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Mathematisch-Naturwissenschaftliche Fakultät

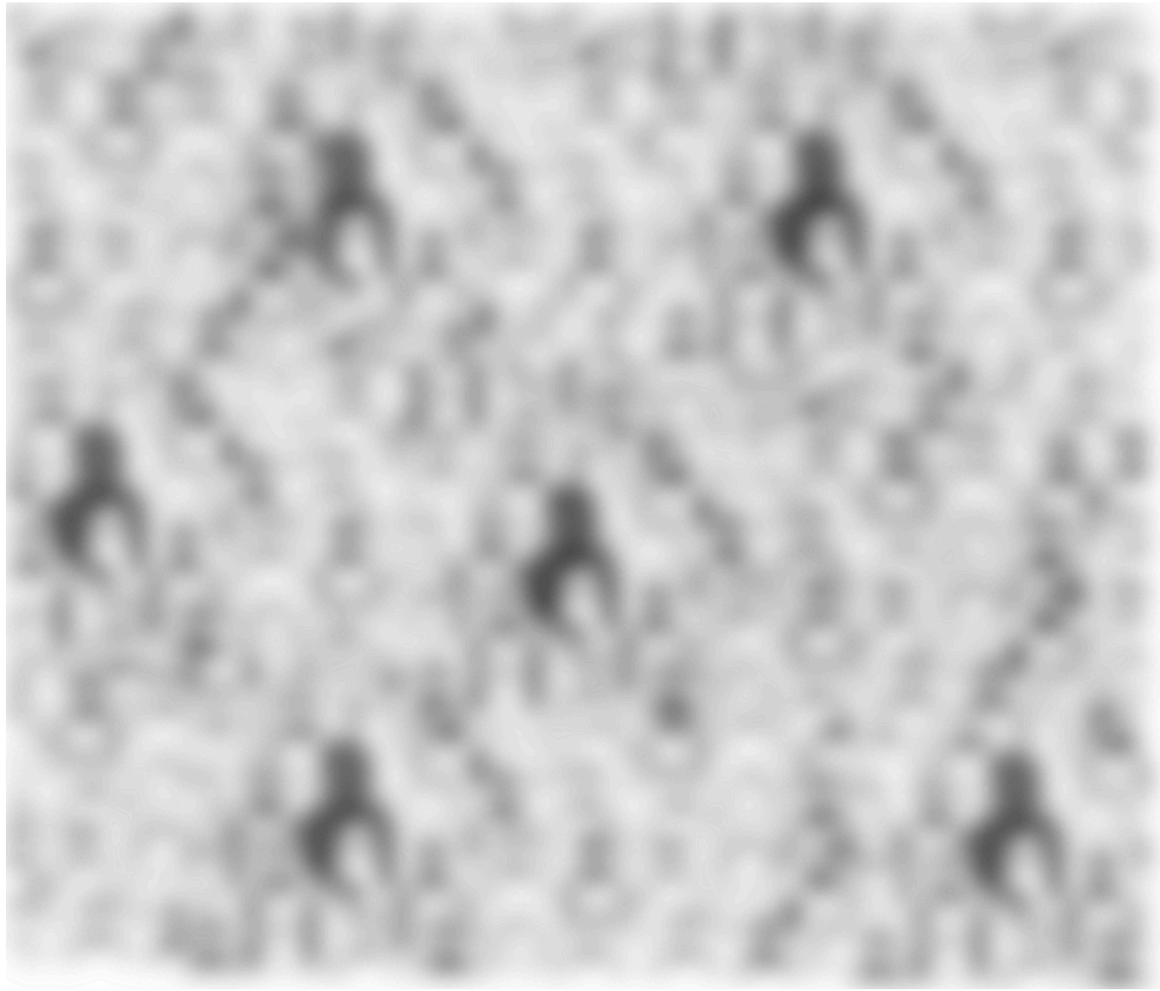
GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

The population of TeV γ-ray sources in the Milky Way - the hidden part of the iceberg -

Constantin Steppa, Kathrin Egberts

Motivation

- Detection of only the brightest sources
- Sub-threshold sources contribute to „measured“ diffuse flux
- Disentanglement of „real“ and „measured“ diffuse flux requires model of source population



Credit: https://www.boredpanda.com/author/ste1/

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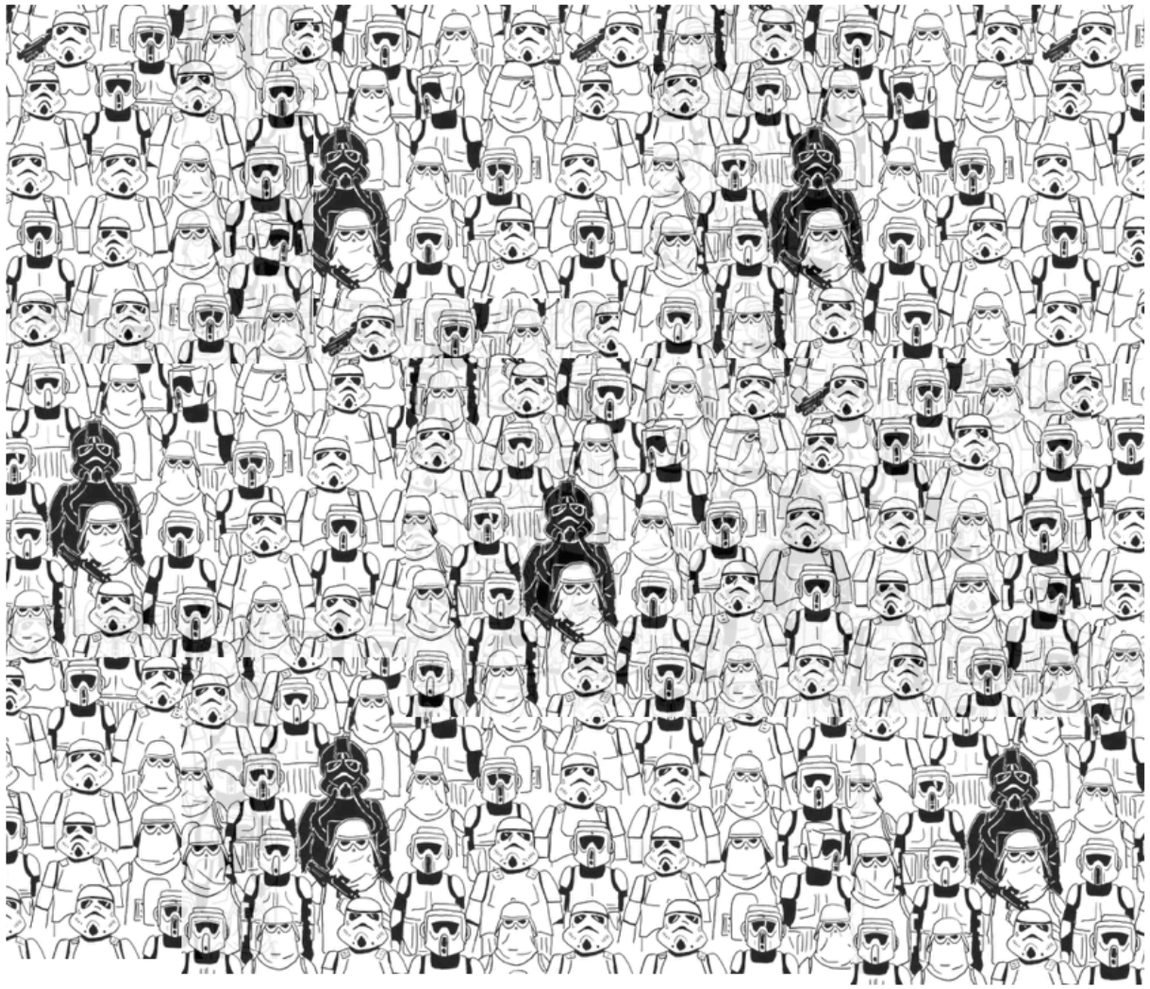

