Galaxy Structure through Bayesian Hierarchical modelling

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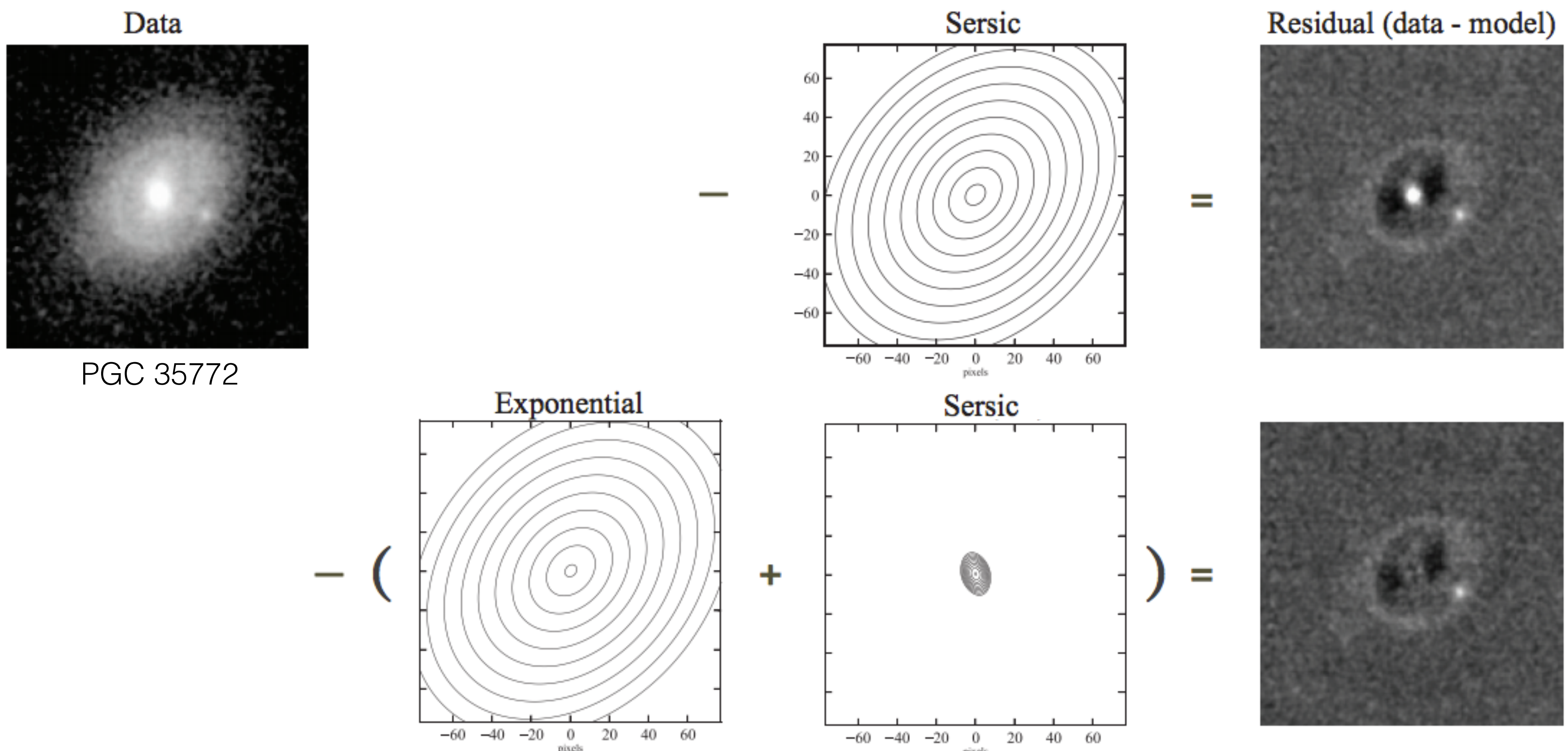
2D Photometric Decompositions



Erwin 2014

*see Lange *et al*. 2016 for more details.

