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Afterglow emission from short GRB jets: simulations meet observational data

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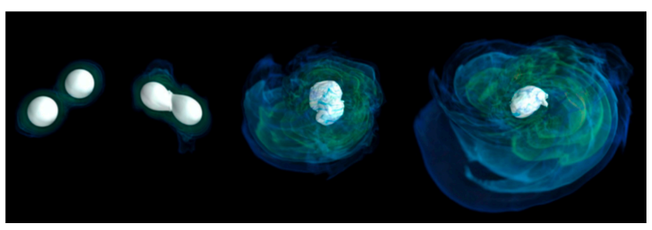
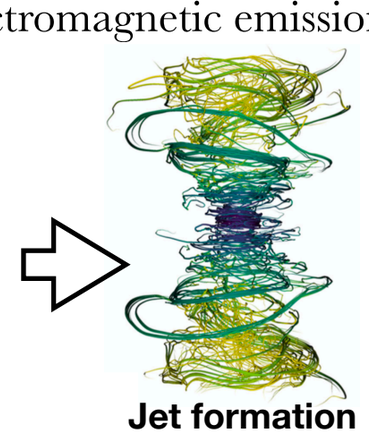
INTRODUCTION

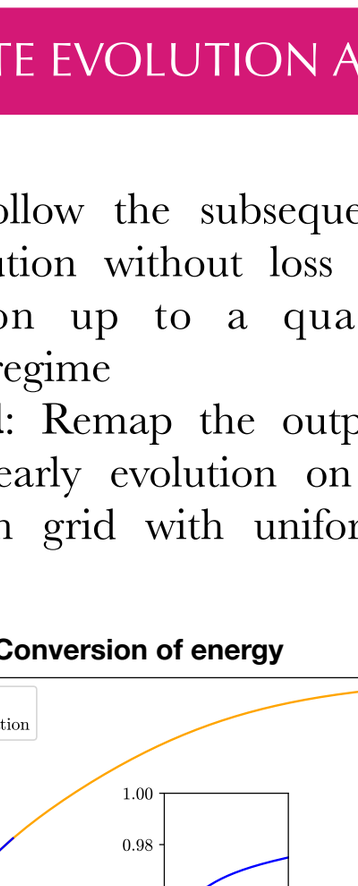
1. Binary neutron star mergers can form a compact object (e.g. accreting black hole) able to launch a relativistic jet
2. The jet breaking out of post-merger environment keeps evolving until reaches the ballistic regime (saturation of velocity and structure)
3. Powerful jets can produce a gamma-ray burst. Later interaction with the interstellar medium leads to the afterglow signal
4. The jet evolution details are imprinted in the electromagnetic emission



Binary neutron star merger



Jet formation

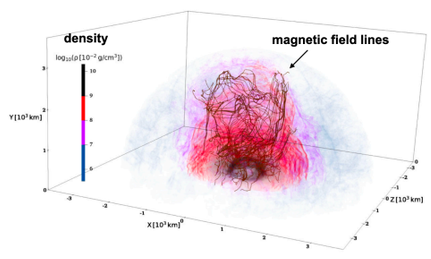


Jet break-out

SCIENTIFIC GOAL

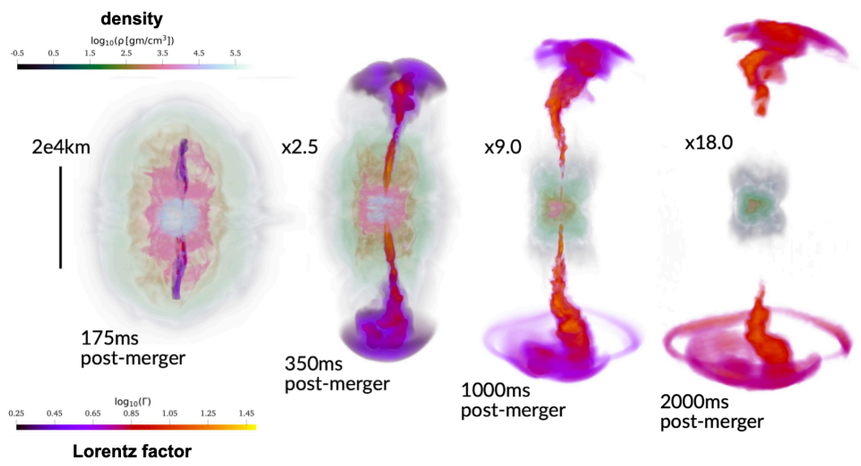
- Combine simulations of the merger process, jet break-out and jet propagation up to a quasi-ballistic regime in the first consistent end-to-end description
- Connect the afterglow emission with the progenitor system and jet injection parameters

JET INJECTION AND BREAKOUT



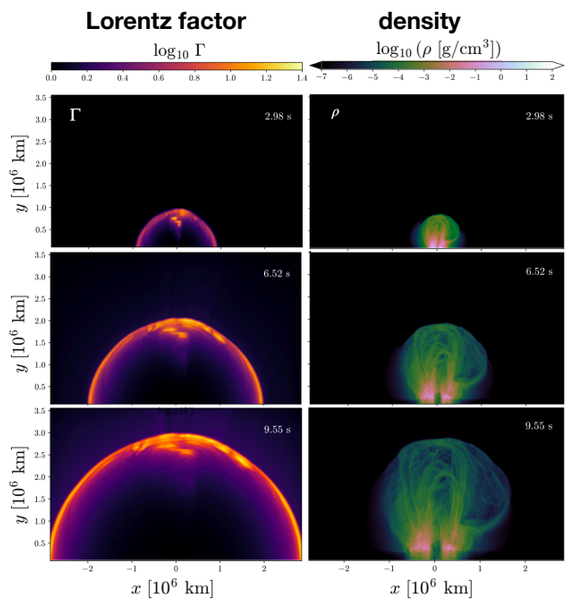
A magnetized jet is launched in a realistic post-merger environment, directly imported from the binary neutron star merger simulation of [1].

