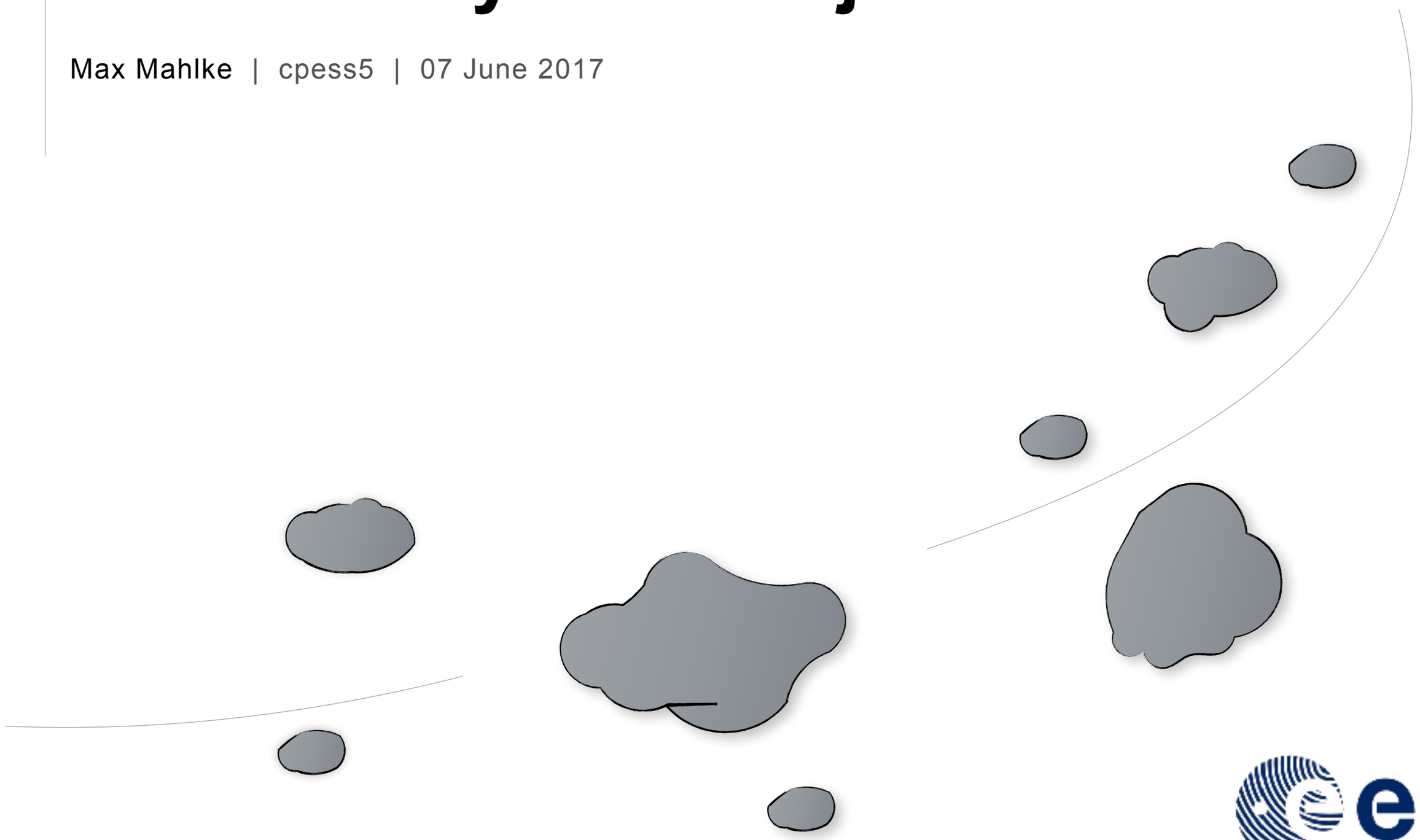
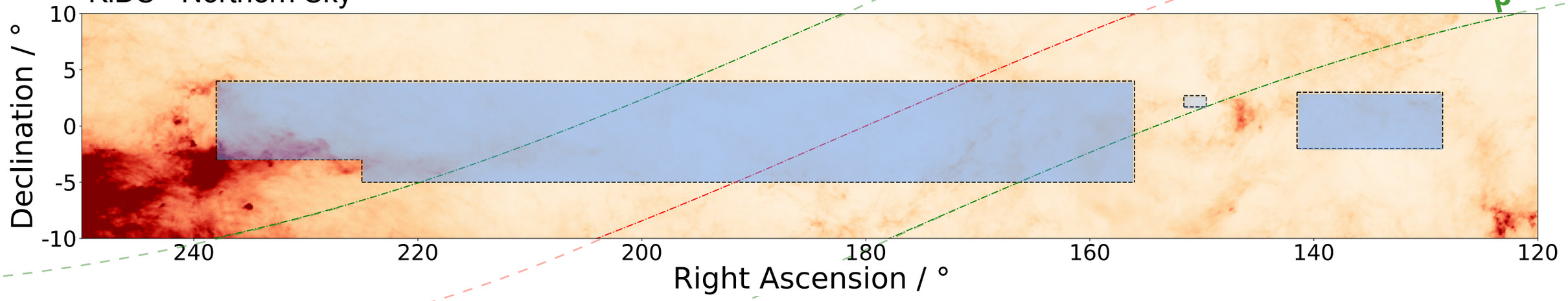
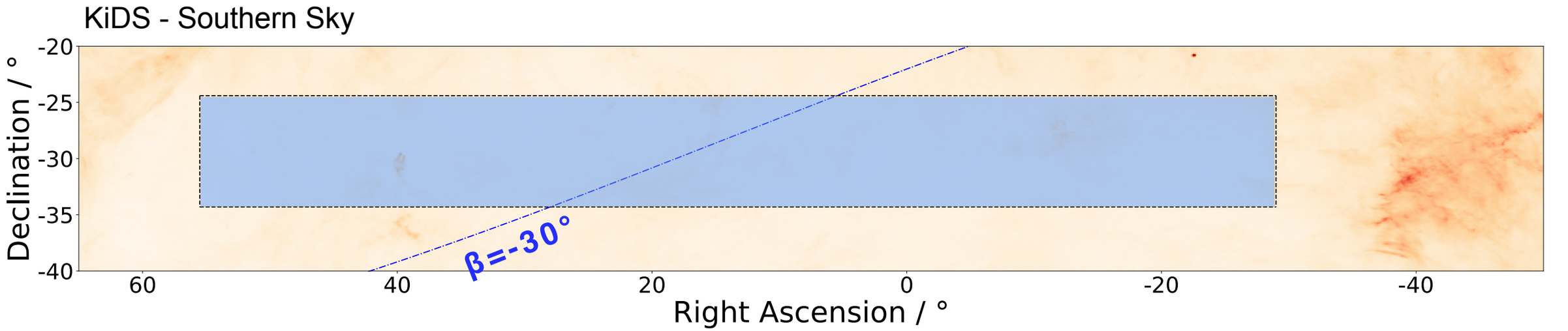
Mining the Kilo-Degree Survey for Solar System Objects

Max Mahlke | cpess5 | 07 June 2017



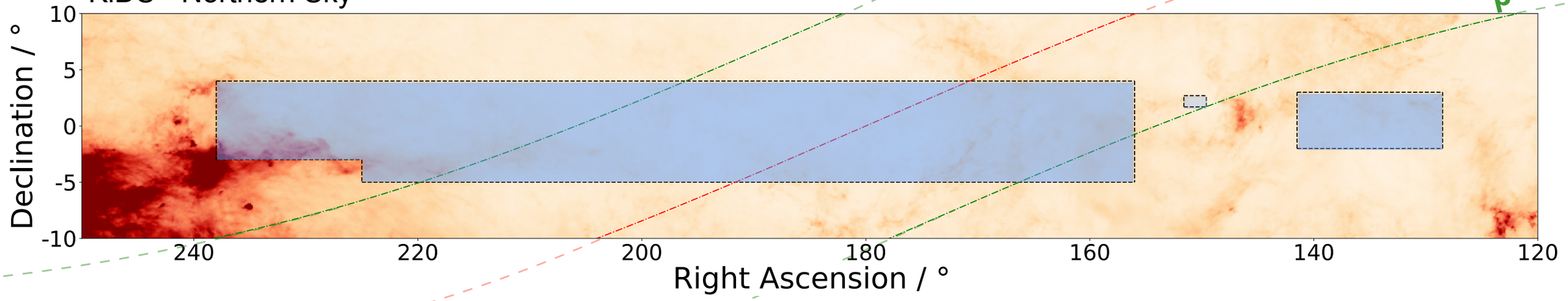
esa
European Space Agency

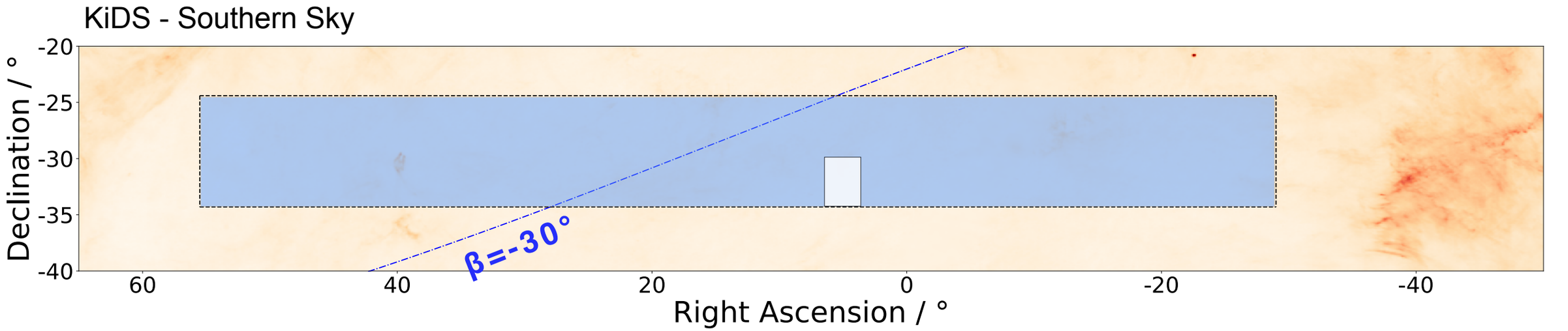




1500 deg^2 imaged in *u*, *g*, *r*, *i*
5-step dithering pattern

VST,
Paranal
Observatory, ESO





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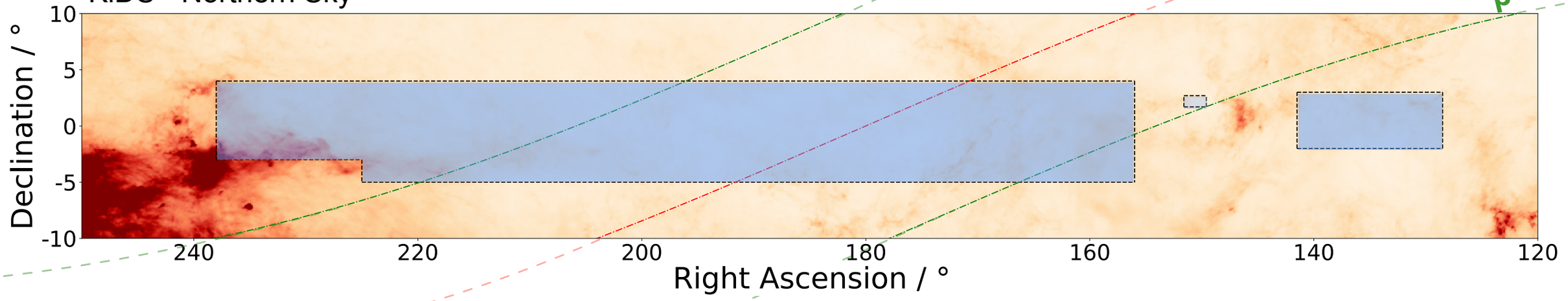

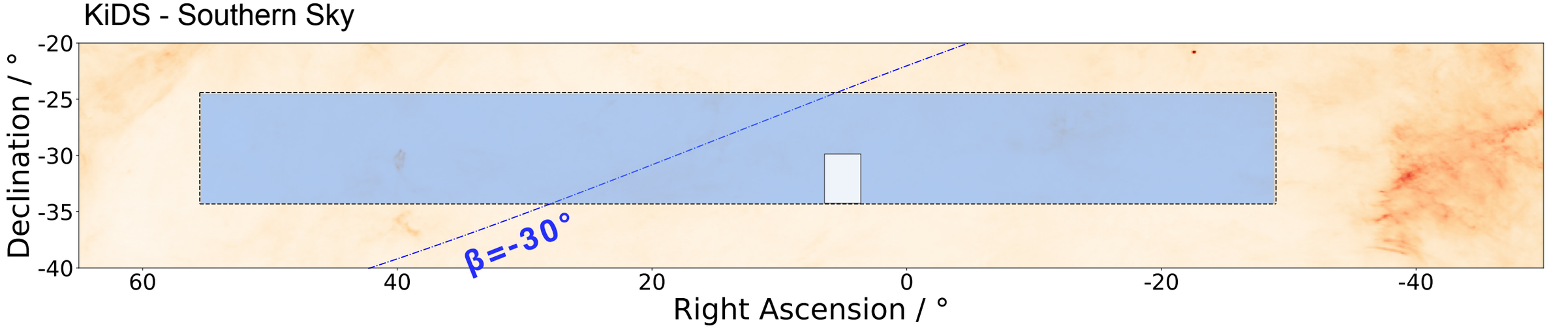

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Paranal
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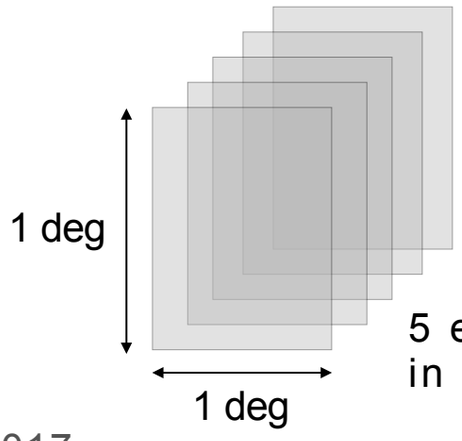
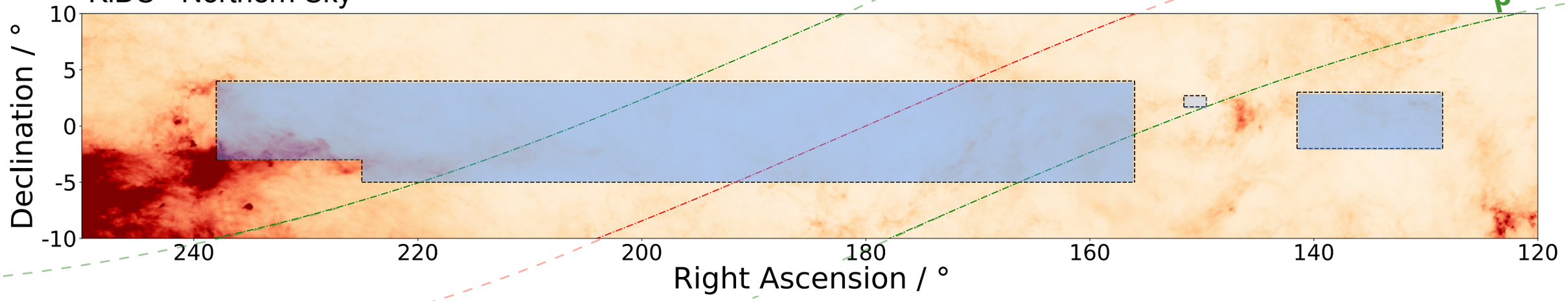
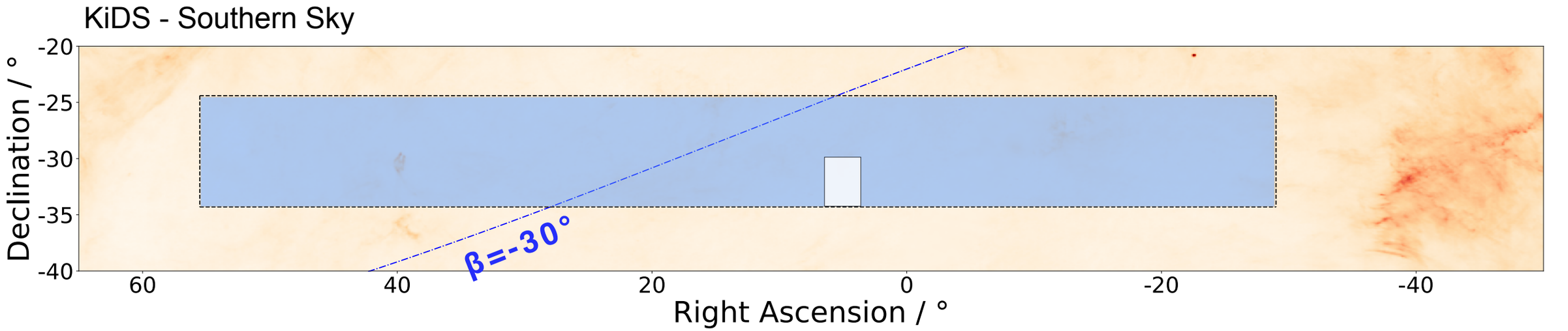


