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High-energy Neutrino and Gamma Ray Emission from Clusters-like Perseus

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We calculate the high-energy gamma-ray and neutrino emissions from galaxy clusters like Perseus that host active galactic nuclei (AGNs). Our primary objective is to distinguish the emission from the central source, such as NGC1275, from the diffuse emission originating in the outskirts of the Perseus cluster. Due to unique magnetic-field configuration, CRs with energy ≤ 10ˆ17 eV can be confined within these structures over cosmological time scales, and generate secondary particles, including neutrinos and gamma-rays, through interactions with the background gas and photons. We employ three-dimensional cosmological magnetohydrodynamical simulations of structure formation to model the turbulent intracluster medium (ICM). We propagate CRs in ICM and intergalactic medium using multi-dimensional Monte Carlo simulations, considering all relevant photohadronic, photonuclear, and hadronuclear interactions. We also include the cosmological evolution of sources like Perseus. By comparing our results with the existing upper limits from IceCube for galaxy clusters and the sensitivity of CTA, we predict that these observatories could potentially establish a new class of astrophysical sources capable of emitting high-energy multi-messenger signals. We also compute the contribution from clusters like Perseus to the diffuse neutrino and gamma-ray background.

Collaboration(s)

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