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Revising the TeV emission of microquasars; the case of Cygnus X-1

Cosmic rays (CRs) remain one of the most mysterious phenomena in modern physics, with their dominant sources and acceleration mechanisms still unresolved. While shock waves of supernova remnants (SNRs) have traditionally been considered the primary origin of Galactic CRs up to the "knee,"this view is increasingly challenged by the lack of consistent TeV counterparts and the discovery of non-SNR Galactic PeVatrons. These developments highlight the need to explore alternative CR accelerators. Black-hole X-ray binaries (BHXBs), the small-scale analogues of active galactic nuclei (AGN), are potential contributors to the Galactic CR spectrum. Recent quasi-stable ~100TeV detection of Cygnus X-1 and other BHXBs by LHAASO suggest CR escape from jets as a plausible mechanism for explaining such emissions. These detections open a new window for revisiting the role of microquasars in the TeV regime. Using a multi-zone, lepto-hadronic jet model, we leverage broadband multiwavelength data to probe BHXB jets. Specifically, we analyze the contribution of the jets to the radio-to-γ-ray spectrum of Cygnus X-1. In this work, we adopt a leptonic jet at launching that is mass-loaded with baryons further out due to the wind of the accretion disc. We investigate how varying proton acceleration assumptions impact jet properties, CR escape efficiency, and the observed spectra. We further examine how such a mass-loading jet model and escape can explain the GeV-to-TeV regime that strongly depends on the multiwavelength emission. Ultimately, BHXBs emerge as compelling candidates for understanding the Galactic CR landscape alongside traditional SNRs.

Contribution

Oral talk

Affiliation

Lapht/CNRS

E-mail

kantzas@lapth.cnrs.fr

Author: KANTZAS, Dimitrios (LAPTh/CNRS)

Presenter: KANTZAS, Dimitrios (LAPTh/CNRS)

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