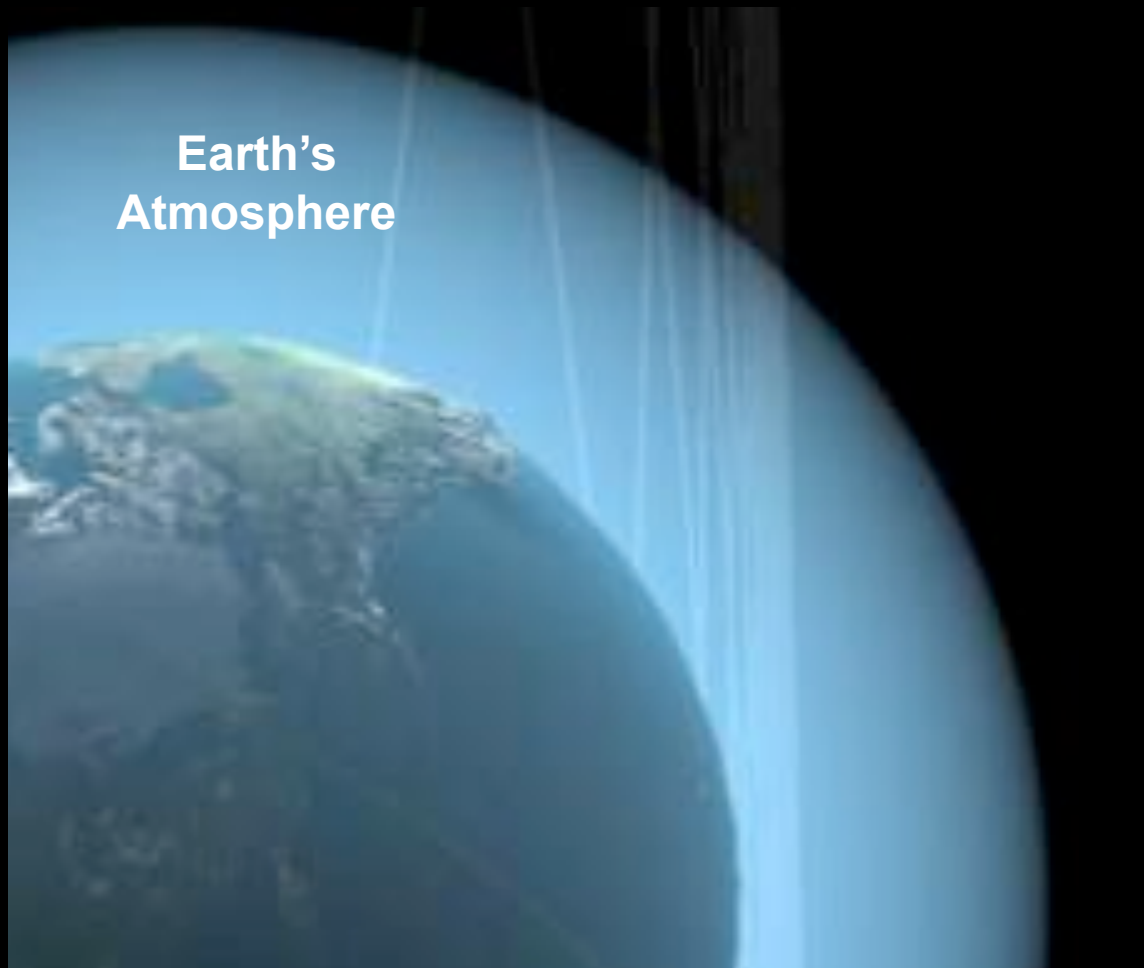
Statistics, Source Detection, and Noise in the Optical / Infrared

ASTR 288C: Lecture 4

Sources of Detected Signal

Astrophysical Sources

Atmosphere transmits most light at optical wavelengths and within "windows" in the infrared



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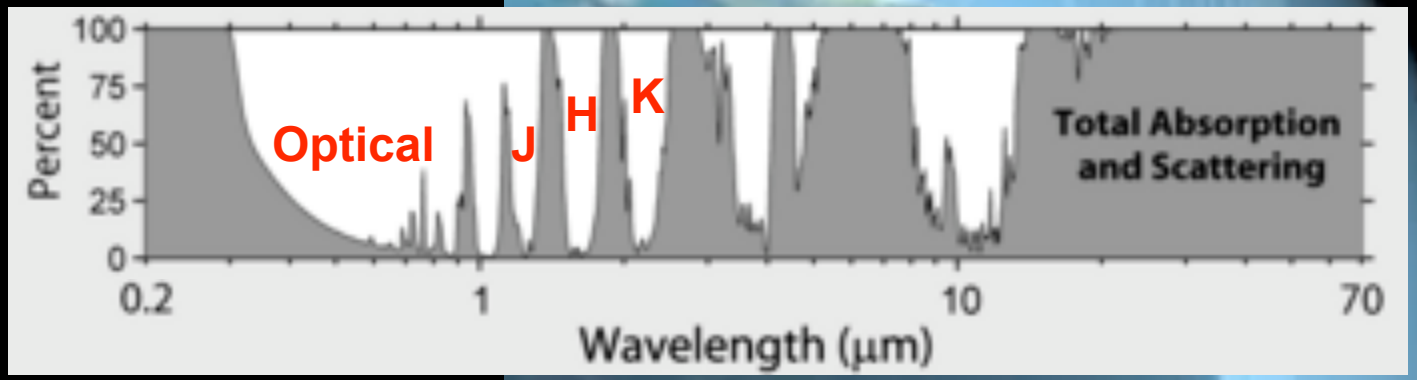

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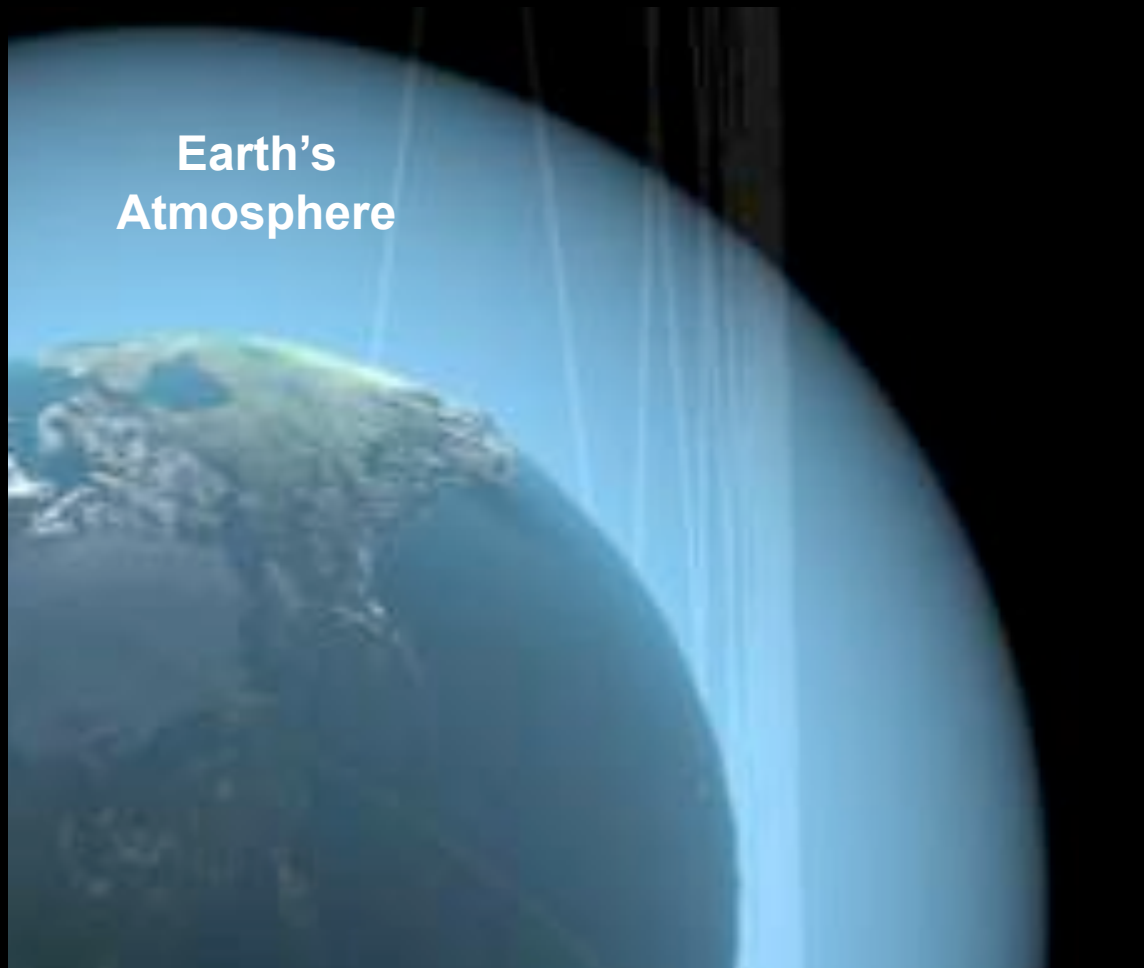

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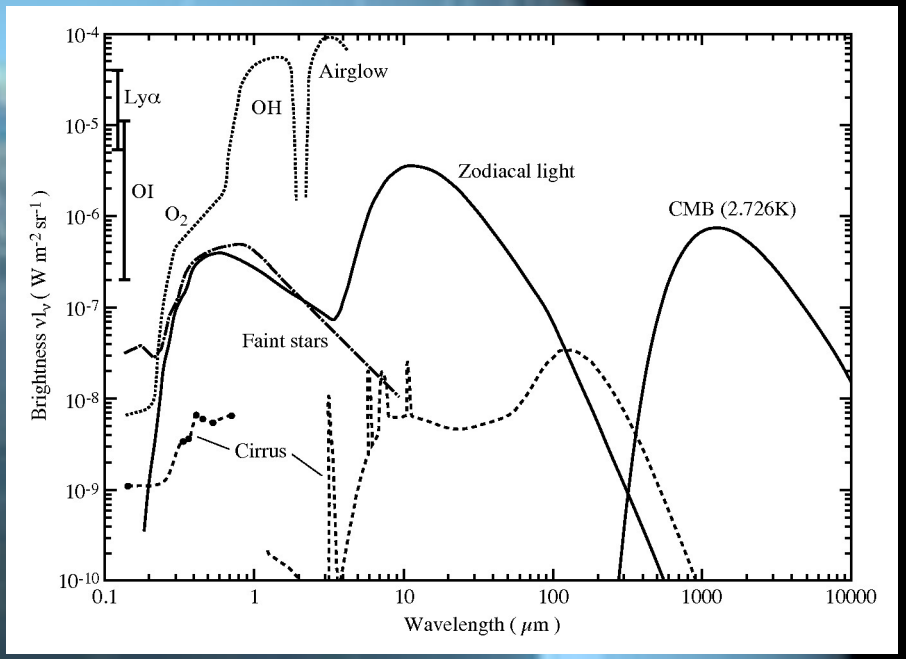

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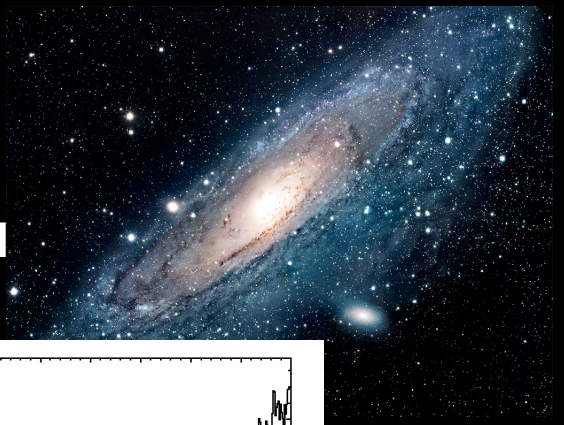

