Is G150.3+4.5 old or one of the closest GeV gamma-ray SNR?

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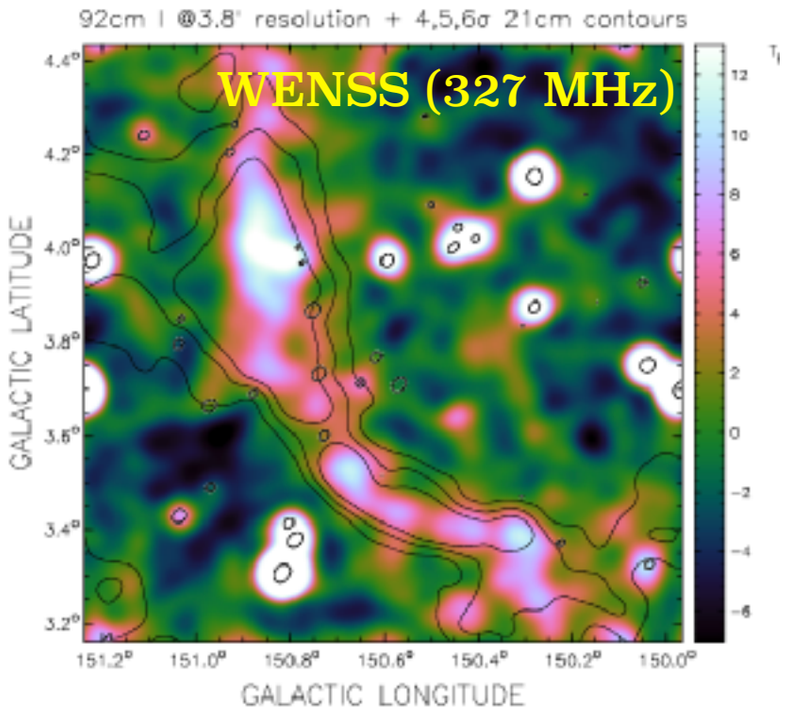
— MODE —
Orléans, 2019

Previous studies

Radio



(Gerbrandt et al. 2014)

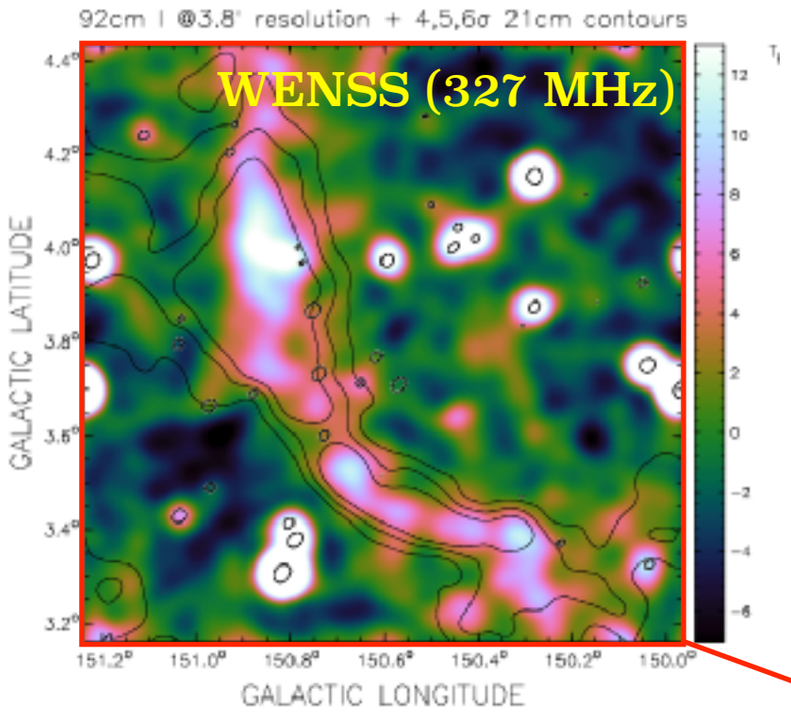
Name: G150.8+3.8 (part of the shell)

Extraction region size: 1.07° x 0.31°

Spectral index: $\alpha = -0.38 \pm 0.10$

Previous studies

Radio



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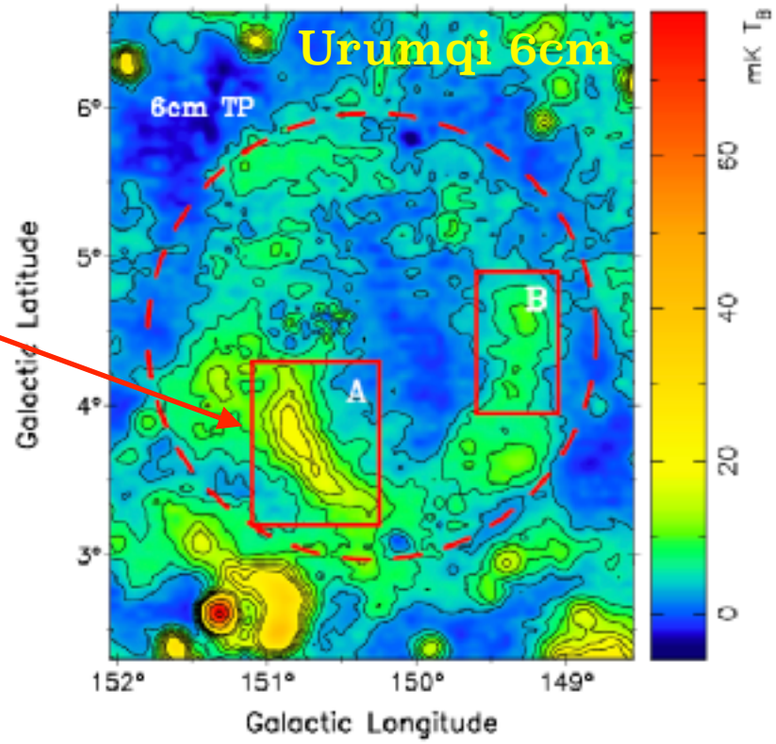
Name: G150.3+4.5

Confirms the non-thermal origin of the emission

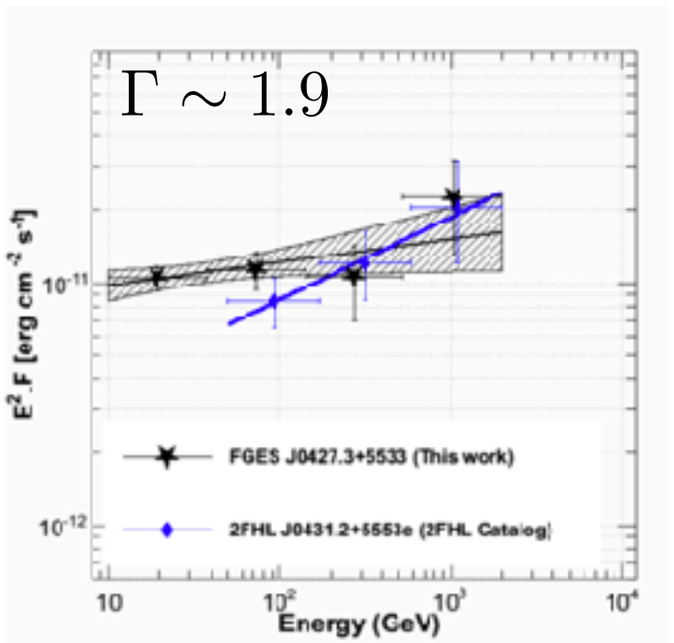
2 bright parts of the shell (D ~ 3°)
=> old or a nearby SNR?

