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A statistical approach to star/galaxy classification

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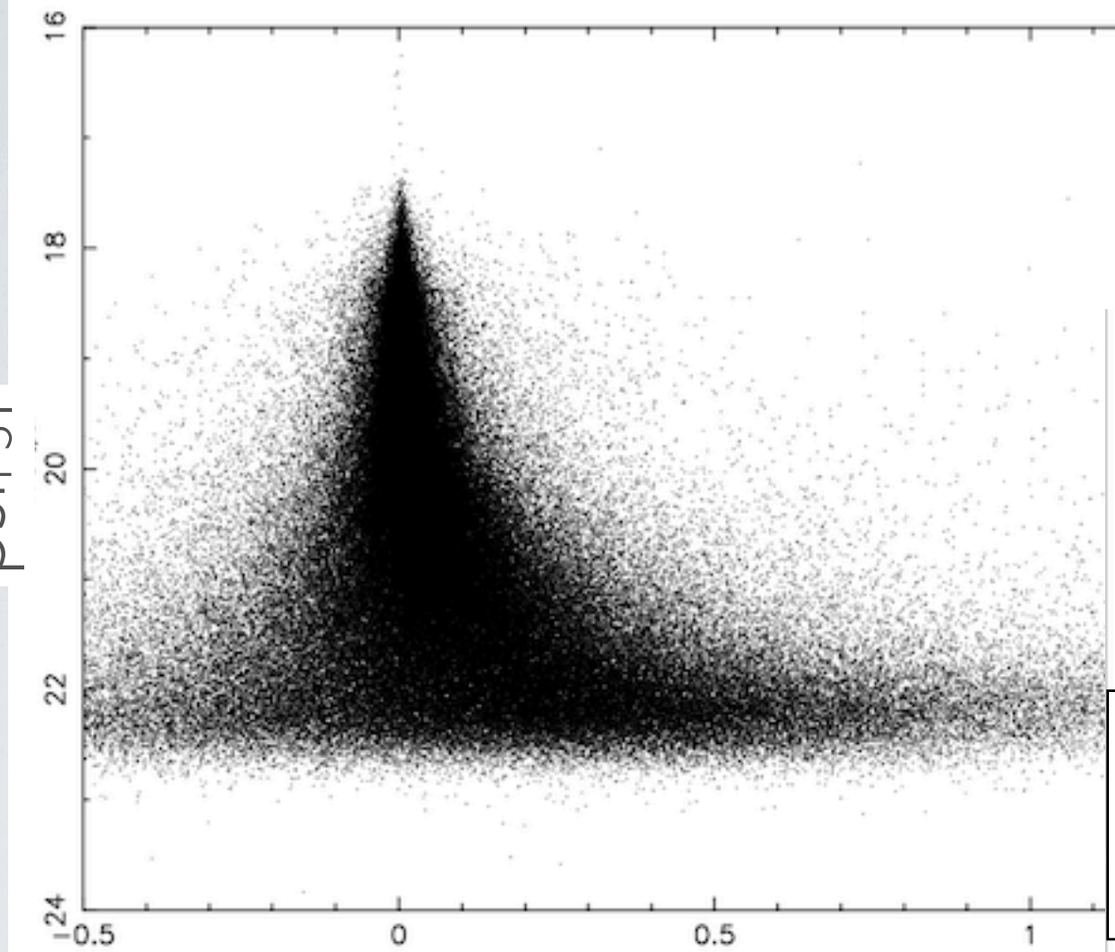
Star/Galaxy separation

