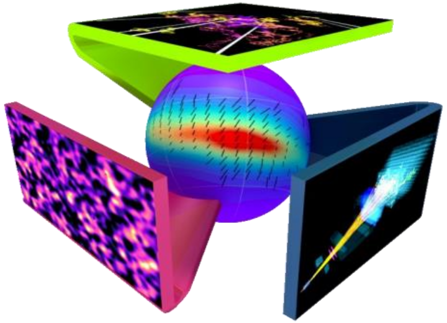


CRC 1491 –
Cosmic Interacting Matter
from source to signal

RUHR-UNIVERSITÄT BOCHUM

GAMMA RAY AND NEUTRINO EMISSION FROM THE GALACTIC CENTER

Cosmic Interacting Matter – Kickoff Meeting

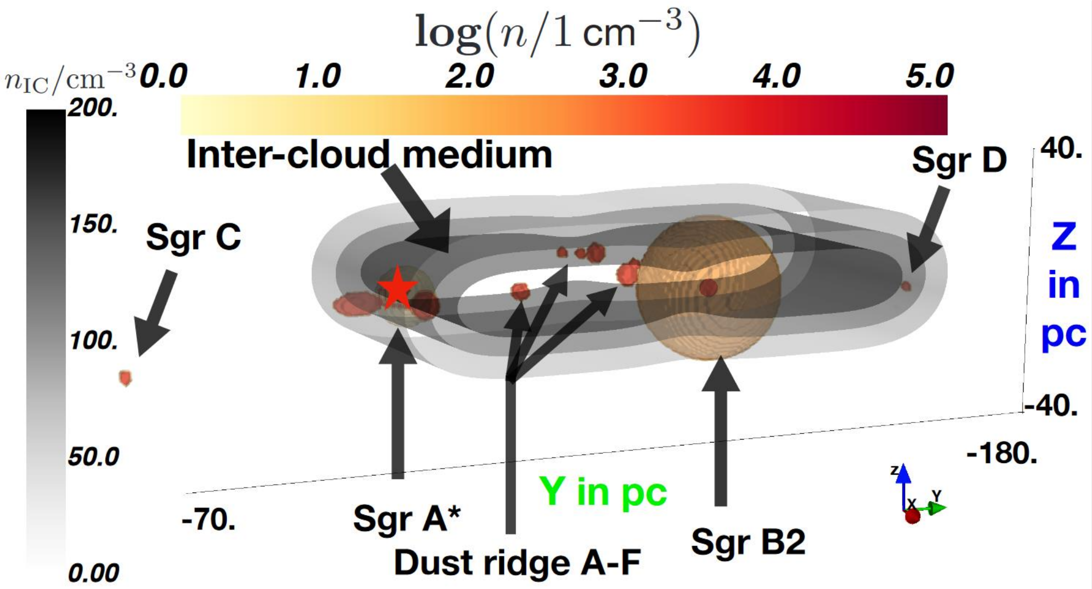
02.06.2022 – Julien Dörner

Galactic Center enviroment – gas distribution

- 13 molecular clouds
  (Guenduez et al. (2019))

- Central 10 pc structure
  (Ferriere et al. (2012))

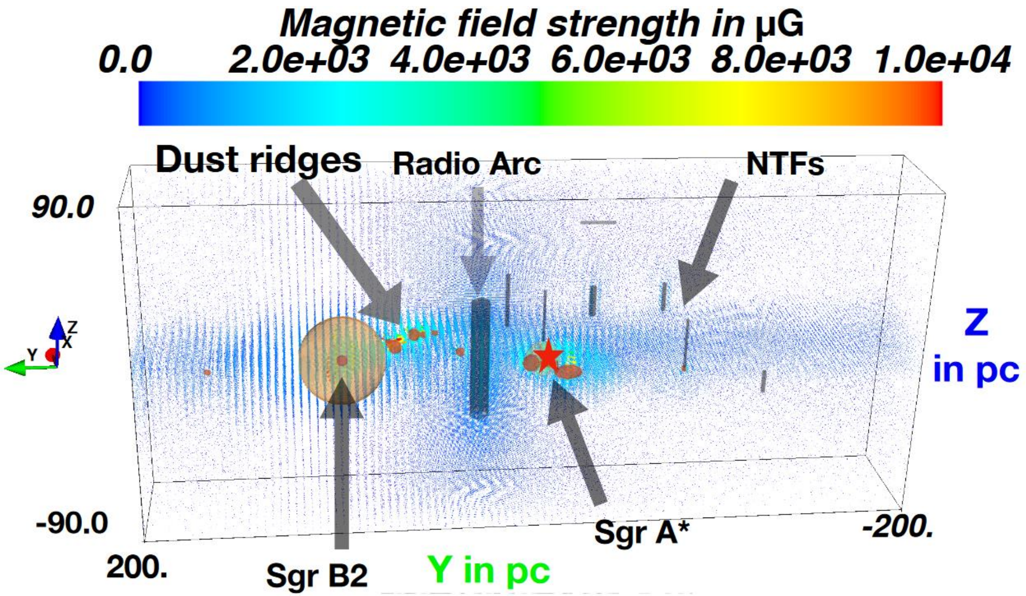
- diffuse intercloud component
  (Ferrire et al. (2007))



