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Acceleration of Relativistic Outflows with Tangled Magnetic Field

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Extracting the rotational energy by magnetic braking is the most promising mechanism driving relativistic outflows of active galactic nuclei, gamma-ray bursts, and pulsar winds, i.e., they must be Poynting dominated flow at their base.
On the other hand, the observed spectral and dynamical signatures of these relativistic objects infer that the magnetization σ (the ratio of Poynting to particle energy fluxes) of the outflows is much less than unity at a dissipation point.
Many studies intended to accelerate the Poynting dominated outflows by reducing the magnetization have been done, called σ-problem.

Recently, we extended the one-dimensional spherically symmetric steady outflow model by Kennel & Coroniti (1984) by formulating the effects of the turbulent magnetic field in order to resolve the σ-problem of the Crab Nebula (Tanaka et al. 2018).
Here, we will show the results for applications of our model to the relativistic outflows.
Interestingly, even cylindrical jets (e.g., Fanaroff-Riley type II) can be accelerated by the effects of the magnetic turbulence.
Although the magnetic turbulence does not reduce the flow magnetization, the radiative cooling of the relativistic flow accompanied with the dissipation of the turbulent magnetic field leads to further acceleration and reduction of the magnetization.

[1] Kennel C. F., & Coroniti F. V., 1984, ApJ, 283, 694
[2] Tanaka S. J., Toma, K. & Tominaga, N., 2018, MNRAS, 478, 4622

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