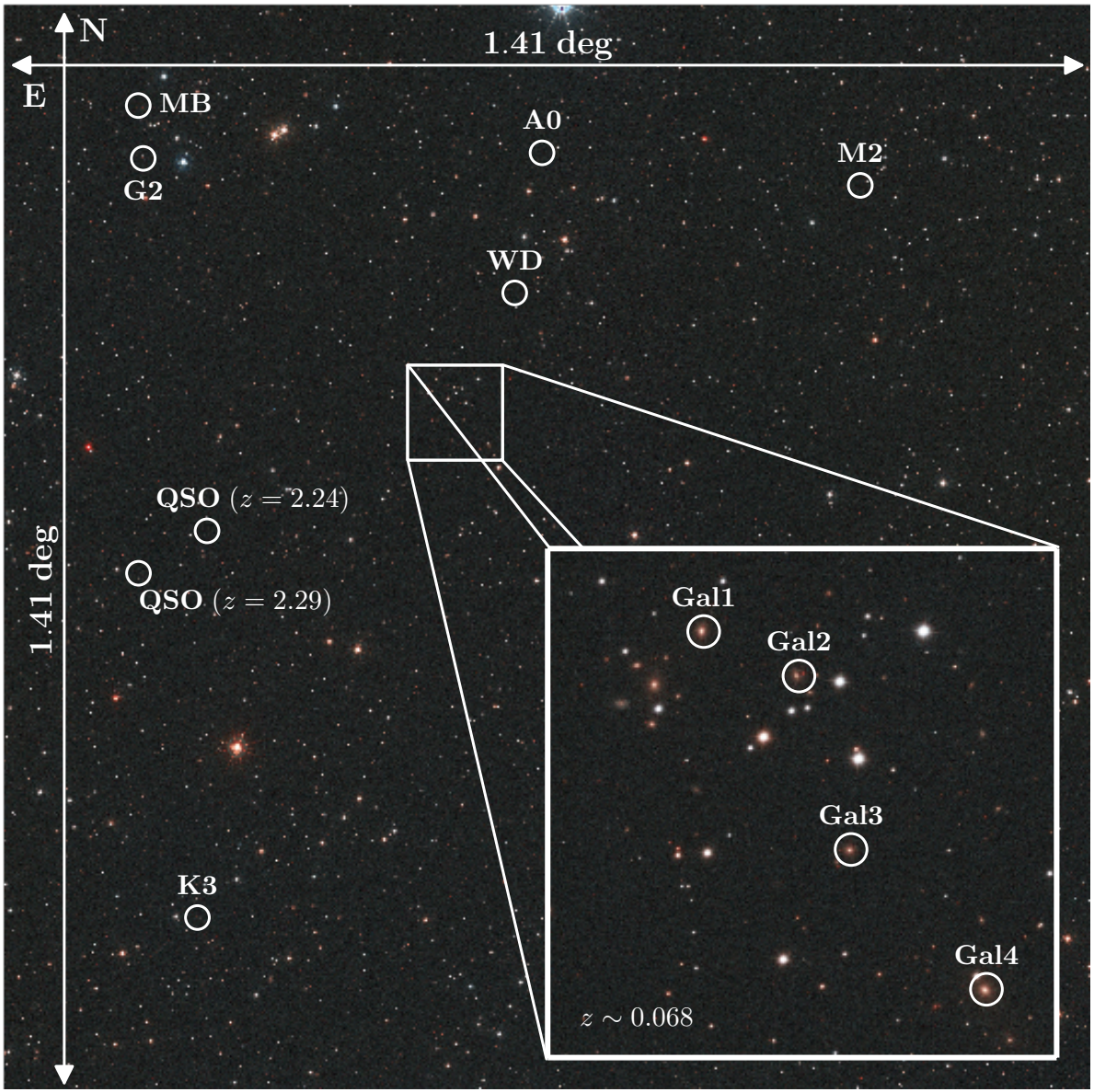

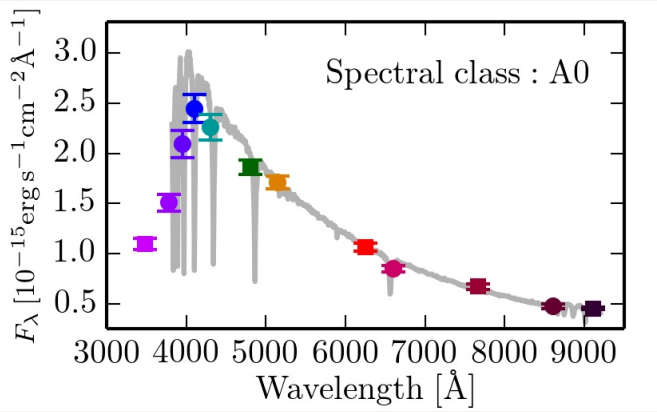

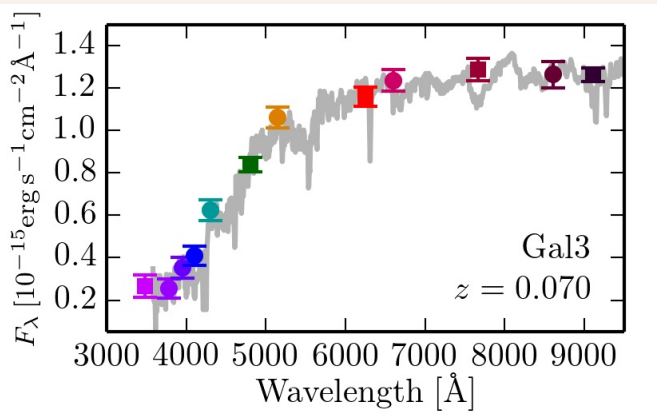

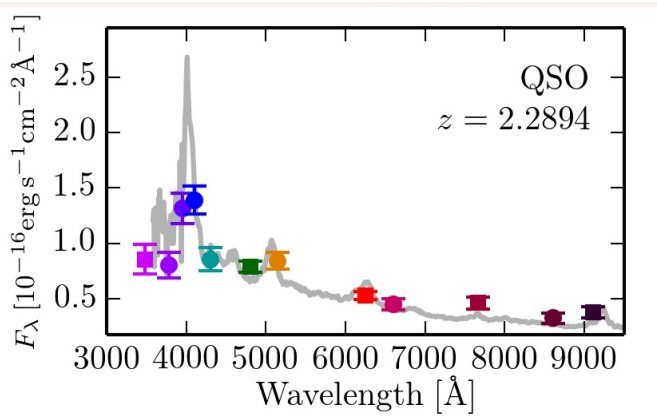

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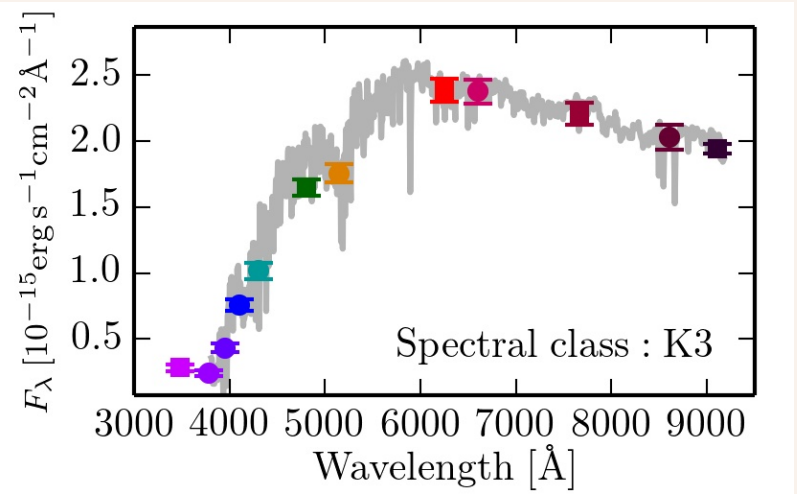

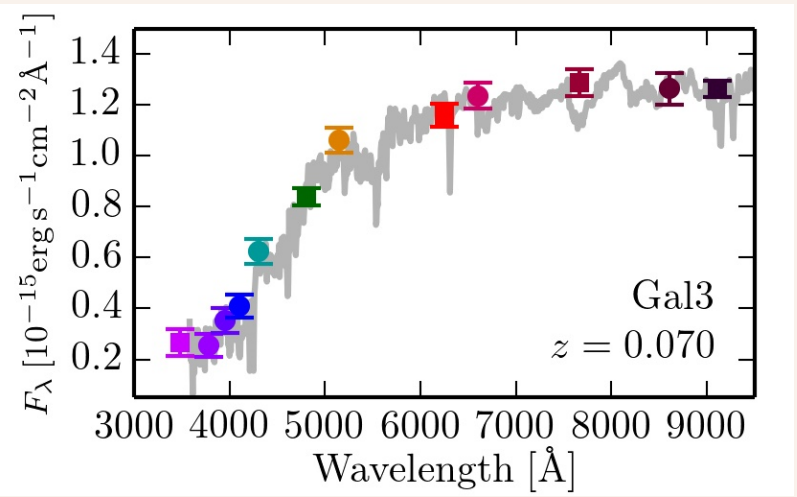

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Goals

Morphological classification of J-PLUS EDR
251k sources with $r < 21$ over 31.7 deg^2

- Simple cut in a concentration parameter (e.g. SDSS; Yasuda+01).
- Machine learning techniques (e.g. `CLASS_STAR` in SExtractor; Bertín&Arnotus96).
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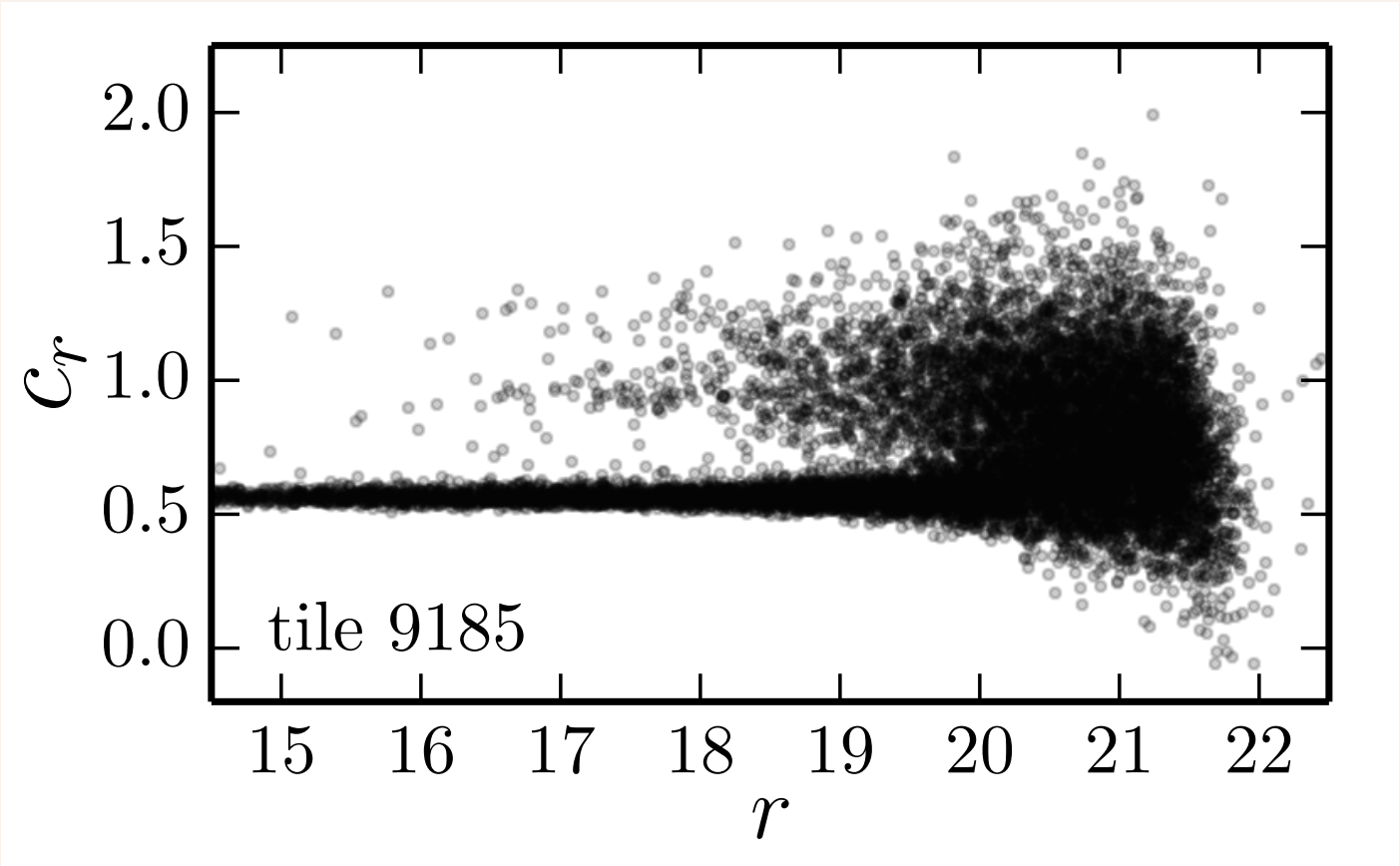

J-PLUS
● SOURCE

SDSS
● STAR
● GALAXY

The **concentration** parameter $c_r = r_{1.5''} - r_{3''}$
seems to work at bright magnitudes... but it fails at $r > 19.5$.

We have to model the stellar and galaxy locus to compute $\mathcal{L}(c_r \mid t)$.

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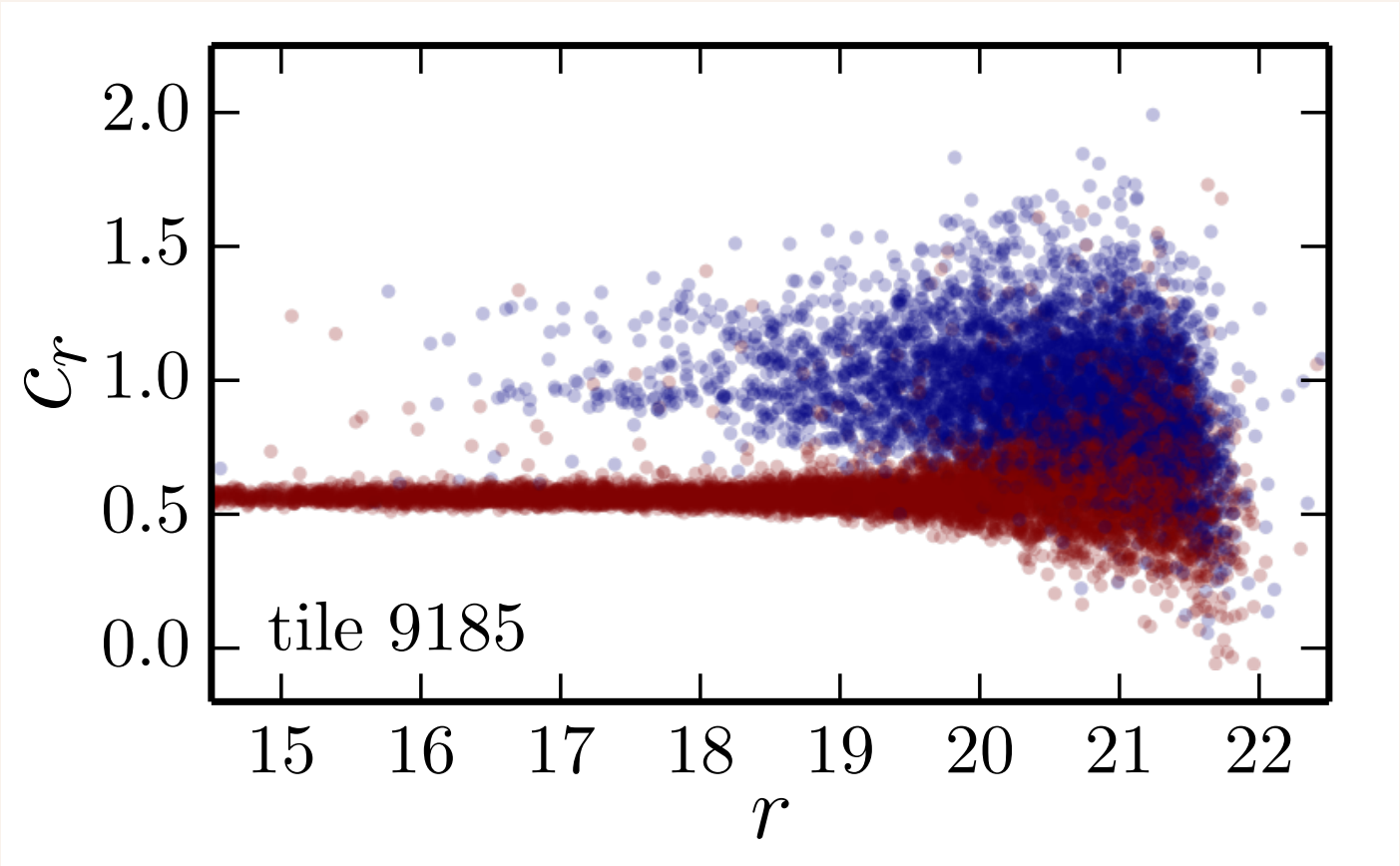