RAPP Center
RUB

Galactic Center enviroment – magnetic field

- 13 molecular clouds
- 7 non-thermal filaments
- Radio arc
- Inter-cloud component



*Guenduez+ A&A **644** (2020) A71*

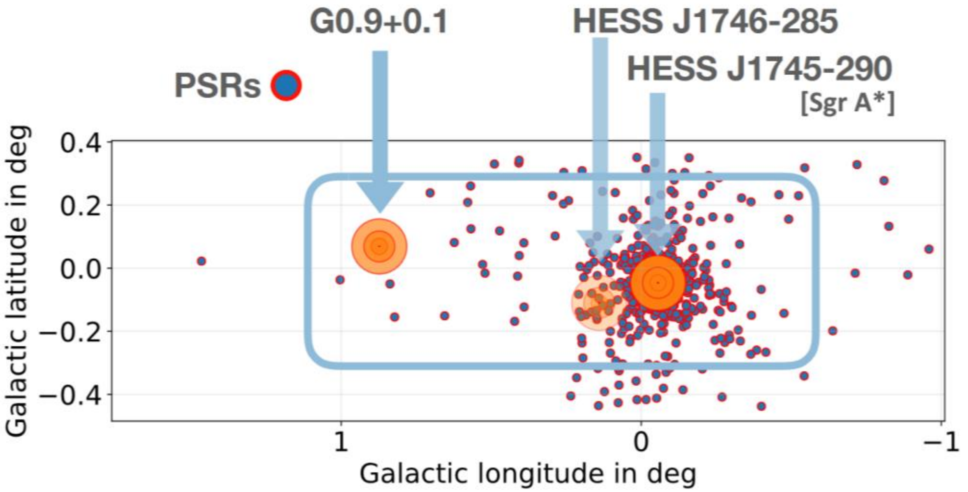
sources of cosmic rays

Testing different source setups:

- **Sgr A*** (also HESS J1745-290)
- **3sr** three SNR
- **uPSR** unresolved pulsar

$$dn/dr = k \cdot r^{-\alpha}$$

- **3sr + uPSR**
- **hom** homog. cylinder



Source	Contirbution [3sr]	Contribution [3sr + uPSR]
HESS J1745-290	72 %	58 %
HESS J1746-285	6 %	5 %
G0.9+0.1	22 %	18 %
uPSR	-	19 %

transport model

$$\frac{\partial n}{\partial t} = \nabla \cdot (\hat{\kappa}\, \nabla n) + \frac{\partial}{\partial E}\left[\frac{\partial E}{\partial t} n\right] + S(\vec{r}, E)$$

Diffusion:

- anisotropic in local magnetic field system
- $\hat{\kappa} = \mathrm{diag}(\kappa_\perp, \kappa_\perp, \kappa_\parallel) = \kappa_\parallel \cdot \mathrm{diag}(\epsilon, \epsilon, 1)$ for $\vec{B} = B\, \vec{e}_z$
- spatially constant
- Quasi-linear theory: $\kappa_\parallel = \kappa_0 \cdot \left(\frac{E}{4\ \mathrm{GeV}}\right)^{\frac{1}{3}}$

simulation

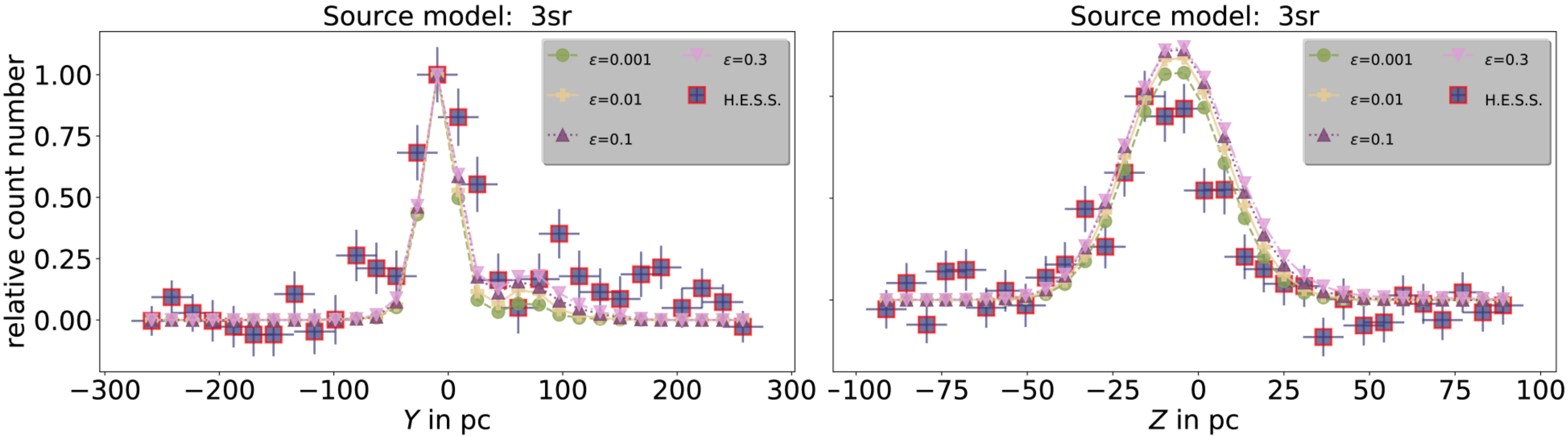
- Using CRPropa 3.1 with SDEs
- Protons (1 TeV – 1 PeV) $\frac{\mathrm{d}N}{\mathrm{d}E}|_s \propto E^{-\alpha_s}$

Interactions

- Hadronic interaction $p + p \rightarrow \pi^{\pm,0} \rightarrow \begin{cases} e^+ \ \nu_e \ \nu_\mu \ \bar{\nu}_\mu \\ e^- \ \bar{\nu}_e \ \bar{\nu}_\mu \ \nu_\mu \\ 2\gamma \end{cases}$
- Inverse Compton
- EM pair production

Find the best source model

- Compare latitudinal and longitudinal γ-ray emission with H.E.S.S data
- Calulate χ^2 for each scenario
- Best fit: **3sr**



