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Neutrinos from Clusters of Galaxies and Radio Constraints

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Cosmic-ray (CR) protons can accumulate for cosmological times in clusters of galaxies. Their hadronic interactions with protons of the intra-cluster medium (ICM) generate secondary electrons, gamma-rays and neutrinos. In light of the high-energy neutrino events recently discovered by the IceCube observatory, we estimate the contribution from galaxy clusters to the diffuse gamma-ray and neutrino backgrounds. For the first time, we consistently take into account the synchrotron emission generated by secondary electrons and require the clusters radio counts to be respected. For a choice of parameters respecting current constraints from radio to gamma-rays, and assuming a proton spectral index of -2, we find that hadronic interactions in clusters contribute by less than 10% to the IceCube flux, and much less to the total extragalactic gamma-ray background observed by Fermi. They account for less than 1% for spectral indexes <-2. The high-energy neutrino flux observed by IceCube can be reproduced without violating radio constraints only if a very hard (and speculative) spectral index >-2 is adopted. However, this scenario is in tension with the high-energy IceCube data, which seem to suggest a spectral energy distribution of the neutrino flux that decreases with the particle energy. We stress that our results are valid for all kind of sources injecting CR protons into the ICM, and that, while IceCube can to test the most optimistic scenarios for spectral indexes $\geq$-2.2 by stacking few nearby massive galaxy clusters, they cannot give any relevant contribution to the extragalactic gamma-ray and neutrino backgrounds in any realistic scenario.

Collaboration

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72

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