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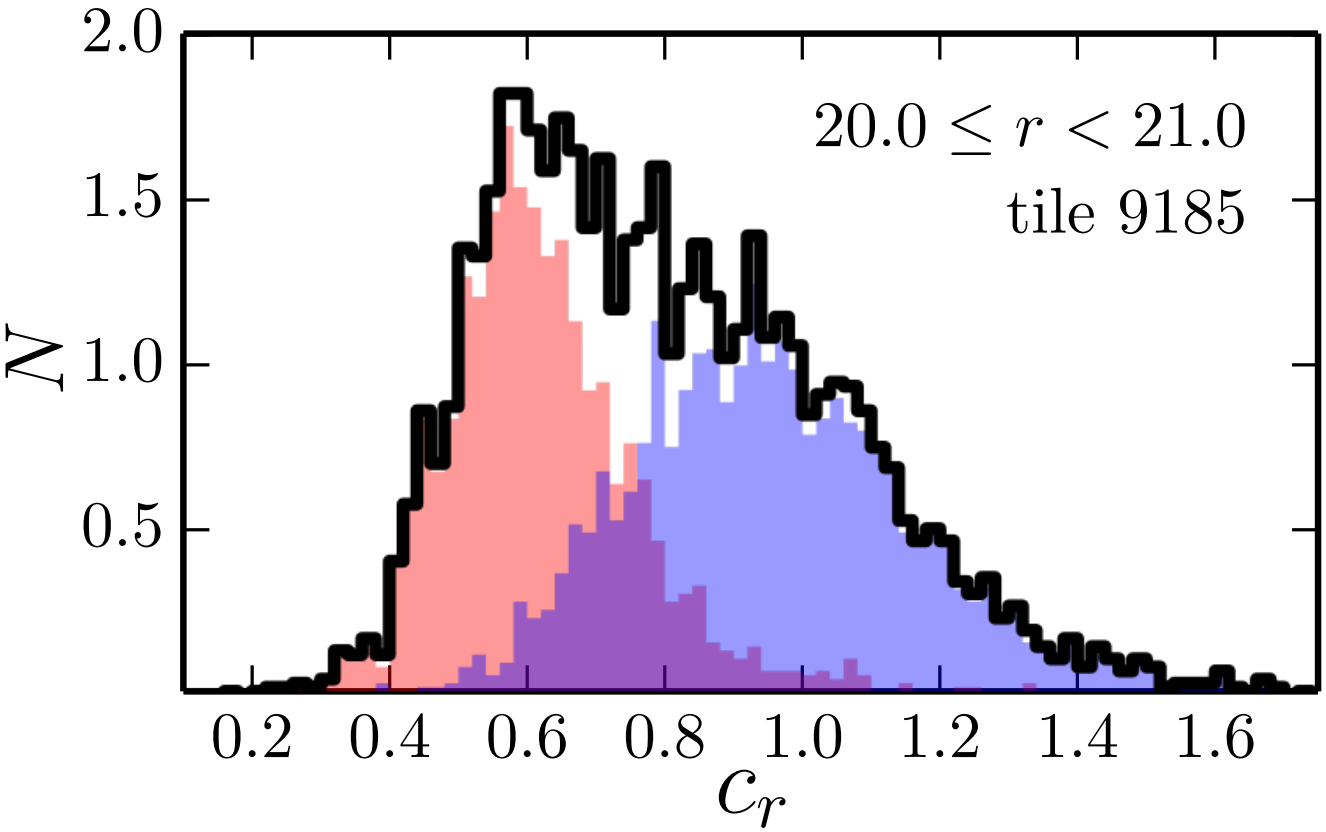

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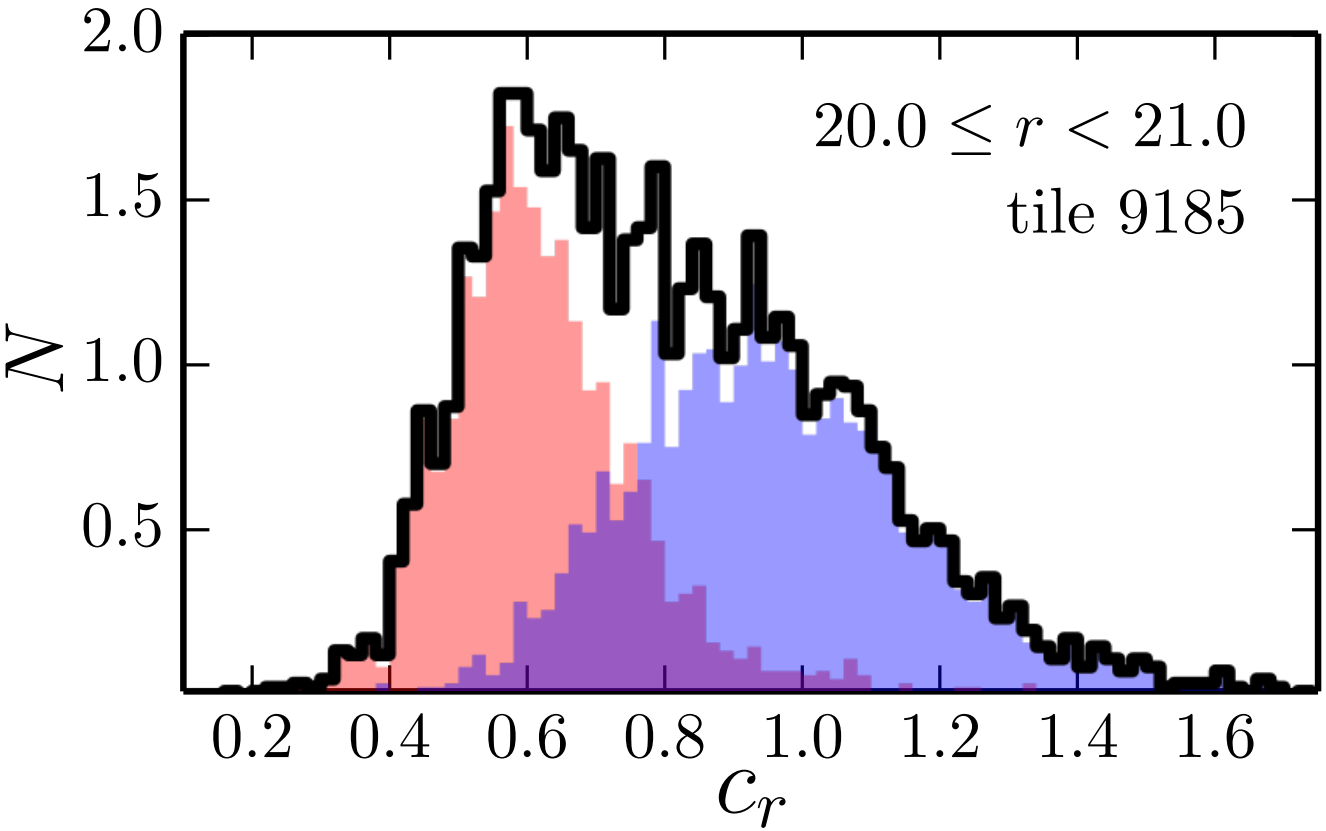

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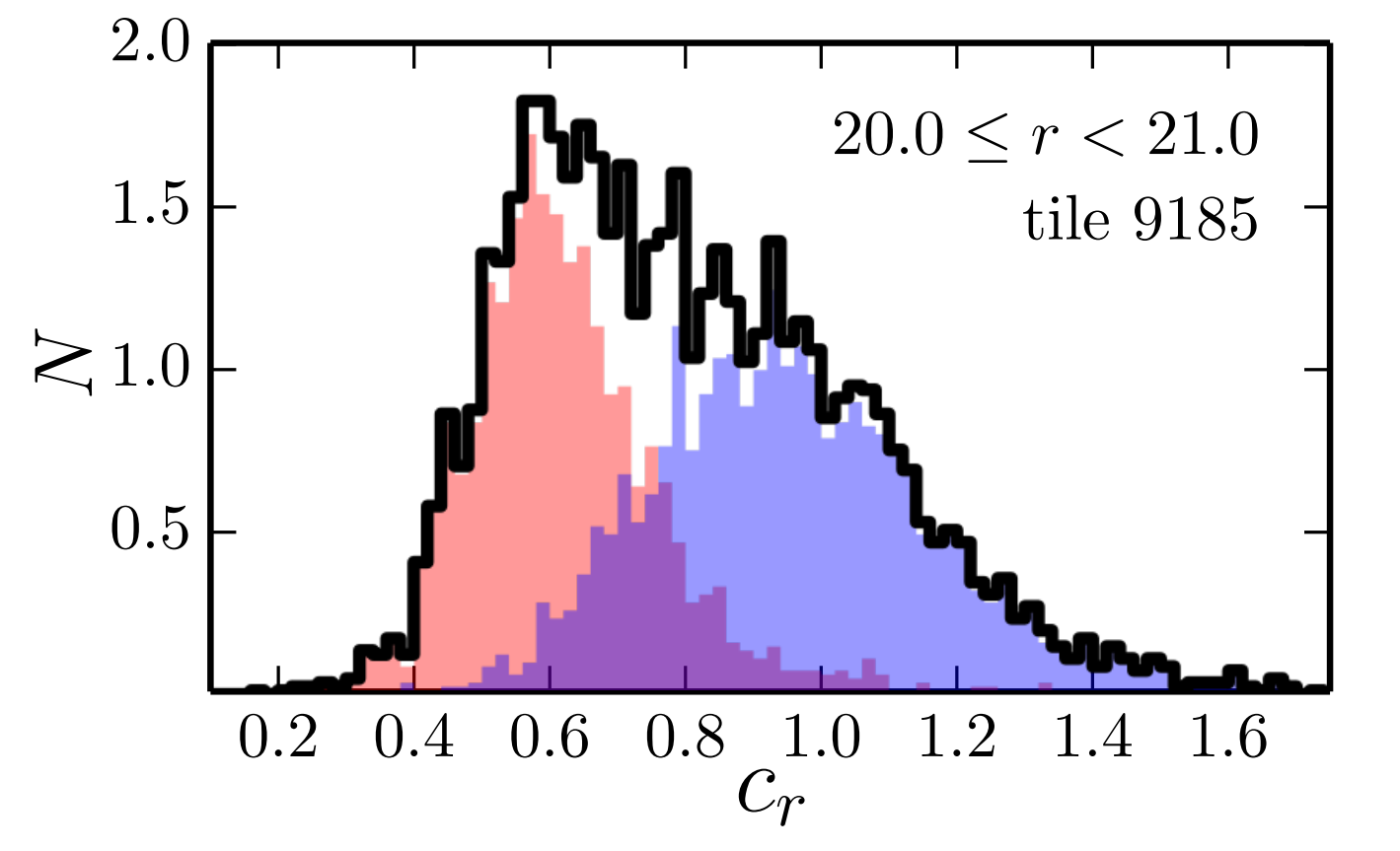
Stellar Locus



J-PLUS
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STAR
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We describe the compact (stellar) locus with a skew Gaussian,

$$D_{\rm s}(c_r|\mu_{\rm s},\sigma_{\rm s}) = P_{\rm G}(c_r|\mu_{\rm s},\sigma_{\rm s})\,\{1+{\rm erf}[\tfrac{4.1\,(c_r-\mu_{\rm s})}{\sqrt{2}\sigma_{\rm s}}]\}$$

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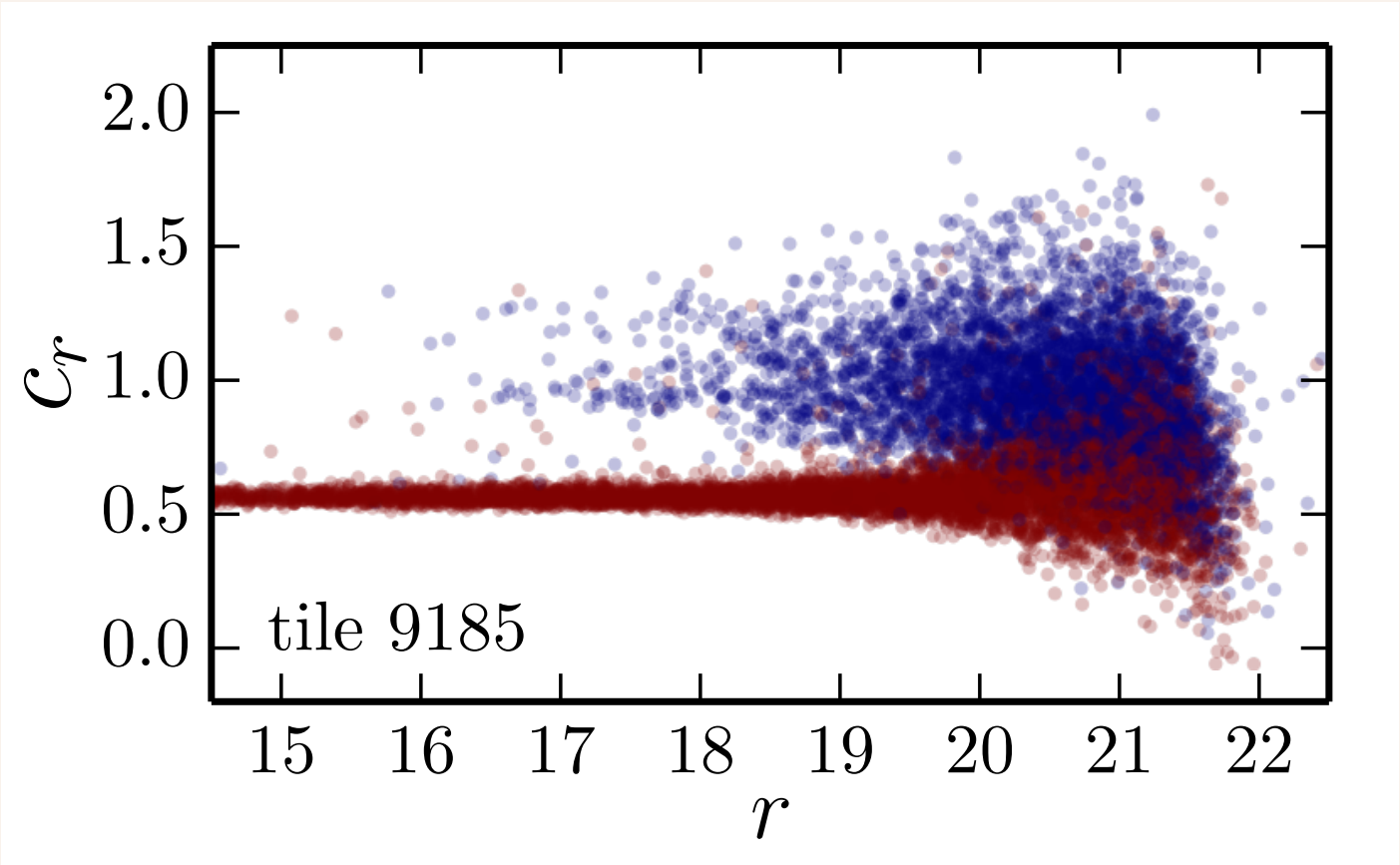

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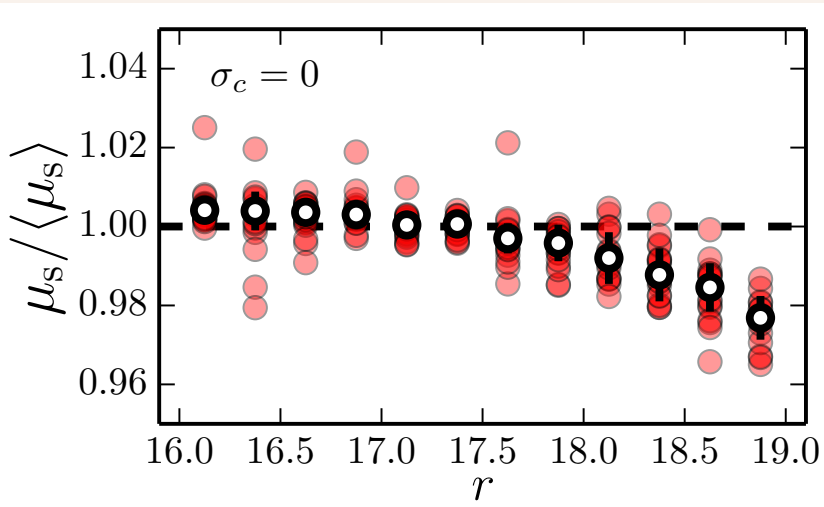

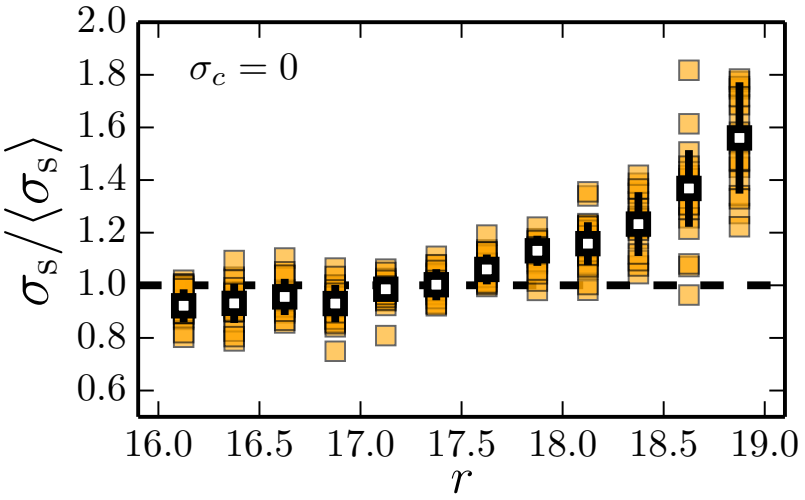

We account for the errors in c_r, including a covariance $\rho = 0.72$.