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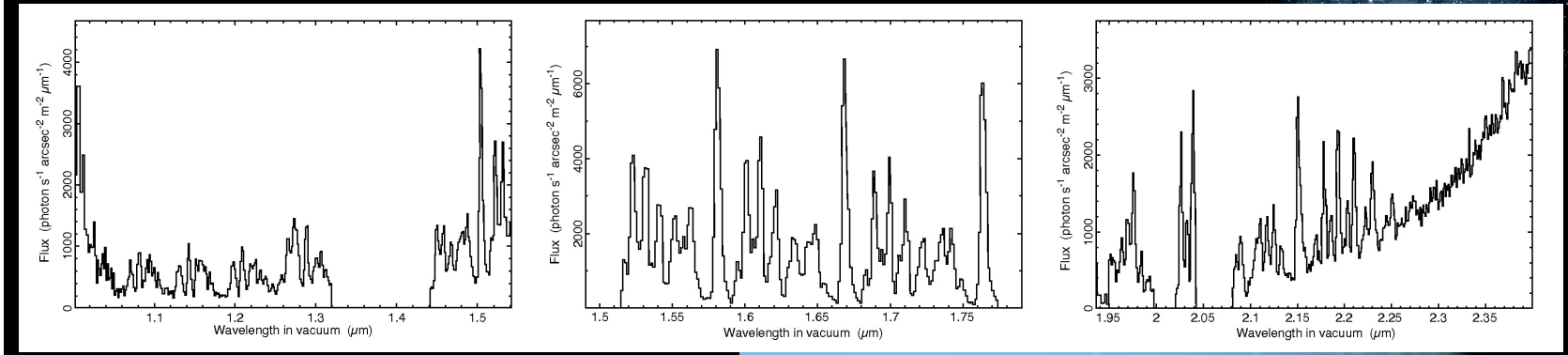

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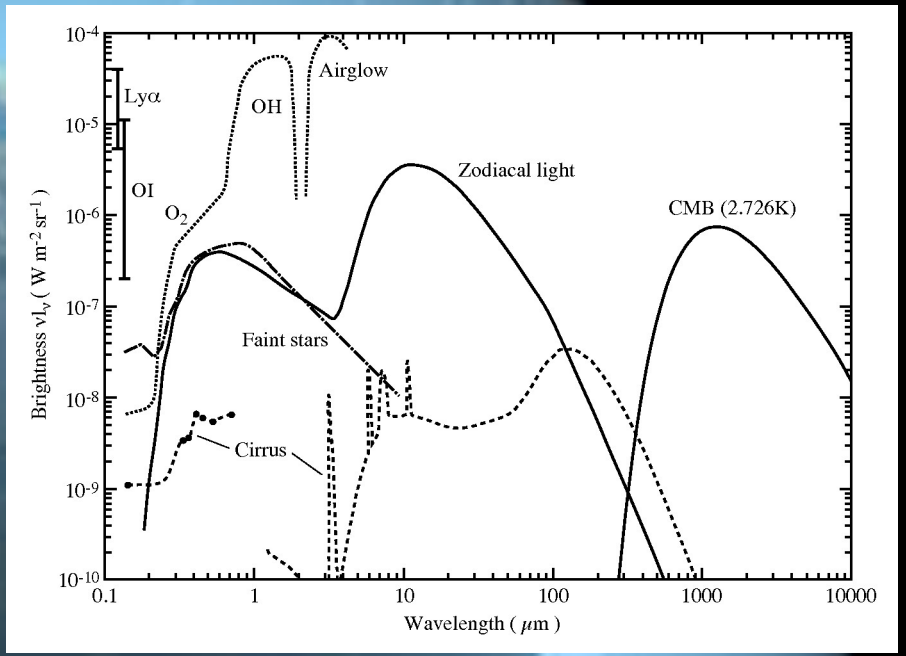

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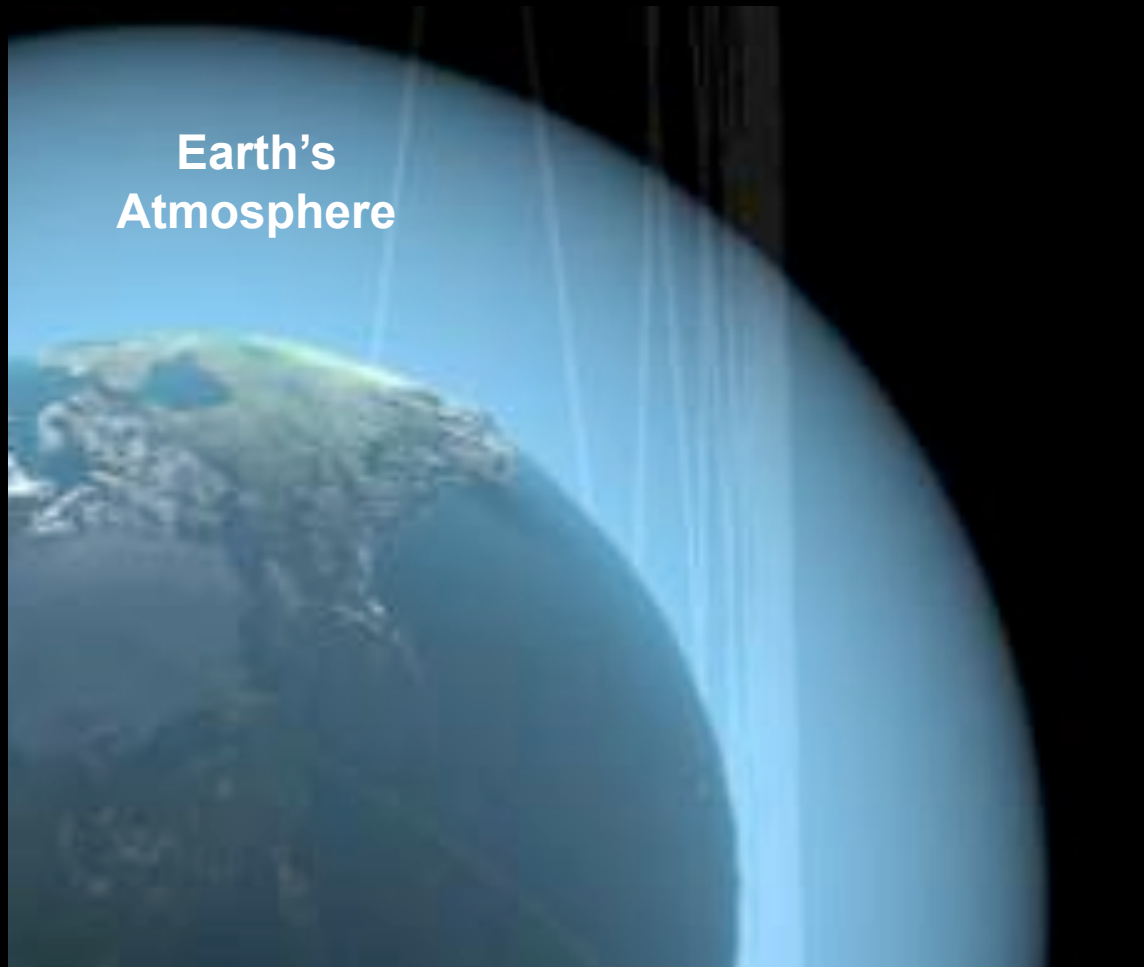

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Earth's Atmosphere

Telescope

Detector

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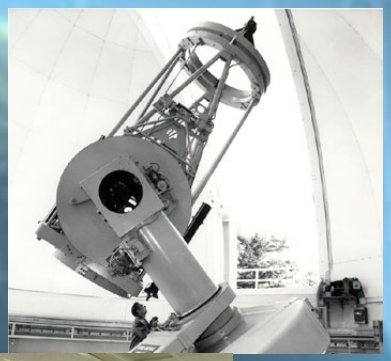

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Thermal emission of detector itself

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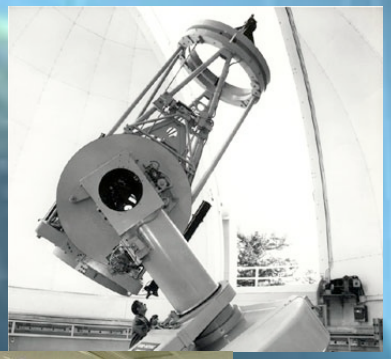

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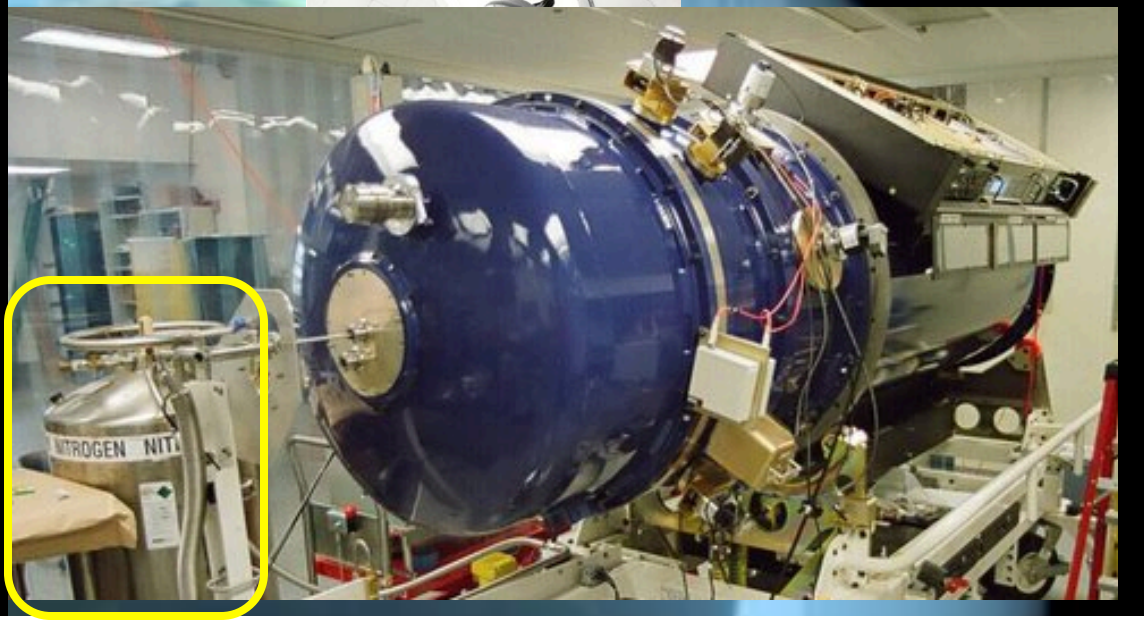

