Galaxies in 3D across the Universe
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How to Simulate Galactic Outflows?

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Abstract. A challenge in cosmological simulations is to formulate a physical model of star-formation (SF) and supernovae (SN) feedback which produces galactic outflows like that widely observed. In several models an outflow velocity ($v_{\rm out}$) and mass loading factor (η) are input to the sub-resolution recipe. We present results from our MUPPI model, which *uses local properties* of gas, and is able to develop galactic outflows whose properties *correlate with global galaxy properties*, consistent with observations; demonstrating a significant improvement in such work.

Keywords. Cosmology: theory – Methods: Numerical – Galaxies: formation

1. Introduction

We explore our novel *sub-resolution* model for SF and SN feedback, **MUPPI** [**MU**lti-**P**hase **P**article **I**ntegrator] (Murante *et al.* 2010, 2014), embedded in the GADGET-3 code, which uses only local properties of the gas. Unlike popular adaptation in the literature, our model has no input expression of $v_{\rm out}$ and η for SN feedback.

2. Conclusions

We measure properties of SN-driven galactic outflows over redshifts $z = 1 - 5$ in cosmological hydrodynamical simulations (Barai *et al.* 2013, 2014). The MUPPI model generates $v_{\rm out}$ and mass outflow rate ($\dot{M}_{\rm out}$) exhibiting positive correlations with galaxy mass and with the star formation rate (SFR) (Fig. 1). However, most of the relations present a large scatter. The mass-loading is between $0.2 - 10$, with an average $\eta \sim 1$.

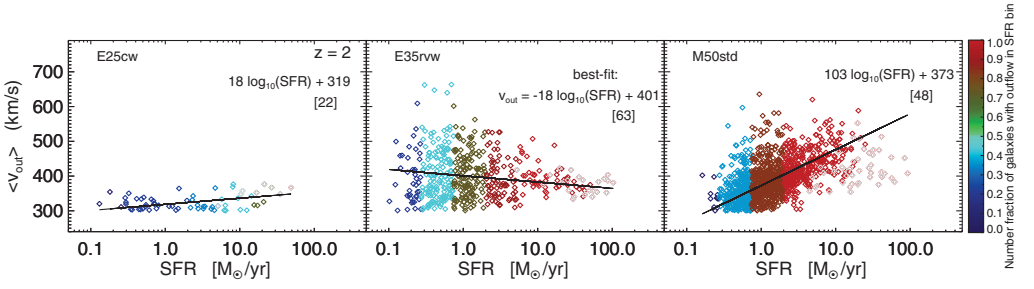

Figure 1. Outflow velocity as a function of SFR of galaxies in three cosmological simulation runs at $z = 2$. The black line is the best-fit relation between $v_{\rm out}$ and $\log_{10}$ (SFR).

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