

# **Simulations Documentation**

## the AWESOME Project

### PART: Notes

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# Chapter 1

## Simulations

# Chapter 2

## Notes

11.09.2012 Update on unconstrained  $512^3$  80Mpc runs and cutout: r128 and r256 documentation partially deprecated!

09.09.2012 IMF Tests for `NGenIC_20905` and the cutout `2.3827E14-88-13-85` cluster - see tables: Stellar mass functions, global star formation rates etc. are influenced by the choice of the IMF. Parameters for Galacticus XML file e.g. for Kennicutt:

```
<parameter>
  <name>imfSelectionMethod</name>
  <value>fixed</value>
</parameter>

<parameter>
  <name>imfKennicuttYieldInstantaneous</name>
  <value>true</value>
</parameter>

<parameter>
  <name>imfKennicuttRecycledInstantaneous</name>
  <value>true</value>
</parameter>
```

06.09.2012 Galacticus jobs on `astro-cluster1` did not run because of memory limit in submit scripts

29.08.2012 New Best Practice (??): Unconstrained sim → Rockstar → cutout around heaviest clump → Rockstar → Galacticus

28.08.2012 Important: Smoothing lenght of Gadget2 simulation strongly influences the number of nodes Galacticus identifies and also the physical properties of the runs. the smoothing lenght that seems not to change the number and (hopefully) the physical properties of the halos is about 0.7% of the initial distance between to DM-bodies.

Table 2.1: IMF Comparison Test Global Parameters

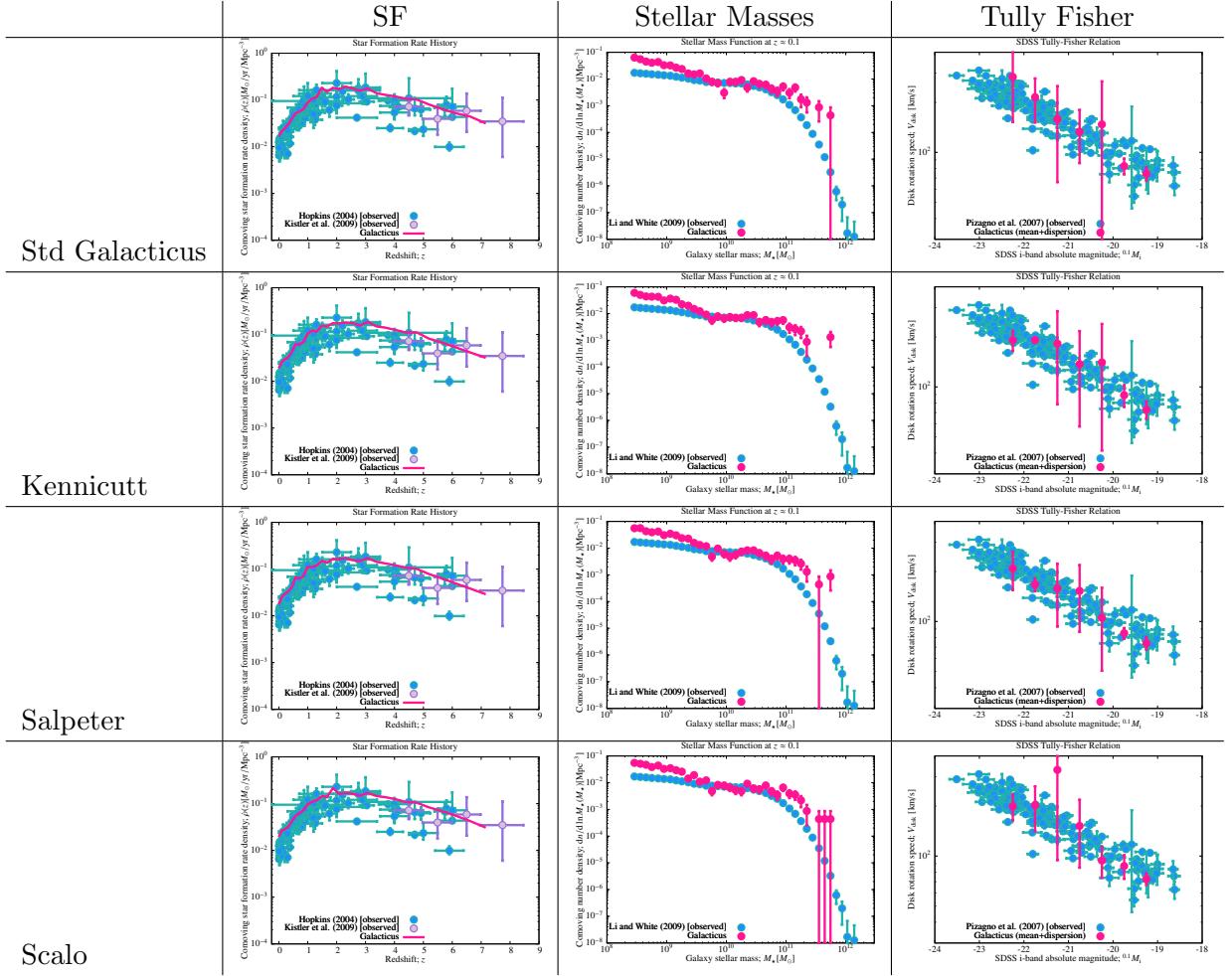


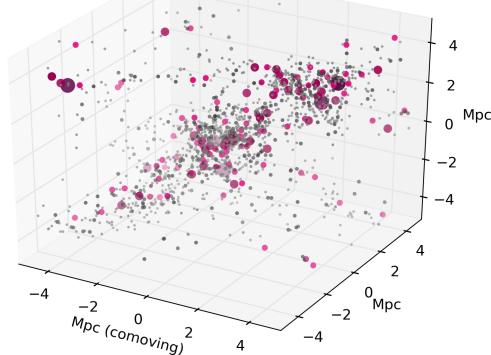
Table 2.2: IMF Comparison Test Halos, Color Coding: SFR

---

z=0

z = 0.00

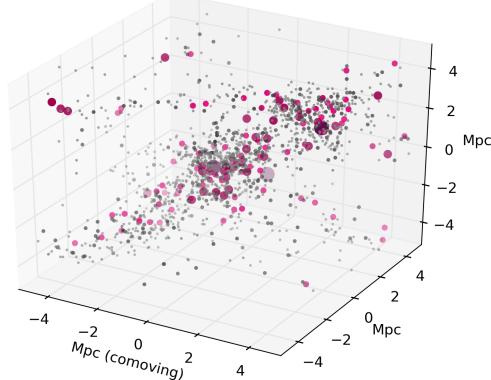
galacticus\_std\_20905.hdf5 Halo Positions with SFR



Std Galacticus

z = 0.00

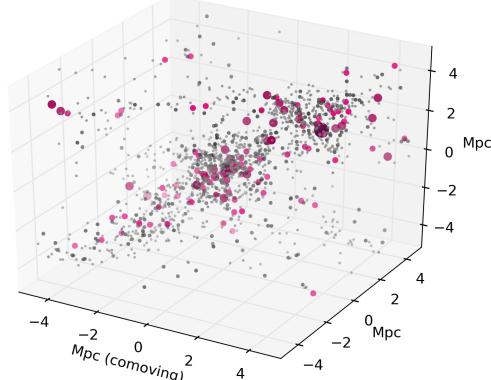
galacticus\_Kennicutt.hdf5 Halo Positions with SFR



Kennicutt

z = 0.00

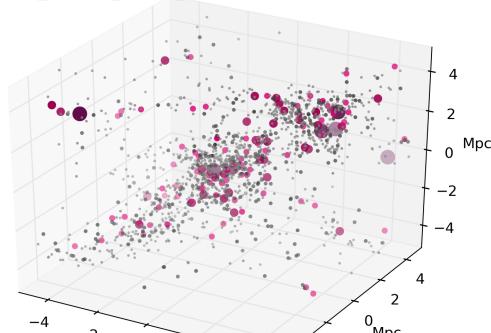
galacticus\_Salpeter\_20905.hdf5 Halo Positions with SFR