1500 deg^2 imaged in *u*, *g*, *r*, *i*
5-step dithering pattern





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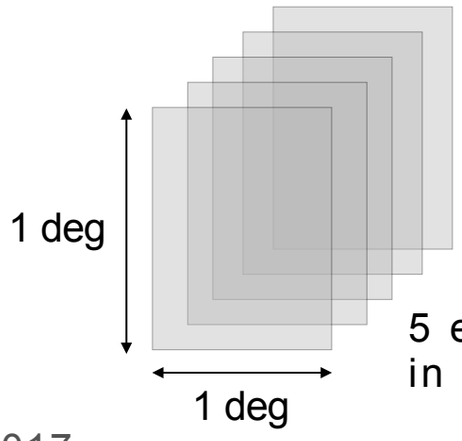
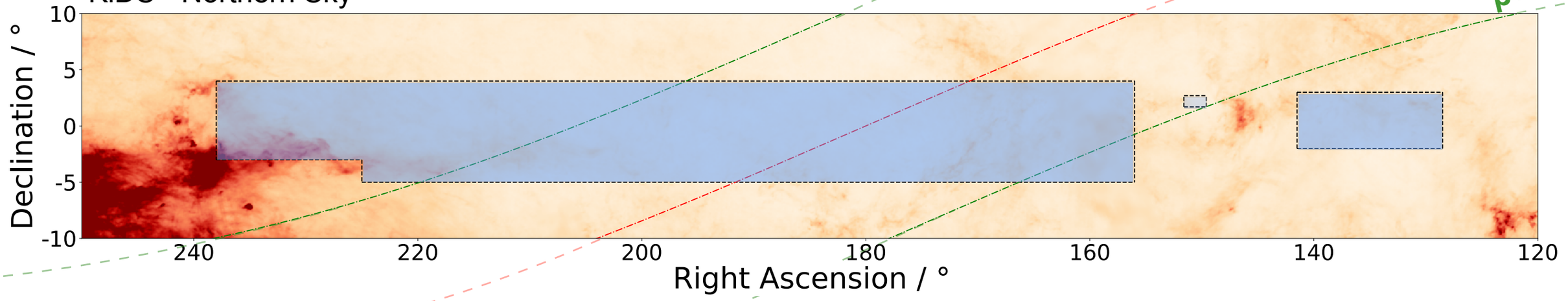
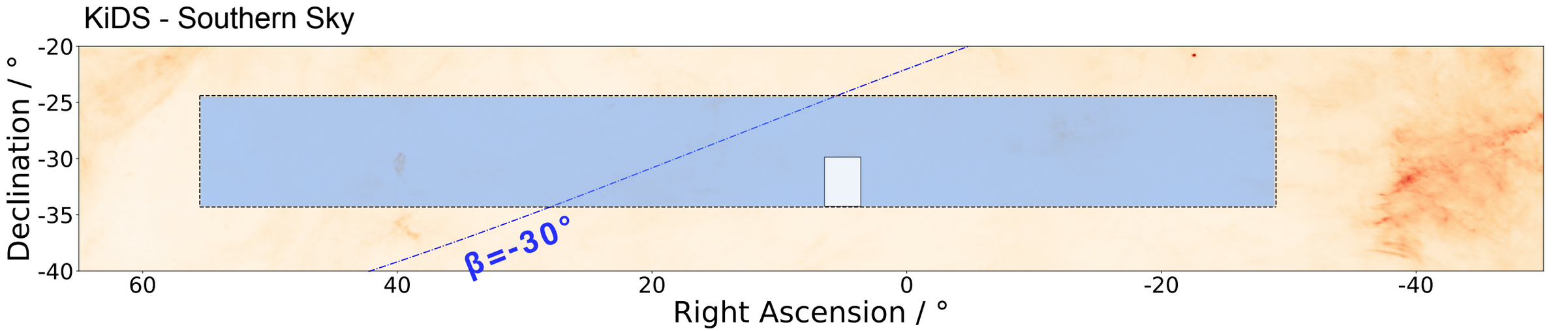
Paranal
Observatory, ESO



1500 deg^2 imaged in *u*, *g*, *r*, *i*
5-step dithering pattern

lots of images





VST,
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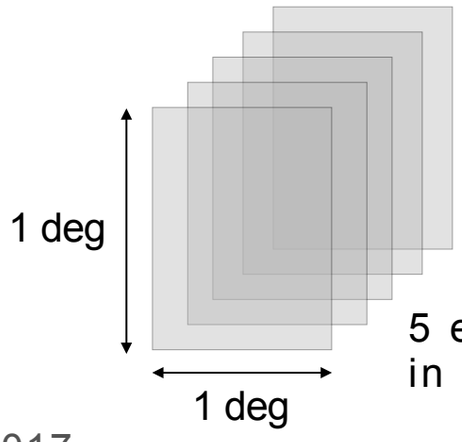
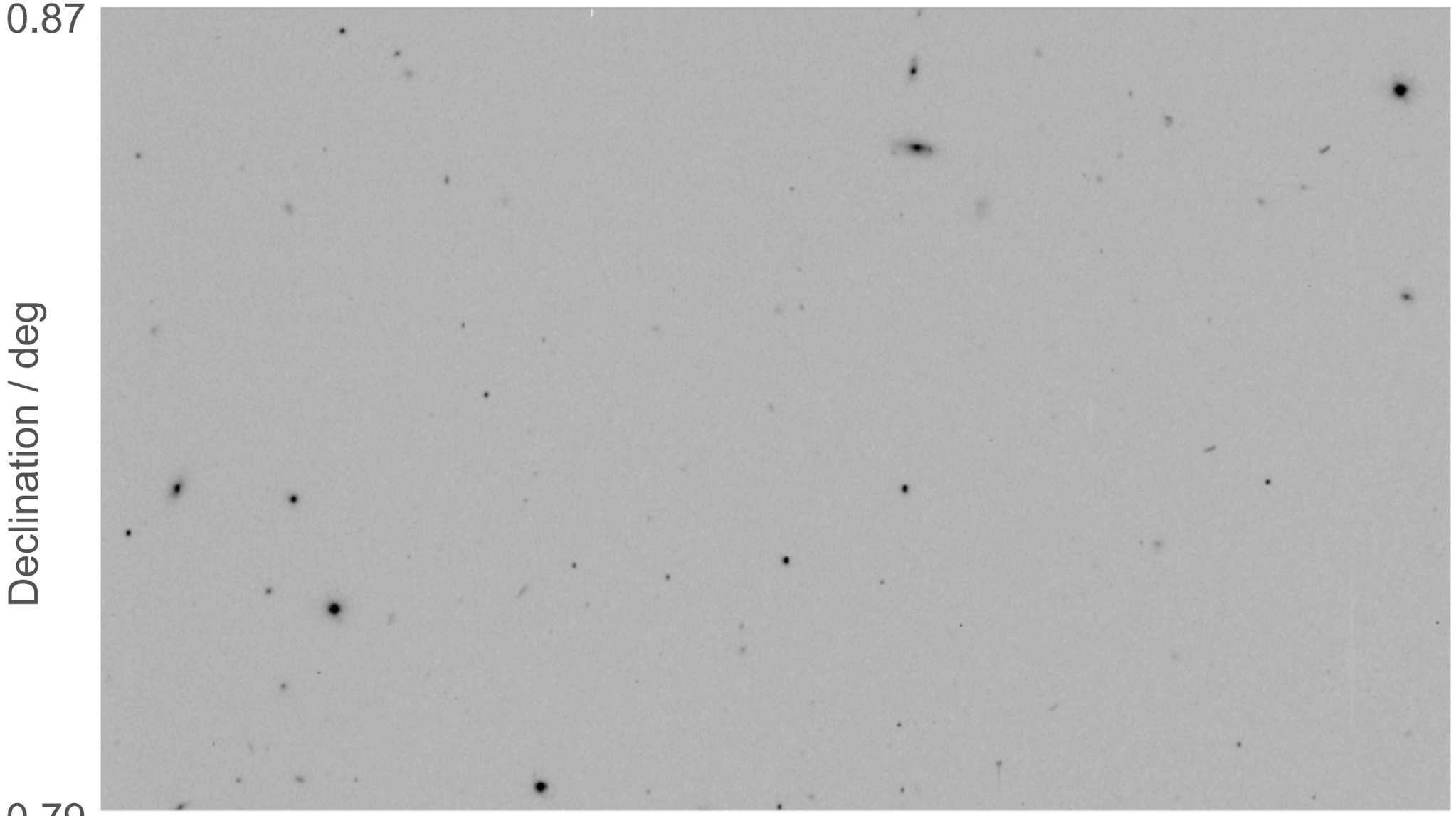


1500 deg^2 imaged in *u*, *g*, *r*, *i*
5-step dithering pattern

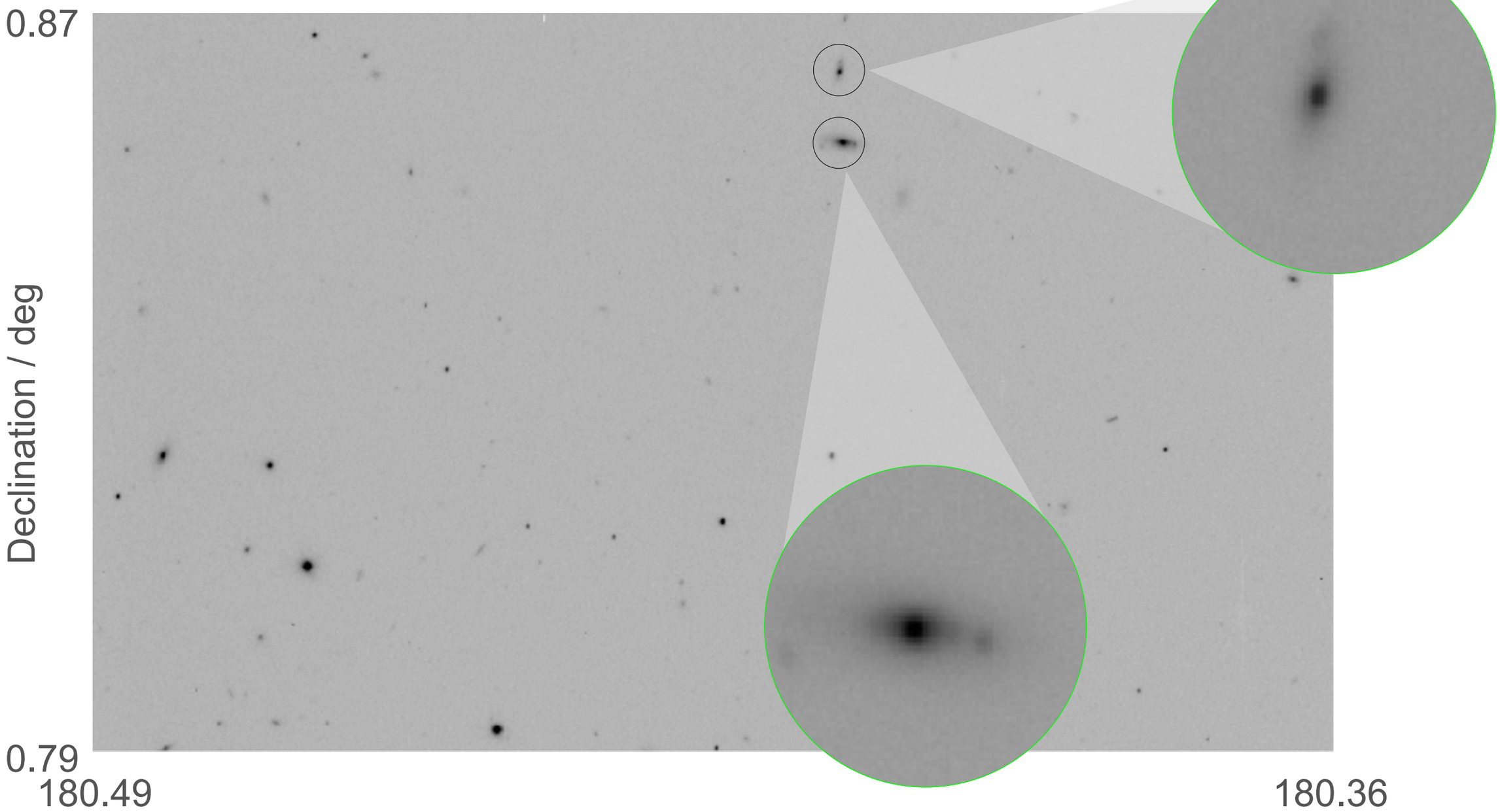
lots of images

lots of SSOs ?



1 Exposure from Field at RA=180.0 / DEC=0.5

Paranal
Observatory, ESO



1 Exposure from Field at RA=180.0 / DEC=0.5

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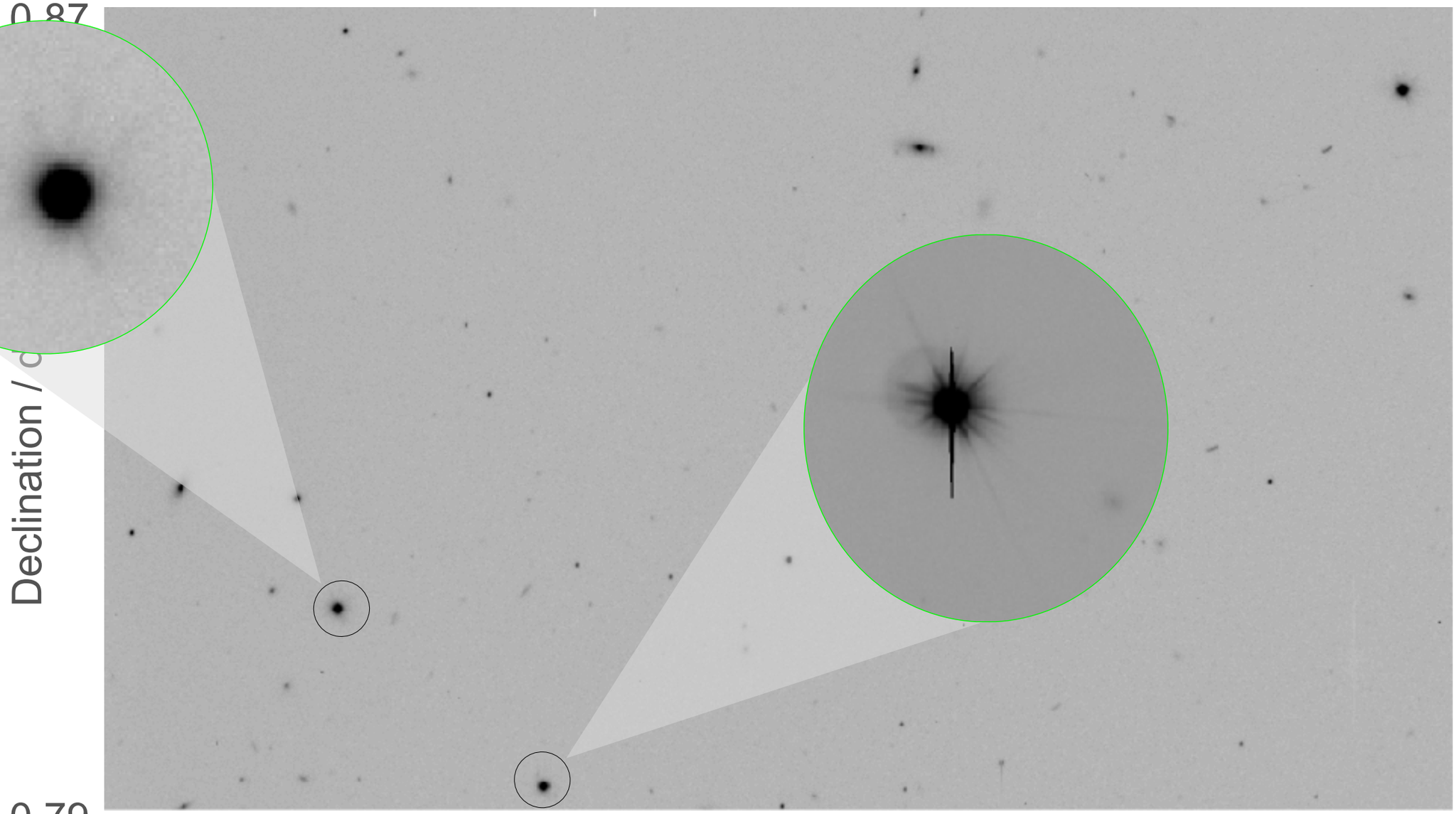

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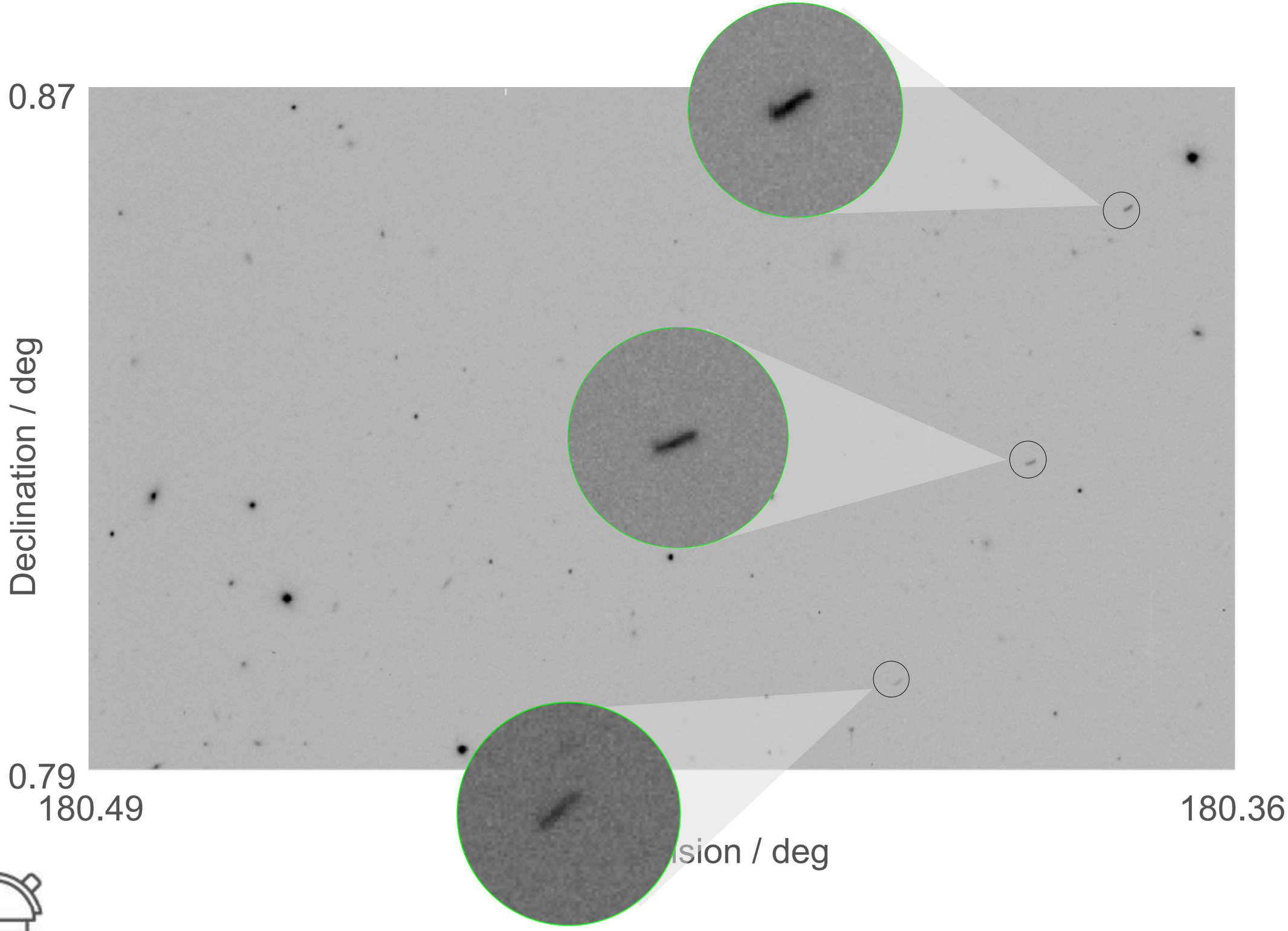