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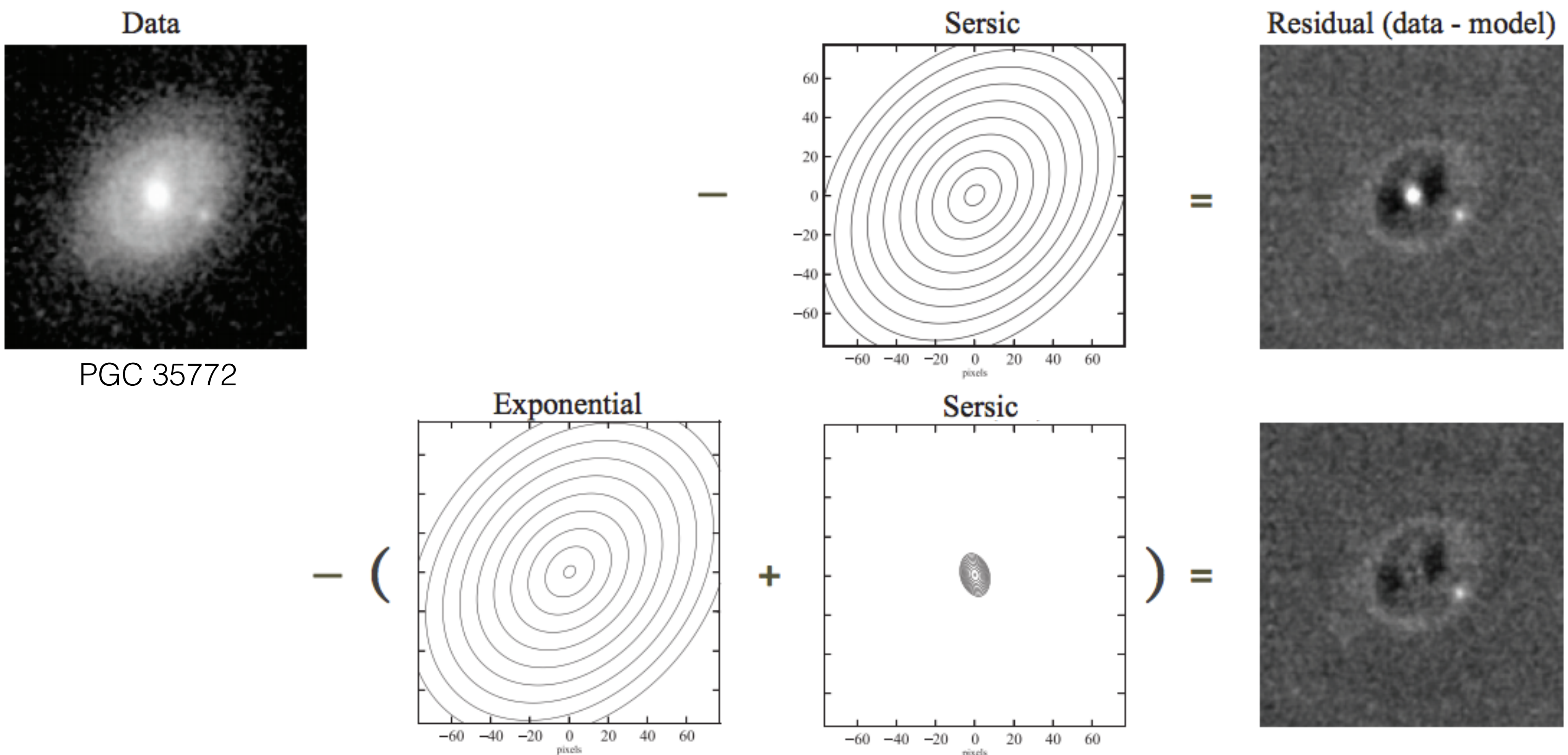

Erwin 2014

Problems with conventional methods:

1) Local minima trapping.
2) Unrealistic solutions.
3) Which model?
4) Representation of errors.

*see Lange *et al*. 2016 for more details.

