The Galactic Center as seen by AGILE: data analysis

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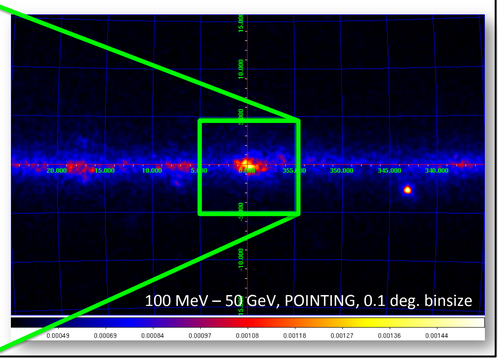
ABSTRACT

The AGILE observation of the Galactic Center region, defined here as a 10 degrees wide region centered in (l, b) = (0, 0) is analyzed in order to disentangle and characterize the many sources present, including the central Super Massive Black Hole (SMBH) SgrA*. Counts, exposure, intensity and gas maps are created for the two AGILE observing modes, POINTING (from July 2007 to October 2009) and SPINNING (from January 4th, 2010 onward), using the latest refined diffuse galactic emission simulation for the gas map. Two energy ranges are analyzed: 100 MeV – 50 GeV and 400 MeV – 50 GeV. A list of sources, with minimum significance threshold of TS square root higher than 3, is produced. Two extremely bright sources are found in the very central region in the full 100 MeV – 50 GeV energy range, and none of them is placed in the SgrA* position, while a map extraction above 400 MeV only shows one source in SgrA* position. A possible low energy flare could be the cause of this discrepancy. The resulting list of AGILE sources is then compared to the catalogs of the Fermi, INTEGRAL, and Swift/BAT telescopes.

Gamma-rays from our big neighbour: the Galactic Center

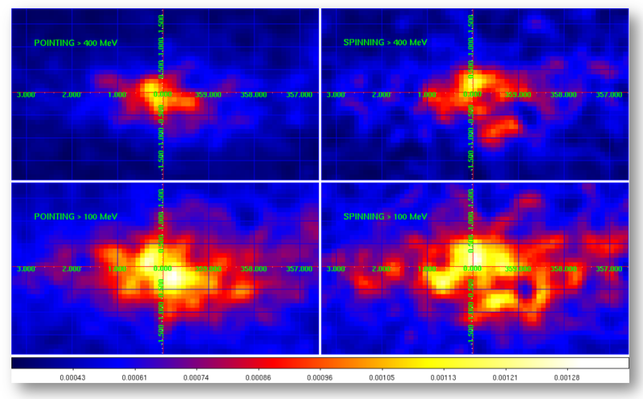
The AGILE [1] observation of the Galactic Center (GC) region, defined here as a 10 degrees wide region centered in (l,b) = (0,0), is analyzed in order to disentangle and characterize the many sources present, including the central Super Massive Black Hole (SMBH) SgrA* [2,3].



Map building

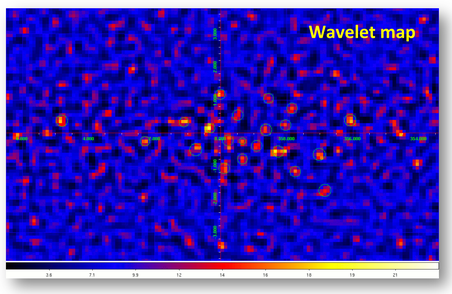
Two AGILE observing modes:
POINTING (from July 2007 to October 2009) and SPINNING (from January 4, 2010 onward):

	POINTING	SPINNING
Binsize	0.1 deg.	0.1 deg.
Filter	FM3.119_ASDCe_I0023	FM3.119_ASDCSTDf_I0023
Start time (TT)	111412800.0	184075134.0
Stop time (TT)	182692800.0	268142400.0
Mapsize	50 deg.	50 deg.
Fovravmax	60 deg,	60 deg.
Phasecode	2	2