Salpeter

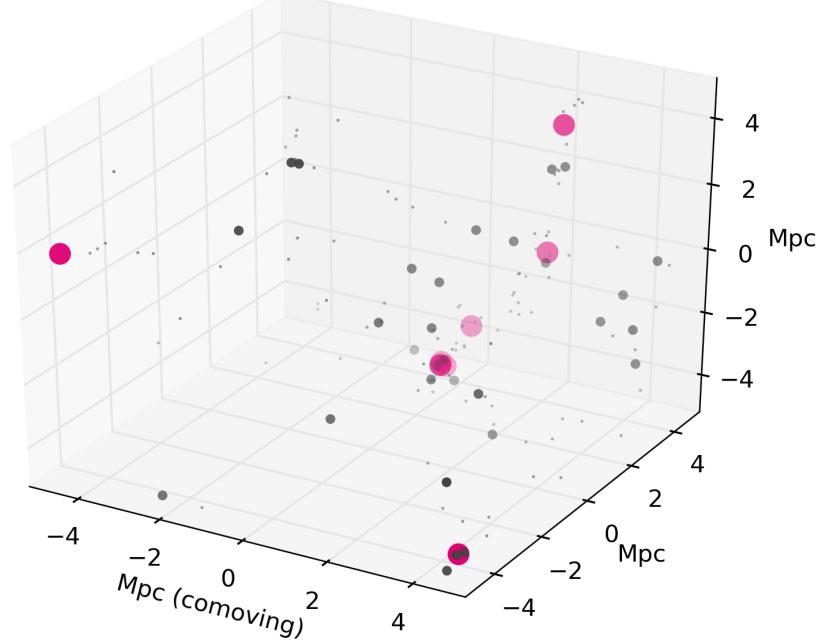
z = 0.00

galacticus\_NGenIC\_20905\_Scalo.hdf5 Halo Positions with SFR



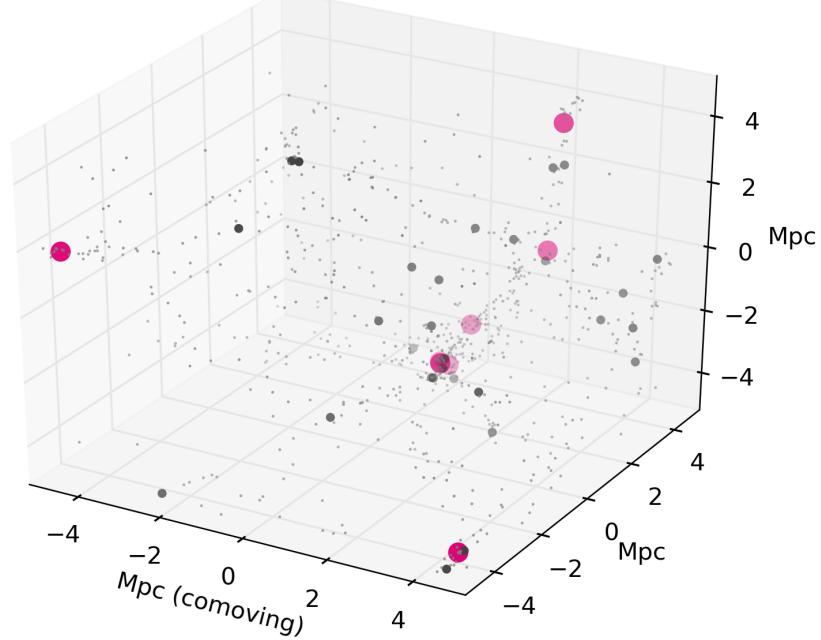
$z = 0.00$

Halo Positions with Masses galacticus\_nestages12.hdf5



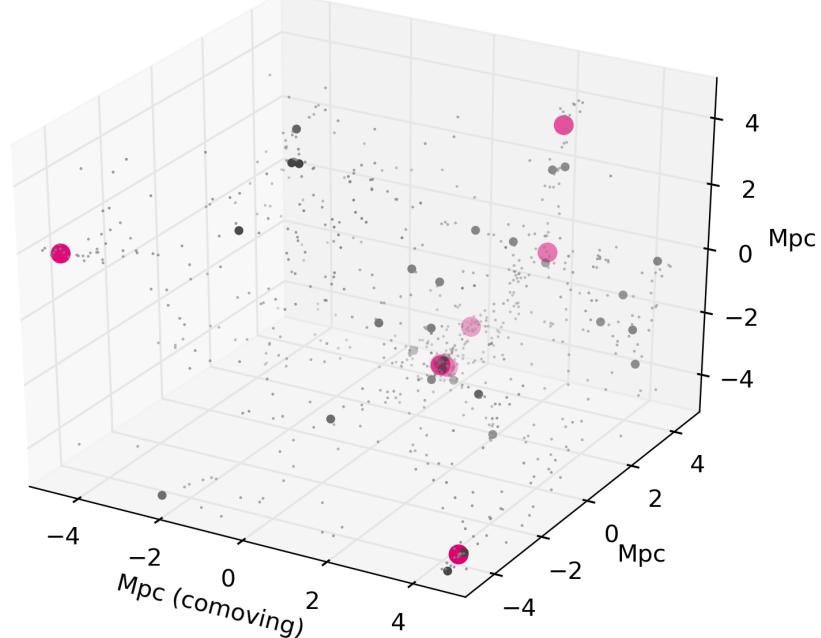
$z = 0.00$

Halo Positions with Masses galacticus\_nestages12SLtest.hdf5

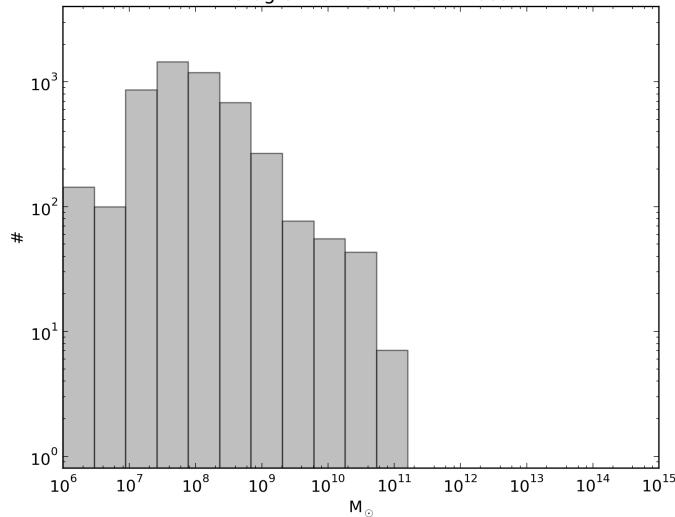


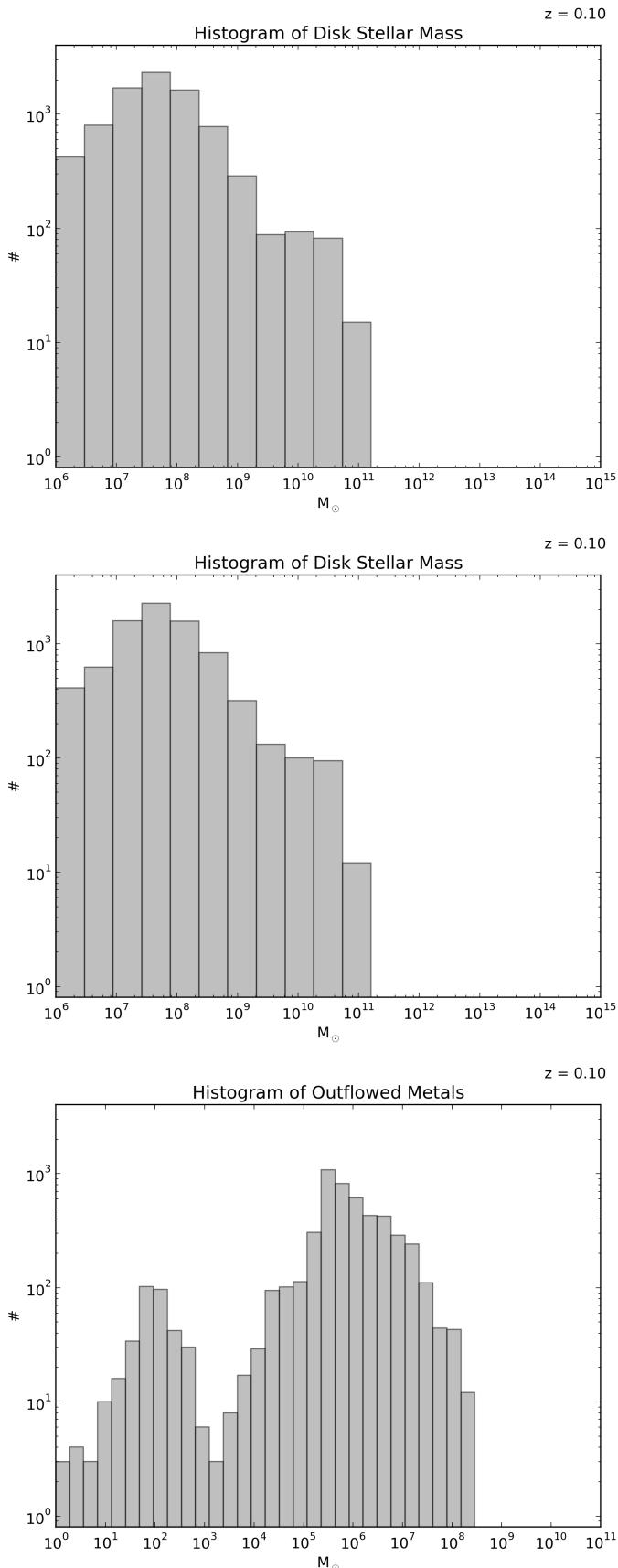
$z = 0.00$ 

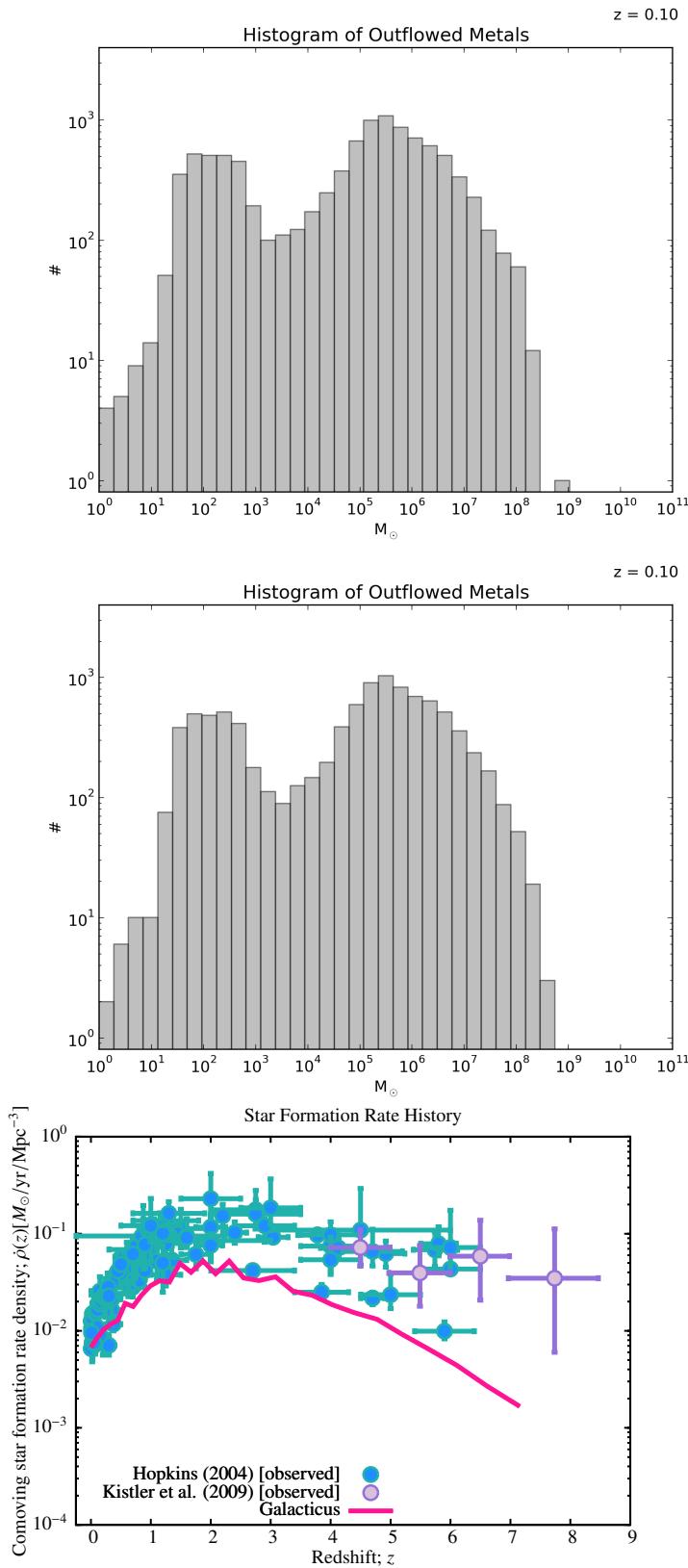
