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Central Finite Volume Methods Applied in Relativistic Magnetohydrodynamics: Applications in Disks and Jets

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Abstract : We have developed a new computer program in Fortran 90, in order to obtain numerical solutions of a system of Relativistic Magnetohydrodynamics partial differential equations with predetermined gravitation (GRMHD), capable of simulating the formation of relativistic jets from the accretion disk of matter up to his ejection. Initially we carried out a study on numerical methods of unidimensional Finite Volume, namely Lax-Friedrichs, Lax-Wendroff, Nessyahu-Tadmor method and Godunov methods dependent on Riemann problems, applied to equations Euler in order to verify their main features and make comparisons among those methods. It was then implemented the method of Finite Volume Centered of Nessyahu-Tadmor, a numerical schemes that has a formulation free and without dimensional separation of Riemann problem solvers, even in two or more spatial dimensions, at this point, already applied in equations GRMHD. Finally, the Nessyahu-Tadmor method was possible to obtain stable numerical solutions - without spurious oscillations or excessive dissipation - from the magnetized accretion disk process in rotation with respect to a central black hole (BH) Schwarzschild and immersed in a magnetosphere, for the ejection of matter in the form of jet over a distance of fourteen times the radius of the BH, a record in terms of astrophysical simulation of this kind. Also in our simulations, we managed to get substructures jets. A great advantage obtained was that, with the our code, we got simulate GRMHD equations in a simple personal computer.

Keywords : finite volume methods, central schemes, fortran 90, relativistic astrophysics, jet
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