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Investigating the difference in FRI and FRII AGN jet morphology with relativistic hydrodynamic simulations

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Relativistic hydrodynamic simulations have become a powerful tool used to simulate the dynamics of jets produced in radio-loud Active Galactic Nuclei (AGN). These AGN jets consist of plasma ejected by a central engine moving at relativistic velocities. Observational studies of AGN jets have shown that they emit variable emission over the whole of the electromagnetic spectrum. The spectral energy distribution (SED) of these sources show dominant components of synchrotron and Inverse-Compton emission produced within relativistic jets originating from the nucleus. While simulations of AGN jets have been able to reproduce many of the observed structures (e.g. radio lobes, hot spots and super-luminal emission components) the physical properties relating to the FRI/FRII division are not well understood. In this study the PLUTO RHD code was used to investigate the parameters required to reproduce structures consistent with both FR I and FRII jets. In the first simulation a Lorentz factor of 10 and supersonic flow of Mach 300 were chosen, while for the second simulation a Lorentz factor of 1.0014 with a supersonic flow of Mach 4 were used. Over similar distances scales the first case shows a well collimated beam with a strong shock at the interface between the jet and ambient medium while the second case shows a less stable beam and larger cocoon. To determine whether the physical structures simulated by the PLUTO code are consistent with the observable FR I/II structures, the synchrotron emission has been calculated to produce radio maps at a single frequency of 1.5 GHz. The first case showed emission structures similar to that of FR II radio galaxies with hotspots at the head of the jet while the second case was more consistent to that of an FR I source with the highest intensity occurring within the beam of the jet. Calculating the multi-wavelength (radio - gamma-ray) SED of a synchrotron self-Compton model for these simulations is very computationally intensive. We are, therefore, currently investigating the use of Monte-Carlo codes in conjunction with the hydrodynamical simulations. These codes can provide us with a time-dependent, multi-zone emission model to compare to observations. Our progress thus far is also presented.

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