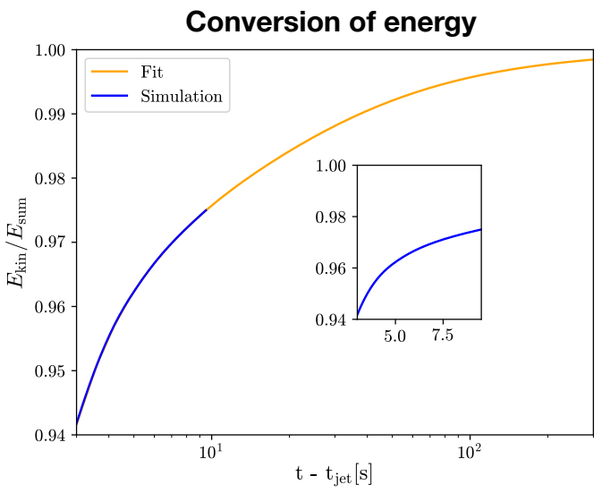
The jet is evolved in a spherical grid with the PLUTO code ([2]) for 3 s, with the details of break-out dynamics imprinted in the final angular structure and energetics [3,4].



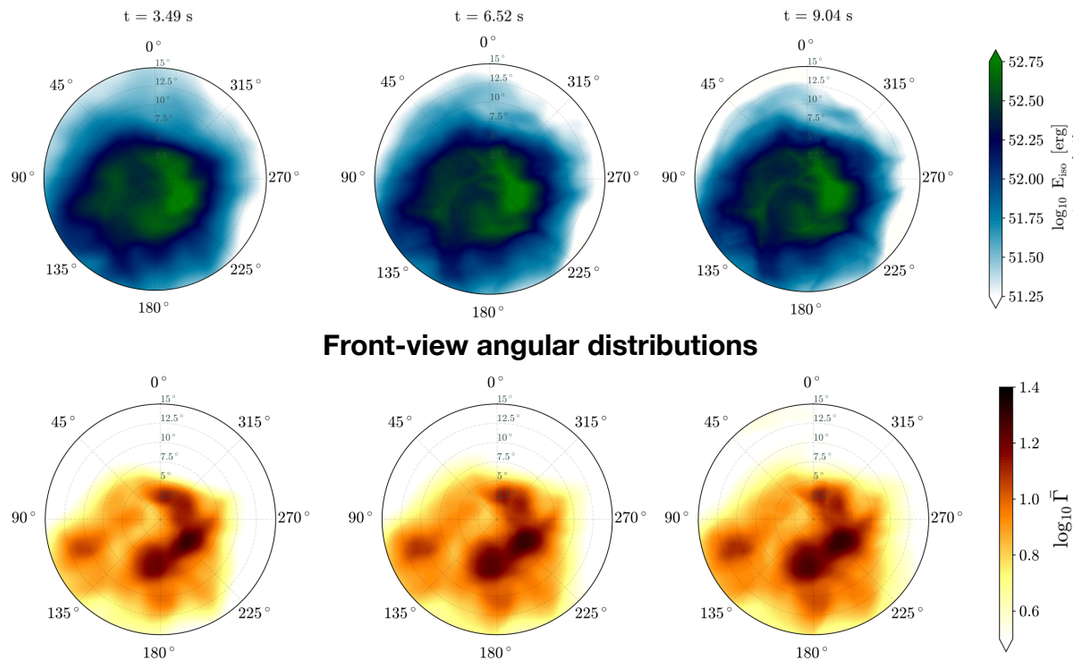
LATE EVOLUTION AND BALLISTIC PHASE

- **Aim**: Follow the subsequent jet evolution without loss of resolution up to a quasi-ballistic regime
- **Method**: Remap the output of the early evolution on a Cartesian grid with uniform cells





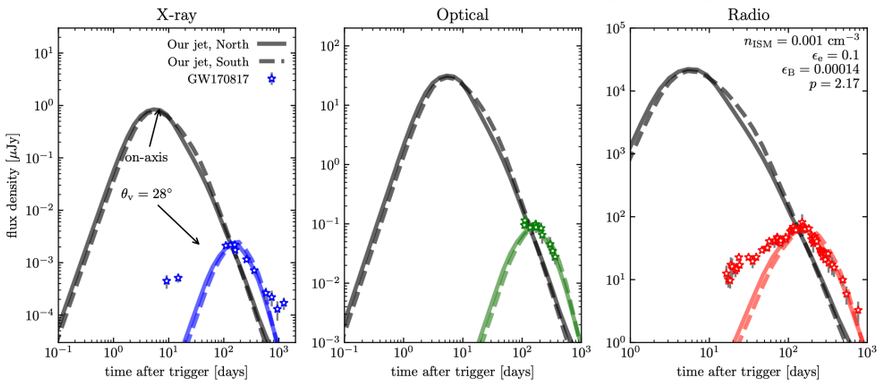
At the end of the simulation (~10 s), ~98% of energy is converted into kinetic form and the angular structure is no longer changing.
Strong deviations from axisymmetry are observed.



OUTLOOK

- Systematic application to a large set of sGRB jet initial parameters, linking the final jet structure with injection and break-out conditions
- Use the outputs in semi-analytic afterglow models to produce lightcurves and compare with observations (e.g. GRB 170817A)

Angle dependent multi-band jet afterglow light curves



Credits: O.S. Salafia

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