

# Far and Near UV sources in the UVIT deep field around IC4329a and their Multi-wavelength Counterparts

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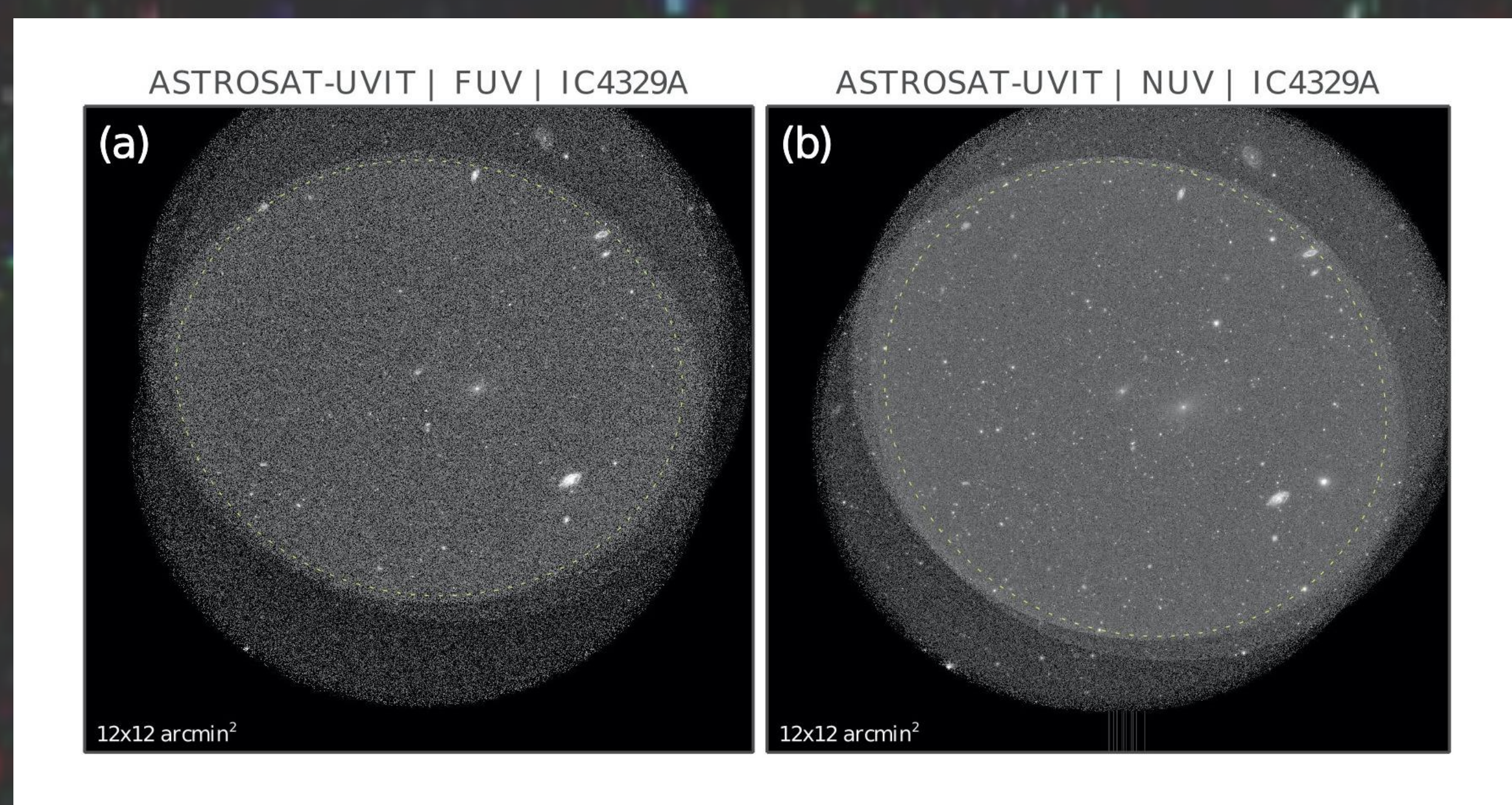
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## ABSTRACT