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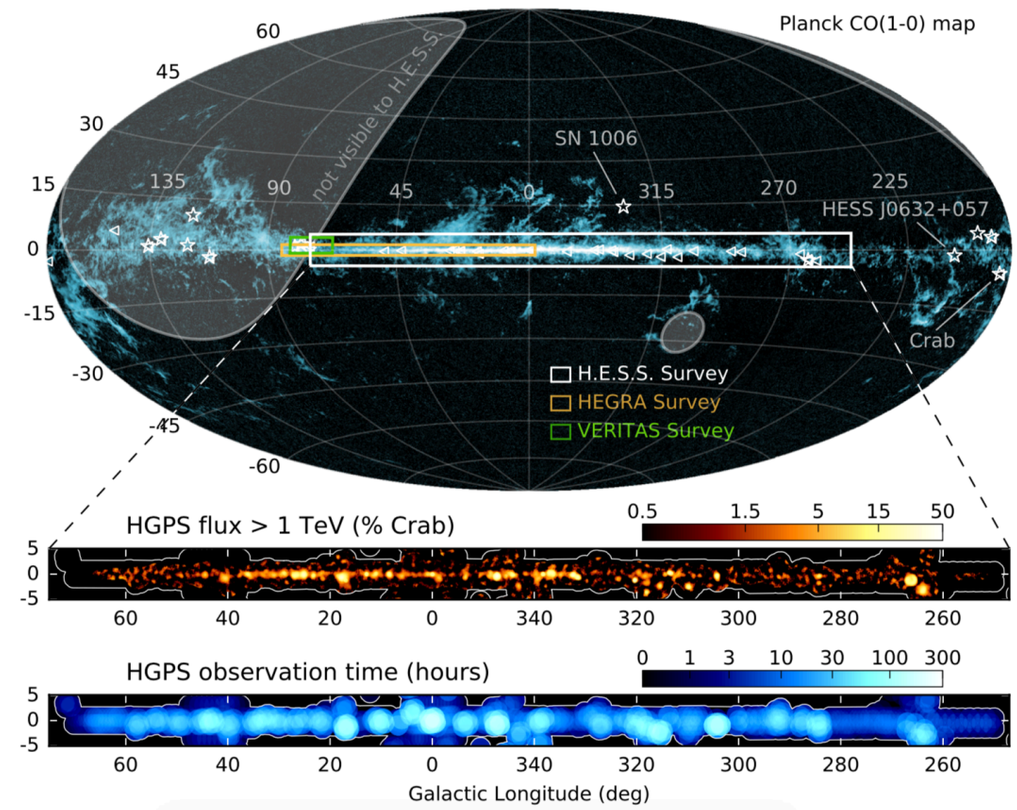
→ Model for the population of **generic** VHE sources based on the information of the HGPS

Model Basis

- H.E.S.S. Galactic Plane Scan
  - Most comprehensive census of galactic VHE sources
  - Rich data, easily accessible
  - But…



Column	Unit	Description
Component_ID		Gauss component identifier (HGPSC NNN)
Source_Name		Source name (HESS JHHmm±DDd identifier) the component belongs to
Component_Class		Component class (see Sect. 4.9)
GLON	deg	Galactic longitude
GLON_Err	deg	Statistical error (1 sigma) on GLON
GLAT	deg	Galactic latitude
GLAT_Err	deg	Statistical error (1 sigma) on GLAT
Sqrt_TS		Square root of the the test statistics of the component (see Eq. 11)
Size	deg	Component size (1 σ Gaussian width)
Size_Err	deg	Statistical error (1 sigma) on Size
Flux_Map	$cm^{-2}\,s^{-1}$	Integral flux above 1 TeV from the morphology fit on the map (total)
Flux_Map_Err	$cm^{-2}\,s^{-1}$	Statistical error (1 sigma) on Flux_Map
Excess		Total model excess contained in the component

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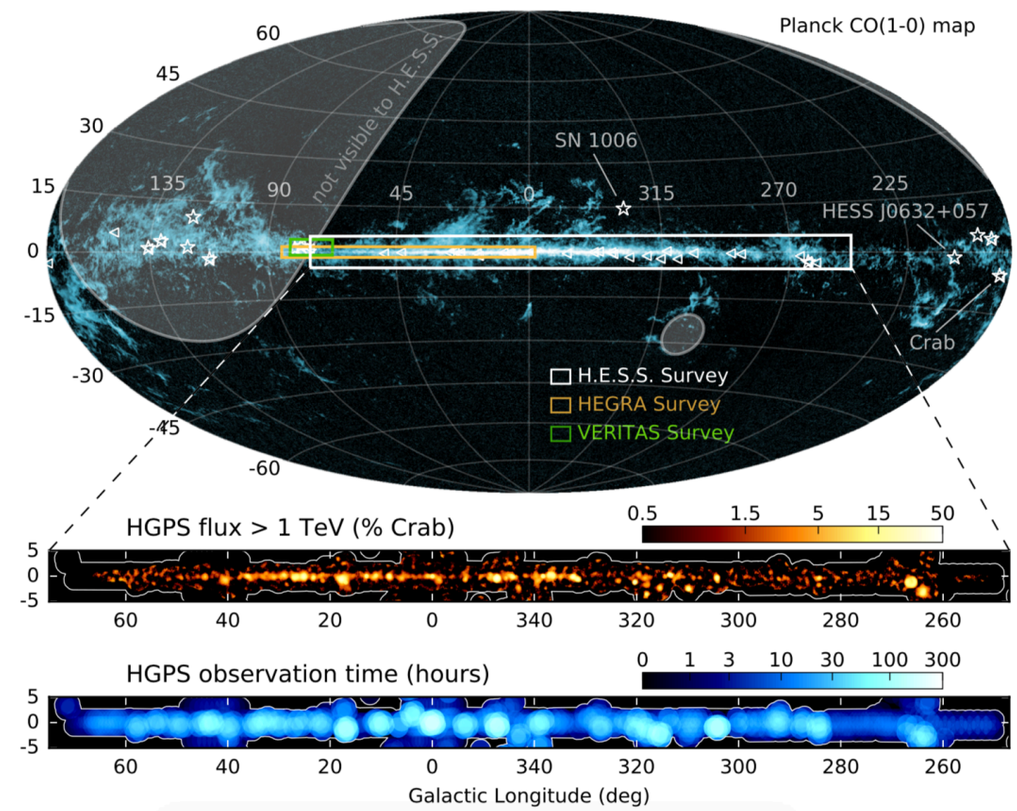
  - But…
    - ~~3D-position~~, ~~luminosity~~, ~~size~~
    - Biased