Bayesian Inference

Baye's Rule:

$$P(\theta|Data) = \frac{P(Data|\theta)P(\theta)}{\sum P(Data|\theta_i)P(\theta_i)}$$

Posterior Joint distribution $\propto$ Likelihood function x Prior distribution

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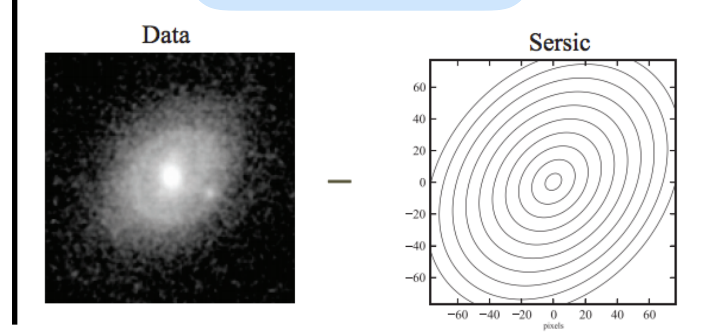

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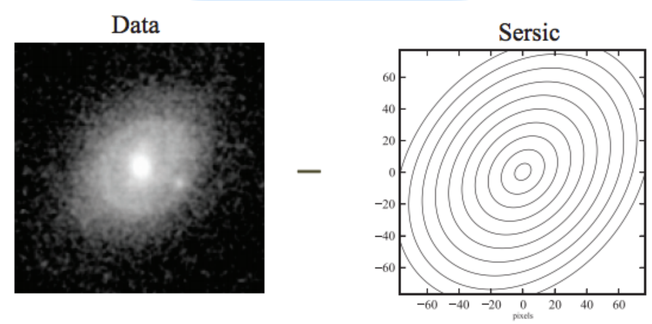

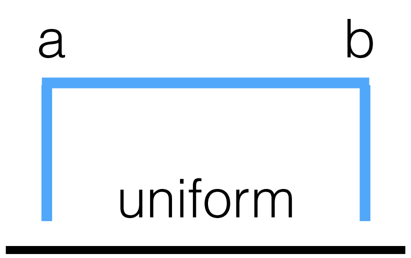

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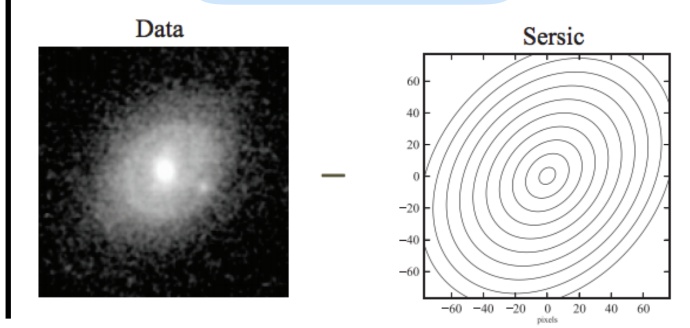
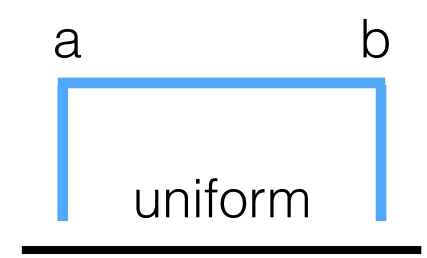
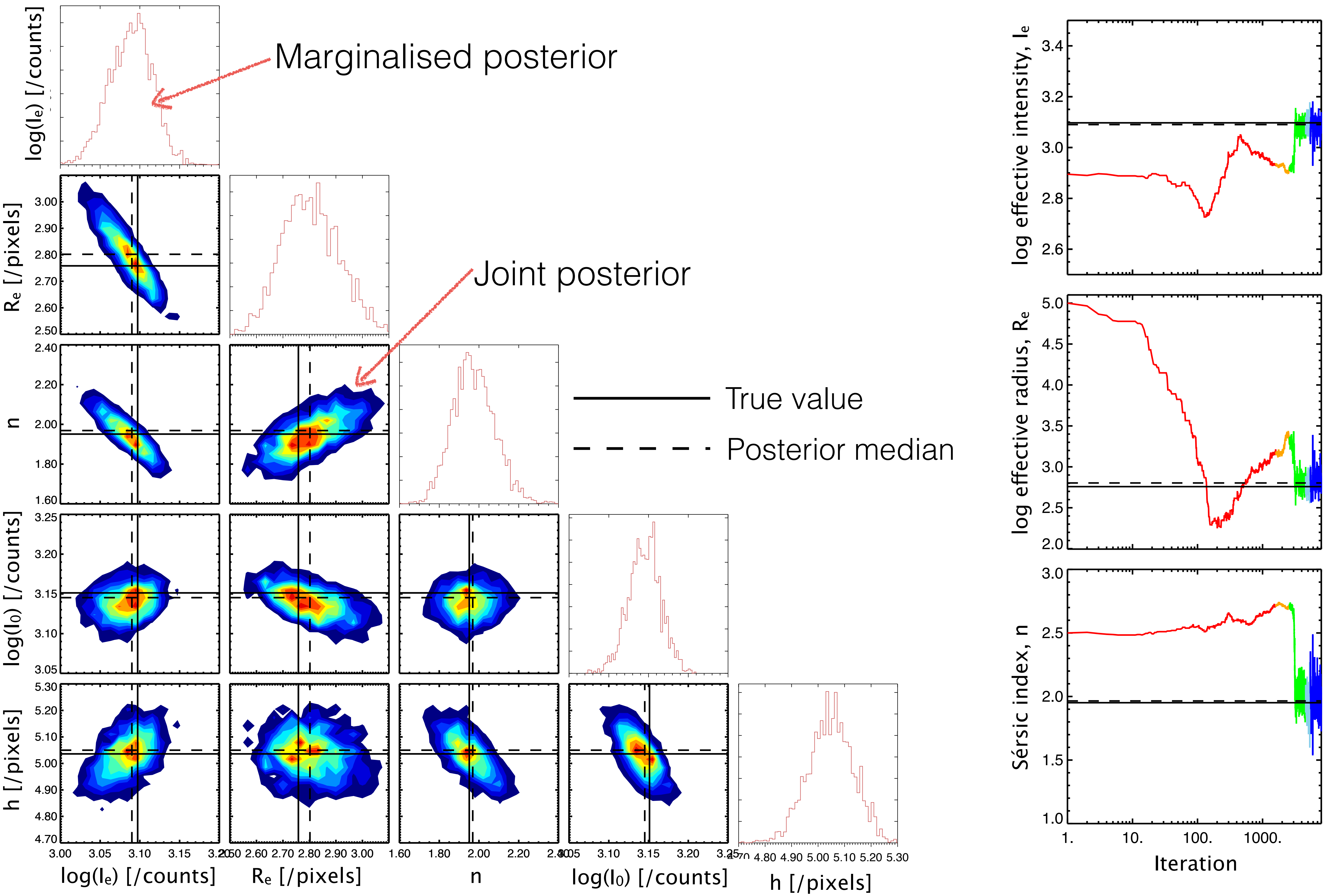




