

Unveiling Hidden Gamma-Ray Sources: Discoveries with SEMIFIC III on Fermi- LAT Data



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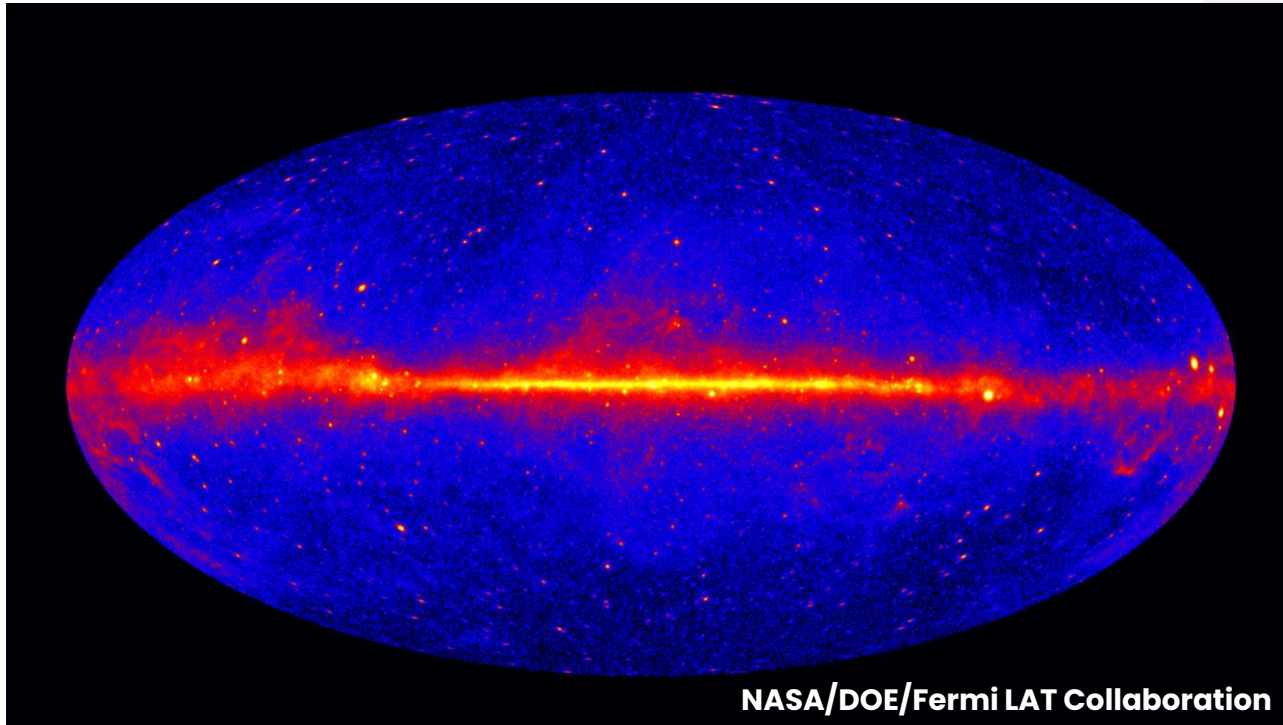
Let's Talk About New Findings!



INTRODUCTION

What is Gamma-Ray Astronomy?

- **Gamma rays have energies exceeding 100 keV.**



Fermi-LAT

Onboard the Fermi satellite

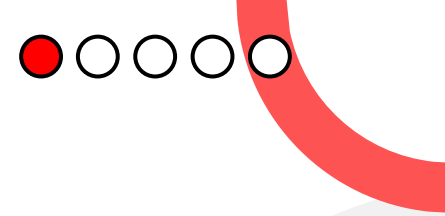
Energy sensitivity \rightarrow 20 MeV to over >300 GeV

Events record accuracy $\rightarrow < 1\mu\text{s}$.

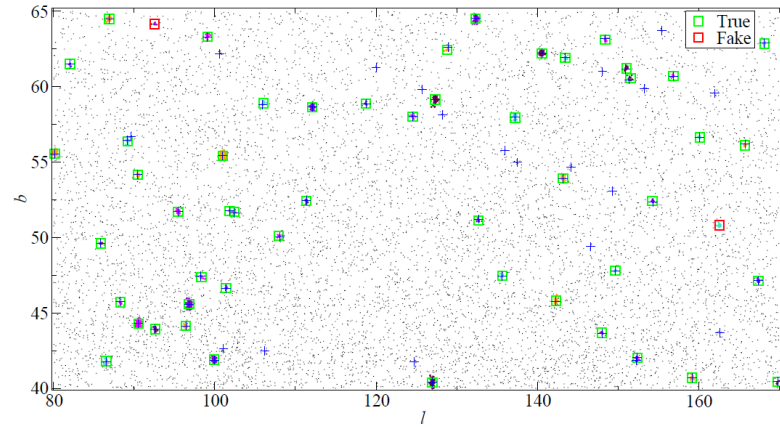
Entire sky covering \rightarrow every 3 hours.

