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Ultra-high-energy cosmic rays from supermassive black holes

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Mechanism of acceleration of charged particles to ultra-high energies above EeV up to ZeV still remains unsolved. Recent multimessenger observations strongly established the source of ultra-high-energy cosmic rays (UHECRs) being extragalactic supermassive black hole (SMBH). I will show that UHECRs can be produced within a neutron beta-decay in a dynamical environment of SMBHs located at the centers of galaxies. For this, I will present the super-efficient mechanism for the energy extraction from SMBHs. Magnetic fields which are usually present in the vicinity of black holes play a role of catalyzing element that increases the efficiency of the energy extraction. From the other hand synchrotron losses and back-reaction of individual charged particles put constraints on the mass of SMBH, magnetic fields and propagation distances of UHECRs.

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