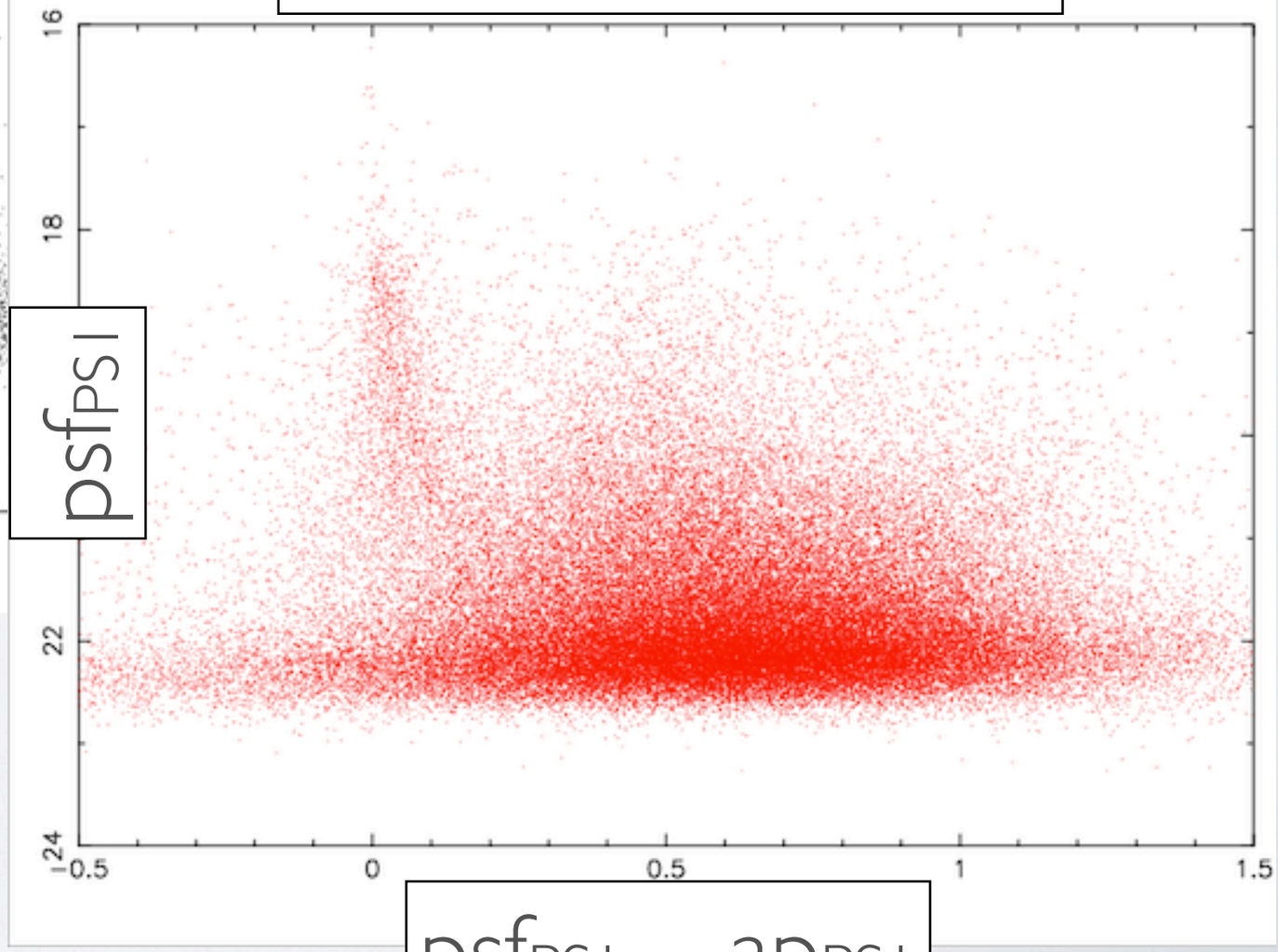
- My take on the problem:
  - Using only PS1 data
  - As few band required as possible
    - so largest possible coverage
    - Probabilistic approach: $P_{star}(mag_{psf}, mag_{psf}-mag_{ap})$
- Using the PAndAS survey for test
  - 400 deg^2 around M31 with CFHT/MegaCam
  - g>25.0, i>24.0, seeing <0.8''
  - "truth" for star/galaxy separation (determined from curve of growth)

Star/Galaxy separation

Stars in PAndAS



Galaxies in PAndAS



Model

$$\frac{\eta A_{\rm star} m^{b_{\rm star}} G(\Delta m, \mu_{\rm star}, \sigma_{\rm star}) + (1-\eta) A_{\rm gal} m^{b_{\rm gal}} G(\Delta m, \mu_{\rm gal}, \sigma_{\rm gal})}{1 + \exp \frac{m - m_{\rm lim}}{\rho}}$$

Model

$$\frac{\eta A_{\rm star} m^{b_{\rm star}} G(\Delta m, \mu_{\rm star}, \sigma_{\rm star}) + (1-\eta) A_{\rm gal} m^{b_{\rm gal}} G(\Delta m, \mu_{\rm gal}, \sigma_{\rm gal})}{1 + \exp \frac{m - m_{\rm lim}}{\rho}}$$

Location on (psf, psf-ap) plane

$$m = g, r, i \ldots$$

$$\Delta m = m_{\rm psf} - m_{\rm ap}$$

Model

$$\frac{\eta A_{\rm star} m^{b_{\rm star}} G(\Delta m, \mu_{\rm star}, \sigma_{\rm star}) + (1-\eta) A_{\rm gal} m^{b_{\rm gal}} G(\Delta m, \mu_{\rm gal}, \sigma_{\rm gal})}{1 + \exp \frac{m - m_{\rm lim}}{\rho}}$$

Location on (psf, psf-ap) plane

Luminosity function

$m = g, r, i \ldots$

$\Delta m = m_{\rm psf} - m_{\rm ap}$

Model

$$\frac{\eta A_{\rm star} m^{b_{\rm star}} G(\Delta m, \mu_{\rm star}, \sigma_{\rm star}) + (1-\eta) A_{\rm gal} m^{b_{\rm gal}} G(\Delta m, \mu_{\rm gal}, \sigma_{\rm gal})}{1 + \exp \frac{m - m_{\rm lim}}{\rho}}$$