Field of view \rightarrow 2.4 sr

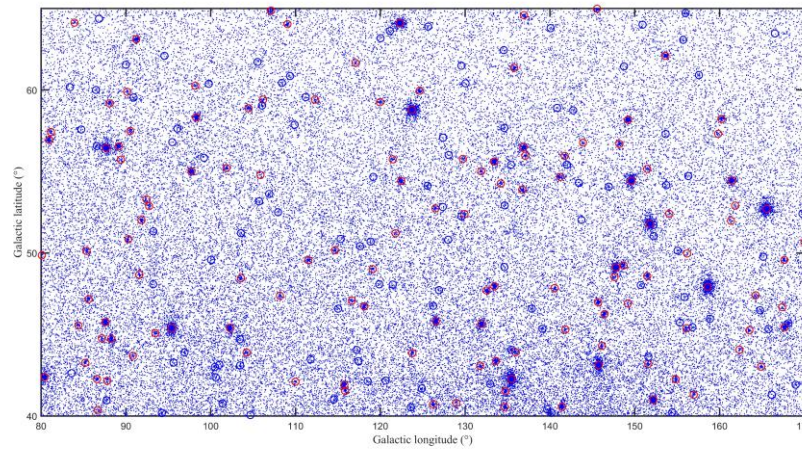




What is the PROBLEM?



A. Tramacere et al (2013).



LAT Data Server (2023).



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Fermi-LAT Data Selection

Fermi-LAT dataset:

Downloaded from the FSSC archive

Events include:

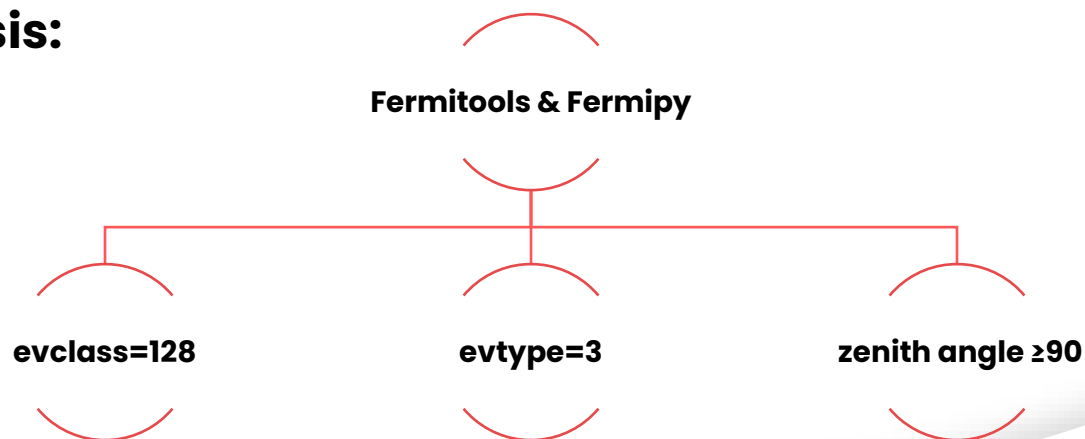
Photons $\rightarrow E_\gamma > 3 \text{ GeV}$ (why?) (Soor et al 2023)