Halo Positions with Masses galacticus\_nestages\_SLtest2.hdf5

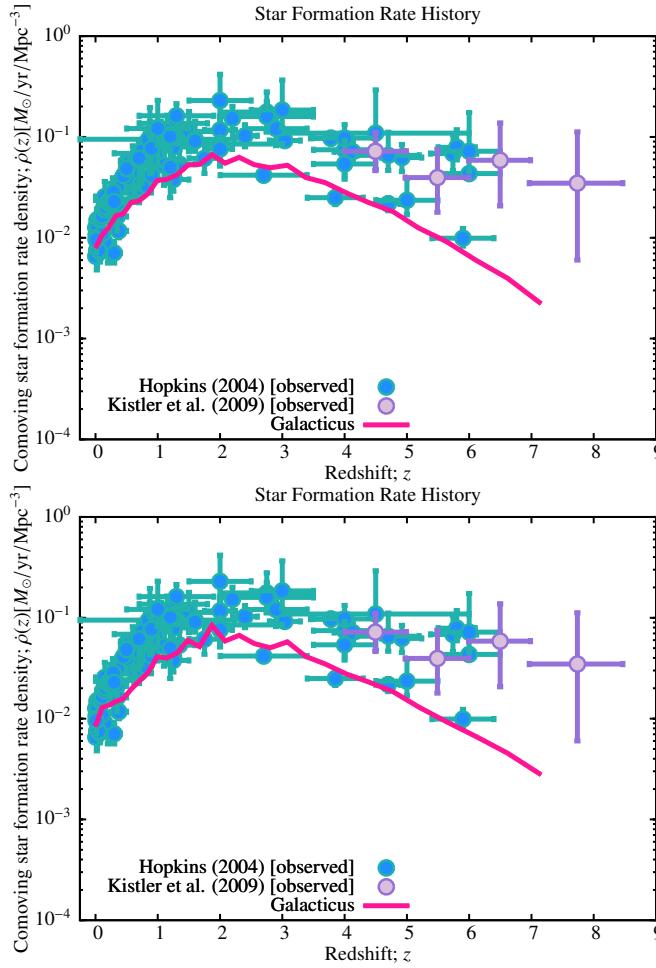
 $z = 0.10$ 

Histogram of Disk Stellar Mass

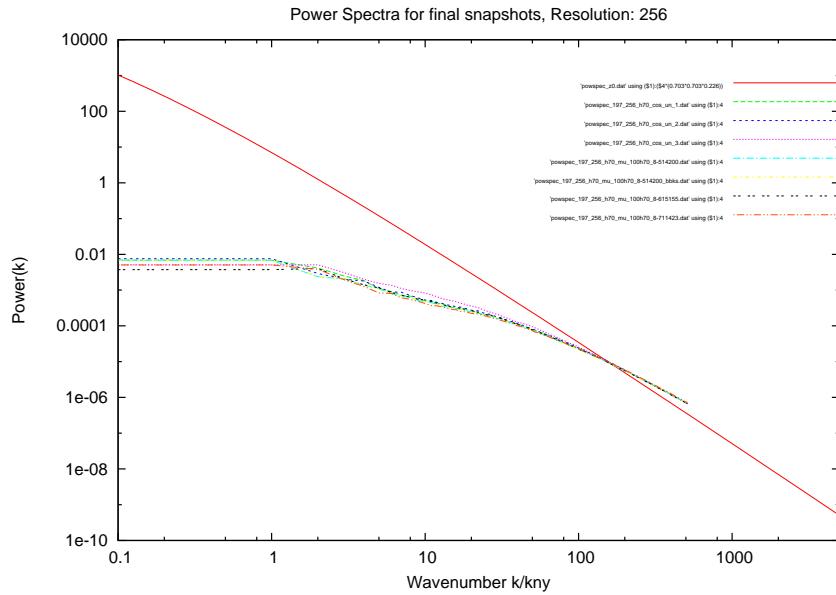


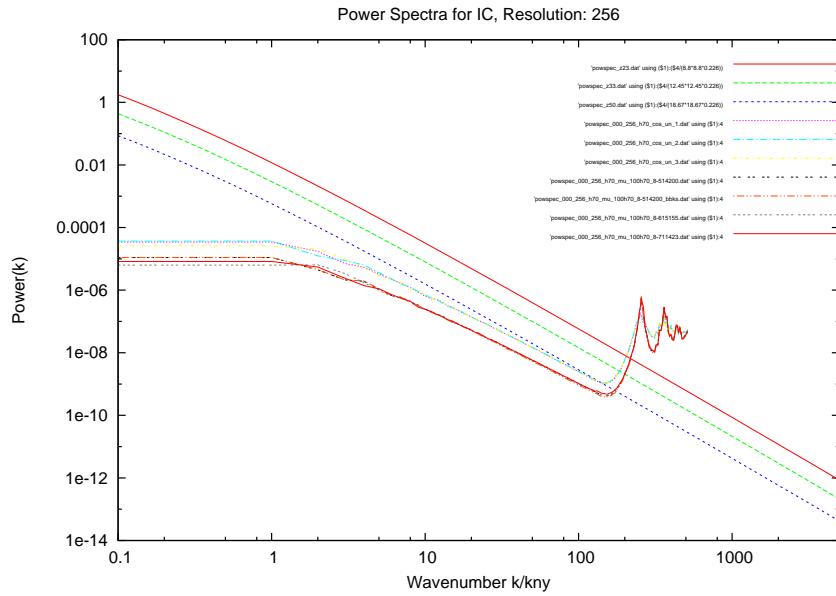






Power Spectra update: Comparison of NGenIC, Cosmic and MUSIC IC generators for 100Mpc unconstrained simulations shows good agreement. The differences with the IC are due to different starting redshifts, the non-agreement with the analytic solution is yet to be cleared up

