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Proton synchrotron, an explanation for possible extended VHE gamma-ray activity of TXS 0506+056 in 2017

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TXS 0506+056, source of the extreme energy neutrino event, IceCube-170922A, has an interesting environment to study the lepto-hadronic emissions. The Fermi-LAT detector reported high energy (HE) γ-ray flare between 100 MeV and 100 GeV starting from 15 September 2017 from this source. Several follow-ups to trace the very high energy (VHE) gamma-ray counterparts around the IceCube-170922A resulted in no success around 22 September 2022. Only after 28 September, the Major Atmospheric Gamma-ray Imaging Cherenkov (MAGIC) telescopes observed the first VHE gamma rays from the blazar above 100 GeV. The ~41 h survey resulted in VHE γ-ray activity until 31 October 2017, nearly 45 days after the HE flare. Here we propose the extended GeV γ rays can be explained by taking two production channels, electron synchrotron self Compton and proton synchrotron for HE and VHE emissions, respectively. The 45 days of VHE emission from the peak of the HE flare can be explained with L′p⊠1047 erg/sec in the jet frame and magnetic field of 2.4 G, consistent with the LEdd for a blackhole mass 5×109 M⊠. With the same luminosity of accelerated protons, we explained the observed neutrino flux with proton-varying-ambient interaction.

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