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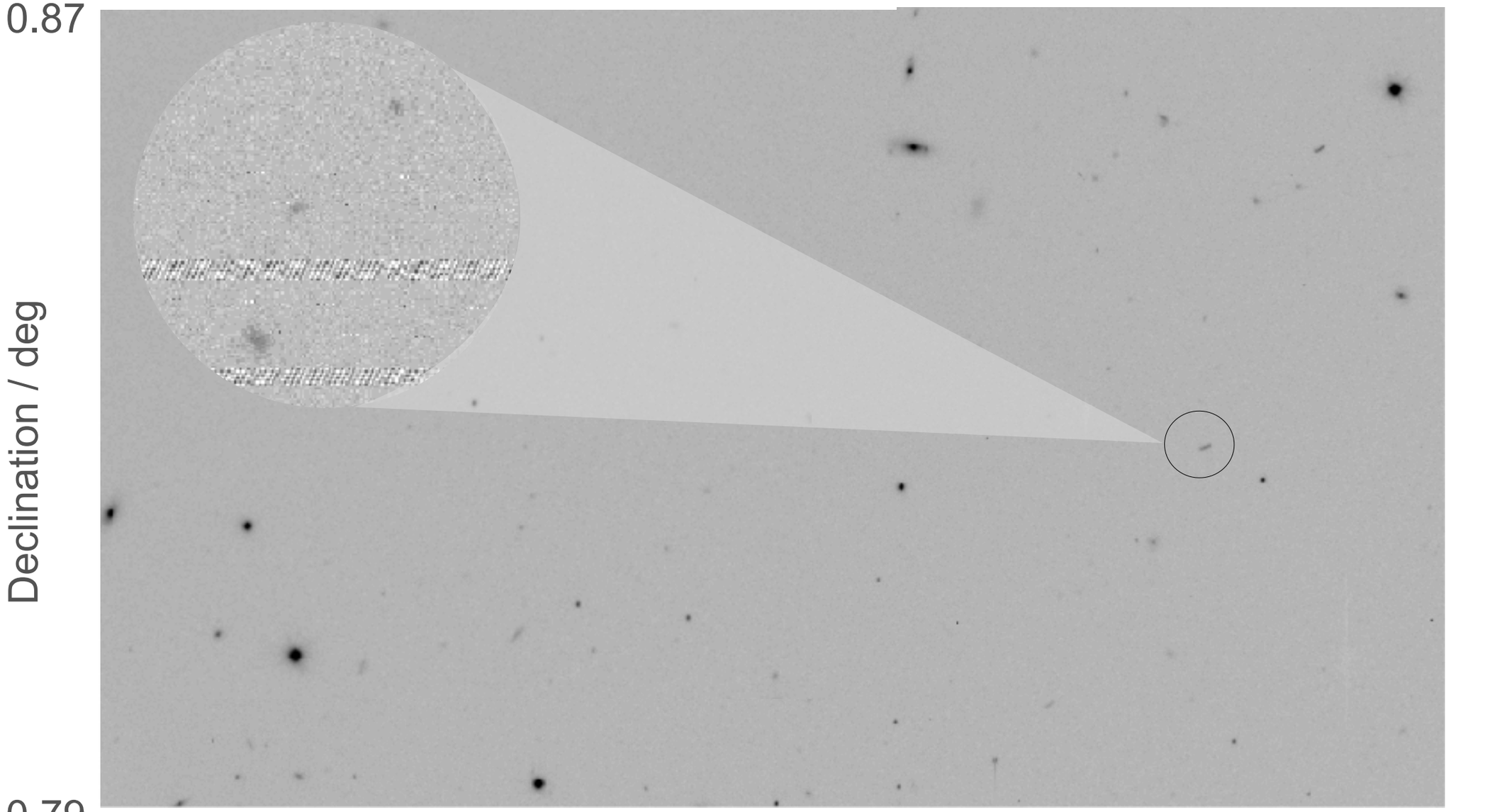
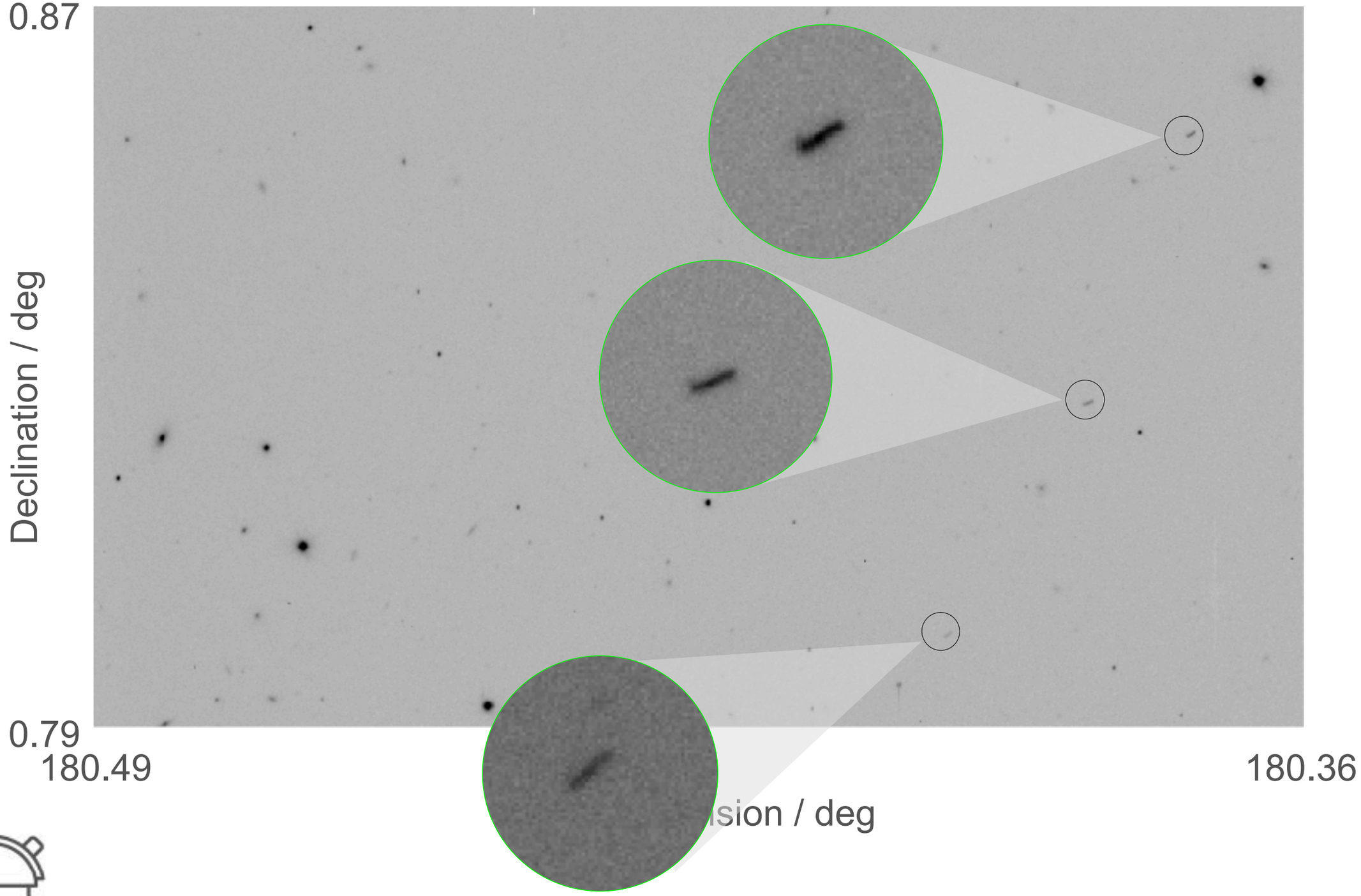


1 Exposure from Field at RA=180.0 / DEC=0.5

Paranal
Observatory, ESO

How do we recover SSOs from survey images?



Paranal
Observatory, ESO

01 - Detect Sources in Images

02 - Link Detections to Objects

03 - Find SSOs in Sample

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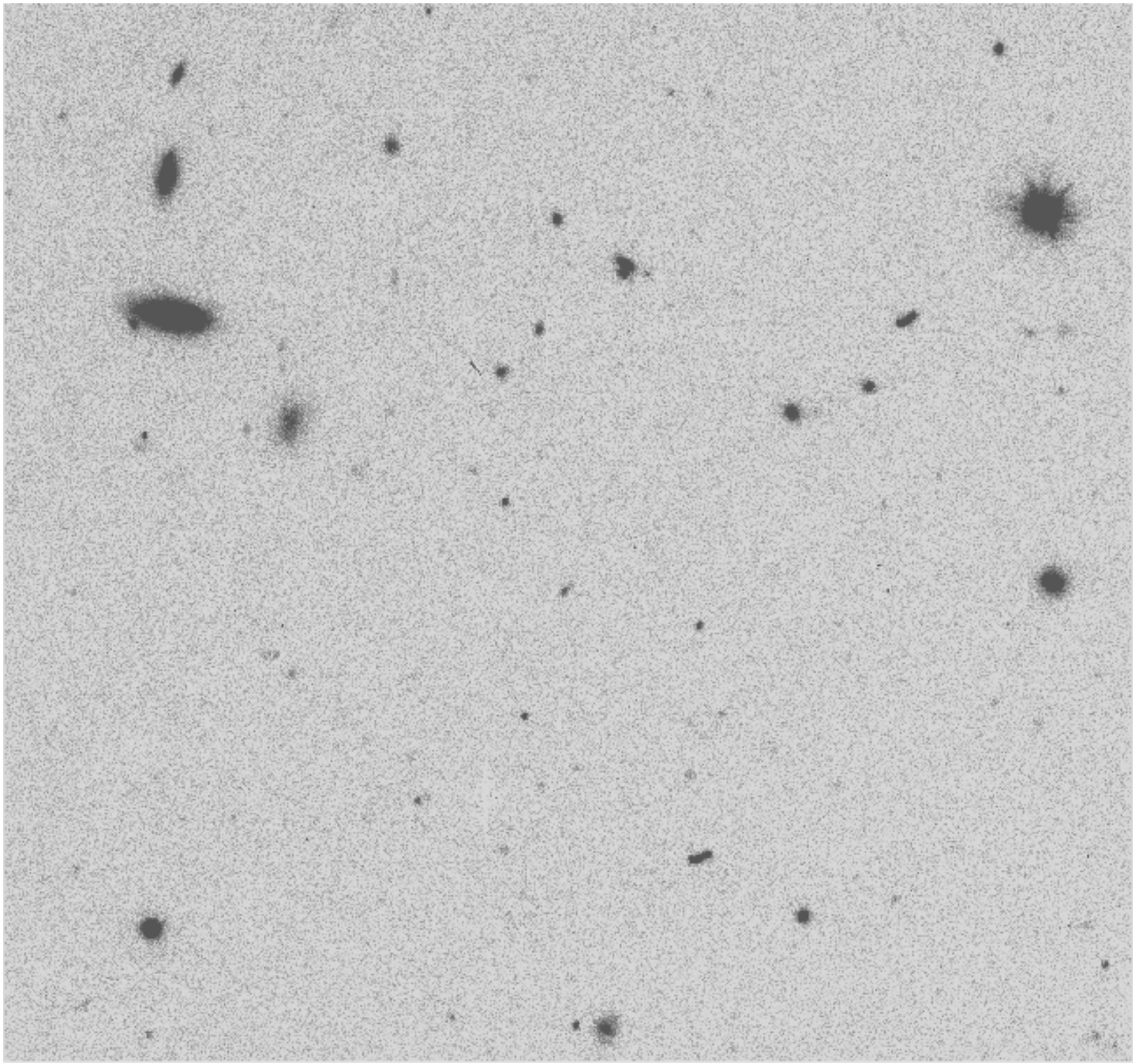
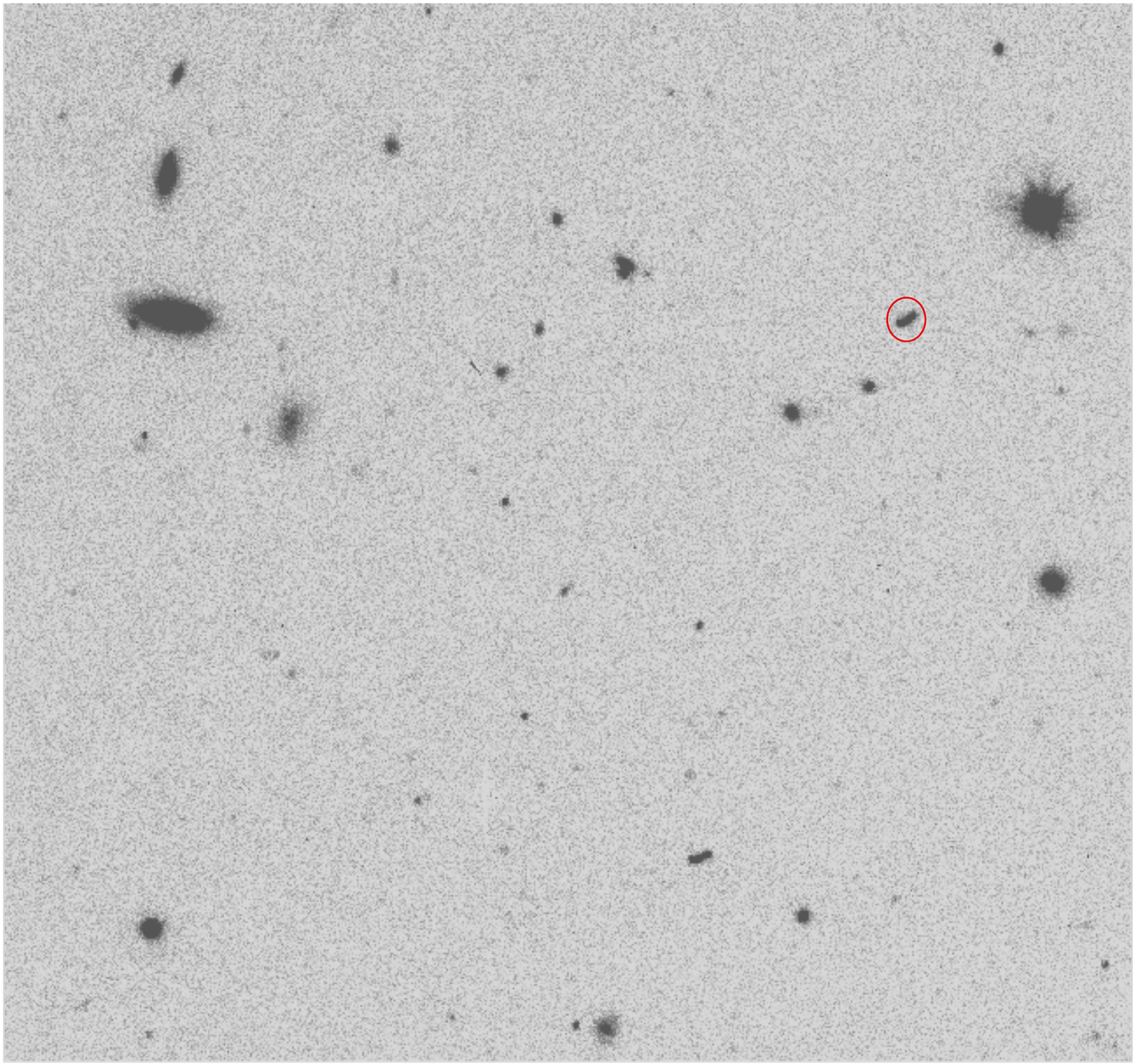
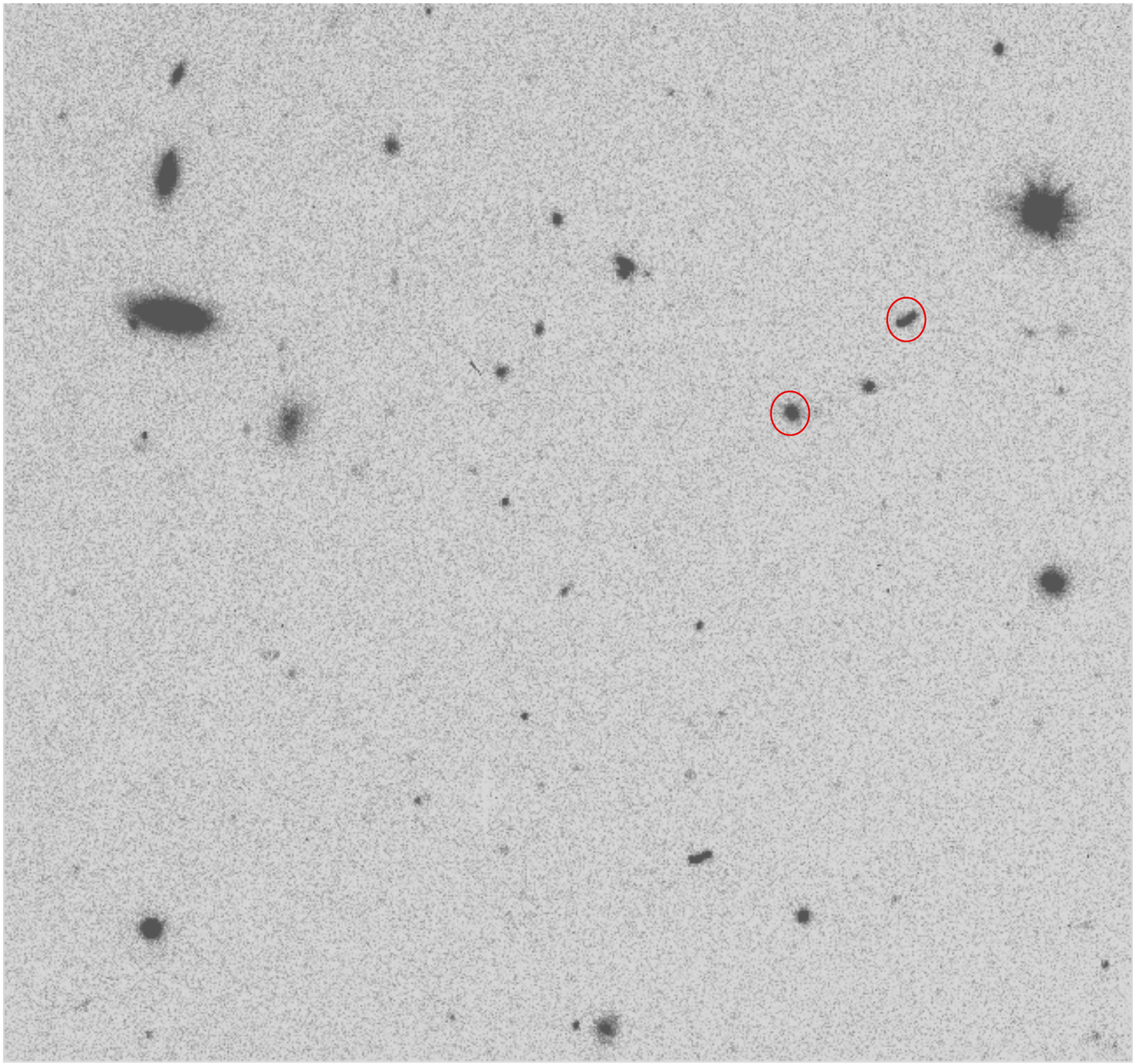
Source Extractor