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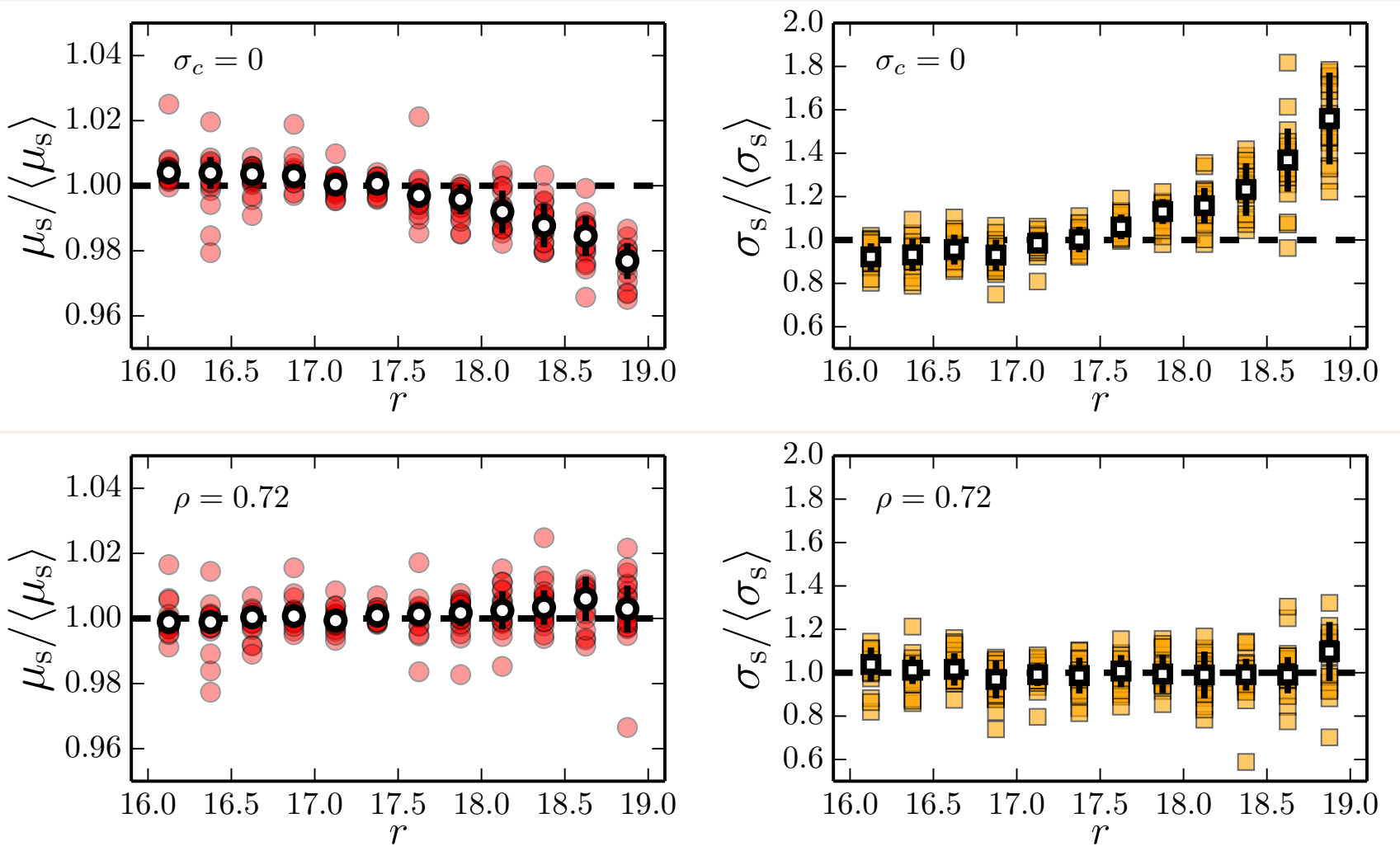

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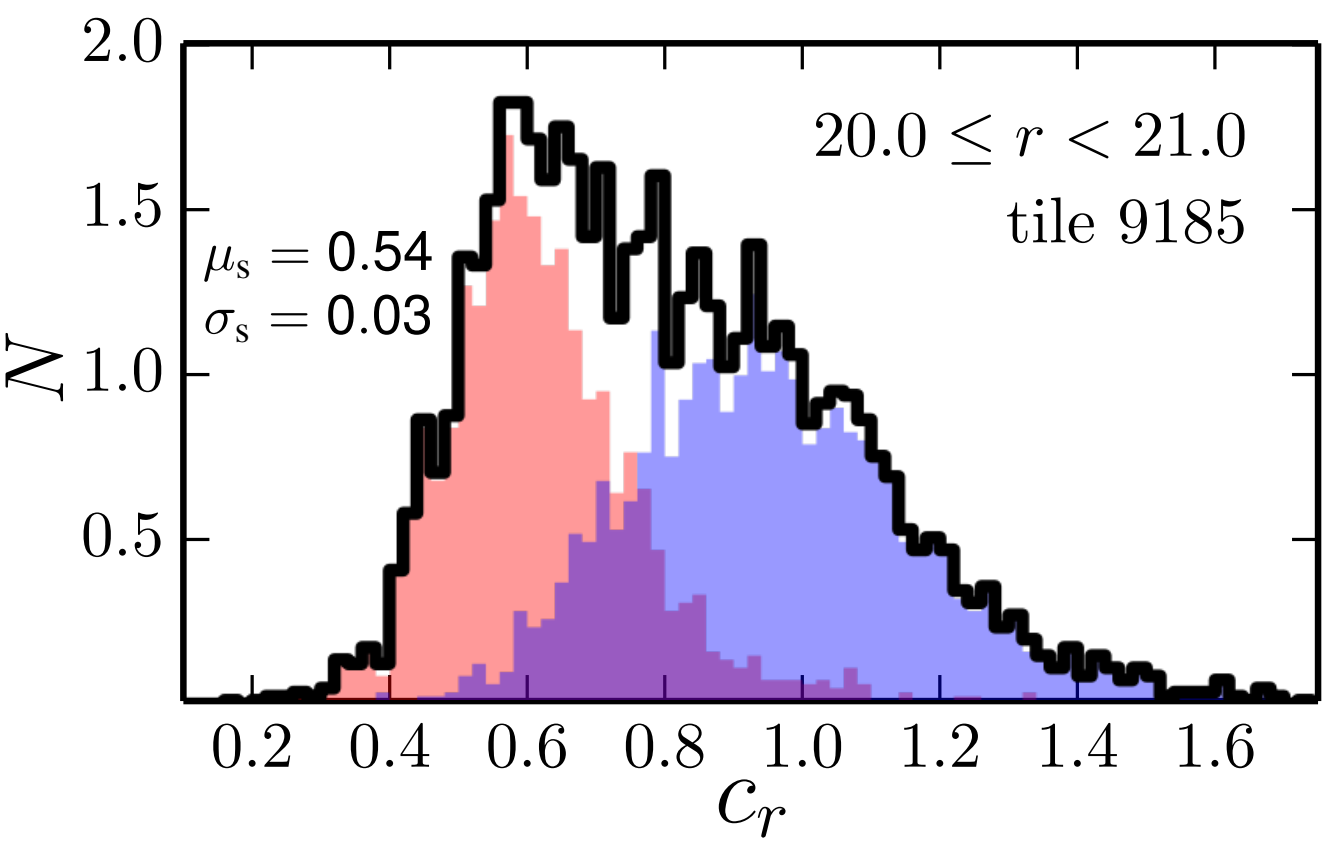

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GALAXY

We describe the extended (galaxy) locus with a log-normal,

$$D_g(c_r|\mu_g, \sigma_g) = \frac{1}{c_r} P_G(c_r|\log \mu_g, \sigma_g)$$

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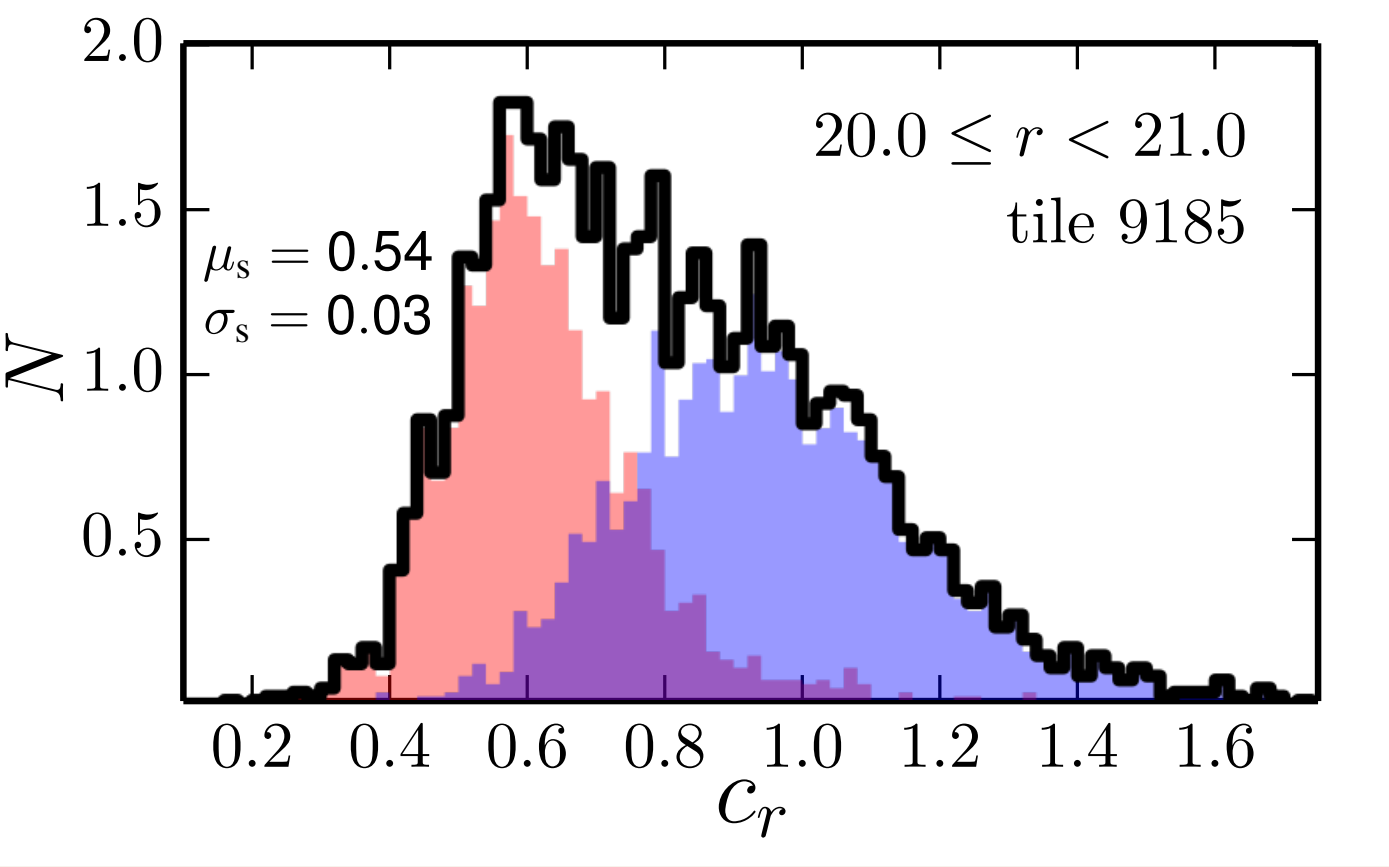

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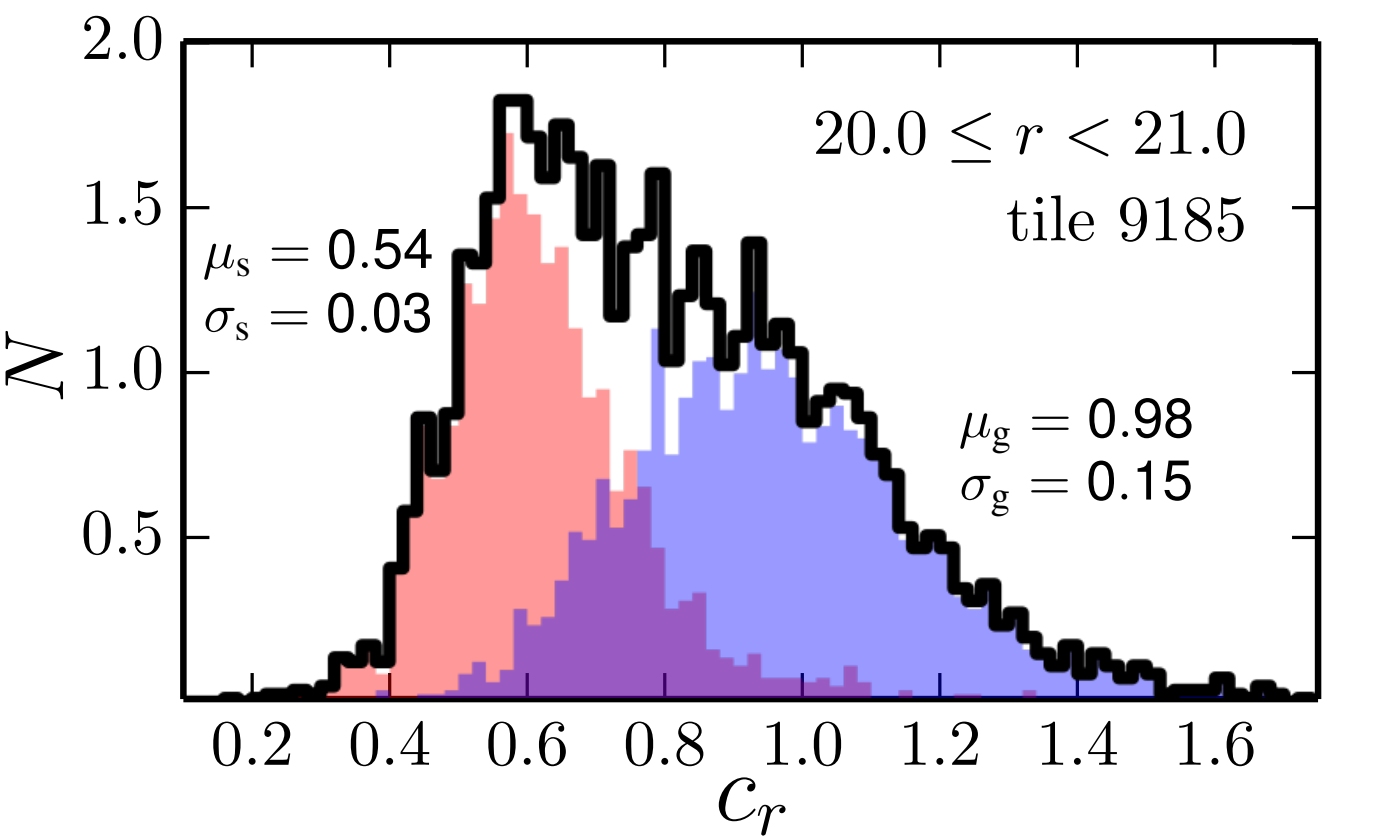