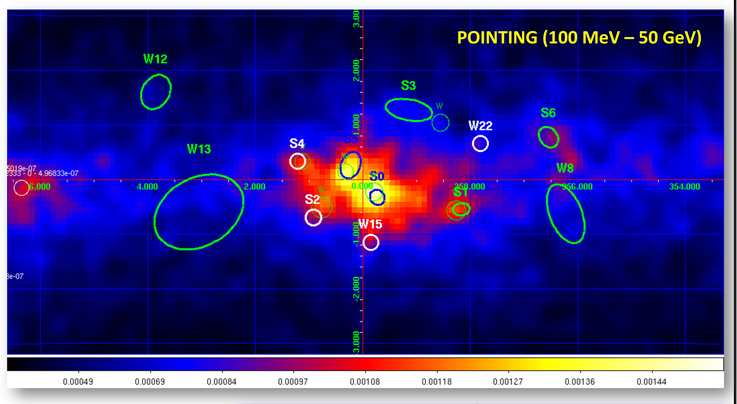
POINTING

The analysis starts from a list of source positions (the seeds) based on the intensity map (S label) and the wavelet map (W label). The sources position and flux (a power law with photon index 2.1 is assumed) are then analyzed using the likelihood ratio test $(\sqrt{T_s} > 3)$.



100 MeV – 50 GeV

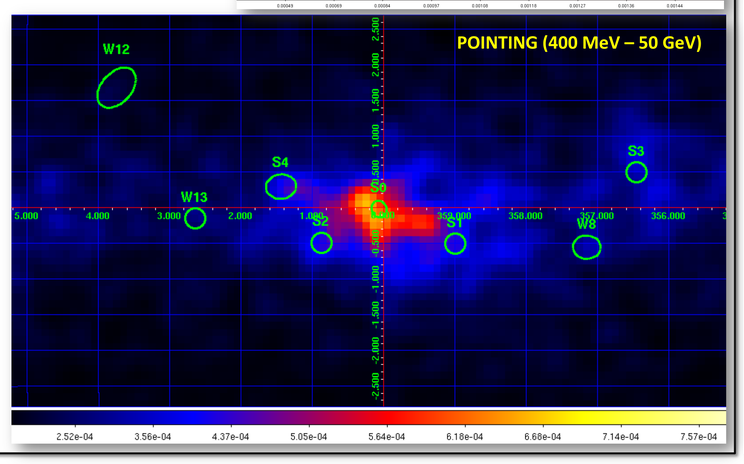
- 12 sources
- We find two extremely bright sources in the very central region (S0 and S5) and none of them is placed in the SgrA* position, which is (l,b) = (359.94, -0.05).



Below 400 MeV the central SgrA* is obscured by a source in the right/bottom position.Two are the hypothesis:
- S0 is a bright, transient flare at E < 400 MeV
- S0 is a regular source at E < 400

400 MeV – 50 GeV

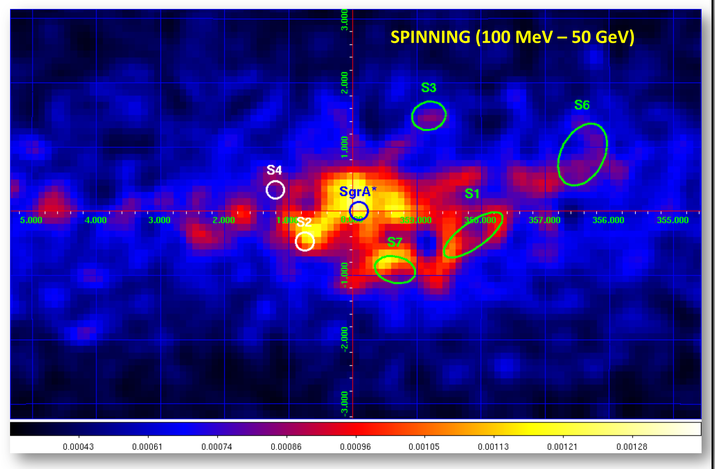
- 8 sources
- Only S0 is found in the map center, close to the actual SgrA* position



SPINNING

In SPINNING mode, only the full 100 MeV – 50 GeV energy range is analyzed.

