

Mysterious ultra-high energy source investigated by astronomers

September 11 2023, by Tomasz Nowakowski



Significance map of the LHAASO J2108+5157 region using \sim 2400 days of data taken by HAWC. Credit: Kumar et al., 2023.



Astronomers from the University of Maryland and the Michigan Technological University, have inspected a mysterious ultra-high energy gamma-ray source known as LHAASO J2108+5157. Results of the study, published August 31 on the pre-print server *arXiv*, could help us unveil the true nature of this source.

Sources emitting gamma radiation with photon energies between 100 GeV and 100 TeV are called very-high energy (VHE) gamma-ray sources, while those with photon energies above 0.1 PeV are known as ultra-high energy (UHE) gamma-ray sources. The nature of these sources is still not well understood; therefore, astronomers are constantly searching for new objects of this type to characterize them, which could shed more light on their properties in general.

A team of astronomers led by University of Maryland's Sajan Kumar decided to take a closer look at one such UHE gamma-ray source designated LHAASO J2108+5157. It is a point-like source with an extension less than 0.39 degrees, known to be associated with the molecular cloud [MML2017]4607—located some 10,700 light years away.

Previous observation of LHAASO J2108+5157 detected no X-ray counterparts and it turned out that the closest X-ray source is the eclipsing binary RX J2107.3+5202 with the separation of about 0.3 degrees. Given that no powerful pulsars or supernova remnants have been detected so far in the vicinity of LHAASO J2108+5157, it is difficult to determine the origin of its gamma-ray emission as it can be explained either by hadronic and leptonic models.

Therefore, Kumar's team observed LHAASO J2108+5157 with the Very Energetic Radiation Imaging Telescope Array System (VERITAS) and the High-Altitude Water Cherenkov Observatory (HAWC) in order to shed more light on the emitted UHE <u>gamma-rays</u>.



The observations found no significant emission close to the position of LHAASO J2108+5158. The astronomers also performed spectral analysis on the circular region with the radius of 0.09 degrees around the position of LHAASO J2108+5157, measuring differential flux upper limits at 1.0, 3.98, and 15.38 TeV energy—consistent with previous studies.

The obtained upper limits exclude the hadronic model and suggest a leptonic origin of emission from few TeV to hundreds of TeV energy. However, the researchers noted that a new molecular cloud has been recently identified in the vicinity of LHAASO J2108+5157, what sheds more light on the origin of the observed gamma-ray emission.

"The morphology of this new cloud highly correlates with the LHAASO J2108+5157 gamma-ray emission up to 2 GeV from Fermi-LAT and emission detected by LHAASO. This makes it more likely that the gamma rays are produced through the hadronic channel with molecular cloud as the main target for the <u>cosmic ray particles</u> accelerated by unidentified PeVatrons," the <u>astronomers</u> concluded.

They added that future observations by CTA and analysis in the X-ray band are required in order to fully understand the nature of LHAASO J2108+5157.

More information: Sajan Kumar et al, VERITAS and HAWC observations of unidentified source LHAASO J2108+5157, *arXiv* (2023). DOI: 10.48550/arxiv.2309.00089

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Citation: Mysterious ultra-high energy source investigated by astronomers (2023, September 11) retrieved 12 May 2024 from <u>https://phys.org/news/2023-09-mysterious-ultra-high-energy-source-</u>



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