Location on (psf, psf-ap) plane

Luminosity function

Completeness

$$m = g, r, i \ldots$$

$$\Delta m = m_{\rm psf} - m_{\rm ap}$$

Model

$$\frac{\eta A_{\rm star} m^{b_{\rm star}} G(\Delta m, \mu_{\rm star}, \sigma_{\rm star}) + (1-\eta) A_{\rm gal} m^{b_{\rm gal}} G(\Delta m, \mu_{\rm gal}, \sigma_{\rm gal})}{1 + \exp \frac{m - m_{\rm lim}}{\rho}}$$

Location on (psf, psf-ap) plane

Luminosity function

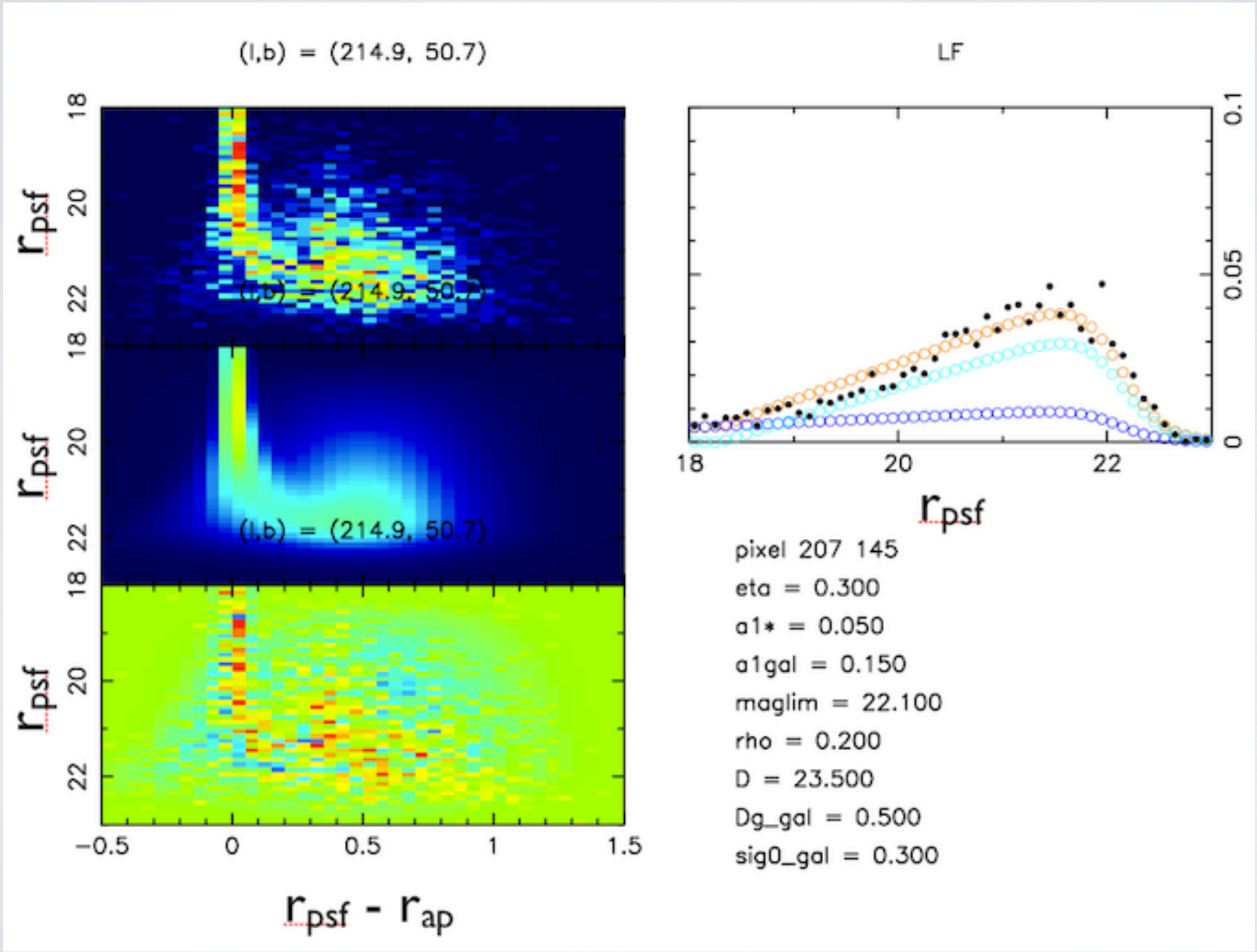
Completeness

Stellar fraction

$$m = g, r, i \ldots$$

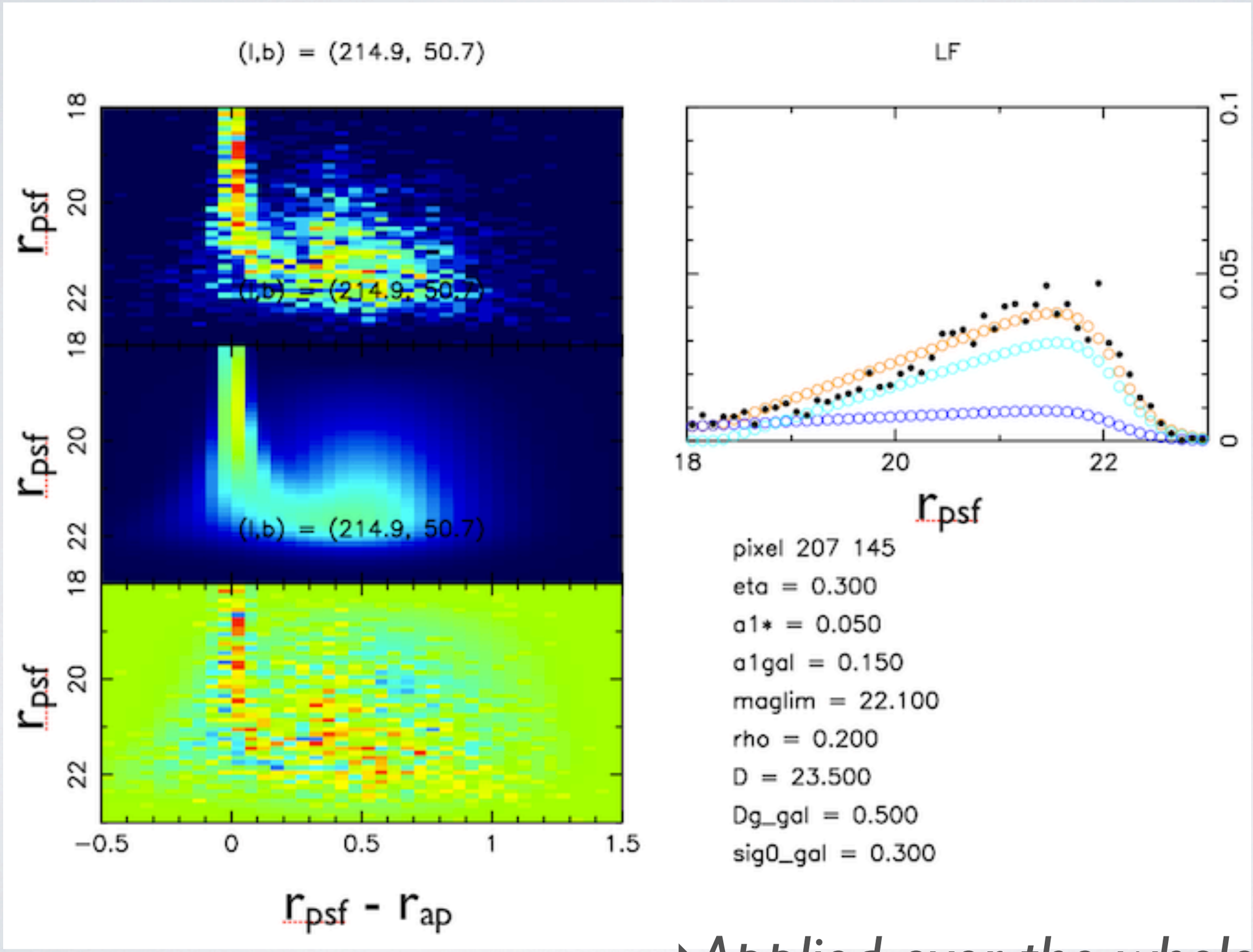