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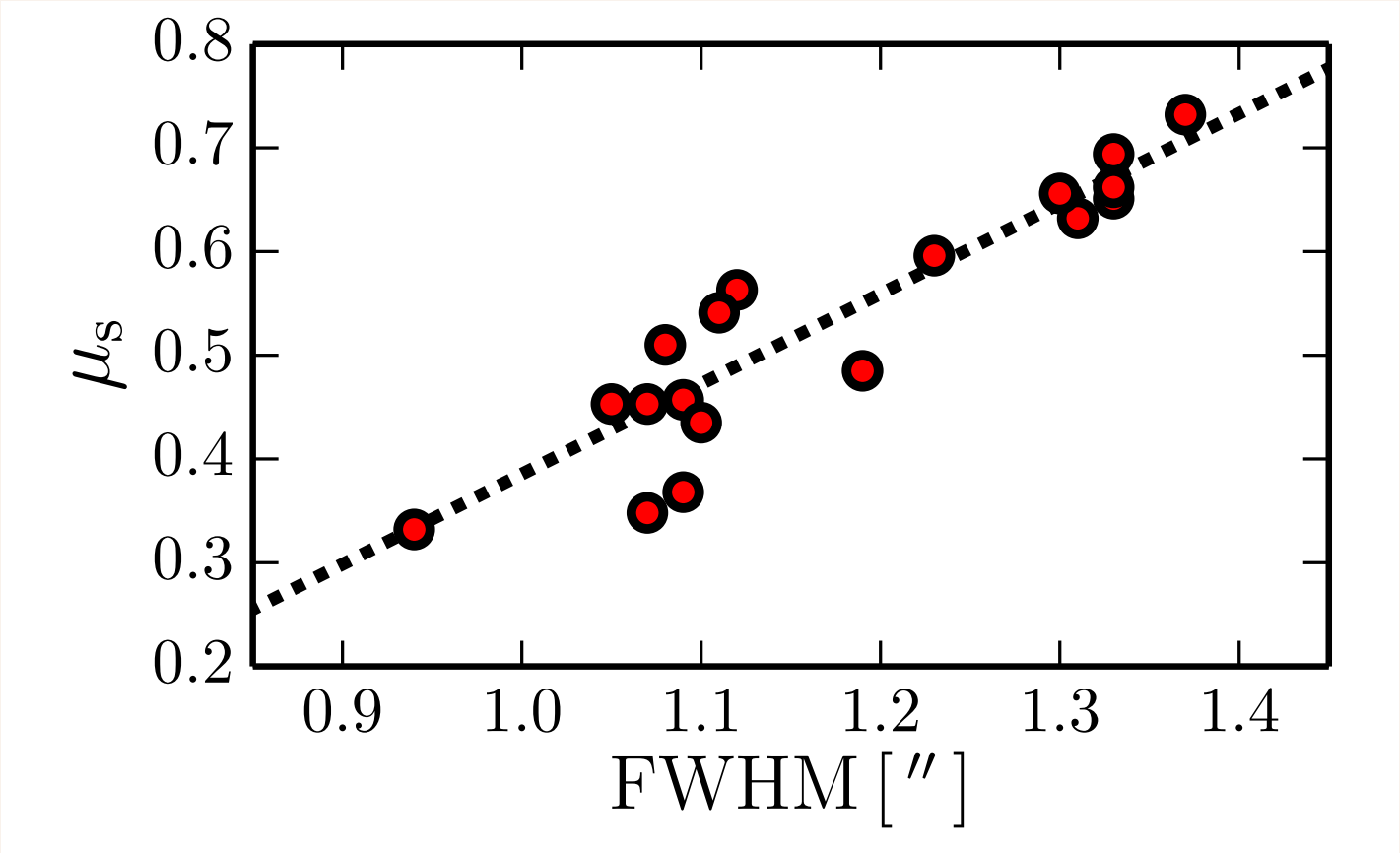
Position of galaxy and stellar locus



The FWHM mainly rules the position of the stellar and the galaxy locus

but is not the only factor (e.g. PSF variations along FoV).

Now we have the likelihood $\mathcal{L}(c_r \mid t, \sigma_{c_r})$.

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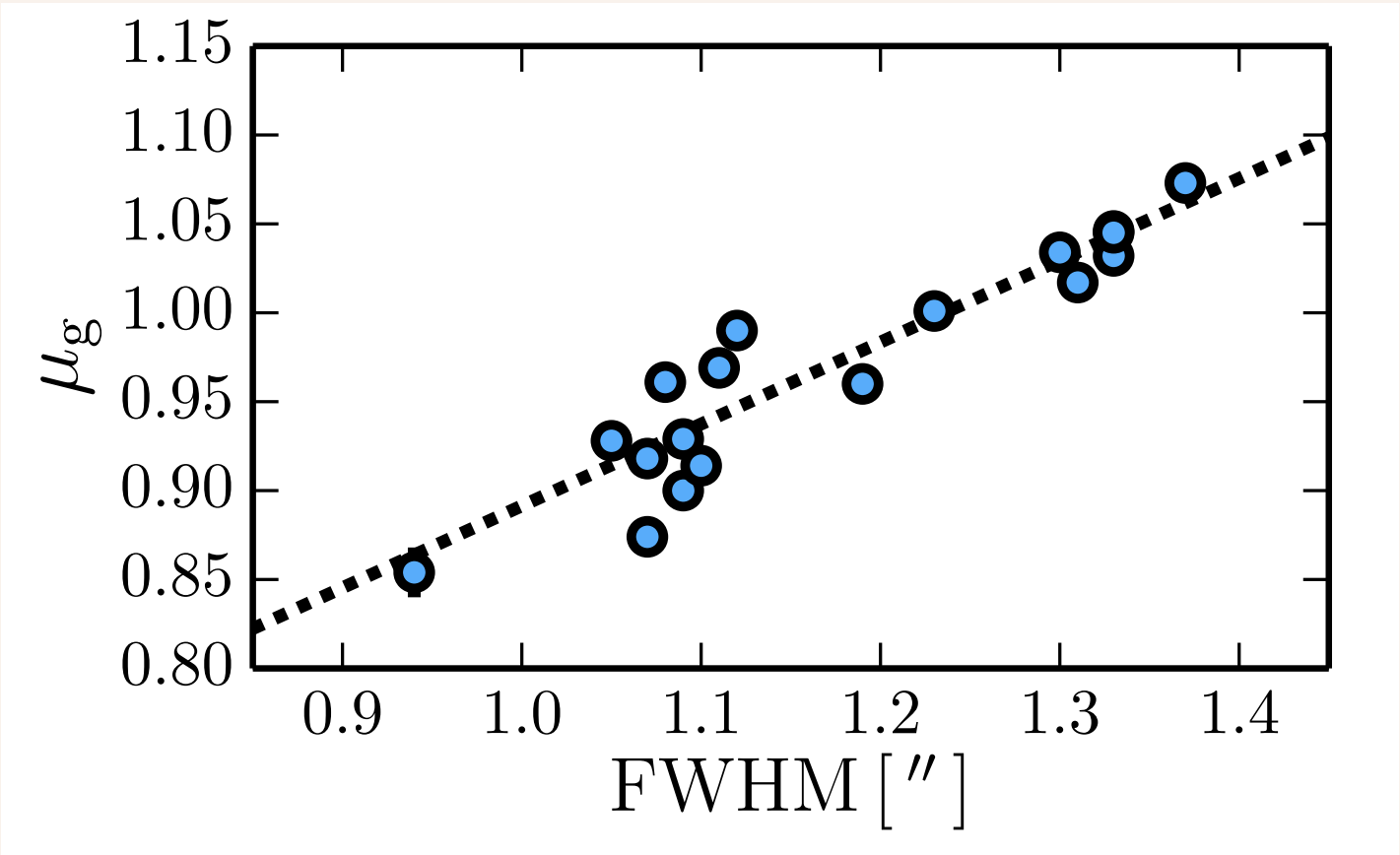

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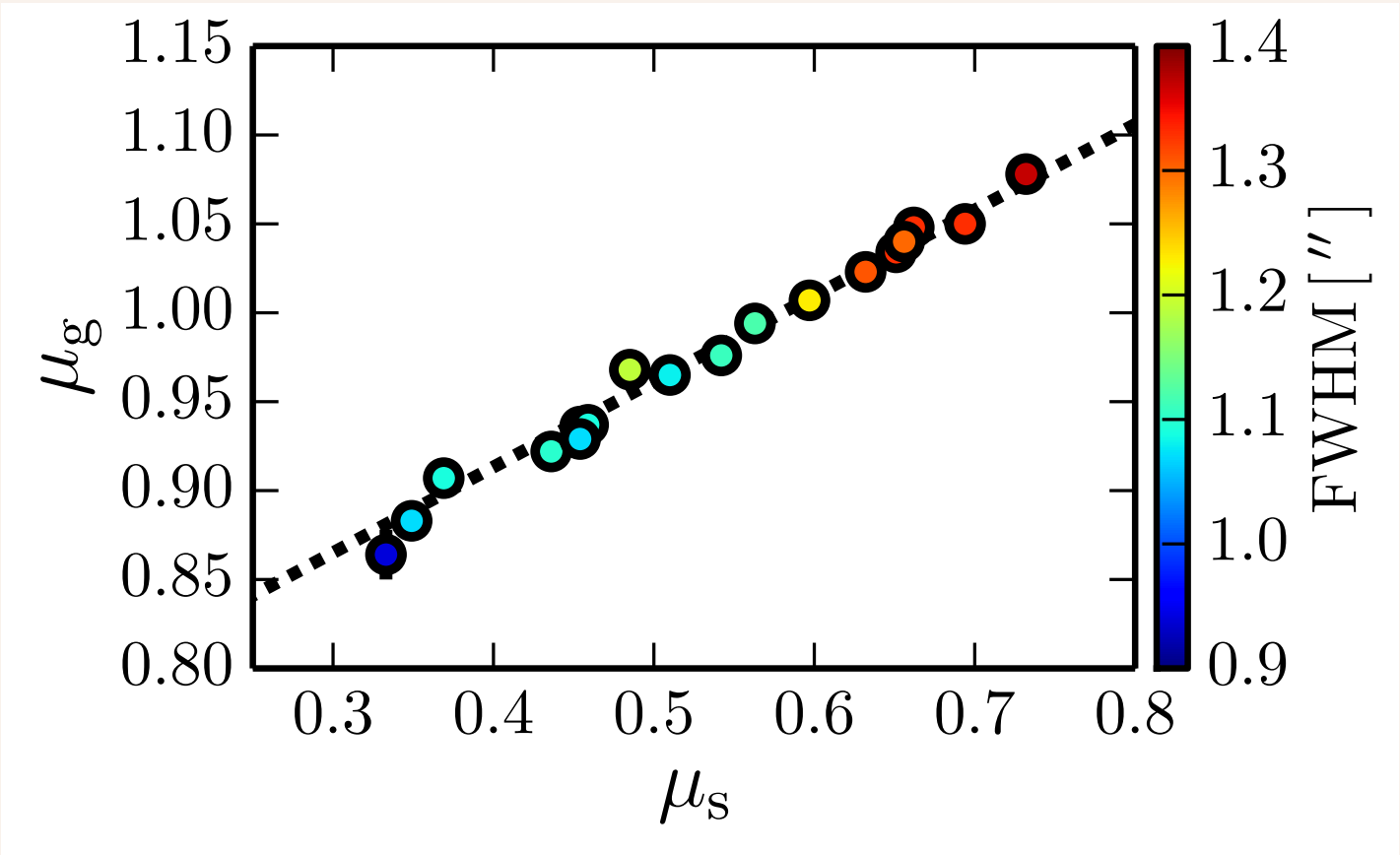

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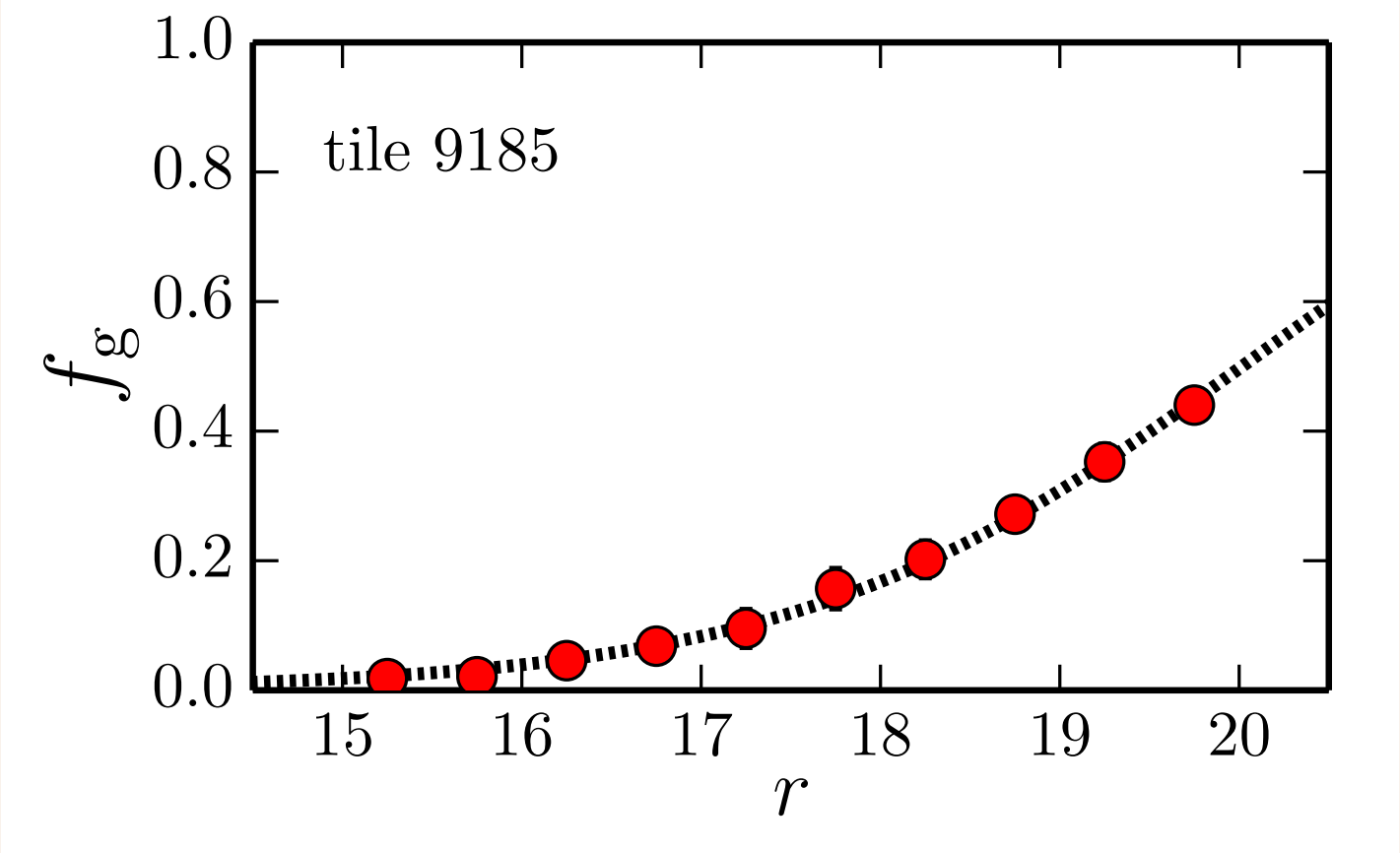
Star/galaxy prior



The **prior** is the star/galaxy fraction with magnitude and sky position,

$$P(\mathrm{g}|r) = f_\mathrm{g}(r) = \frac{1}{1+\exp[-\kappa_\mathrm{p}(r-\mu_\mathrm{p})]}.$$

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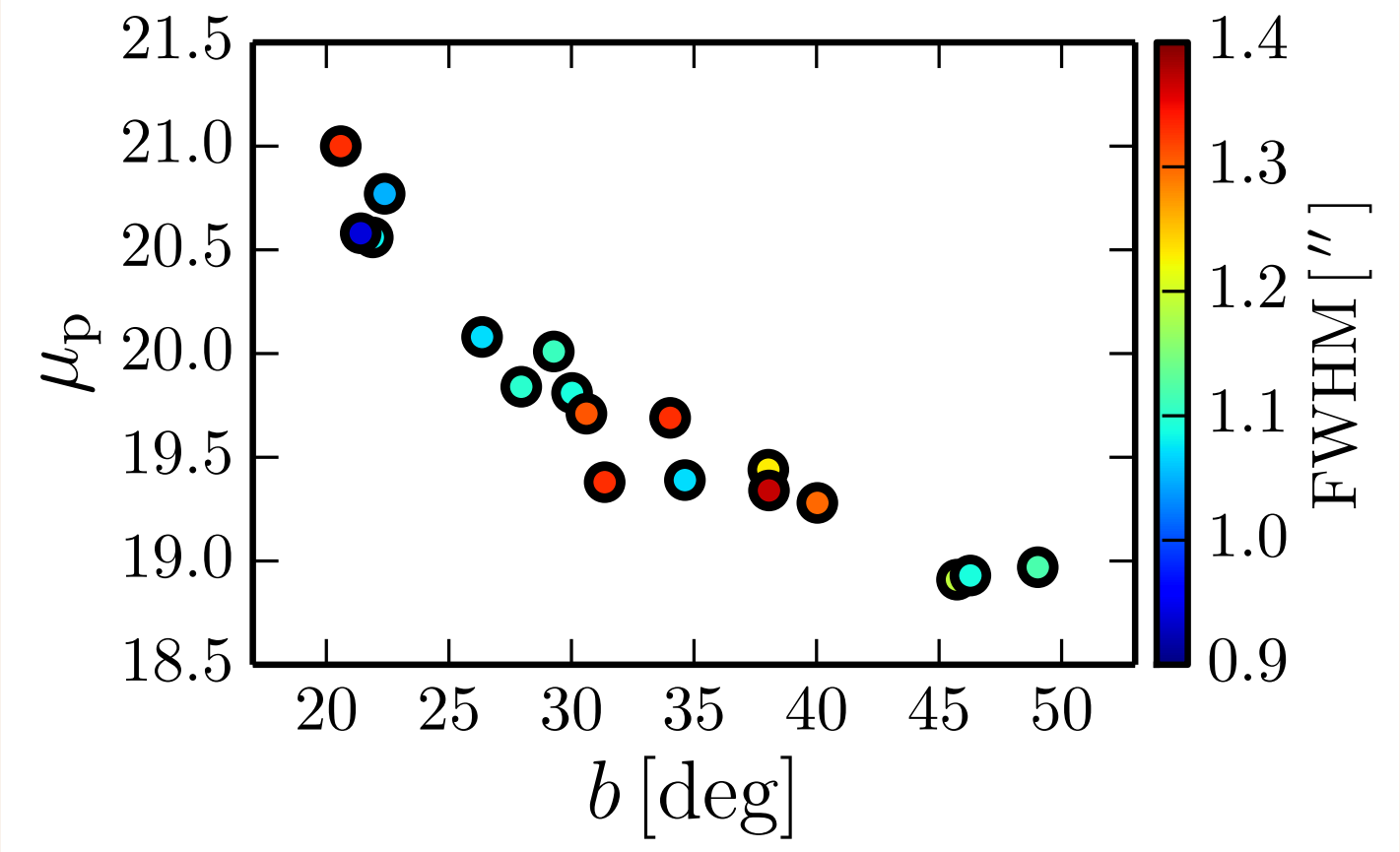