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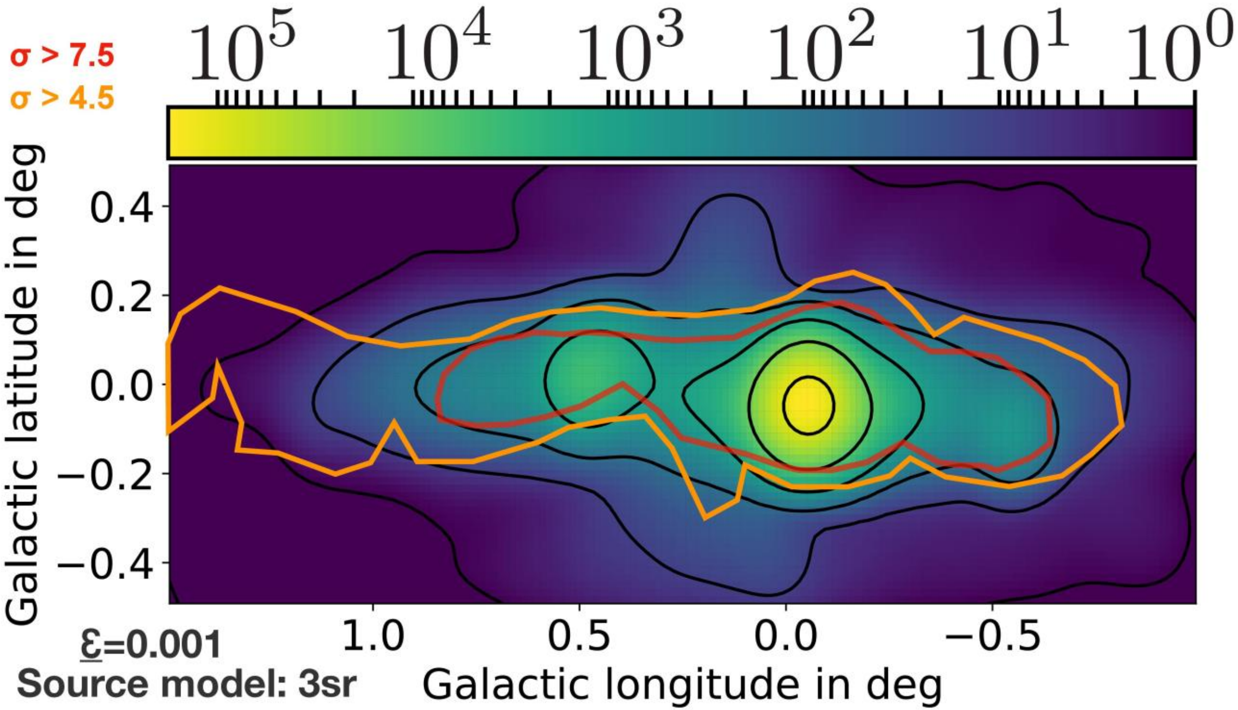
Compare 2d countmaps

