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A two-zone model for blazar emission: implications for TXS 0506+056 and the neutrino event IceCube-170922A

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A high-energy muon neutrino event, IceCube-170922A, was recently discovered in both spatial and temporal coincidence with a gamma-ray flare of the blazar TXS 0506+056. It has been shown, with standard one-zone models, that neutrinos can be produced in the blazar jet via hadronic interactions, but with a flux which is mostly limited by the X-ray data. In this work, we explore the neutrino production from TXS 0506+056 by invoking two physically distinct emission zones in the jet, separated by the broad line region (BLR). Using the Doppler-boosted radiation of the BLR as the target photon field, the inner zone accounts for the neutrino and gamma-ray emission via p-gamma interactions and inverse Compton scattering respectively, while the outer zone produces the optical and X-ray emission via synchrotron and synchrotron self-Compton processes. The different conditions of the two zones allow us to suppress the X-ray emission from the electromagnetic cascade, and set a much higher upper limit on the muon neutrino flux than in one-zone models. We compare, in detail, our scenario with one-zone models discussed in the literature, and argue that differentiating between such scenarios will become possible with next generation neutrino telescopes, such as IceCube-Gen2.

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