



# Extended Very-High-Energy Gamma-Ray Emission around PSR J0622+3749: Constraints on the Diffusion Coefficient

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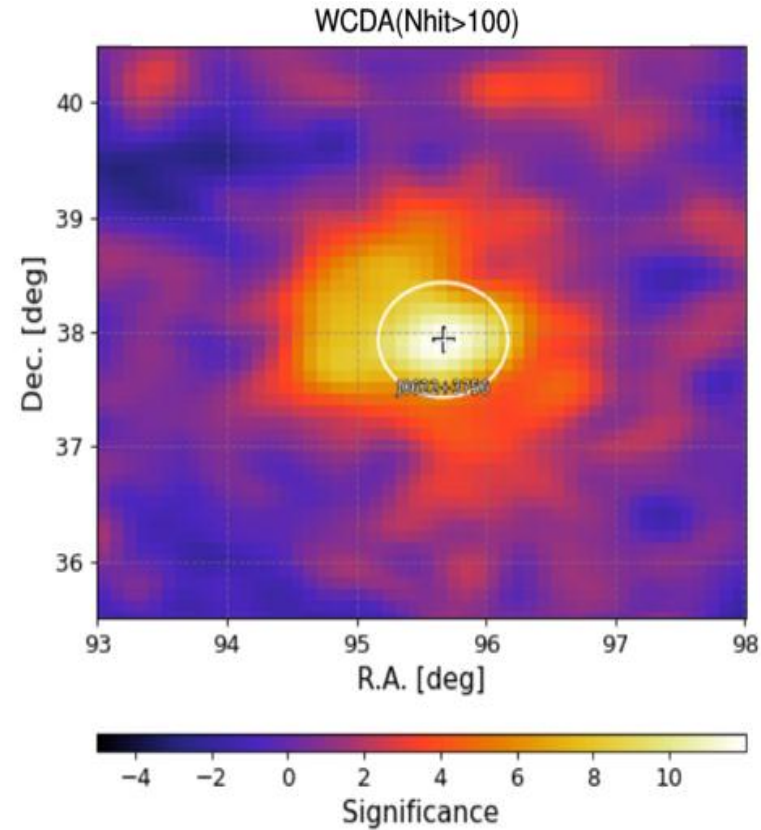
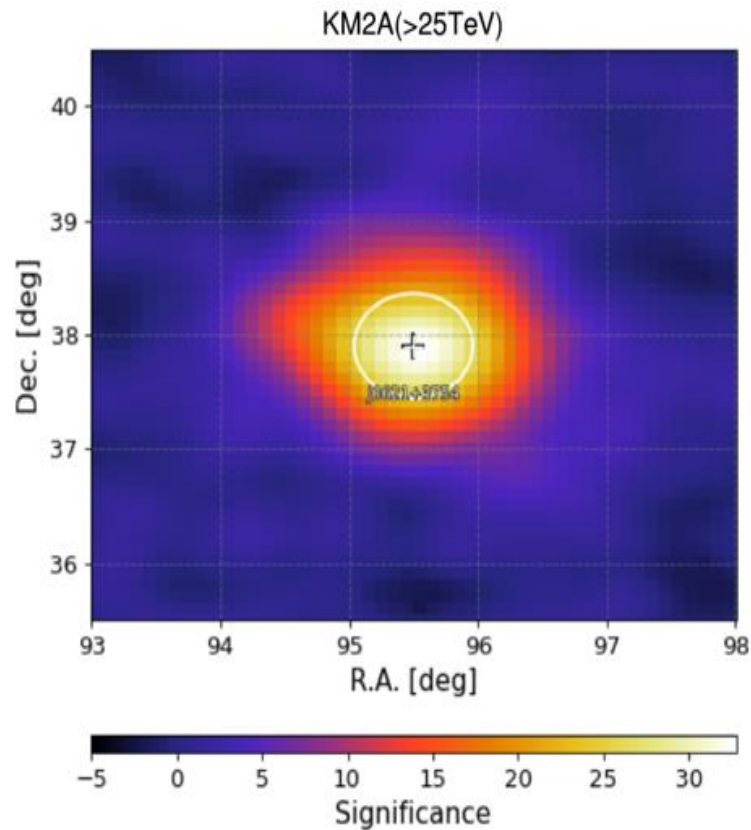
# Introduction