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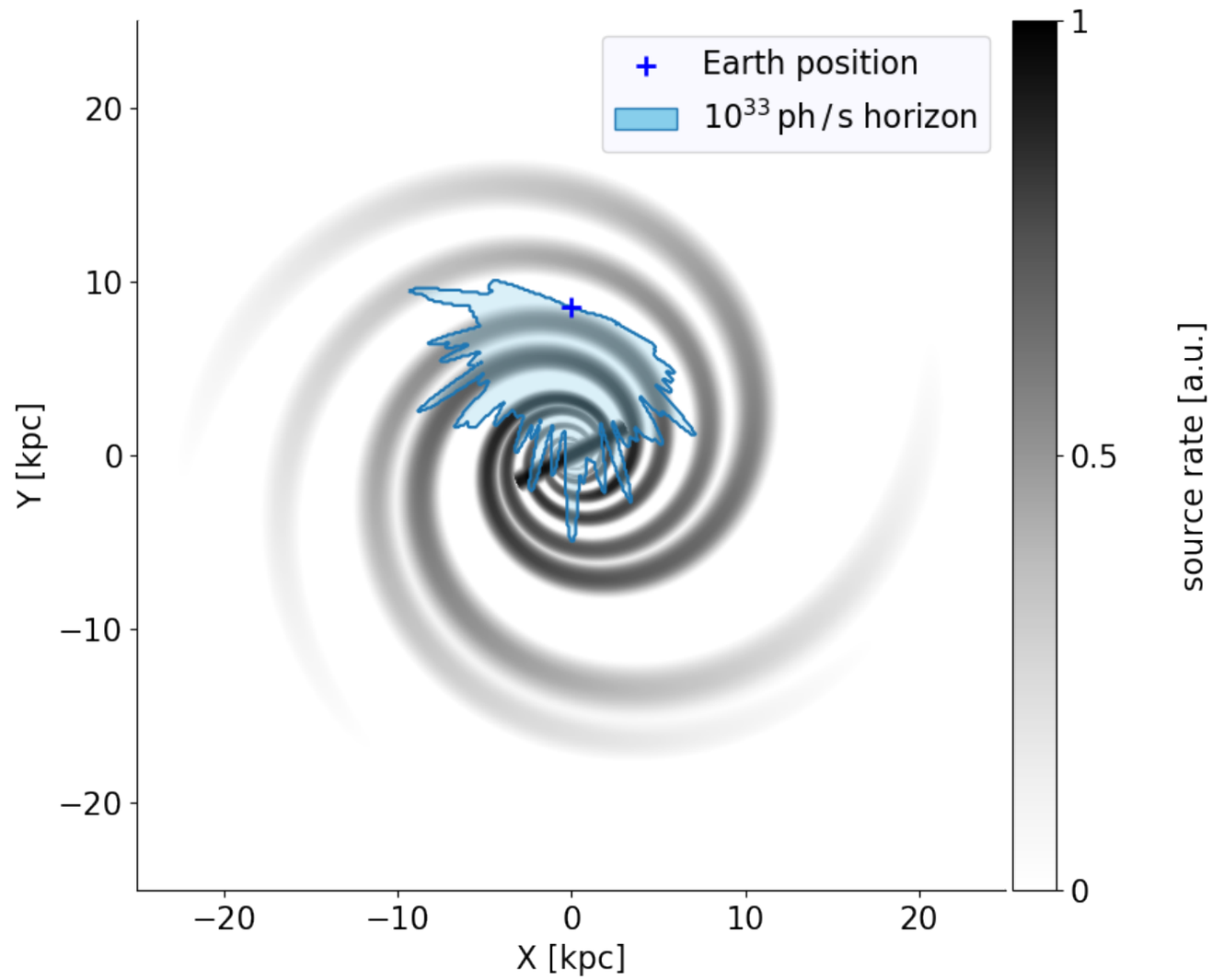
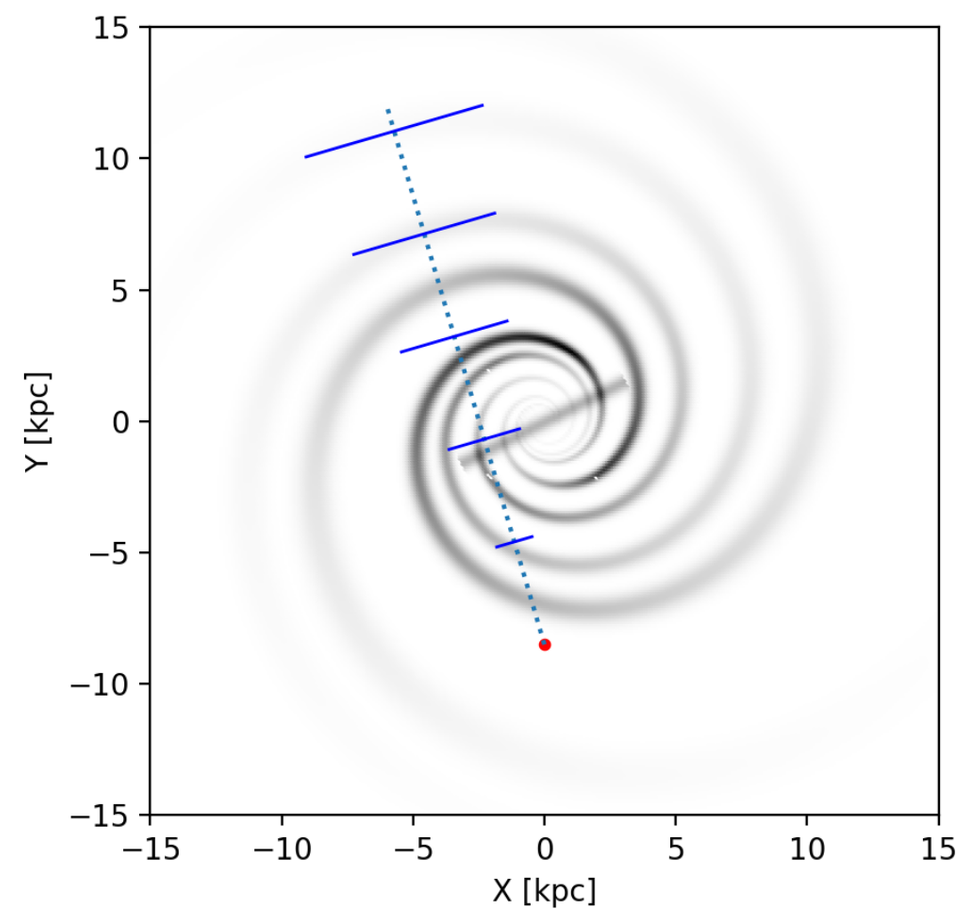
1. Component - 3D Source Density

