Simulations Documentation

the AWESOME Project

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Contents

Chapter 1

Notes

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09.03.2012 strange error in 2 galacticus jobs `stages_12` and `stages_13` → Markus' converter outdated with new consistenttrees?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

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 develooper
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
consistentree: `NgenIC_15039`, galacticussing
restarted: `stages_21` rockstarred auf AMD-04
first 512^3 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 512^3 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 revisision 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

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_sta harre   r     02/10/2012 15:19:56 astro18  16
83493 0.60500 d31c_2_sta harre   r     02/10/2012 15:20:37 astro29  16
83494 0.60500 d31c_3_sta harre   r     02/10/2012 15:21:17 astro25  16
83495 0.60500 d51c_sl100 harre   r     02/10/2012 15:23:21 astro31  16
83496 0.54786 d3+3c_sl50 harre   r     02/10/2012 15:37:13 astro12  16
83497 0.60500 d3+3c_sl50 harre   r     02/10/2012 15:39:16 astro30  32
83498 0.60500 d15+3c_sl5 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

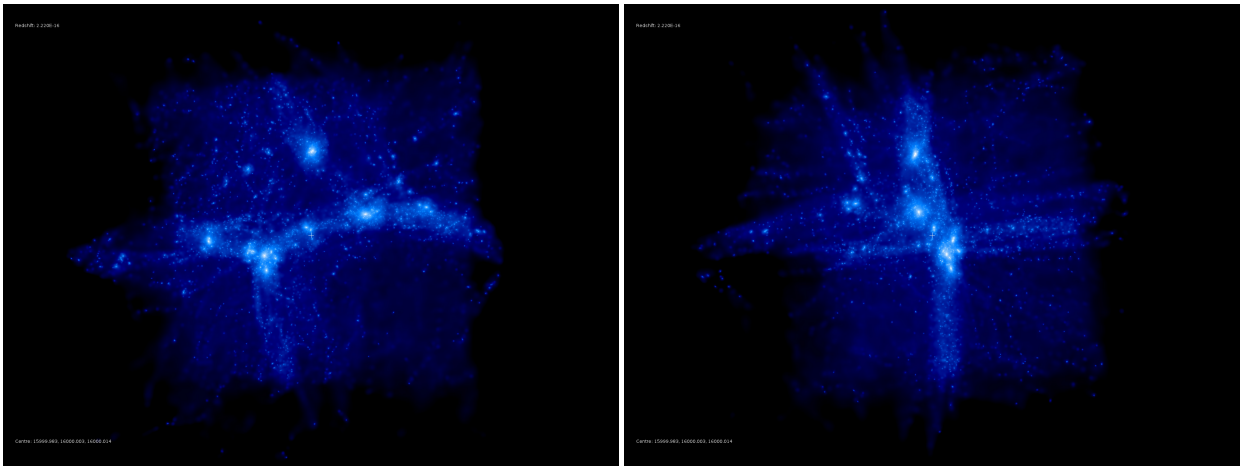
30.01.2012 new consistenttree with vmax=20

