3D relativistic hydro models for SS433: virtual views on precessing jets

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Observations allow to look closer and closer into objects powering relativistic jets associated with accretion disks. This is also true for SS433, where observations down to the sub-parsec scale infer how an X-ray binary gives rise to a corkscrew patterned relativistic jet. Many simulations of jets associated with high energy astrophysical objects assume axisymmetry, allowing to cut down computational cost. Due to the inferred precessional motion of the SS433 jet, we aim for 3D simulations to accurately follow non axisymmetric processes, like the jet precession and its deflection by interstellar matter. XRB SS433 is well known through kilo-parsec scale observations with Chandra, showing its interaction with the supernova remnant W50, and on sub-parsec scale with VLA observations of its radio emission. We target the latter sub-parsec scale and focus on how the variation of the Lorentz factor of the injected matter influences the general jet dynamics. We visualize the 3D data, and also realize radio mappings, to compare our results with observations. For our study we use a relativistic hydrodynamic model assuming a baryonic jet. We solve the Euler equations in special relativity with a closure relation using a relativistic effective polytropic index. Our 3D simulations use an adaptive mesh refinement scheme [1]. We use parameters extracted from observations to impose thermodynamical conditions of the ISM and jet proper, i.e. period and angle of precession, bulk velocity and opening angle of the jet. Knowing the kinetic luminosity of the jet, we can estimate the ISM/jet density contrast, which varies with the adopted jet Lorentz factor. We then see how this affects its ISM interaction, by tracking the kinetic and thermal energy content, of the various ISM and jet regions. We follow and adjust the approach adopted in recent axisymmetric simulations [2] using a combination of tracers and local properties of the impacted medium. Our simulation follows simultaneously the evolution of the population of electrons which are accelerated by the jet. The evolving spectrum of these electrons, together with an assumed equipartition between dynamic and magnetic pressure, gives input for estimating the radio emission from our simulation. Ray tracing according to a direction of sight then realizes radio mappings of our data, which we can compare to VLA observations of SS433.

[1] R. Keppens et al., JCP 231, 718 (2012)
[2] R. Monceau-Baroux, R. Keppens & Z. Meliani, A&A 545, A62 (2012)