The primary aim of our project is to produce a catalogue of bright sources in Far ultra-violet and near ultra-violet band as well as study their variability on short timescales. The excellent spatial resolution of UVIT and its unique feature of simultaneous imaging in both FUV and NUV band enables us to produce UV colour for our detected sources, as well as simultaneous variability studies in both the bands help us to study the nature of UV emission from these sources. We have analyzed the deep UVIT field around the Seyfert galaxy IC4329a and detected 4530 sources up to AB magnitude of 25.996 in NUV and 571 sources up to AB magnitude of 25.361 in FUV band above SNR of 5. We performed astrometry and photometry on all the detected sources and produced a catalogue containing their position, Far and near UV flux, magnitudes and UV colours. We are also investigating the UV variability for some bright sources in our field on short time scale. We found 676 sources in NUV and 66 sources in FUV that have Gaia counterparts. We also searched for X-ray counterparts and found 99 NUV sources and 26 in FUV sources that have been detected in XMM-Newton Serendipitous Source Catalogue.

## OBSERVATION and DATA

UVIT, onboard ASTROSAT observed the Seyfert Galaxy IC4329a five times between February to June, 2017(PI: Gulab Chand Dewangan) in Photon-Counting mode using two broad-band filters, FUV BaF2 and NUVB13. We processed the data for all five observations using UVIT-customised pipeline CCDLAB and merged them together to obtain final science ready image. The net exposure of the merged image is 82 ks in NUV(NUVB13) and 84 ks in FUV(BaF2) band.



Composite image of the five observations of field around IC4329a in FUV and NUV band. The yellow ellipse indicates the overlapping area of the field that is common to all five observations. We have used this common area as our field of view..

## BACKGROUND ESTIMATION

To estimate the background we initially detected sources using SExtractor software and then masked all the detected sources along with all the pixels outside our field of view. We randomly placed 1000 random boxes of 5x5 pixel-size boxes across the masked image. Then we measured the average photon counts in each boxes in the sample, which gave us a distribution for photon counts per pixel for the image. After applying sigma-clipping algorithm in order to reduce the possible contribution from any undetected faint sources, we calculated the mean and standard deviation of the sigma-clipped sample by fitting a Gaussian distribution which essentially gives us the values for background and background noise respectively. We found the mean background value to be  $6.39 \times 10^{-5} \pm 2.22 \times 10^{-7}$  cts/sec/pix for NUV and  $2.36 \times 10^{-5} \pm 1.14 \times 10^{-7}$  cts/sec/pix for FUV respectively.

