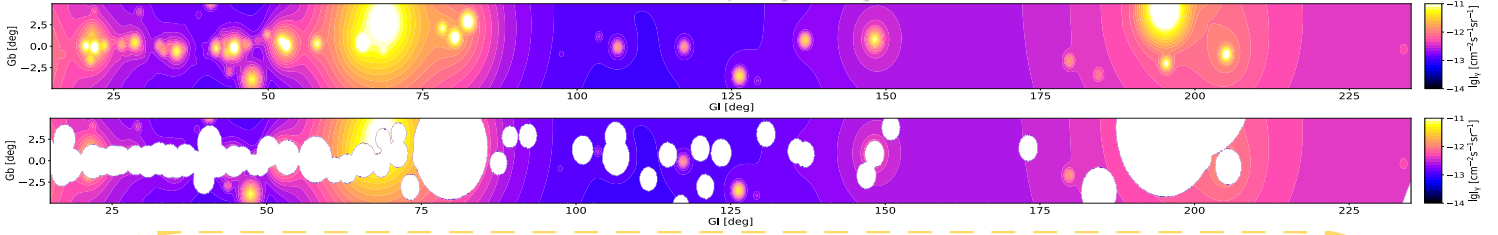


The high-energy diffuse gamma-ray emission and neutrino emission are expected from the Galactic plane, generated by hadronuclear interactions between cosmic rays (CR) and interstellar medium (ISM). Therefore, measurements of these diffuse emissions will provide important clues on the origin and nature of Galactic CRs. Comparing the latest observations of LHAASO and IceCube on the diffuse Galactic gamma-ray and neutrino emissions respectively, we suggest that the diffuse gamma-ray emission at multi-TeV energies contains a considerable contribution of a leptonic component. By modelling the gamma-ray halos powered by middle-aged pulsars in our Galaxy with taking into account the magnetic field configuration and the interstellar radiation field in the Galaxy, we demonstrate that the collective contribution of pulsar halos can account for the excess in the measured diffuse gamma-ray emission with respect to the prediction of CR-ISM interactions. The resulting one-dimensional profile along the Galactic longitude is also consistent with the observation.

25-100TeV intensity map from pulsar halos



➤ Neutrino intensity map from IceCube

➤ Pulsar halos as dominating sources of DGE at multi-TeV

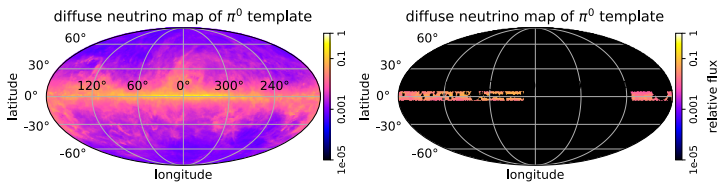


FIG. 1. Neutrino intensity map with the  $\pi^0$  template. Left panel: all-sky intensity map. Right panel: intensity map in the same ROI of LHAASO's DGE analysis, after removing the region out of the Galactic plane and masking the LHAASO source region.

(a) 2ID model, Inner Galactic Region

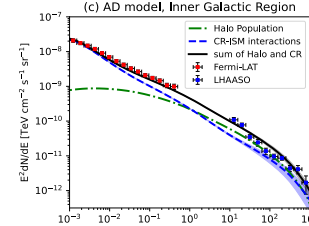
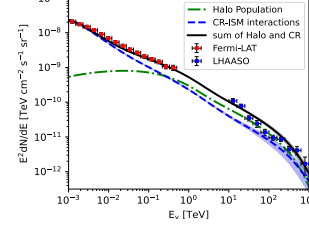


FIG. 3. Expected contribution of DGE from pulsar halos and CR-ISM interactions. Top panel: under the two-zone isotropic diffusion model (2ID model). Bottom panel: under the anisotropic diffusion model (AD model).

➤ Gamma-ray intensity map predicted by CR-ISM interactions

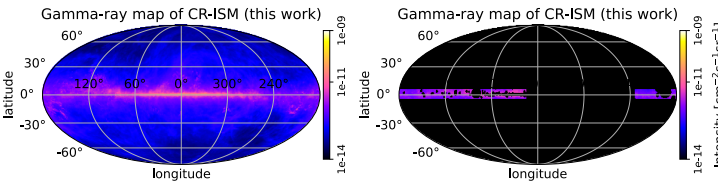


FIG. 2. All-sky diffuse gamma-ray intensity map in 10–1000 TeV predicted by the CR-ISM interaction model considered in this work.

➤ DGE converted from IceCube  $\nu$ , DGE predicted by the CR-ISM model and LHAASO's observations

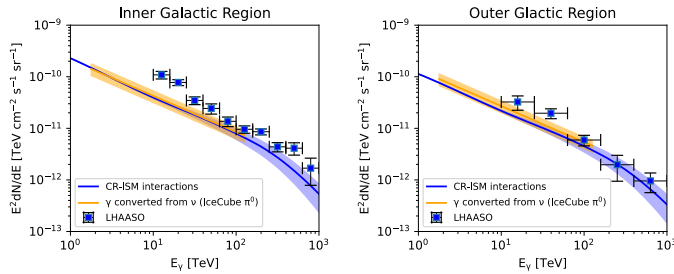


FIG. 2. Comparison of the DGE fluxes derived from different analyses in the inner Galactic plane (the left panel) and the outer Galactic plane (the right panel).

➤ Galactic longitudinal gamma-ray profile from pulsar halos consistent with LHAASO's observations

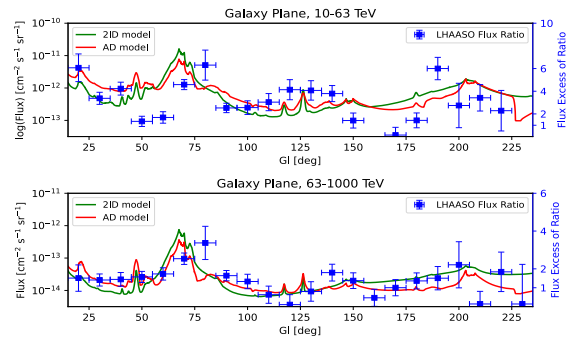


FIG. 4. Galactic longitudinal gamma-ray profile of predicted from pulsar halos. Also shown in the flux excessive ratio of LHAASO's measurement to the predicted one from CR-ISM interactions (blue squares).

## Conclusion:

- (1) Comparing the latest observations of LHAASO and IceCube on the diffuse Galactic gamma-ray and neutrino emissions respectively, we suggest that the diffuse gamma-ray emission at multi-TeV energies contains a considerable contribution of the leptonic origin.
- (2) The collective contribution of pulsar halos can account for the excess in the measured diffuse gamma-ray emission with respect to the prediction of CR-ISM interactions. And the resulting one-dimensional profile along the Galactic longitude is also consistent with the observation.

## References:

- [1] R.U. Abbasi et al., "Observation of high-energy neutrinos from the Galactic plane". Science 380, 6652, 1338-1343 (2023)
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