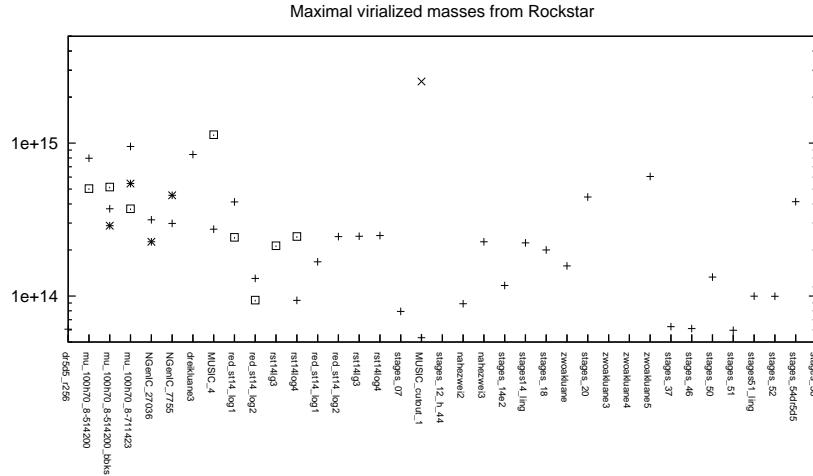


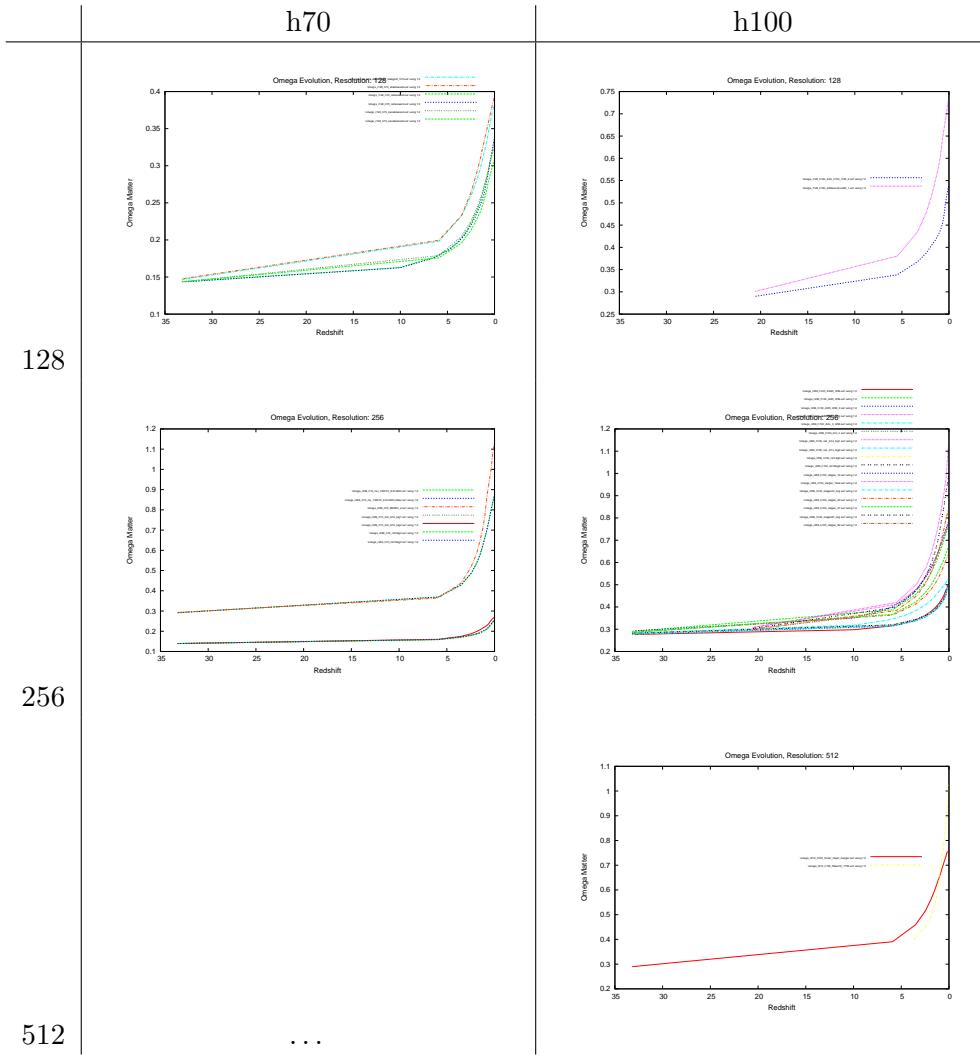


Homogenization of runs is going on  
Radial studies and positional analysis of Galacticus outputs: strange strange strange

23.07.2011 Found normalization for power spectra plots - now puzzling for physical reasons - seem systematically too low; maybe an issue with calculating the Hubble constant which enters with  $h^{-2}$