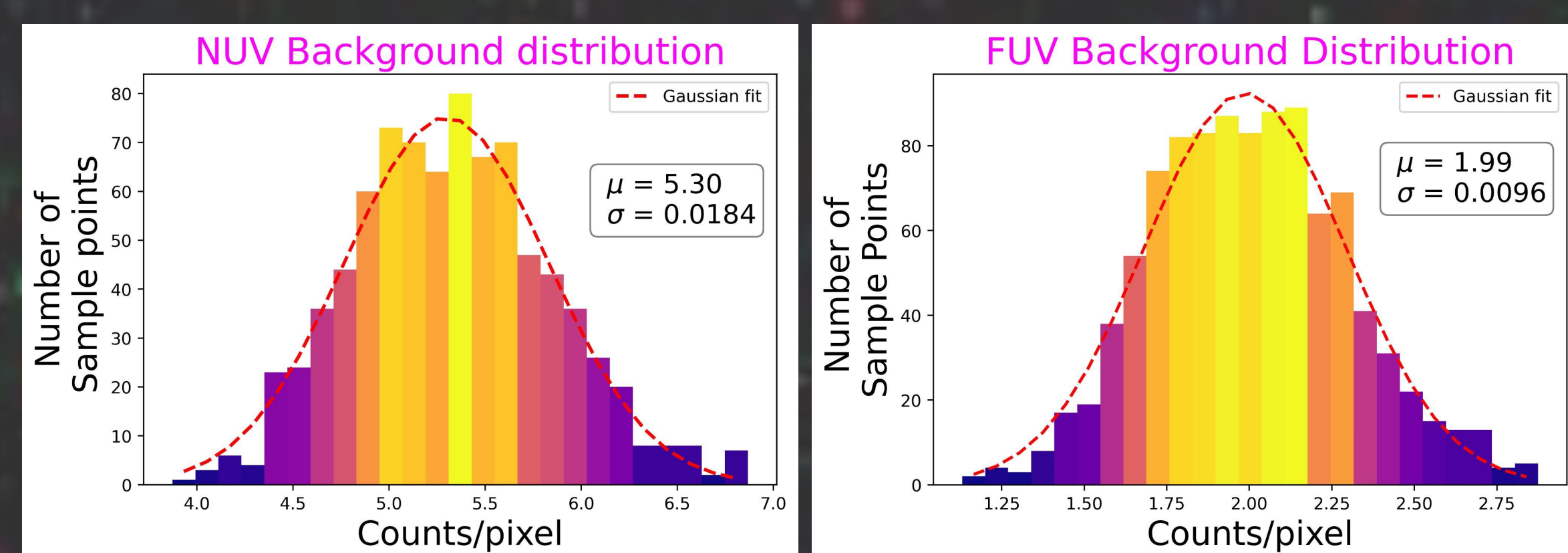


Figure: Background distribution for NUV (left panel) and FUV filters( right panel)

## SOURCE DETECTION AND PHOTOMETRY

We have used standard photometry software SExtractor to detect sources and perform photometry on all detected sources. Since SExtractor is primarily developed and used for source detection in optical band images and the smooth optical profile of many galaxies turns into a fragmented irregular shaped profile in UV band, SExtractor can not detect all sources properly in a UV band image. To tackle this problem we used several different values for detection parameters of SExtractor to detect all sources across the field correctly. Table 1 and 2 shows the values of different parameters that we used to detect extended sources and the nearby sources properly. In total we have detected 4530 sources in NUV and nearly 571 sources in FUV above SNR of 5. For photometric calculations we have used Kron apertures that captures 94% of total radiated emission for each source and produced a catalogue containing the sky coordinates and different properties such as total flux, AB magnitude etc for each source.

