Contribution ID: **263** Type: **not specified**

Galactic Cosmic Ray accelerators and Their multi-messenger Signals

Wednesday, 13 September 2023 14:45 (15 minutes)

The origin and acceleration mechanisms of Galactic cosmic rays (CRs) are still unknown. Gamma-ray observations have been crucial in identifying potential sites of CR acceleration. However, understanding these observations is challenging because both hadronic and leptonic processes can produce gamma rays, and different mechanisms may be responsible for accelerating various CR species. A multi-messenger approach that includes current and potential observations of radio, X-ray, gamma-ray, and neutrino signals is necessary to disentangle these complex acceleration mechanisms and emission processes. In this talk, I will present the latest findings from our research involving semi-analytical methods and accurate numerical simulations to study the multi-messenger emissions produced by nearby very-high-energy astrophysical accelerators, particularly wind bubbles associated with compact star clusters, and pulsar wind nebula.

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Session Classification: CCR: Charged Cosmic Ray

Track Classification: Charged Cosmic Rays