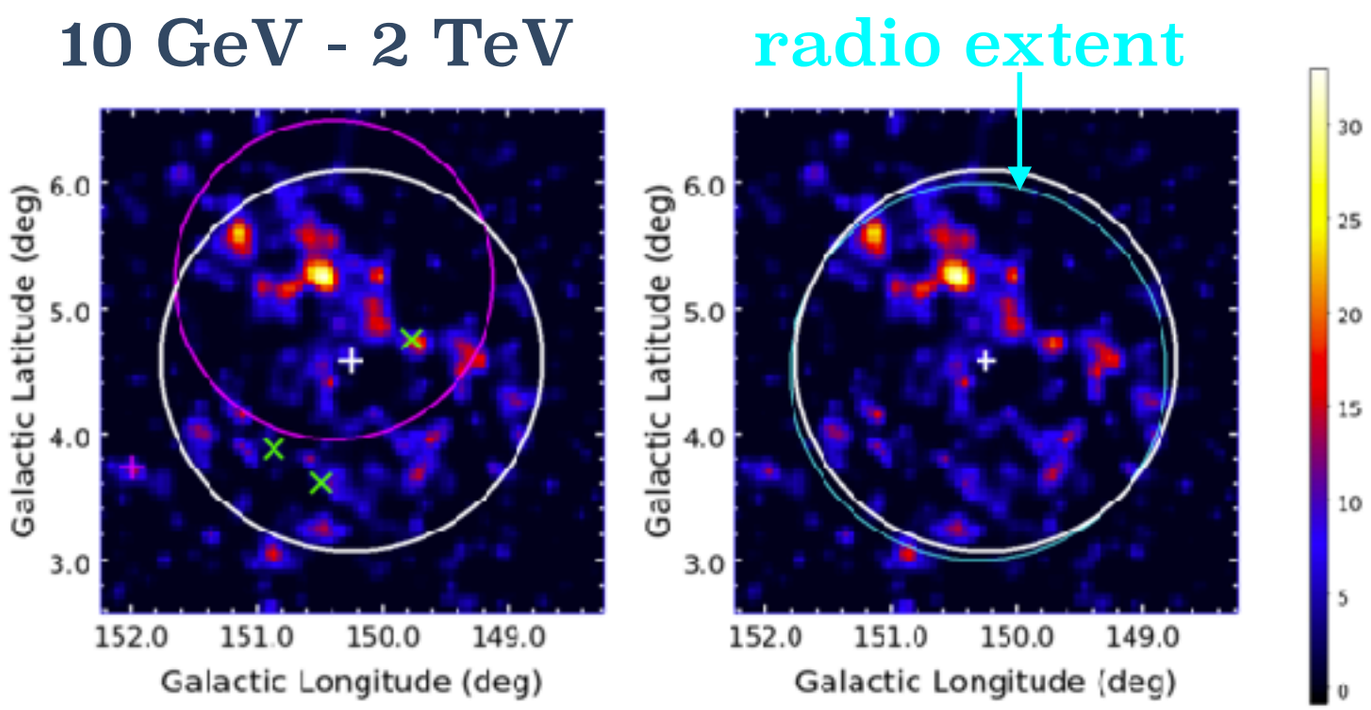


(Gao & Han 2014)

Previous studies

Gamma rays

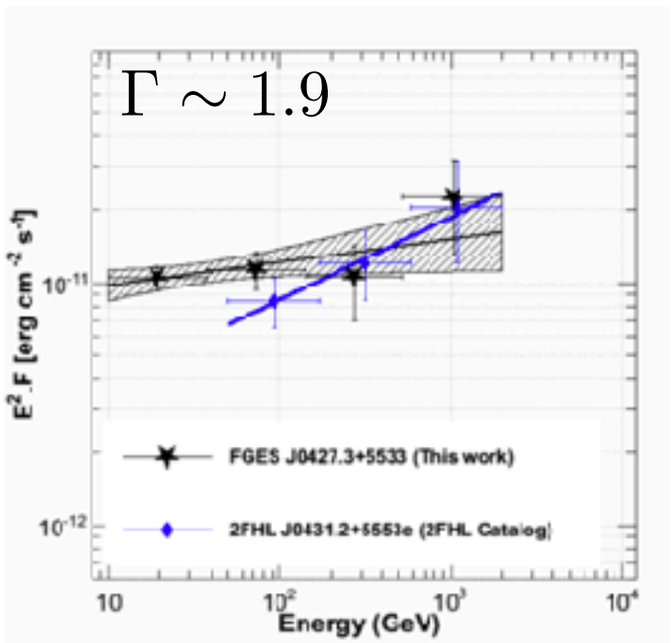




(FGES catalog, Ackermann et al. 2017)

