SExtractor cold+hot detection mode

Having removed the light contaminations from ICL and bCGs, the resulting processed image is aimed to provide substantial improvement in catalog analysis. In this section, we focus primarily on performing the source identification/detection and measurement (including photometry and profile modeling) on the processed image. We have developed a series technical steps to reliably accomplish these. The workflow in Figure 1 outlines the main steps to assemble the final catalog, which consists of two separate subsamples, namely, sources detected on the processed image and already subtracted bCGs. The background colors are used to distinguish different stages, as indicated in the background of each box. Below we will present the details of each step.

We start to construct a robust catalog on the processed image, with SExtractor parameters only. The workflow for this stage is labeled with yellow background color in Figure 1. To minimize the contamination from false detections in our catalog, before running SExtractor we first mask all the bCG residuals, foreground stars, and noisy image edges by hand using DS9 region. Since we expect the catalog to be as complete as possible, great care is given to avoid the unintentional masking of faint sources around the residuals. We also mask large gravitationally lensed galaxies that are usually shredded into multiple spurious objects. In Figure 2, We overlay the combined mask regions with translucent cyan color on top of the processed image for visualization purpose. In essence, the processed image is not modified during the source extraction process, but it is the weighted image on which the mask is directly operated.

After masking the weight image, we run SExtractor cold+hot mode to produce the original catalog. In order to optimize the configuration parameters, the output Kron ellipses are then overplotted onto the detection image to visually check whether the source deblending and measurement are reasonable. We adjust the relevant configuration parameters and plot kron ellipses of the updated catalog again. The above steps are repeated in iteration until a satisfactory combination of the rigorous source deblending and minimum spurious shredding is reached. These fine-tuned SExtractor cold and hot mode parameters will be adopted as the optimal set of configuration parameters, which are listed in Table 1.

Nonetheless, we found that there are four local regions where the Kron ellipses of detected sources are significantly overestimated and appear to be very crowded on the image by visual inspection.

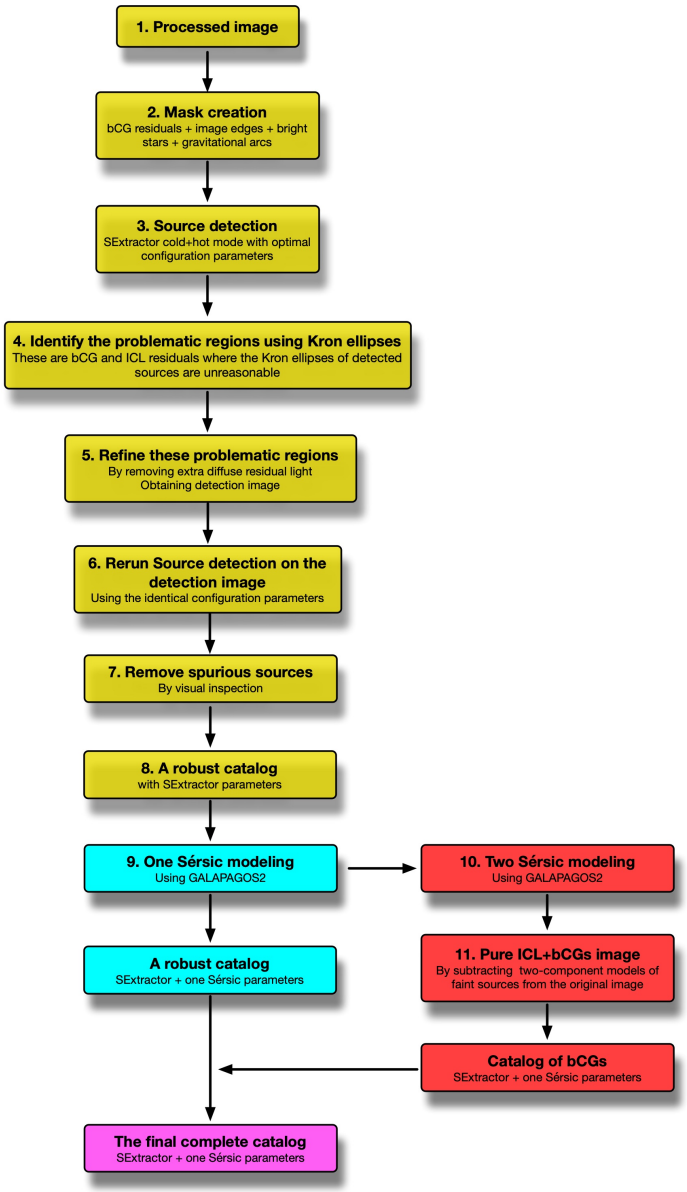

Figure 1: Flowchart representing the main steps performed in constructing the final catalog. Different stages are color-coded, as indicated in the background of each box. Yellow background color relates to build a reliable catalog on the detection image, with SExtractor prarameters only, and cyan color is to further derive their single Sérsic parameters. Red background emphasizes on measuring the same parameters for bCG sample on separate image, which is generated by subtracting faint galaxies from the original image. Purple color presents the final combined catalog.