- Assumption:
  - VHE source density
    $\propto$ ISM density
- Model components:
  - Four-arm, emissivity model traced by CII
  - Central bar, as observed in Spitzer data



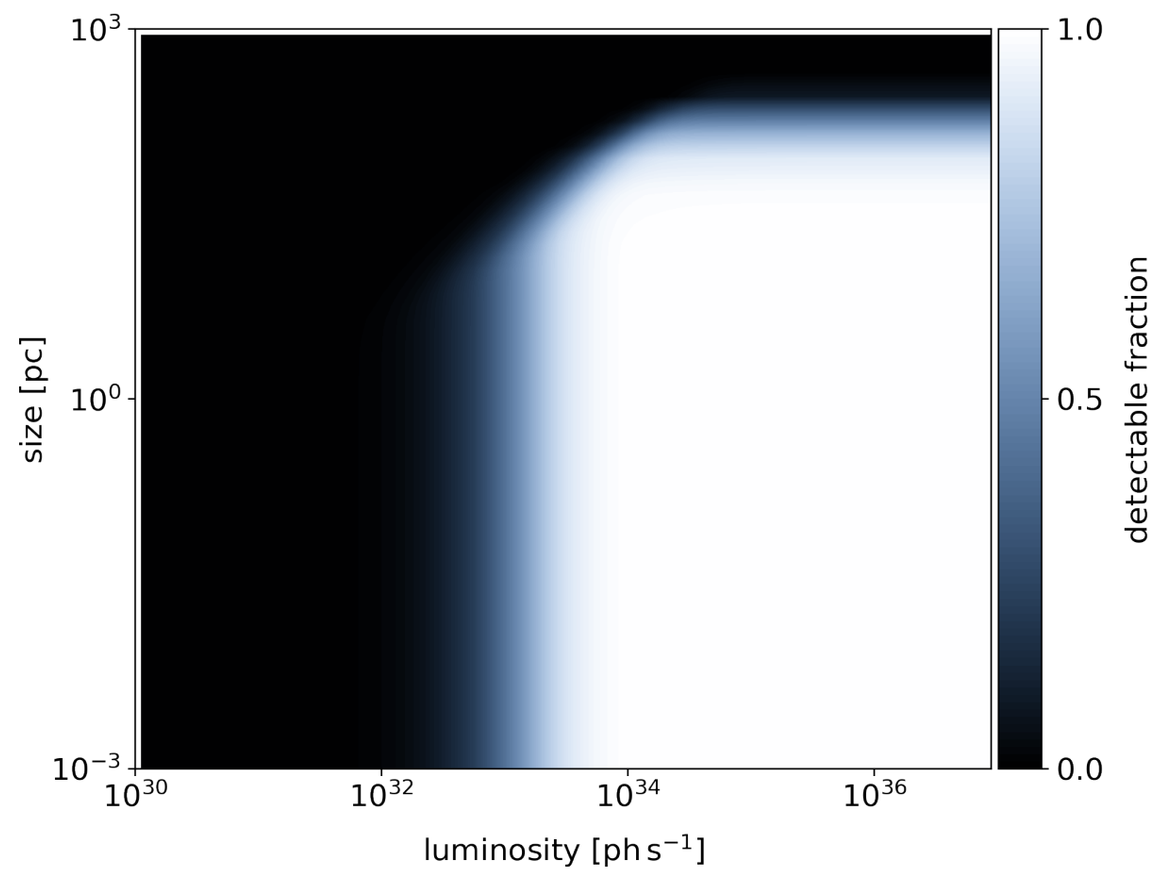
2. Component - Luminosity- & Size Distribution

- Source properties
  - Distance required for conversion of observable to intrinsic properties
  - Sample source density along line of sight —> distance pdf
  - Distance pdf & flux / angular extension —> luminosity pdf / size pdf



2. Component - Luminosity- & Size Distribution

- Bias correction
  - For fixed luminosity and size determine fraction of resolved sources from spatial distribution and the HGPS sensitivity