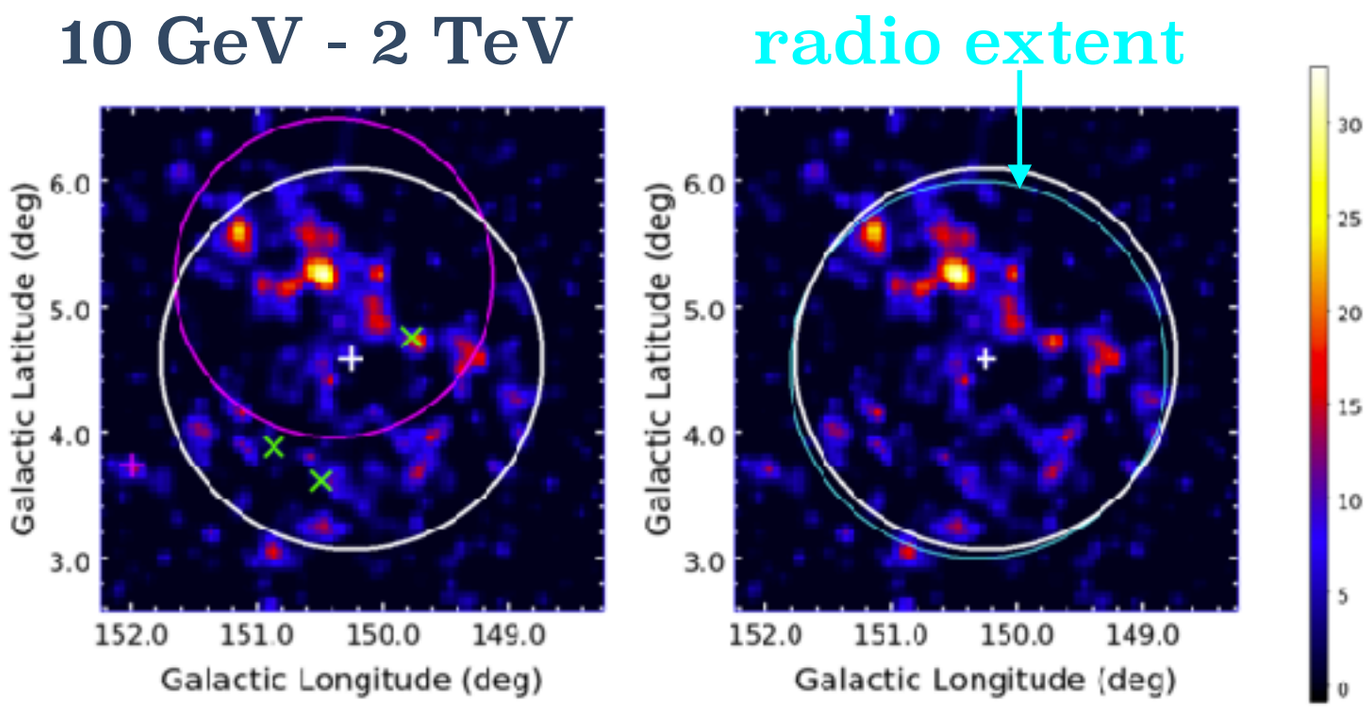
Previous studies

Gamma rays



(FGES catalog, Ackermann et al. 2017)

(Mysore et al., Fermi Symp. 2015)



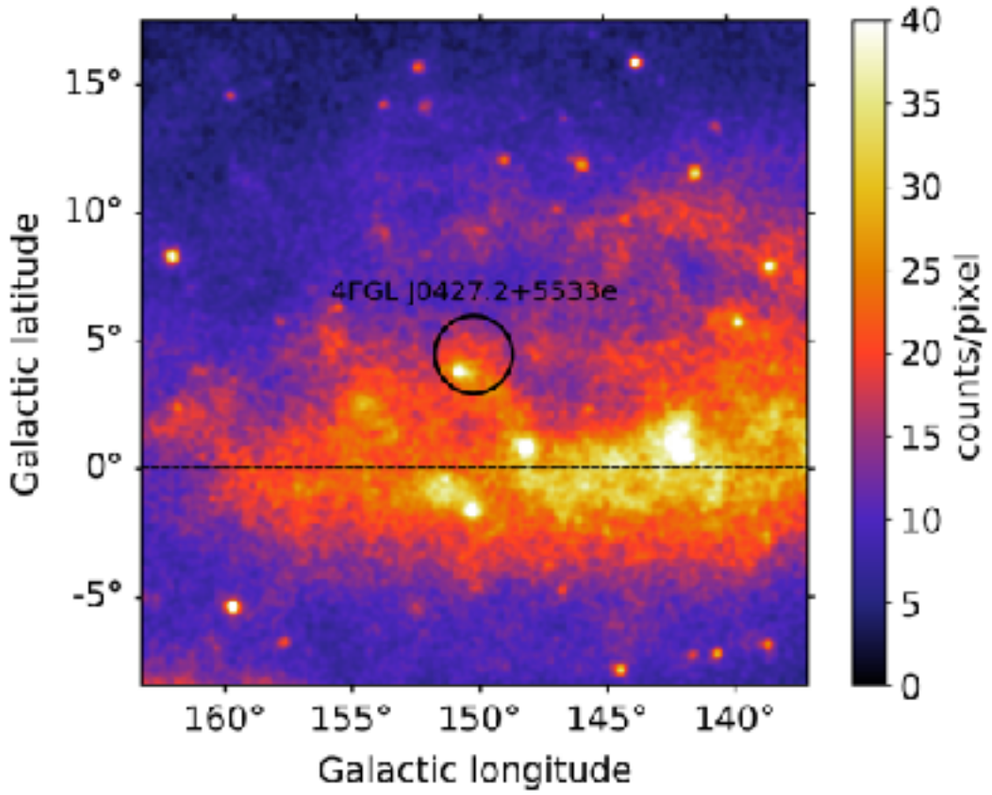
$\mathrm{TS} = 295$ $\mathrm{TS}_{\mathrm{ext}} = 280$

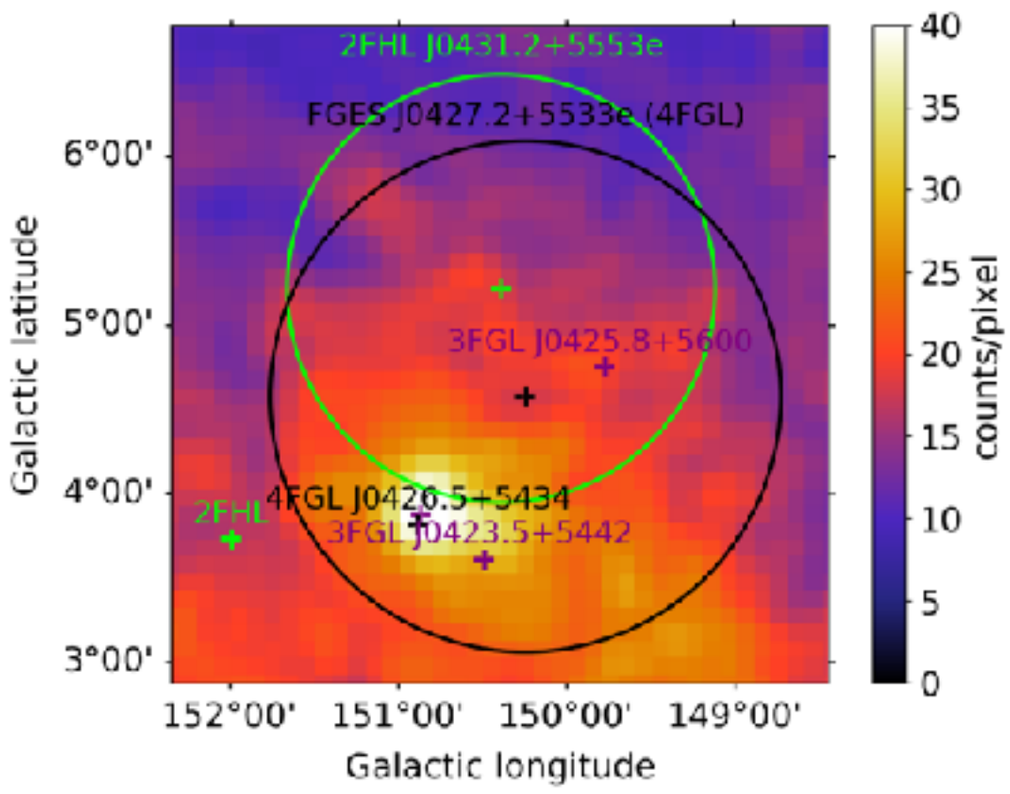
With HI data, they suggest a distance of d = 0.6 kpc (size of 30 pc)