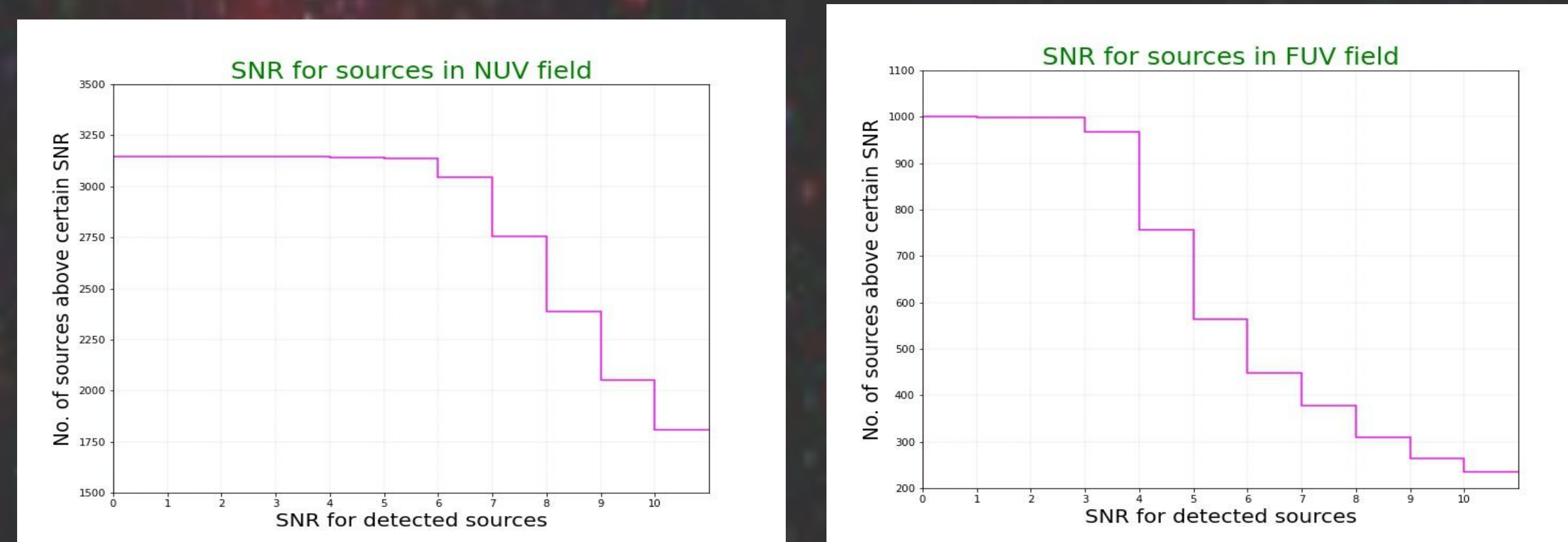
Parameter	main catalogue file	catalogue file 2	catalogue file 3	catalogue file 4	catalogue file 5	catalogue file 6	catalogue file 7
DETECT_THRESH	2.0	3.0	6.0	2.0	5.0	5.0	3.0
DETECT_MINAREA	10	10	20	10	20	4	15
DEBLEND_NTHRESH	32	10	32	32	10	10	10
DEBLEND_MINCOUNT	0.001	0.1	0.1	0.01	1.0	1.0	1.0
Comment	Total 794 sources replaced by 372	609 sources replaced by 279	109 sources replaced by 40	31 source replaced by 15	15 sources replaced by 17	13 sources replaced by 9	17 sources replaced by 12

