title: A General Relativistic Magnetohydrodynamic Model for the Emission Structure of the M87 Jet

Relativistic collimated outflows (or jets) have been observed in active galactic nuclei (AGNs). It is widely thought that they are formed in a system composed of a black hole (BH) at the center of a galaxy and surrounding plasma. The plausible formation mechanism of jets is electromagnetic extraction of the rotational energy of the BH. General relativistic magnetohydrodynamic (GRMHD) simulations show that the globally ordered magnetic field is realized only in the funnel region around the rotation axis, where relativistic jet appears to be formed. No particle is injected into the jet from the BH, of course, and the globally ordered magnetic field prevents the surrounding thermal plasma particles from diffusing into the jet. The origin of particles in jets is still unclear. This is called the “mass-loading problem”.
Recent radio observations of the relativistic jet in M87 radio galaxy have shown a triple-ridge structure. We examined the stationary axisymmetric synchrotron emission model with the assumption that the energy density of the electromagnetic field is much larger than the one of matter and found that our model can produce the triple-ridge structure. We also showed that the computed image depends strongly on the density distribution of the emitting particle in the jet (Ogihara, Takahashi & Toma 2019). We are now extending the special relativistic model to general relativistic MHD model in order to more realistically constrain the density distribution at the vicinity of the black hole where the jetted particles are thought to be injected.
This study will be complementary to theoretical analyses of the Event Horizon Telescope and future observations.

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