Inter-Lagrangian Baryon Transfer in the SIMBA Simulations

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Physical Motivation

- Feedback causes gas to be blown out of galaxies
- This is especially true in simulations that include AGN feedback
- Where does that gas go?



Angles-Alcazar+, Baryon Cycling and Galaxy Assembly on FIRE, 2017







SIMBA

- New cosmological simulation suite
- Sub-grid parameters based on scalings from FIRE (Hopkins+ 2018)
- Includes a sophisticated AGN feedback model





GSMF for the 50 Mpc/h SIMBA volume (Dave+ 2019)



Let's talk about metrics

- The effect of feedback itself is hard to quantify
- Can see effect on GSMF, etc. indirectly
- Very few direct metrics exist
- Have to run simulations with/out; these are usually invalid because of calibration.





NoJet (L) v.s. full model (R)







Lagrangian regions

- Define the "Lagrangian region" by the dark matter of a collapsed object at z=0
- Look at the spatial region those particles are spread over in the ICs
- Extend to gas using nearest neighbour searching



$$z = 99$$

$$M_{halo} = 7 \times 1$$







BTMF (Baryon Transfer Mass Functions)





LTCaesar

- LTCaesar, the code that does this matching, is fully open source and available
- We want to apply this to other simulation suites (next up EAGLE, Illustris, and maybe TNG?) so get in touch if you are interested!

= Û github.com C Ð 💭 Search or jump to 👗 ++ 💽+ Pull requests Issues Marketplace Explore UBorrow / lagrangian-transfer ⊙ Unwatch - 1 ★ Star 0 Ÿ Fork 0 ↔ Code 💿 Issues 1 n Pull requests 0 🔟 Projects 0 📖 Wiki 📊 Insights 🌣 Settings Some lagrangian transfer code written for the KSPA Edit Manage topics ⊕ 147 commits 𝘕 4 branches S 0 releases **1** contributor Clone or download Branch: master - New pull request Create new file Upload files Find file Latest commit 9ec8490 20 days ago JBorrow Merge branch 'master' of https://github.com/JBorrow/lagrangian-transfe Added new data function for Ir tracing 20 days ago Itcaesa

—	0	, 0
scripts	Ensured that -1 was not counted as a 'halo'	21 days ago
🖿 tests	Added function that increases the virial radius of only the lagrang	3 months ago
.gitignore	Added pickled objects to the gitignore	5 months ago
■ README.md	Added note about unsort arrays	3 months ago
analyse.py	Added ability to run analysis with a changed virial radius for the la	3 months ago
requirements.txt	Added module info and setup.py so this can actually be instaleld	5 months ago
setup.py	Revved to 0.5.0 because we broke the API	3 months ago

README.md

Lagrangian Transfer

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This small library is used to calculate the transfer of mass between lagrangian regions in cosmologcal simulations.

Requirements

- python3 no attempts will be made to ensure that this code works with older versions of python
- caesar you will also need to generate the relevant halo catalogues for each snapshot that you would like to include in the analysis. The version of caesar that we recommend is the custom version available here: https://bitbucket.org/laskalam/caesar.
- h5py for reading snapshots.
- numpy for numerical routines.
- scipy for the KDTree routines.
- tqdm (optional) for a status bar.

And that's it! We assume that your output files are GADGET-oid compatible, i.e. that they are HDF5 files, with collections for particles where:

• PartType0 are gas particles

PartType1 are dark matter particles





Conclusions

- New feedback models include jet modes
- The impact these jet modes have is clear visually, but hard to quantify; can use the spread metric to visualise.
- Feedback drives gas flow between halos; ~5-10% of the mass of a MWlike galaxy originates from another galaxy

KAVLI SUMMER PROGRAM IN ASTROPHYSICS







Where to go with this?

- Can use these metrics to put constraints on feedback models
- Of course, this is very difficult to measure in observations
- Can tie into metallicity measurements, etc.





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But where does it go?

- Only 20% of the baryonic mass of a given Lagrangian region ends up in the final halo
- The rest ends up outside any LR: delayed infall and feedback out of galaxies.





Validation

Expanded *r*_{vir}





Smoothing LRs

