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A Neutral Beam Model for High-Energy Neutrino Flares from TXS 0506+056

The IceCube collaboration reported a $\sim 3.5\sigma$ excess of 13 ± 5 neutrino events in the direction of the blazar TXS 0506+056 during a $\sim$6 month period in 2014-2015, as well as the multi-messenger flare of neutrinos and gamma rays with $\sim 3\sigma$ in 2017. We explore the possibility that both events are explained in the context of the neutral beam model of blazar jets. We demonstrate that the neutral beam model gives a consistent explanation for the 2014-2015 flare without violating X-ray and gamma-ray constraints, and naturally enhances the neutrino flux by a factor of a few for the 2017 flare. The model implies that blazars, like TXS 0506+56, are efficient accelerators of light cosmic-ray nuclei, such as helium, and that cosmic-ray ions have to carry a significant fraction of the power released via mass accretion onto the central supermassive black hole.

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