- Charged cosmic rays (CRs) are believed to propagate diffusively in the turbulent magnetic field of the Milky Way.
- The diffusion coefficient, which depends on the properties of the turbulent interstellar medium (ISM), is a key parameter governing CR propagation.
- We present an updated analysis of the extended very-high-energy (VHE) gamma-ray emission around the middle-aged (207.8 kyr) pulsar PSR J0622+3749 using LHAASO data, including the spatial significance (TS), energy spectrum, and constraints on the diffusion coefficient.
- These results provide new insights into the diffusion process of cosmic rays in the vicinity of the pulsar.

# Analysis

Data used:

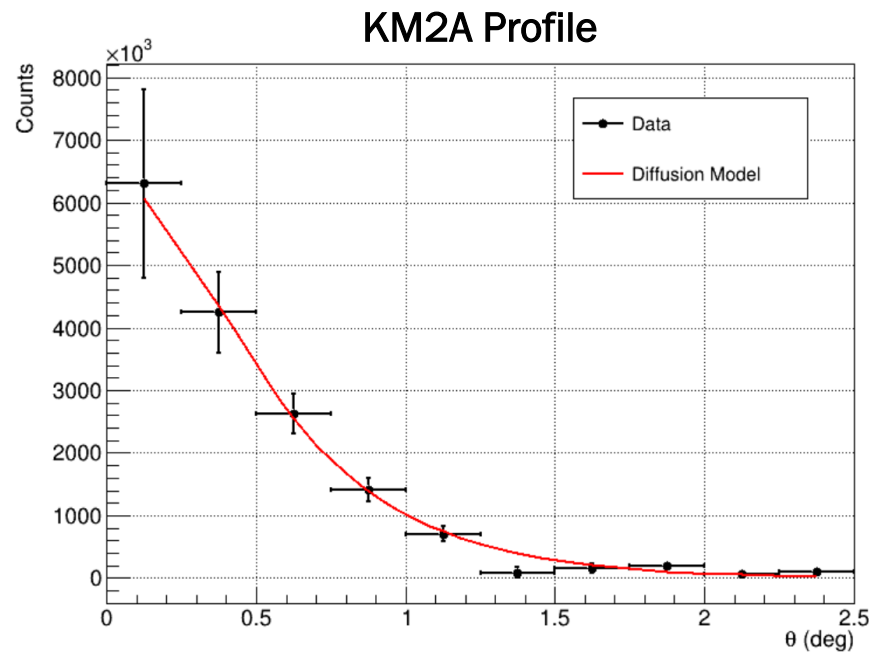
- LHAASO-WCDA: Cod, 2021.03 - 2025.07
- LHAASO-KM2A:  $\frac{3}{4}$  + full (- 2025.07)