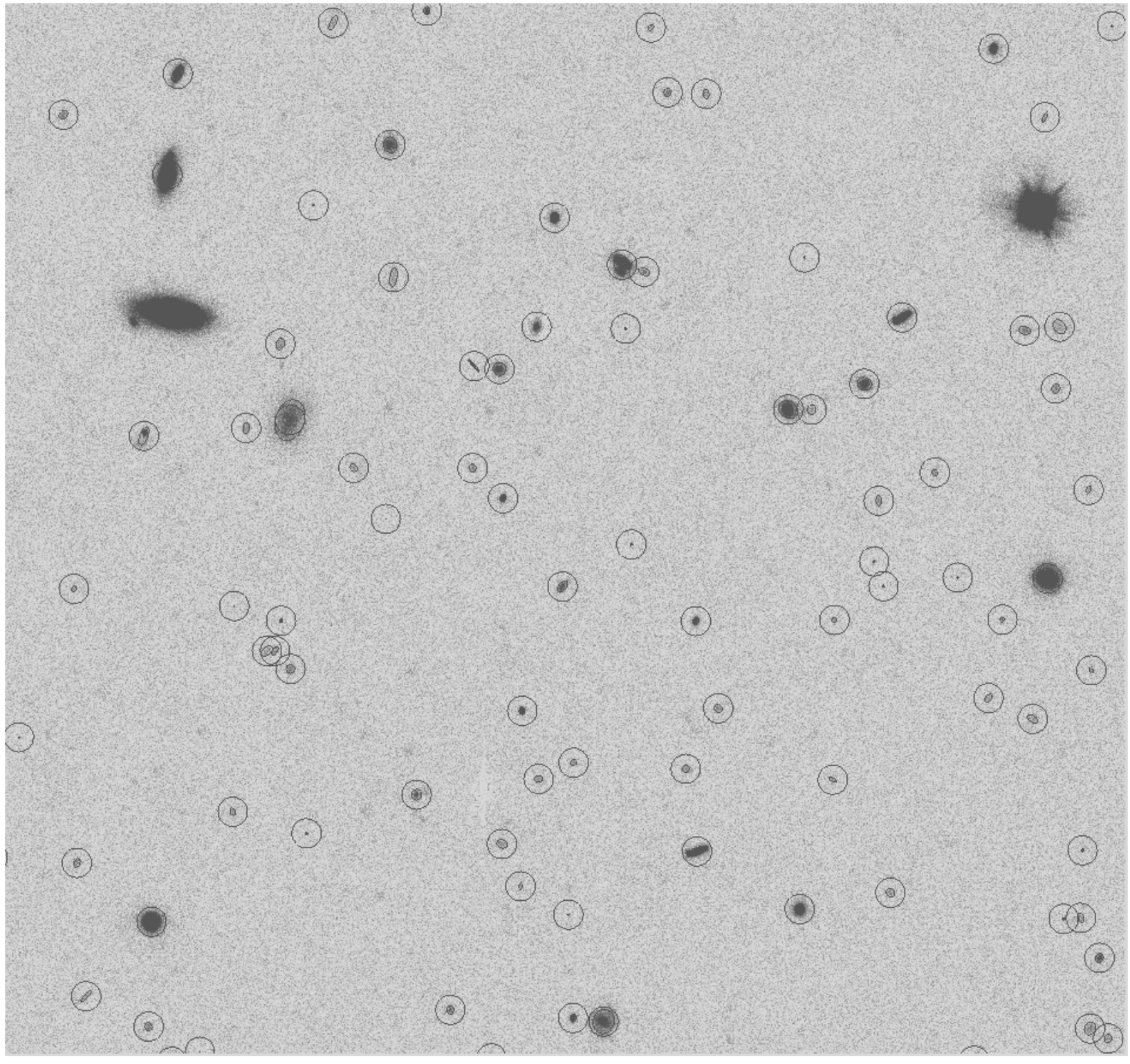
Source Extractor



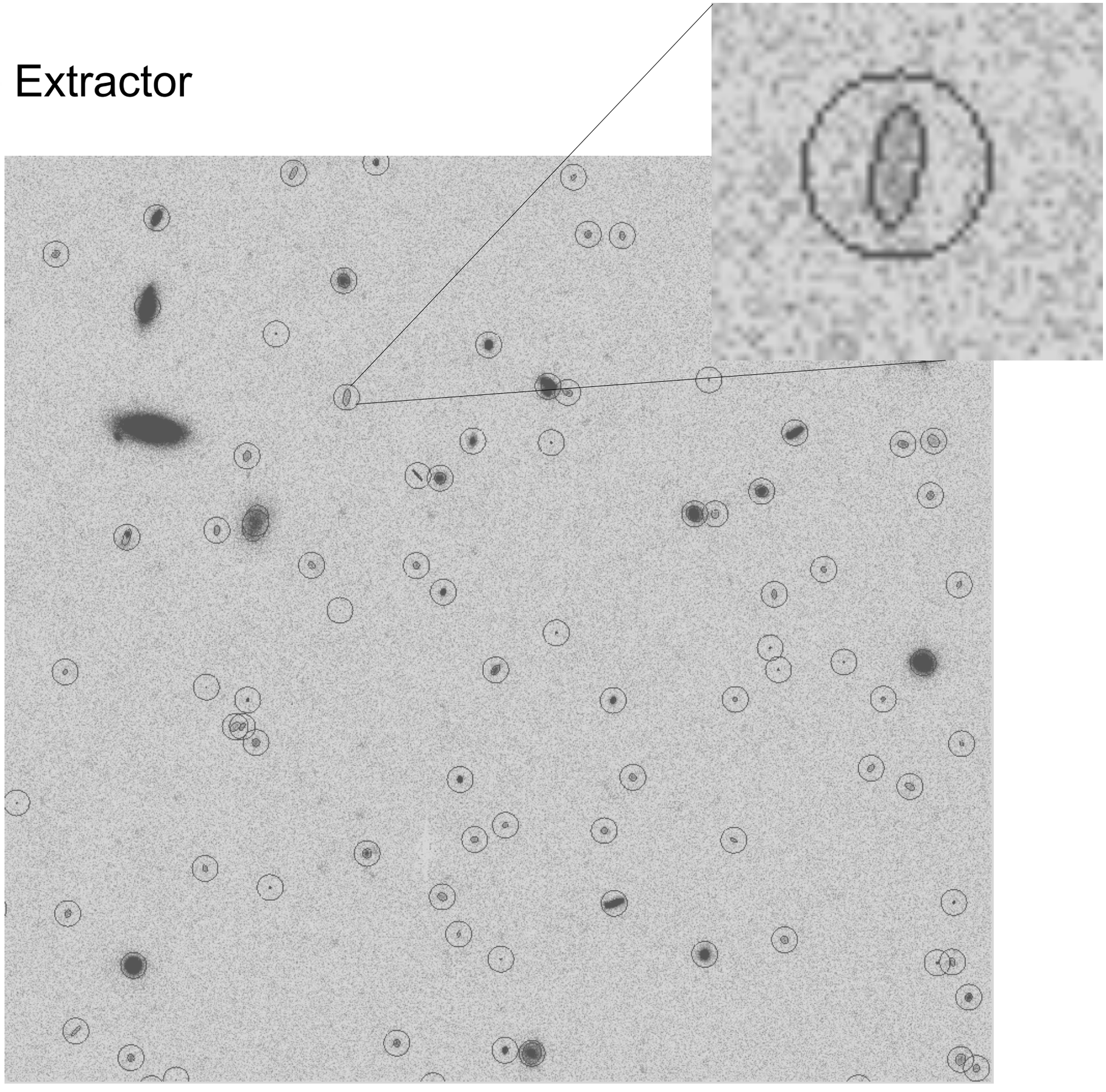
Source Extractor



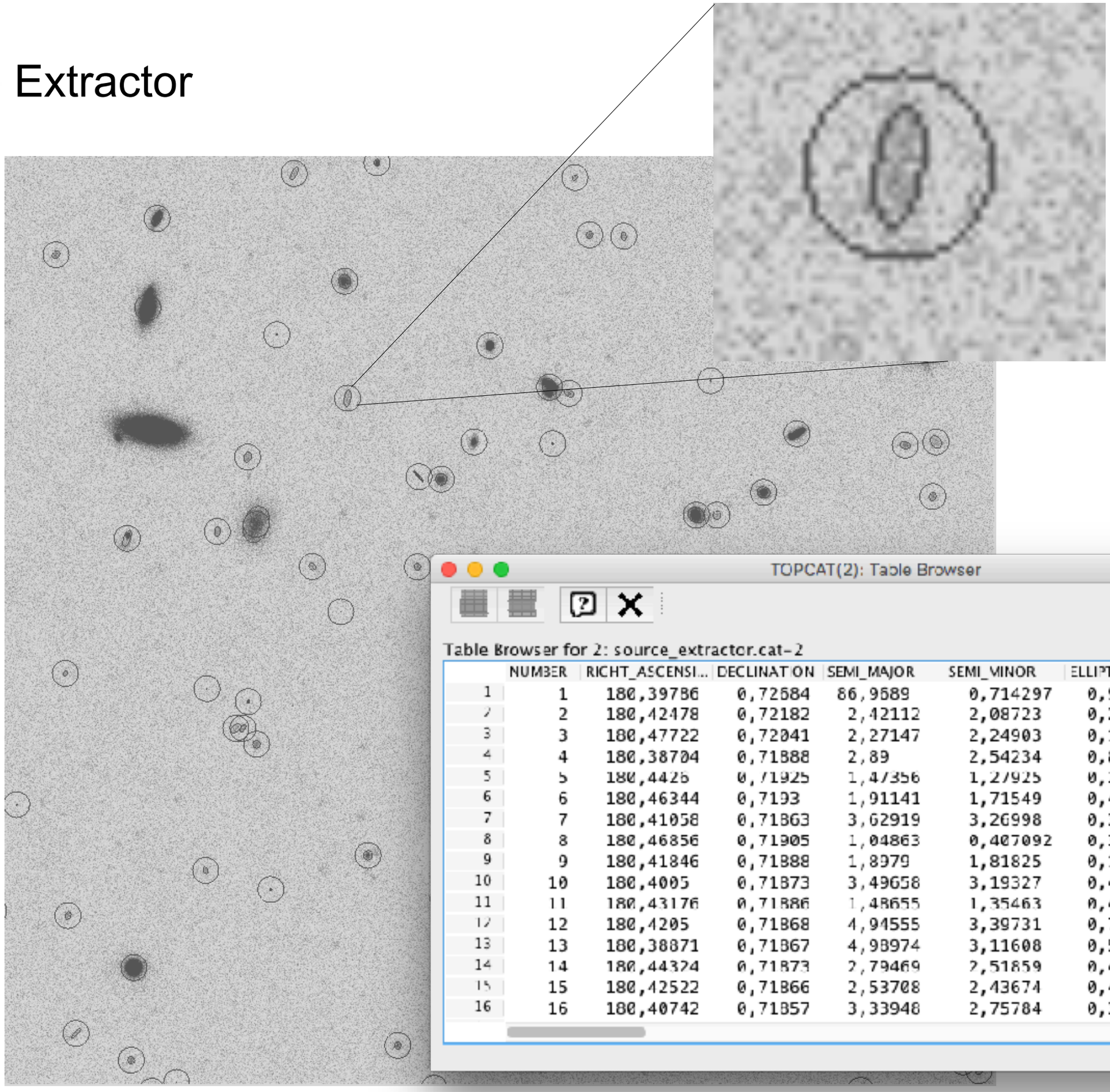
Source Extractor



Source Extractor



Source Extractor



TOPCAT(2): Table Browser

Table Browser for 2: source_extractor.cat-2

	NUMBER	RICHT_ASCENSI...	DECLINATION	SEMI_MAJOR	SEMI_MINOR	ELLIPTICITY	X_IMAGE
1	1	180,39786	0,72684	86,9589	0,714297	0,991787	469,818
2	2	180,42478	0,72182	2,42112	2,08723	0,297299	923,817
3	3	180,47722	0,72041	2,27147	2,24903	0,144232	1808,3
4	4	180,38704	0,71888	2,89	2,54234	0,828957	287,242
5	5	180,4426	0,71925	1,47356	1,27925	0,260854	1224,44
6	6	180,46344	0,7193	1,91141	1,71549	0,465951	1575,88
7	7	180,41058	0,71863	3,62919	3,26998	0,398238	684,357
8	8	180,46856	0,71905	1,04863	0,407092	0,323275	1662,24
9	9	180,41846	0,71888	1,8979	1,81825	0,178849	817,272
10	10	180,4005	0,71873	3,49658	3,19327	0,448967	514,284
11	11	180,43176	0,71886	1,48655	1,35463	0,422468	1041,51
12	12	180,4205	0,71868	4,94555	3,39731	0,748321	851,639
13	13	180,38871	0,71867	4,98974	3,11608	0,596394	315,4
14	14	180,44324	0,71873	2,79469	2,51859	0,482506	1235,29
15	15	180,42522	0,71866	2,53708	2,43674	0,497045	931,236
16	16	180,40742	0,71857	3,33948	2,75784	0,346118	631,014

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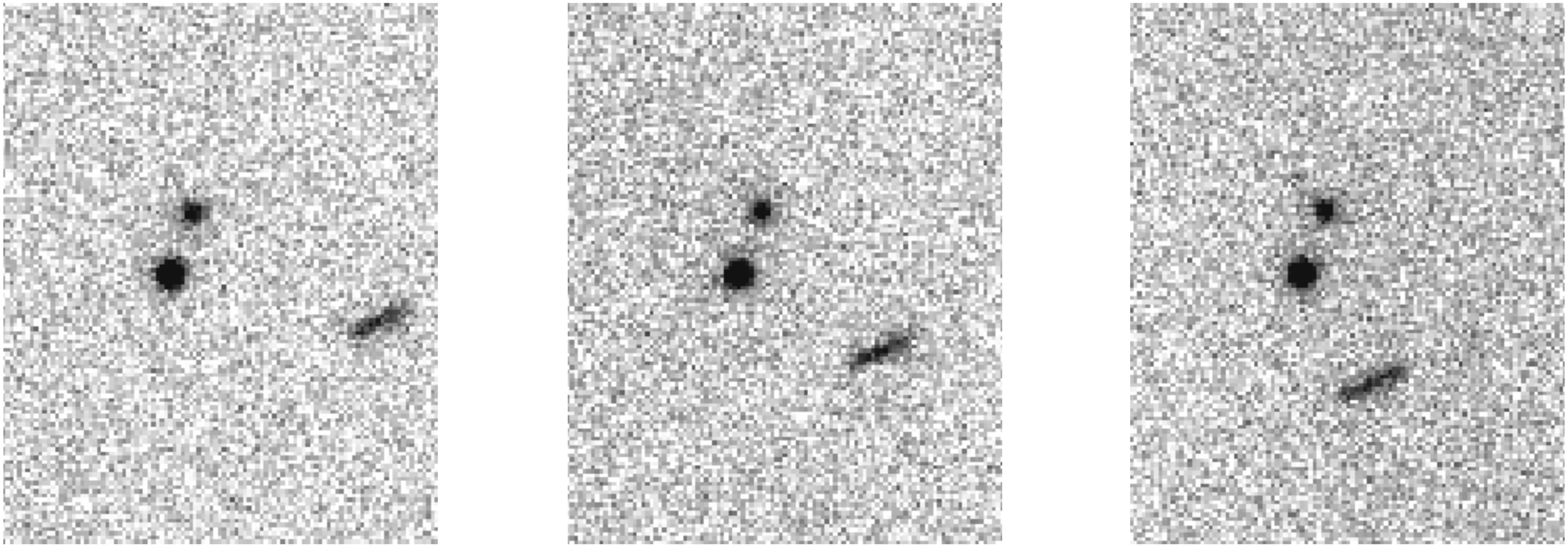
SCAMP