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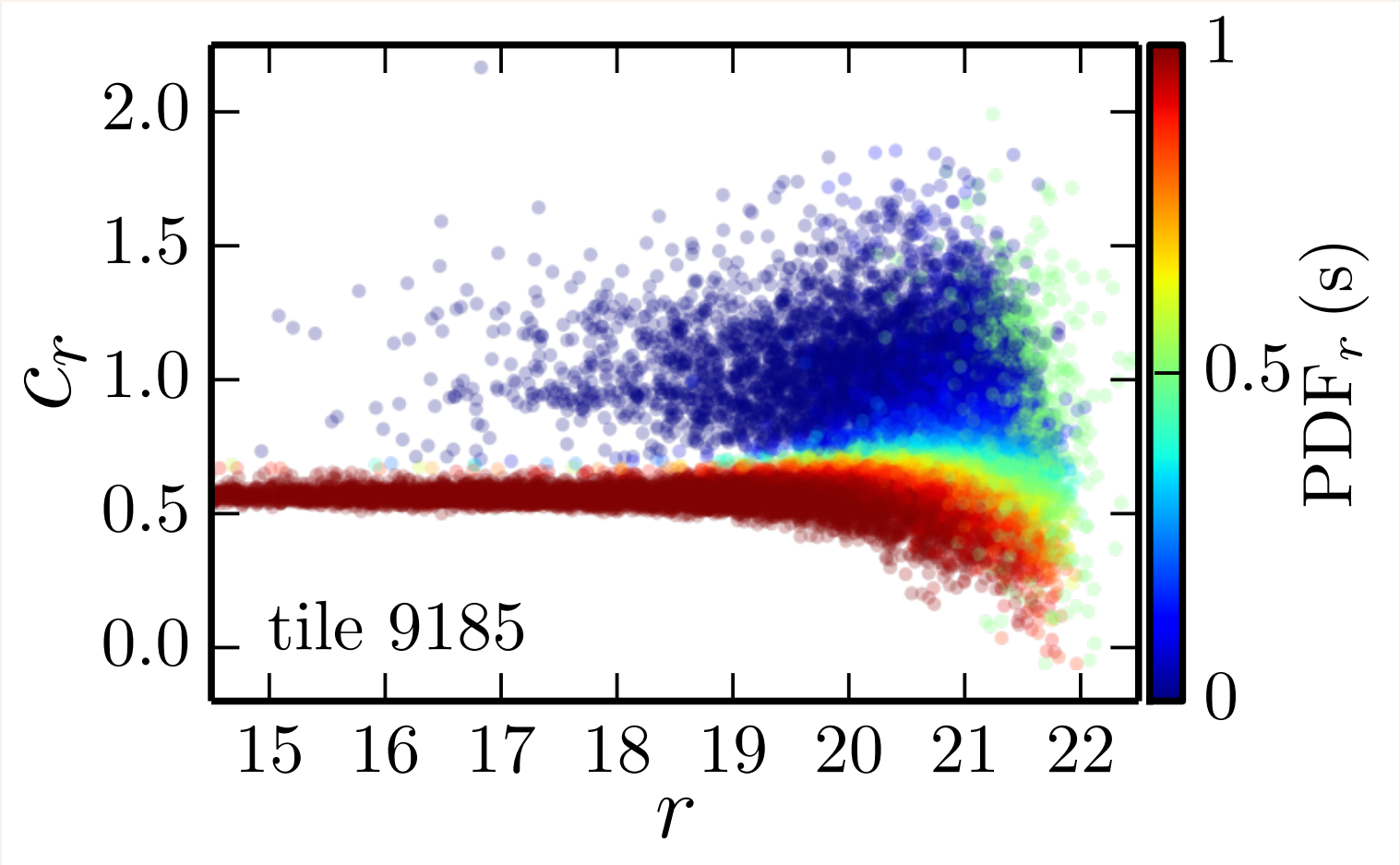
Star probability density function



$$\mathrm{PDF}_r\,(\mathrm{s}) \propto P\,(\mathrm{s})\;\mathcal{L}(c_r \,|\, \mathrm{s}, \sigma_{c_r})$$

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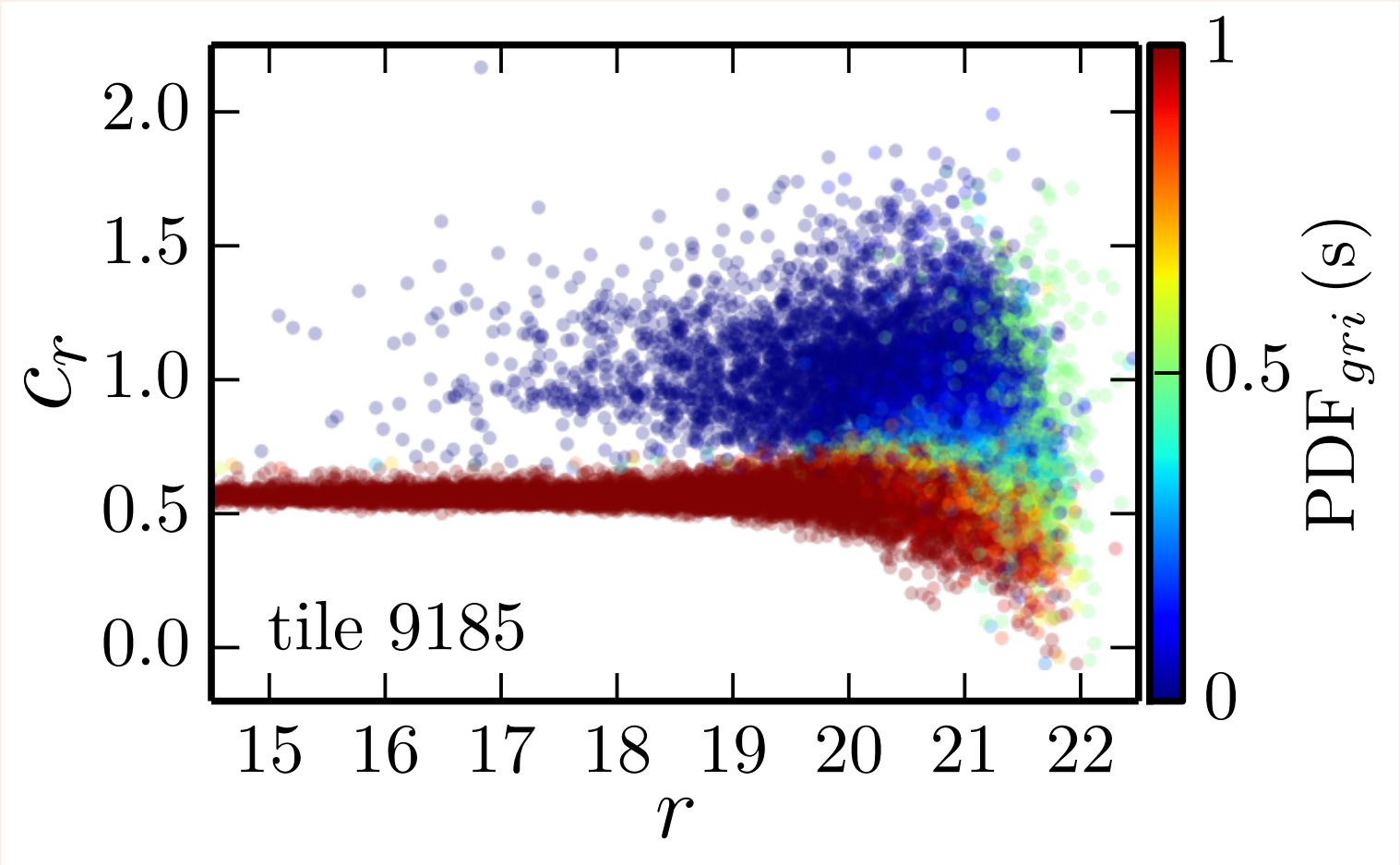
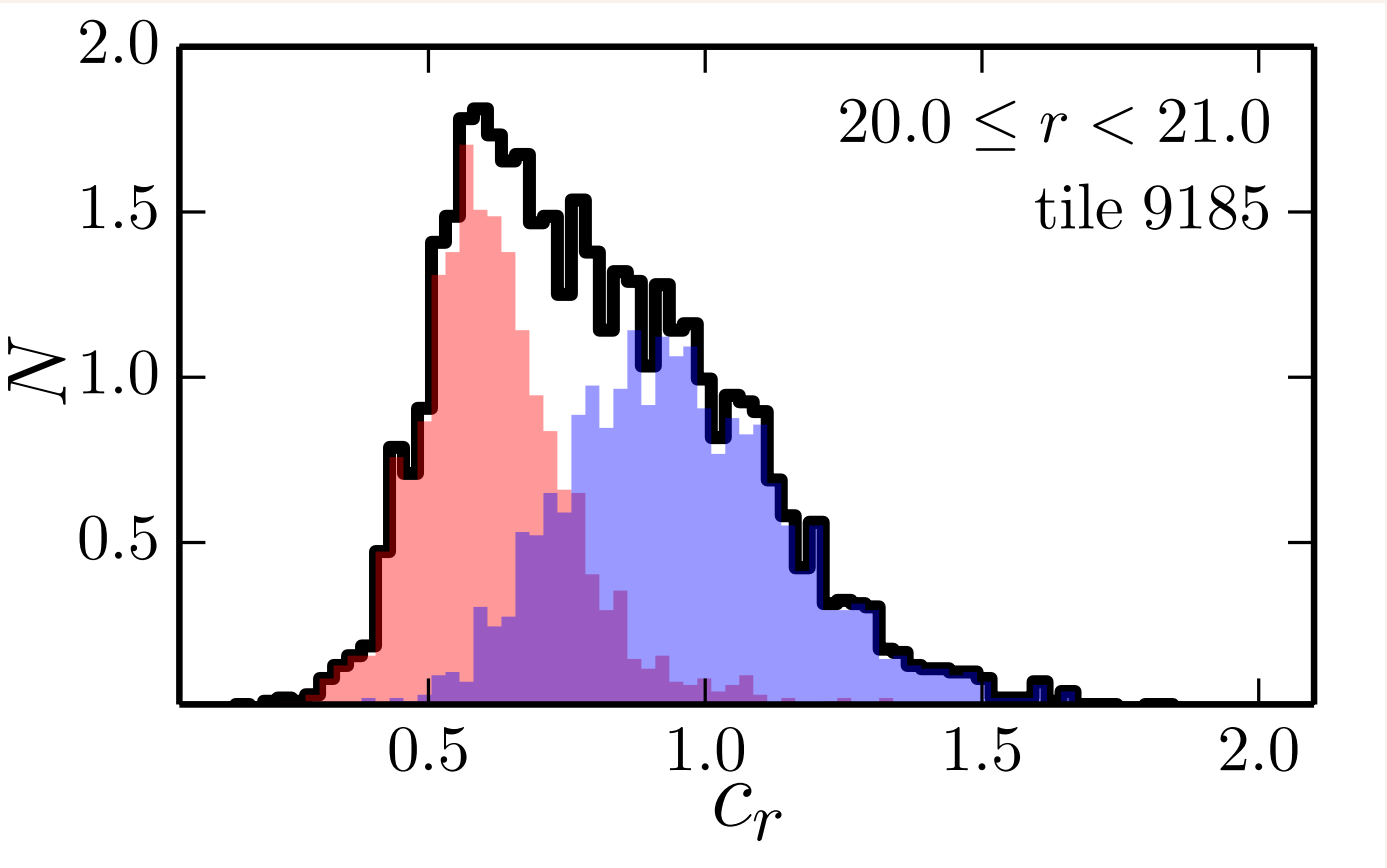


$$\mathrm{PDF}_{gri}(\mathrm{s}) \propto P(\mathrm{s})\, \mathcal{L}(c_r \,|\, \mathrm{s}, \sigma_{c_r})\, \mathcal{L}(c_g \,|\, \mathrm{s}, \sigma_{c_g})\, \mathcal{L}(c_i \,|\, \mathrm{s}, \sigma_{c_i})$$

Distribution on c_r with magnitude



J-PLUS

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STAR

GALAXY

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A boolean classification holds at $r < 20$,
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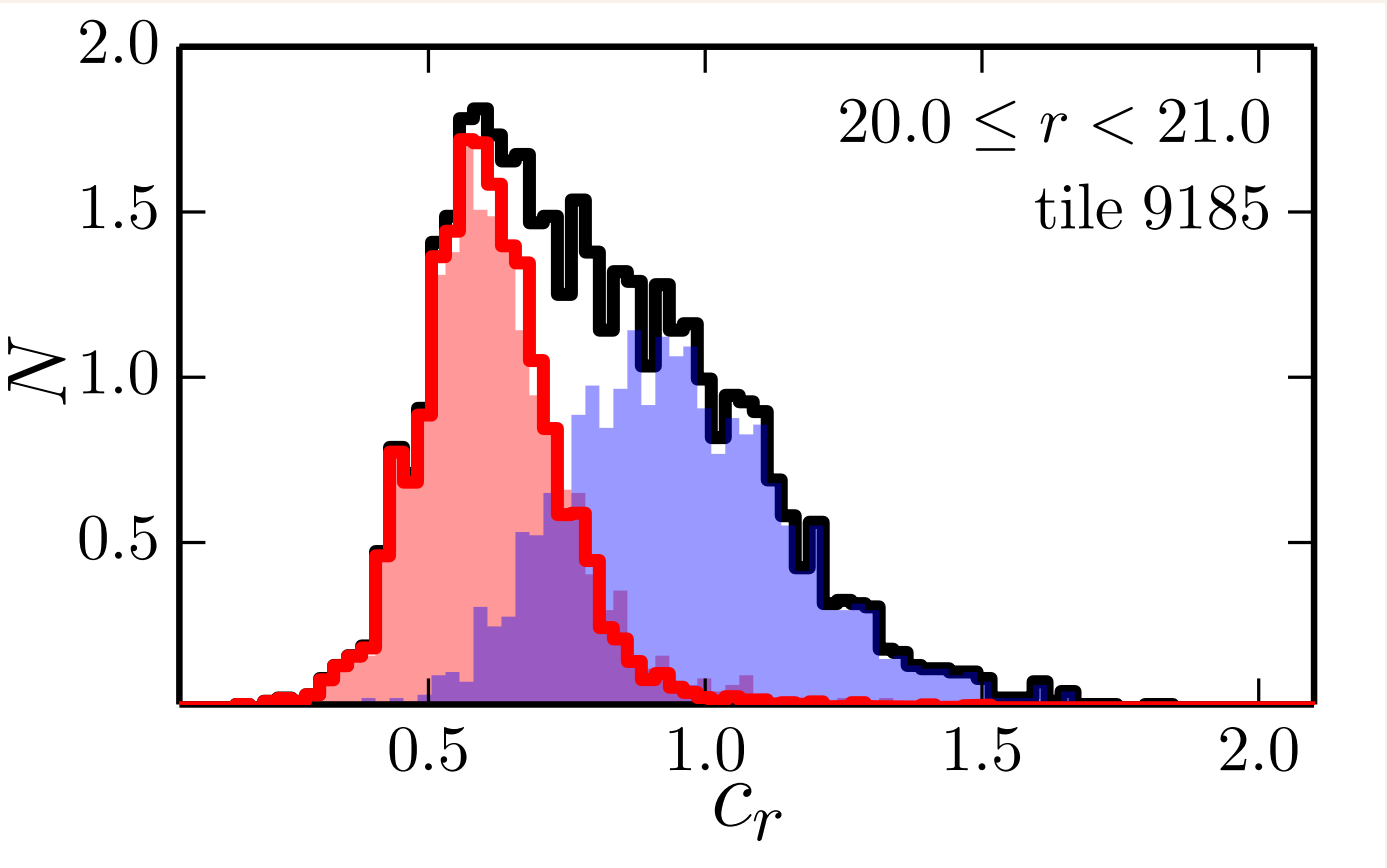