29.06.2012 Comparison of maximal virialized masses in all simulations

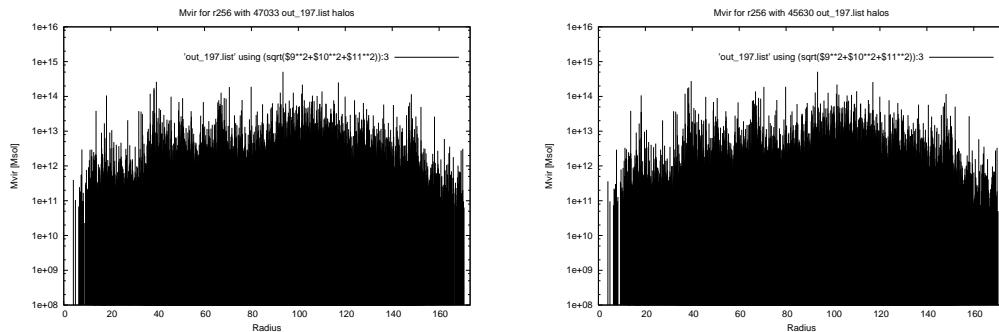


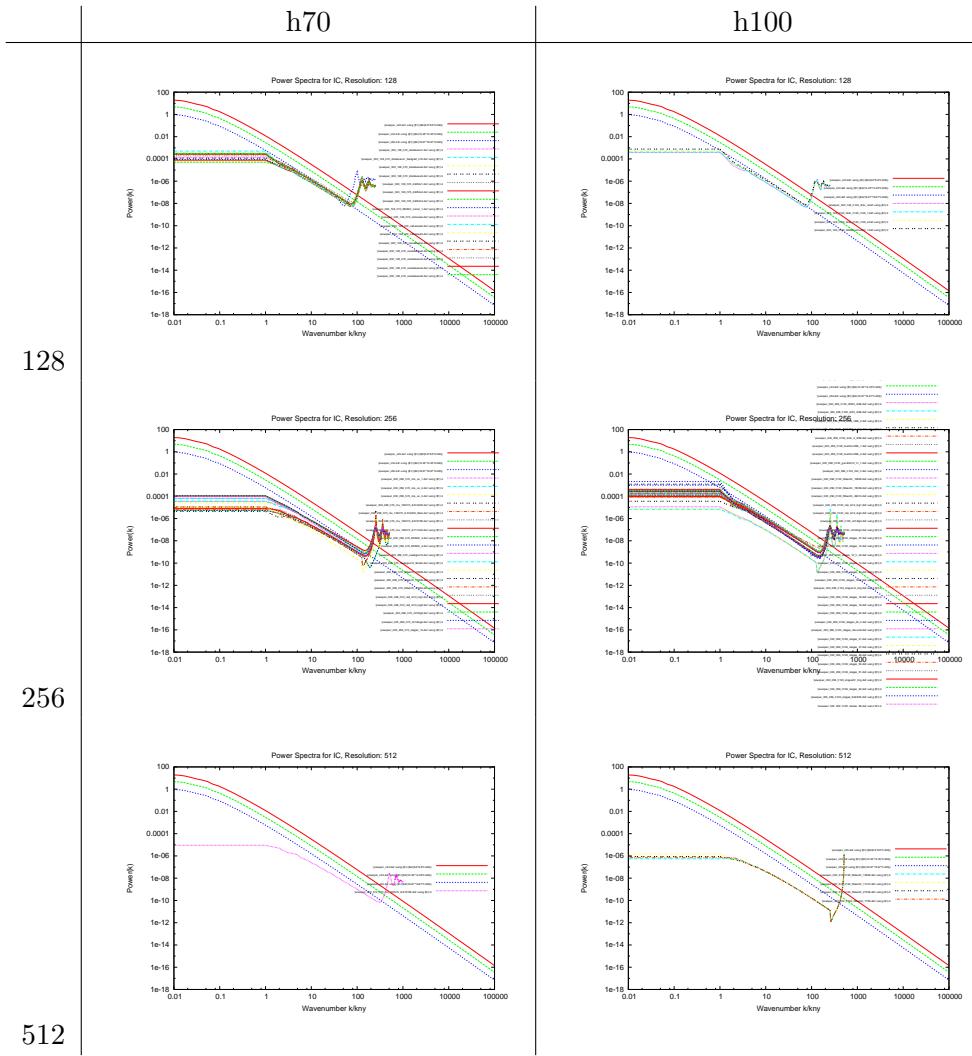


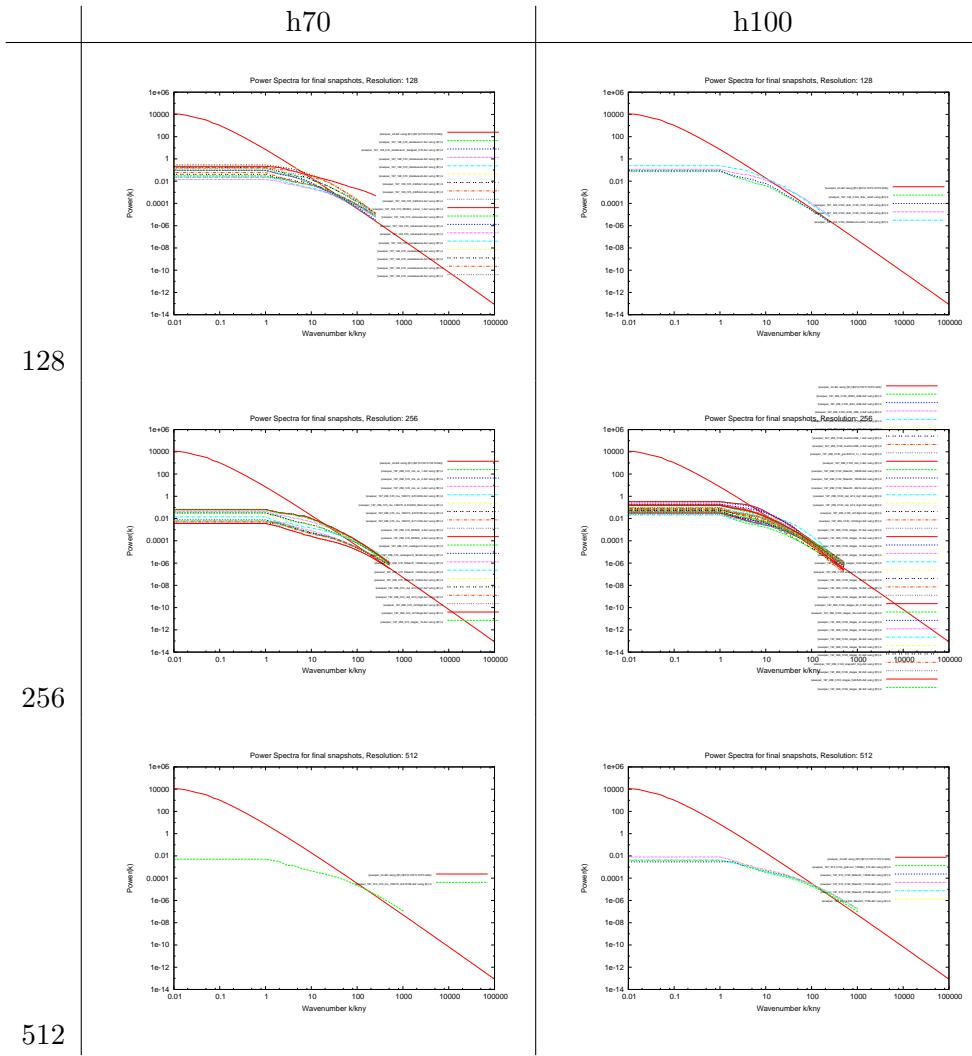
Oliver Hahn has answered to my question regarding transfer functions - 2DO: answer Cutout program `sh cutout.sh` written that identifies heaviest virialized mass from Rockstar outputs, cuts a 20Mpc box around - this we investigated for the  $\Omega_{\text{matter}}$  evolution `plot_omega_evolution.sh`:

28.06.2012 Power spectra analysis with reference model from Stephane Colombi which has to be normalized correctly yet `sh powmesplots_combined.sh!` (2DO)

25.06.2012 Rockstar comparison runs DM/baryons have to be checked + doublechecked with different transfer functions







Plots do not suggest a big difference when same seed but Eisenstein / VS BBKS transfer function is used

18.06.2012 Gas/DM tests for cutout simulation are partially running - Question: is rescaling done in every time step and how? Markus claims, this is calculated from  $\Omega_{\text{baryon}}$  but it should be taken just from the number of particles.

14.06.2012 First test run for a simulation with gas in it `MUSIC_cutout_1` as a rockstar job where the config file was not altered → one test how much the gas contributes for halo finder. Next step: set the `MULTIPLE_PARTICLES` flag resp. rescale

12.06.2012 Comparison of different `linger.dat`s for `stages_14` see table:

`MUSIC_3` and `MUSIC_4` are to be rockstar-tested with respect to different particle types

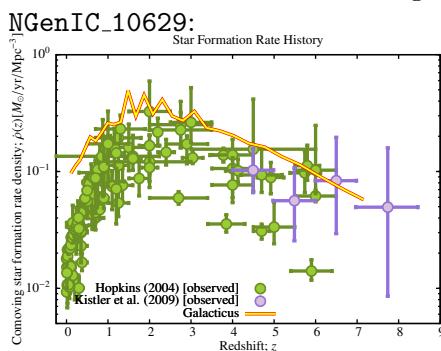
+ Markus wants to test refinement

Galacticus: "merging halos [...] have zero separation"-error reported to Peter Behroozi because this occurs already in `tree_0_0_0.dat`.

10.06.2012 Galacticus bug in stellar spectra calculation reported; Link: <https://bugs.launchpad.net/bugs/101>  
→ fixed in rev836  
Third pair of simulations is being galacticussed  
Markus' findins with Gadget2 units should be checked with respect to the pipeline (especially Rockstar)

05.06.2012 Comparison of h100+h70 runs with different `linger.dat`s is being finalized. Third pair of simulations is being rockstarred.

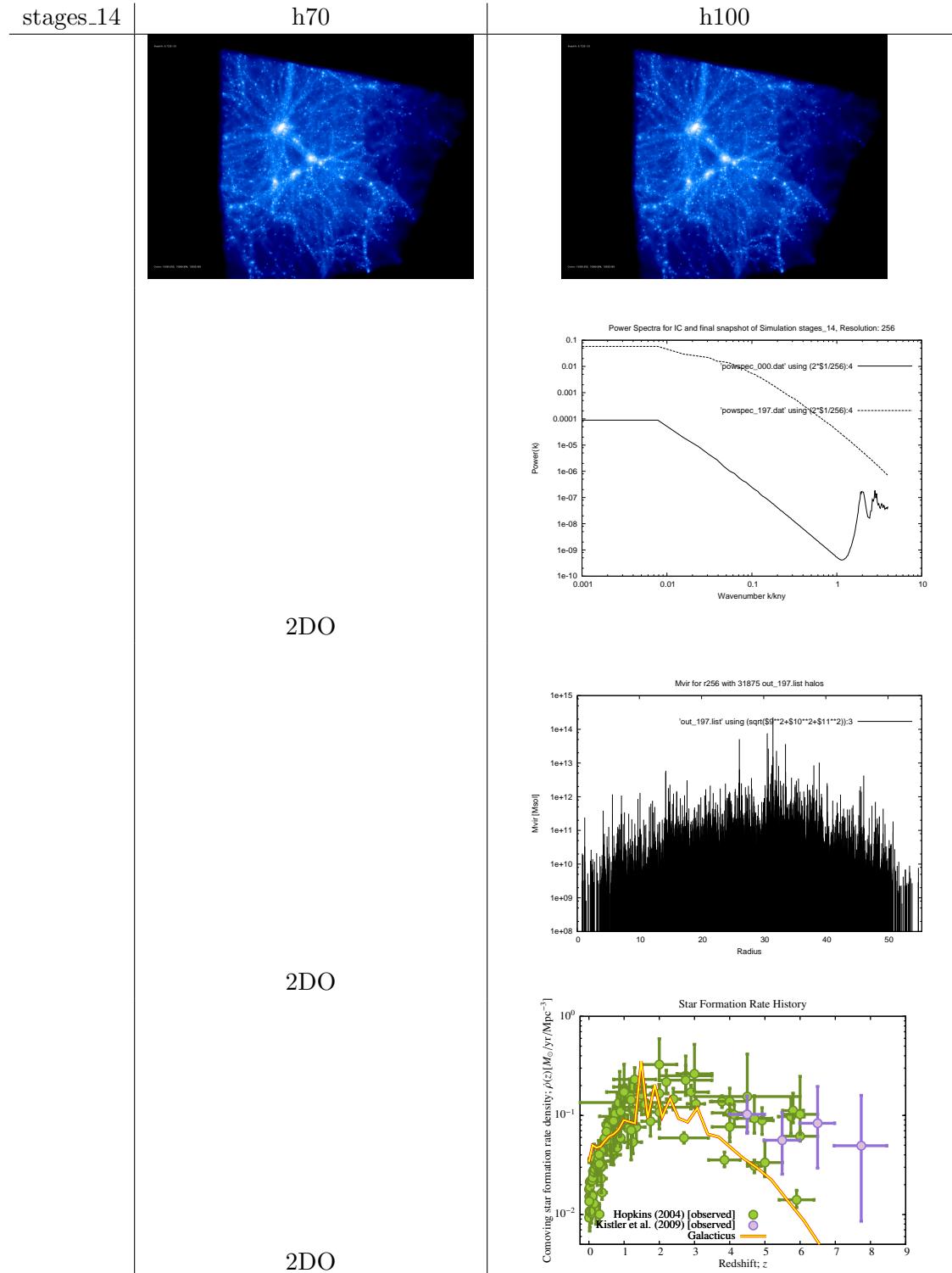
21.05.2012 Star formation rate mystery still unsolved - checked the parameter files for problems (including redshift) - but there is no obvious error / difference. One suspicion: it could be that new `linger.dat` files which produce initial conditions with rather late redshifts ( $\cong 18$ ) influence the SFR negatively; reason to believe that is that the NGen-IC runs all have rather high SFR and their initial redshifts are quite high; e.g.

