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On the energy transfer from low power jets to the IGM

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Abstract. Recent high resolution hydrodynamic simulations of Massaglia et al. 2016 with the PLUTO code have shown that low power FRI jets form turbulent structures over scales of several kilo-parsecs. We aim to carry out two simulations of jet induced feedback, with two different jet powers. One of the primary focus of the work will be to check the growth and transport of turbulence induced by the jet, the generation of sound waves and the subsequent heating of the IGM.

1. Introduction

AGN jets are very efficient carriers of energy that can be released to their ambient medium on different scales. For this reason they are thought to be good candidates, on one side, for preventing the catastrophic cooling of the intracluster medium (Fabian 1994, 2012, Bower et al. 2006, Croton et al. 2006) and the resulting powerful cooling flows and, on another side, for playing a fundamental role in the evolution of their host galaxies, by the impact that can have on star formation (Fabian 2012). At the galactic scale, the Fanaroff-Riley I jets, although of lower power with respect to those of Fanaroff-Riley IIs, are extremely important from the point of view of feedback. This is because the FR I jets remain confined within the central regions of the host over longer timescales (and possibly for their whole lifetime), furthermore low power sources largely outnumber high power sources.

2. Results

In this project we focused on the jet energy deposition at galactic scales from such low power radiosources. Our aim was to develop a proper setup and a set of diagnostic tools for analyzing and quantifying this process. In particular we examined the sound waves generated by turbulent jets. In Fig. 1 we show longitudinal cuts of the pressure distribution at two different times with, superimposed, the contour of the tracer distribution representing the portion of the volume occupied by the jet material.

In Fig. 2 we show instead a transverse cut of the pressure distribution. The figures show clearly how the sound waves generated by the turbulent jet propagate both on the sides and in front of the jet. In order to better quantify the roles of turbulence and of the sound waves, we show in Fig. 3 the distributions of vorticity (in green) and of the velocity divergence (in pink and orange). The vorticity shows the turbulent jet, while the velocity divergence shows the acoustic field around the jet. There are dif-

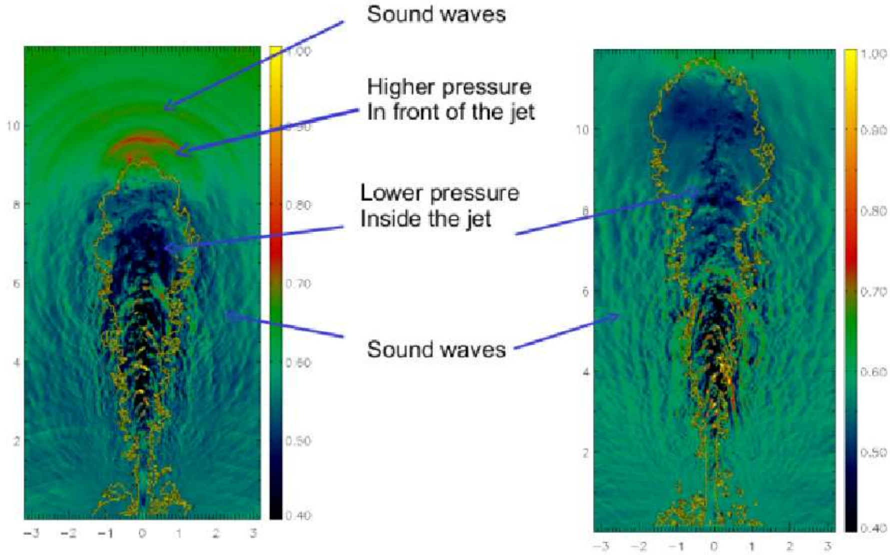

Fig. 1. In the figure we show longitudinal cuts of the pressure distribution at two different times with, superimposed, the contour of the tracer distribution representing the portion of the volume occupied by the jet material.

ferent mechanisms for the generations of sound waves: the Lightill mechanism (Lightill 1952), fragments of the jet moving at supersonic velocities (Tam & Burton 1984) and the conversion of vortices in waves in the presence of shear flows (Chagelishvili et al. 1997).

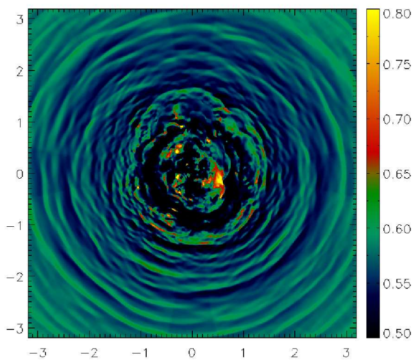

Fig. 2. In the panel we show instead a transverse cut of the pressure distribution. The figures show clearly how the sound waves generated by the turbulent jet propagate both on the sides and in front of the jet.

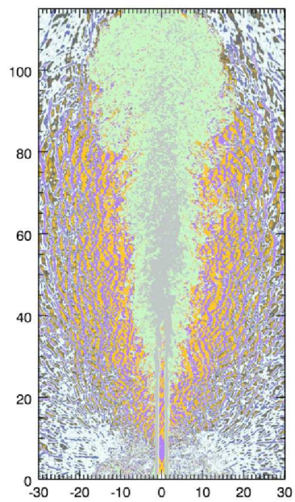

Fig. 3. In order to better quantify the roles of turbulence and of the sound waves, we show in the figure the distributions of vorticity (in green) and of the velocity divergence (in pink and orange). The vorticity shows the turbulent jet, while the velocity divergence shows the acoustic field around the jet.

All these mechanisms are at work in the present situation, however it is quite difficult to disentangle their different roles. We also measured the efficiency of sound generation by integrating the acoustic energy flux on a cylinder surrounding the jet and we found a value around 30%.

The results seem to be promising and we developed a set of tools for analysing the outcome of numerical simulations. This project has been propedeutical for a more extended analysis and the MOU INAF-CINECA has provided us with the opportunity of obtaining in a prompt way the resources needed for the testing phase of this project, which is essential for preparing a larger allocation request.

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