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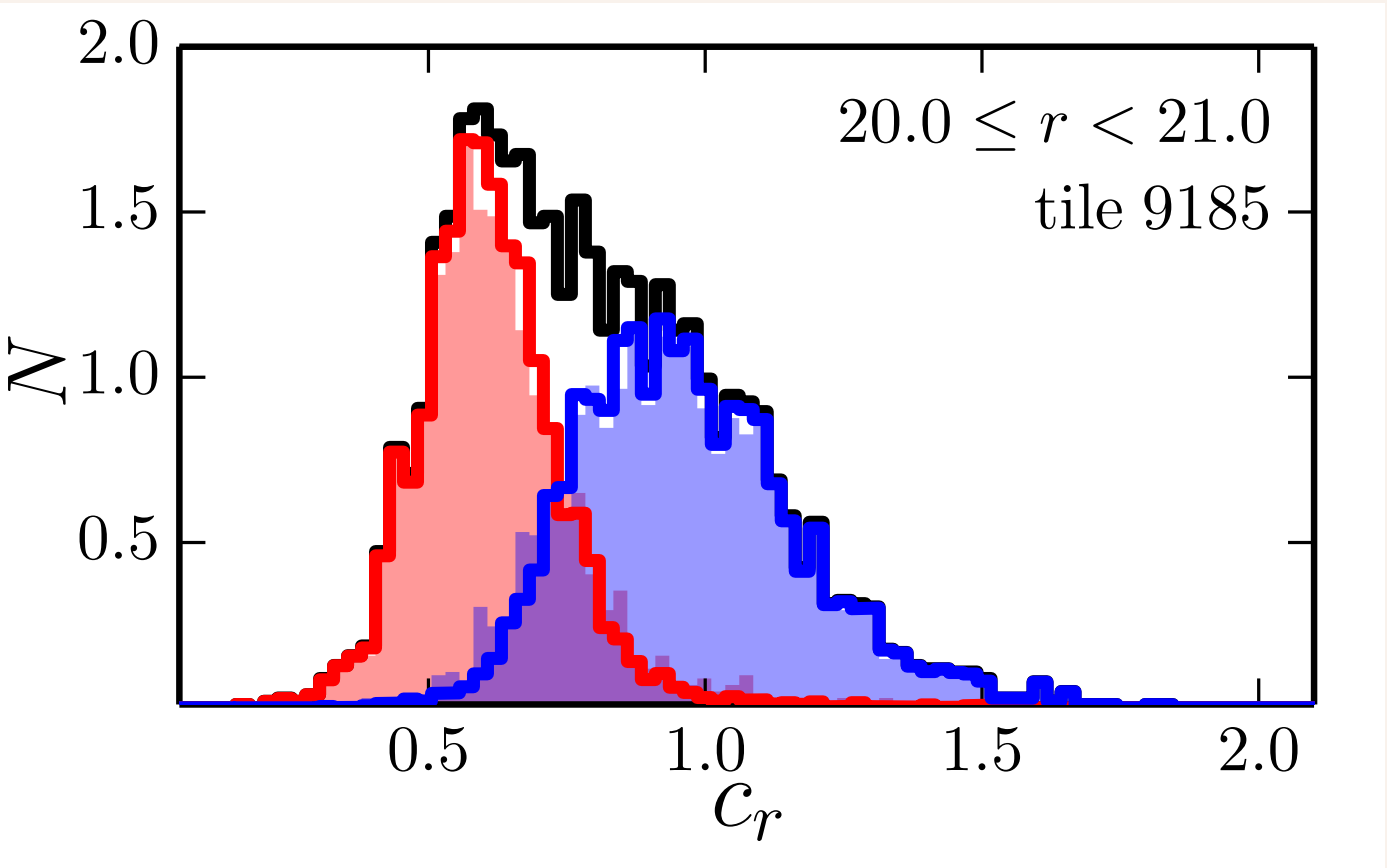

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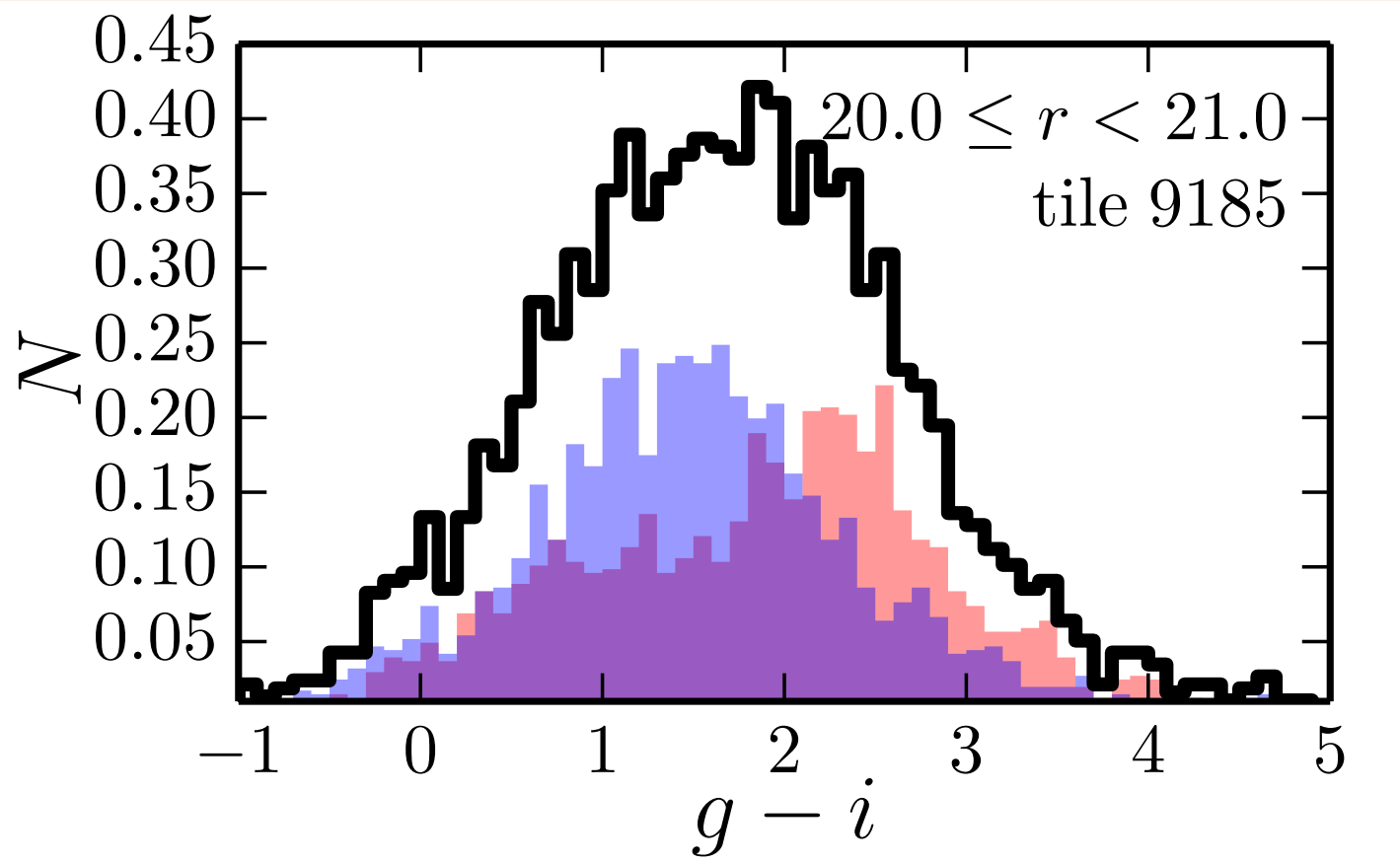
Distribution on ($g - i$) with magnitude



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GALAXY

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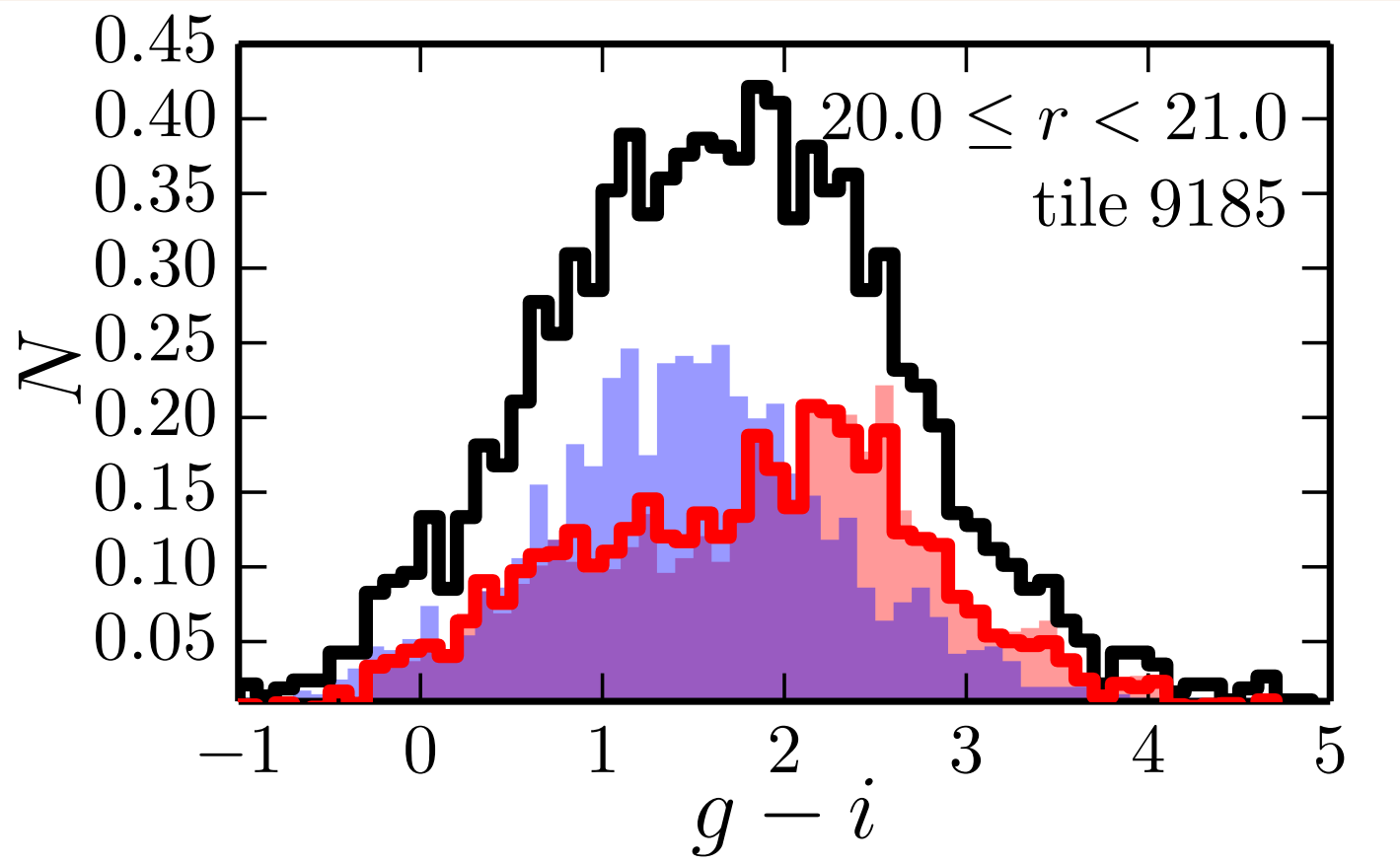
The ($g - i$) colour distribution of star and galaxies is also reproduced with our classification.

Distribution on ($g - i$) with magnitude



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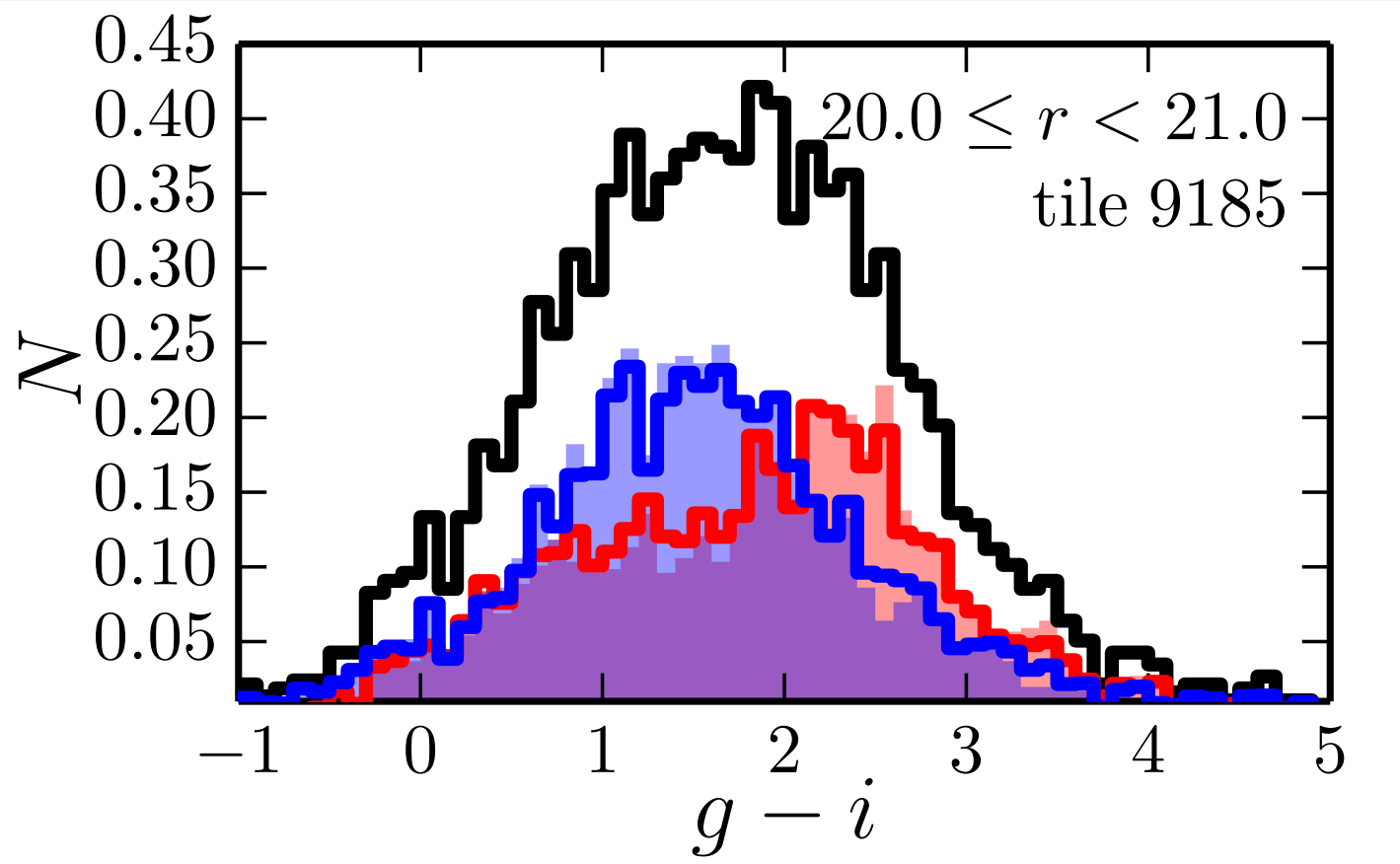

