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Deciphering the gamma-ray emisson from the Cygnus region

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The Cygnus X region has become a source of great interest since its detection in gamma-rays by Fermi, HAWC and recently LHAASO, the latter having measured photon energies above 1 PeV. This likely indicates the presence of a hadronic source of PeV cosmic rays in the region, although the accelerator has not been yet identified. The emission is coincident with the stellar association Cygnus OB2, which hosts hundreds of OB stars and 3 Wolf-Rayet stars distributed within about 15 pc. The feedback of these powerful stars, through interacting stellar winds, a priori provides efficient channels for particle acceleration up to very high energies. Collective processes around the centre of the cluster, acceleration around large-scale wind termination shocks or supernova events are possible scenarios to account for the gamma-ray emission. In order to identify the most plausible mechanisms contributing to the nonthermal processes in the region, we have run large-scale hydrodynamic simulations, resolving individual massive star winds and their interactions. I will show in this talk that these simulations rule out several of the aforementionned acceleration scenarios, in particular because Cygnus OB2 is too extended to enable efficient stellar wind interactions at large scales. I will then present a detailed model of plausible acceleration processes. In the end it seems that the gamma-ray spectrum can only be understood by invoking recent supernovae explosions in the Cygnus X region or a contribution from the Cygnus X-3 microquasar at the highest energies.

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