1. Reference Catalog of FOV

2. Pattern Matching between the 5 exposures of one field



t_0 t_1 t_2

SCAMP

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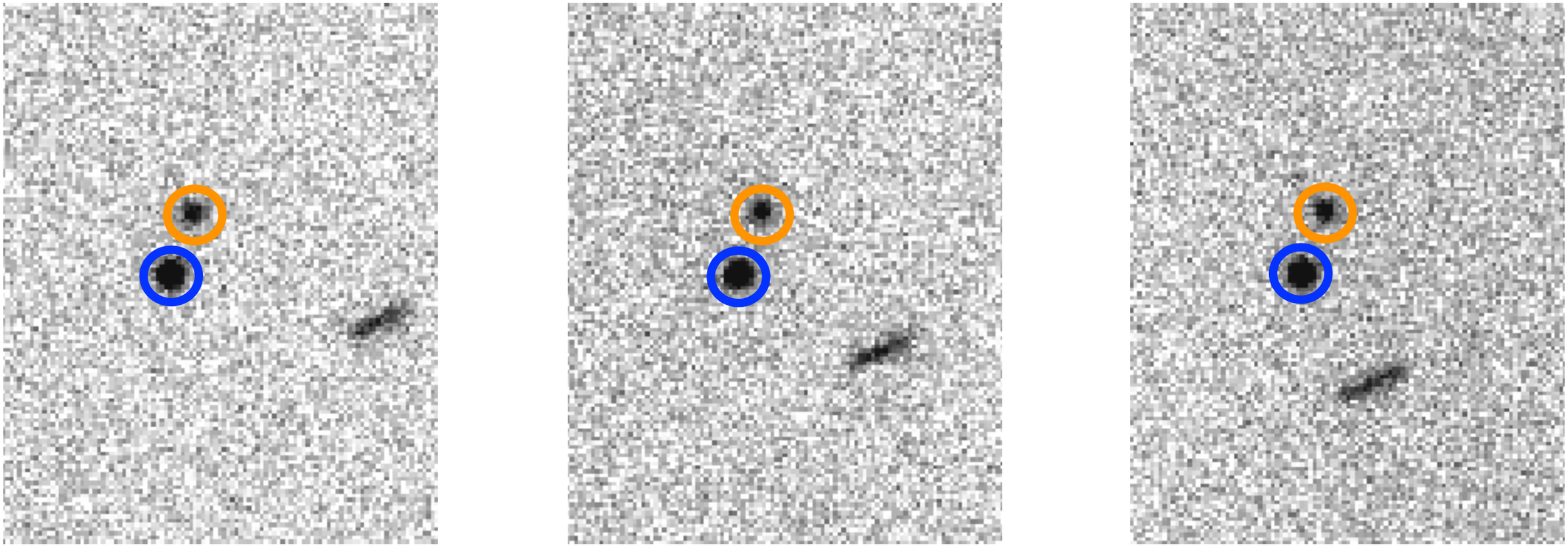

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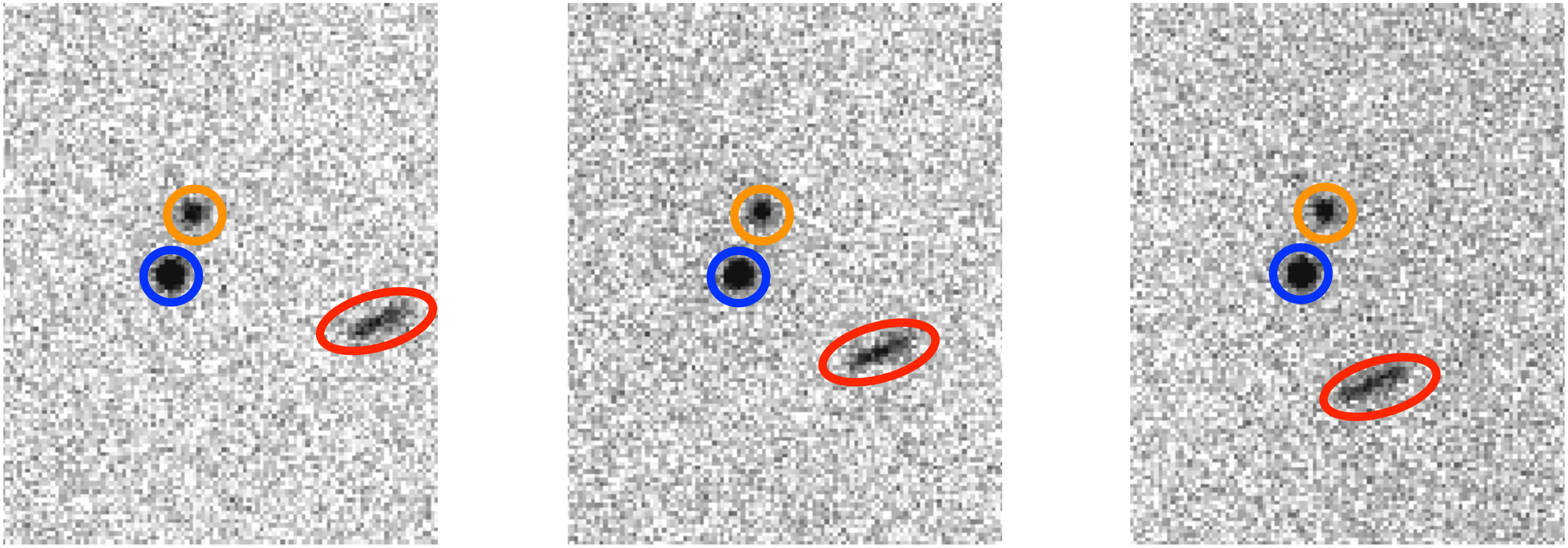

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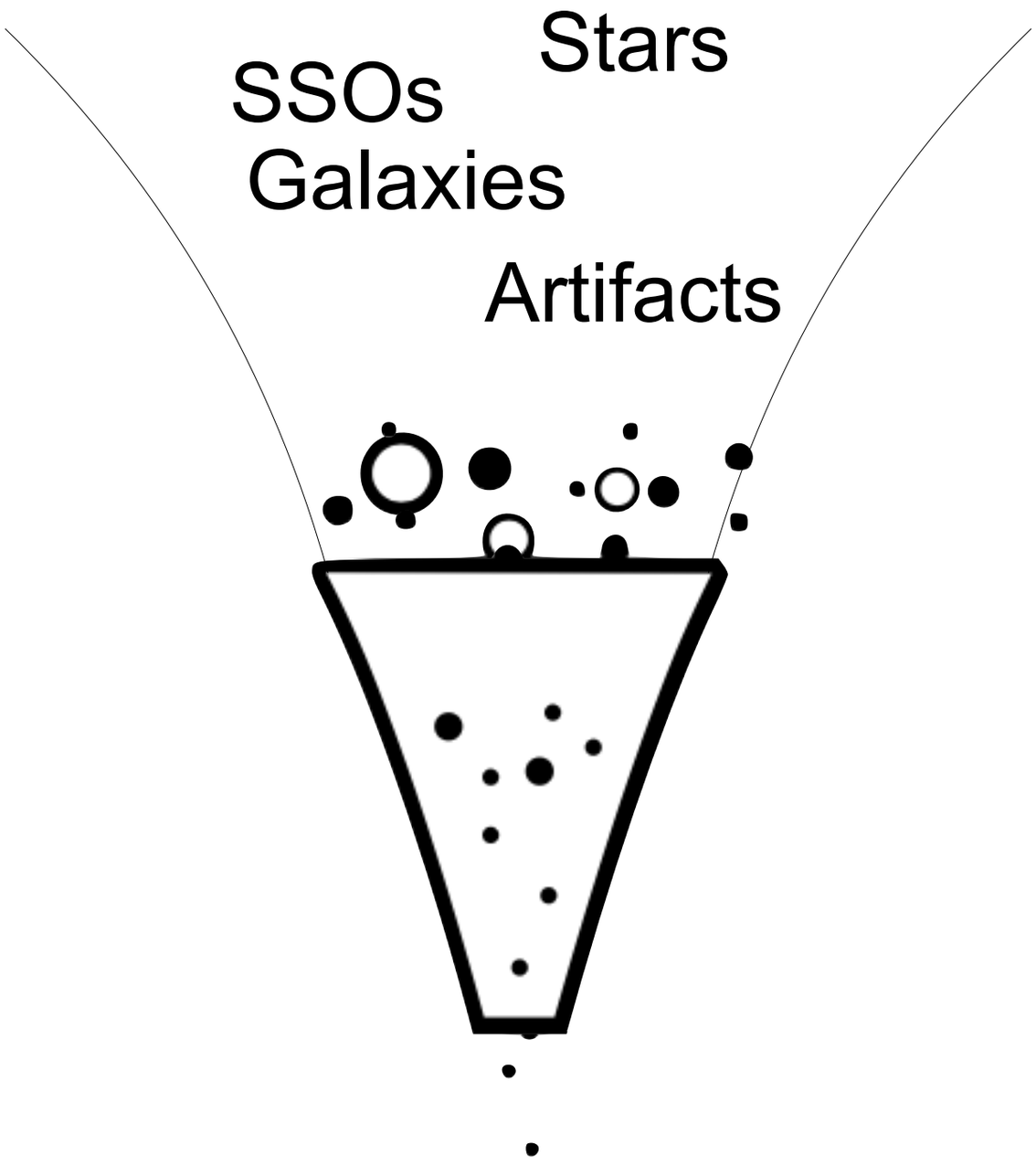
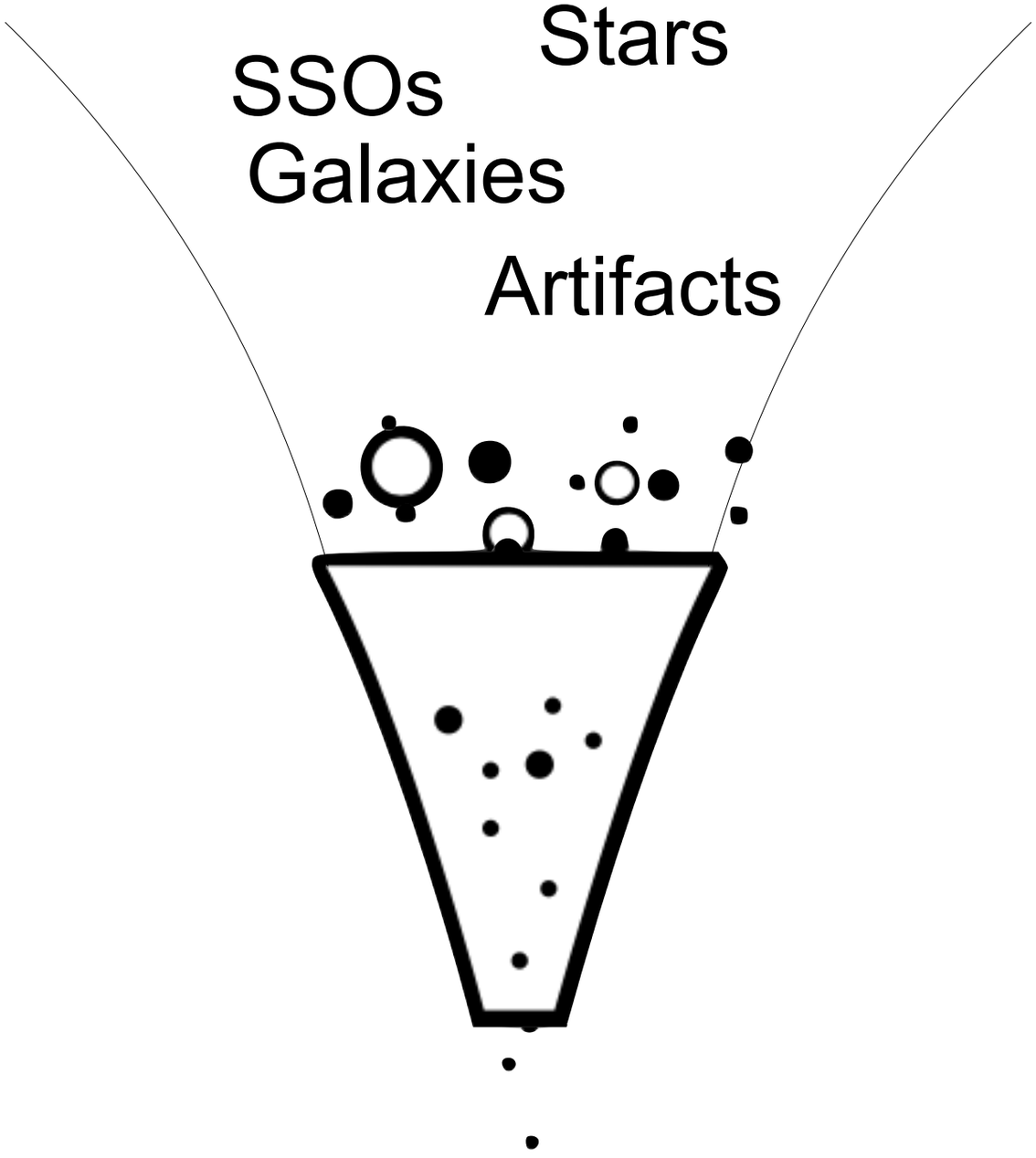