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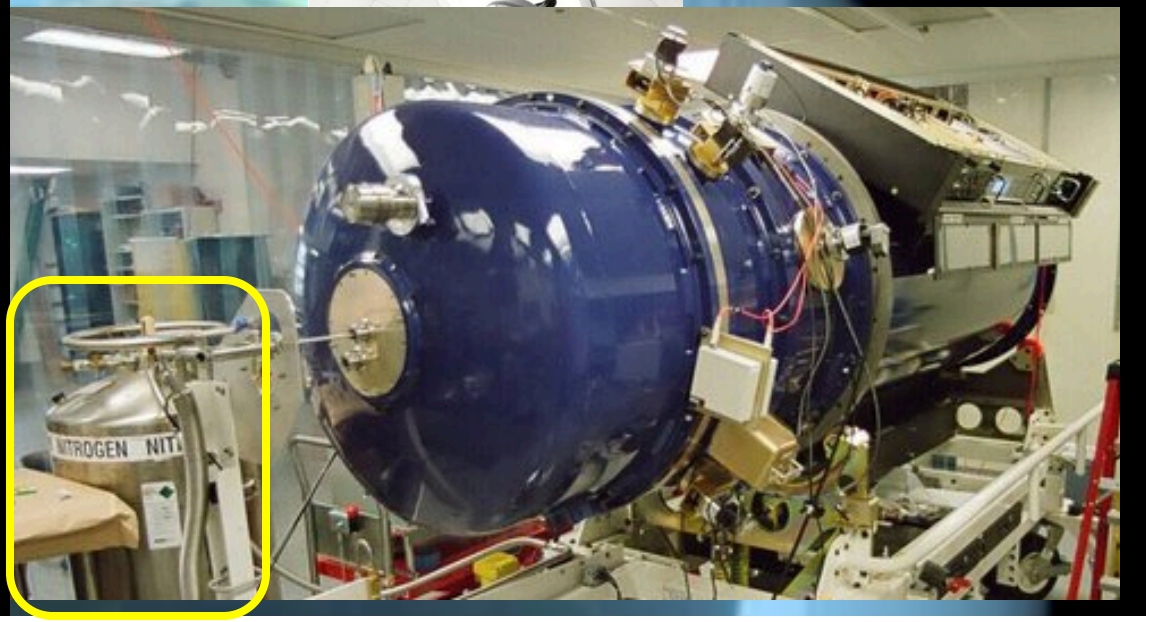

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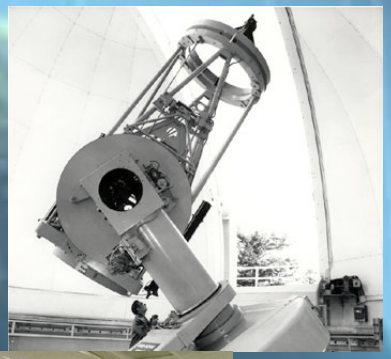

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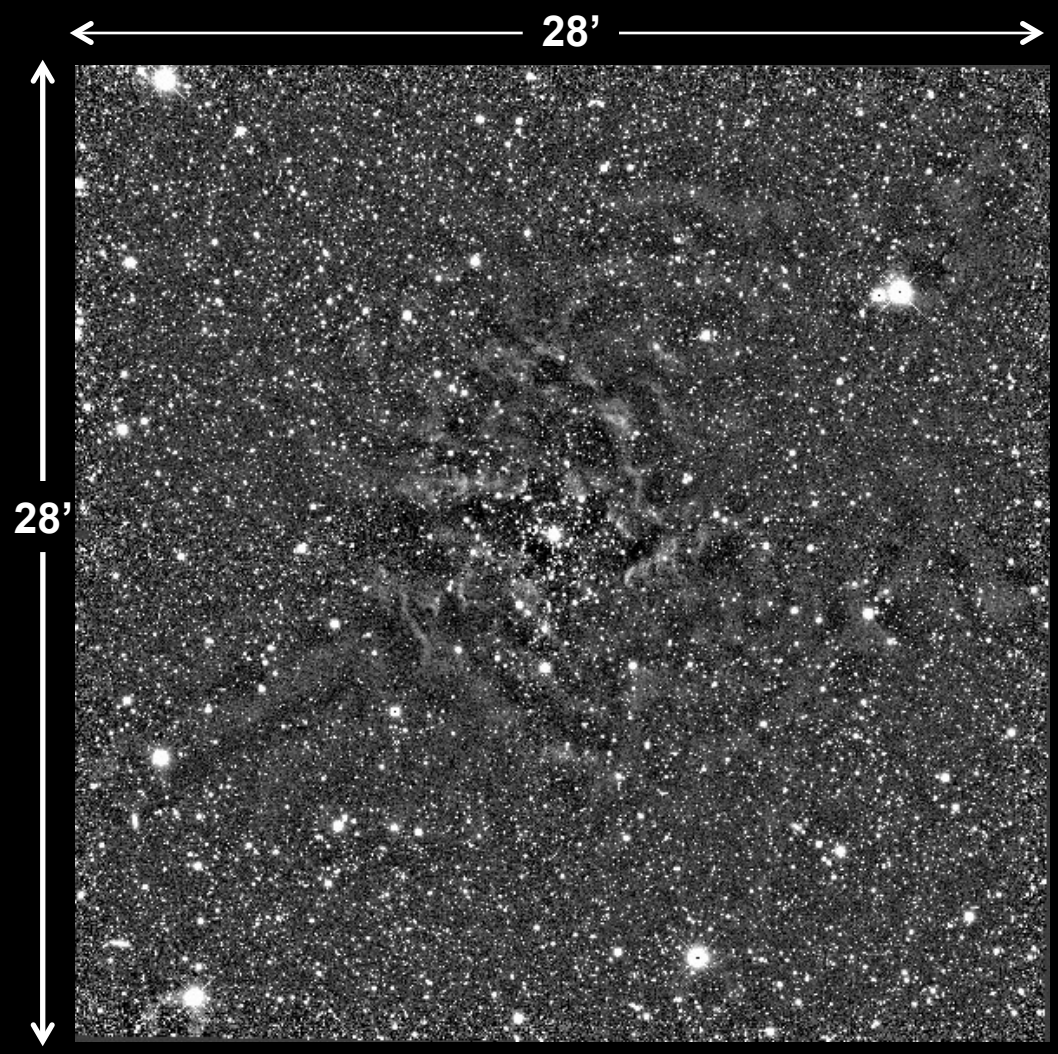

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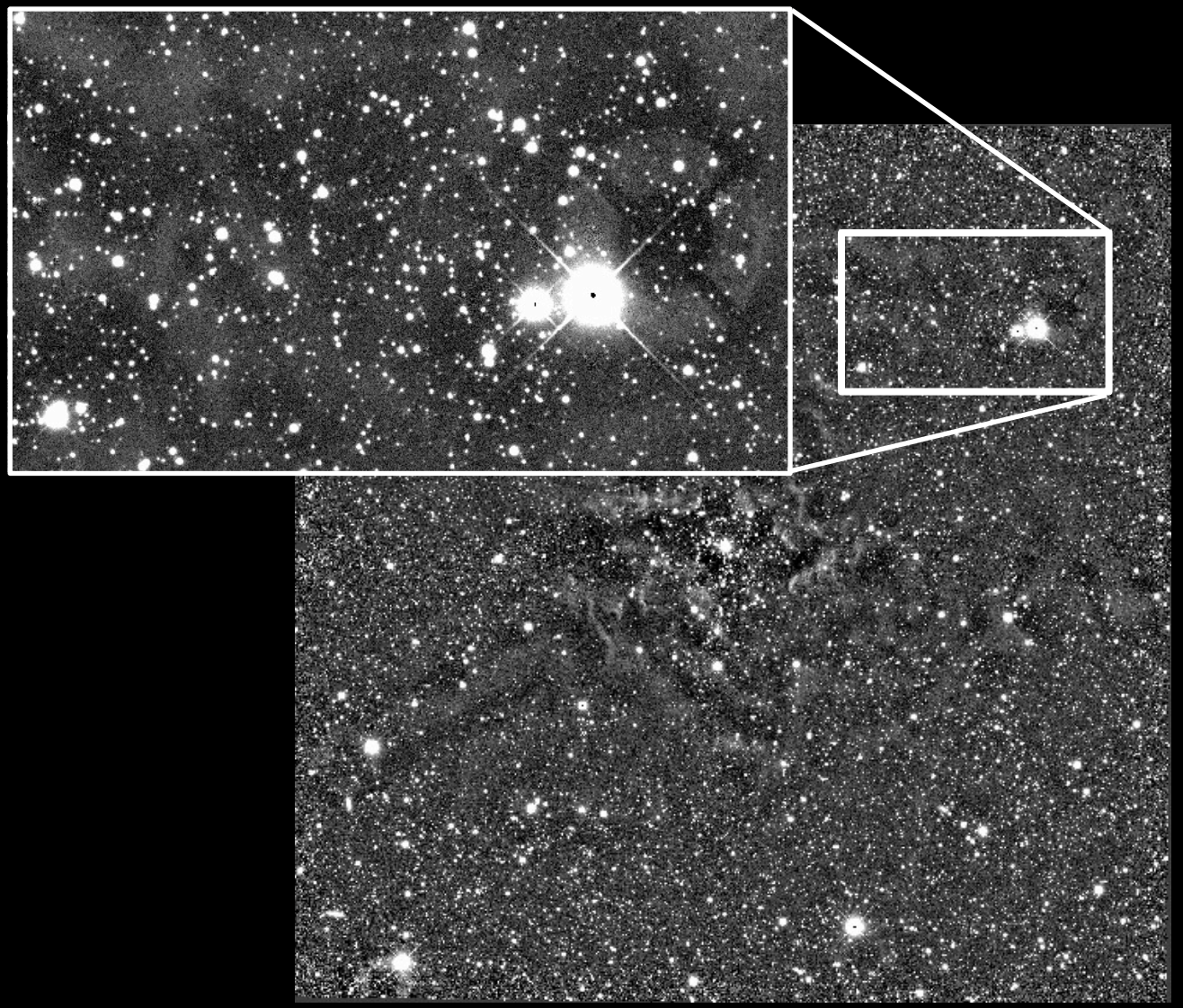

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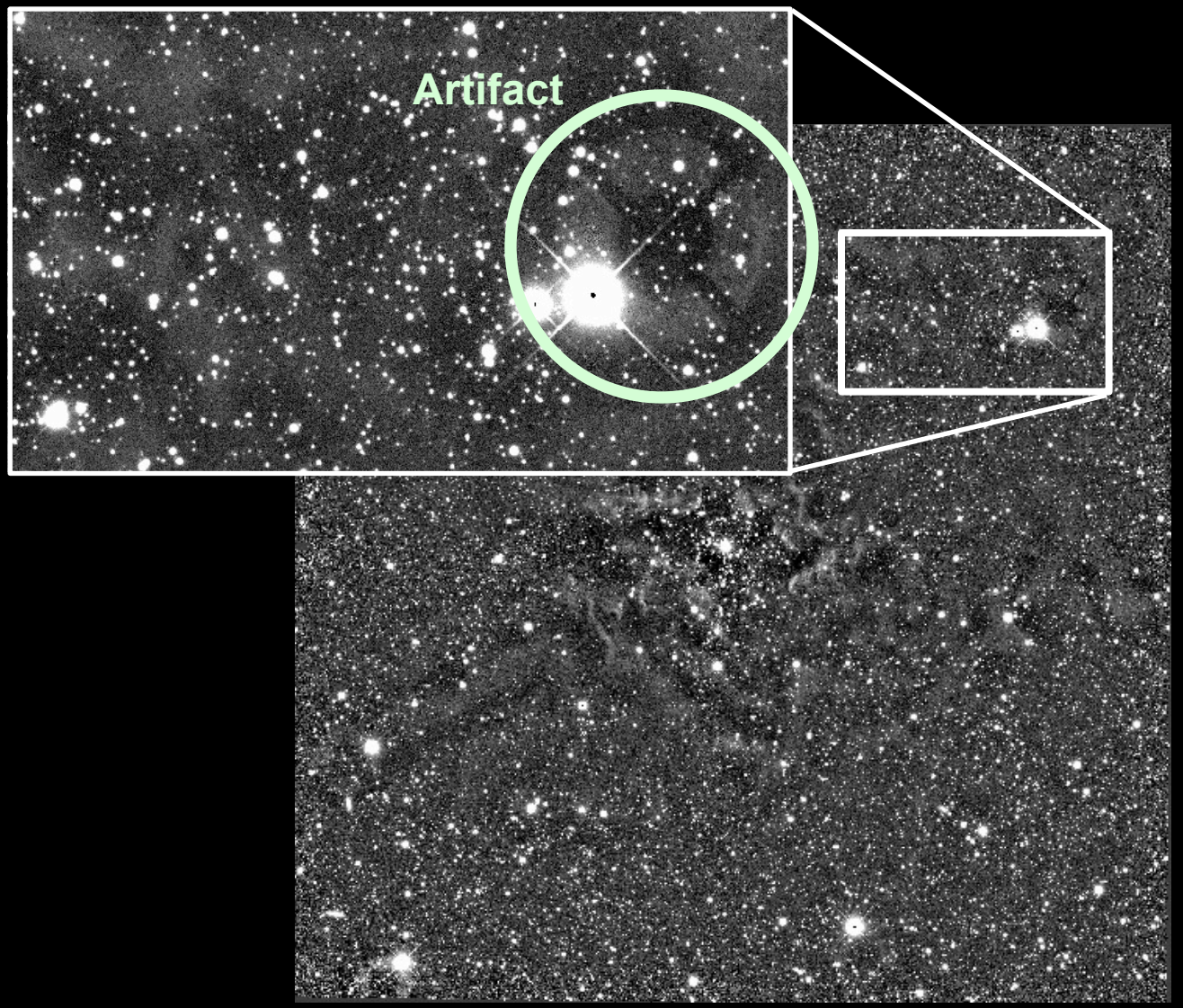