15 years of data from 4 August 2008 to 4 August 2023

$0 < l < 360$

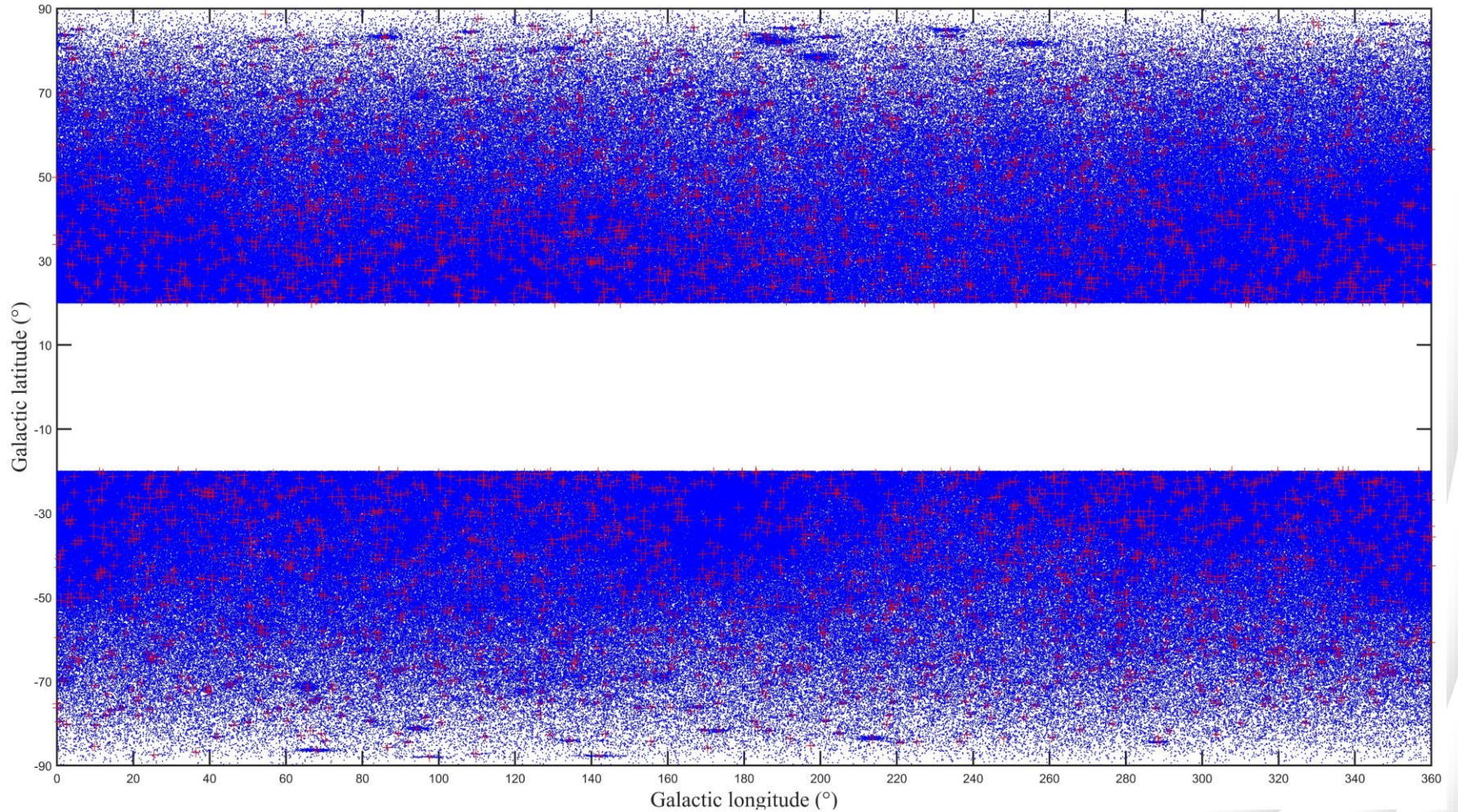
$|b| > 20$

Analysis:

