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Photo-hadronic pair creation and neutrino production in magnetospheric current sheets of accreting black holes

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Non-jetted AGN exhibit hard X-ray emission with a power law spectrum above ∼2 keV, which is thought to be produced through Comptonization of soft photons by electrons and positrons (pairs) in the vicinity of the black hole. The origin and composition of this plasma source, known as the corona, is a matter open for debate.

Our study focuses on the role of relativistic protons accelerated in black-hole magnetospheric current sheets in the pair enrichment and neutrino production of AGN coronae. We present a model that has two free parameters, namely the proton plasma magnetization $\sigma_{\rm p}$, which controls the peak energy of the neutrino spectrum, and the Eddington ratio $\lambda_{\rm Edd}$ (defined as the ratio between X-ray luminosity $L_{\rm X}$ and Eddington luminosity $L_{\rm Edd}$), which controls the amount of energy transferred to secondary particles.

Our results indicate a strong dependence of the secondary pair density on the Eddington ratio. More specifically, when $\lambda_{\rm Edd}$ exceeds a critical value $\lambda_{\rm Edd,crit} \propto \sigma_{\rm p}^{-1}$, in which photohadronic interactions in the magnetospheric region can produce enough secondary pairs to create coronae with Thomson optical depths, $\tau \sim 0.10 - 10$. We also present the predicted high-energy neutrino spectrum and discuss our results in light of the recent IceCube observations of TeV neutrinos from NGC 1068, NGC 4151 and CGCG 420-015. Moreover we apply our model on a population of non-blazar AGN sources providing a prediction of the stacked neutrino flux. The latter analysis lies below the IceCube upper limits with NGC 1068 being one of the most dominant contributors to the stacked spectrum.

Collaboration(s)

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