Table 1

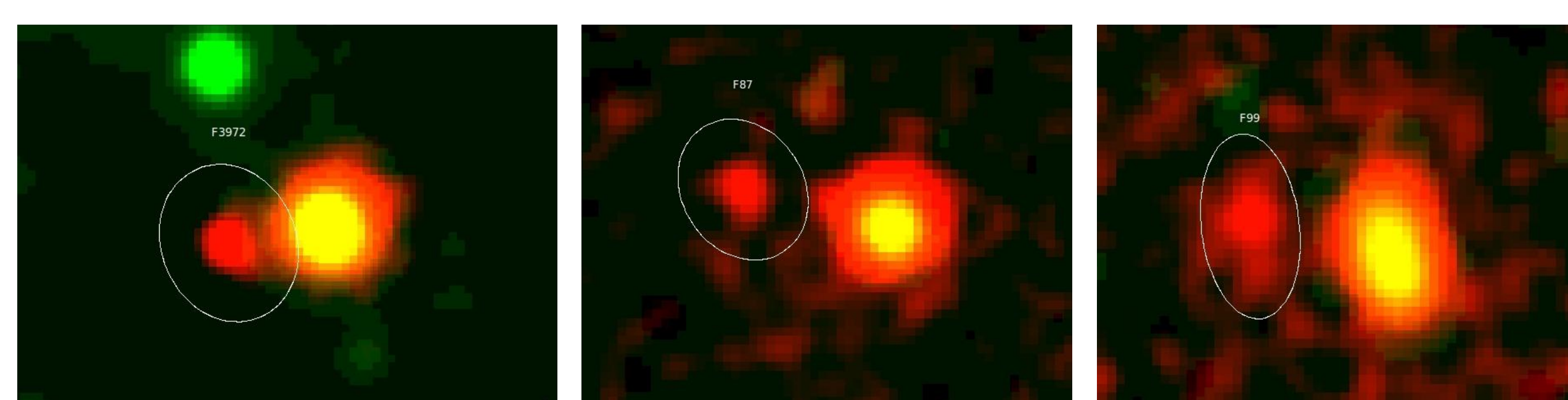
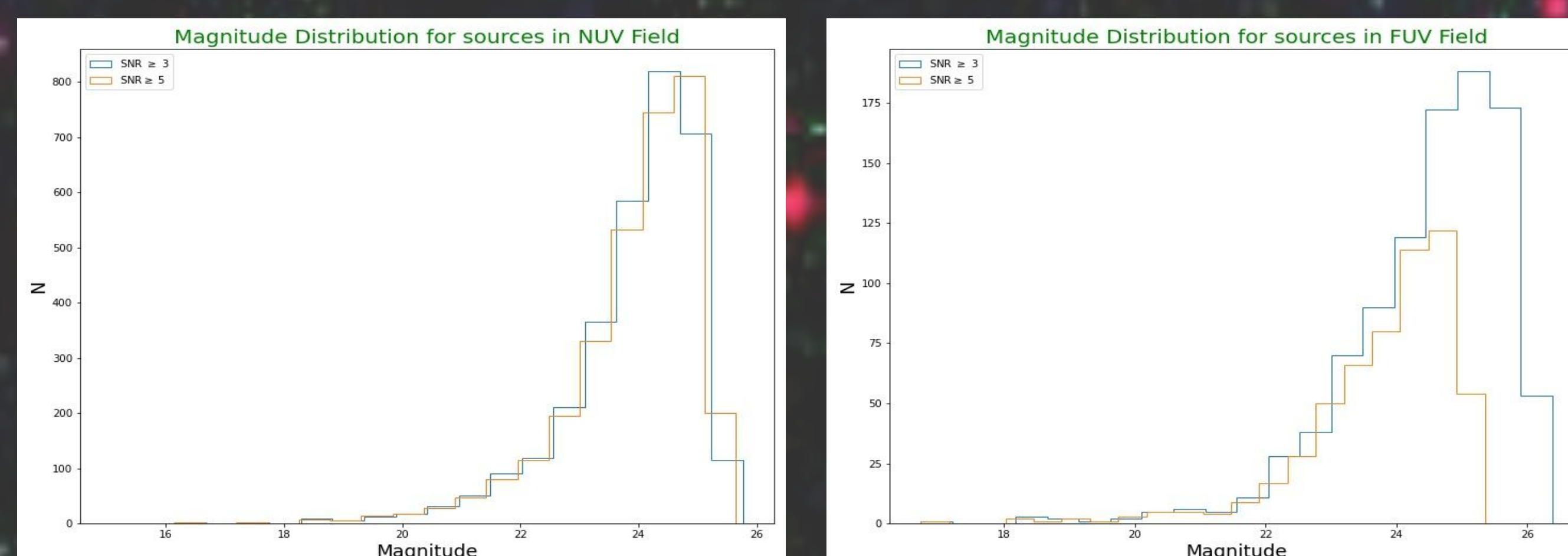
Table:  
The Table 1 and Table 2 show the detection parameter values used for source detection in NUV field in FUV field respectively

Filename	main catalogue file	catalogue file 2	catalogue file 3	Catalogue file 4
DETECT_THRESH	1.0	1.5	3.0	6.0
DETECT_MINAREA	10	10	10	10
DEBLEND_NTHRESH	32	32	32	32
DEBLEND_MINCOUNT	0.05	1.0	1.0	1.0
Comment	Total 130 sources were replaced by 16	26 sources replaced by 9	104 replaced by 5	2 sources were added only

Table 2



Plots in the above panel shows Number of sources above a certain SNR for NUV and FUV field and the plots in below panel shows the magnitude distribution of sources detected above 3 and above 5 SNR separately for both the bands.



The two-colour (Red: FUV and Green: NUV) images show three interesting sources present in the field. The sources shown by the elliptical region are very prominent in FUV band but they don't seem to possess a bright NUV counterpart.

## ACKNOWLEDGEMENT

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