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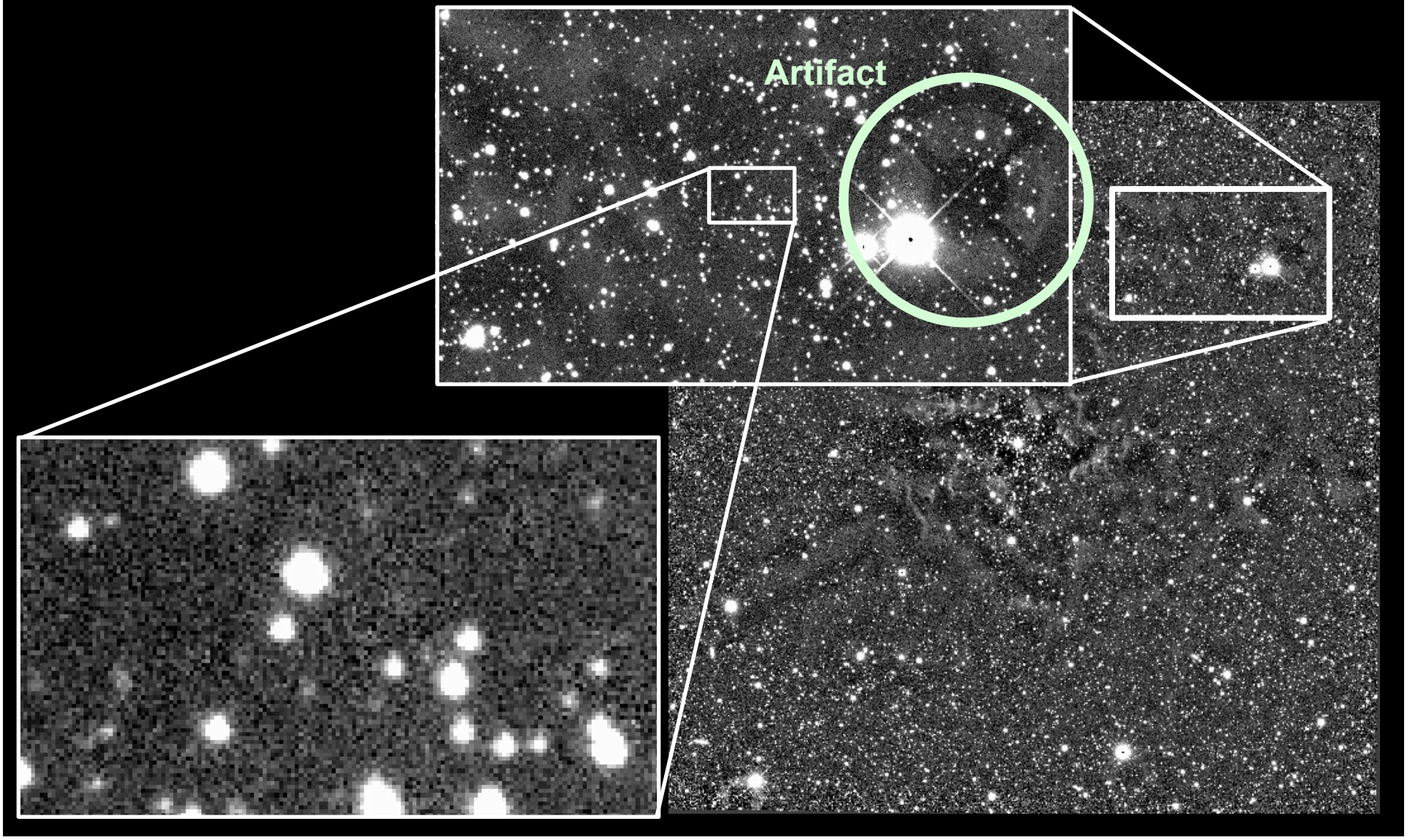

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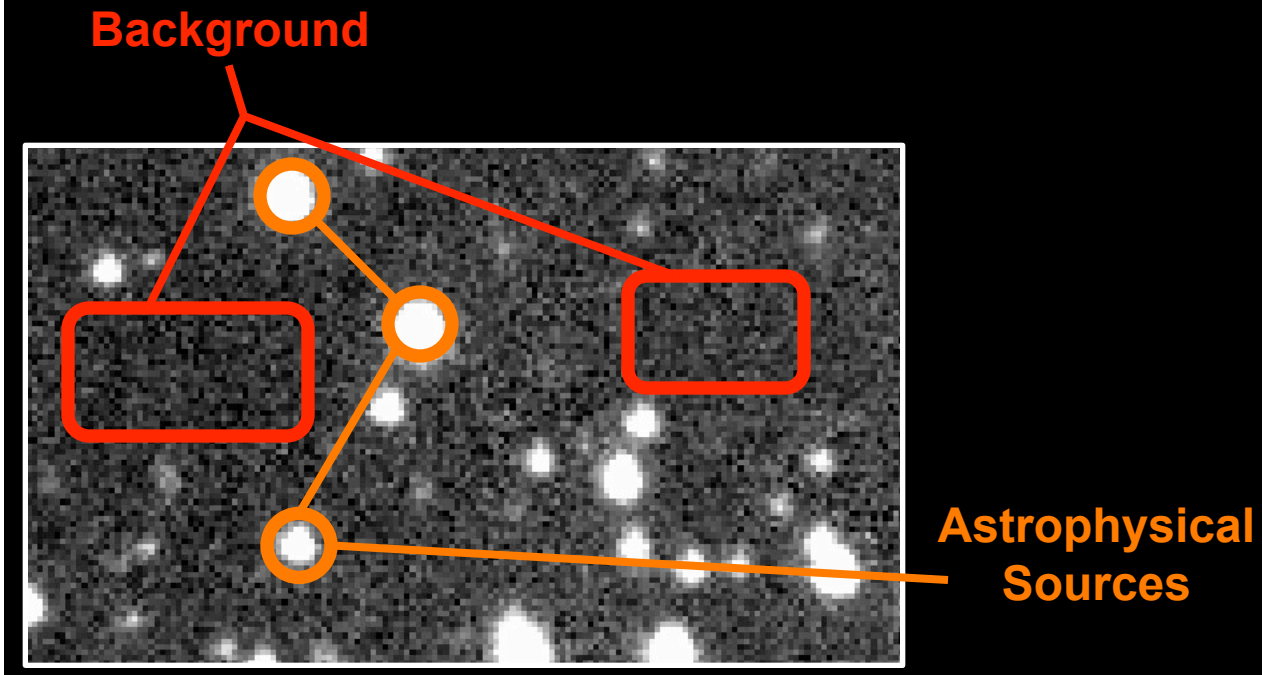

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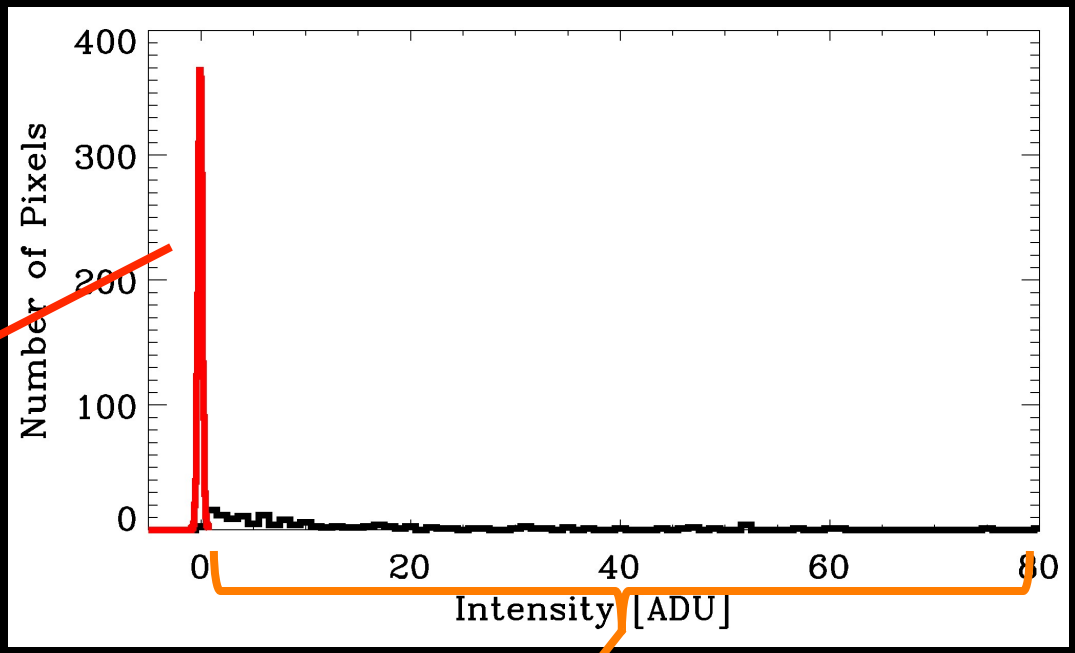

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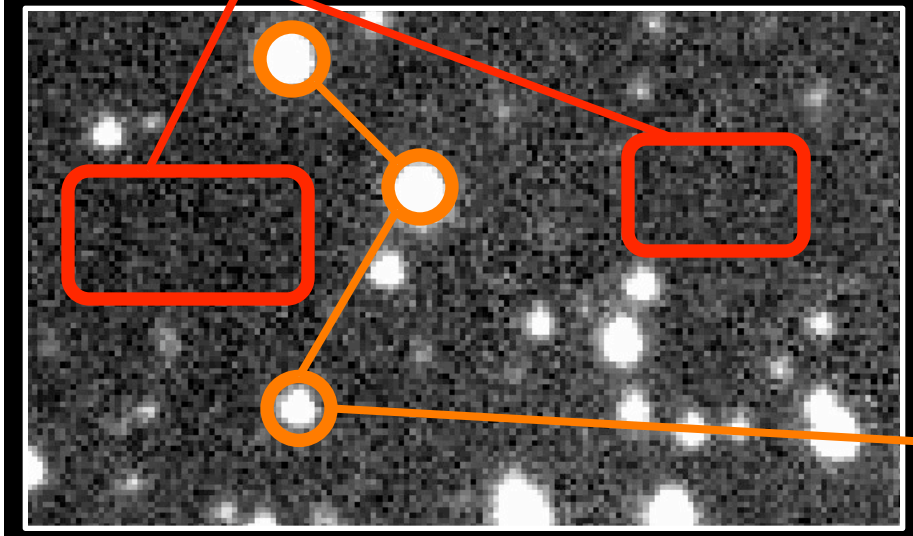


