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Simulating the synchrotron emission from Active Galactic Nuclei jets with grid based relativistic hydrodynamic code

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Abstract content
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Grid based numerical hydrodynamic codes have been used to simulate the evolution of a variety of astrophysical environments, ranging from stellar winds to accretion disks in binary systems. These simulations can be used as valuable tools in the correlation between theoretical models and observational data. In this study a grid based relativistic hydrodynamic simulation is created, using the freely available numerical code PLUTO ver 4.2, to study possible causes of variability in AGN. The code uses shock-capturing Godunov-type methods to solve the fluid dynamic conservation equations on a structured mesh grid. To simulate the production of a jet similar to those observed in AGN a three dimensional static grid was created containing 512x512x512 computational cells. A uniform background medium was assigned to this grid, while a nozzle was defined on the z=0 boundary to inject a pressure matched relativistic jet, with Γ=10 (v=0.995c), into the medium. The simulation showed the formation of a central collimated relativistic beam along with a surrounding cocoon region. In addition, a post-processing emission modelling code is being developed, in order to determine the emission produced by such a relativistic jet. The emission model utilizes the data produced by the hydrodynamic code in order to calculate intensity maps based of the synchrotron self absorption model, which has been previously applied in analytical models. The emission code specifically takes into account the effects produced by the relativistic motion of the emitting regions which can lead to effects such as the Doppler boosting observed in blazars. Synchrotron based emission models can be applied to other astrophysical objects such as X-ray binary systems which means that the application of the emission code can be adapted to other studies.

Primary author: Mr VAN DER WESTHUIZEN, Izak (University of the Free State)

Co-authors: Mr VAN SOELEN, Brian (University of the Free State); Prof. MEINTJES, Pieter (University of the Free State)

Presenter: Mr VAN DER WESTHUIZEN, Izak (University of the Free State)

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