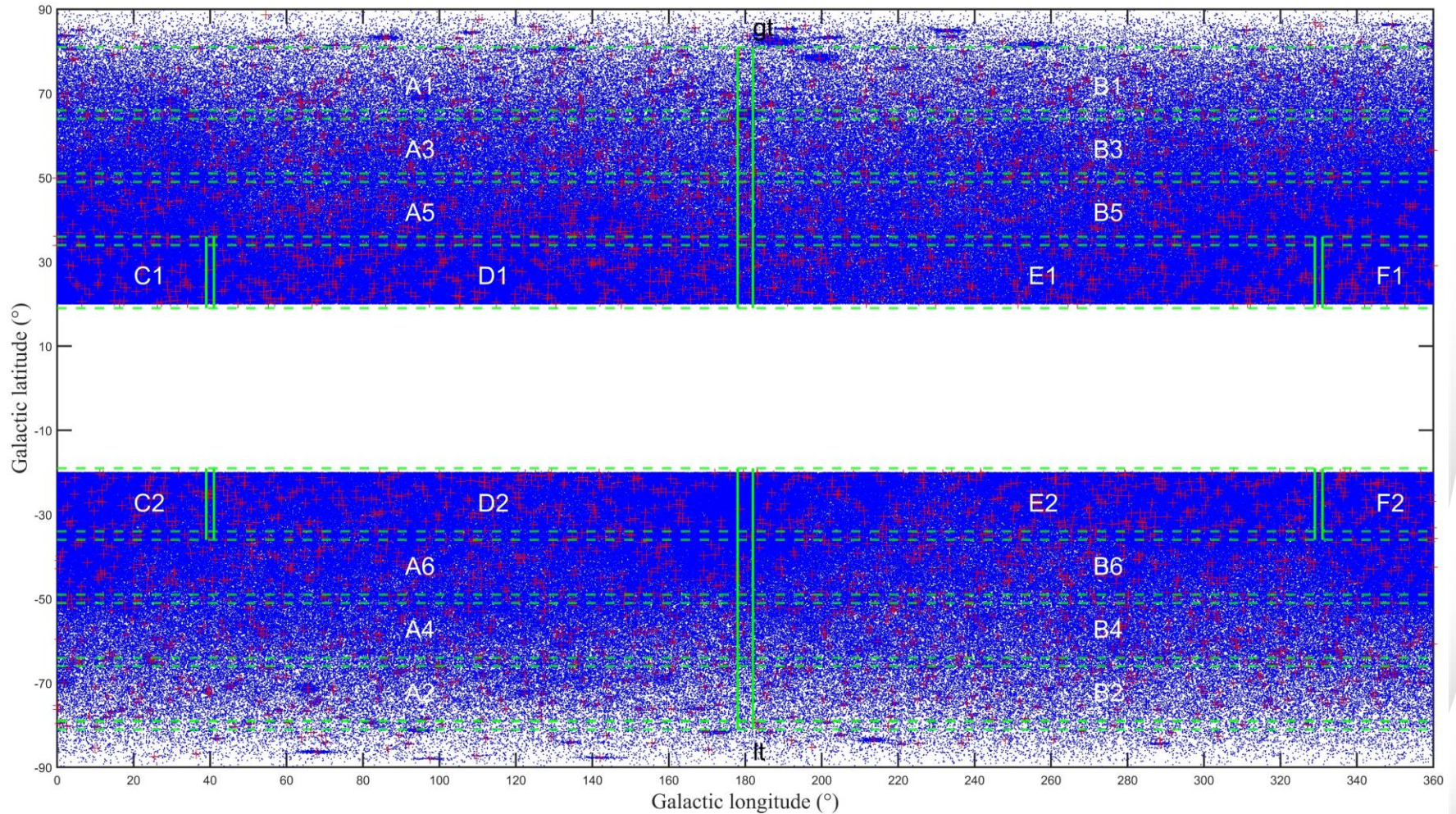




Scatter plot: 2M photons & 3936 sources



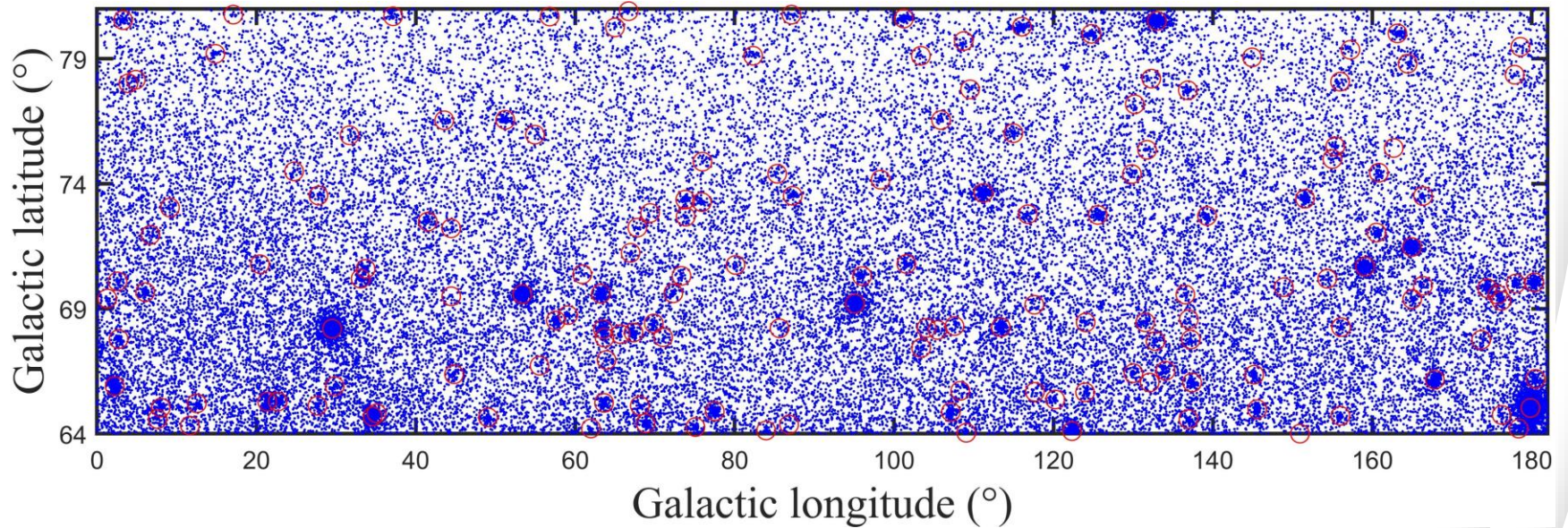
Let's cut the field to explore!