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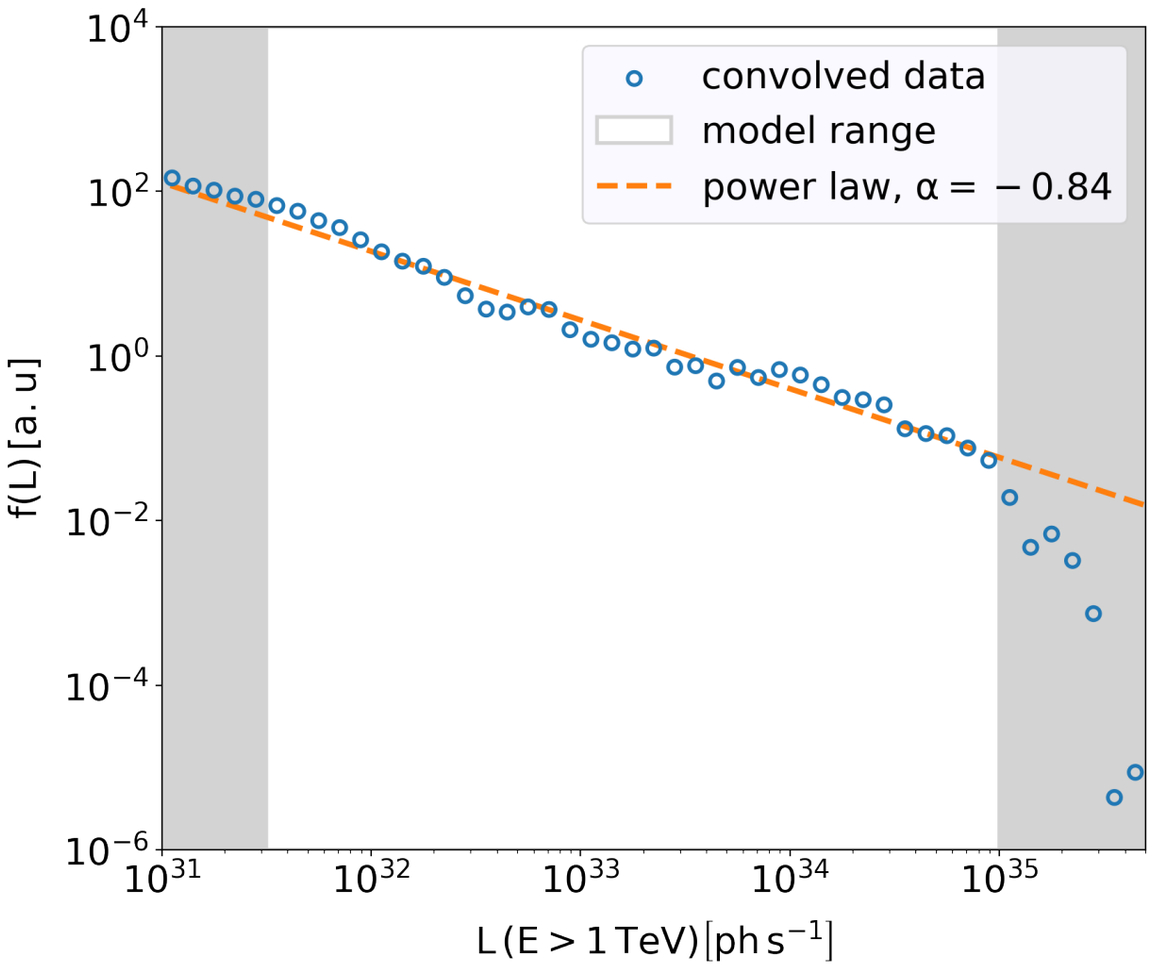
