

Spheromaks and How Plasmas May Explain the Ultra High Energy Cosmic Ray Mystery

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In recent papers published in the *Astrophysical Journal*, we show how accretion disks around massive black holes could act as dynamos producing magnetic jets similar to the early stages of plasma gun injection creating spheromaks in the laboratory. In a third paper in preparation, we show how these jets evolving at a velocity $0.01c$ naturally produce runaway ion beams accelerated to 10^{20} eV or more, finally ejected as Ultra High Energy (UHE) cosmic rays long regarded as one of the mysteries of astrophysics. Each step of the acceleration process is due to a hyper-resistive electric field: first by MRI turbulence in the accretion disk, then MHD kink mode turbulence in the jet, and finally electrostatic kinetic modes occurring at the nose end of the jet. It is these kinetic modes, perhaps overlooked by astrophysicists, that account for most of the acceleration. The model correctly predicts several observables, including the observed synchrotron radiation, the cosmic ray energy spectrum and UHE cosmic ray intensity on Earth.