$$\Delta m = m_{\rm psf} - m_{\rm ap}$$

Star/Galaxy separation model



1 deg^2 region

Star/Galaxy separation model

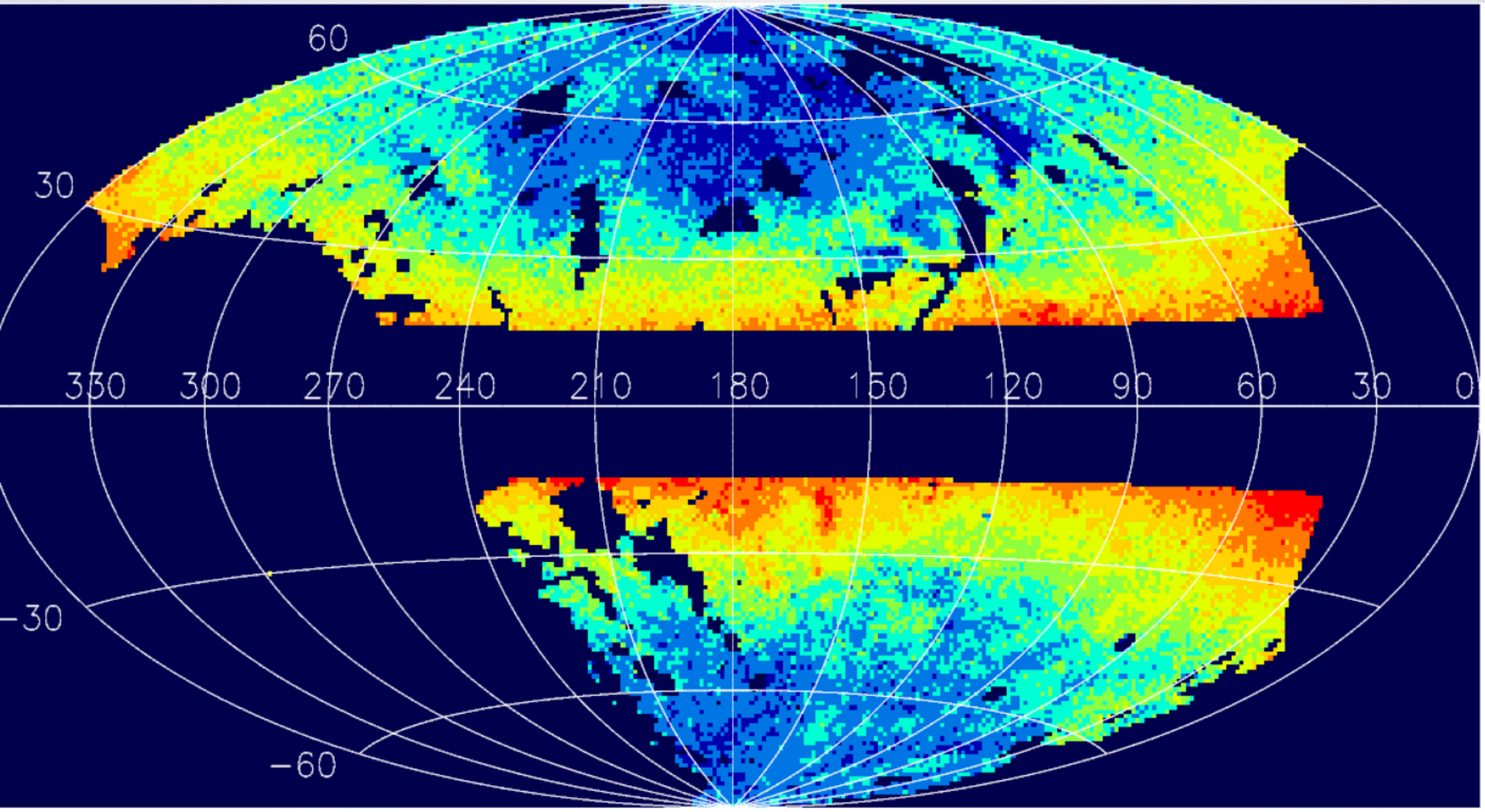


1 deg^2 region

→ *Applied over the whole PS1 sky*

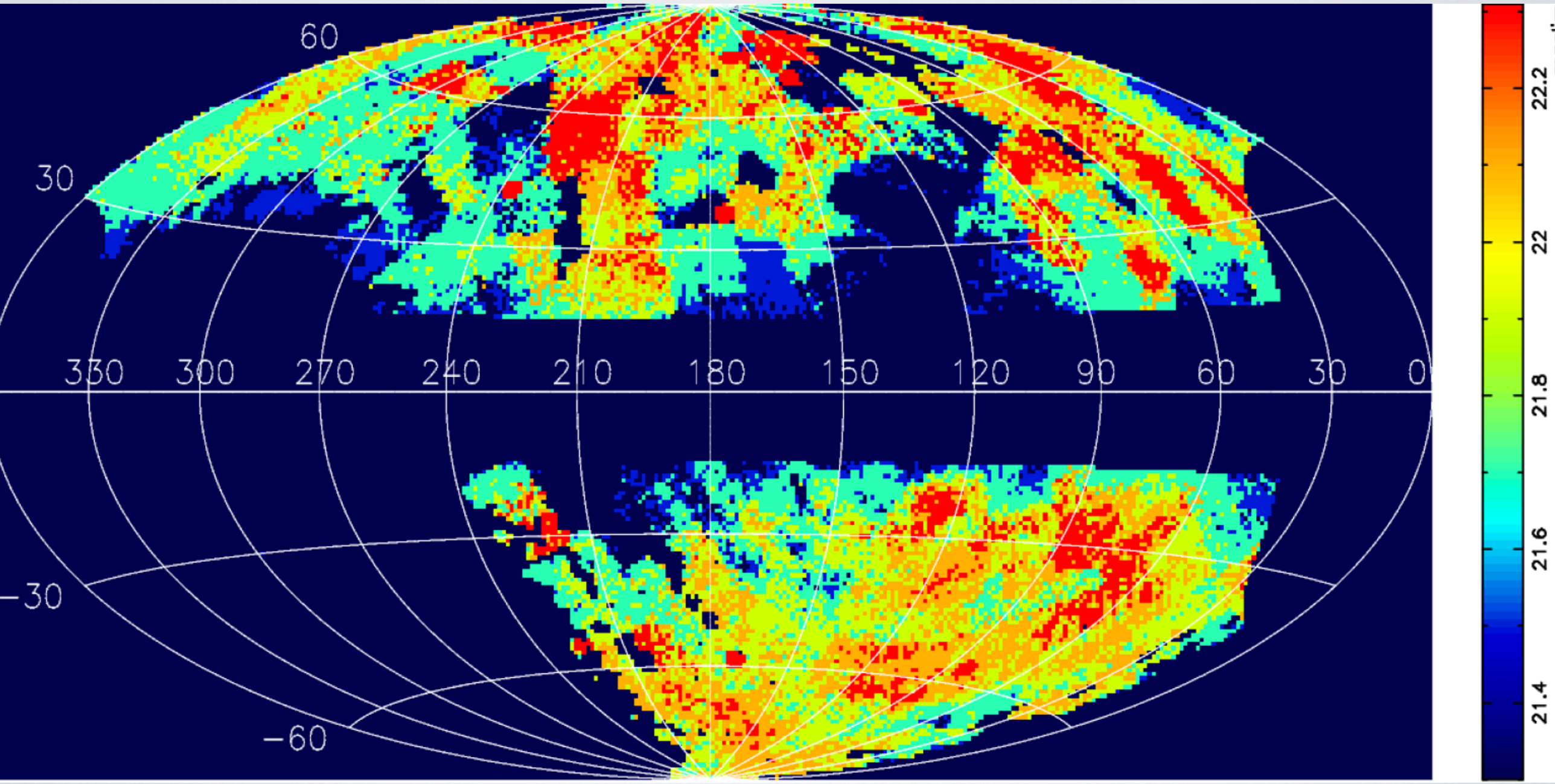