=> One of the closest GeV gamma-ray SNRs

Gamma ray analysis

- 10 years of Fermi-LAT data
- Starting with the latest catalog release (4FGL) and diffuse emission models
- Instrument response functions: P8R3_V2
- All events selected (no selection on angular resolution or energy dispersion reconstruction quality) from 1 GeV to 1 TeV





Morphological analysis

— From the 4FGL catalog:

4FGL J0427.2+5533e (G150.3+4.5)

- Radial disk (radius = 1.51°)
- Logarithmic parabola spectrum

4FGL J0426.5+5435

- Point source
- Logarithmic parabola spectrum

— With the Fermipy package:

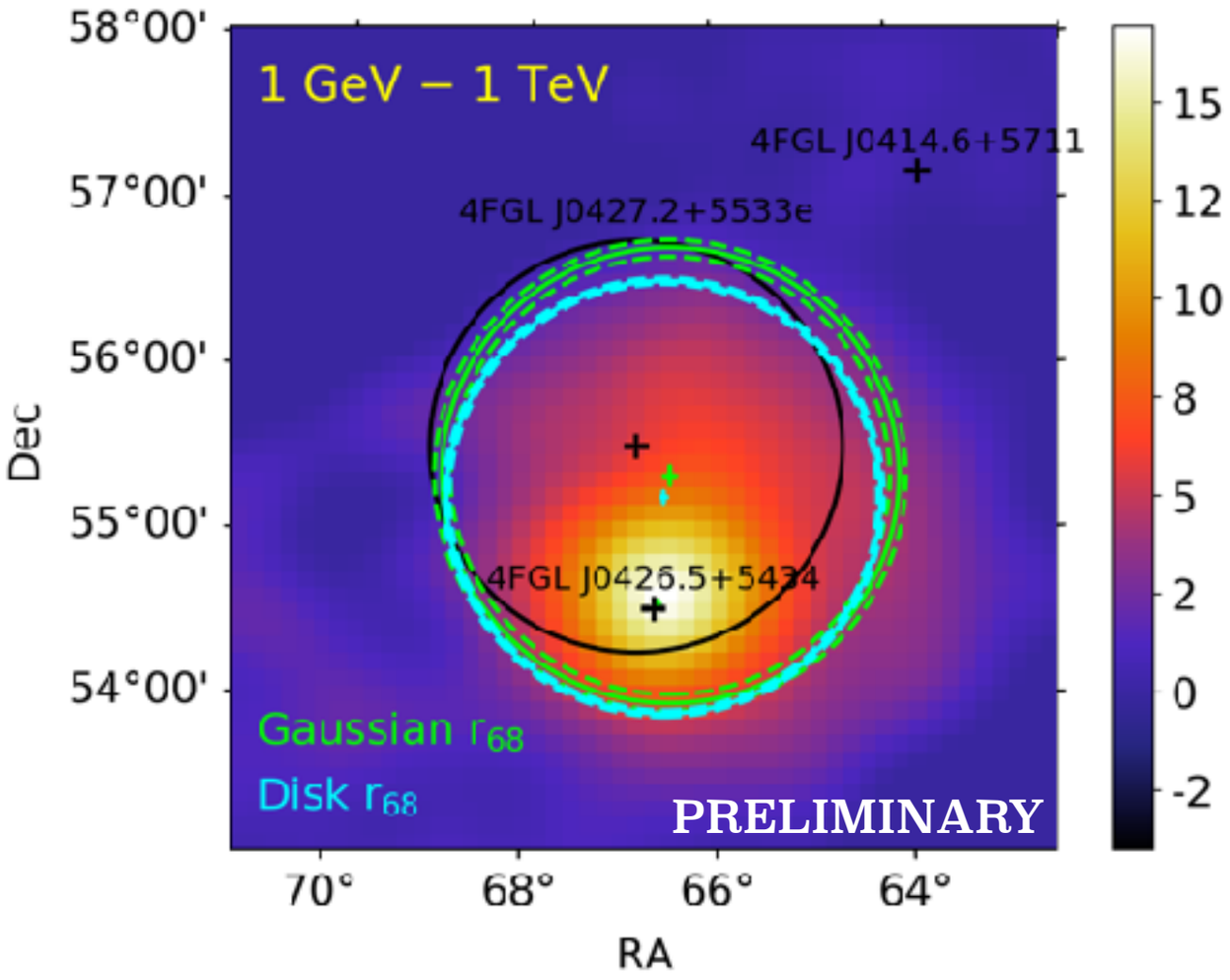
1. Localization + extension of 4FGL J0426.5+5435
2. Localization + extension of G150.3+4.5 (testing a radial Gaussian and a radial disk models)

(free norm of sources up to r = 7° during the morphological and spectral fits; all other sources are fixed to their best-fit value found in this analysis)