Stars
SSOs
Galaxies
Artifacts

Stars

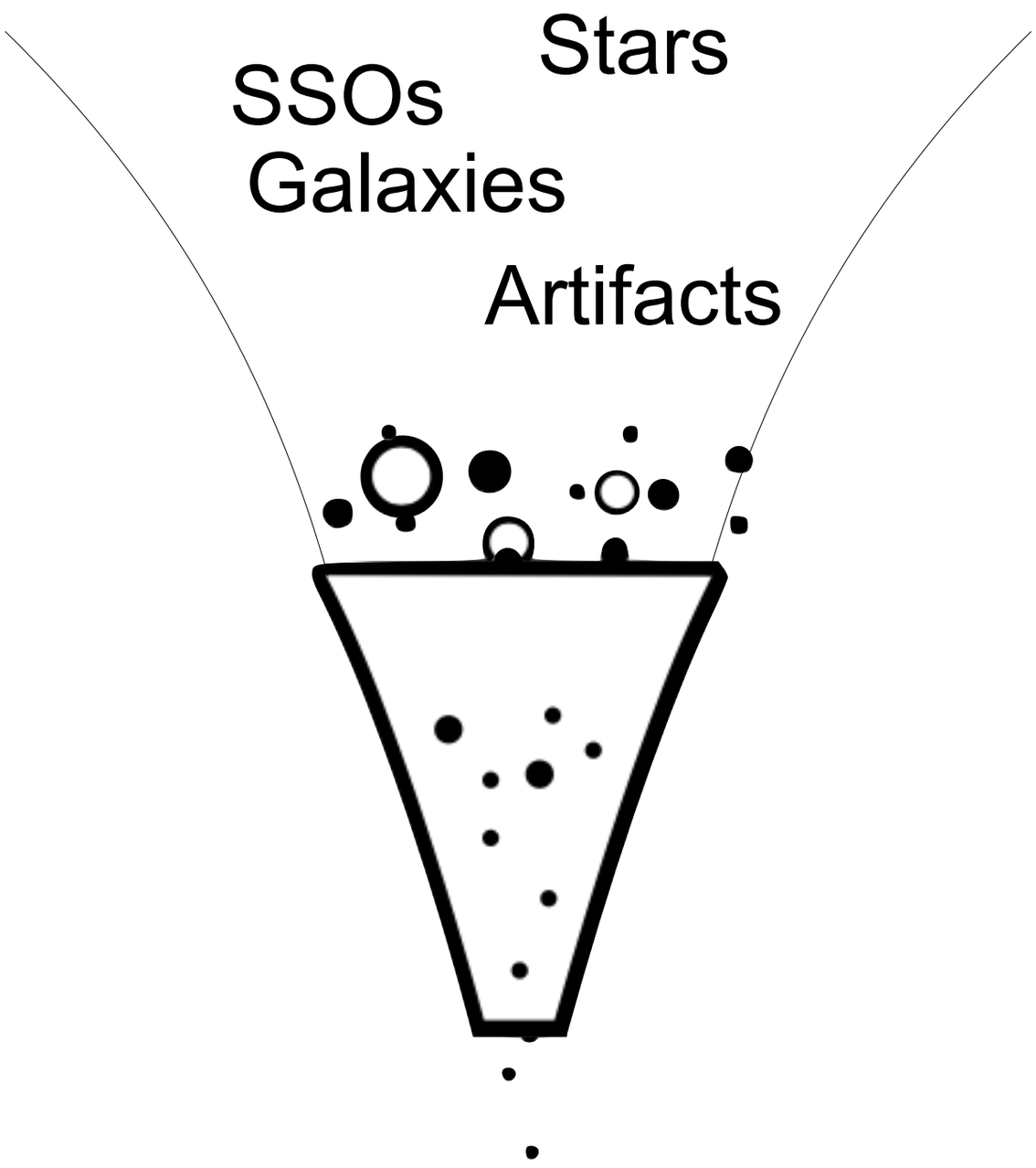
SSOs

Galaxies

Artifacts



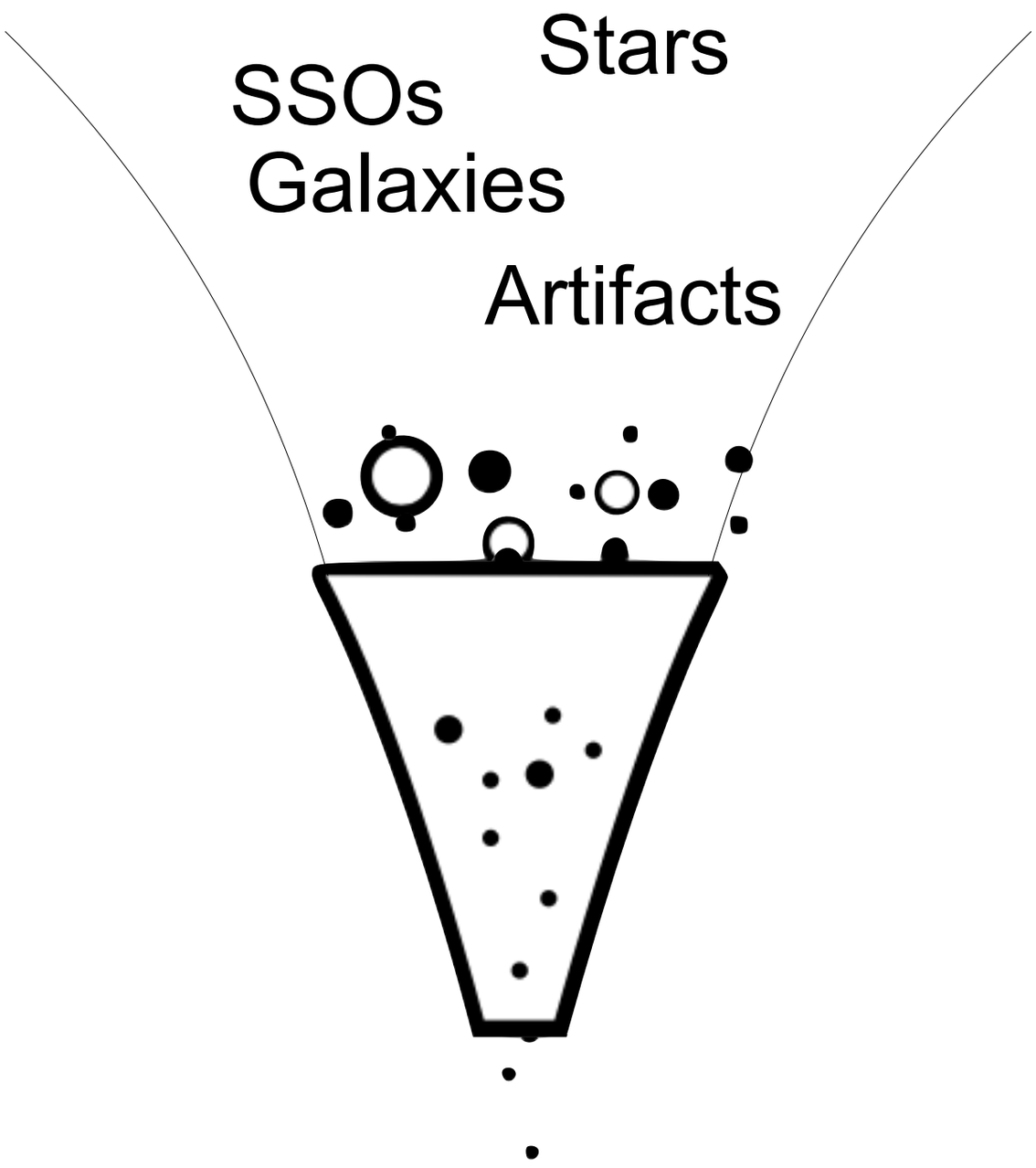
Motion



Motion

NUMBER OF DETECTIONS

3 - 5



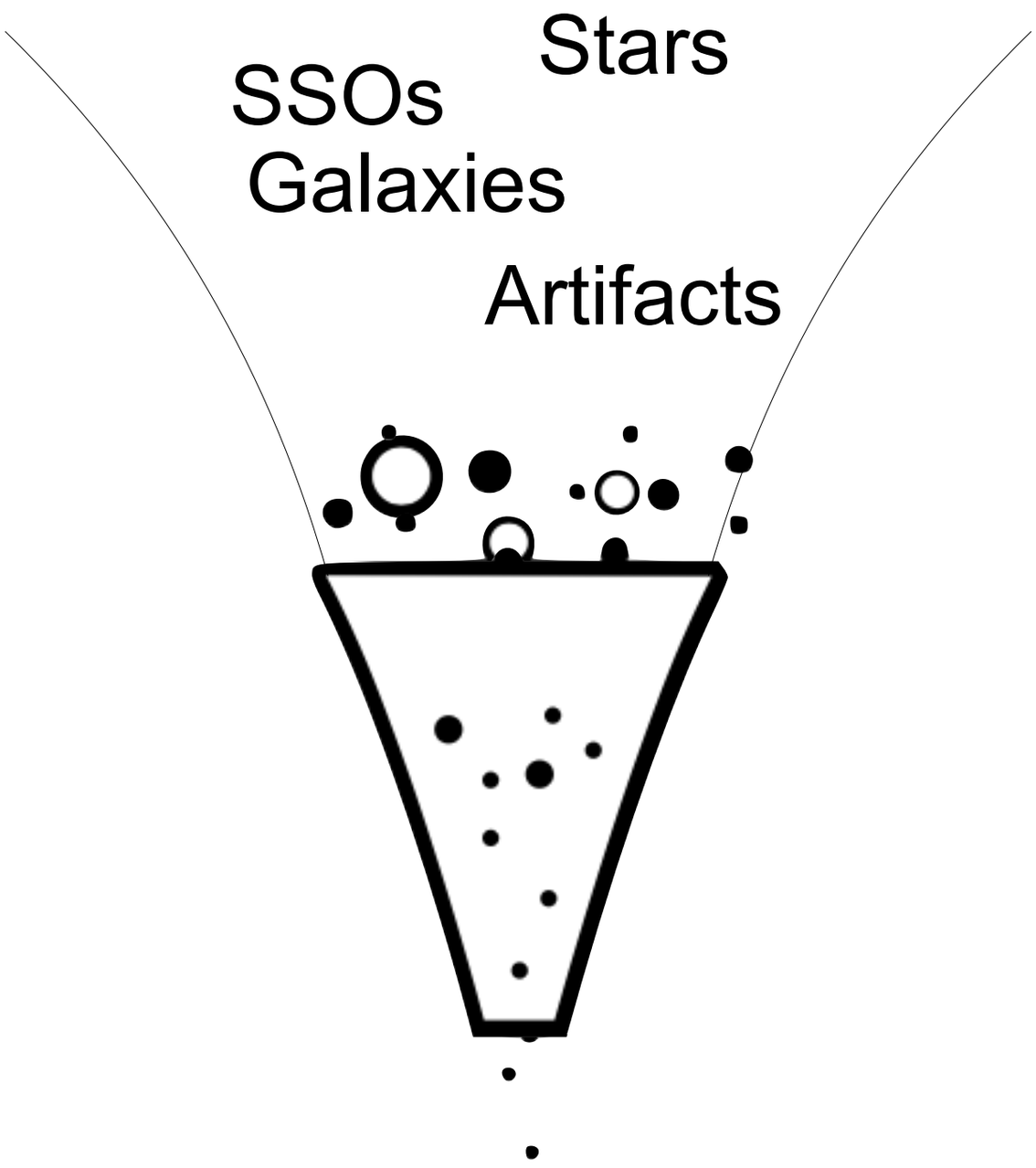
Motion

NUMBER OF DETECTIONS

3 - 5

PROPER MOTION

0 - 200 "/h



Motion

NUMBER OF DETECTIONS

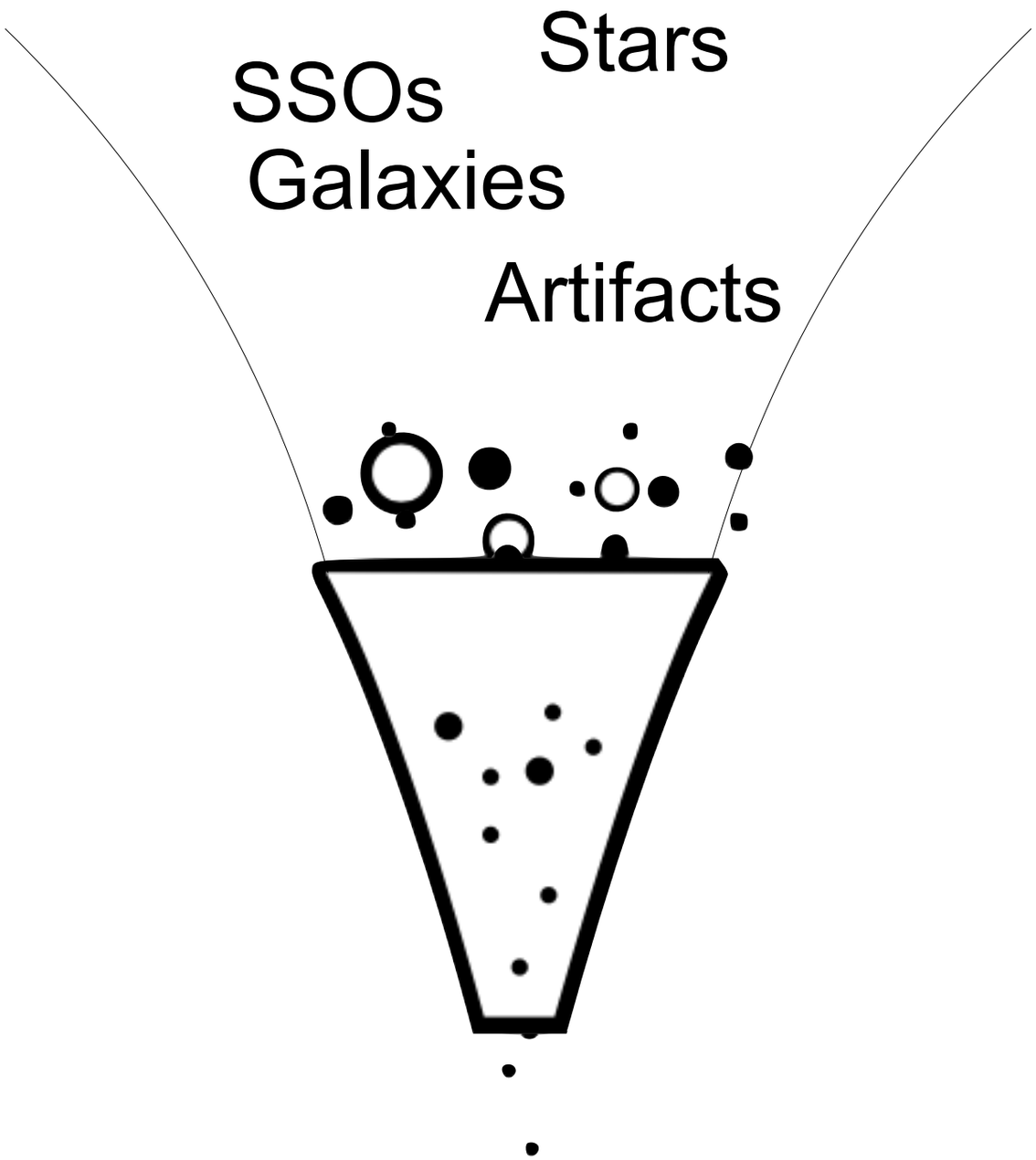
3 - 5

PROPER MOTION

0 - 200 "/h

LINEAR MOTION

$R^2 > 0.95$



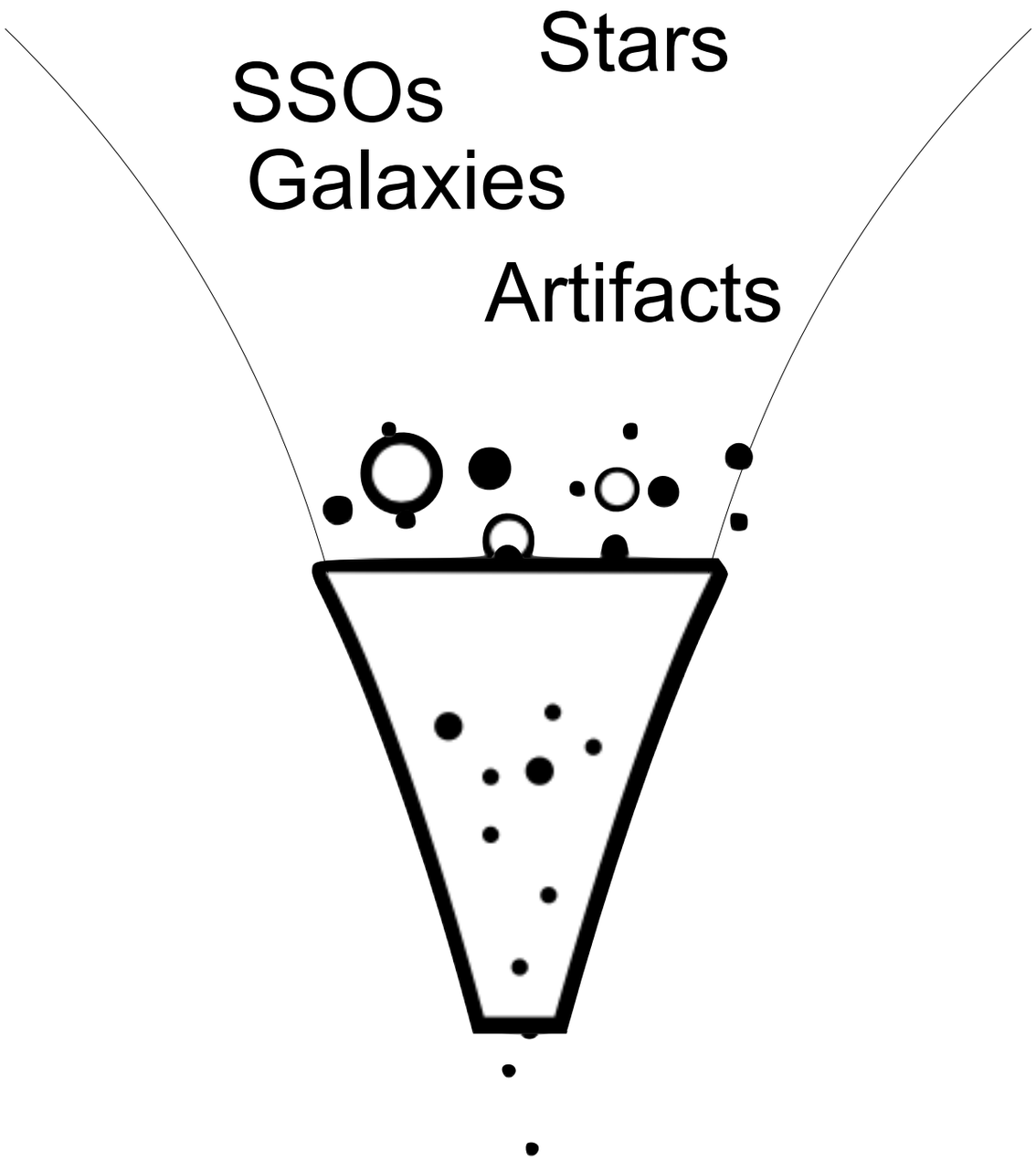
Motion

NUMBER OF DETECTIONS 3 - 5

PROPER MOTION 0 - 200 "/h

LINEAR MOTION $R^2 > 0.95$

Appearance



Motion

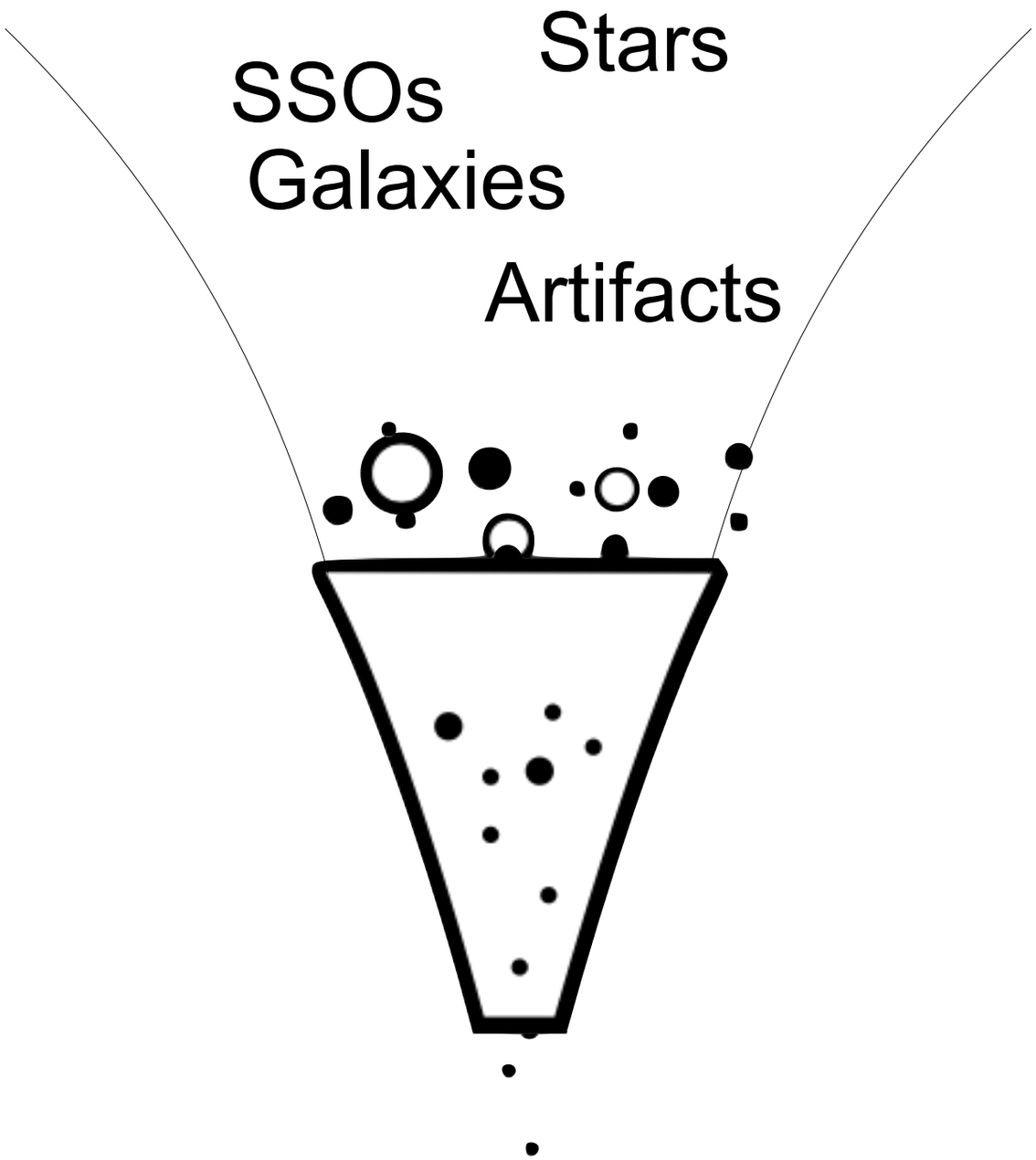
NUMBER OF DETECTIONS — 3 - 5

PROPER MOTION — 0 - 200 "/h

LINEAR MOTION — $R^2 > 0.95$

Appearance

CONSTANT TRAIL SIZE — $R^2 > 0.95$



28,290 SSOs

7% Artifacts

Motion

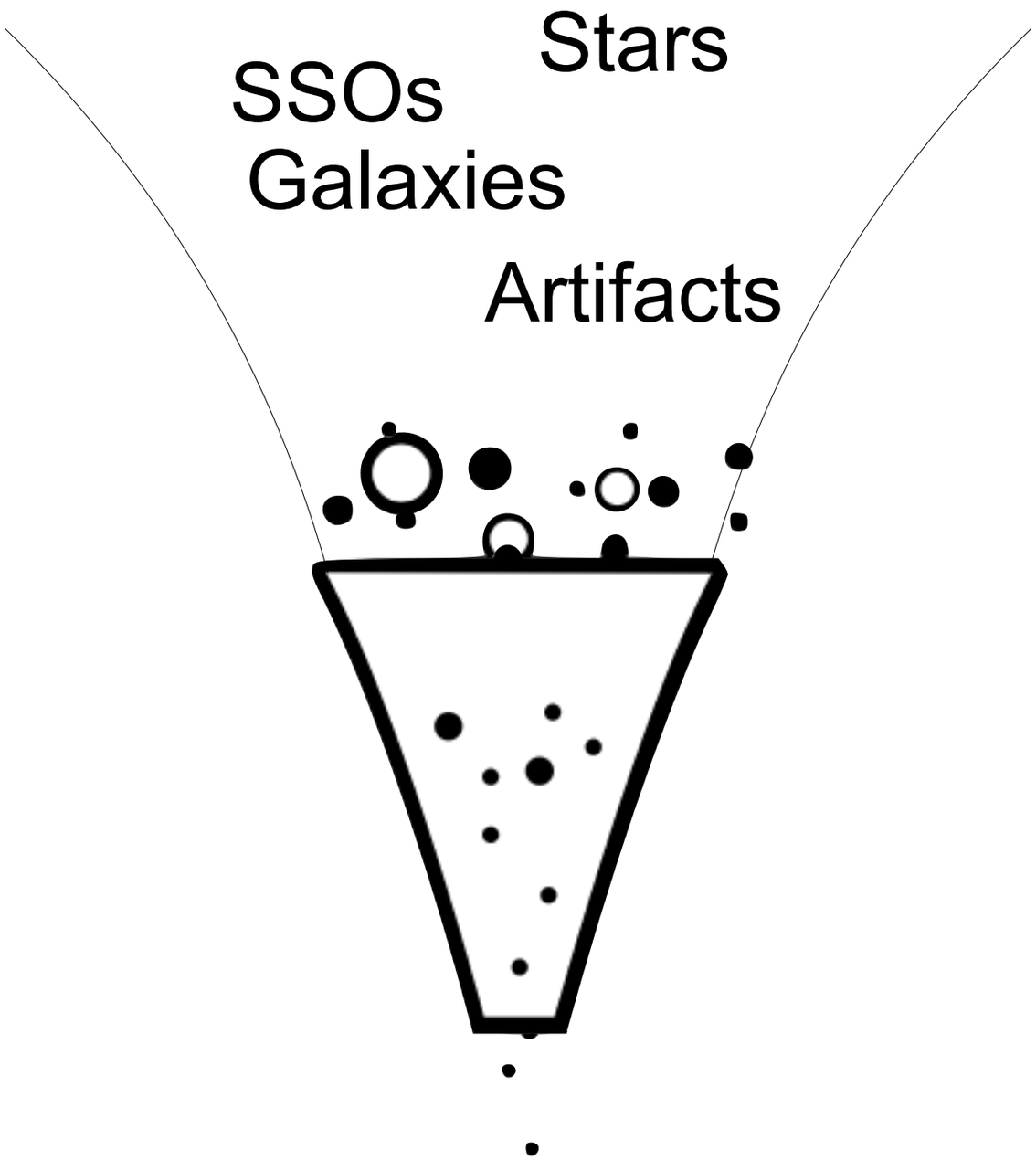
NUMBER OF DETECTIONS — 3 - 5

