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Ultrafast VHE Gamma-Ray Flares of AGN

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Abstact

We analyze three scenarios to address the challenge of ultrafast gamma-ray variability reported from active galactic nuclei. We focus on the energy requirements imposed by these scenarios: (i) external cloud in the jet, (ii) relativistic blob propagating through the jet material, and (iii) production of high-energy gamma-rays in the magnetosphere gaps. We show that while the first two scenarios are not constrained by the flare luminosity, there is a robust upper limit on the luminosity of flares generated in the black hole magnetosphere. This limit depends weakly on the mass of the central black hole and is determined by the accretion disk magnetization, viewing angle, and the pair multiplicity. For the most favorable values of these parameters, the luminosity for 5-minute flares is limited by 2×10^{43} erg s-1, which excludes a black hole magnetosphere origin of the flare detected from IC 310. In the scopes of scenarios (i) and (ii), the jet power, which is required to explain the IC 310 flare, exceeds the jet power estimated based on the radio data. To resolve this discrepancy in the framework of scenario (ii), it is sufficient to assume that the relativistic blobs are not distributed isotropically in the jet reference frame. A realization of scenario (i) demands that the jet power during the flare exceeds by a factor 10^2 the power of the radio jet relevant to a timescale of 10^8 years.