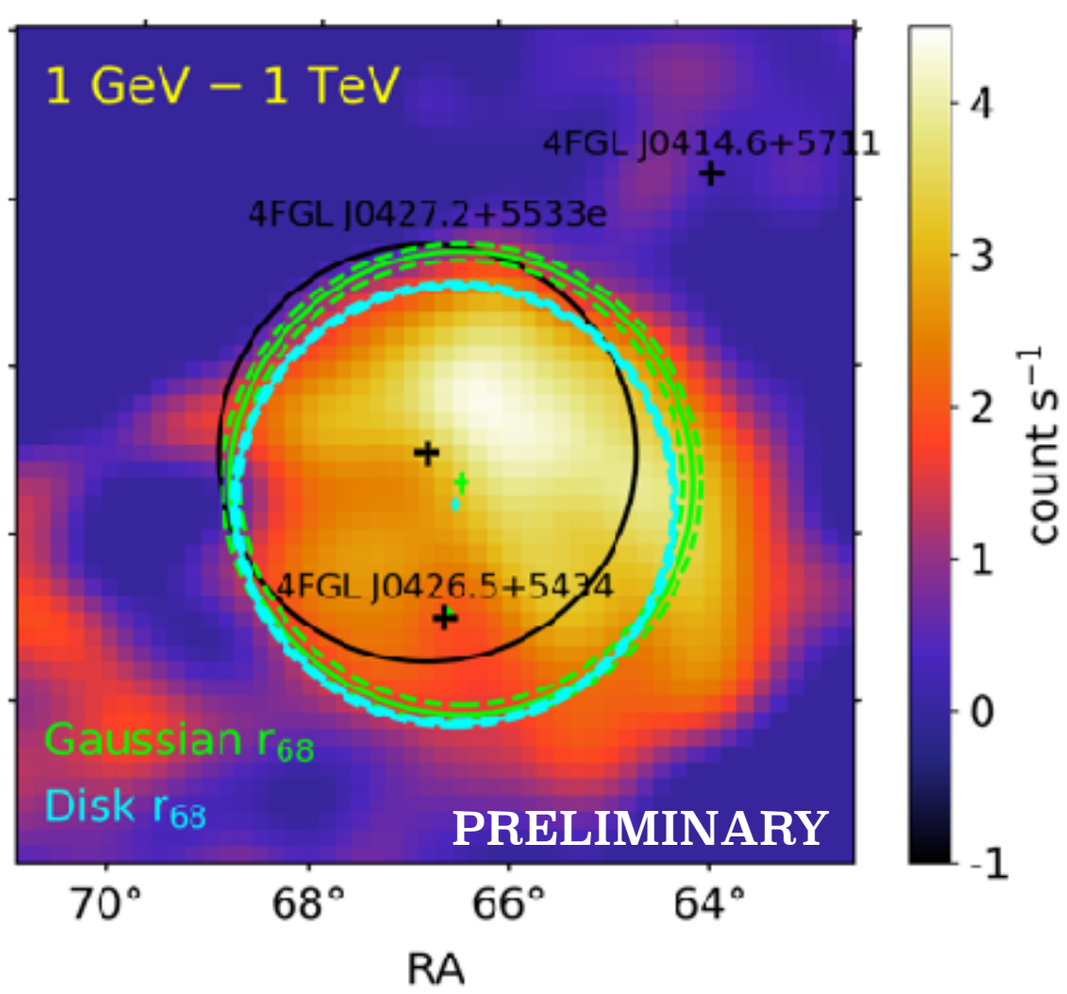
Morphological analysis

Residual count maps without:

the 2 sources in the model



G150.3+4.5 in the model



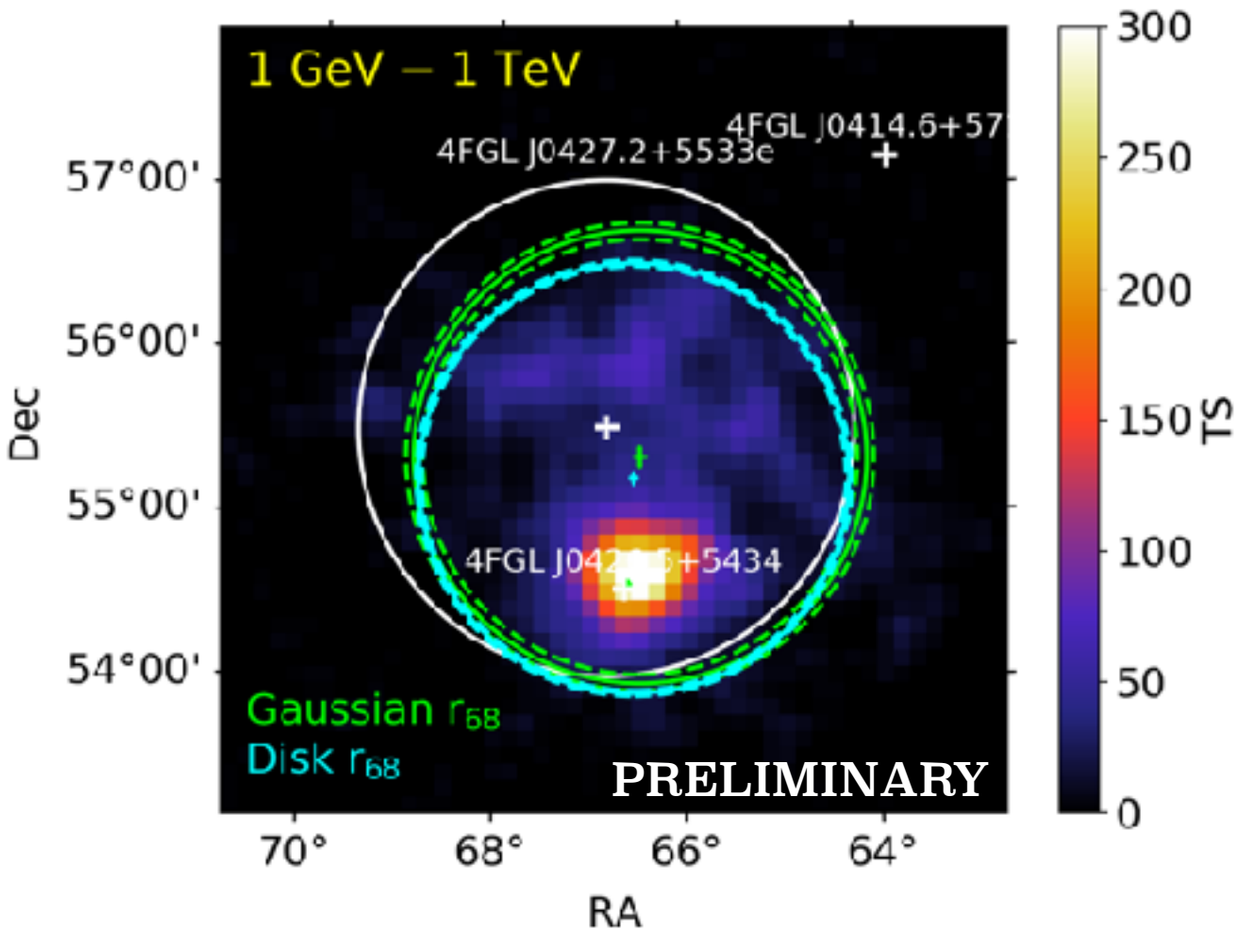
- **4FGL J0426.5+5435 is not extended**
- **G150.3+4.5 is best modeled by a radial Gaussian than a disk**

$$\Delta\mathrm{TS}(\mathrm{Disk} \rightarrow \mathrm{Gaussian}) = 23.7 \qquad \mathrm{TS}_{\mathrm{ext}} = 601.9$$