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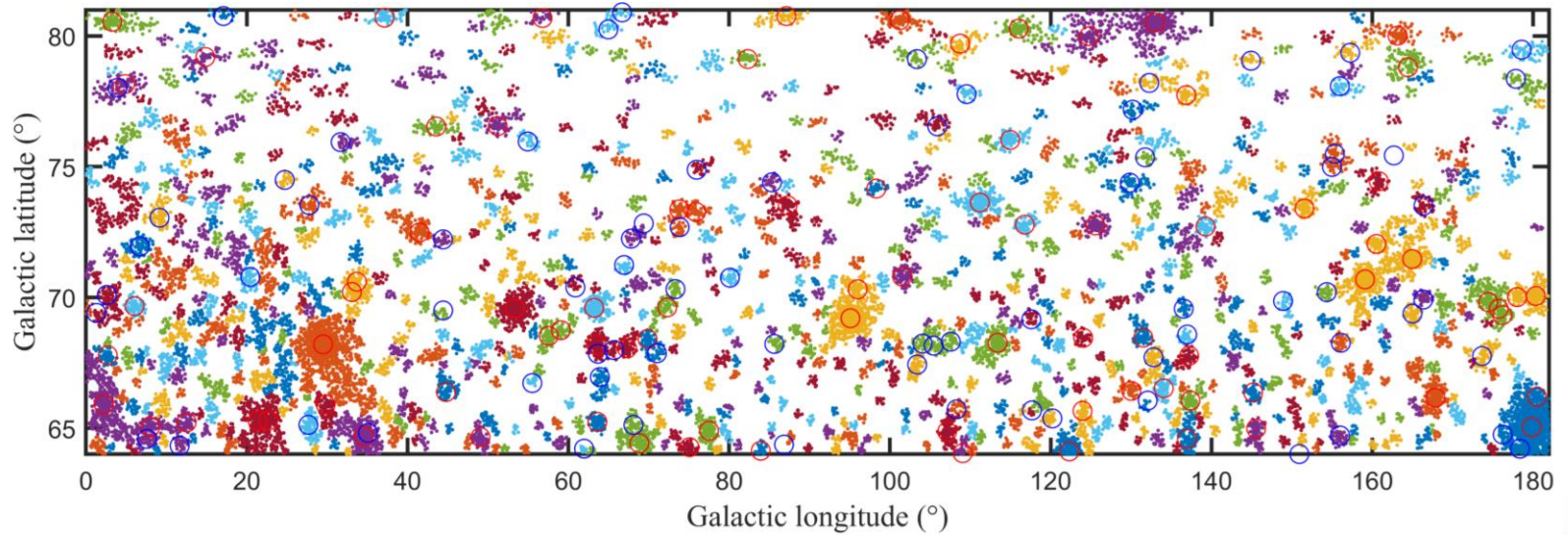
Data Denoising

Let's consider a scenario where we choose from one of the 22 fields.