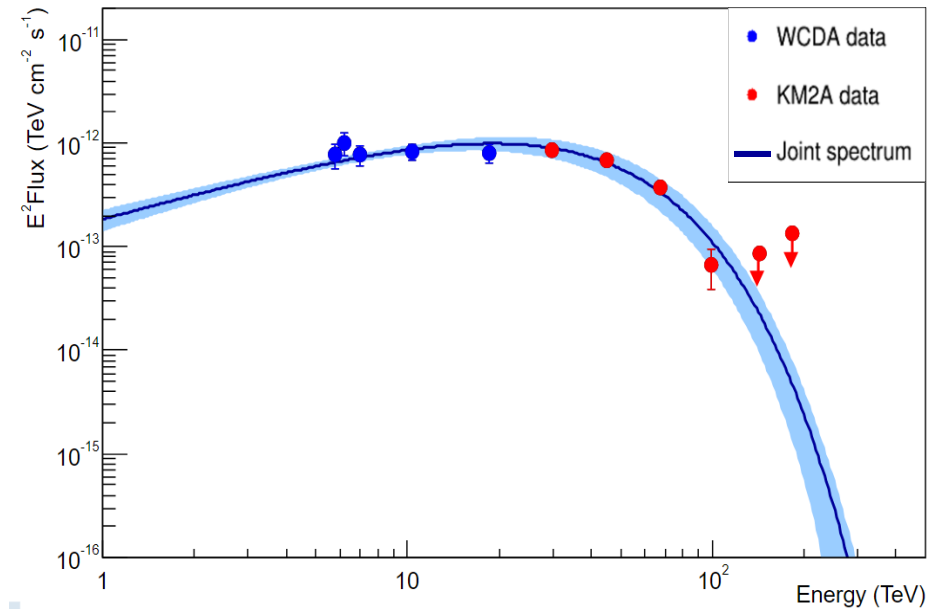
# Analysis

- The following formula is the **diffusion model** we use,  $\theta_d$  is a parameter,  $\theta$  is the distance from the source

$$f(\theta) \propto \frac{1}{\theta_d(\theta + 0.085\theta_d)} \exp[-1.54(\theta/\theta_d)^{1.52}]$$



- One-dimensional distribution of the > 25 TeV  $\gamma$ -ray emission.



- The energy spectrum obtained from the joint fitting of WCDA and KM2A. Shaded area shows 1 $\sigma$  confidence level

# Analysis



model	Data	R.A.	Dec.	$\sigma/\theta_d$	Flux	$\alpha$	$E_{cut}$	TS
Gaussian model	WCDA	$95.50 \pm 0.06$	$37.98 \pm 0.05$	$0.45 \pm 0.04$	$7.79 \pm 1.17$ @3TeV	$-1.66 \pm 0.35$	$33.75 \pm 29.76$	311
	KM2A	$95.53 \pm 0.03$	$37.92 \pm 0.02$	$0.45 \pm 0.02$	$1.15 \pm 0.86$ @50TeV	$0.55 \pm 0.68$	$12.76 \pm 2.28$	1808
	Joint fit	$95.52 \pm 0.03$	$37.93 \pm 0.02$	$0.45 \pm 0.02$	$1.80 \pm 0.15$ @7TeV	$-1.15 \pm 0.11$	$22.31 \pm 1.69$	2096
Diffusion model	WCDA	$95.51 \pm 0.06$	$37.96 \pm 0.04$	$1.37 \pm 0.17$	$9.31 \pm 1.50$ @3TeV	$-1.60 \pm 0.36$	$29.47 \pm 24.78$	316
	KM2A	$95.53 \pm 0.03$	$37.91 \pm 0.02$	$1.18 \pm 0.06$	$1.26 \pm 0.94$ @50TeV	$0.55 \pm 0.68$	$12.83 \pm 2.29$	1825
	Joint fit	$95.54 \pm 0.02$	$37.91 \pm 0.02$	$1.27 \pm 0.06$	$2.02 \pm 0.18$ @7TeV	$-1.16 \pm 0.11$	$22.58 \pm 1.75$	2116

- The energy spectrum and morphological parameters obtained from the 3D likelihood fit using Power law + Ecut.

Flux is with units of  $10^{14} \times 1/TeV \text{ cm}^2 \text{ s}$ .

