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Insights from leptohadronic modelling of the brightest blazar flare

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The blazar 3C 454.3 experienced a major flare in November 2010 making it the brightest γ-ray source in the sky of the *Fermi*-LAT. Motivated by the 3σ association of a $gtrsim290$ TeV muon neutrino IceCube170922A with an electromagnetic flare in TXS 0506+056 and noting that 3C 454.3 was $\sim$ 100 times brighter than TXS 0506+056, we enquire what level of the neutrino flux we could expect from the brightest blazar flare of 3C 454.3. We obtain seven daily consecutive spectral-energy distributions (SEDs) of the flare with publicly available multiwavelength data. We simulate the physical conditions in the blob during the flare and obtain a robust upper limit to the amount of high-energy protons in the jet of 3C 454.3 from the electromagnetic SED using the high statistics of X-ray data. We construct a neutrino light curve of 3C 454.3 and estimate the expected neutrino yield at energies $\geq$ 100 TeV for 3C 454.3 to be up to 6×10^{-3} muon neutrinos per year. We show that if the acceleration timescale for protons is as slow as for electrons the peak of the neutrino SED happens around 100 TeV - 1PeV. If protons have a more efficient acceleration, the peak energy of the neutrino SED can be as high as $\sim$ 100 PeV, similar to the energy of the recently discovered KM3-230213A neutrino. Finally, we extrapolate our model findings to the light curves of all *Fermi*-LAT flat-spectrum radio quasars. We find that next-generation neutrino telescopes are expected to detect approximately one multimessenger ($\gamma + \nu_\mu$) flare per year from bright blazars with neutrino peak energy in the hundreds TeV - hundreds PeV energy range and show that the electromagnetic flare peak can precede the neutrino arrival by months to years.

Collaboration(s)

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