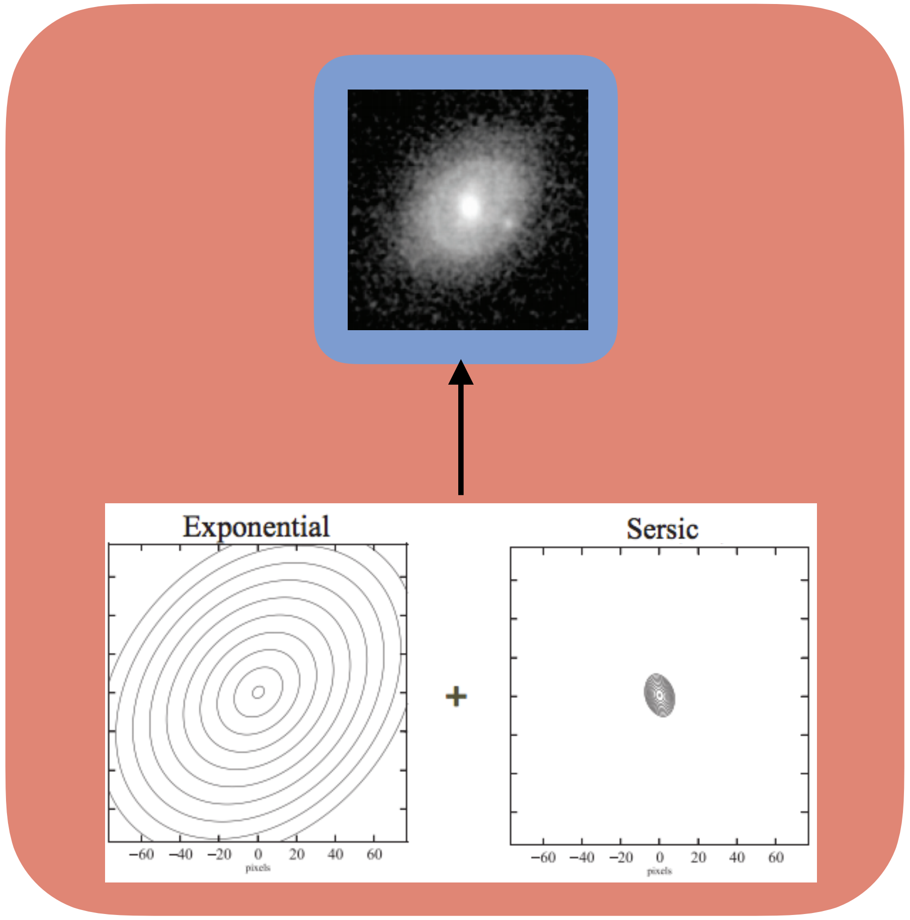
Previous Problems:
1) Local minima trapping.
2) Unrealistic solutions.
3) Which model?
4) Representation of errors.

