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Ionized accretion disks orbiting magnetized black holes

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We give summary of some astrophysically important new phenomena related to ionized Keplerian or toroidal disks orbiting around a Kerr black hole immersed in a large-scale external magnetic field.

1. Under appropriately chosen conditions the electrons can be treated in "force-free" approximation, while ions in "dielectric approximation". Then off-equatorial "dielectric clouds" could be formed and represent an obstacle for the Blandford-Znajek process.
2. Keplerian disks ionized near the ISCO could be important in creation of ultra-high energy cosmic rays. Due to the magnetic Penrose process realized in a proper way, protons or ions could be accelerated up to energy overcoming 10^22 eV in conditions quite realistic from astrophysical point of view.
3. Slightly charged hot-spots orbiting near the ISCO could give rise to high-frequency quasi-periodic oscillations (HFQPOs) in X-rays observed around supermassive black hole in Active Galactic Nuclei, with predicted frequencies in agreement with observed frequencies, if the so called epicyclic geodesic model of HFQPOs is applied with modification given by the interaction of the large-scale magnetic field with charge of the hot-spot.
4. The new radiative Penrose process has been recently discovered, being related to the negative energy photons created due to the back-reaction of the charged particles moving in the ergosphere of the magnetized black holes. This kind of Penrose process can both increase by one order energy of the radiating particle, or can lead to "floating orbits" crossing repeatedly the ergosphere boundary.

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