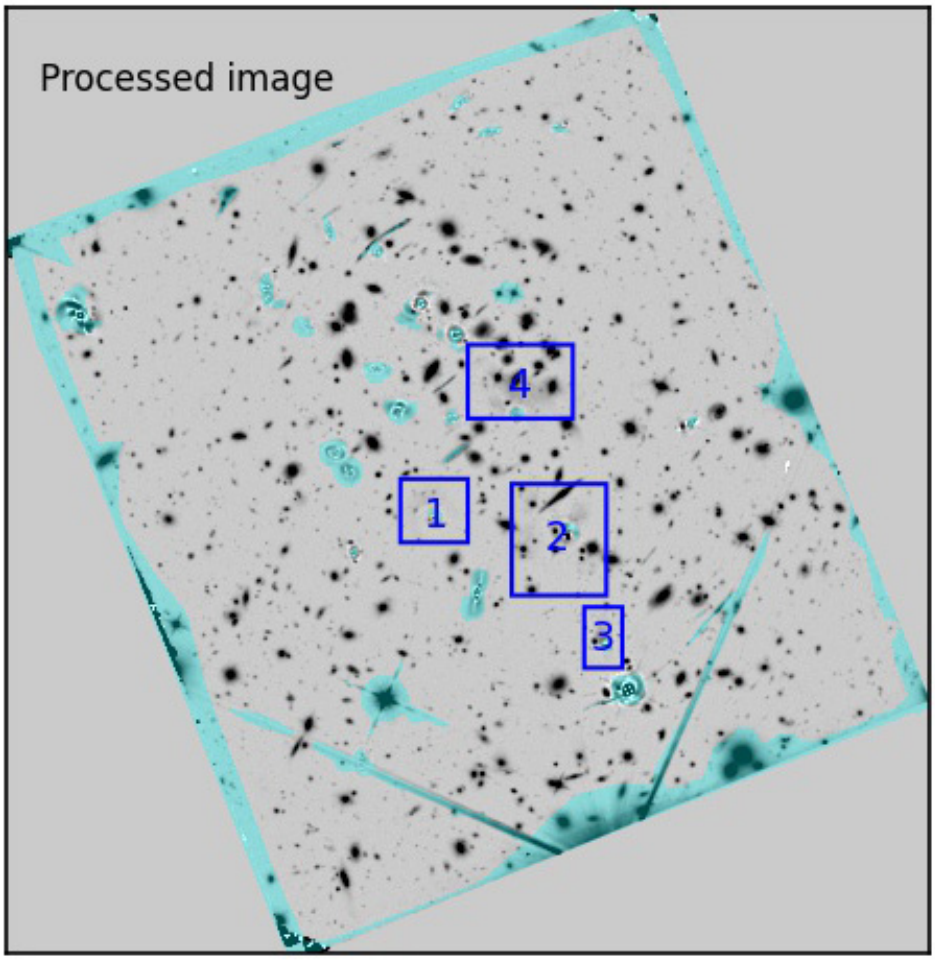

Figure 2: The panel shows the processed image. Overlaid in tranlucent cyan color indicate masked regions. Note that such plot is only for visualization purposes, because the mask image is directly applied to modify the corresponding weight image, not the processed image, during the source extraction process. The blue boxes labelled with id numbers mark four special regions, where source measurements are impaired by the contamination from remnant diffuse residuals from our previous subtraction procedure.

Table 1: SExtractor COLD and HOT mode parameter sets

Parameter	COLD	HOT
DETECT_MINAREA	20	5
DETECT_THRESH	3.0	0.8
ANALYSIS_THRESH	3.0	0.8
FILTER_NAME	gauss_4.0_7x7.conv	gauss_4.0_7x7.conv
DEBLEND_NTHRESH	64	64
DEBLEND_MINCOUNT	0.001	0.00001
BACK_SIZE	128	32
BACK_FILTERSIZE	1	3
BACKPHOTO_TYPE	Local	Local
BACKPHOTO_THICK	48	48
MEMORY_OBJSTACK	3000	3000
MEMORY_PIXSTACK	300000	300000
MEMORY_BUFSIZE	1024	1024

Notes. A Gaussian filter is applied to smooth the images before the detection run. For both detection modes, we adopt the same smoothing filter (gauss_4.0_7x7.conv) with FWHM = 4 pixels. We find that using this kernel size could arrive a good compromise between depending close neighbors and shredding large objects into multiple independent components. In this study, we mainly focus on aggressive deblending, given the overabundance of early-type galaxies in cluster core. However, in more general HST field such as CANDELS where the occurrence of large late-type galaxies is more frequent, larger filtering kernel for cold detection mode should be adopted to include substructures of large galaxies within the same galaxy.

References

Bhatawdekar R., Conselice C. J., Margalef-Bentabol B., Duncan K., 2019, MNRAS, 486, 3805

Merlin, E., Amorìn, R., Castellano, M., et al. 2016, A&A, 590, 30

Pagul, A et al., 2021, ApJS, 256, 27

Zibetti, S., White, S. D. M., Schneider, D. P., & Brinkmann, J. 2005, MNRAS, 358, 949