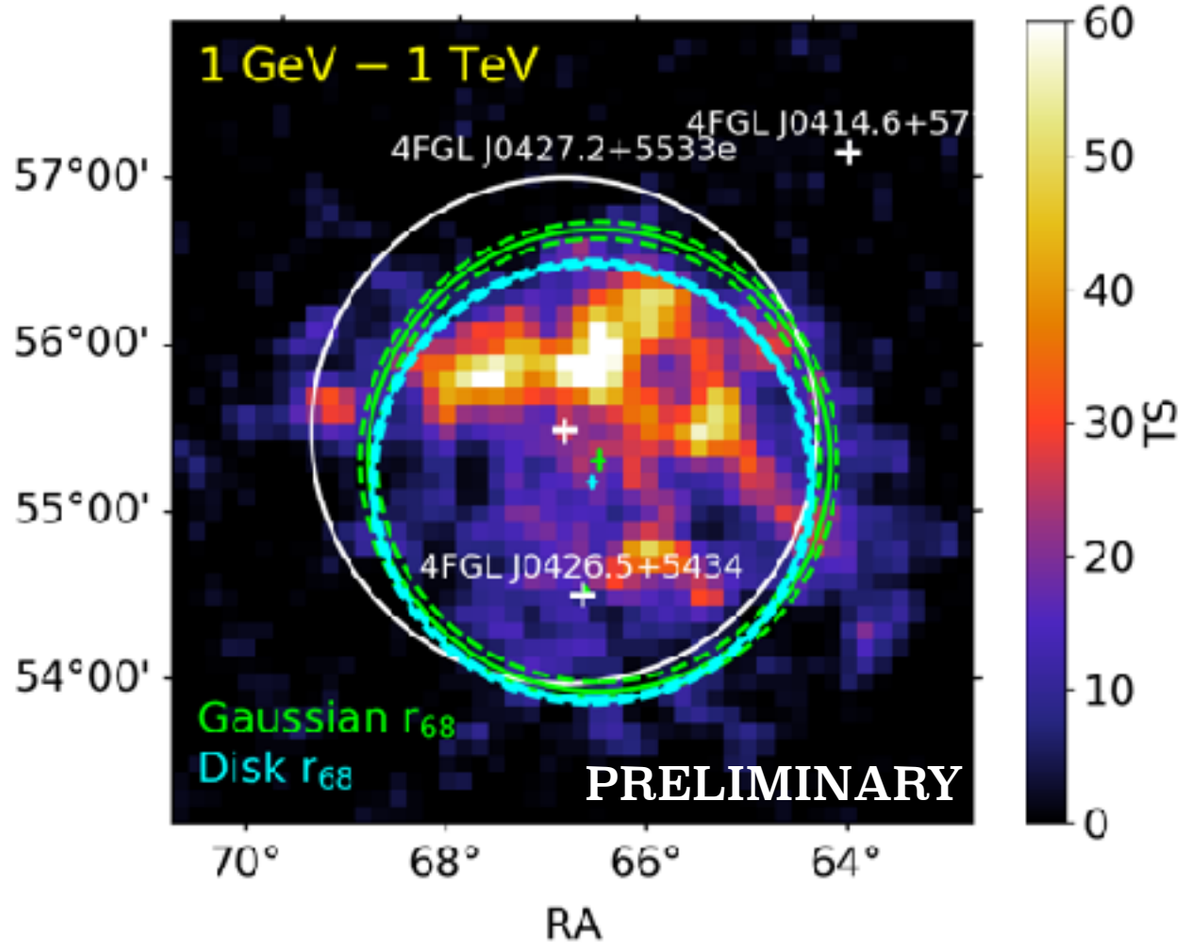
Morphological analysis

Residual TS maps without:

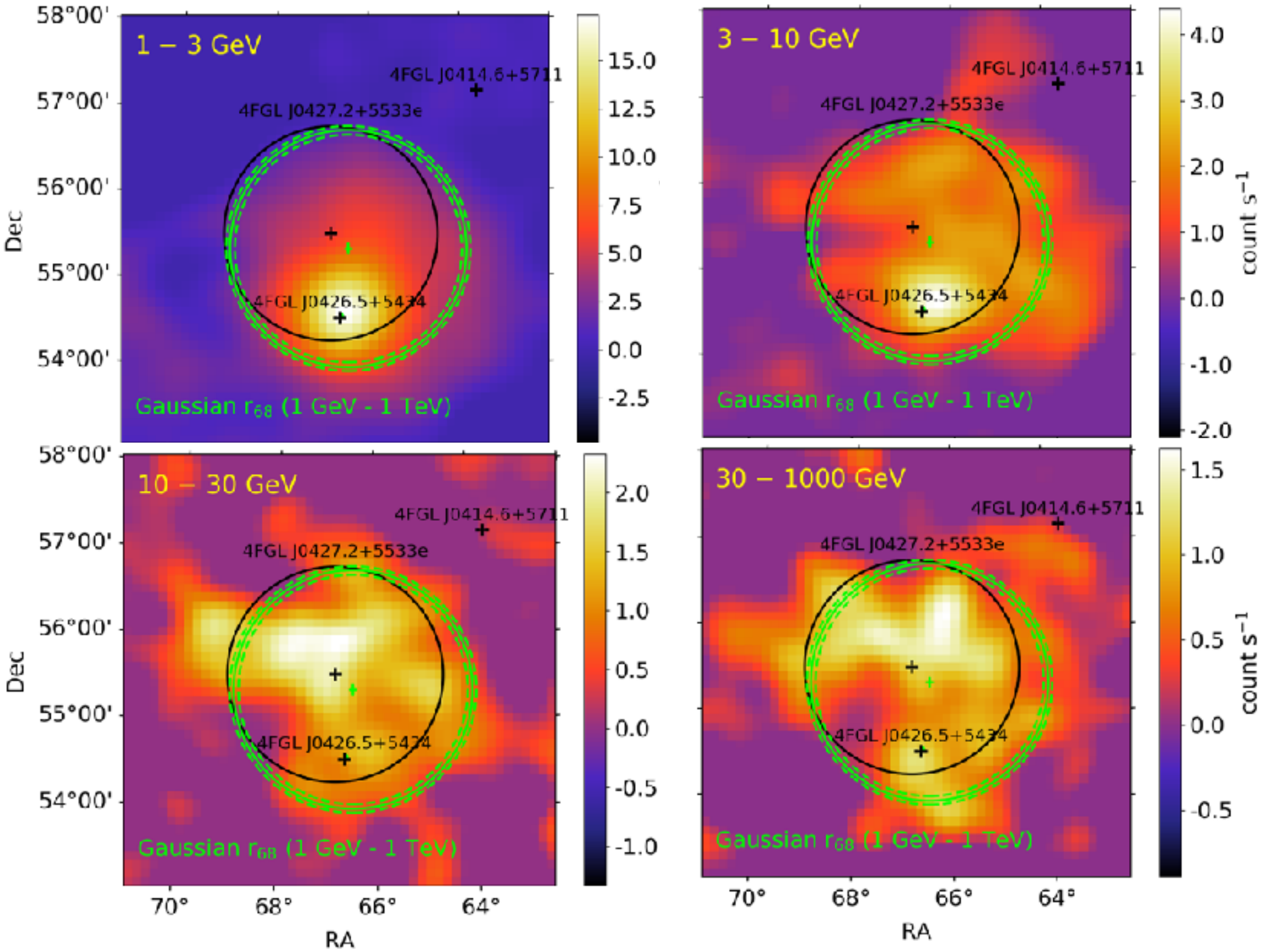
the 2 sources in the model



G150.3+4.5 in the model



Residual count maps without the 2 sources



Spectral analysis

- **G150.3+4.5 (radial Gaussian)**

$$N_0 = (8.10 \pm 0.50) \times 10^{-14} \ \ \mathrm{cm^{-2} s^{-1} TeV^{-1}}$$

$$\alpha = 1.64 \pm 0.05 \qquad \beta = 0.05 \pm 0.02 \qquad \mathrm{TS} = 616.4$$

$$E_b = 8.97 \ \mathrm{GeV} \qquad \Delta\mathrm{TS}_{\mathrm{logP} \rightarrow \mathrm{PL}} = -7.38$$

