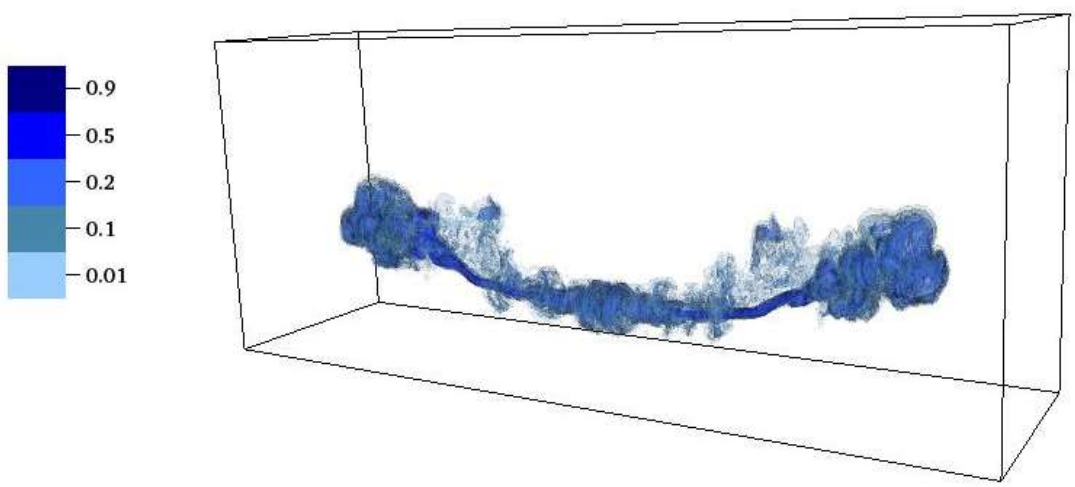
REPORT on Project related to the account INA17_C2A07

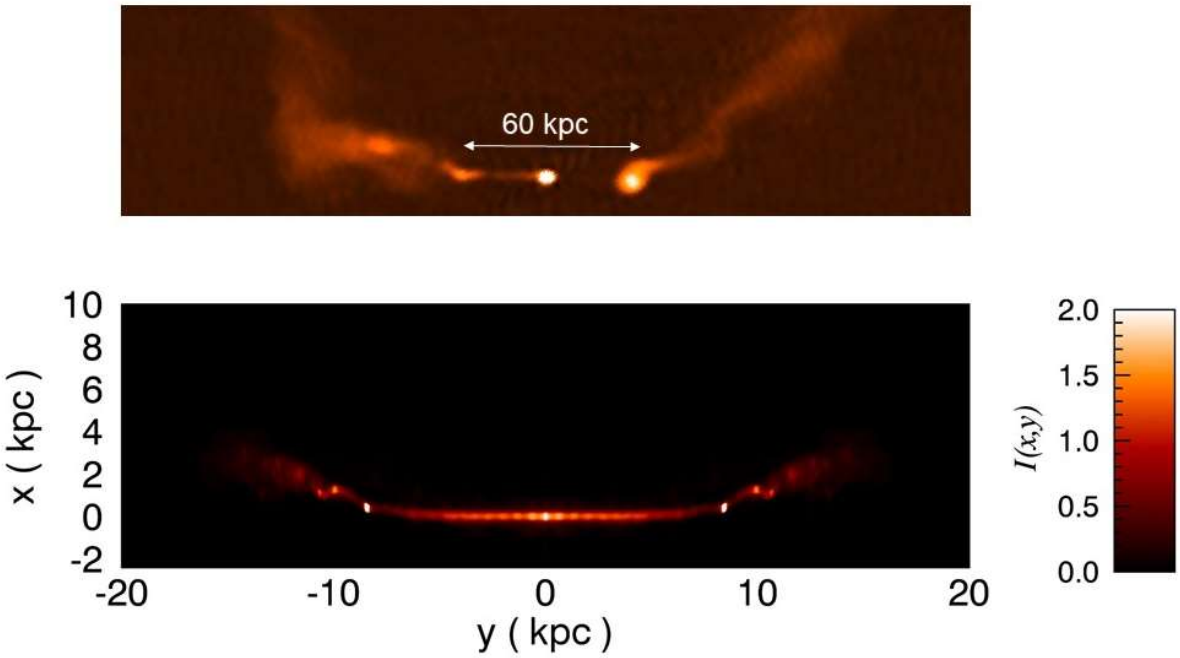
The numerical calculations carried out with the Marconi HPC under the account INA17_C2A07 are connected to a research program that aims to explore the properties of the jets of low-power extragalactic radio sources of Fanaroff-Riley I type in terms of their main physical parameters, namely: jet velocity, density, temperature and magnetic field intensity. The program began in the 2015 and in still under way. A first paper (Massaglia et al. 2016) concerned the study of the propagation of supersonic jets in the hydro-dynamical limit, while a second paper (Massaglia et al. 2019), that has been published as results of the computations under the account INA17_C2A07 in object, concerned the effects of the jet magnetization. In more detail:

jets in radio sources of low power, that are the most common in the Universe, typically move at nonrelativistic velocity and show plume-like morphologies that in many instances appear distorted and bent. We have investigated the role of magnetic field on the propagation and evolution of low-power jets and the connection between the field intensity and the resulting morphology. The problem has been addressed by means of three-dimensional magnetohydrodynamic (MHD) simulations. We considered supersonic jets that propagate in a stratified medium. The ambient temperature increased with distance from the jet origin maintaining constant pressure. Jets with low magnetization showed an enhanced collimation at small distances with respect to hydrodynamic (HD) cases studied in a previous paper. These jets eventually evolveed in a way similar to the HD cases. Jets with higher magnetization were affected by strong nonaxisymmetric modes that leaded to the sudden jet energy release. From there on, distorted plumes of jet material moved at subsonic velocities. This transition is associated with the formation of structures reminiscent of the “warm spots” observed in wide-angle-tail (WAT) sources.

Three-dimensional iso-contours of the tracer distribution for the WAT case.



Top panel: radio image at 4.6 GHz of 3C 465, obtained from the NRAO VLA Archive Survey Images Page (and rotated counterclockwise by 145°) showing the typical morphology of WATs. The resolution is 4" and the FOV is 2' x 7', corresponding to 70 x 250 kpc. Bottom panel: cut in the (y; z) plane of the (smoothed) brightness distribution in arbitrary units.



Bibliography:

Massaglia, S.; Bodo, G.; Rossi, P.; Capetti, S.; Mignone, A.
"Making Faranoff-Riley I radio sources. I. Numerical hydrodynamic 3D simulations of low-power jets"
2016, A&A, 596A, 12

Massaglia, S.; Bodo, G.; Rossi, P.; Capetti, S.; Mignone, A.
"Making Faranoff-Riley I radio sources. II. The effects of jet magnetization"
2019, A&A, 621A, 132

The main, and crucial, advantage of the MoU CINECA-INAF calls is the the computation resources become available within a few days after the project's approval, instead of waiting months as happens for the ordinary calls.