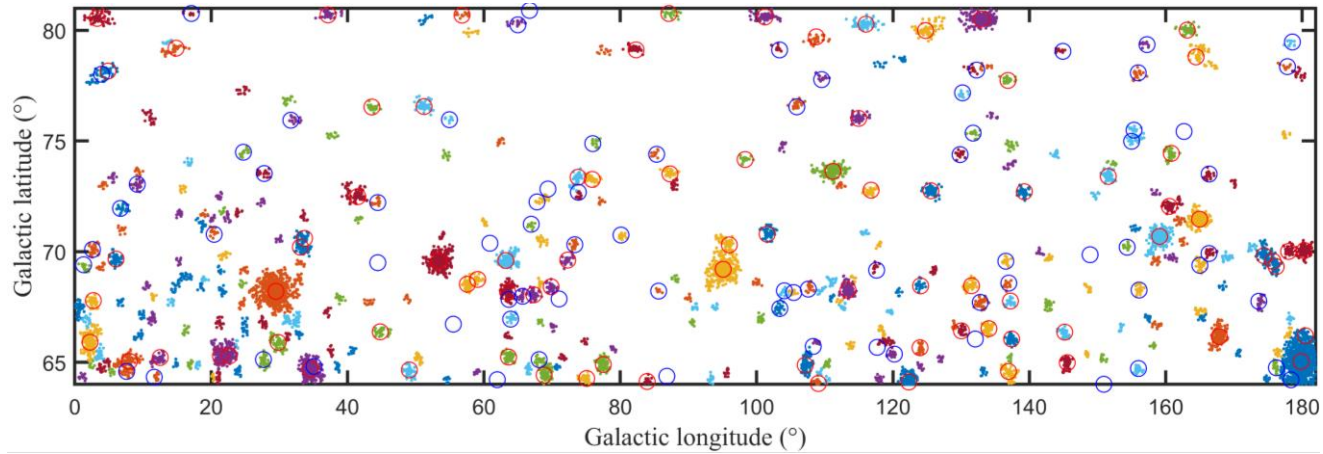


DBSCAN before denoising

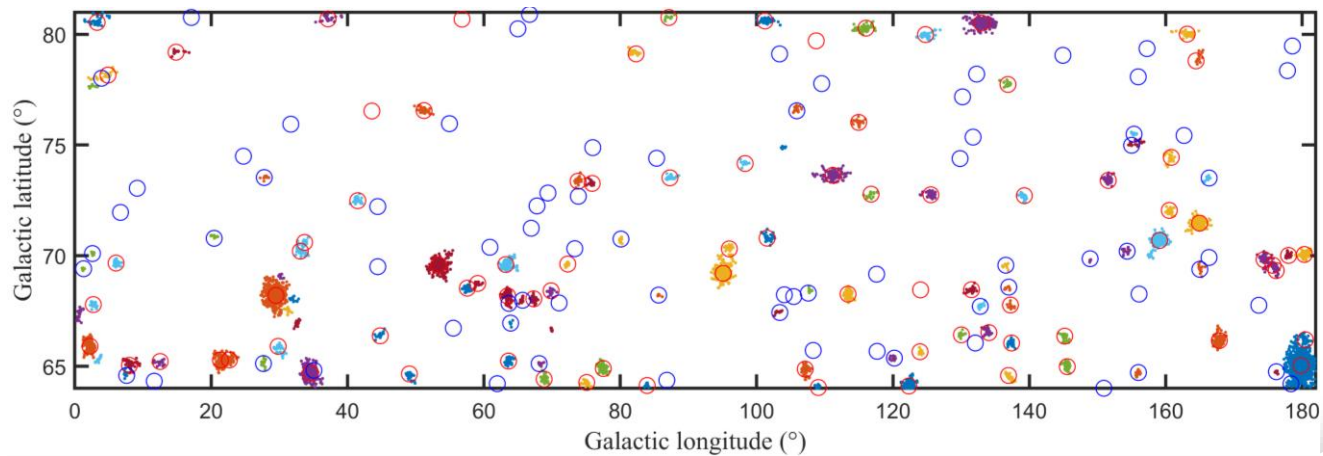




DBSCAN after denoising



Apply DBSCAN on the Field With Cut $a > \bar{a}$



Apply DBSCAN on the Field With Cut $a > \bar{a}/2$



4

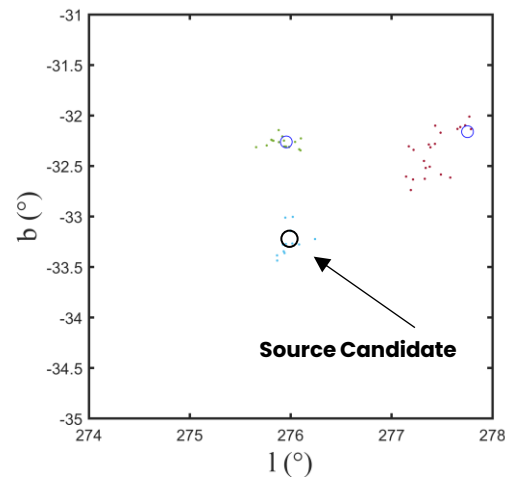
Analysis New Sources



We completed our analysis and removed noise from all 22 fields to discover new sources!

After that, we discovered a total of **16 potential sources!**

Just like this one:



Cluster Sig

$$S = \sqrt{2 \left(N_{\text{on}} \ln \left[\frac{2N_{\text{on}}}{N_{\text{on}} + N_{\text{off}}} \right] + N_{\text{off}} \ln \left[\frac{2N_{\text{off}}}{N_{\text{on}} + N_{\text{off}}} \right] \right)},$$

Li & Ma (1983).

TS (Test Statistic)

