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Investigating the Origin of the Neutrino Excess in the Cygnus Bubble Core

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The Large High Altitude Air Shower Observatory (LHAASO) observed a giant γ-ray bubble from the direction of the Galactic star-forming region Cygnus-X. The morphology and the energy spectrum of the bubble suggest that these γ-rays are correlated to the interactions between cosmic rays and gas clumps, indicating the expectation of an extended neutrino counterpart. Using public IceCube muon-track data, we found hints of neutrino signals exceeding both the atmospheric background and isotropic astrophysical neutrinos within the bubble, with a post-trial significance of 1.7σ. Interestingly, within 0.7° of the bubble center, the neutrino signals show a notable excess over expectations, even if all γ-rays of Cygnus bubble are of hadronic origin. To explain observations, we proposed that neutrinos primarily originate from a central γ-ray hidden source, with the microquasar Cygnus X-3 dominating the excess. This finding hints at microquasars as potential sources of high-energy neutrinos. Next-generation neutrino telescopes at the $10\,\mathrm{km}^3$ scale could have the capability to identify these sources.

Collaboration(s)

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