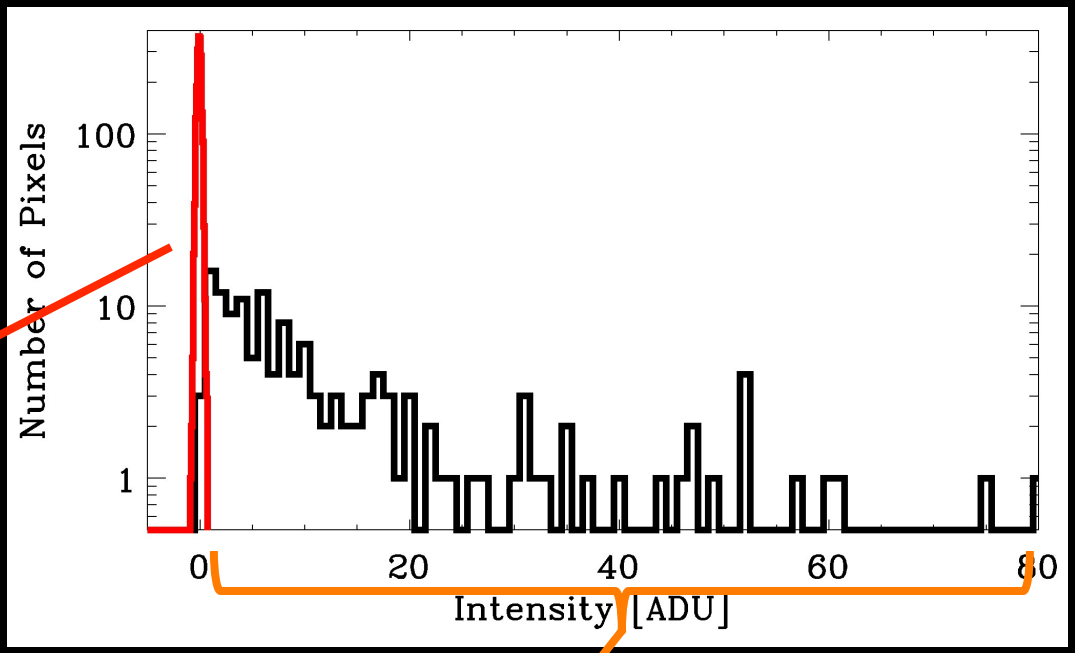
Astrophysical Sources

Sources of Detected Signal

Background ~ 0 ADU since these are REDUCED (not RAW) images.

REDUCED images have had the background level subtracted.

The RAW images have backgrounds of ~1000 ADU, significantly greater than the astrophysical sources identified below.



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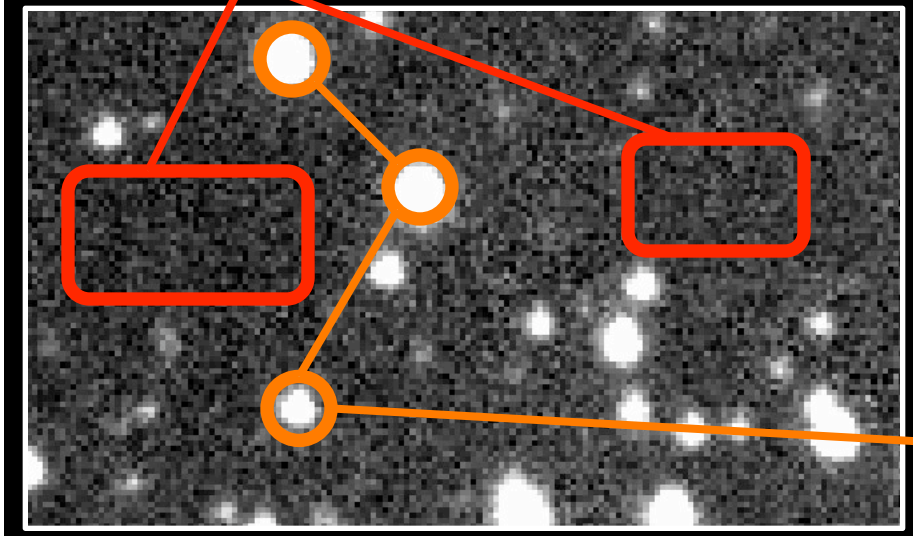

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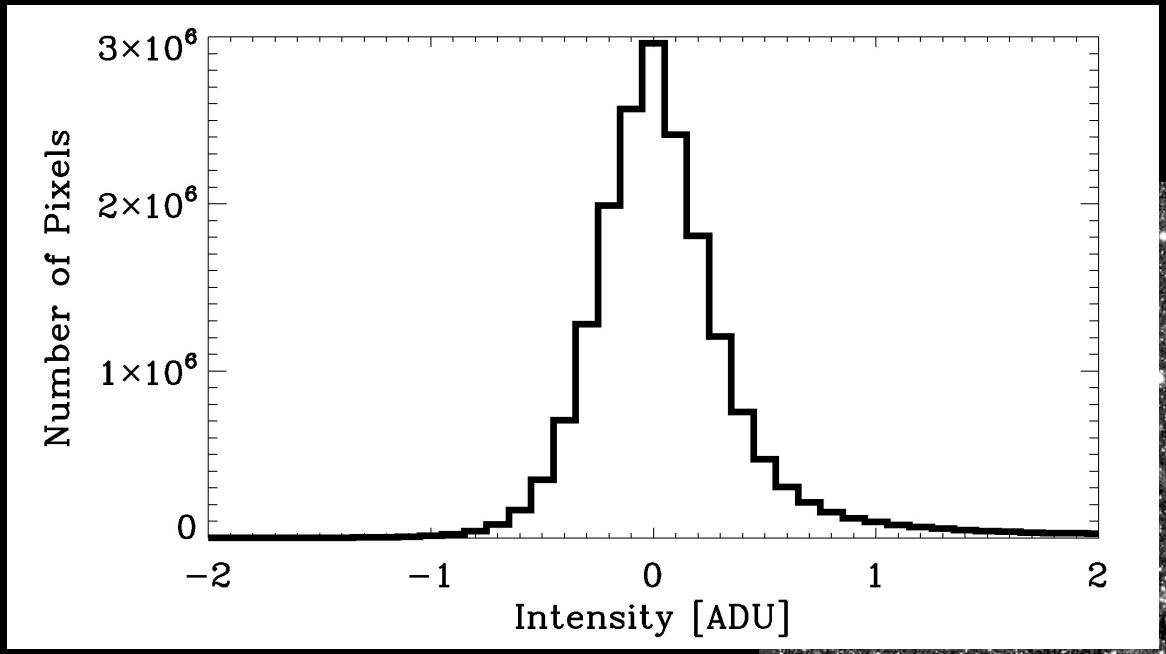

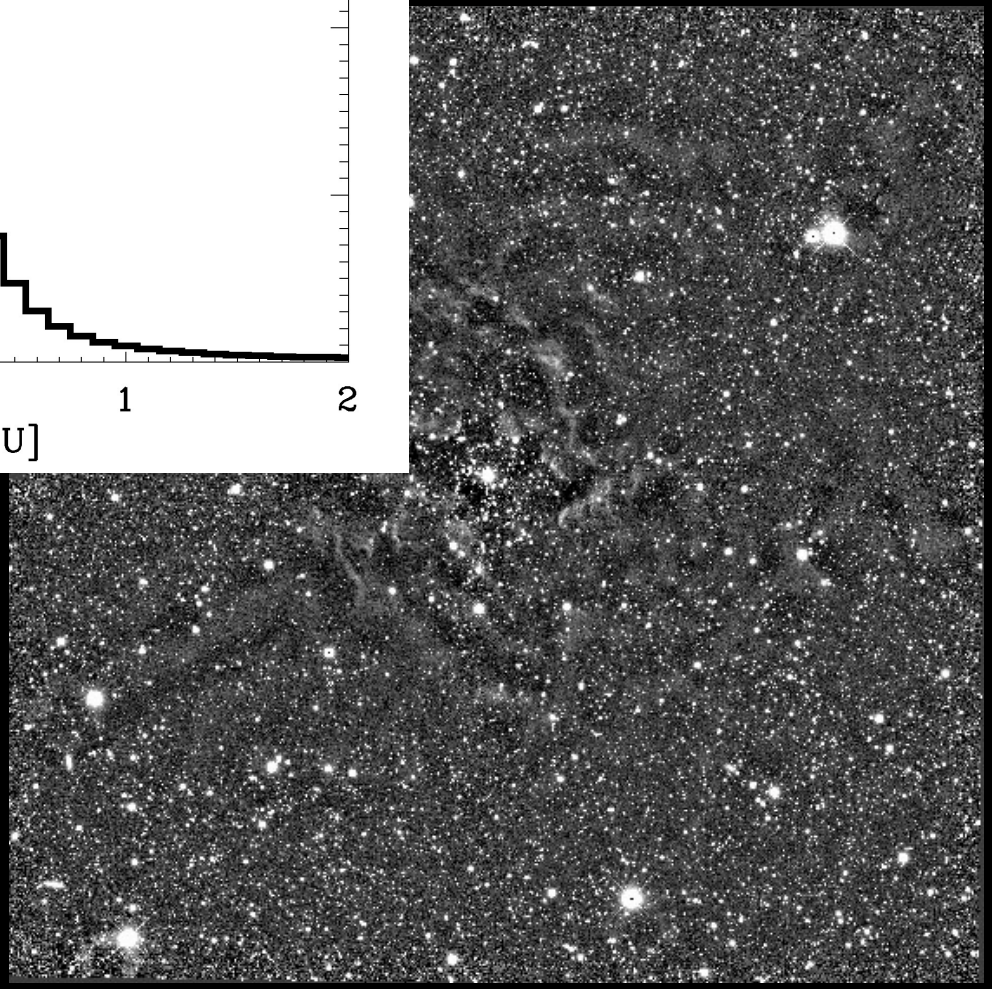

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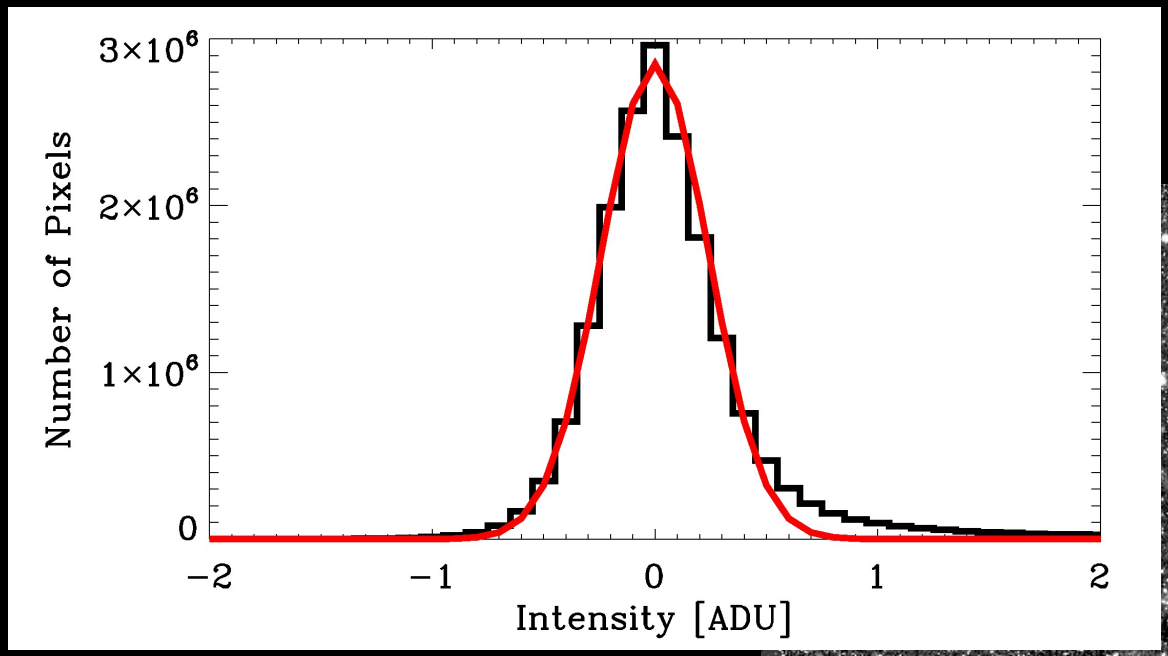