PROPER MOTION — 0 - 200 "/h

LINEAR MOTION — $R^2 > 0.95$

Appearance

CONSTANT TRAIL SIZE — $R^2 > 0.95$



28,290 SSOs

7% Artifacts

Motion

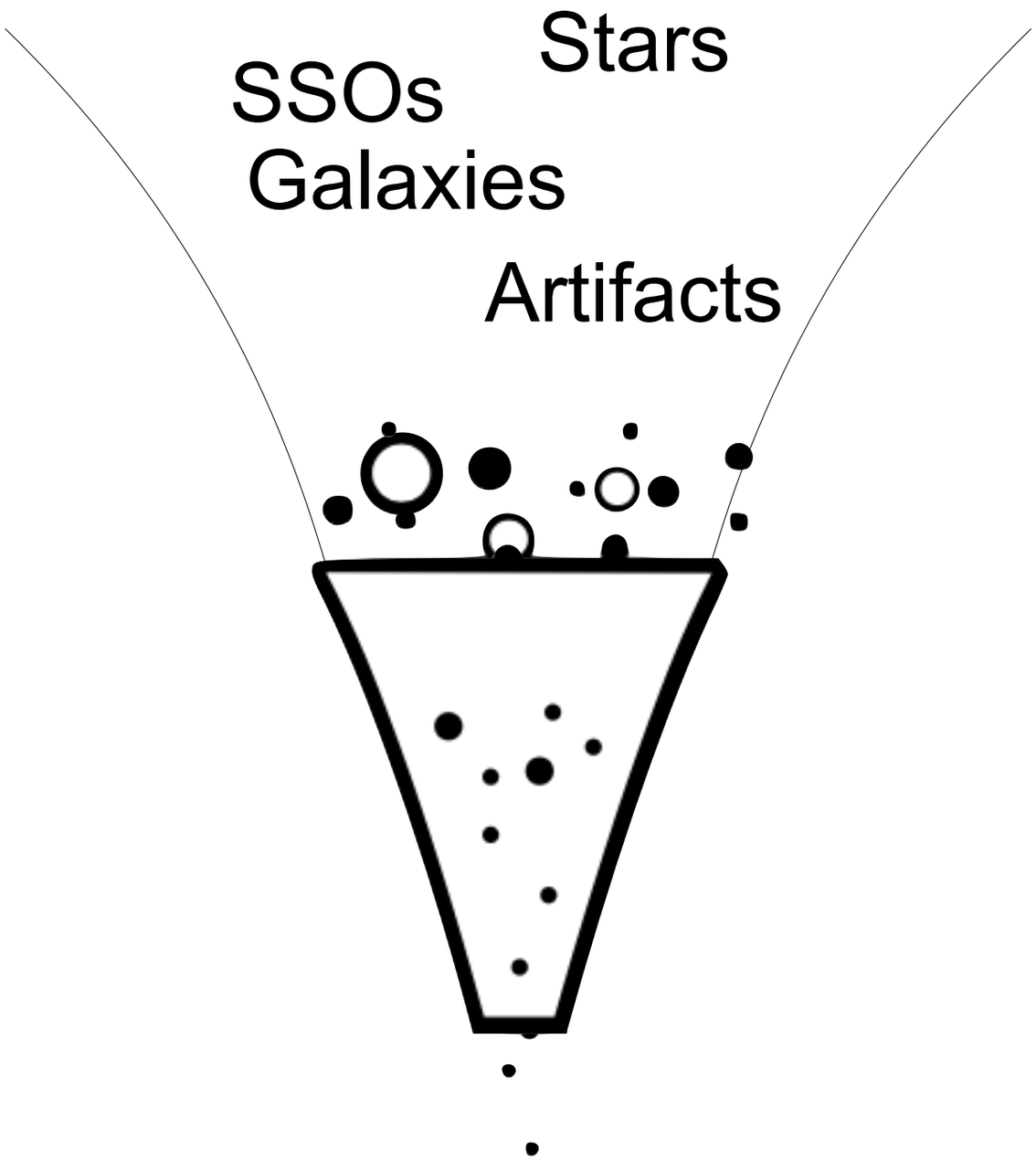
NUMBER OF DETECTIONS — 4 - 5

PROPER MOTION — 0 - 200 "/h

LINEAR MOTION — $R^2 > 0.95$

Appearance

CONSTANT TRAIL SIZE — $R^2 > 0.95$



28,290 SSOs

7% Artifacts

21,072 SSOs

0.3% Artifacts

Motion

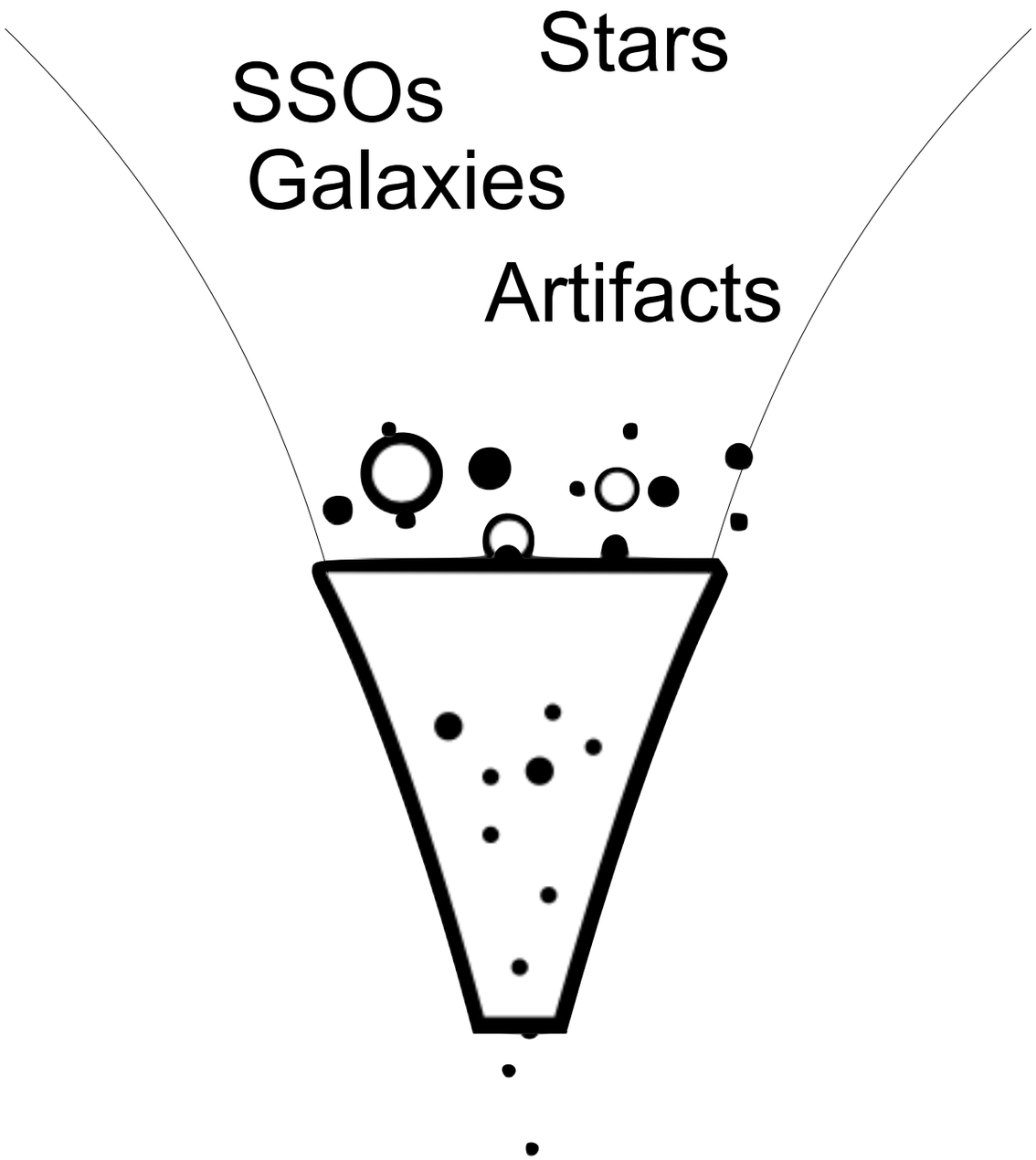
NUMBER OF DETECTIONS 4 - 5

PROPER MOTION 0 - 200 "/h

LINEAR MOTION $R^2 > 0.95$

Appearance

CONSTANT TRAIL SIZE $R^2 > 0.95$



Motion

NUMBER OF DETECTIONS — 4 - 5

PROPER MOTION — 0 - 200 "/h

LINEAR MOTION — $R^2 > 0.95$

Appearance

CONSTANT TRAIL SIZE — $R^2 > 0.95$

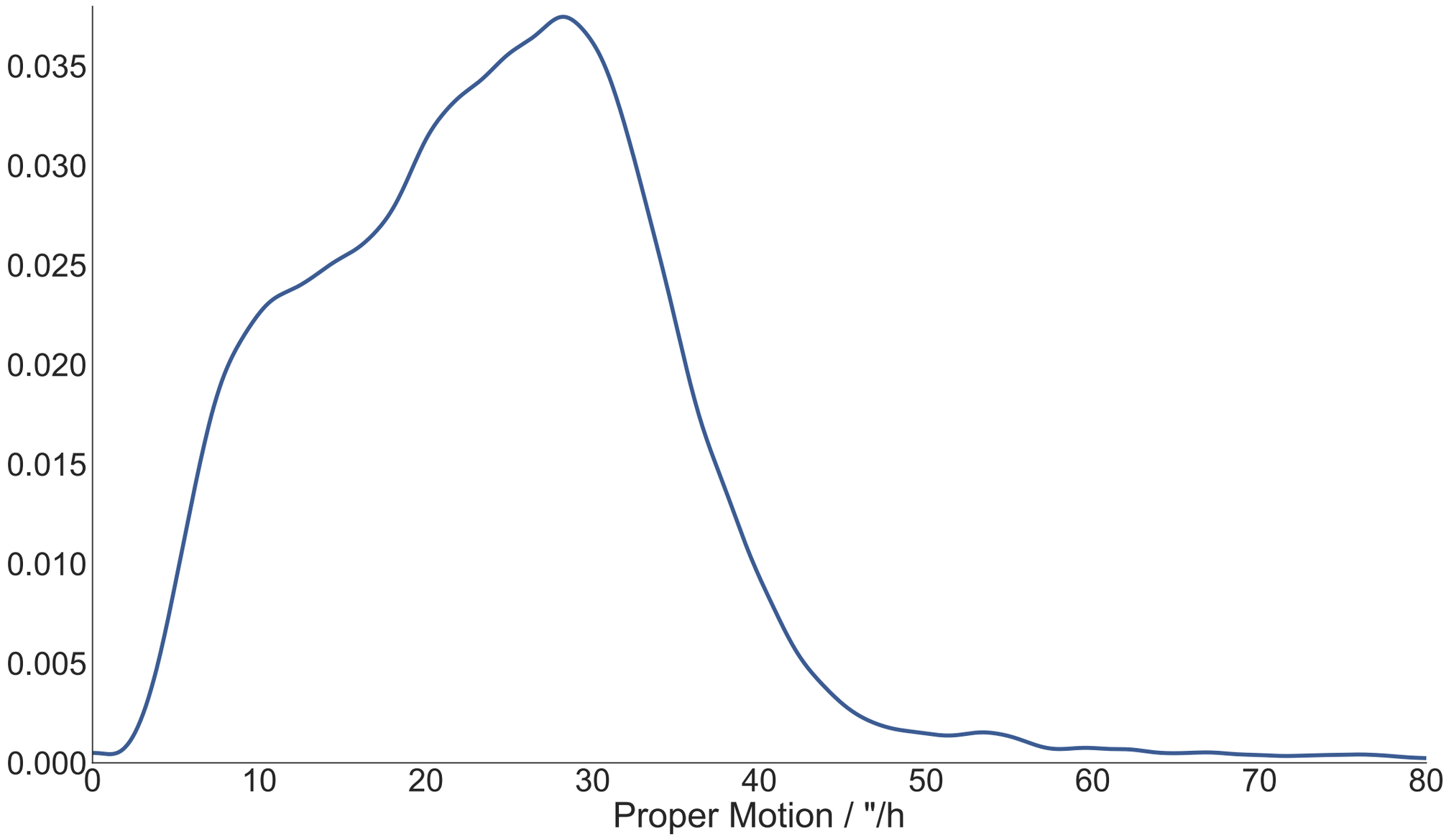
28,290 SSOs ← Sample of Sources with 3 - 5 Detections

7% Artifacts

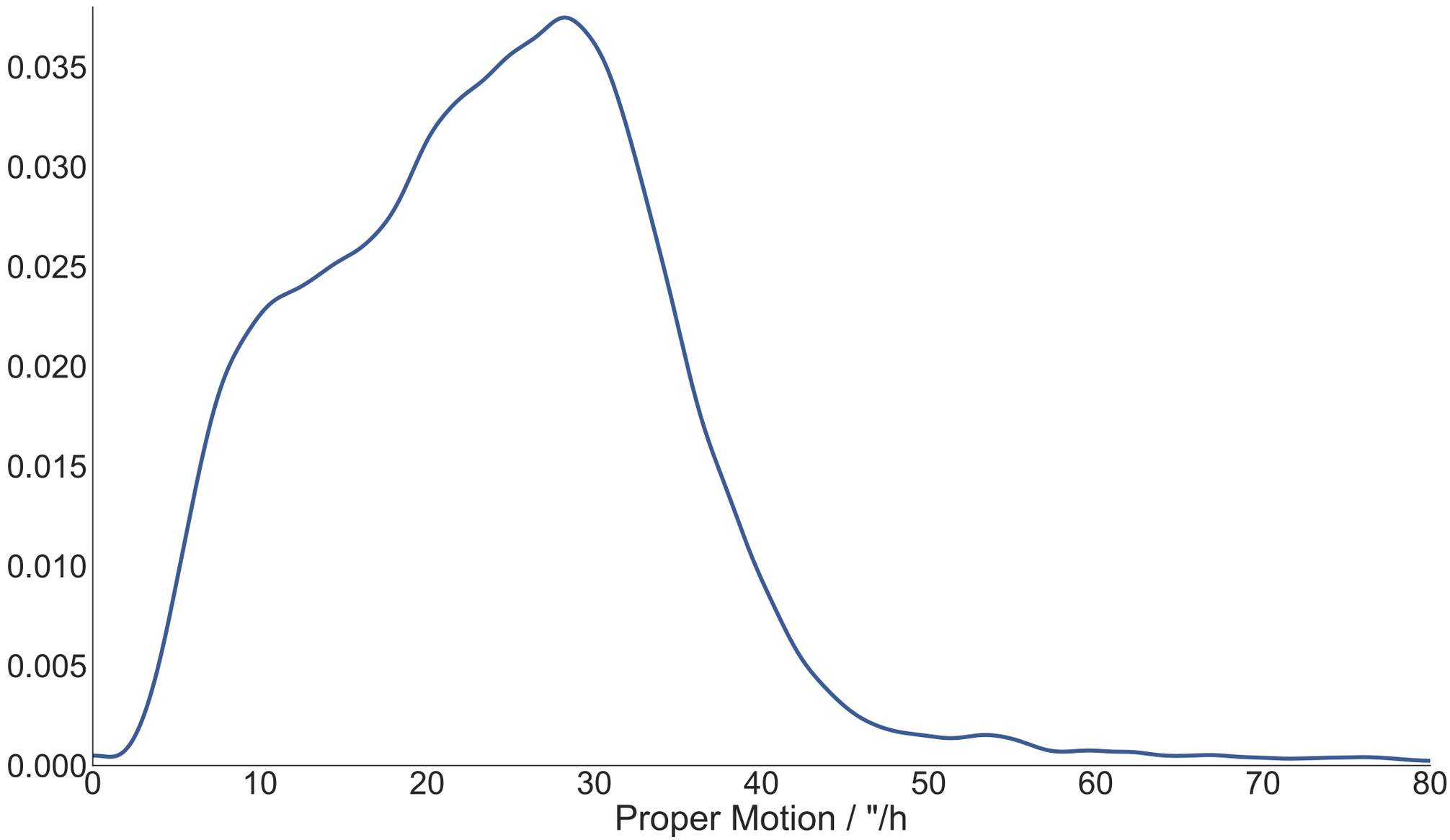
21,072 SSOs ← Sample of Sources with 4 - 5 Detections