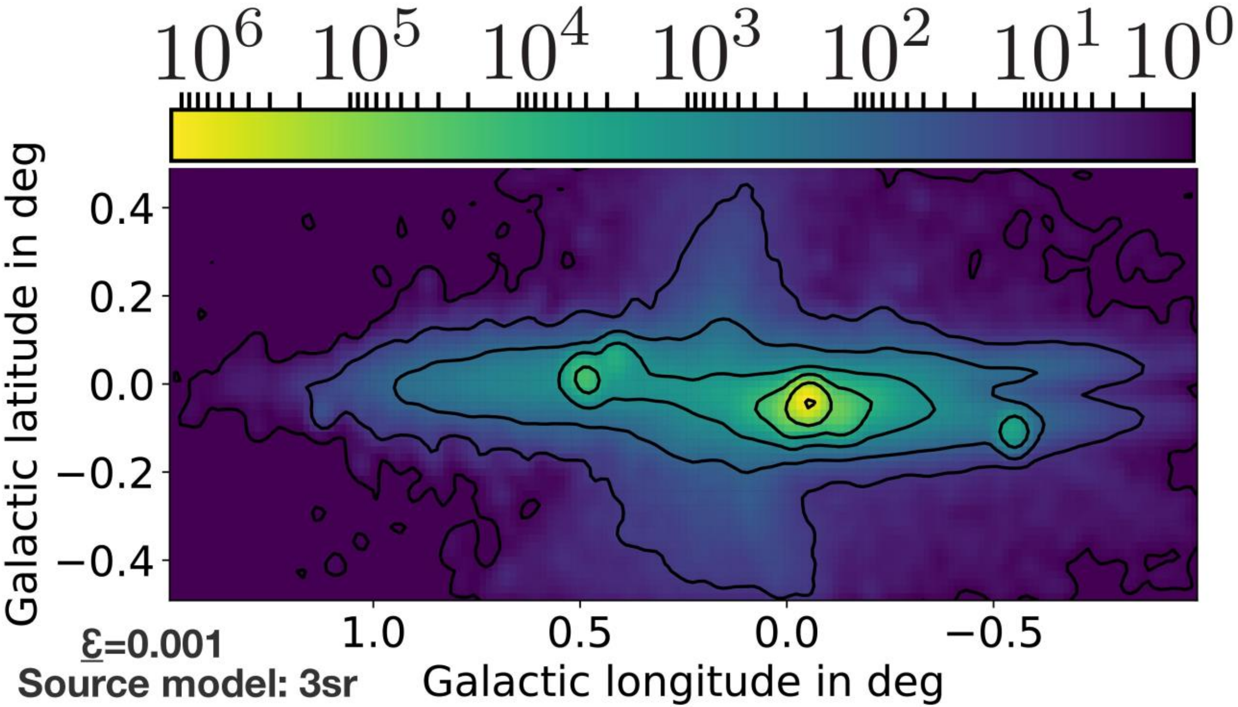


H.E.S.S. resolution

$\sigma = 0.077°$

RAPP Center RUB

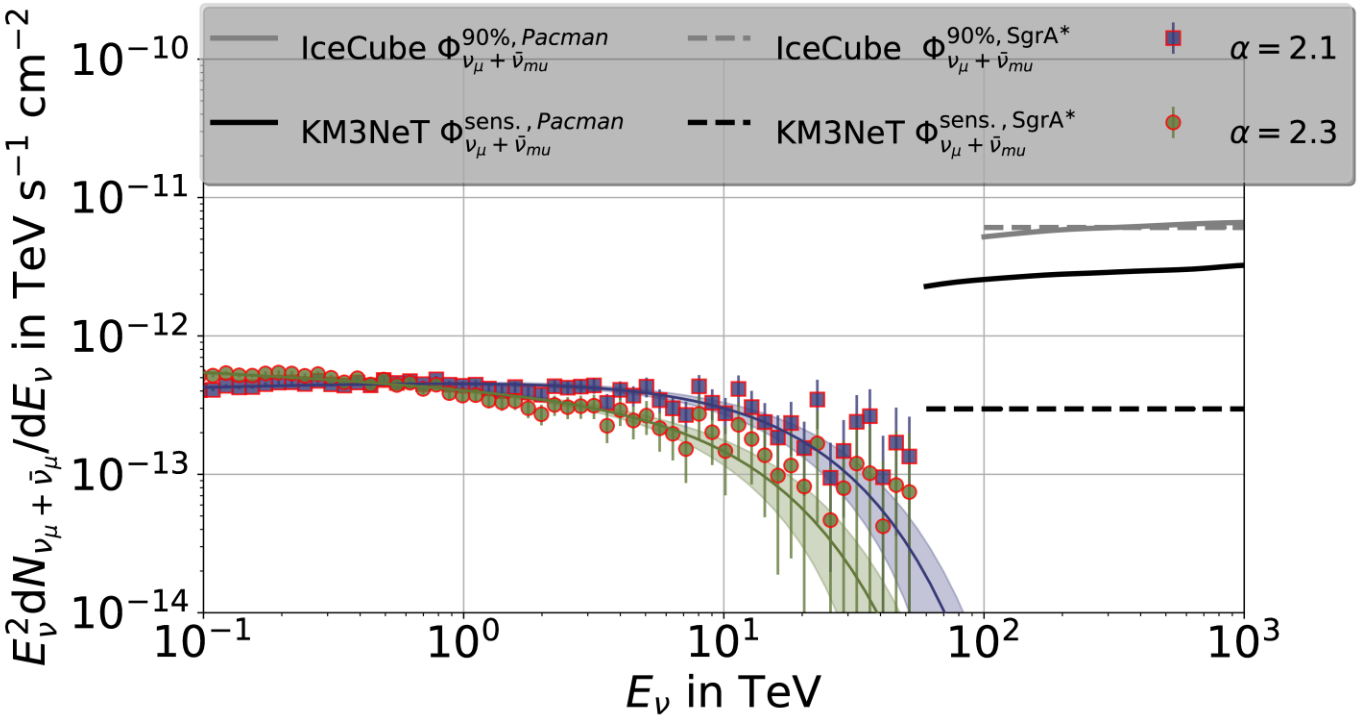
Compare 2d countmaps



CTA resolution

$\sigma = 0.03°$

Neutrino flux



Conclusion

- 3 dominant sources
- Distribution of (unresolved) pulsars does not match the data
- We expect dominating parallel diffusion $\kappa_{\perp}/\kappa_{\parallel} = 0.001$
- Some unresolved small-scale features → more detailed gas map
- Neutrino detection unlikely

Outlook (project A1)

- Outflow structure (advection)
- Structure of the Fermi-Bubbles
- Lower energy