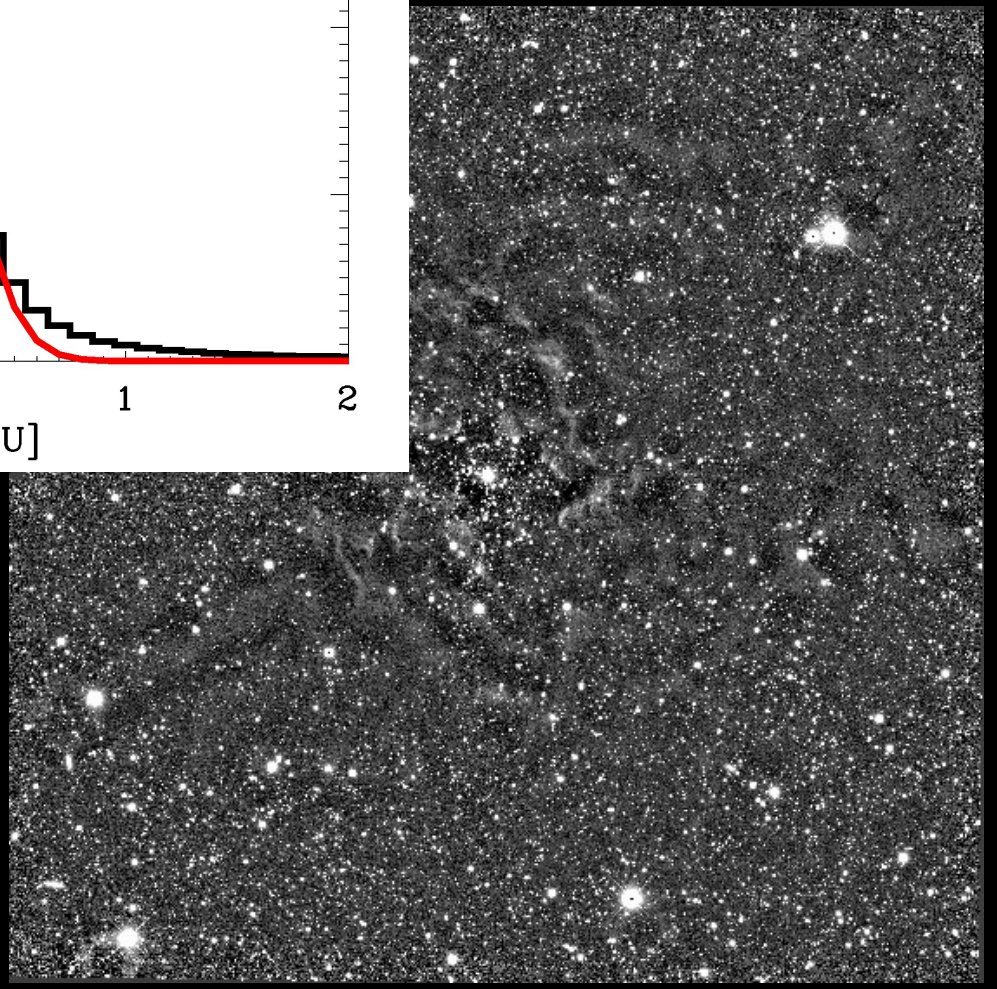

Gaussian

$$N = N_{peak}\, e^{-\frac{1}{2}\left[\frac{x - x_0}{\sigma}\right]^2}$$

$$\sigma = \frac{FWHM}{2\sqrt{2 \ln 2}}$$

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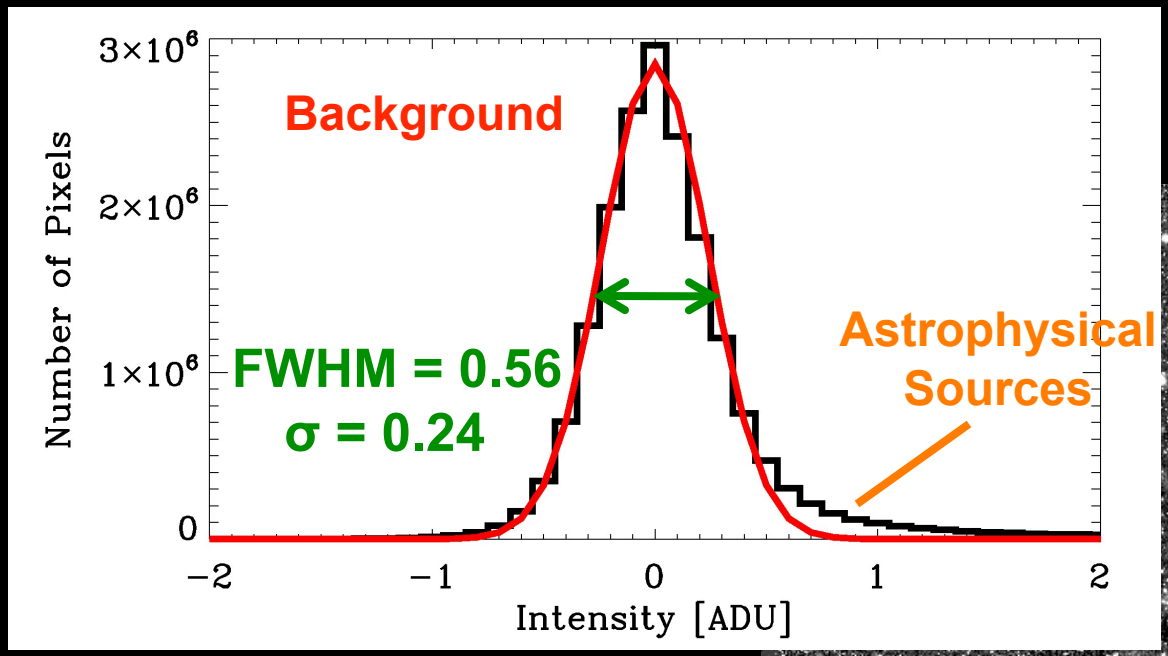

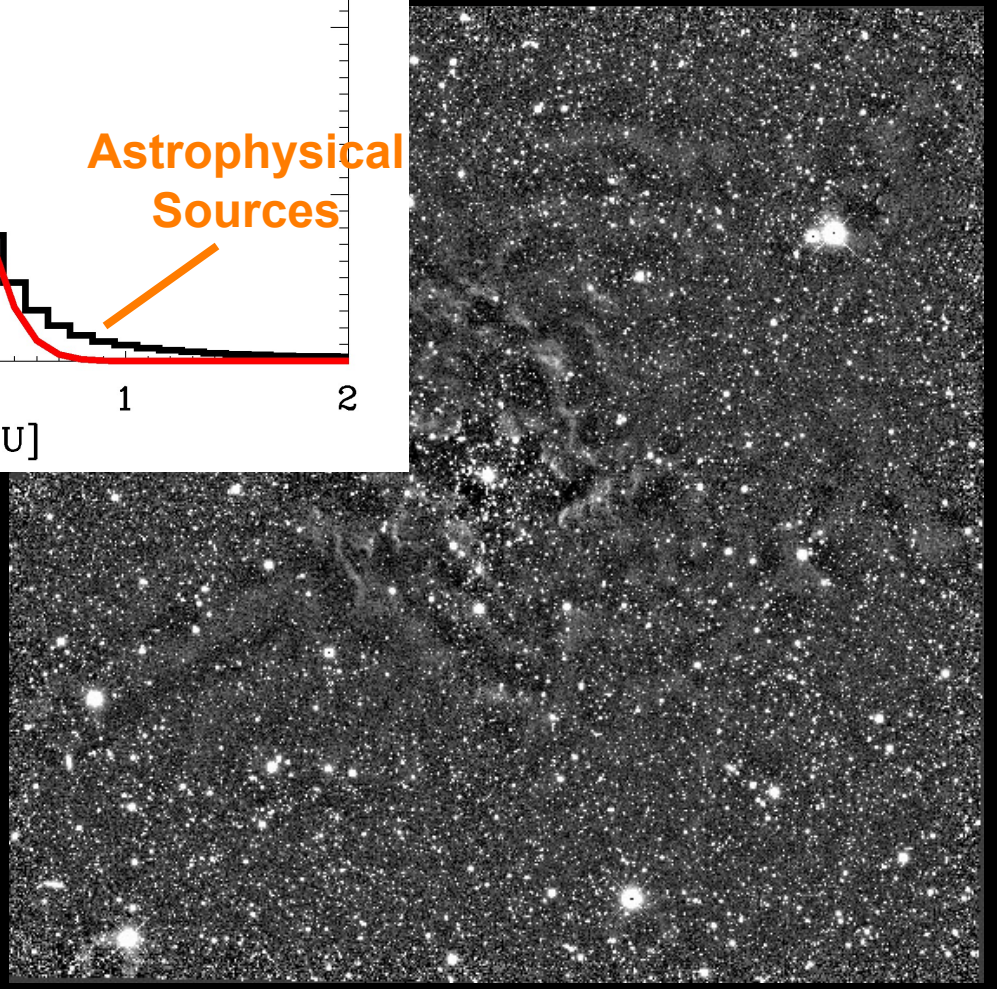

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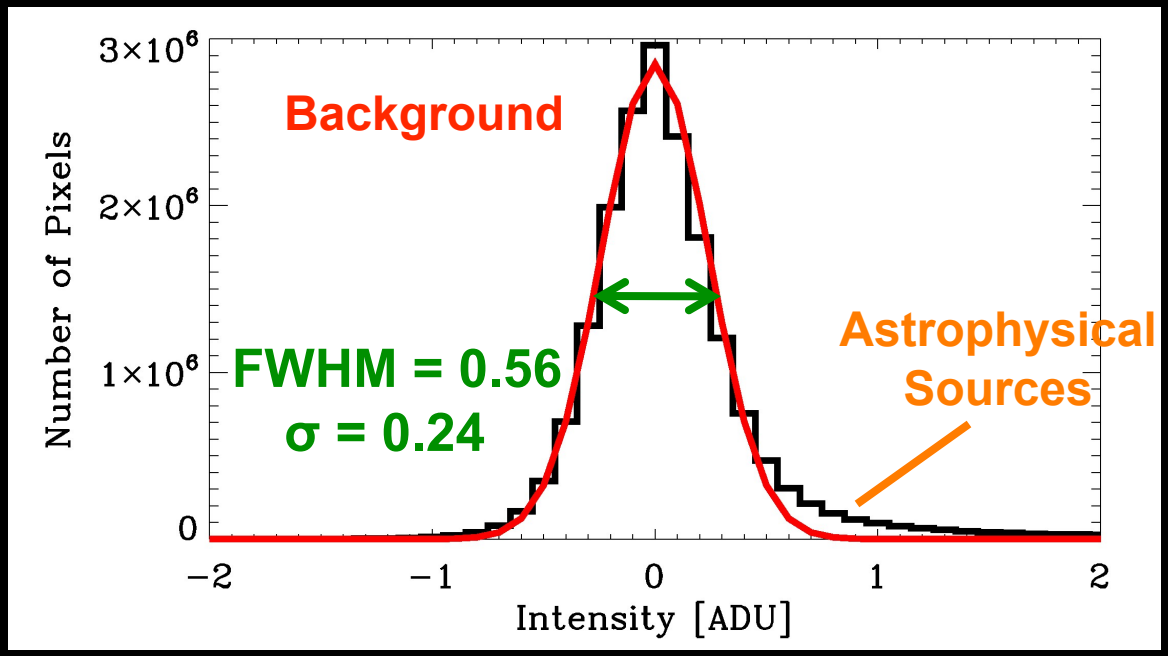

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What is the "TYPICAL" background level?