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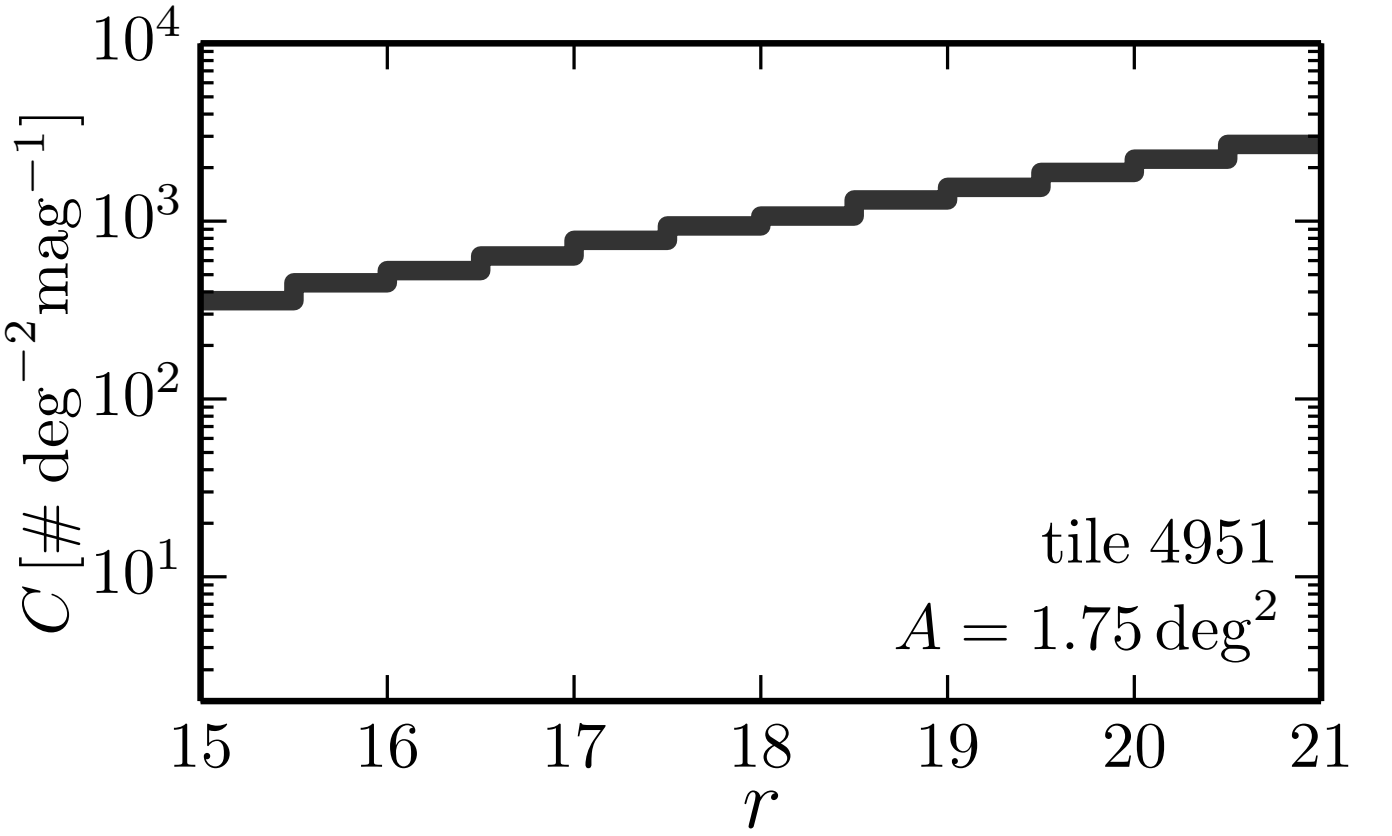

STARS

TRILEGAL

SDSS

J-PLUS

GALAXIES

SDSS

J-PLUS

Yasuda+01

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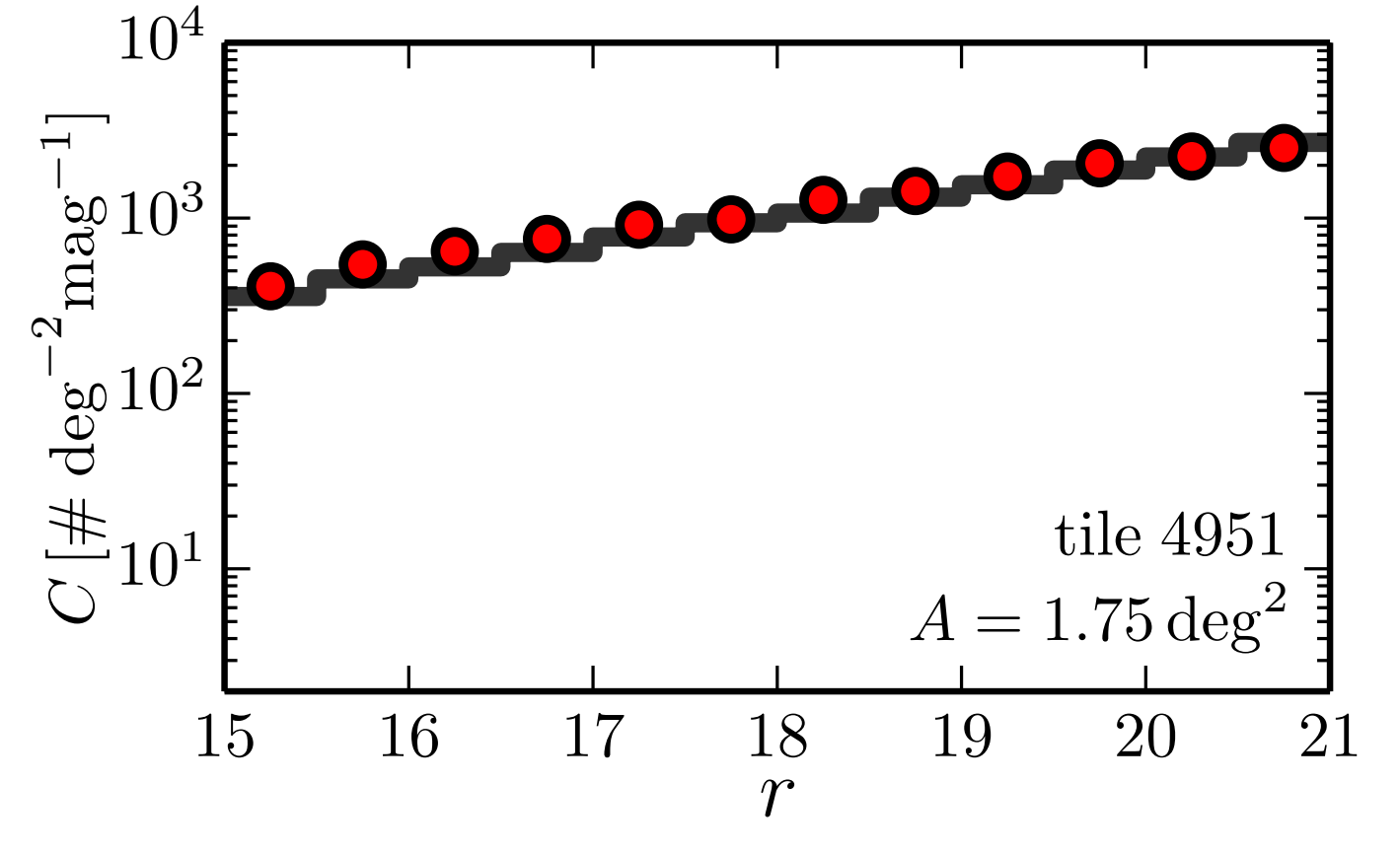

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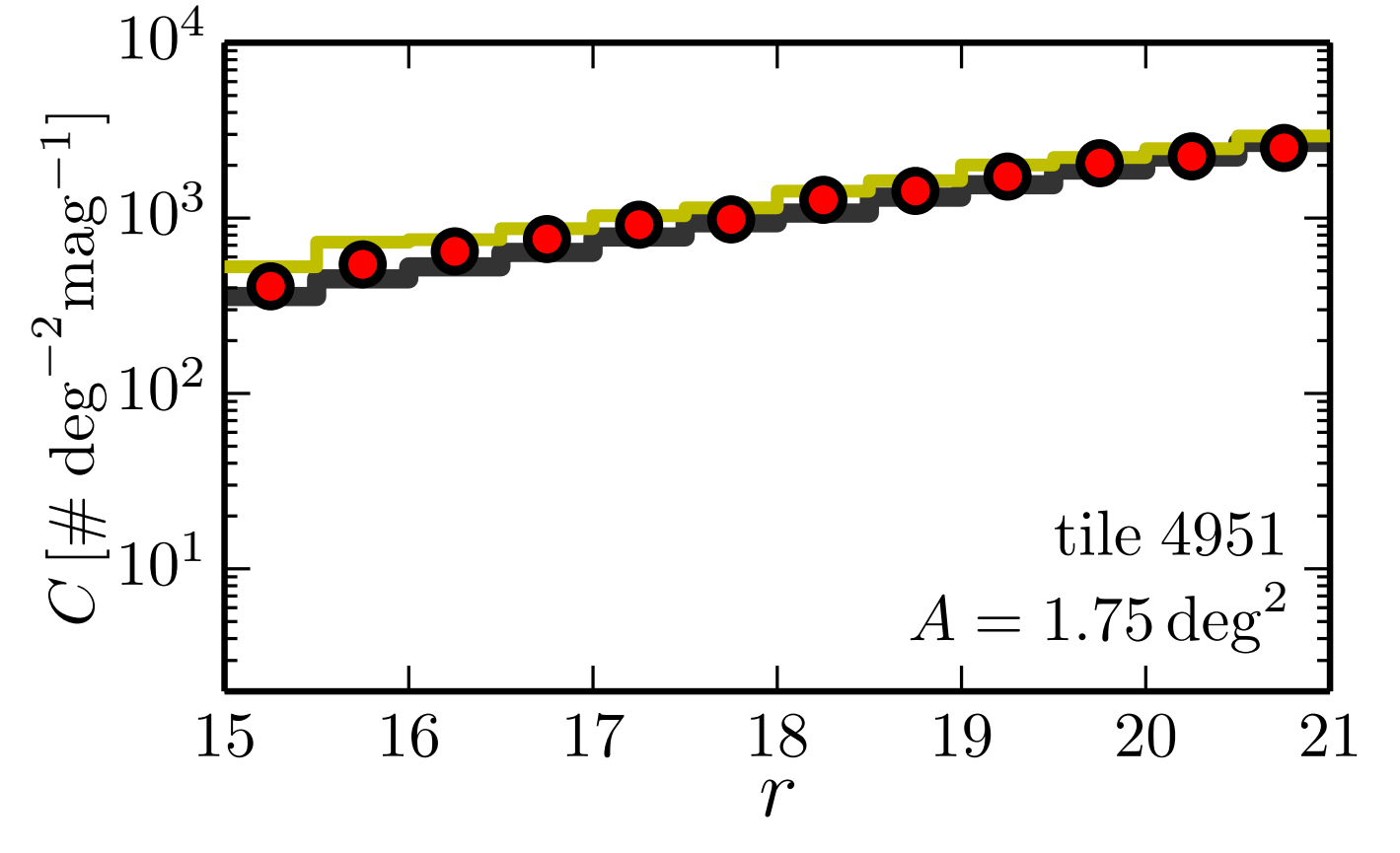

STARS

TRILEGAL

SDSS

J-PLUS

GALAXIES

SDSS

J-PLUS

Yasuda+01

Kashikawa+04

Huang+01

Kümmel+01

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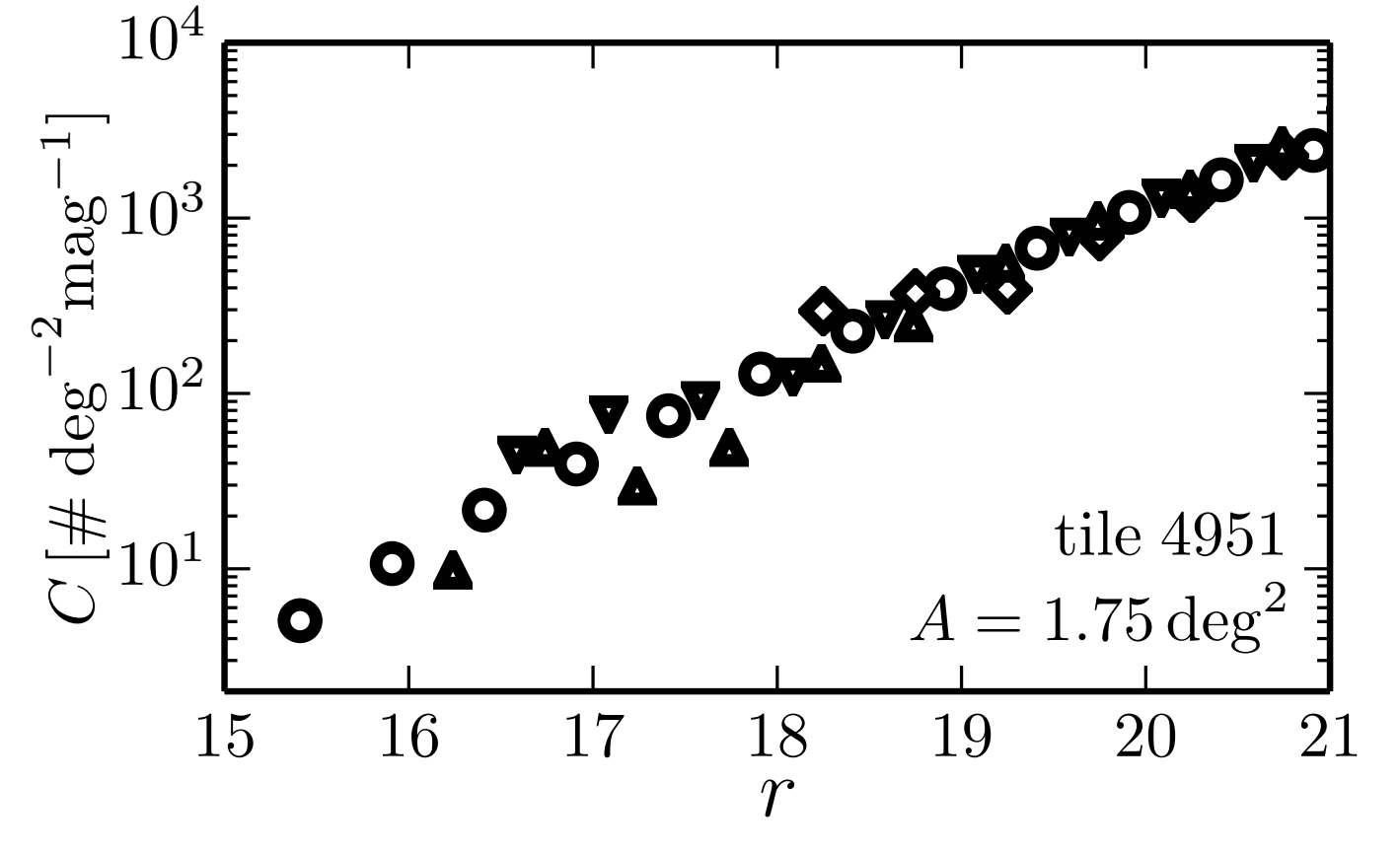

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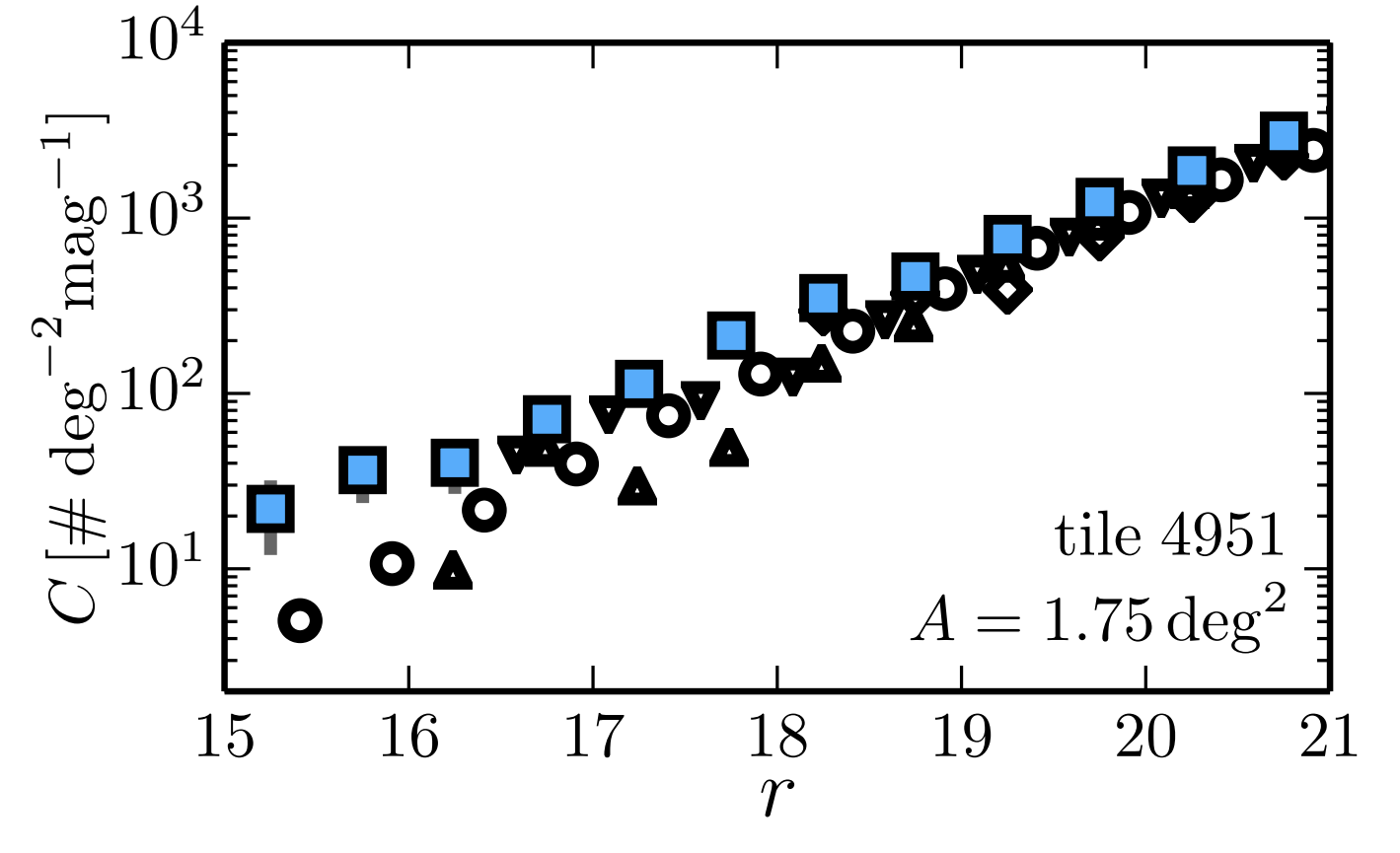

