Magnetic Polarization and Radiative Losses in Extragalactic Relativistic Magnetized Jets

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Introduction

Relativistic jets present in different astrophysical scenarios such as quasars, blazars, or radio galaxies are part of the most energetic phenomena in the universe. The knots observed in these jets, with apparent superluminal particles, are interpreted as propagating shock waves. A mechanism that can produce these waves, comes from the magnetic fields surrounding the jet. In this work, we solved numerically the equations of ideal magnetohydrodynamics in special relativity, with radiative losses of the gas that interacts with an external medium, and considering a non-vanishing vector of magnetic polarization parameterized by the magnetic susceptibility.

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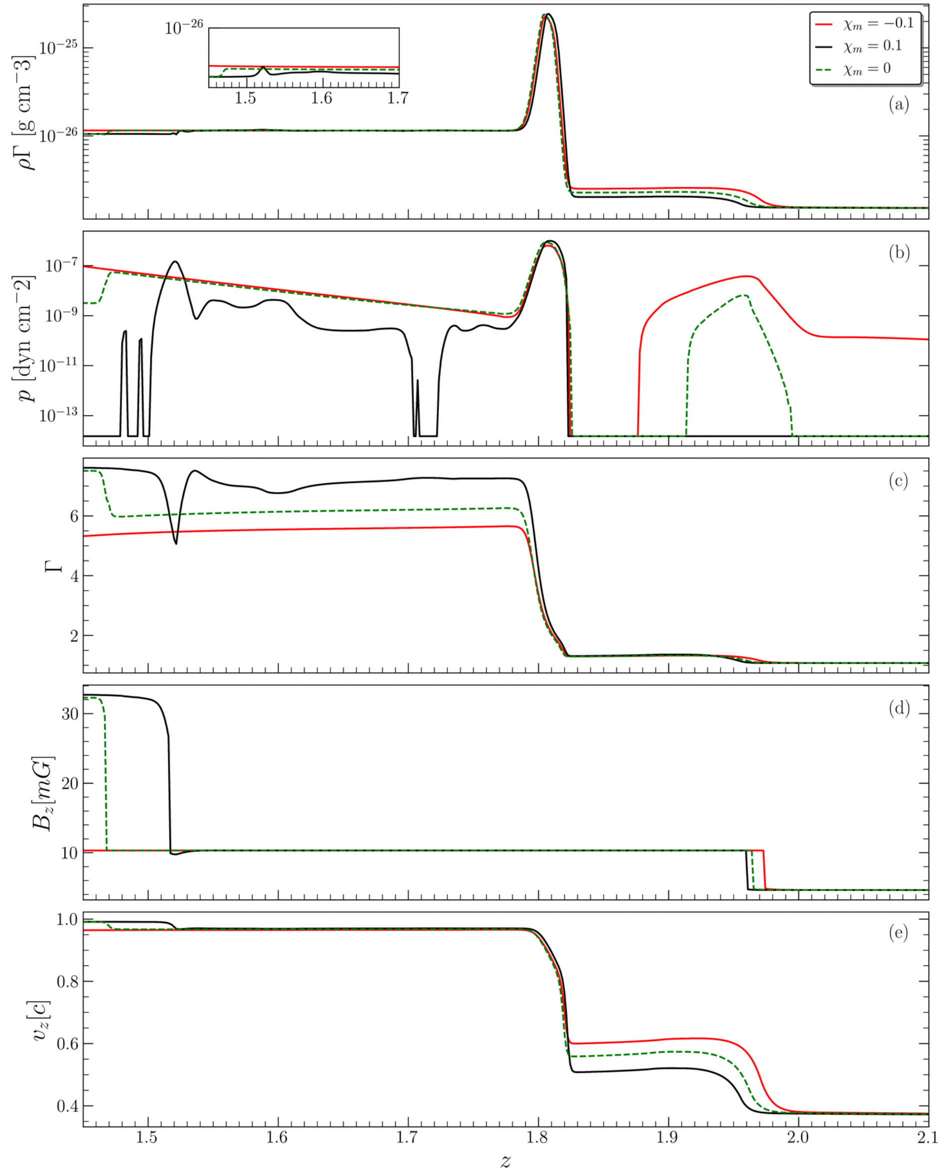


shock structure

From large to small z, diamagnetic fluid (red line) shows the highest density in frontal shock. Additionally, in the second shock, there is a peak with minimal differences for the three susceptibilities, χm. This peak implies that the gas accumulates in that area and expands with more force, as we can appreciate in (b), where there is a large decrease in pressure. Besides, when reverse shocks appear, it shows that paramagnetic and no polarized fluid (black and green lines, respectively) are faster than diamagnetic ones.