Markov Chain Monte Carlo Solutions:
1) Exploration of parameter space.
2) Priors.
3) Bayesian model selection.
4) Posterior probabilities.

Bayesian Inference



Hierarchical Bayesian Inference



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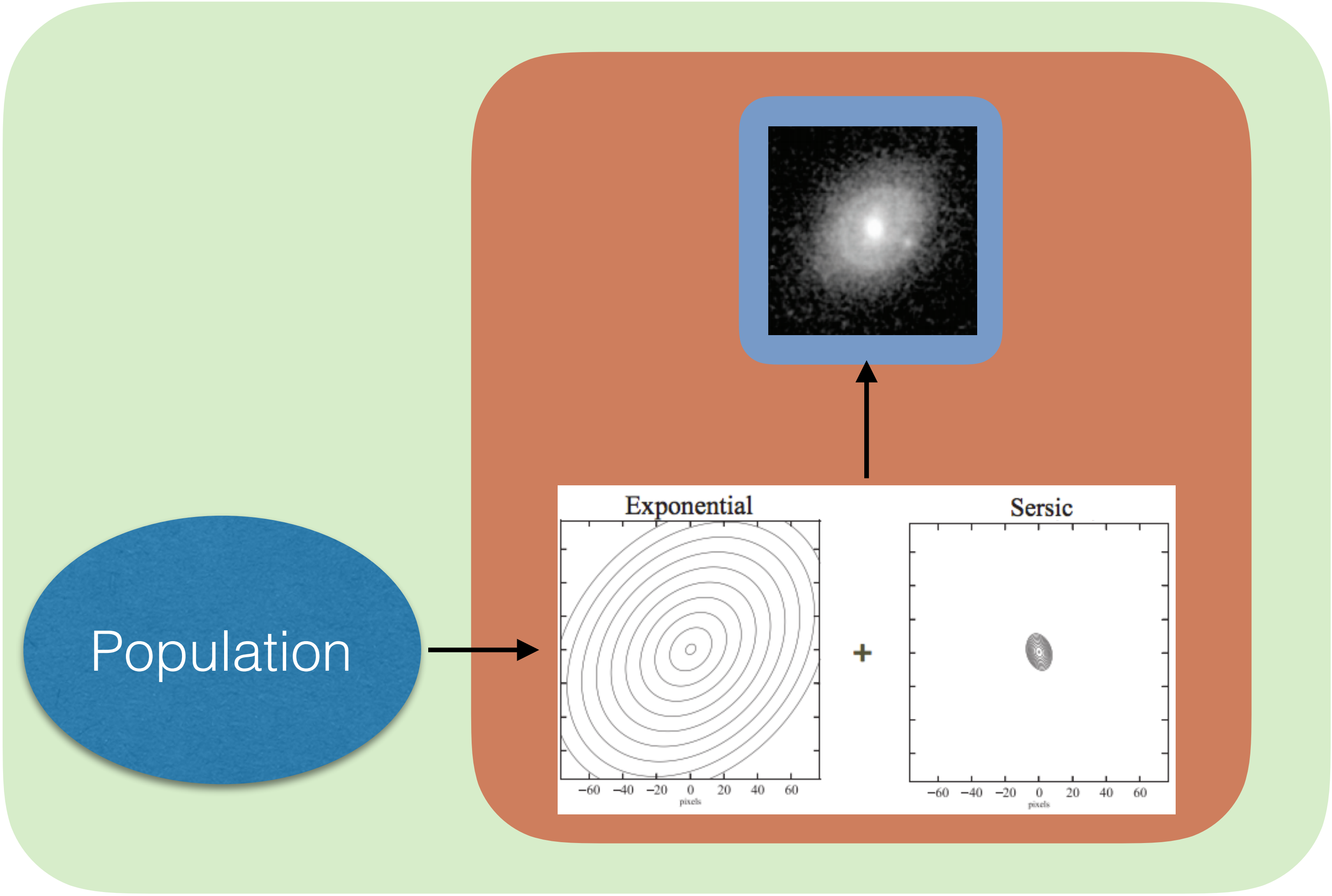

