

On the Potential Galactic Origin of the Ultra-High-Energy Event KM3-230213A

Mischa Breuhaus on behalf of the KM3NeT collaboration

The neutrino event KM3-230213A

- Detected by KM3NeT on 13. February 2023 at 01:16:47 UTC
- Published in nature on 12.02.2025
- Median neutrino energy: 220 PeV, 90% confidence range: 72 PeV - 2.6 EeV
- Galactic coordinates: $l = 216.1^\circ$, $b = -11.1^\circ$. 68% error: 1.5° , 99% error: 3.0°
- At least one order of magnitude more energetic than any neutrino detected so far



Preprint related to this poster

This poster summarises the results of a preprint published in arXiv under the following link:
<https://arxiv.org/abs/2502.08387>

You can scan the QR-code on the right to directly find the article



Scientific question: Can KM3-230213A be of Galactic origin?

Potential gas target

- Dominant neutrino production mechanism in the Milky Way: hadronic collisions
- Monoceros R2 (Mon R2) molecular cloud is within the error region
 - Distance from Earth: ~830 pc
 - Mass: $\sim 9 \times 10^4$ solar masses

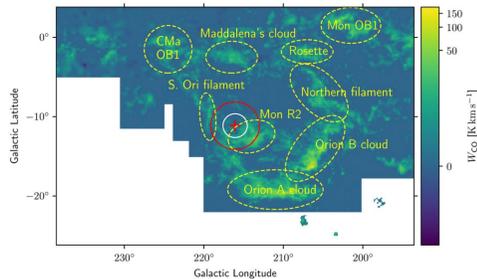


Figure: CO map from Dame et al. 2001 tracing molecular gas. Event position is marked by red cross, white and red circles show 68% and 99% containment radii

➔ Potential gas target for cosmic rays exists

Galactic diffuse emission

- Produced by diffuse cosmic rays in the Milky Way
- At KM3-230213A energies: negligible compared to e.g. a cosmogenic origin

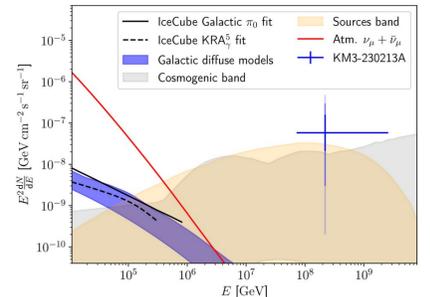


Figure: Diffuse models (blue band) compared to flux for KM3-230213A and expectations of extragalactic emission

➔ Can not explain KM3-230213A

Conclusion:

A Galactic origin is very unlikely

Limits from γ -rays

- Neutrino source expected to produce γ -rays too
- Sources < 1TeV: 4FGL J0616.2-0653, 4FGL J0624.8-0735, Mon R2 cloud
- No source at energies above
- No detection by HAWC \rightarrow limits on Galactic neutrino emission

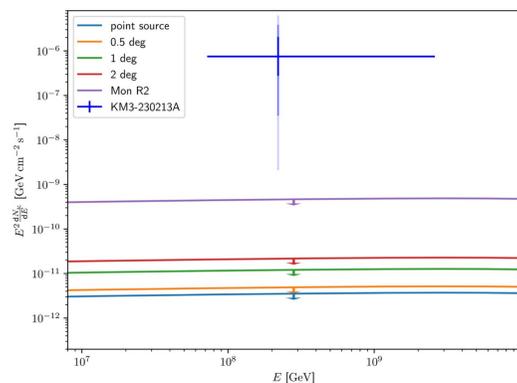


Figure: Point-source flux derived from KM3-230213A with limits on neutrino emission from HAWC non-detection for different source extensions and Mon R2

➔ Limits on Galactic neutrino flux well below the required neutrino flux

Potential cosmic ray accelerators

- Most Galactic accelerators struggle to reach the required energies
- Within error region: 2 weak stellar clusters (collective wind powers < 10^{34} erg/s)
- Within 5° radius: 3 additional weak stellar clusters, only weak pulsars (spin-down luminosities < 10^{33} erg/s)

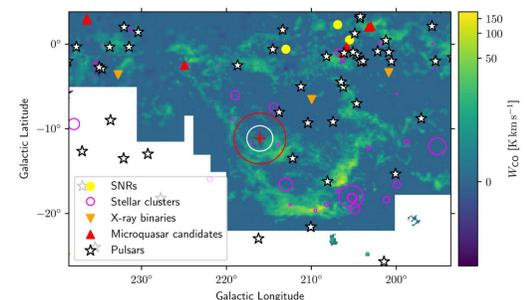


Figure: Positions of potential accelerators over the CO map of Dame et al. 2001. Neutrino event position marked with red cross, 68% and 99% containment radii are indicated with the white and red circles

➔ No known sufficiently powerful accelerator nearby

Contact details

Mischa Breuhaus, CPPM (Marseille, France)
 Email: breuhaus@cppm.in2p3.fr