Star/Galaxy separation model

determined fraction of stars in catalogue

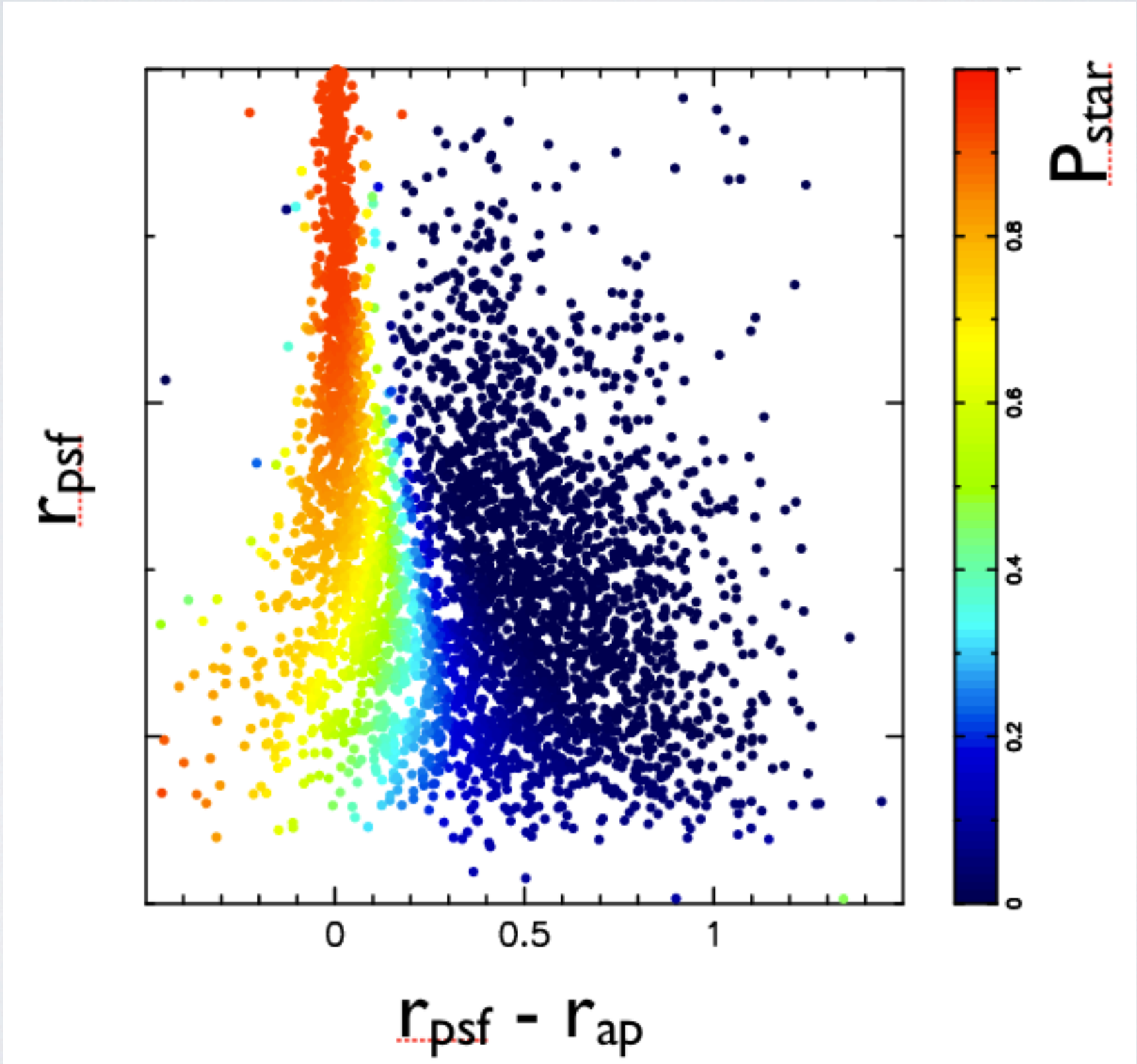


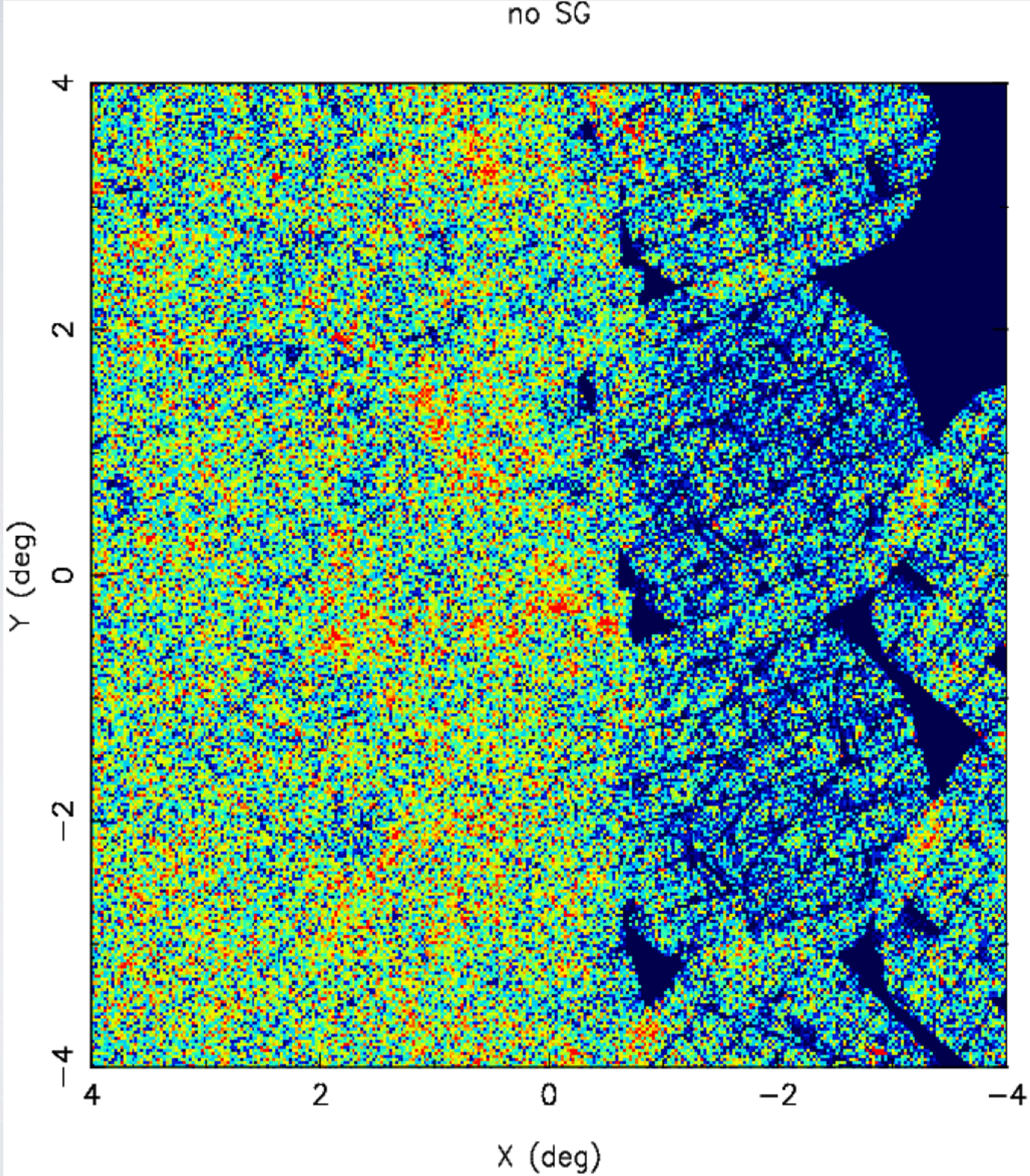
Star/Galaxy separation model

magnitude limit

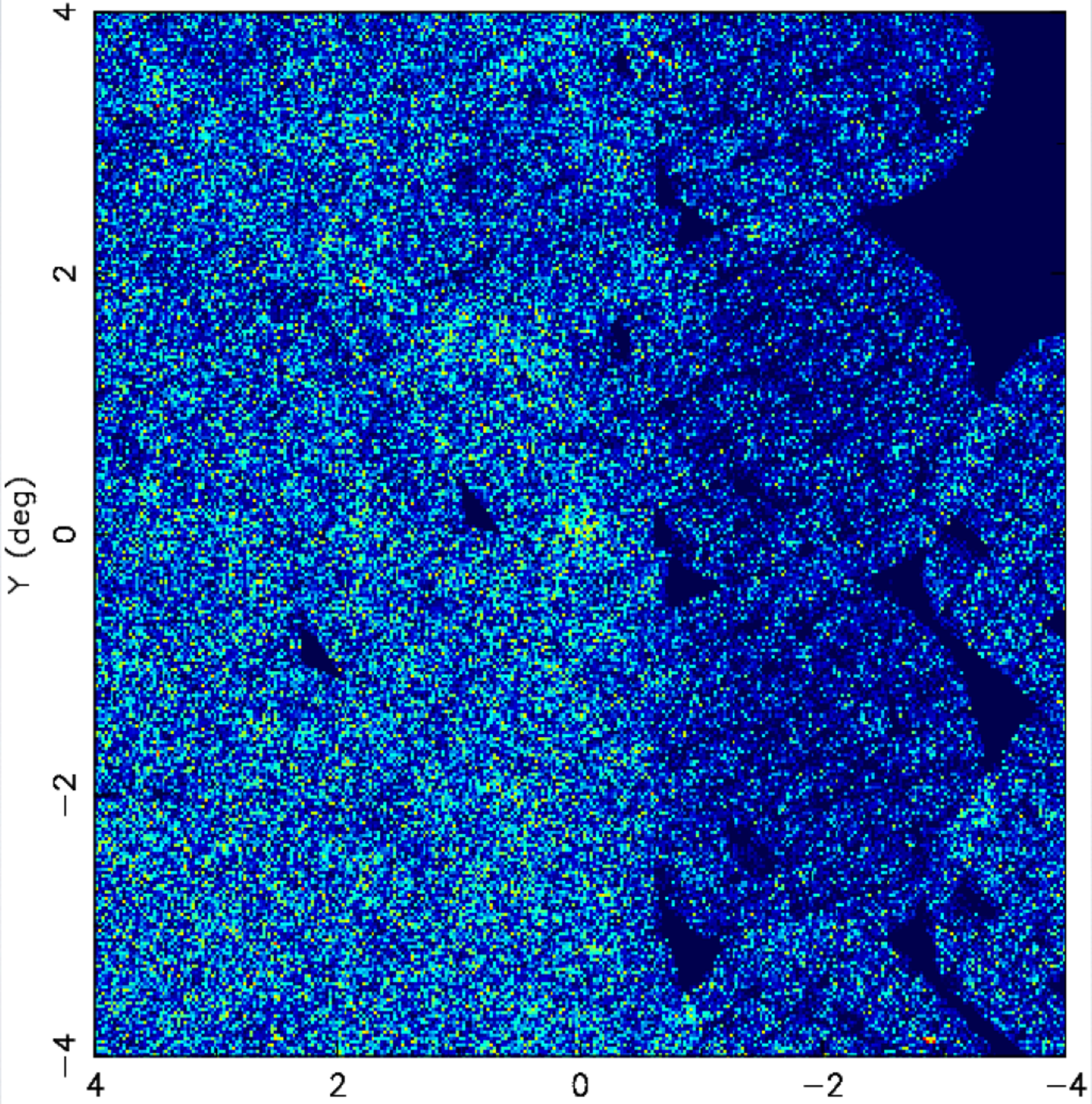


Star/Galaxy separation catalogue




no SG
Y (deg)
4
2
0
−2
−4
4
2
0
−2
−4
X (deg)

SG



Worries/To Do List

- Star/galaxy models really encompassing stars/galaxies?
  - To be checked with different surveys at different Galactic coordinates
- Sharp model changes from area to area
  - Use global prior on some parameters?
- Different bands shouldn't be fitted independently
  - Fraction parameter similar but not identical
  - Depth, luminosity function, etc. independent
- Can add some stellar locus star/galaxy probability
  - cf. Fadely, Hogg & Willman