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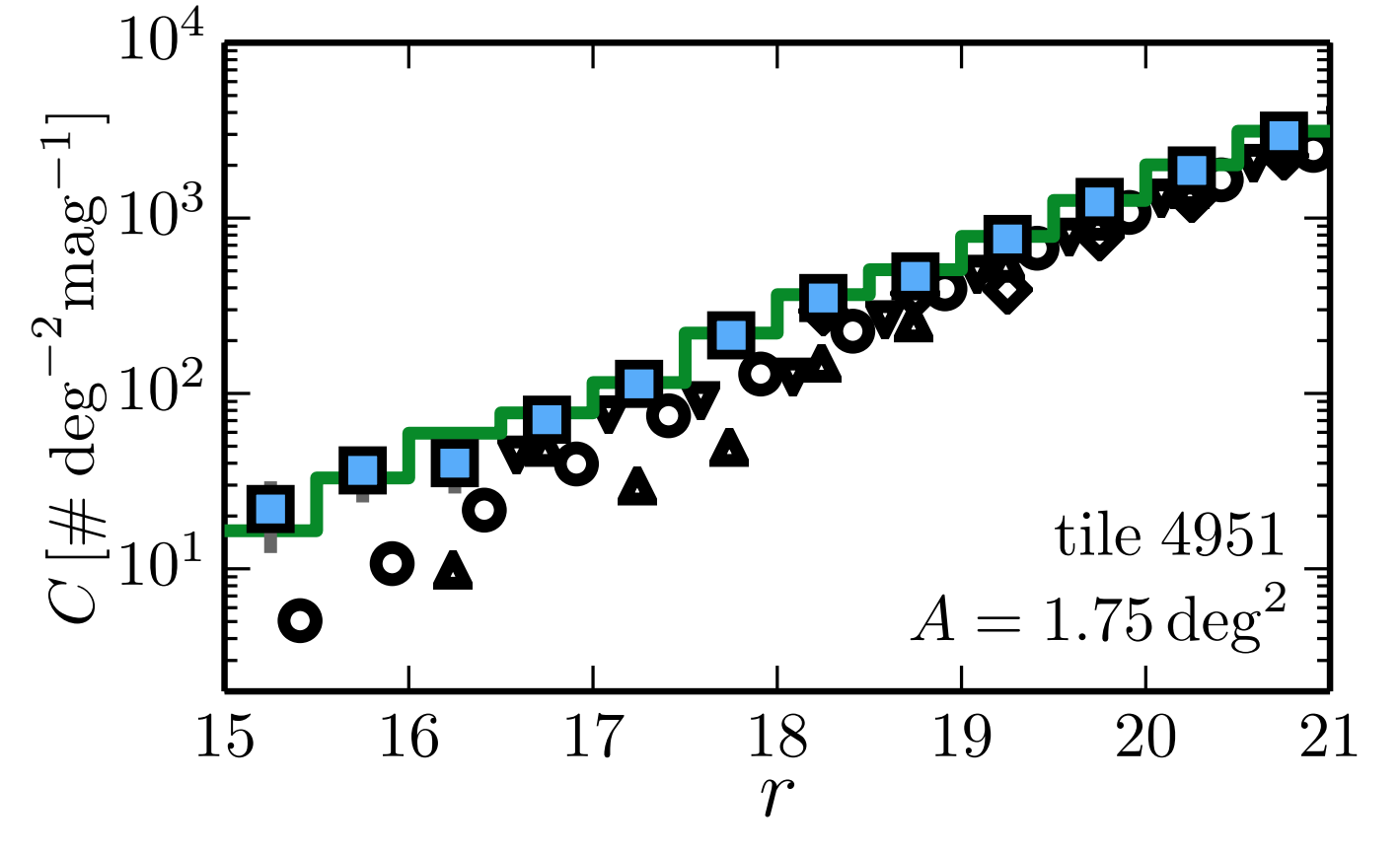

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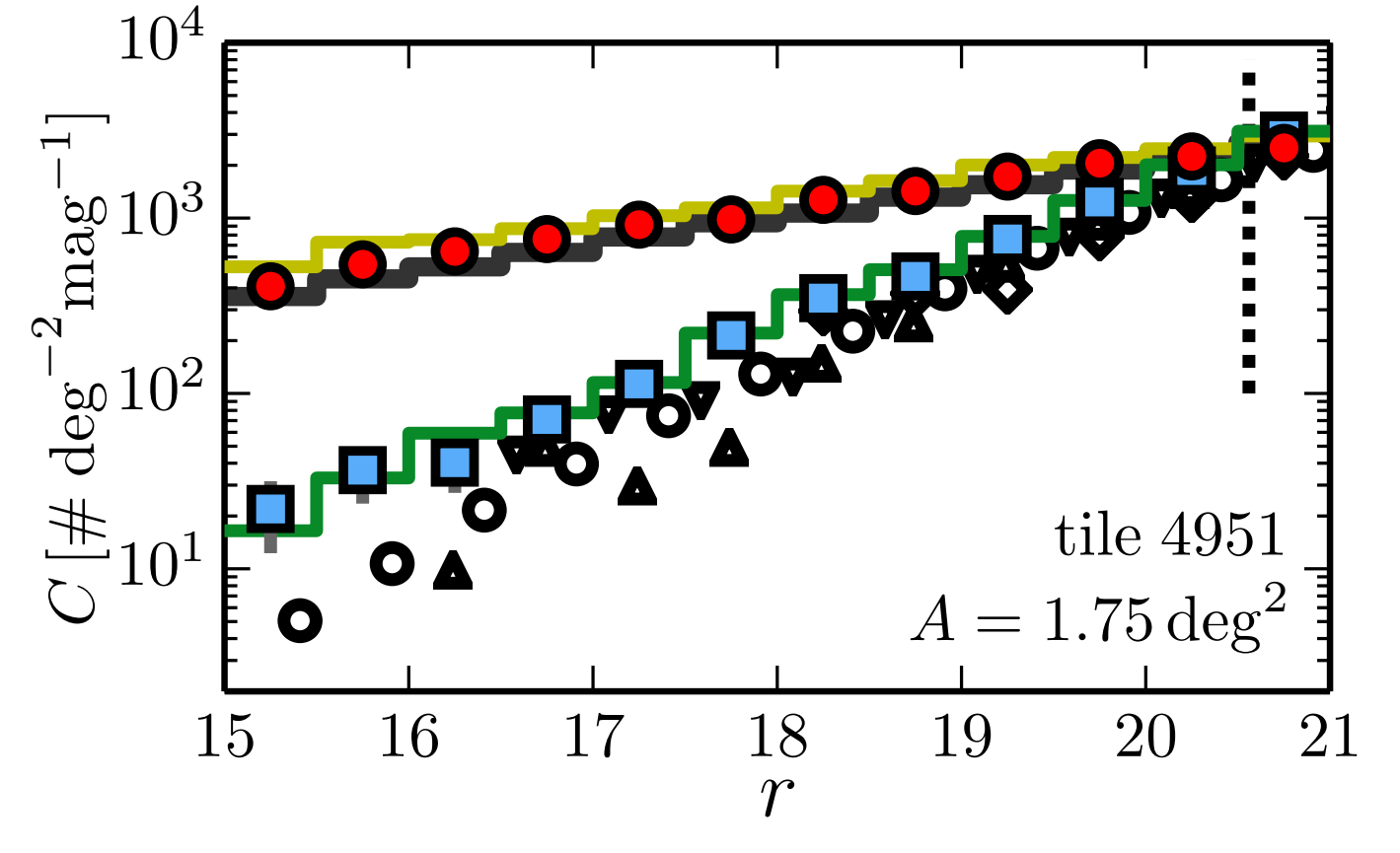

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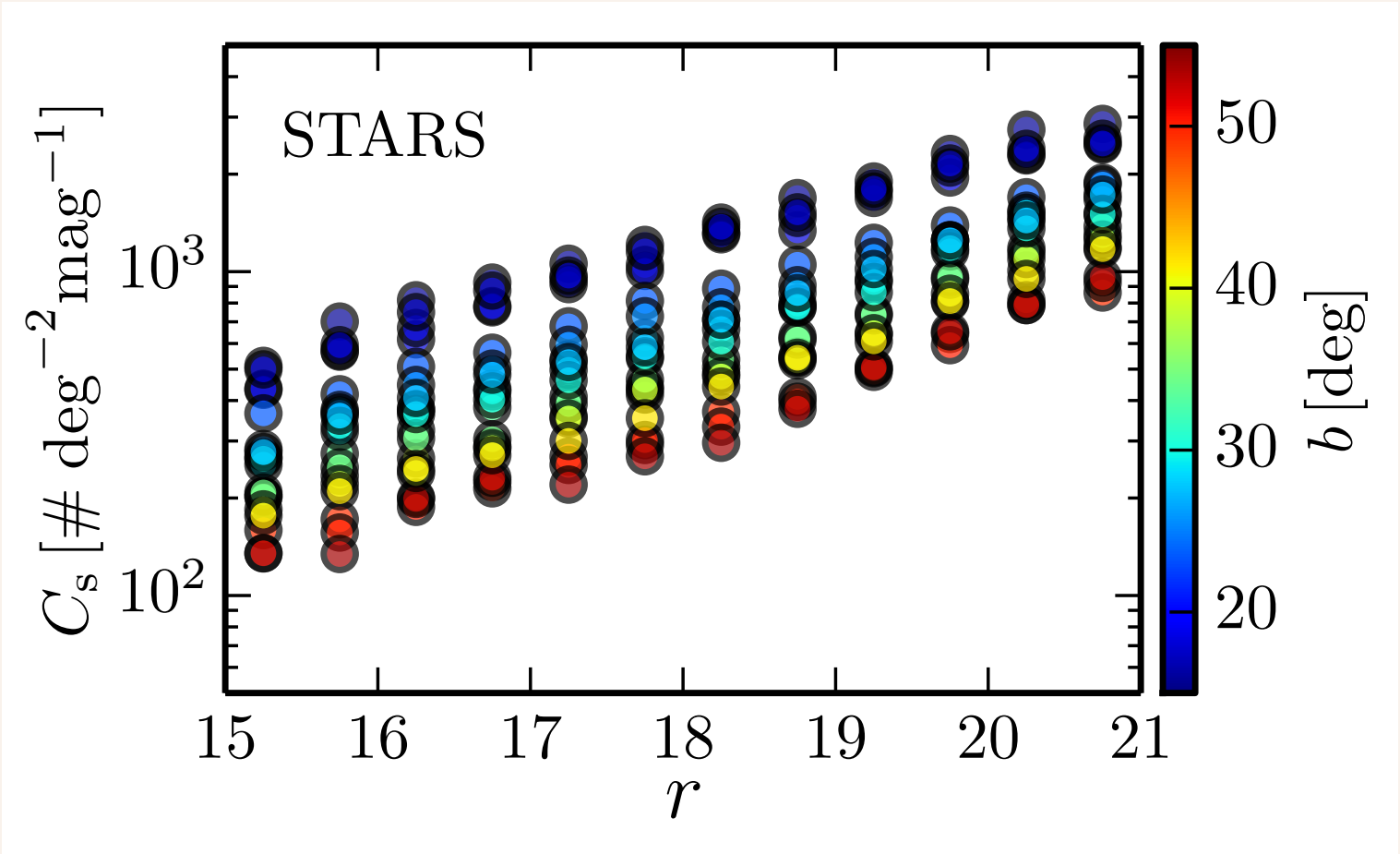
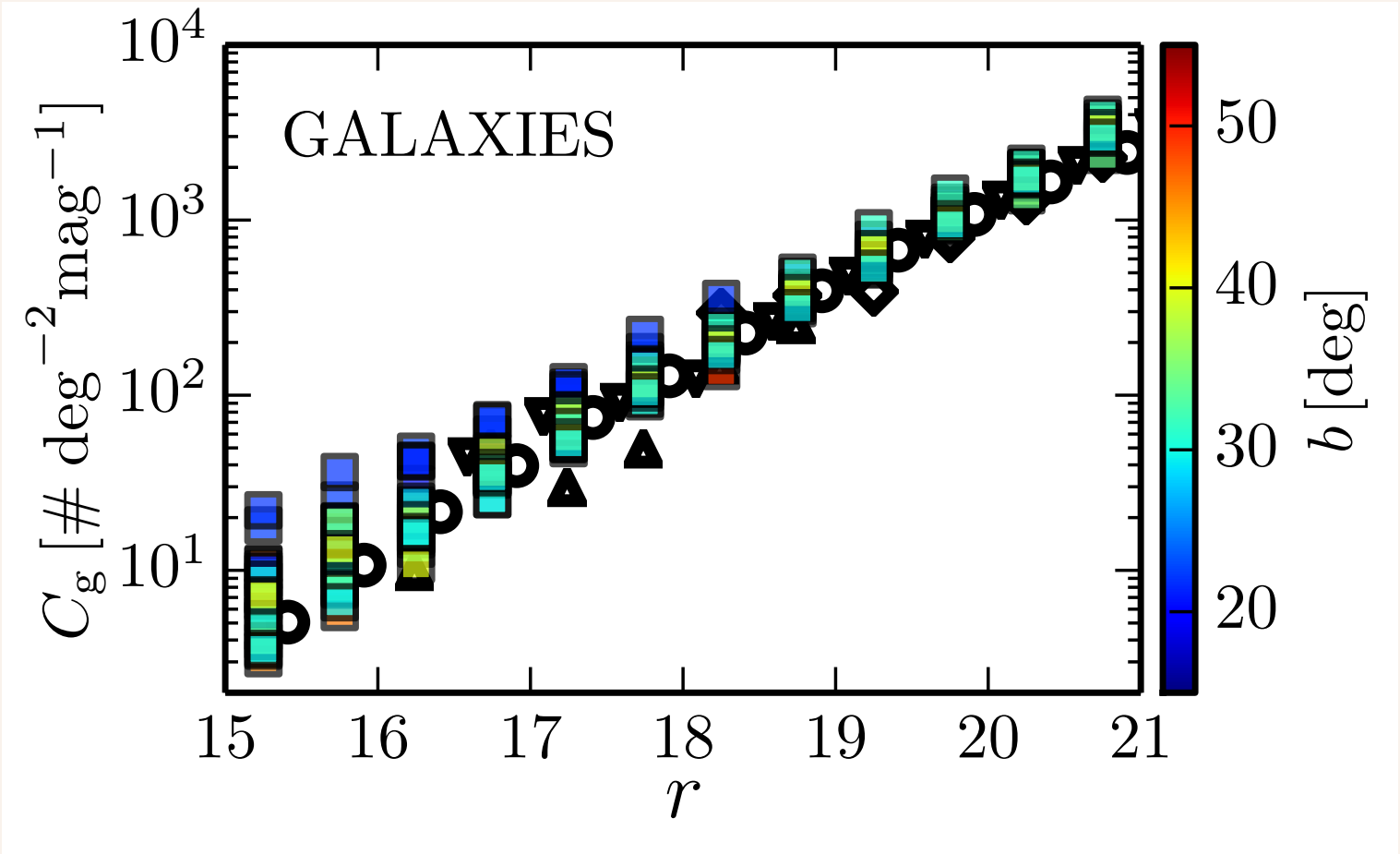
Star number counts in J-PLUS EDR



We have ∼150k stars over 31.7 deg^2.
The star density increases as we move away from the MW disc.

Galaxy number counts in J-PLUS EDR



We have ∼101k galaxies over 31.7 deg^2.
The dispersion in the counts decreases with magnitude.

Conclusions

We performed a **Bayesian morphological classification** of J-PLUS EDR sources over 31.7 deg^2

J-PLUS EDR comprises ∼150k stars and ∼101k galaxies with $r < 21$.
The number counts are in good agreement with previous work.

The final J-PLUS will comprise
∼**30 million stars** and
∼**25 million galaxies**.

Thanks for your attention!!

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