- **4FGL J0426.5+5435 (spectrum: log parabola => power law)**

$$N_0 = (2.56 \pm 0.34) \times 10^{-11} \ \ \mathrm{cm^{-2} s^{-1} TeV^{-1}}$$

$$\Gamma = 3.57 \pm 0.14 \qquad \mathrm{TS} = 356.5$$

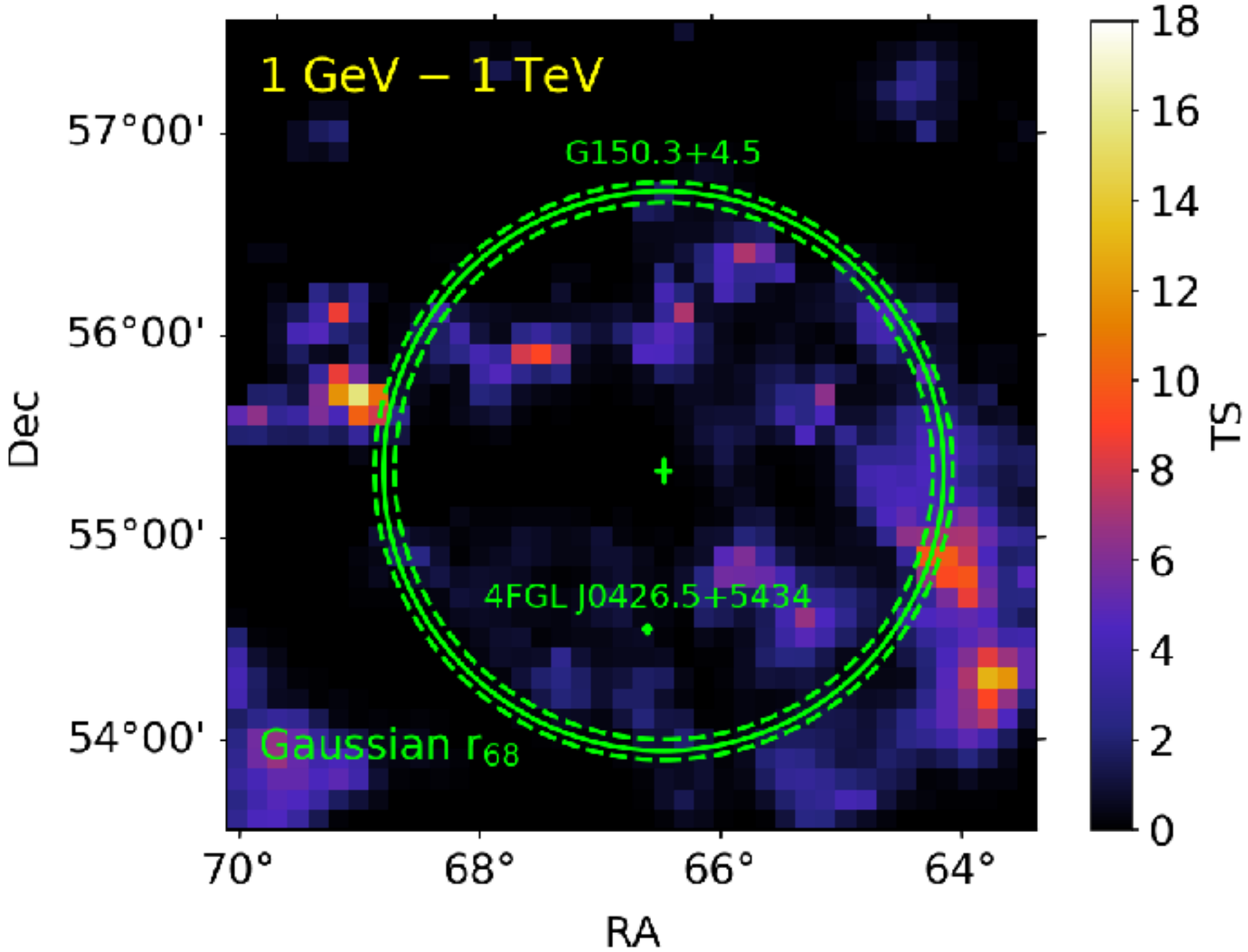
$$E_0 = 0.65 \ \ \mathrm{GeV}$$

=> G150.3+4.5 spectrum is similar than that obtained for young TeV shell-type SNRs

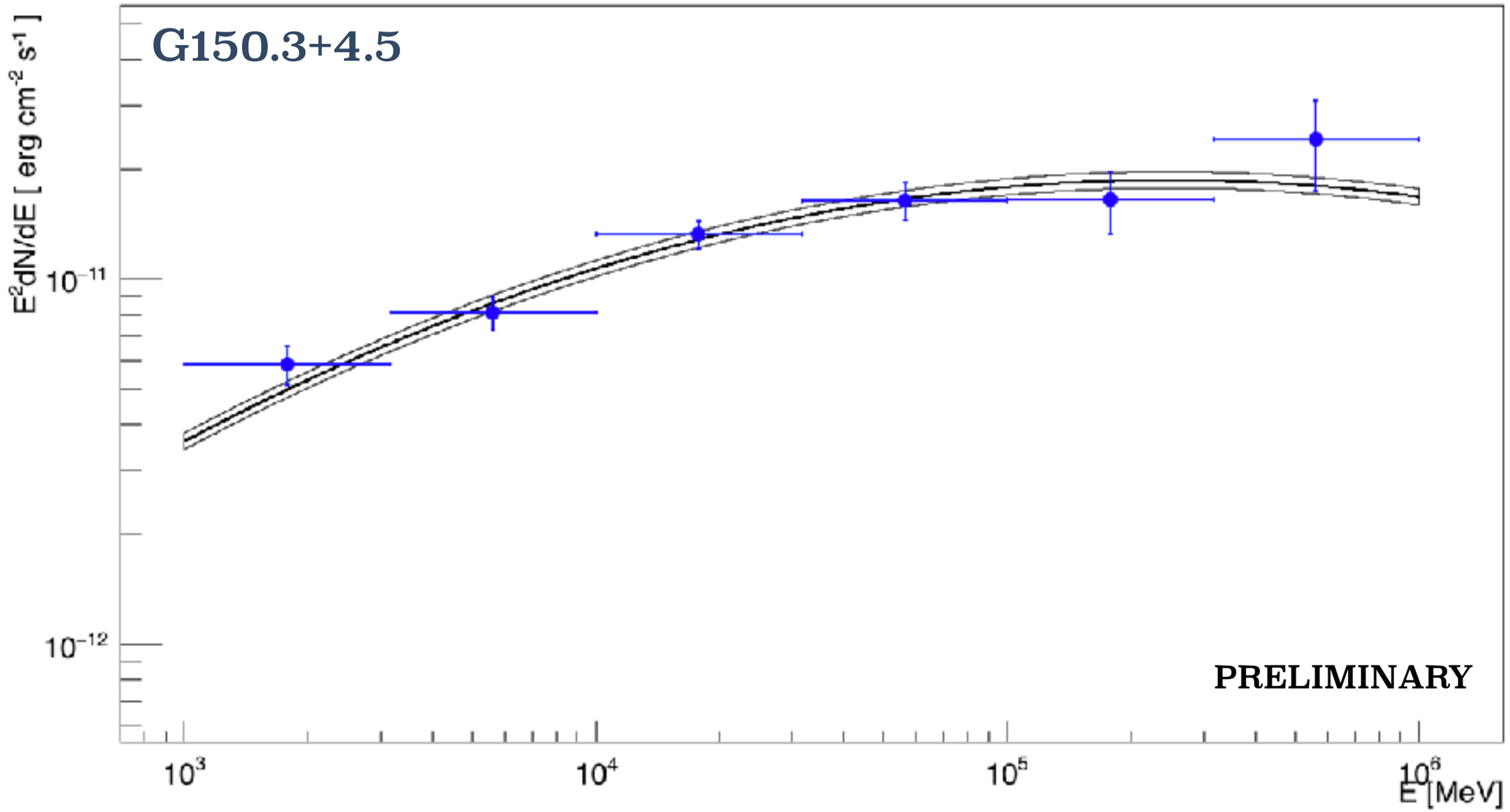
=> 4FGL J0426.5+5435 is brighter than G150.3+4.5 at low energies