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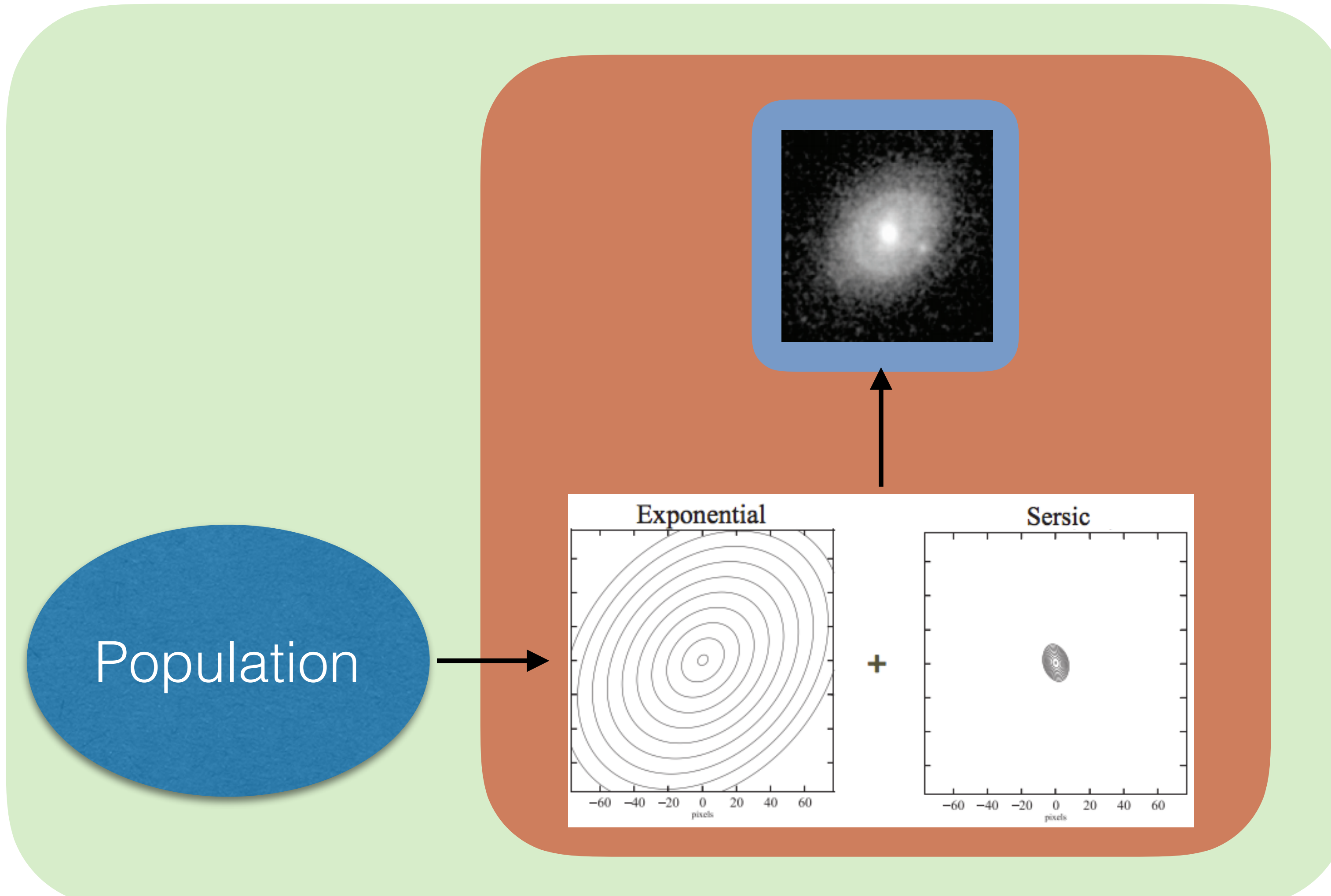