$$TS = -2 \ln(L_{\text{max},0} / L_{\text{max},1}),$$

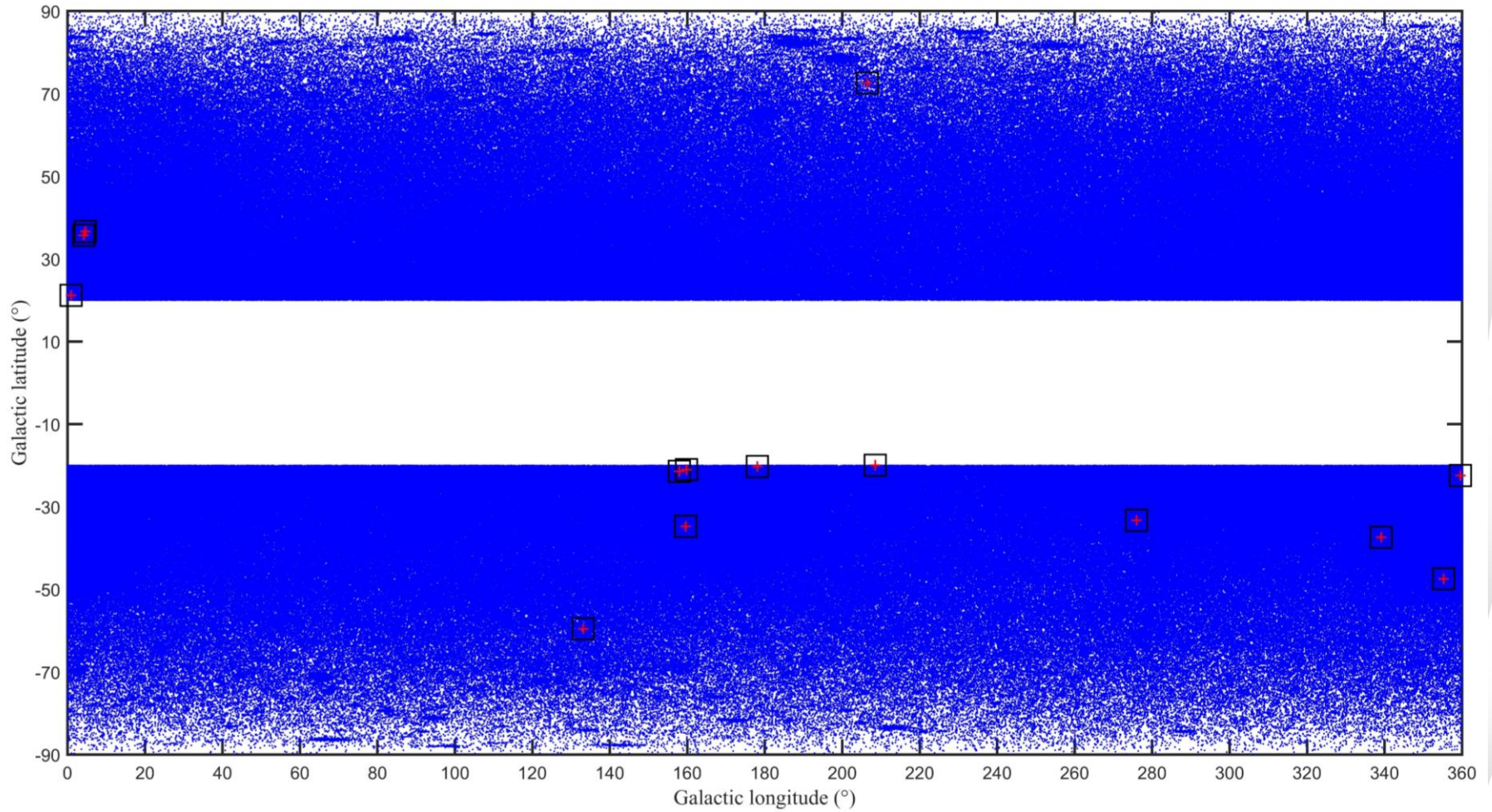
M. Ackermann et al (2013).

&

$$S = \frac{1}{2} \sqrt{TS}$$

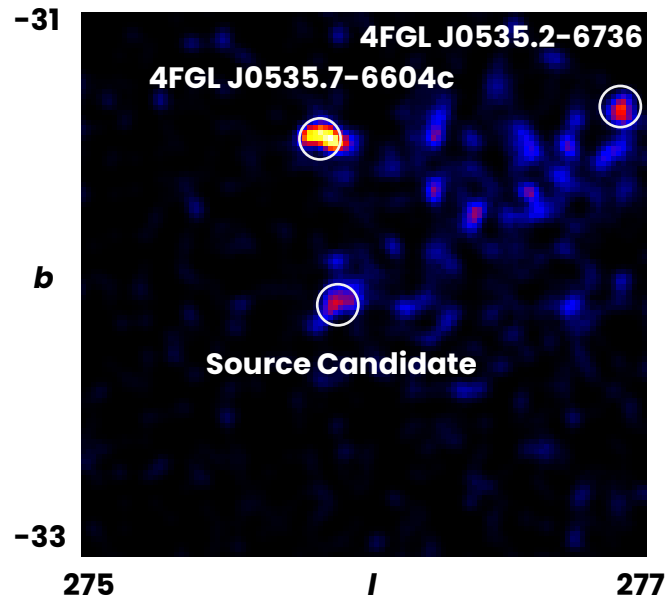
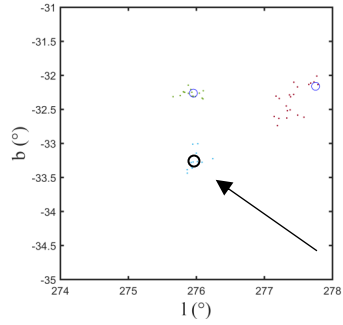
Campana & Massaro (2021).

