IMPLEMENTATION AND TESTING OF MODELS FOR THE SOLAR WIND

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The solar wind is a flow of plasma coming from the Sun, playing an important role in the study of space weather. The space weather is defined as the whole of perturbations of the Earth's magnetic field driven by variable kinds of solar activity. Disturbances in the Earth's magnetosphere can damage satellites, it can cause telecommunication problems and even power supply breakdowns. The aim of this project is a three-dimensional simulation of solar wind propagation.

To achieve this goal the Euphoria code is used. This finite volume, structured grid solver can solve Euler and magnetohydrodynamic equations and has the advantage that it is able to handle multi-block grids and can perform parallel computations. The solver was tested for different types of problems. The possibility to do parallel computations was extensively tested and used for the solar wind simulations.

Starting from a simple model for the solar wind, more complexity is included in successive steps. A polytropic relation between density and pressure was supposed, making superfluous the energy equation, simplifying computations. One- and two-dimensional simulations of hydrodynamic winds were successfully done (Figures 1 and 2). For a two-dimensional model with a magnetic field it was not possible to obtain physically relevant results due to the fact that a non-divergence free magnetic field is created throughout the calculations. Consequently, we were not able to extend our work to the simulation of realistic three dimensional models. Methods for conservation of $\nabla.B=0$ should be investigated in the future.

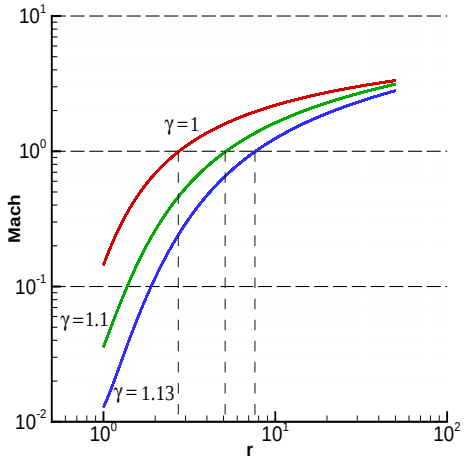

Figure 1: Mach number in function of radius for 1D spherical symmetric wind model. Polytropic index varies from γ=1 to γ=1.13

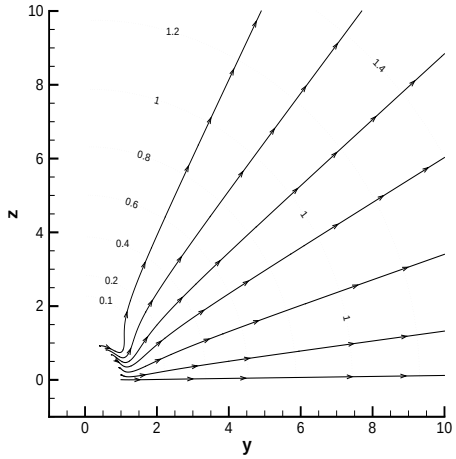

Figure 2: Streamlines and Mach curves for a star rotating 20 times faster than the Sun. Streamline bending due to centrifugal force