The effect of spiral arms on the Sérsic photometry of galaxies

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1. Introduction

When we study galaxies, there are two importent quantities to describe the gobal properties of a galaxy: the total flux and the half-light radius.
The standard approach to measuring the total flux and the half-light radius of a galaxy is by fitting its image with a simply parameterised model for its surface brightness distribution.
The most commonly used model is the Sérsic profile:

$$I(x, y) = I_0 \exp\left\{-b(n)\left(\frac{R}{R_\mathrm{e}}\right)^{1/n}\right\}$$

1. Introduction

The Sérsic profile model can approximate the surface brightness distribution of a broad range of galaxies, from massive ellipticals to disks. But when we use it to fit some galaxies which have substructures such as spiral arms, rings, bars, or shells, a Sérsic profile model is unable to reproduce their images down to the noise level.

So, how much do these substructures affect the fitting? In this work, the author investigate the possible bias introduced by fitting a Sérsic model to galaxies with spiral arms.

2. The sample

The author focus on bulge-dominated spirals galaxies, beaucise these are objects for which it is easier to separate the spiral arms from the underlying smooth component of the surface brightness profile.

In this work, the author obtained a sample of 53 bulge dominated spiral galaxies from the SDSS.

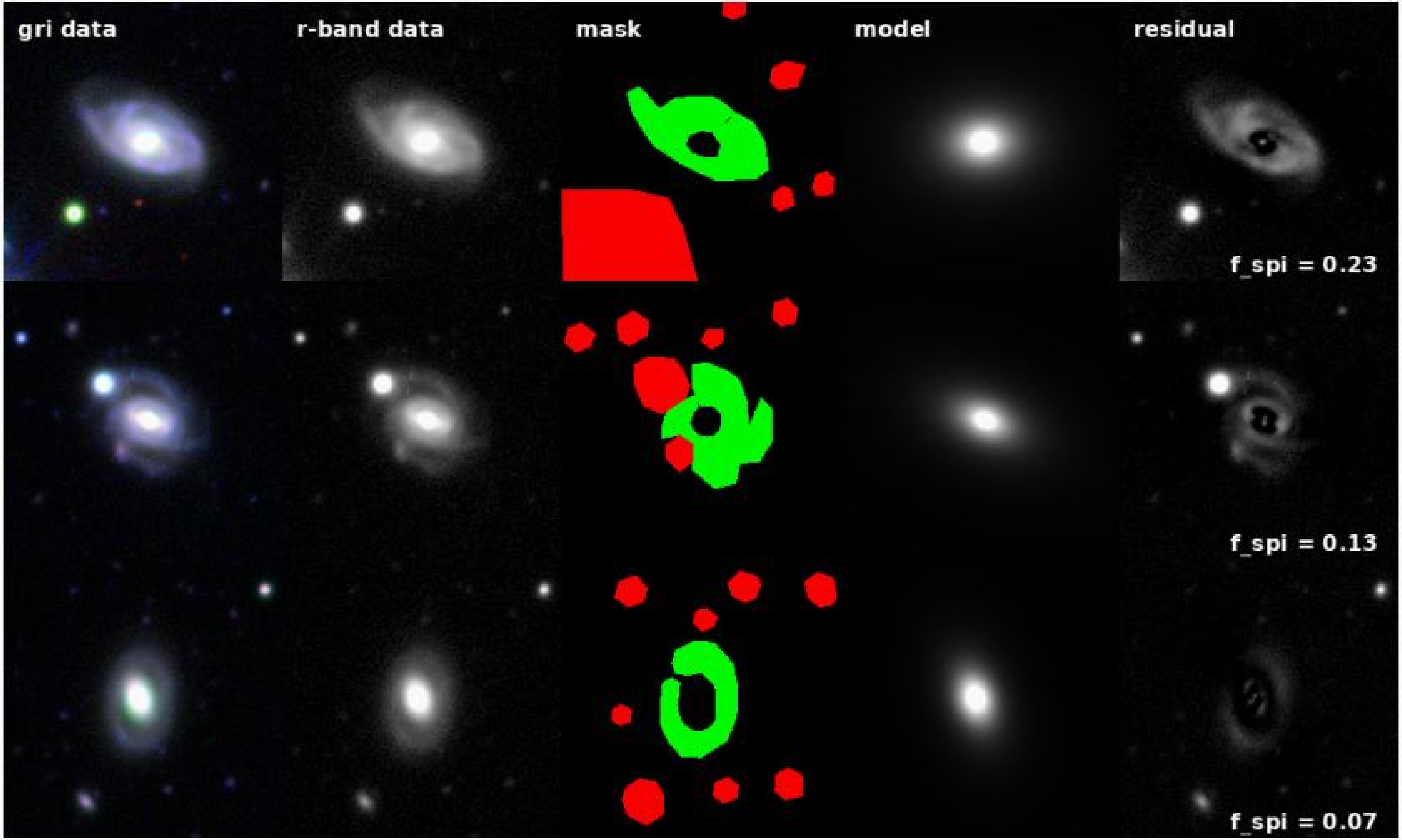
3. Photometric decomposition

f_{spi} :the r-band spiral-arm-to-total ratio

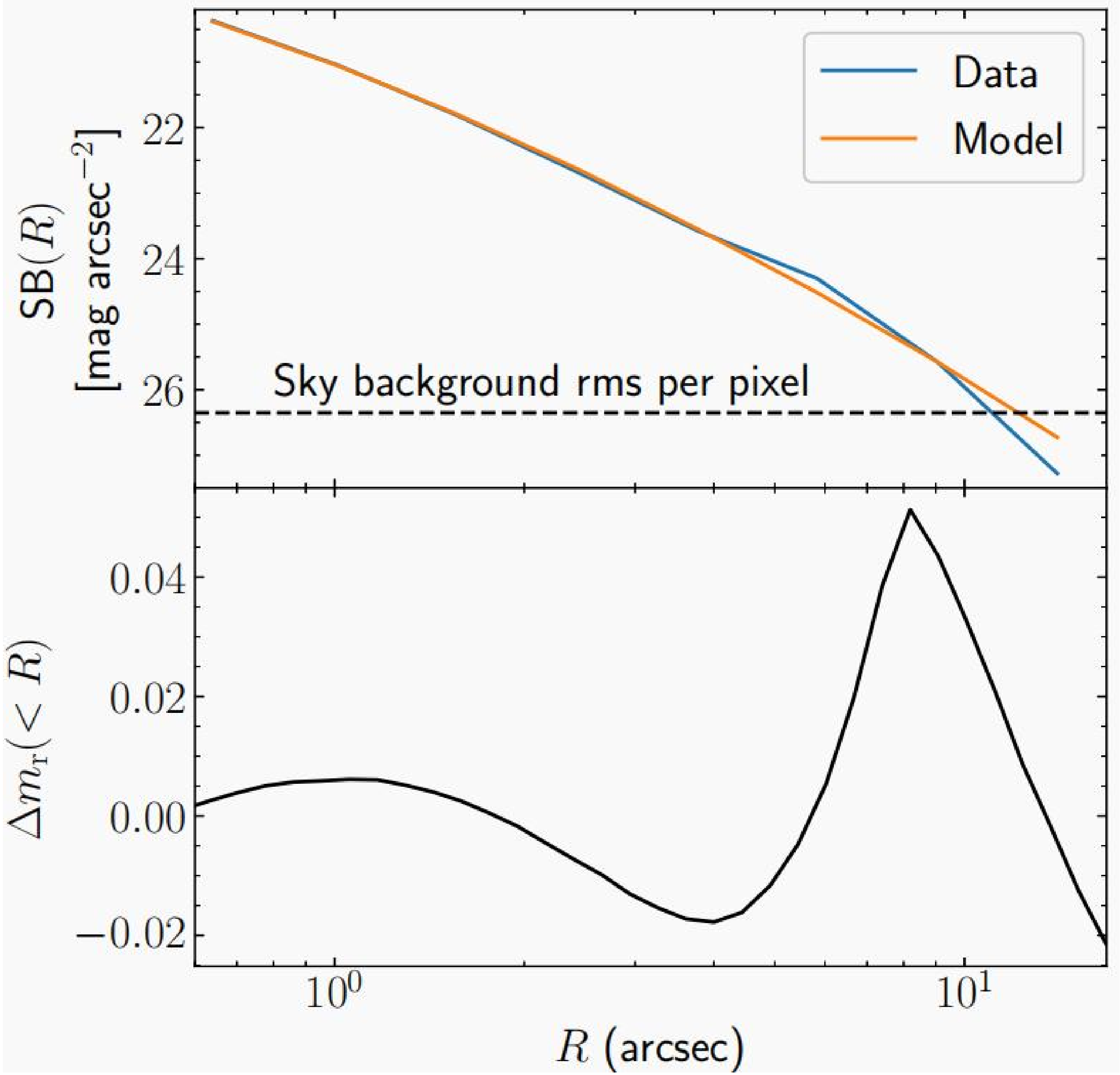
$R_{spi,lw}$:the light-weighted radius

$$R_{\mathrm{spi,lw}} = \frac{\sum_{i\in \mathrm{spi}} I_i \cdot R_i}{\sum_{i\in \mathrm{spi}} I_i}$$