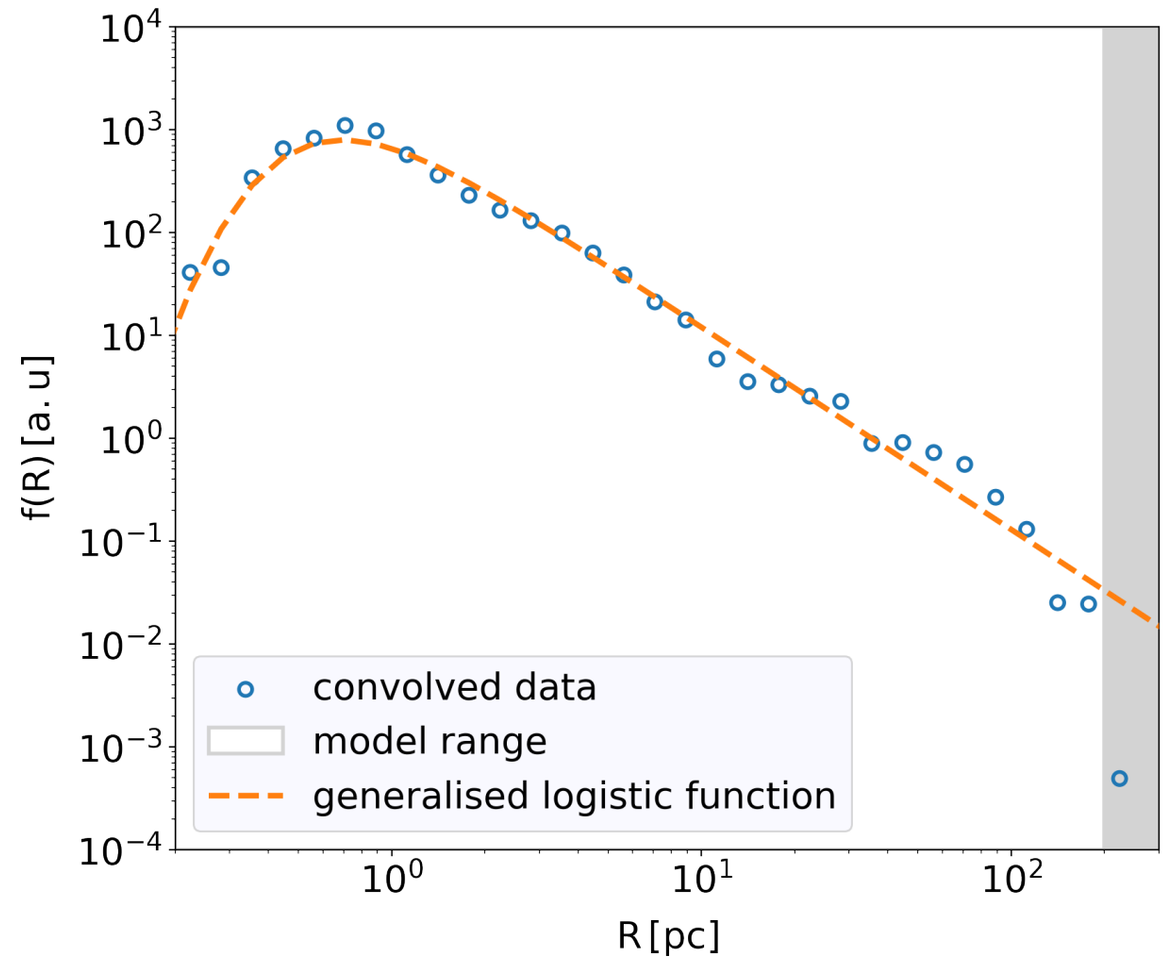
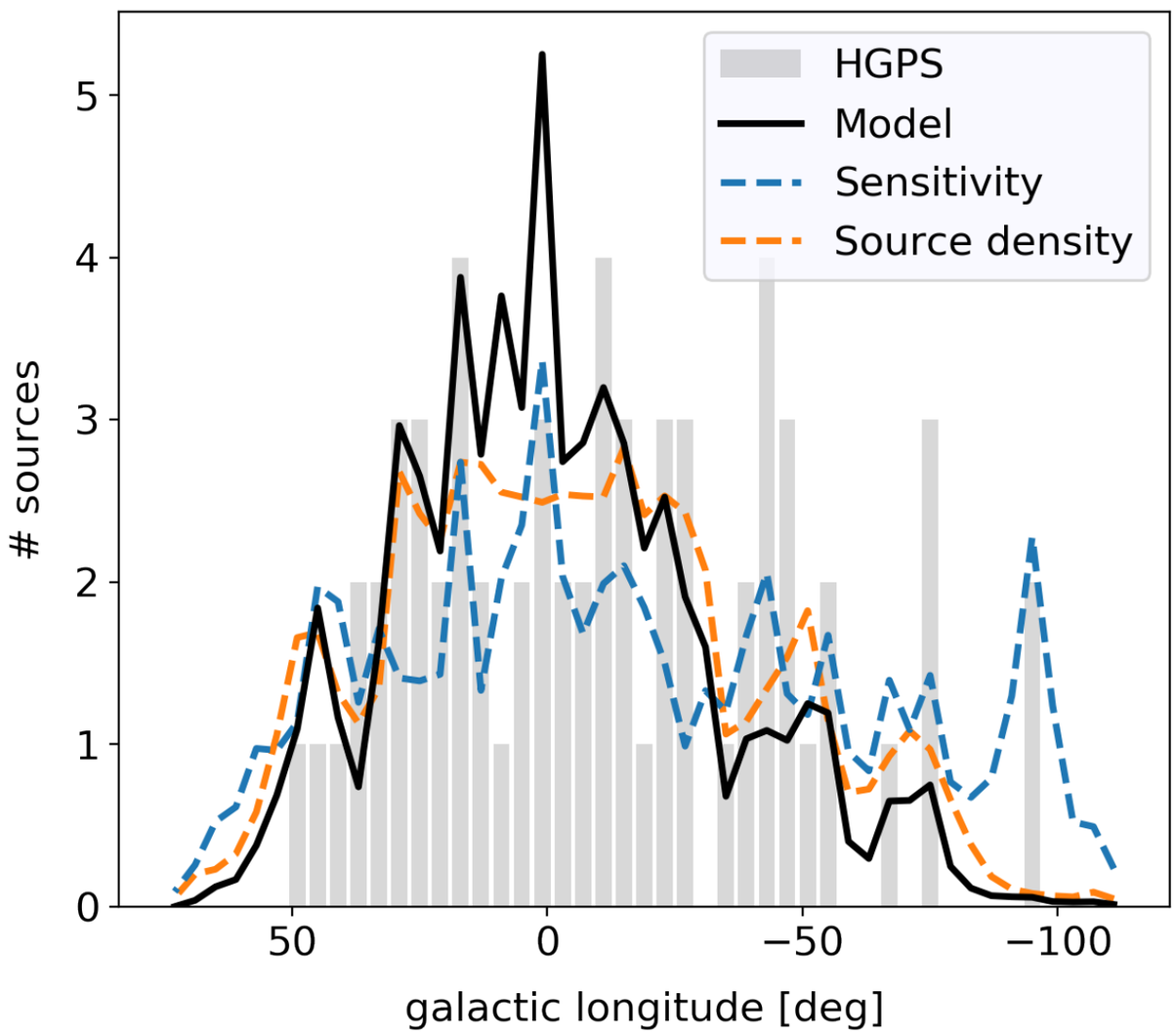
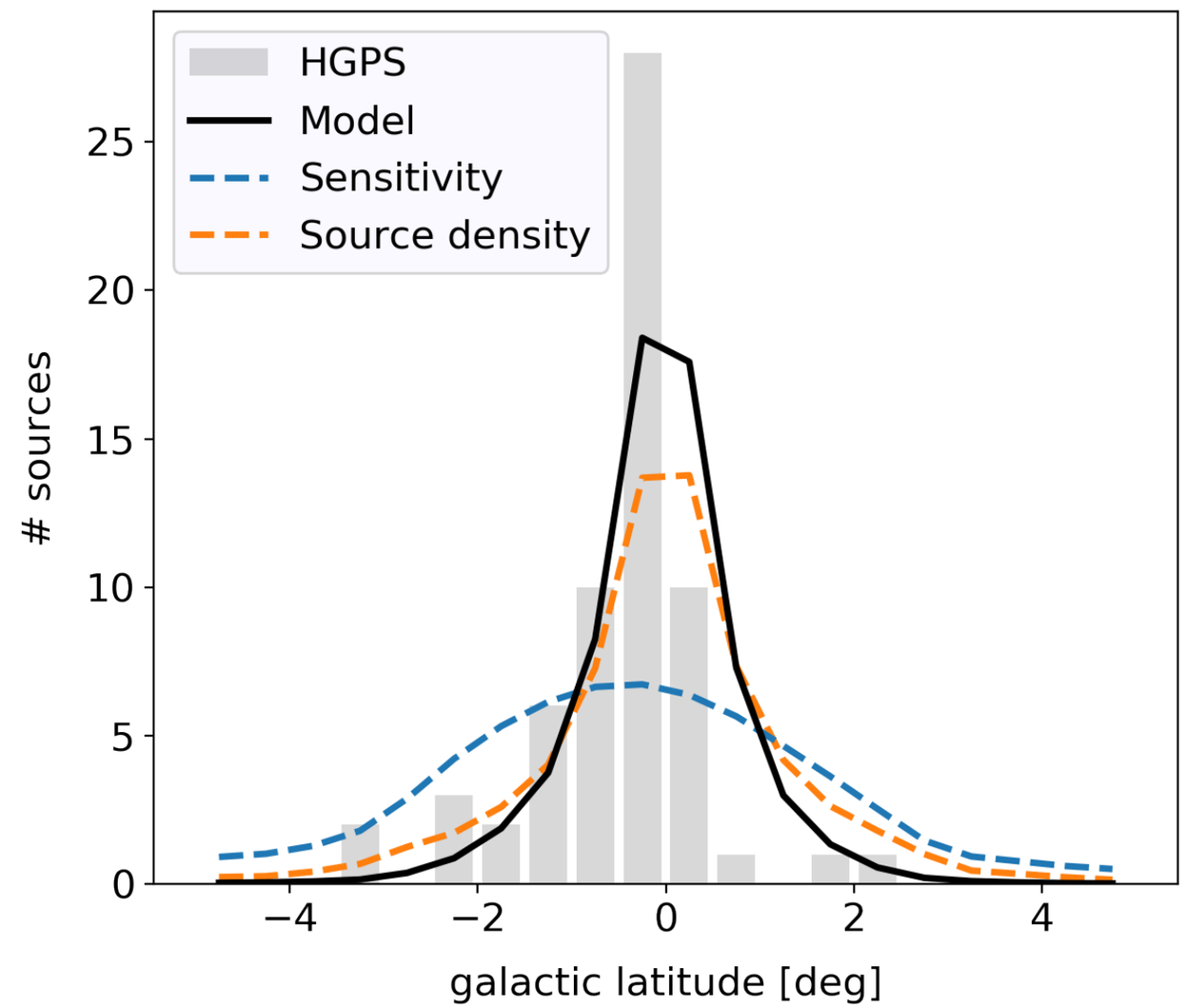


