Selection for parameter for new simulation

Summary of parameters used in Athina's 2023 Work.

As we are planning to run the new simulations of relativistic jets as an extension of Athina's 2023 papers. The summary of the simulation parameters used in Athina's 2023 papers is as follows

1. Jet radius (r_{jt})) = 100
2. Strength of the toroidal magnetic field (Bo) = 0.5
3. Lorentz factor γ= 15
4. Mass ratio of the jet species $e^{\pm}$, e^{-} - i^{+} (m_i/m_e) = 4, and for e^{-} -p^{+} (m_e/m_p) = 1836
5. Jet species: e − i+, e−p+, and $e^{\pm}$
6. Number density in the jet (njt) = 8
7. Number density in ambient plasma (namb) = 12

By implementing these parameters, the simulation results for global jet structure (Lorentz factor), electron density, current density (Jx), magnetic field component (By), electric field component (Ex), particle acceleration, and particle energy distribution were observed.

For my thesis work, I plan to perform simulations with the Lorentz factor γ = 10 and keeping all the other simulation parameters same as that of Athina's work.

Rationale for Parameter Selection

1. Lorentz Factor (γ = 10)

We aim to conduct simulations with Lorentz factor **γ = 10** because it is suitable for the study of AGN jets. The Lorentz factor affects the growth of plasma instabilities, particle acceleration and topology of magnetic field. So, it is considered as an important physical parameter in our simulation. Also, the previous results shows that the growth rate of plasma instabilities is greater for smaller Lorentz factor. So, it is important parameter for our new simulations.

How to apply it on new simulation: for γ = 10

In skh18painputN.f

Vijet = 0.9949874371*C.   # obtained by using formula of Lorentz factor.

It is wise to change a single simulation parameter at a time.

In next simulation we can change the initial magnetic field B_o =1.0 keeping all parameters same as that of Athina's 2023 paper.

2. Initial magnetic field (Bo = 1.0)

This is a very important factor in our simulation as even a small value of initial magnetic field changes the evolution of the relativistic jet significantly. Firstly, Athina compared the simulation results for global jet structure (with different plasma compositions), electron density, magnetic field, and current density with unmagnetized jet and magnetized jet with a small initial magnetic field Bo=0.5. It shows the significant difference in the jet evolution even with a small magnetic field. These simulation results provide clues for the particle acceleration as well as sites for the possible magnetic reconnection. The magnetization factor depends on B_o as $\sigma \propto B_0$. As we know the initial magnetic field strength affects the many physical parameters of the jets as we observed in Athina's simulation result. Therefore, it is crucial to perform simulations with different magnetization factor to compare the growth of plasma instabilities. At first, we aim to perform the simulations with initial magnetic field strength B_0 = 1.0 = 2x 0.5 i.e. magnetic field strength two times as that used by Athina, so that magnetic energy will be four times greater than that of Athina's simulation and it may give more interesting results. We can guess that the results will be more interesting as they will show significant differences in jet structure, electron density (collimation of jet), electric field structure, magnetic field structure, current density, particle acceleration pattern, particle energy distribution, and possible reconnection sites.

How to apply in simulation: B_0 = 1.0
vi skh18painputN.f. and implement
bh0=1.0*c
3. Jet species: $e^{\pm}$ and e^{-}- i^{+} with mass ratio (m_i/m_e = 1, 4)

How to apply in simulation:

for pair jet mi = me
For electron-ion jet mi=me*4.0

5. Number Density (njet/namb= 8/12): Same

How to apply in simulation:
dens = 12.0 for ambient density
densj = 8.0