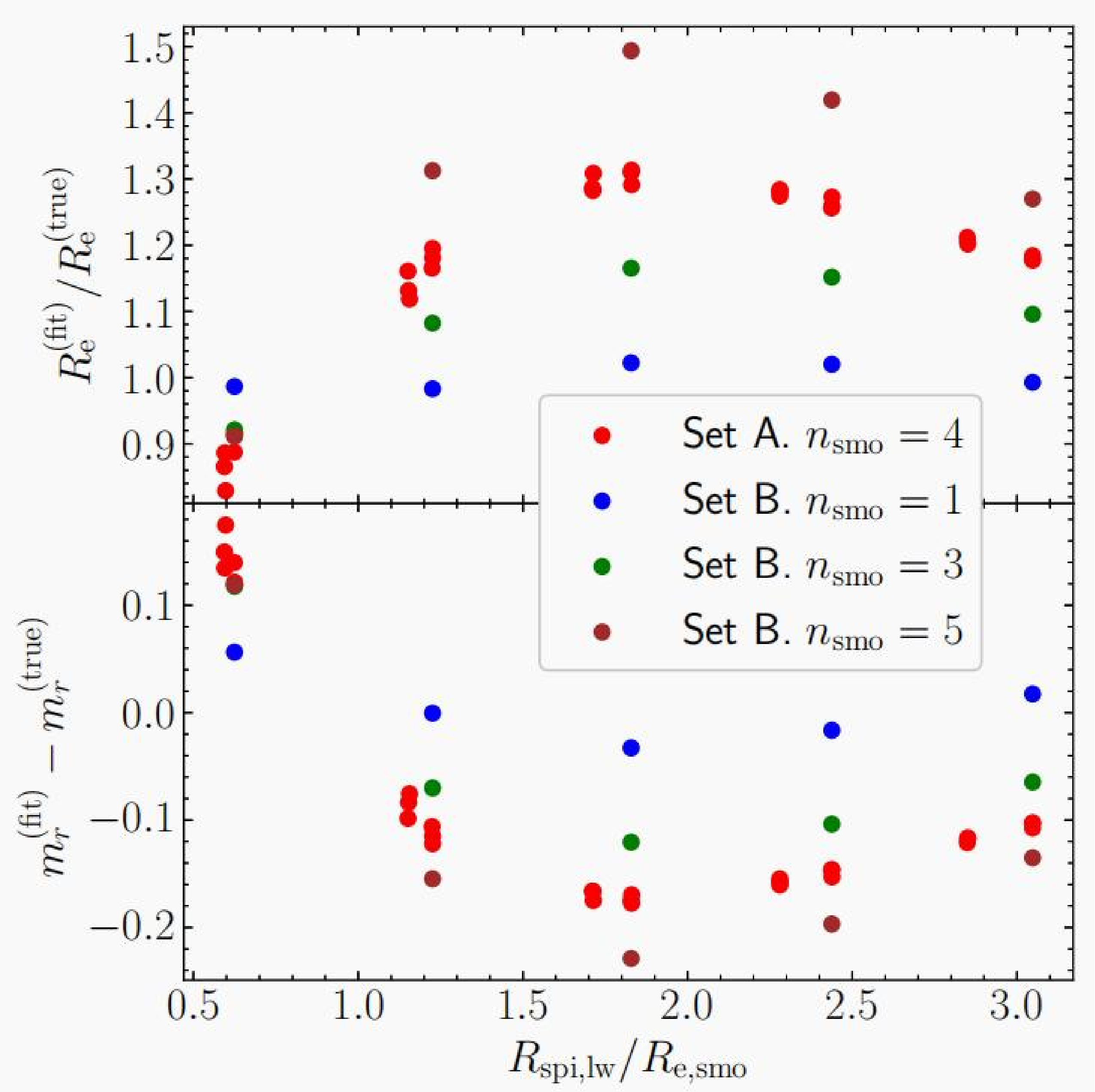
3. Photometric decomposition



4. Tests on simulated galaxies



4. Tests on simulated galaxies

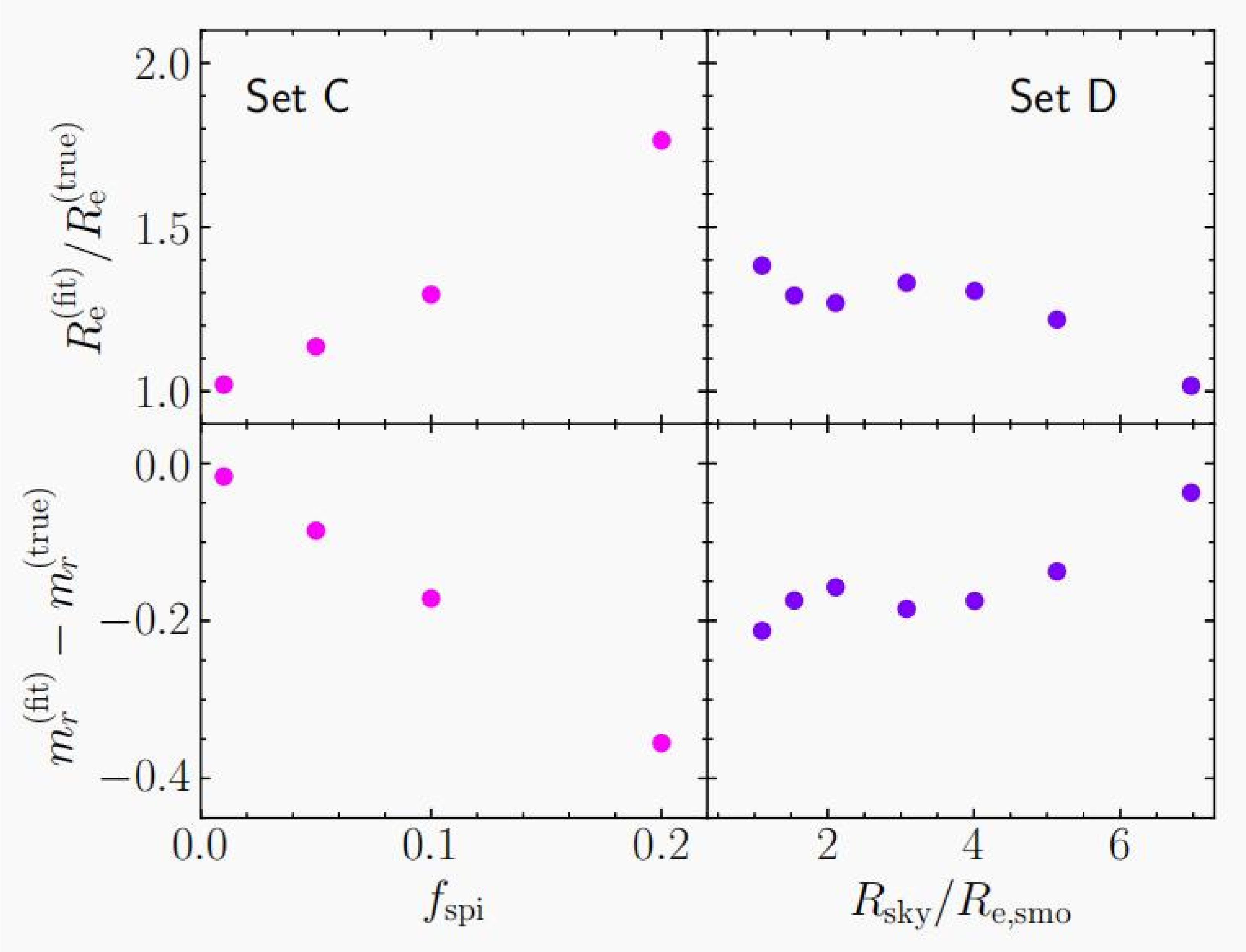


$R_{e,smo}$: the half-light radius of the smoth part

m_r: the magnitude of r-band

n_{smo}:Sérsic index of the smooth component

4. Tests on simulated galaxies



4. summary

The spiral arm will produce a deviation during sersic fitting, affecting the surface brightness profile at the larger radius and the final measured magnitude and half-light radius.

The greater the proportion of the spiral arms that occupy the entire galaxy, the greater the bias.

The magnitude of the bias is also related to the sersic index of the smooth part of the galaxy, and the larger the index is, the more significant the bias is.

Increasing the depth of the data will help us reduce the impact of bias.