W06a Linear stability of astrophysical jets meant for magnetized core-collapse supernovae

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Strong magnetic field in the core-collapse supernova (CCSN) progenitor is supposed to extract the rotation energy and drive the collimated jet structure formation along the rotation axis. CCSN jets are subject to different instabilities during the propagation and formation, such as Kelvin-Helmholtz instability induced by shear flow, current-driven instability (CDI) induced by the magnetic field and even magnetorotational instability (MRI) which is driven by differential rotation and magnetic field. Recent study on the CCSN simulations observed the growth of kink instability ($m = 1$ CDI) in bipolar jets leads to jet distortion, and jet simulation results provide clear linear phase and non-linear phase for each instability mode. However, the linear analysis results were still lacking. In this study, we performed the linear analysis on magnetized non-relativistic jets, considering the application of CCSN. We employ the Laplace transform in time and Fourier transform in jet axial and azimuthal on linearized ideal MHD equations. The position of singularity, which indicates the instability mode, in the complex s (the variable in the Laplace transform) plane is discussed, and eigenfunctions corresponding to each mode are derived. We suggest each instability mode only exists in short k (axial wave number) case, and MRI always plays a sub-dominant role. Our results provide a new perspective for the analysis of CCSN simulation and obtained eigenfunctions could be discussed in detail in future jet simulations.