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Non-Linear Particle Acceleration

Context: Astrophysical plasmas; Numerical Simulations; Instabilities

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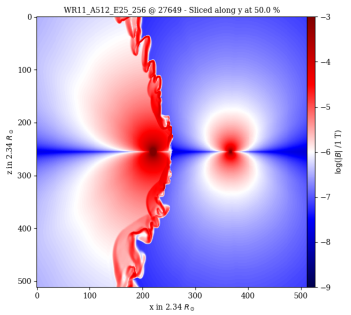
Abstract

An important acceleration process for cosmic rays is Fermi-I acceleration, where particles are scattered back and forth over a shock wave. On average they gain energy in each of these shock crossings. This process directly follows when solving the cosmic-ray transport equation either analytically or as in this case with the computer. What is often neglected, however, is that the energy gain of the particles also implies an energy loss of the gas. To consider this effect is the main aim of this bachelor project. For this, the interested candidate will first set up a one-dimensional simulation of a shock wave using the CRONOS code. Next, the particle-transport equation will be solved in the environment of the modelled shock wave. Finally, the energy density of the accelerated cosmic-ray particles is to be computed from the simulation and then added as an external pressure to the gas simulation. By this, we will be able to judge the importance of the effect of this back reaction.

Helpful Skills

- Basic programming knowledge
- Interest in fluid mechanics and numerical simulations



Potentially particle-accelerating shocks in colloding-wind binary simulations