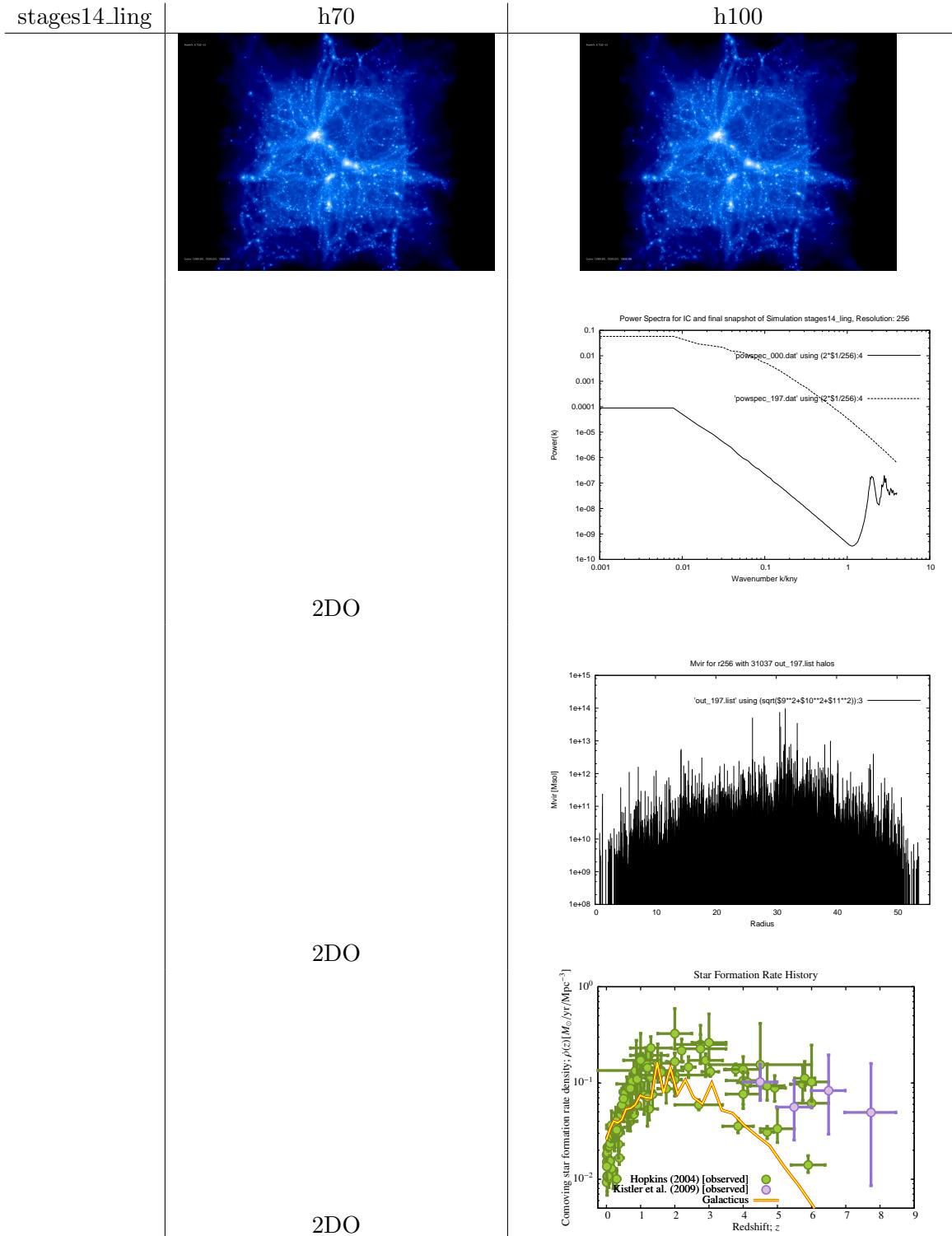


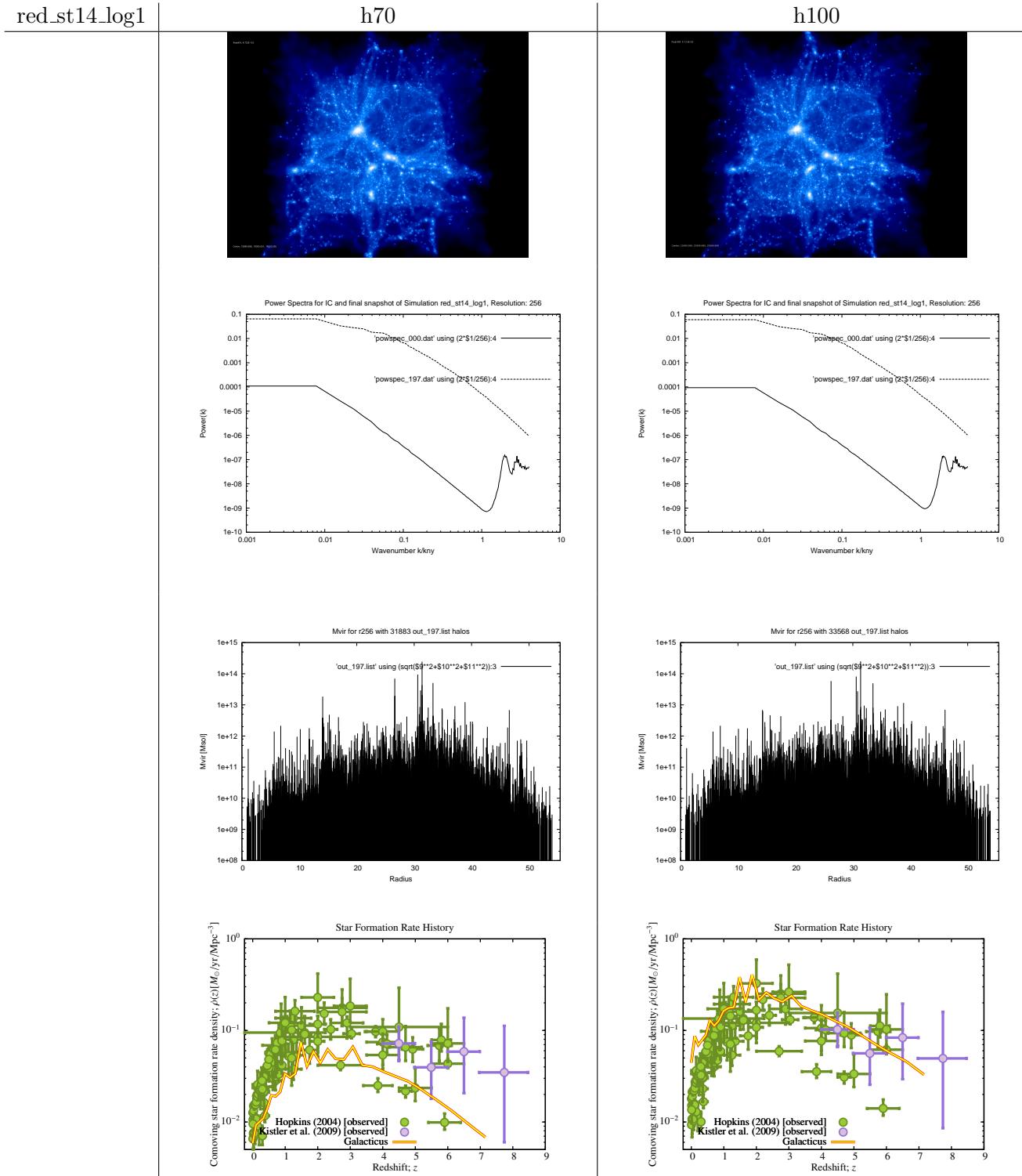
In Galacticus revision 821 the latest bug 'I think this was due to a missing limitation on the rate at which metals can be driven out of hot halos' is fixed and the 100h simulations runs again

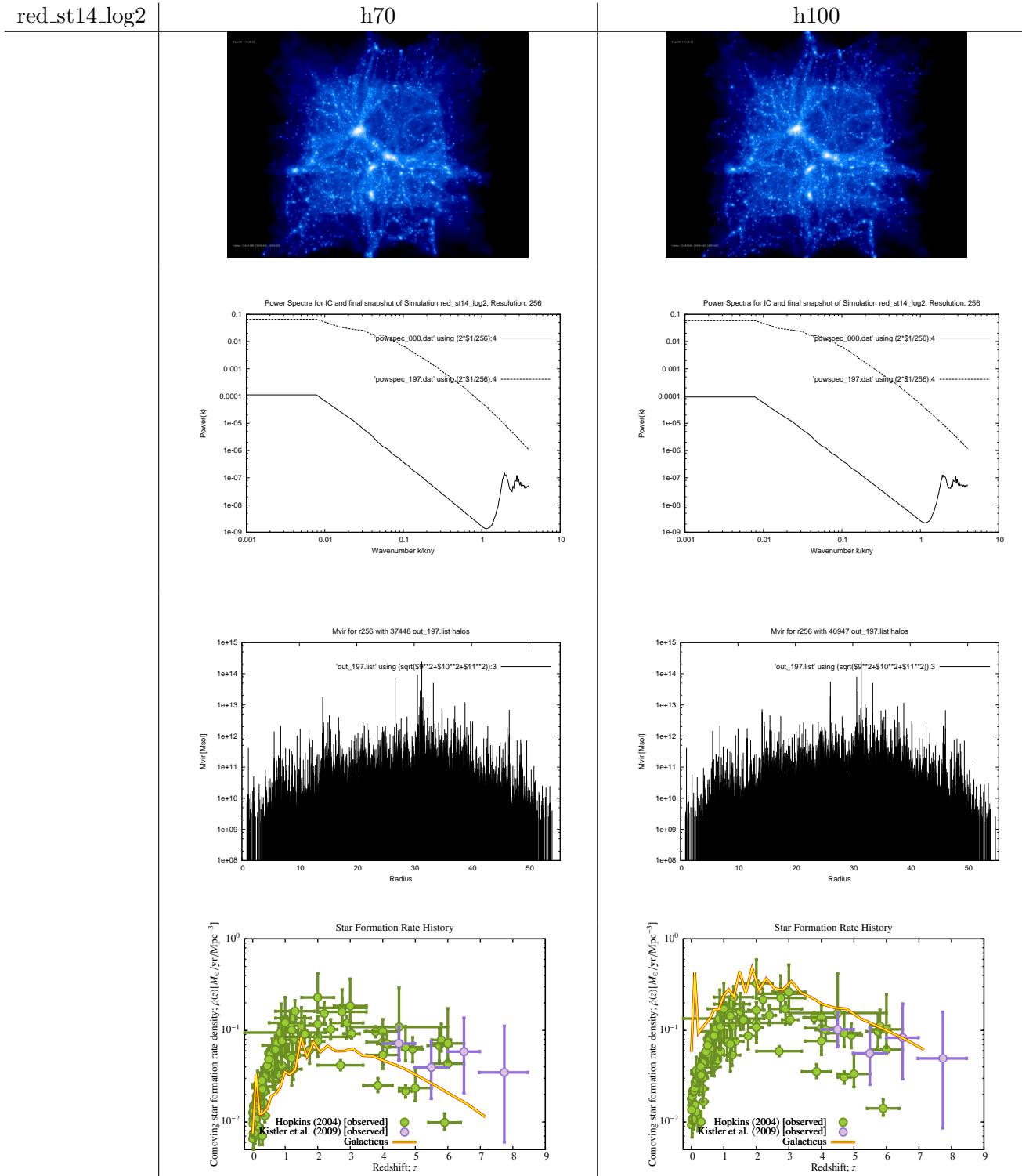
11.05.2012 Galacticus bug report

```
Fatal error in ODEIV2_Solve():
ODE integration failed with status -1
...
...
```