Potential sources on scatter plot





TS Map



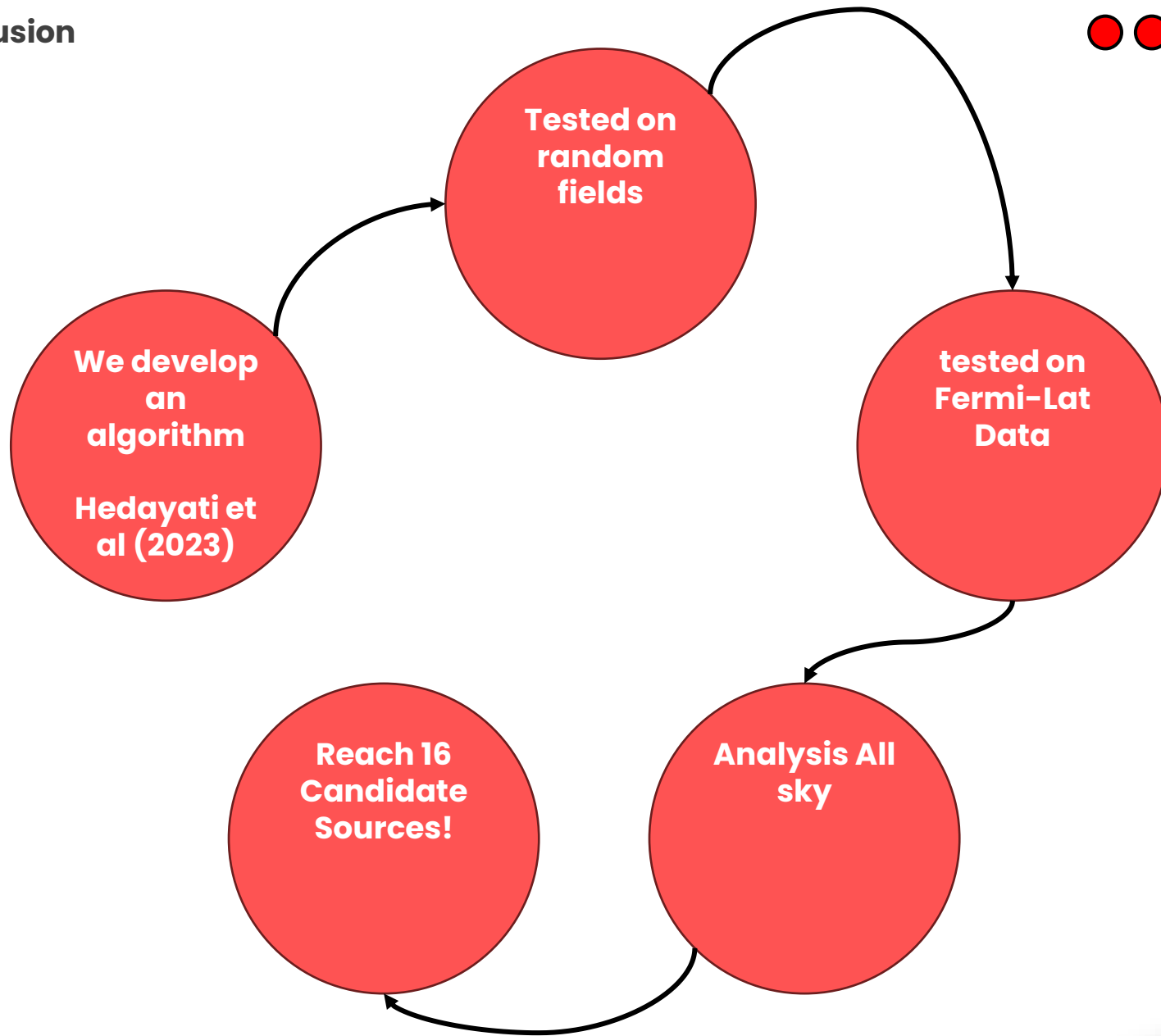
**Table of results**

Name	L	B	N	S	estimate TS
New Source 1	1.877	-66.208	5	2.596	26.957
New Source 2	133.141	-59.541	6	2.834	32.126
New Source 3	206.453	72.582	6	2.703	29.225
New Source 4	4.609	36.609	6	2.813	31.652
New Source 5	4.168	35.727	7	3.014	36.337
New Source 6	159.576	-34.746	7	3.017	36.409
New Source 7	355.246	-47.482	5	2.566	26.337
New Source 8	339.129	-37.404	5	2.592	26.874
New Source 9	0.944	21.174	5	2.717	29.528
New Source 10	178.076	-20.262	5	2.556	26.133
New Source 11	159.812	-21.028	7	2.964	35.141
New Source 12	157.951	-21.429	7	2.991	35.784
New Source 13	159.567	-34.740	5	2.589	26.812
New Source 14	208.502	-19.971	5	2.790	31.136
New Source 15	275.982	-33.250	9	3.412	46.567
New Source 16	359.550	-22.442	5	2.605	27.144



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Conclusion



Thanks!

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