$\chi_m < 0 \longrightarrow$ Diamagnetic

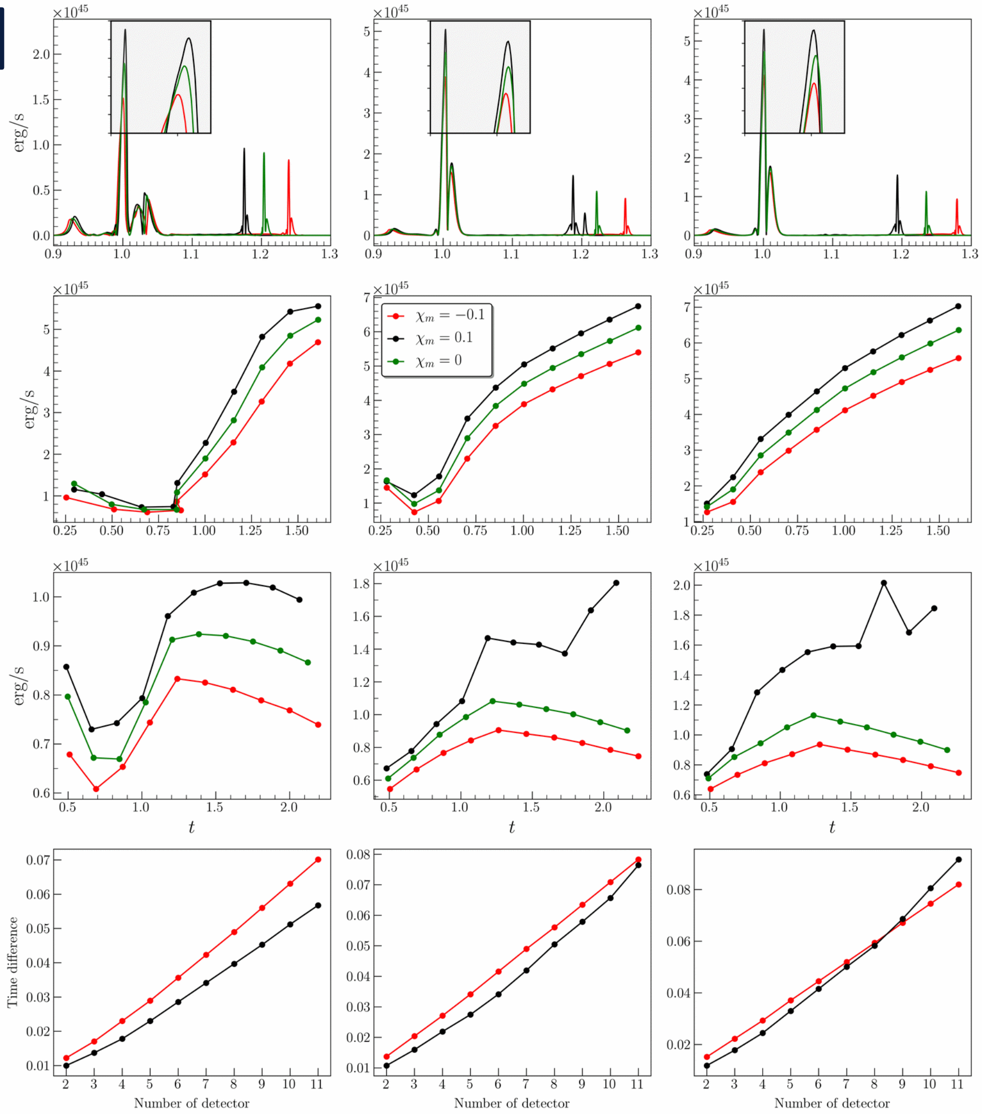
$\chi_m > 0 \longrightarrow$ Paramagnetic

$\chi_m = 0 \longrightarrow$ Non polarized

Power profiles

Max power of the jet was measured over ten detectors located on the numerical grid in the direction of propagation. In each of these detectors, we determined the loss of energy as the difference between the initial energy that material had when it was ejected, and the energy radiated away as the jet moved.

- First row: power emission on the sixth detector for the three values of susceptibilities. The peak in the luminosity indicates that the energy is radiated very effectively because of the initial strength of the shock, which implies that it could be the emission of high-energy photons at various wavelengths.
- Second row: maximum amount of energy loss per unit of time and volume in all detectors. Diamagnetic fluids are more efficient due to their velocity being slower than the other ones.
- Third row: max power measured over each detector. These values correspond to the last peak registered in time.
- Fourth row: time difference with no polarized fluid of the last peak registered in time over each detector.



Remarks

- Magnetic susceptibility increases the relativistic character of a fluid with diamagnetic properties compared to a non-polarized fluid.
- When interacting with a less dense medium, the jet has a compression of the gas that makes it up and when it expands, it accelerates the particles, causing greater energy emissions.
- The loss of energy was the highest for paramagnetic fluids in comparison to diamagnetic or no polarized ones. This implies that diamagnetic fluids are more efficient because their velocity is slower than the others.