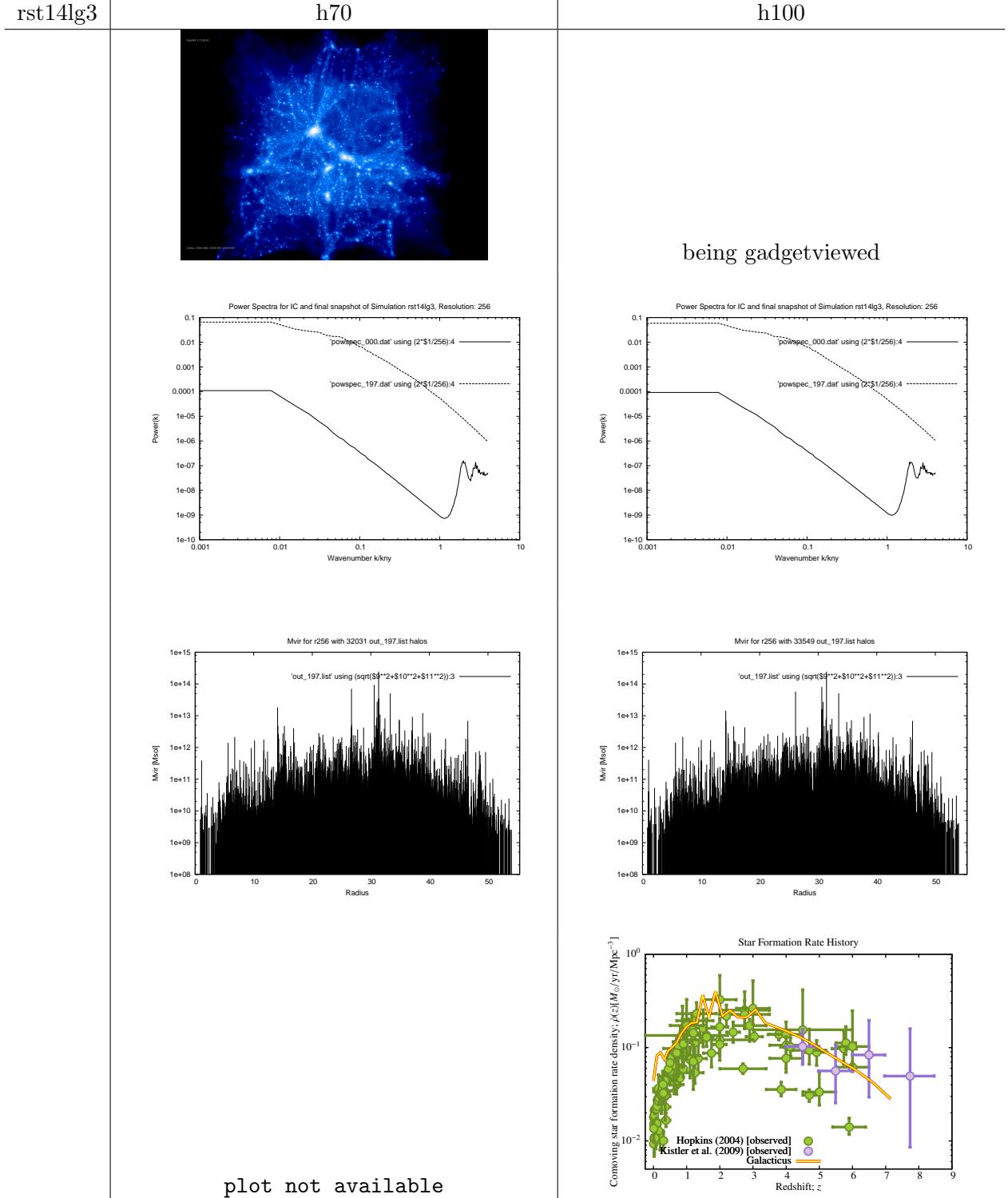


Table 2.3: Comparison

Link: <https://bugs.launchpad.net/galacticus/+bug/998007>  
 - occurs in `stages_12_h_44` with h100.

10.05.2012 Complete reinstallation of system since I had messed up my perl installation severely.  
 Now the plotting scripts run again in revision 809.

08.05.2012 Compiler flags for checking linking

```
-Wl,--verbose
```

gives attempts/success/fail info about opening files.

New Galacticus revisions had problems compiling but already fixed by Benson in rev 805. For consistency also update on pc122 so perl5 is still under construction

02.05.2012 Had to reinstall `perl5` (download + recompile) cause Galacticus plot routines did not work any more: Moreover I had to:

```
$PERL5LIB=/usr/lib/perl5:/usr/local/lib/perl/5.12.4:  

/usr/share/perl5:/usr/local/share/perl/5.12.4  

$export PERL5LIB
```

to get Galacticus itself compile again.

25.04.2012 Is low star formation rate in recent galacticus outputs related to missing IC redshift?  
(99 assumed)

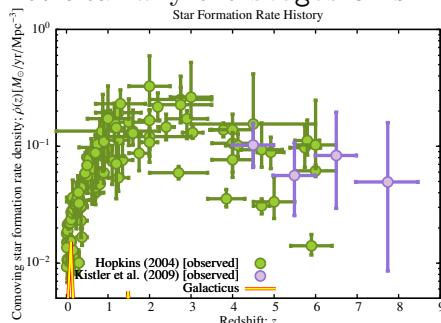
19.04.2012 `stages_52` simulation still shows extremely low star formation rate in history plot (Galacticus rev. 771) although also in Markus' converter-ed input file the box size of 44.8 Mpc is correct

18.04.2012 Comparison runs look principally nice but not equal - may be caused by different `linger.dat`

Comparison runs have to be redone since `grafic_h70` and `grafic_h100` were not recompiled after changing `constr.f` and `grafic.inc`

2DO: check comparison runs, check new galacticus runs and restart rockstar job on MACH

17.04.2012 Started some comparison runs bewteen H=70.3 and H=100 with same `linger_syn` parameters, same constraints and seeds  
 found nice program with GUI to look at hdf5 files and also to edit them, called `vitable` - big files take very long to load but once loaded it runs smoothly  
 not clear why the `stages_52` simulation plots show such little star formation rate



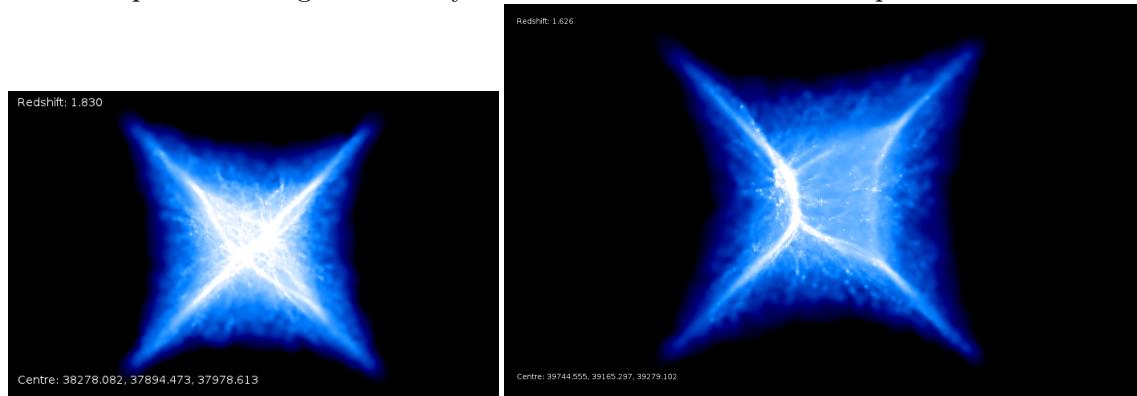
16.04.2012 re-doing the rockstar jobs that did not work on intel queue now on the AMD machines (**stages\_54dr5d5**)

512er run is being rockstarred on MACH (128 cores) faster than on our AMDs → quit job on astro-cluster

12.04.2012 Explicitly defining the ports when havin several server processes on the frontend did not seem to work for the intel queue, all three rockstar jobs stopped working after some time

04.04.2012 E-Mail correspondence with Sabine Kreidl to Rockstar on MACH  
Recompiled Gadget with **PLACEHIGHRESREGION=1** on and PMGRID resolution of 256 for 256er run

03.04.2012 Tried nonperiodic Gadget boundary conditions → leads to star-like patterns



02.04.2012 Correspondence with Peter Behroozi concerning OpenMP parallelization possibilities in Rockstar → tried suggested loops and auto-parallelization. Jobs on intel machines freeze ...

