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Gamma-ray signatures of particle acceleration at stellar wind termination shocks up to PeV energies

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Young massive stellar clusters have recently brought attention as PeVatrons candidates, to explain the knee of the cosmic ray spectrum and how protons can be accelerated to such energy scale in galactic sources. The new detector LHAASO is the first to probe well the photon detection band >0.1 PeV, that can correspond to multi-PeV hadronic cosmic rays. Thus, it enables the use of its gamma-ray data to constrain the galactic particle acceleration models and parameters, and to identify the contribution from the different categories of galactic accelerators to the observed cosmic ray flux, especially in the PeV domain.

To that extent, we model the escape and the transport of cosmic rays from their accelerator to molecular clouds, where a lot of p-p interactions producing gamma rays occur. We are focusing on the case where the source is a young massive star cluster, hence the particles are accelerated in stellar wind termination shocks before escaping. We try to determine in a semi-analytical approach the parameters needed (distance between cloud and source, time, slope of injection, number of stars, etc) to produce an excess in the gamma-ray flux corresponding to PeV cosmic rays, that could be detectable by LHAASO. This enables to constrain the subspace of the parameter space for which a detectable excess could exist, and therefore constrains the subset of systems (cluster+cloud) that could produce such an excess. Then, the goal is to find such systems and compare predictions of the models for the gamma-ray flux to LHAASO data in order to determine more precisely different acceleration parameters, such as the wind termination shock efficiency or the injection spectrum in the interstellar medium. Another goal is to try to explain some of the dark PeVatrons seen by LHAASO with systems star cluster+cloud.

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