Residual TS map

Best-fit model:



Spectral Energy Distribution



- Hard spectrum => young SNR or very low density environment?
- G150.3+4.5 will probably be observed with CTA

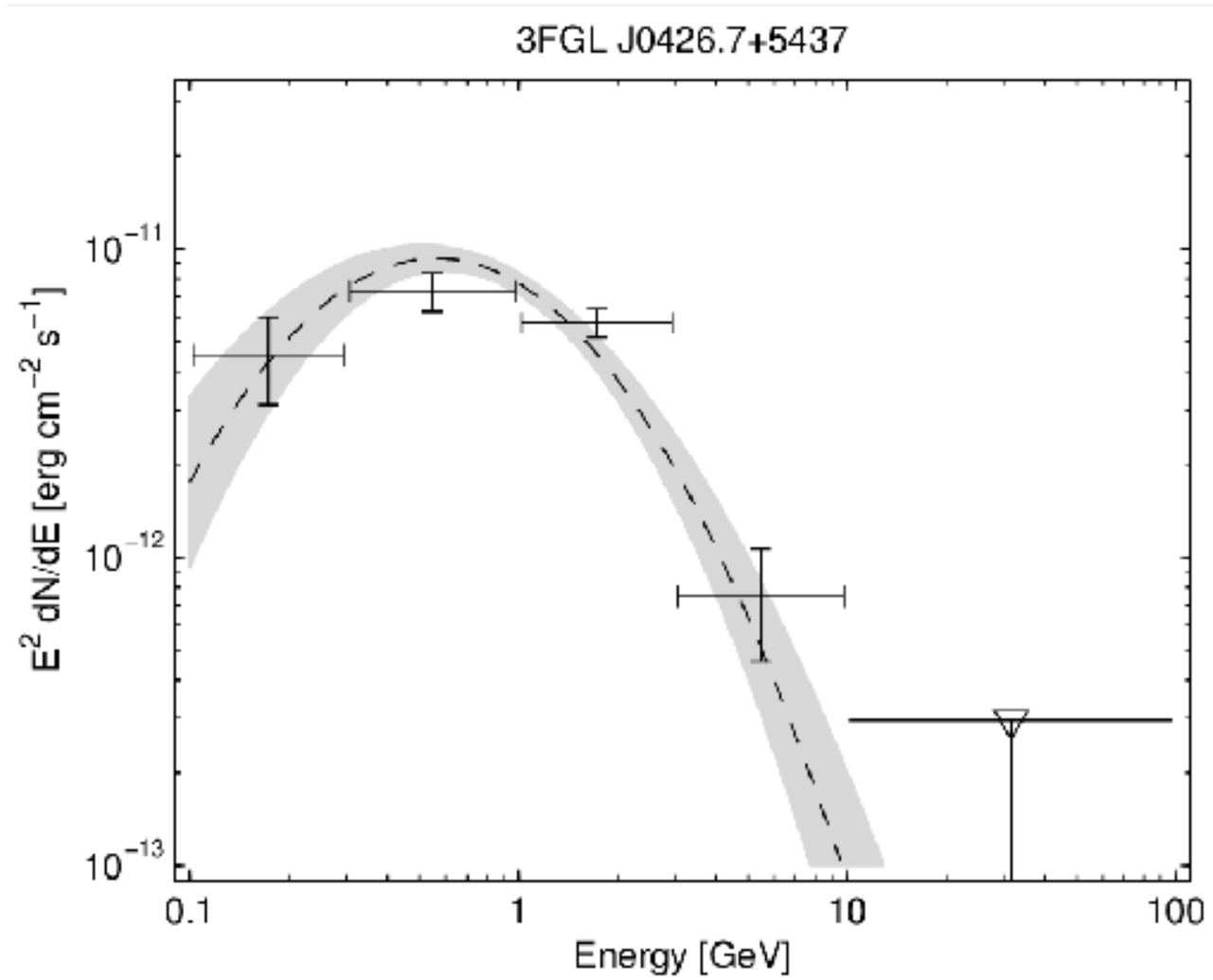
Status

What is the nature of 4FGL J0426.5+5435?

- No variability reported in the 3FGL catalog
- No multi-wavelength counterparts found so far
- Nothing reported in the Simbad database at this position

Spectrum from the 3FGL catalog:

=> Need to investigate the SED at low energy and the variability



Status

If lower-energy studies reveal a pulsar-like spectrum from 4FGL J0426.5+5435:

Is the source associated to G150.3+4.5 (composite SNR?)

Assuming a certain distance, we could derive the spin down power of the pulsar (reasonable off plane?), the age of the SNR (could the pulsar have traveled such distance with a typical velocity of 500 km s^{-1}?)

Next steps

- Constrain the origin of the gamma-ray emission from G150.3+4.5: down to lower energies (300 MeV — 1 TeV) — In progress

- Investigate the high-energy part of the spectrum: extrapolated the diffuse emission models to higher energies than 1 TeV?

- Investigate the nature of 4FGL J0426.5+5435 and its possible association with the G150.3+4.5

- Any suggestion are very welcome