27.03.2012 **512er\_major\_merger** Rockstar run is very slow even on 24 cores  
**consistenttree** has parameter **BOX\_DIVISIONS** which divides the box in this number cubed parts and makes **tree\_X\_Y\_Z.dat** output and is very very fast this way → have to rewrite reading routine in Markus' converter

26.03.2012 Intel compiler auto-parallelization test runs on LEO3 for converter v0.5  
512<sup>3</sup> runs produced Segfaults with Markus' converter v0.4 → fixed

21.03.2012 2DO: change virial radius reading in galaxcicusStart.xml to false and let intern value powmes scripts, plotting scripts (spin, vrms)

20.03.2012 powemes installed

19.03.2012 NGenIC starting redshift test, if corrected initial z leads to lower star formation rate did show, that suspicion was not proven. Other explanation has to be found. Vrms and Spin videos are in the works.

14.03.2012 2DO: new stages simulations in Documentation (at least 46, 50, 51)  
Script that makes \*.pngs out of halo masses at all time steps is running over all

simulations in r256 for comparison beweteen Bertschinger and NGenIC ICs  
 Rerun some Bertschinger ICs with updated linger.dat and spectral index  $\neq 1$  to see how this influences star formation rate (linger runs and runs)

13.03.2012 Unclear why all NGenIC simulations show much higher star formation and plot scripts yield different output files though the same .xml file as always is used

11.03.2012 NGenIC\_15039 produces "unreadable" output, is bein rerockstarred from scratch

```
+++
Plot_Star_Formation_History.pl:
+++
Useless use of private variable in void context at ../../perl//XMP/MetaData.pm line
HDF5-DIAG: Error detected in HDF5 (1.8.4-patch1) thread 0:
#000: ../../src/H5D.c line 507 in H5Dget_type(): not a dataset
    major: Invalid arguments to routine
    minor: Inappropriate type
Error Calling PDL::IO::HDF5::Dataset::get: Can't get HDF5 Dataset type.
at ../../perl//Galacticus/HDF5.pm line 88
HDF5-DIAG: Error detected in HDF5 (1.8.4-patch1) thread 0:
#000: ../../src/H5D.c line 507 in H5Dget_type(): not a dataset
    major: Invalid arguments to routine
    minor: Inappropriate type
Error Calling PDL::IO::HDF5::Dataset::get: Can't get HDF5 Dataset type.
at ../../perl//Galacticus/HDF5.pm line 88
Illegal division by zero at Plot_Star_Formation_History.pl line 58.
```

09.03.2012 strange error in 2 galacticus jobs `stages_12` and `stages_13` → Markus' converter outdated with new consistenttrees?

**idea:** drd5\_r256\_2 shows a major merger in progress → make a set of similar simulations with slightly different parameters

**idea:** make voids as constraints so that netto gravity is more centered towards over-densities

08.03.2012 add nohup to `./rockstar server_ib.cfg` in `qsubrockstar.sh` and rename `rocky_startscript` to something recognizable

83973	0.60500	wcon1Gy.st	jan	r	11:01:23	astro14.astro-beowulf.	64
83974	0.50500	rocky_star	harre	r	13:14:22	astro-x4600-04.astro-beo	1
83976	0.55421	stages_28_	harre	r	13:52:36	astro22.astro-beowulf.	32
83977	0.55421	stages_29_	harre	r	13:56:35	astro25.astro-beowulf.	32
83980	0.55421	stages_30_	harre	r	14:07:12	astro28.astro-beowulf.	32
83984	0.55421	stages_31_	harre	r	14:14:23	astro31.astro-beowulf.	32
83988	0.51611	rocky_star	harre	r	14:49:20	astro-x4600-04.astro-beo	8
83989	0.51611	rocky_star	harre	r	14:50:54	astro-x4600-03.astro-beo	8
83993	0.51611	rocky_star	harre	r	15:12:52	astro-x4600-04.astro-beo	8
83995	0.51611	rocky_star	harre	r	15:16:43	astro-x4600-03.astro-beo	8
83992	0.58278	c803_test_	markus	qw	14:54:54		50
83985	0.55421	stages_32_	harre	qw	14:14:31		32
83986	0.55421	stages_33_	harre	qw	14:14:41		32

re-galacticussing NgenIC\_15039 again since plotting scripts complain that there is no output for a=0

2DO: test speedup of galacticus with 1,2,4,8 threads

**Rockstar** works if infiniband is forced with PARALLEL\_IO\_SERVER\_INTERFACE = "ib0", the client IP address is indeed NOT necessary, client process is started with auto-rockstar.cfg Gadget recompiled with newest openmpi version → should use infiniband now

06.03.2012 submitted 4 jobs with same seed but different constraints parameters

Memory agglomeration fix also on cluster + email to developer

Wrote E-Mails to Rien de Weijgaert and Peter Behroozi

re-rockstarring stages\_21 on my machine pc122 → dumped due to memory

02.03.2012 re-galacticussing NgenIC\_15039 cause 200 output redshifts lead to > 30GB file + added luminosity output redshifts from Markus' .xml file

Peter answered and sent **consistent\_trees** v0.99, but problem persists - suspicion: Snapshotnames.dat must be changed (delete corresponding lines) for runs that have < 200 outputs!

rockstar won't start any more ... network problem suspected

01.03.2012 wrote E-Mail to Peter concerning **find\_parents\_and\_cleanup**:

**find\_parents\_and\_cleanup.c**:130 problem

consistenttree: NgenIC\_15039, galacticussing

restarted: stages\_21 rockstarred auf AMD-04

first 512<sup>3</sup> simulation NgenIC\_7755 finished successfully - lasted 1 day on 64 cores  
wrote E-mail to de Weijgaert concerning constrained ICs

29.02.2012 stages\_12 re-rockstarred auf AMD-03

stages\_21 rockstarred auf AMD-04 - crashed

100Mpc 512<sup>3</sup> jobs: 11410, 15725, 27036, 7755

10 100Mpc ICs generated

**Note: try bigger volumes with NGen-IC**

added output redshifts derived from **gadget\_timer.txt** as parameter **outputRedshifts** in .xml file

Random seeds that do not create cluster like structures at 32Mpc box: 589, 12170, 13610, 16604, 16749, 17362, 17433, 29666, 32223, 17595, 22045, 3724, 3183, 4152, 7581, 8502, 10153, 10657, 22946, 14841, 25060, 29468, 32634

Random seeds that look a little interesting: 15039 → rockstarred on AMD-03 (finished), 26214 → rockstarred on AMD-04

28.02.2012 Successfully started some N-GenIC jobs for comparison of IC generation

17.02.2012 Discussion with Asmus about Stages Cluster → try more systematic approach to ICs

15.02.2012 Galacticus revision 708 - drd5\_r256\_2 not fixed → E-Mail to Andrew check tomorrow: Galacticus jobs fuenfincr256\_1 and drdx\_3\_r256

**Note: think about / find a good method for common metadata**

14.02.2012 Wrote E-Mail to Bertschinger.

13.02.2012 Deleted some jobs I started yesterday because they had artificial crosses or were practically unconstrained

Third simulation `fuenfincr256_1` ran through - Galacticus restart worked well!

**Note: IC with same seed but higher resolution do not yield the same simulation!** → started two more test runs from r128 sims to doublecheck

→ Note from April 2012: different `linger.dat` suspected

12.02.2012 Updated Galacticus to revision 707 as suggested by Andrew and added parameter `hotHaloOutflowAngularMomentumAlwaysGrows` to xml file.

Two of four simulations ran through (copied hdf5 to transfer), two crashed → try to continue at saved states!

10.02.2012 wrote E-Mail to Andrew about performance problems and wavelenght computation error in `fuenfincr256_1`

started some runs with higher central delta and broader smoothing lenghts, i.e.  $32/dx$  and  $100/dx$ ; all 128 resolution except second last one (same seed!):

83492	0.60500	d31c_1_st	harre	r	02/10/2012	15:19:56	astro18	16
83493	0.60500	d31c_2_st	harre	r	02/10/2012	15:20:37	astro29	16
83494	0.60500	d31c_3_st	harre	r	02/10/2012	15:21:17	astro25	16
83495	0.60500	d51c_s1100	harre	r	02/10/2012	15:23:21	astro31	16
83496	0.54786	d3+3c_s150	harre	r	02/10/2012	15:37:13	astro12	16
83497	0.60500	d3+3c_s150	harre	r	02/10/2012	15:39:16	astro30	32
83498	0.60500	d15+3c_s15	harre	r	02/10/2012	15:44:23	astro30	16

09.02.2012 `drd5_r256` last written to hdf5 file feb 09, 05:07

`fuenfincr256_2` last written to hdf5 file feb 06, 03:28

`drd5_r256_2` last written to hdf5 file feb 07, 00:50

02.02.2012 `drdx_h100_128_1` run has again severe consistency metric problem

→ not clear why

upper python script does not work, was commented out again

plan: **move to python scripts in general in order to have easier arithmetic calculations**

plan: create new folder structure and remove old simulations → done

31.01.2012 note:  $h=70.3$  in galacticus xml input file is expected, consistent tree obviously implies it

→ fixed: changed in markus parameter file for the converter and in xml file

→ question: why not read out?

→ python `updateGalacticusStart.py` from Markus

30.01.2012 new consistenttree with  $vmax=20$