Relativistic Alfvén pulse emission from black hole accretion disk and particle acceleration via wake fields in relativistic jets

Akira Mizuta[1], Toshikazu Ebisuzaki[1], Toshiki Tajima[2], Shigehiro Nagataki[3,4,5]
[1] Computational Astrophysics Laboratory, RIKEN, Wako, Saitama, Japan
[2] Department of Physics and Astronomy, U.C. Irvine, Irvine, United States
[3] Astrophysical BigBang Laboratory, RIKEN, Wako, Saitama, Japan
[4]Interdisciplinary Theoretical & Mathematical Science Program (iTHEMS), RIKEN, Saitama, Japan
[5]Interdisciplinary Theoretical Science Research Group (iTHES), RIKEN, Saitama, Japan

We have performed three dimensional general relativistic magnetohydrodynamic simulations of accretion flows onto supermassive black hole to see timevariablities of the disk states caused by the magnetic fields and emissions of relativistic Alfvén pulse from accretion disk into the jets. Magnetic fields are amplified by magnetorotational instability (MRI) and dissipates. Then magnetic field is amplified again soon. These magnetic field activities cause the disk state transition from thermal pressure dominate state to magnetic filed dominate state and disk state transitions occur repeatedly. When well amplified magnetic field is dissipated, strong and relativistic Alfvén waves are emitted from the accretion disk into the jets. These Alfvén waves propagate in the relativistic jets and finally become electric-magnetic waves by mode conversion due to decrease of mass density along the jet. Since the strength parameter of emitted Alfvén waves is extremely high as ~10^{10} for substantial fraction of Eddington accretion rate accretion flow onto super massive black holes, charged particles are accelerated to relativistic speed by the ponderomotive force as proposed by Ebisuzaki & Tajima (2014). The accelerated protons becomes cosmic-rays and electrons emit gamma-rays by the interaction with magnetic fields. The timescales of flares and repeat cycle of the flares of gamma-rays from subclass of AGN jets (blazars) are consistent with duration and repeat cycle of Alfvén pulse observed in our numerical simulations.