Contribution ID: **46** Type: **Oral presentation**

Star-Jet Interactions and Gamma-Ray Flares

Monday, 26 October 2015 17:28 (15 minutes)

We propose a model to explain the ultra-bright GeV gamma-ray flares observed from the blazar 3C454.3. The model is based on the concept of a relativistic jet interacting with compact gas condensations produced when a star (red giant) crosses the jet close to the central black hole. The study includes an analytical treatment of the evolution of the envelop lost by the star within the jet, and calculations of the related high-energy radiation.
The model readily explains the day-long, variable on timescales of hours, GeV gamma-ray flare from 3C454.3, observed during November 2010 on top of a weeks-long plateau. In the proposed scenario, the plateau state is caused by a strong wind generated by the heating of the star atmosphere by nonthermal particles accelerated at the jet-star interaction region. The flare itself could be produced by a few clouds of matter lost by the red giant after the initial impact of the jet. In the framework of the proposed scenario, the observations constrain the key model parameters of the source, including the mass of the central black hole: M_BH□10ˆ9M□, the total jet power: L_j□10ˆ48 erg s−1, and the Doppler factor of the gamma-ray emitting clouds, δ□20. Whereas we do not specify the particle acceleration mechanisms, the potential gamma-ray production processes are discussed and compared in the context of the proposed model. We argue that synchrotron radiation of protons has certain advantages compared to other radiation channels of directly accelerated electrons.

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Session Classification: Gamma-Ray Astrophysics

Track Classification: Gamma-ray Astrophysics