- 7 sources are found
- the S0 source disappears, and only a central source very close to the SgrA* position is found. **This result is consistent with S0 being a bright flare visible below 400 MeV.**

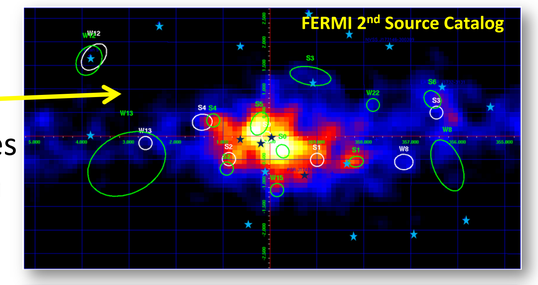


AGILE source list and comparison with Fermi, INTEGRAL, and Swift

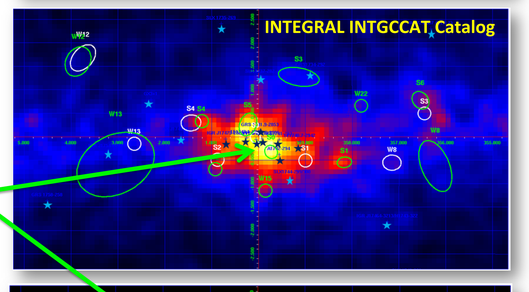
POINTING (100 MeV – 50 GeV):

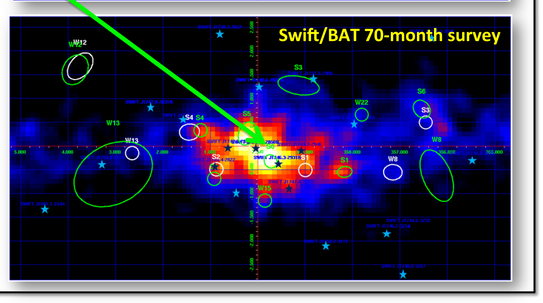
1. **S0** (359.735, -0.315952): sqrt(TS) = 10.6957
2. **S1** (358.161,-0.55018852): sqrt(TS) = 16.1861
3. **S2** (0.9194302,-0.69583514): sqrt(TS) = 5.96614
4. **S3** (359.1339,1.2720396): sqrt(TS) = 8.65947
5. **S4** (1.2098696,0.3324123): sqrt(TS) = 4.62577
6. **S5** (0.231808, 0.247845): sqrt(TS) = 6.1384
7. **S6** (356.537,0.77185288): sqrt(TS) = 11.6954
8. **W8** (356.22,-0.62937323): sqrt(TS) = 6.91544
9. **W12** (3.90809 1.61745): sqrt(TS) = 6.50634
10. **W13** (2.38464, -0.207449): sqrt(TS) = 5.14992
11. **W15** (359.85, -1.15021): sqrt(TS) = 3.03317
12. **W22** (357.806, 0.659137): sqrt(TS) = 4.62217

The FERMI 2nd source catalog [4] does not confirm the AGILE sources in the very central region



The INTEGRAL and Swift/BAT catalogs present a source close to S0, but a more detailed analysis is needed





Summary and future actions

- In POINTING mode (100 MeV – 50 GeV), a total of 12 sources with sqrt(*Ts*)>3 is found by adding together the position seeds obtained from the intensity map and the wavelet map analysis in POINTING mode;
- Above 400 MeV (POINTING), a total of 8 sources is found and only a central, close to SgrA*, source is present;
- In SPINNING mode (100 MeV – 50 GeV), a total of 7 sources is found with a singular, central source close to SgrA*;
- The hypothesis of a possible flare as the cause of the discrepancy in the very central region could be confirmed by the Swift/BAT source SWIFT J1746.3-2931B found close to S0.
- In order to better reveal the AGILE Galactic Center sources and understand this complex scenario, we plan to analyze the POINTING observation with a binsize of 0.05 deg, selecting three different energy bands: 100 MeV – 400 MeV, 400 MeV – 1 GeV, 1 GeV – 50 GeV.

References

[1] Tavani, M. et al., A&A, 502, 995, 2009
[2] Chernyakova, M. et al., ApJ 726, 60, 2011
[3] Aharonian, F. and Neronov A., ApJ 619, 306, 2005
[4] Nolan, P.L. et al., ApJS, 199, 31, 2012