Piece-wise constant representation*:

Heaviside step function

$$P(\theta|\{f_d\}) = \sum_d \frac{f_d}{(\theta_{d,max} - \theta_{d,min})} \times \Theta(\theta - \theta_{d,min})\Theta(\theta_{d,max} - \theta)$$

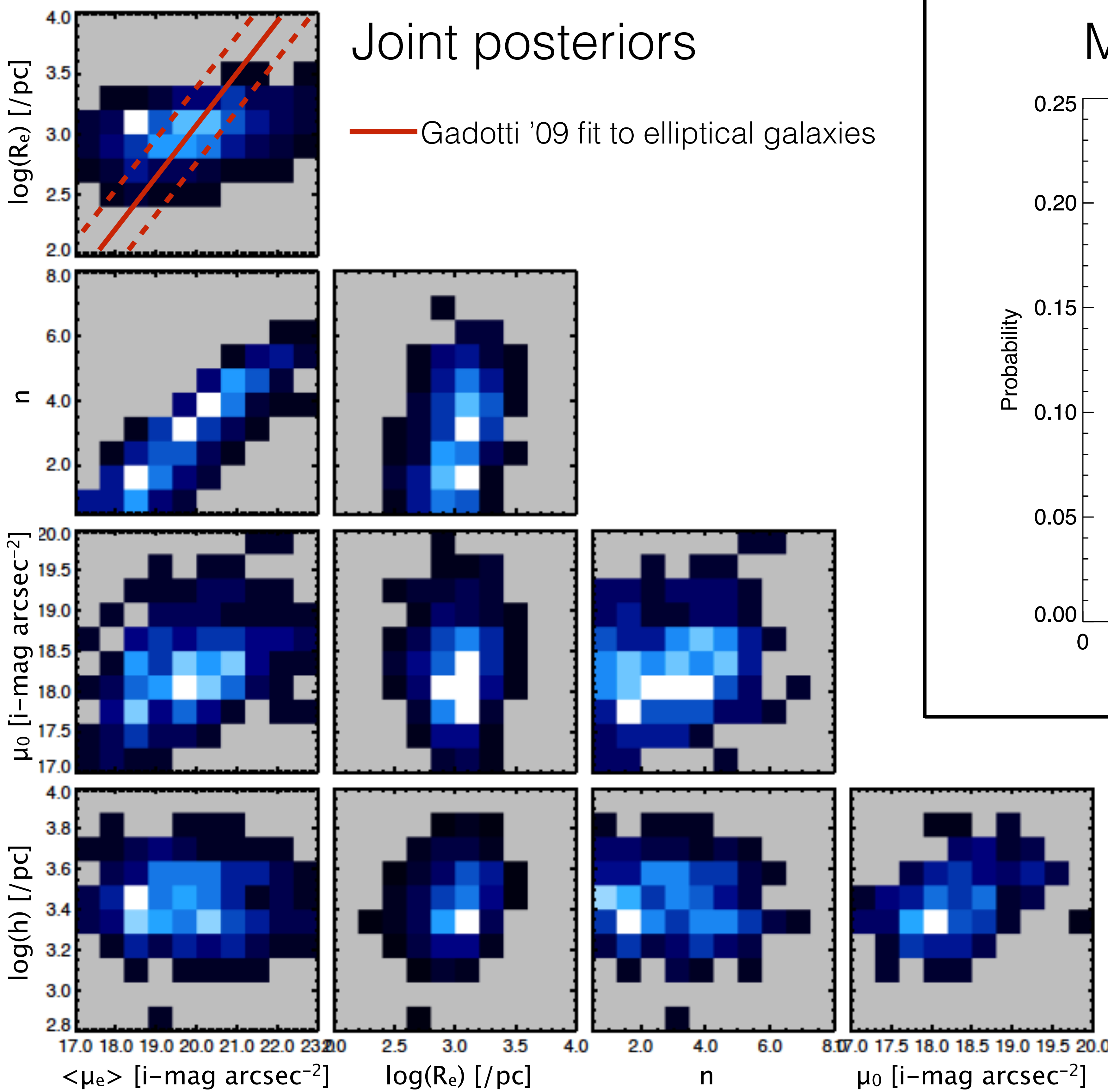
f_d - Probability of finding an object in the bin labelled *d*