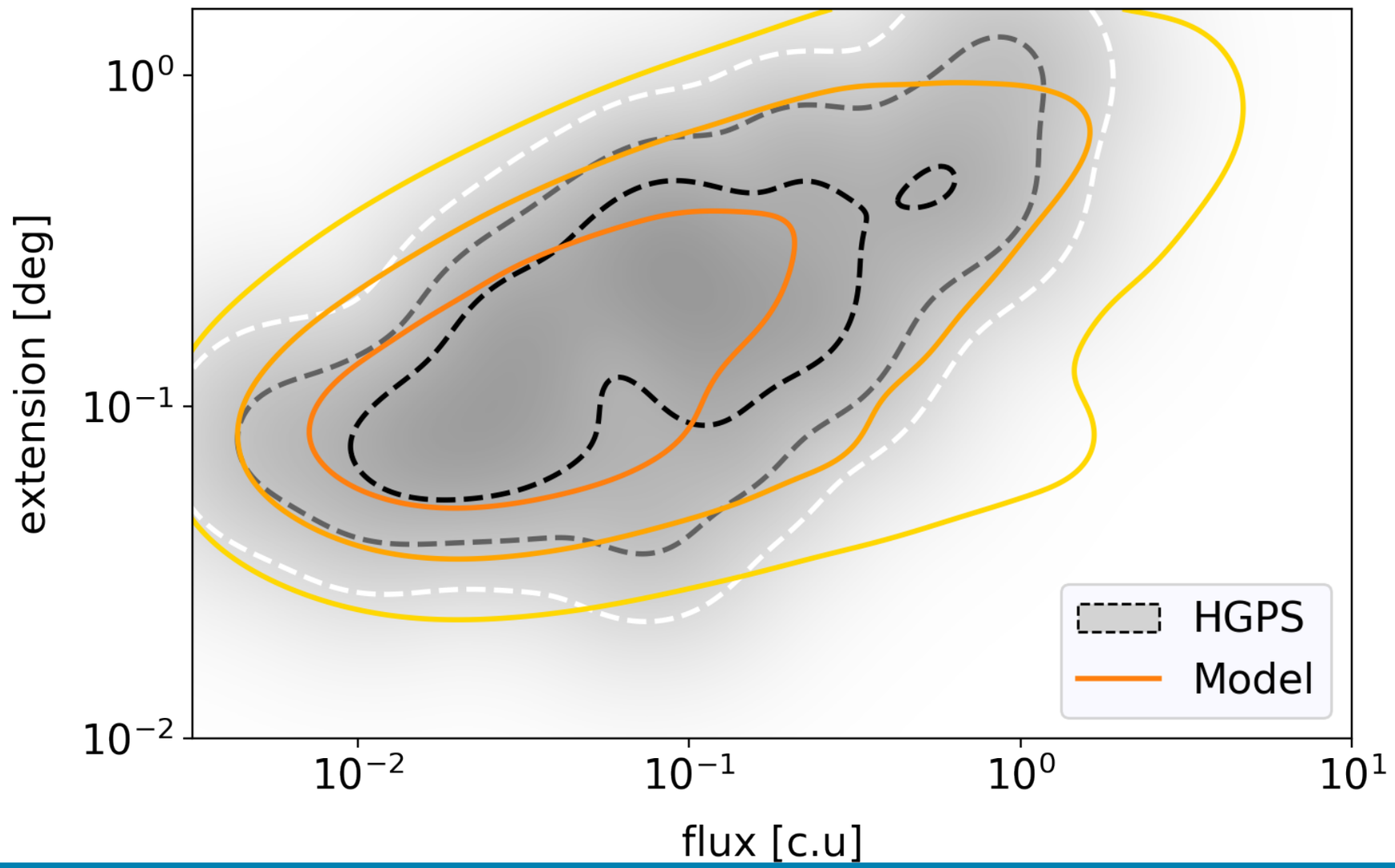


Comparing Simulation With Data - Spatial Distribution -

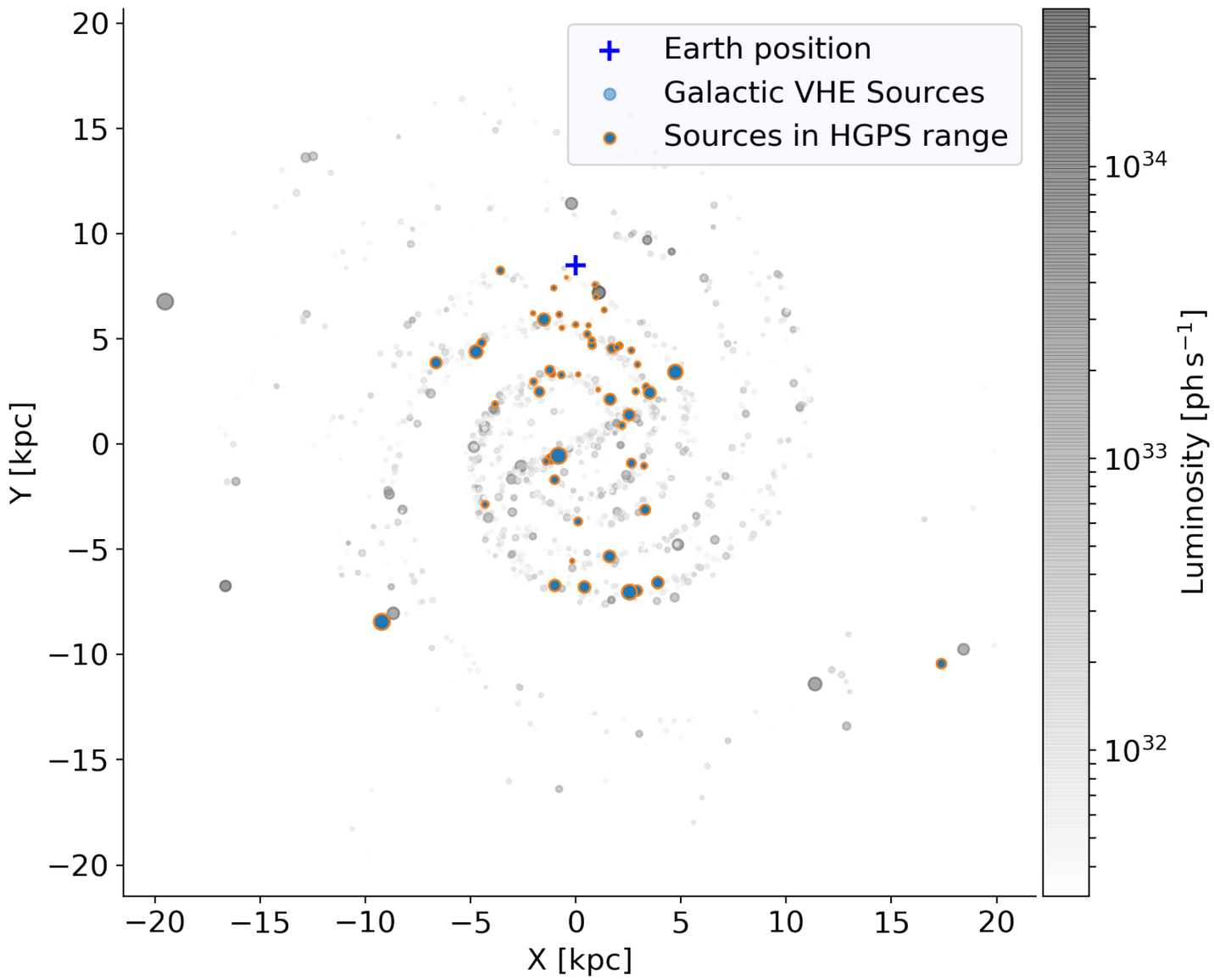




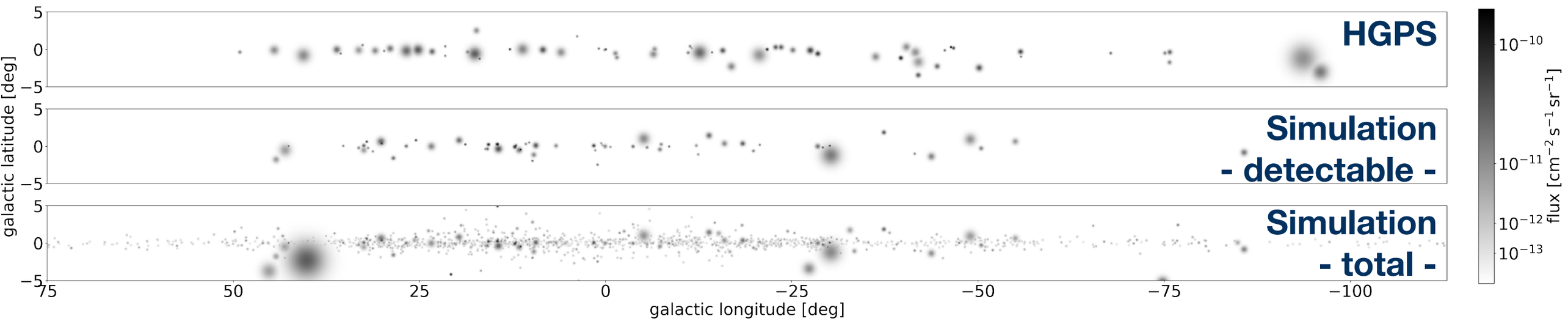
Comparing Simulation With Data
- Flux & Angular extension -



Example

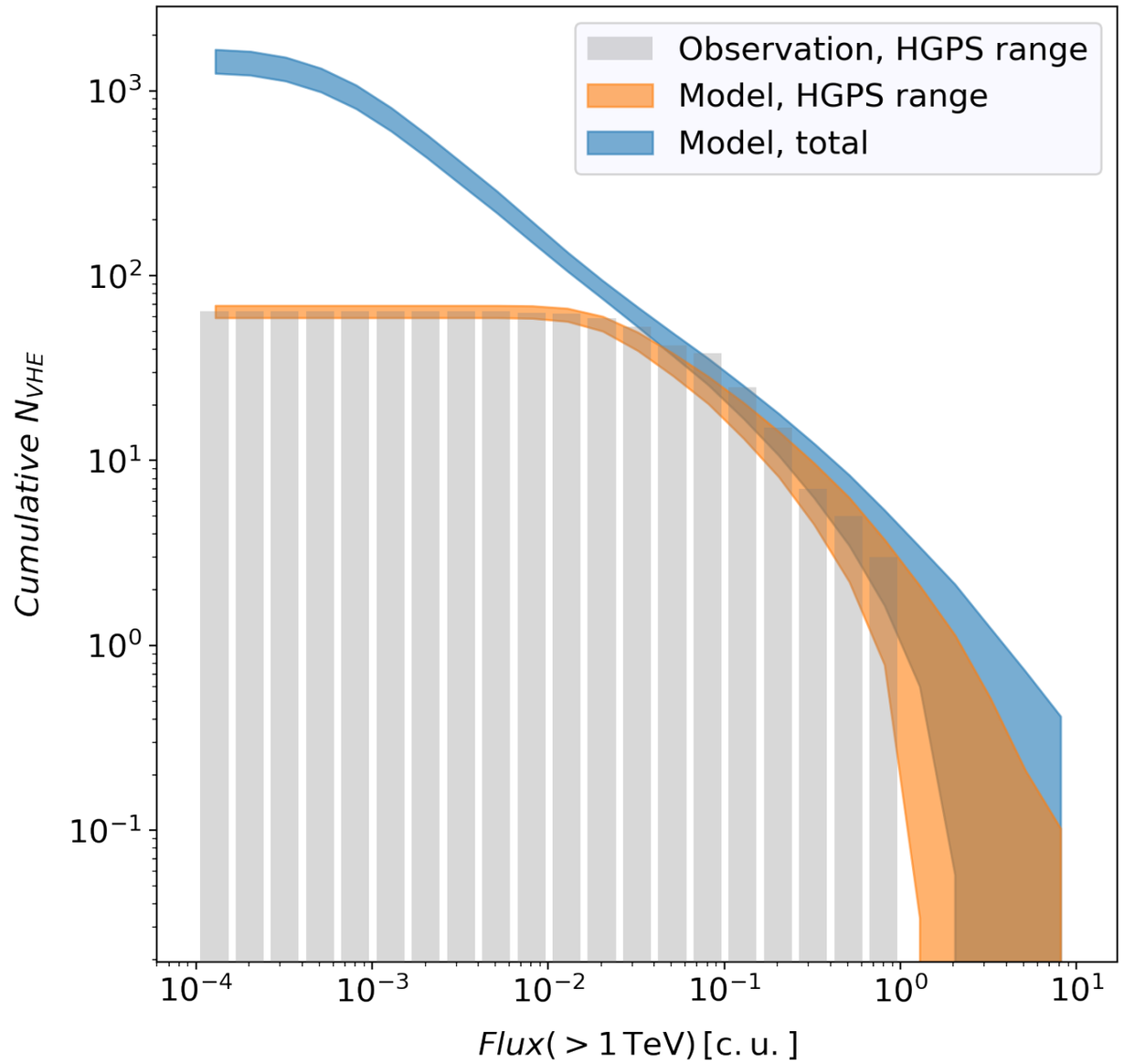

Earth position
Galactic VHE Sources
Sources in HGPS range
Y [kpc]
X [kpc]
Luminosity [ph s^{-1}]
20
15
10
5
0
−5
−10
−15
−20
10^{34}
10^{33}
10^{32}

Example


HGPS
Simulation
- detectable -
Simulation
- total -
galactic latitude [deg]
galactic longitude [deg]
flux [cm^{-2} s^{-1} sr^{-1}]
5
0
−5
75
50
25
0
−25
−50
−75
−100
10^{-10}
10^{-11}
10^{-12}
10^{-13}

Predictions

- Number of Galactic sources
  - total: ~ 1450
- Flux of Galactic sources
  - Detected / total in HGPS range: ~69%



Summary & Outlook

- We have presented a data-driven model of the Galactic population of VHE sources
- According to this model, the total number of VHE sources is around 1450, the total flux yet hidden in unresolved sources in the HGPS amounts to ~50% of the flux in detected sources
- Our simulations show that source confusion will play a major role for future instruments like CTA
- Application of this model to diffuse emission measurement in the HGPS - work in progress


Thank you for your attention!