

Proton acceleration in the active galactic nuclei

Acceleration of the high energy cosmic rays protons in the active galactic nuclei is considered.

The major acceleration stage is the centrifugal acceleration in a magnetosphere of the central machine light cylinder surface. In the during to calculations, the received dependence of the maximum energy on the parameter of the magnetization κ and relation parameter α of toroidal and poloidal magnetic fields led to the conclusion that achievement of a theoretical maximum limit of value L-factor isn't possible for the accelerated particle in the magnetosphere of a black hole due to restrictions of the topology of toroidal and poloidal magnetic fields imposed by features of the relation. The analysis of special cases of the relation of a toroidal and poloidal magnetic field showed what in the presence of the toroidal magnetic field which is significantly more poloidal (case AGN with jet) the maximum L-factor value reaches $\gamma_{max}^{2/3}$, in the case when toroidal field to become smaller in comparison to the poloidal field (case non-active galaxy nuclei) the maximum L-factor value doesn't exceed $\gamma_{max}^{1/2}$.

The relativistic jet is the finishing area of the high energy proton acceleration. Here acceleration is carried out generally with a radial electric field. During the calculations was discover 3 acceleration regimes. The untrapped regime occurring in the case of the proton acceleration from the initial L-factor from the magnetosphere $\gamma_{max}^{2/3}$ to the theoretical maximum L-factor γ_{max} . The proton starts near the jet axis and moves directly inside out of the jet surface. In this case dimensionless parameter of the electric field β significantly more than the parameter of the magnetic field α . In the case of the trapped regime, the proton acceleration occurring by moving along the jet with oscillations in the radial direction. In the case of a strong toroidal magnetic field proton preaccelerated in the magnetosphere are pressed to the jet axis and practically is not accelerated in the jet.

For a number of the active galactic nucleus, such as M87 the maximum values L-factor for accelerated protons for scenarios of existence or lack of a toroidal magnetic field were defined. For special cases, there was a defined value of the maximum energy of the protons accelerated in object Sgr. A* magnetosphere that was confirmed by the experimental data obtained on the massive HESS of Cherenkov telescopes. Also, for cases microquasar such as SS433 was calculated proton acceleration energy and derived the acceleration regime.

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