***Mathematical description of a d-dimensional histogram**

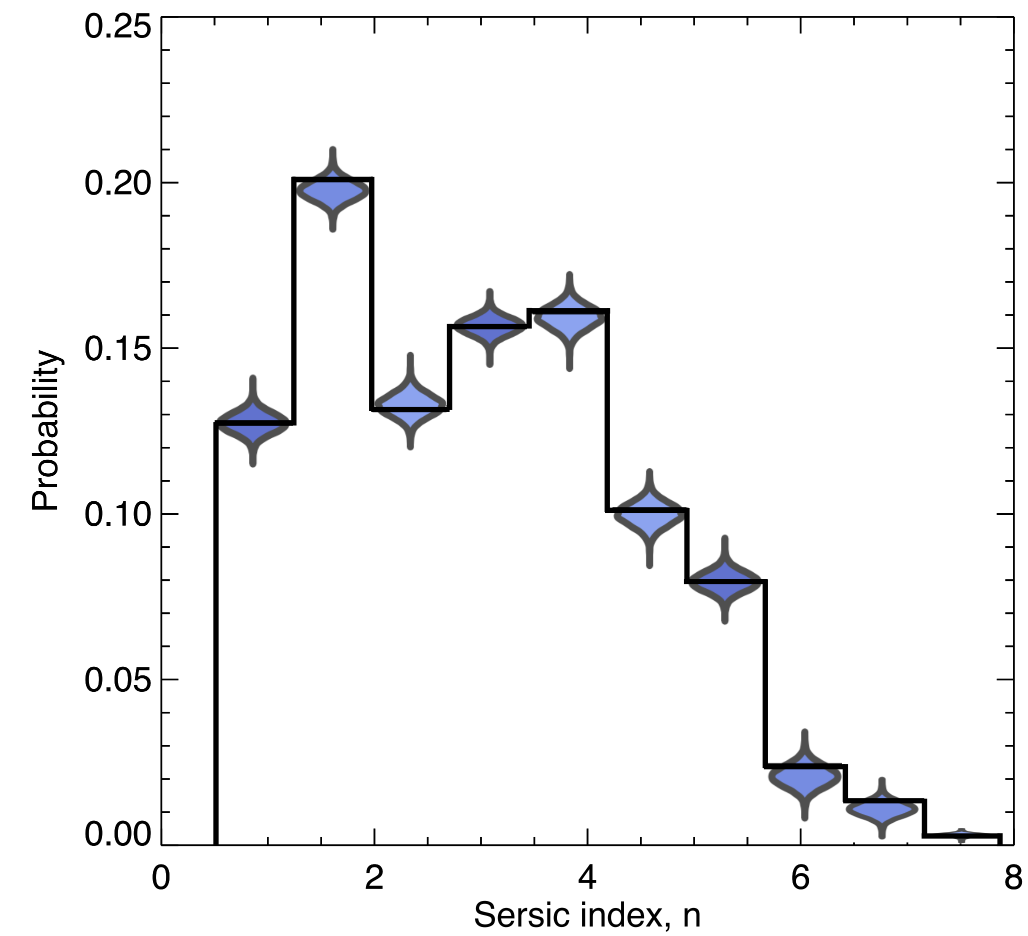
Hierarchical Bayesian Inference

Joint posteriors

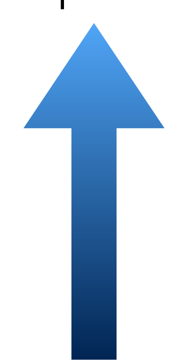
Gadotti '09 fit to elliptical galaxies



Marginalised posterior



Higher probability



Lower probability