# Analysis

- By solving the electron propagation equation:

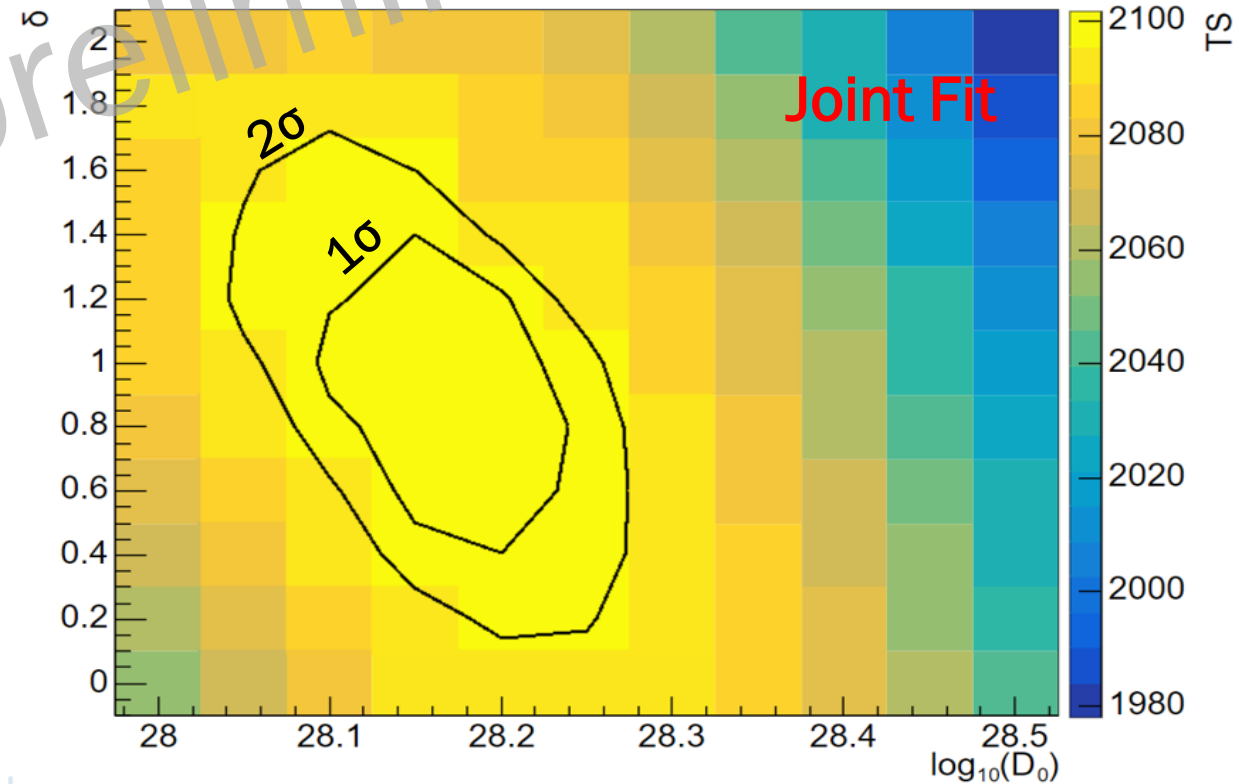
$$\frac{\partial N(E, \vec{r}, t)}{\partial t} = \nabla \cdot [D(E)\nabla N] + \frac{\partial}{\partial E} [b(E)N] + Q(E, \vec{r}, t)$$

diffusion      energy loss      source

$$D(E) = D_0 \left( \frac{E}{10 \text{ TeV}} \right)^\delta$$

we scan the parameter space of  $D_0$  ( $\text{cm}^2 \text{ s}^{-1}$ ) and  $\delta$ . For each pair of  $D_0$  and  $\delta$ , an electron spectrum fitting is performed.

- The source has an age of 207.8 kyr and is located at a distance of 1.6 kpc.





# Summary

- We used the latest data and found that this source shows **high significance** in both KM2A and WCDA.
- From the TS analysis, the results for the diffusion model morphology are **slightly better than** those for the Gaussian model.
- Preliminary results of the diffusion coefficient  $D_0$  and spectral index  $\delta$  indicate that the TS is relatively consistent with the diffusion model, while the value of the spectral index  $\delta$  **cannot be well constrained**.



Thanks for your listening.