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Modelling photon transport in the vicinity of neutrino source TXS 0506+056

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In September 2017, the IceCube Neutrino Observatory detected an extremely-high-energy neutrino event, consisting of a muon coming from the bottom of the detector through the Earth, likely originated by a neutrino of energy of around 290 TeV. Promptly alerted, the Fermi LAT and MAGIC collaborations detected at more than 5σ a flare from the known gamma-ray blazar TXS 0506 +056, at a redshift ~0.34, within the region of sky consistent with the 50% probability region of the IceCube neutrino (of about one degree in size). The MAGIC detection allowed to determine a cutoff for the electromagnetic emission at ~400 GeV. The associated emission of gamma rays and neutrinos from the same source hints at an "hadronic mechanism"for the production of high energy cosmic rays.

In this paper we present a characterization of the photon fields and photon transfer in the vicinity of blazar TXS 0506+056 in order to characterize the properties of the emitting region. This was done under the assumptions of a true association between the detected neutrino and the active state blazar and that the neutrino and electromagnetic emission arise from the same spatial region.
The produced photon spectrum is expected to be similar to that of neutrinos, but photon energy is likely to degrade due to interactions, both with nearby fields and, along their path to Earth, with the extragalactic background light (EBL). Taking as a starting point the reported energy difference between the neutrino and electromagnetic components, a Monte-Carlo simulation of the evolution of an electromagnetic shower in the appropriate environment was implemented in order to extract the relevant features of the photon transport. The results can be used to constrain the size of the emitting region, a crucial parameter for many models of the electromagnetic emission of blazars.

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Summary

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