

## **Research Result Report**

### **ICRR Inter-University Research Program 2024**

Research Subject:

1. - Research focuses on the detection and observation of sources of high-energy cosmic and gamma radiation with the Alpaca experiment (under construction)
2. Research on PeV sources of cosmic rays (PeVatrons) to clarify the nature of gamma rays in a hadronic context, with synergies to radio astronomy to determine the density of nucleons (protons; hadrons), and with synergies to X-rays to complement the leptonic (electron) component.

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Participating Researchers:

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Summary of Research Result :

We have published three articles, one on Alpaca and two on the PeVatrons candidates LHAASO J2108+5157 and V4641 Sgr. The Alpaca publication is about the installation of the detector and the PeVatron's publications are about the investigation of the hadronic and leptonic components in the gamma-ray emission observed in these sources.

#### **1.- Alpaca:**

Anzorena, M., de la Fuente, E., Fujita, K., Garcia R., et al., 2025, Experimental Astronomy, Volume 59, Issue 1, id.13, DOI: 0.1007/s10686-025-09981-z

In the Alpaca experiment, a new method is presented that uses the muon lateral distribution and an underground muon detector to achieve a high discriminating power against hadrons.

## 2.- PeVatrons:

A) -- *PeVatron LHAASO J2107+5158*: Hadrons

Akash Gupta, Eduardo de la Fuente, Ram K. Yadav, Alicia Porras, et al. “Are Kronberger 80 and/or Kronberger 82 regions *PeVatron* candidates for LHAASO J2108+5157?”, Publications of the Astronomical Society of Japan, accepted April, 10<sup>th</sup>, 2025

This paper explains and quantifies for the first time why the star-forming regions in the vicinity of the PeV emission region LHAASO J2108+5157 cannot be considered as Pevatrons for the observed PeV emission.

B) -- *PeVatron V4641 Sgr*: Leptons

Suzuki, Hiromasa, Tsuji, Naomi, Kanemaru, Yoshiaki, ; Shidatsu, Megumi, Olivera-Nieto, Laura, Safi-Harb, Samar Kimura, Shigeo S., **de la Fuente, Eduardo** et al, “Detection of Extended X-Ray Emission around the *PeVatron* Microquasar V4641 Sgr with XRISM” The Astrophysical Journal Letters, Volume 978, Issue 2, id.L20, 7 pp..

In this paper, we explain that if the X-ray rays are of thermal origin, the measured extension, temperature and plasma density can be explained by a jet with a luminosity of  $\sim 2 \times 10^{39} \text{ erg s}^{-1}$ , which is comparable to the Eddington luminosity of this system.

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