MEAN intensity = 0.88 ADU

MEDIAN intensity = 0.02 ADU

MODE intensity = 0.00 ADU

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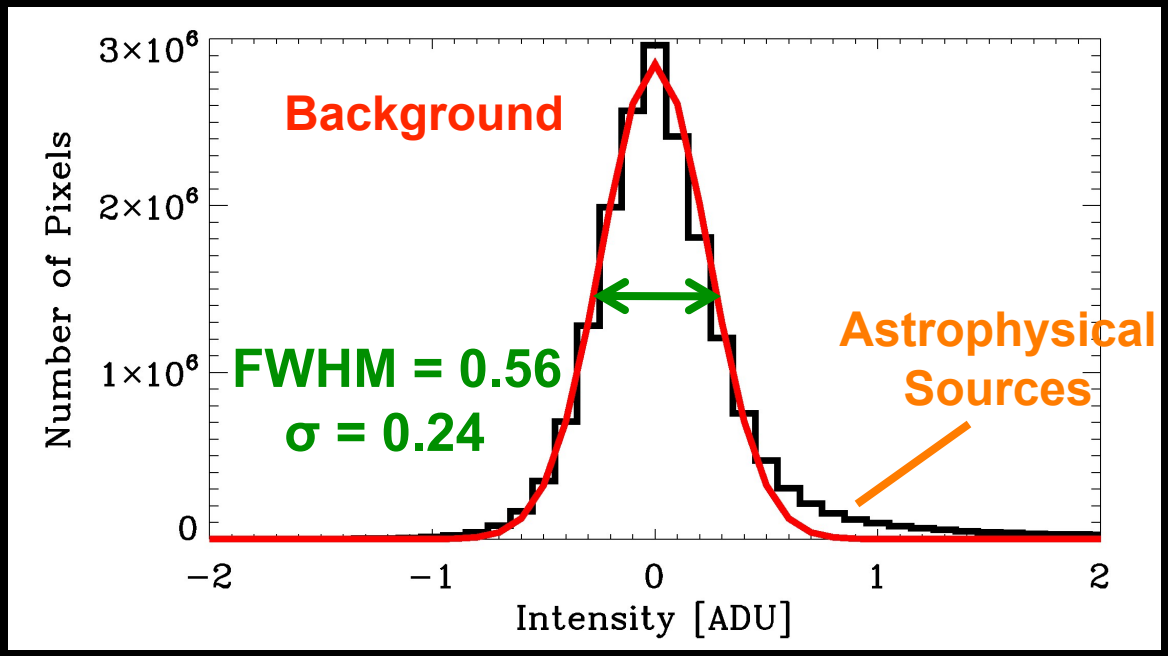

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What is meant by “TYPICAL”?

What is the typical weight of the pets in the neighborhood?

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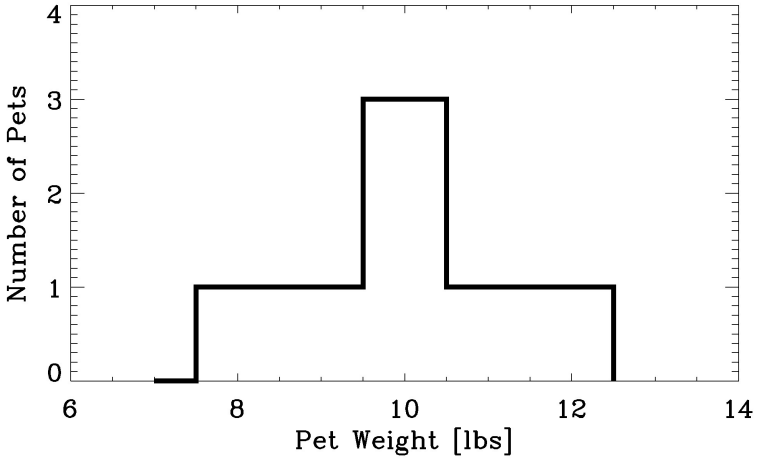
MEAN = 9.9 lbs

MEDIAN = 10.0 lbs

MODE = 10.0 lbs



Buz
11 lbs

Dizzy
9 lbs

Tiger
10 lbs

Lanky
8 lbs

Dash
10 lbs

Fido
12 lbs

Teddy
10 lbs

What is meant by “TYPICAL”?

What is the typical weight of the pets in the neighborhood?

MEAN = ~~9.0 lbs~~ 1008.6 lbs

MEDIAN = 10.0 lbs

MODE = 10.0 lbs

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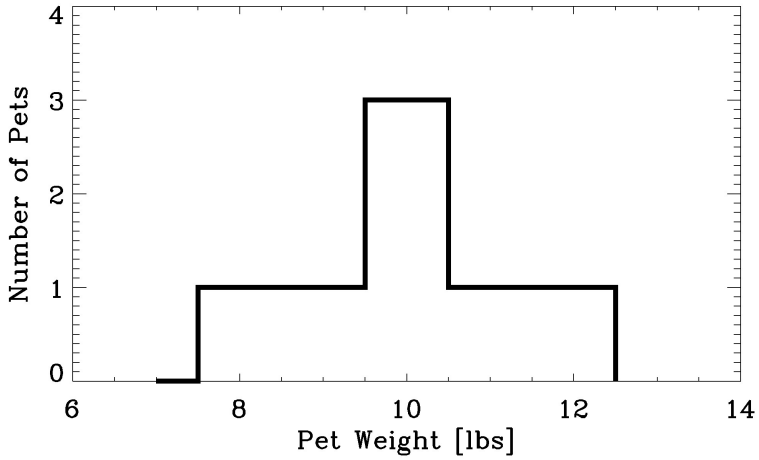
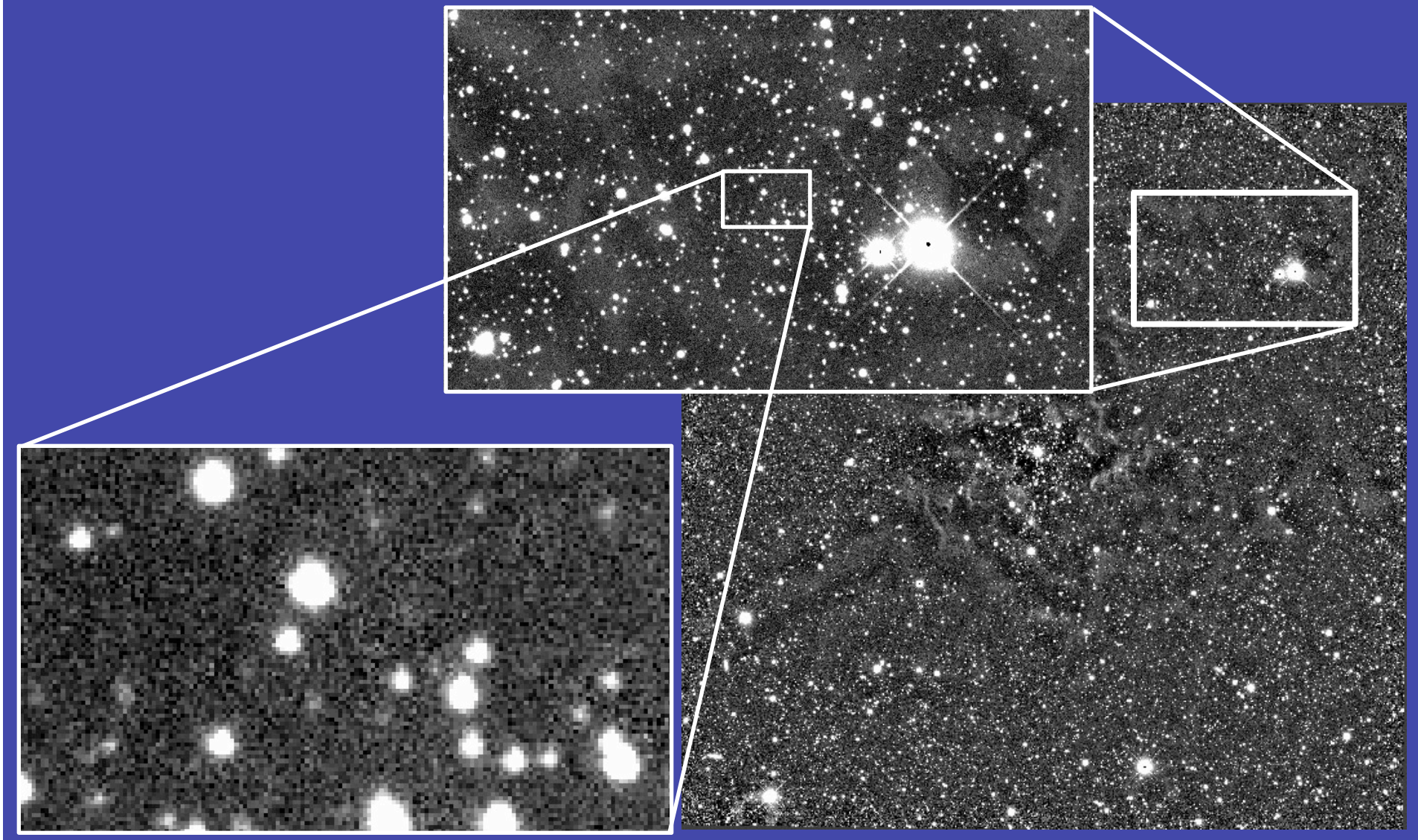


Elsa
8000 lbs

Source Detection

Identification of a real signal from an astrophysical source



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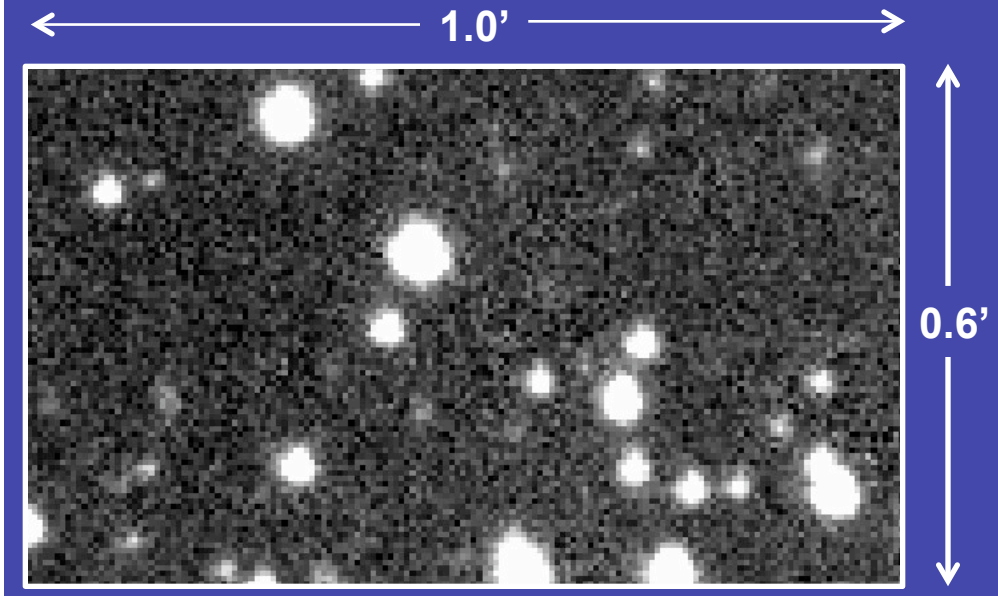