0.3% Artifacts

Proper Motion distribution of the 28290 SSO candidates in the sample:

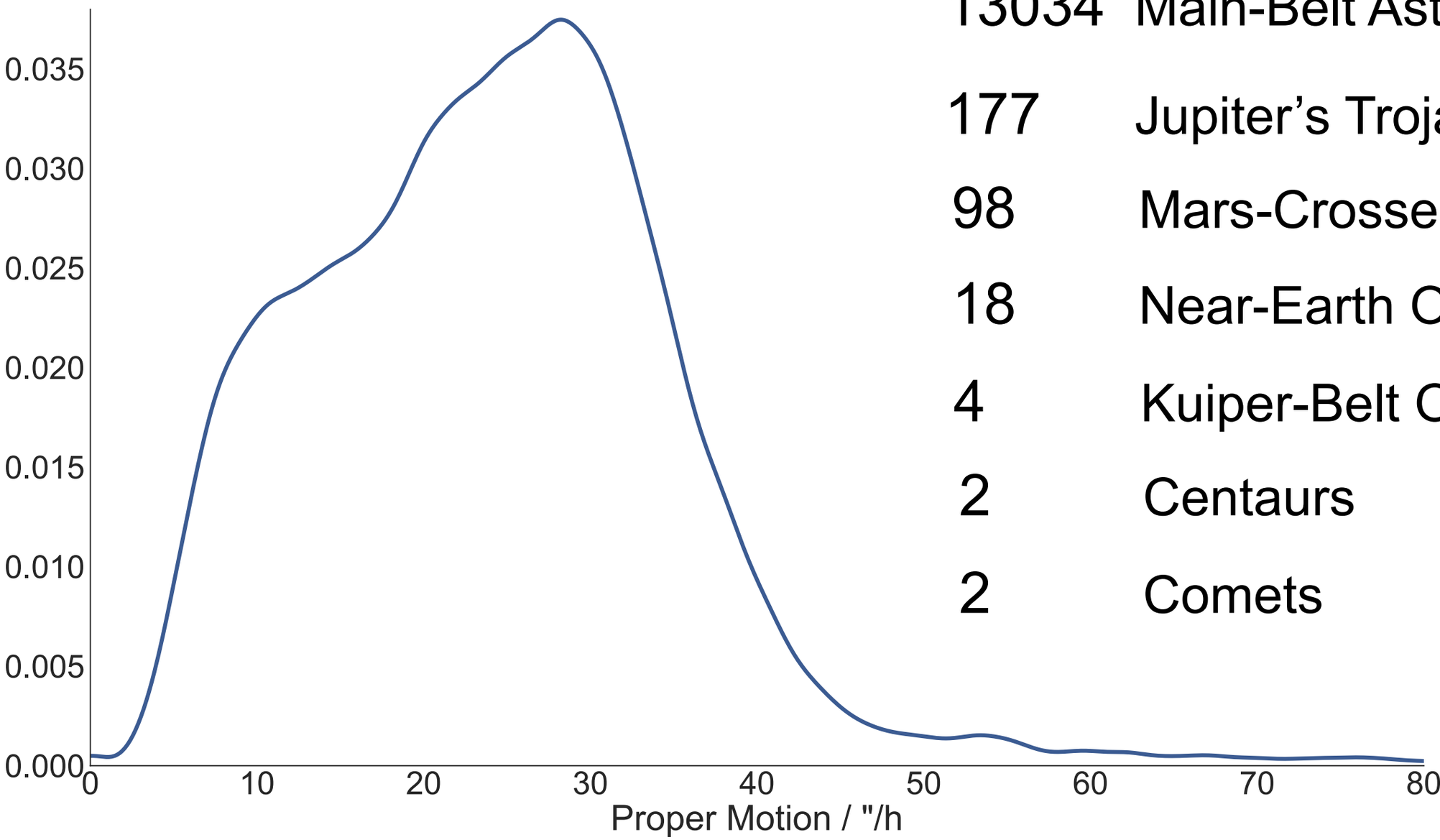


Proper Motion distribution of the 28290 SSO candidates in the sample:



47% of the SSO candidates in the sample have a match within 10" in the SkyBoT database

Proper Motion distribution of the 28290 SSO candidates in the sample:



47% of the SSO candidates in the sample have a match within 10" in the SkyBoT database

Among the **cross-matched** SSOs:

13034	Main-Belt Asteroids
177	Jupiter's Trojan Asteroids
98	Mars-Crossers
18	Near-Earth Objects
4	Kuiper-Belt Objects
2	Centaurs
2	Comets

53% of the SSO candidates in the sample have no match within 10" in the SkyBoT database

46% of the SSO candidates in the sample have no match within 10" in the SkyBoT database

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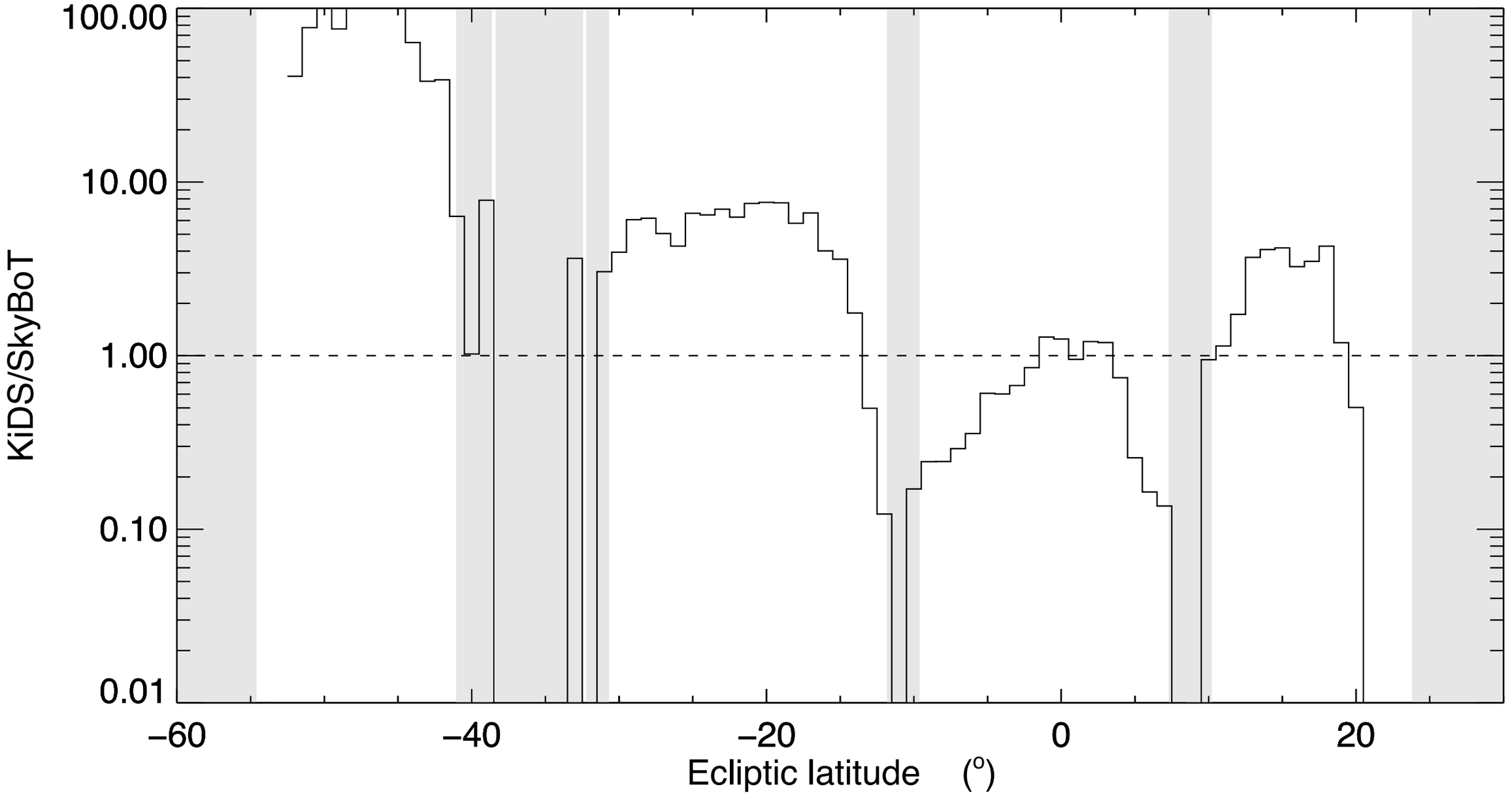
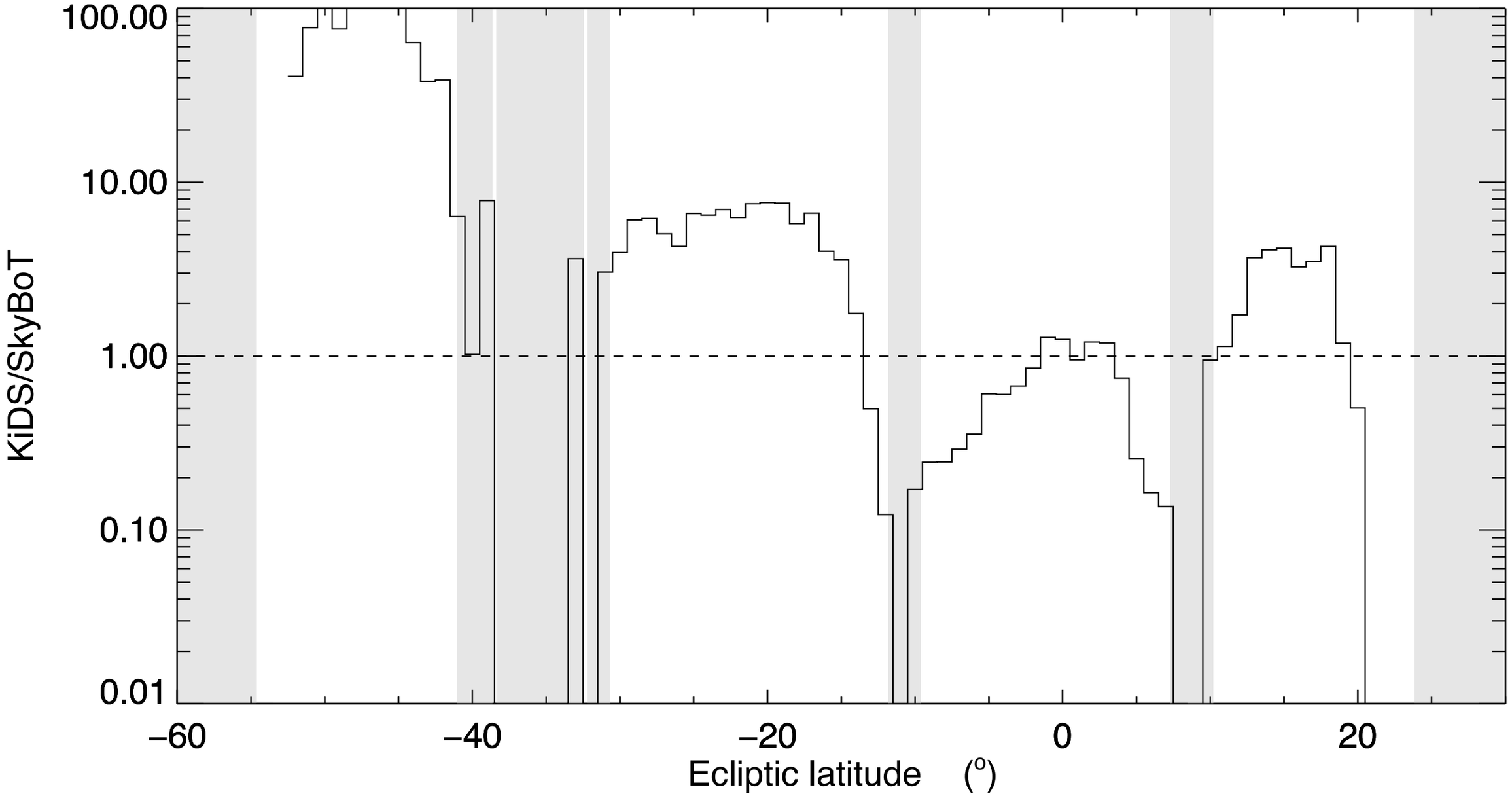


46% of the SSO candidates in the sample have no match within 10" in the SkyBoT database

Where did we find more SSOs than we expected to find?



46% of the SSO candidates in the sample have no match within 10" in the SkyBoT database

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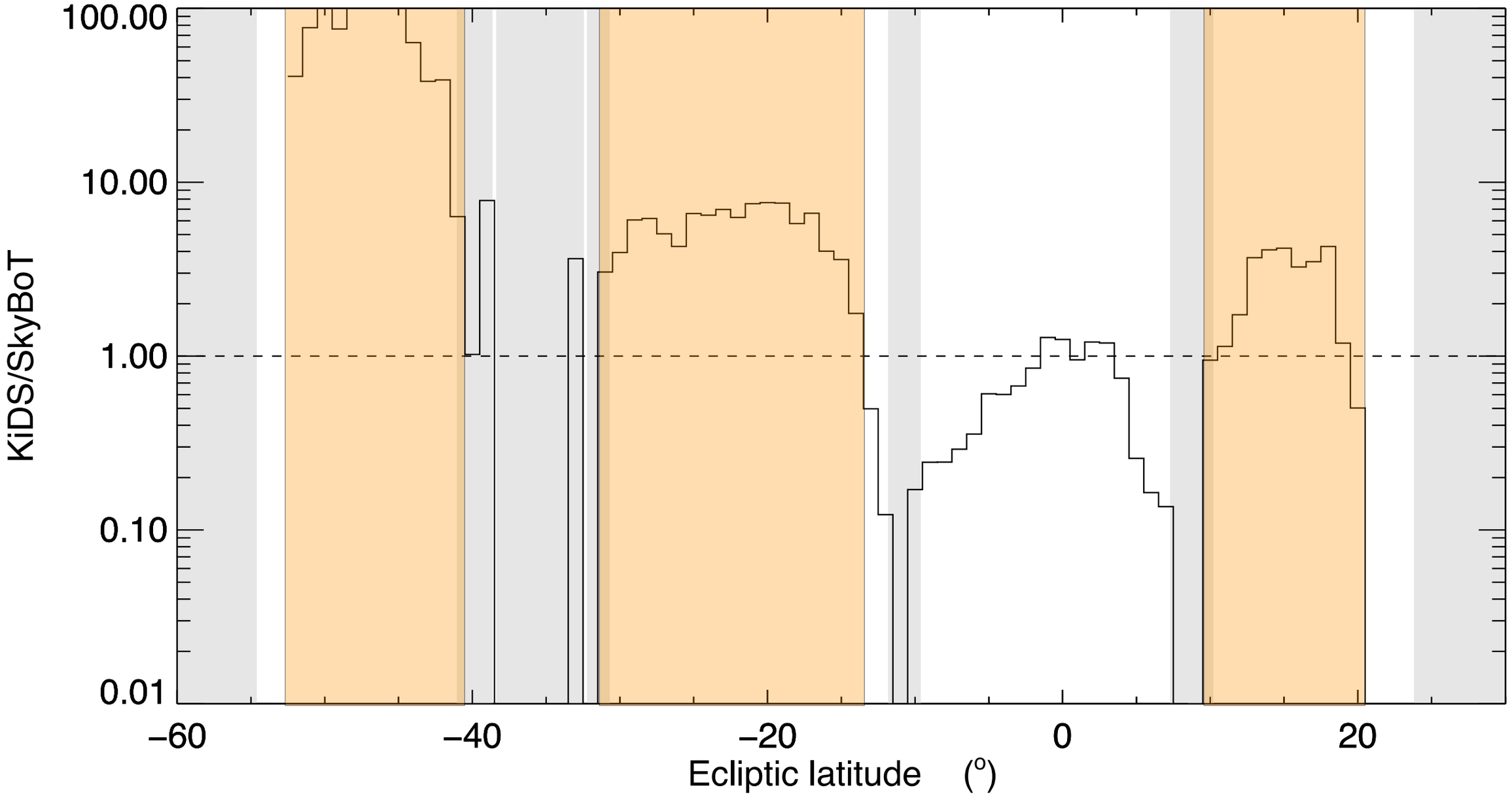

Conclusion

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Method to find SSOs in wide-field surveys that apply dithering strategy

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VISTA Surveys at ESO

UKIDSS

LSST

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All SSO candidates with 3+ detections were submitted to the Minor Planet Centre

A paper summarizing our method and results has been submitted to A&A

Thank you very much

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+ the KiDS collaboration

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