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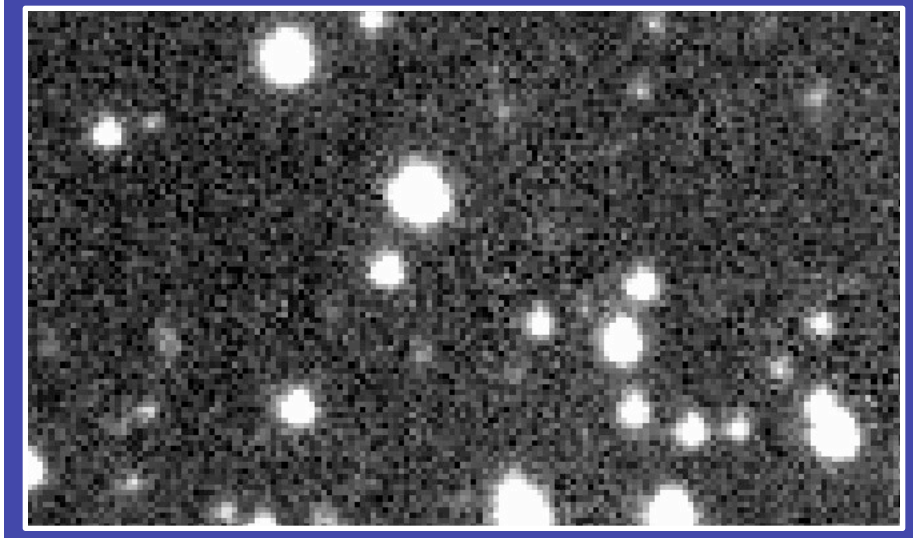
By eye, 31-36 sources in 1.0’ x 0.6’

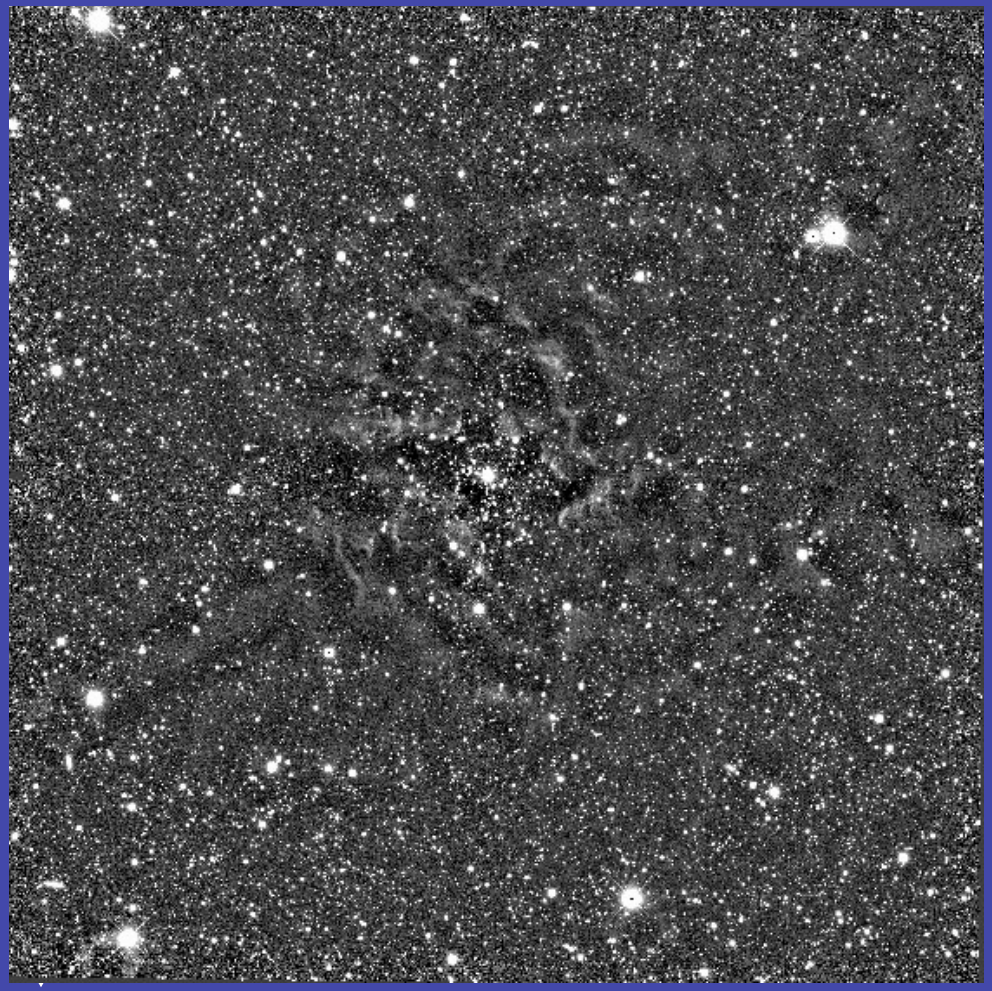


Source Detection

Identification of a real signal from an astrophysical source

ANY VOLUNTEERS ?!

Suggests ~43-50k sources in 28.8’ x 28.8’ !



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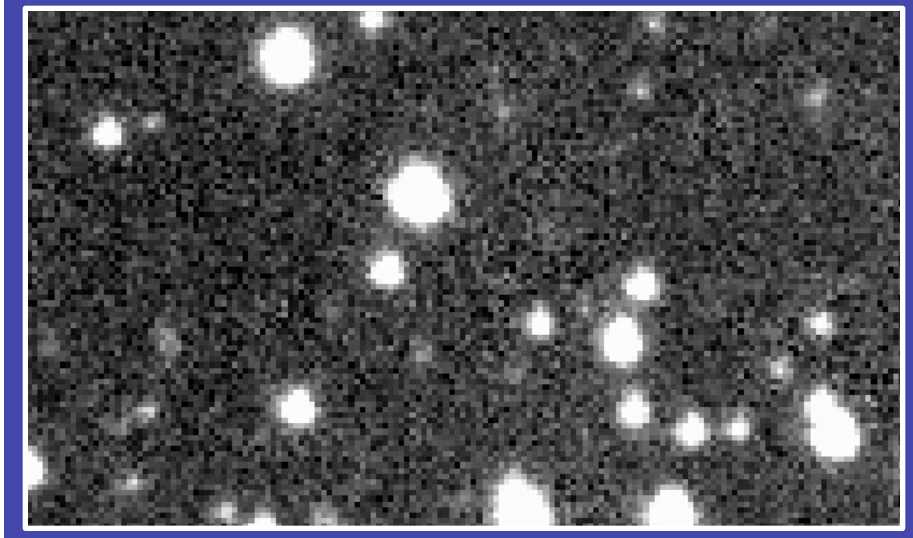

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ANY VOLUNTEERS ?!

Clearly, we need an automated source detection method.

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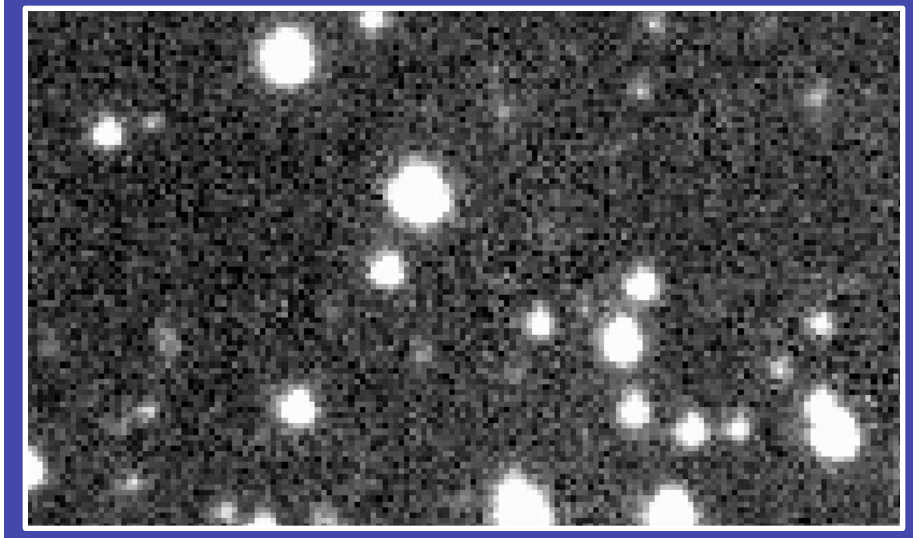

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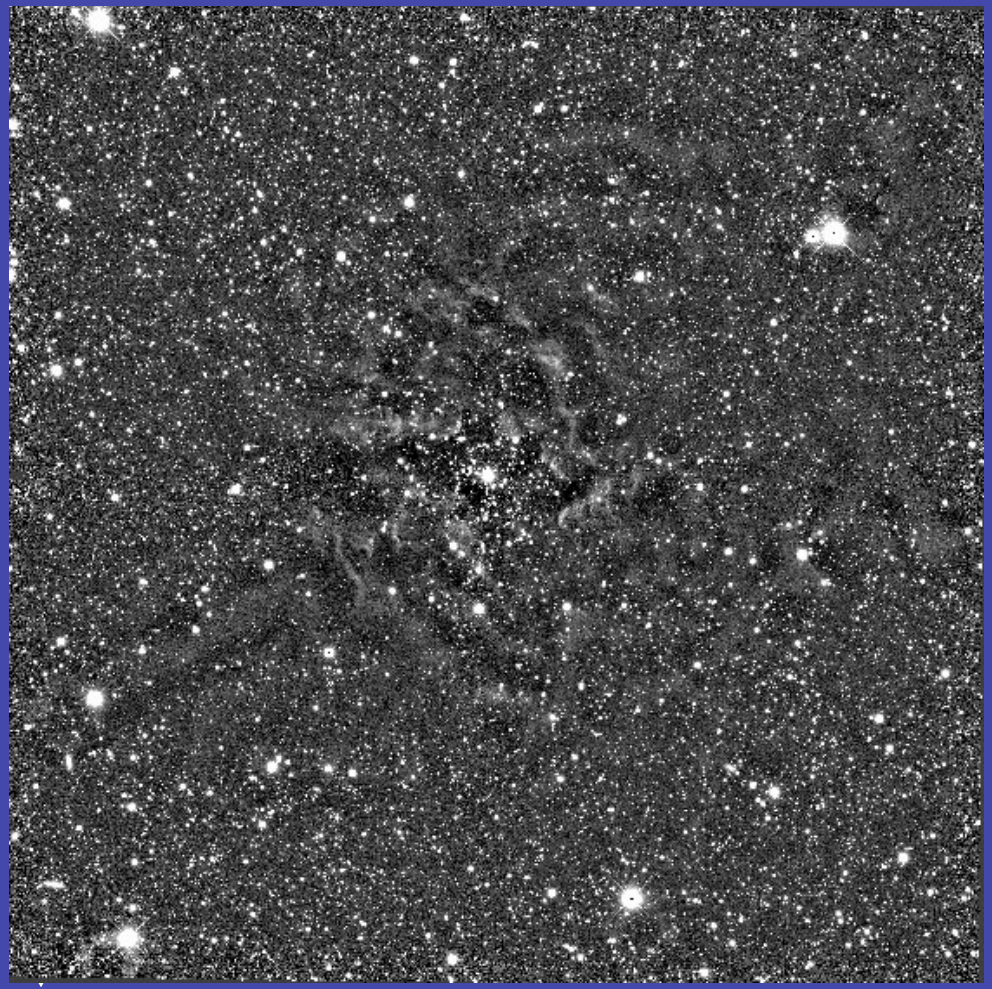

Source Detection

Identification of a real signal from an astrophysical source

Automated source detection procedures:

IRAF *daofind*

IDL *daofind*

SExtractor