Chapter 2

Simulations

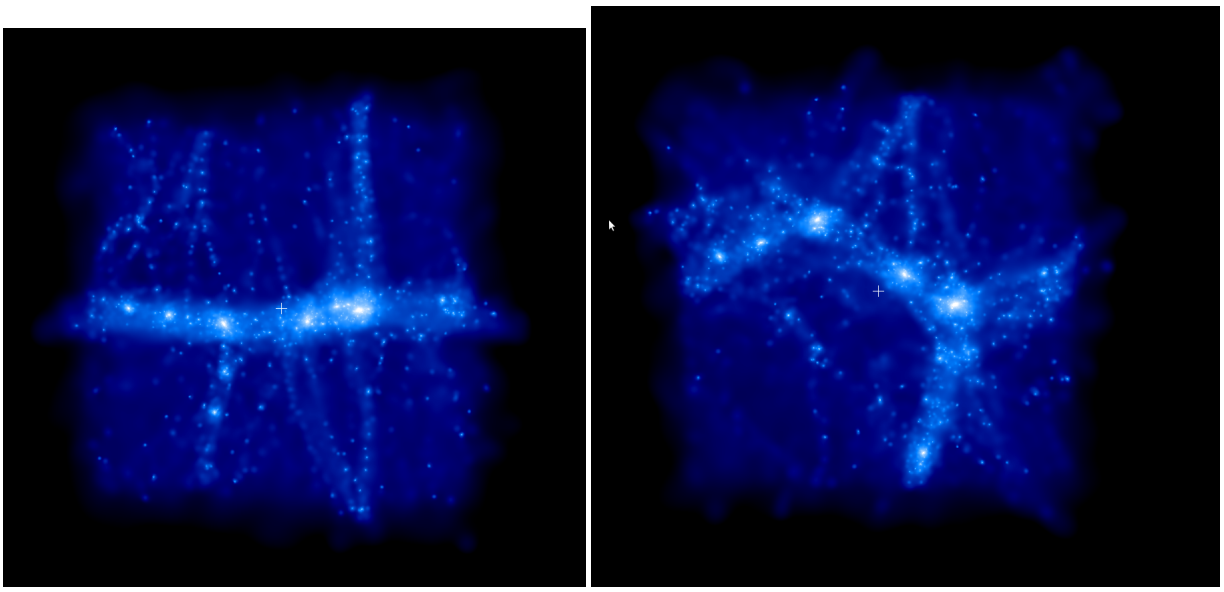
2.1 r128

2.1.1 drdx_3



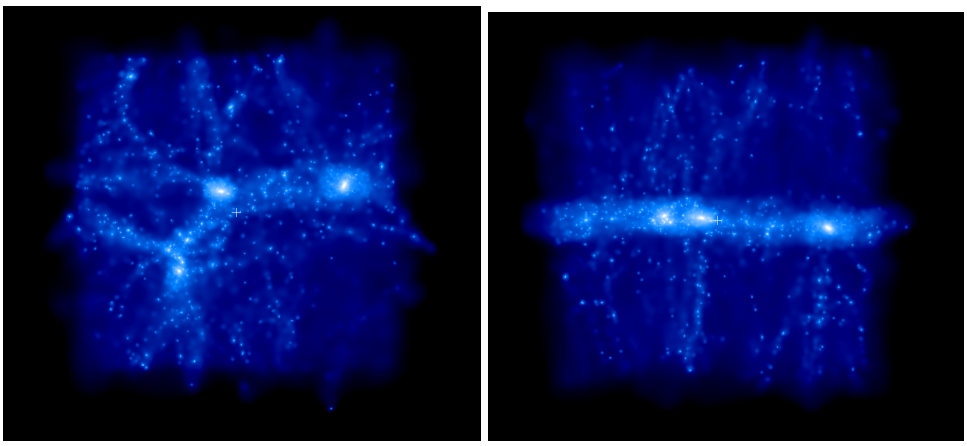
ROCKSTARRED $\surd$
pfff $\rightarrow$ Error: too few halos at scale factor 0.926072 to calculate consistency metric.

2.1.2 drdx_h100_r128_1



ROCKSTARRED $\surd$
consistenttree: too few halos at scale factor 0.896 ... $\rightarrow$ wtf?

2.1.3 drdx_h100_r128_2

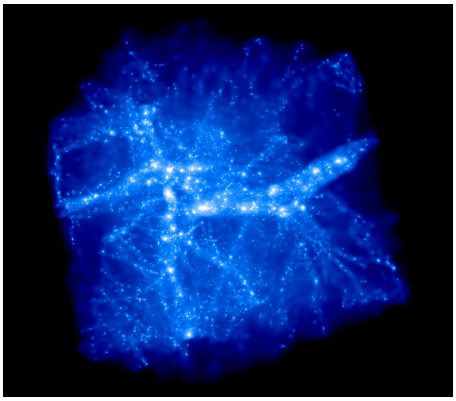

is being rock-starred

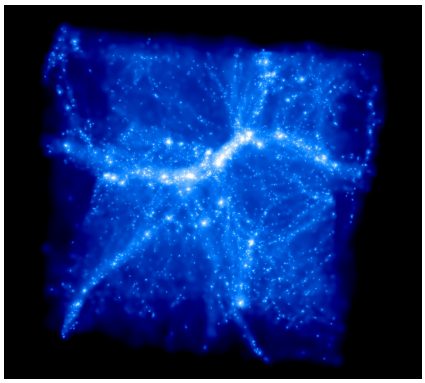
2.1.4 drkltest+3c+sl50_1

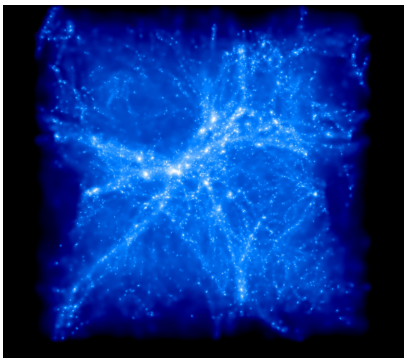
```
Error: too few halos at scale factor 0.890265 to calculate consistency metric.
Please remove this and all earlier timesteps from the scale file and rerun.
(DescScales.txt)
```

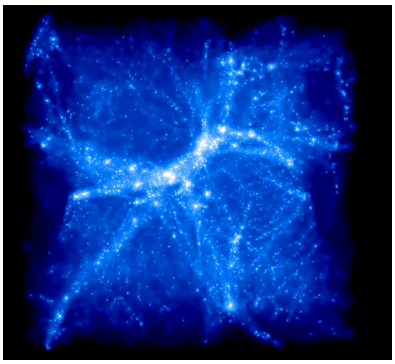
2.2 r256

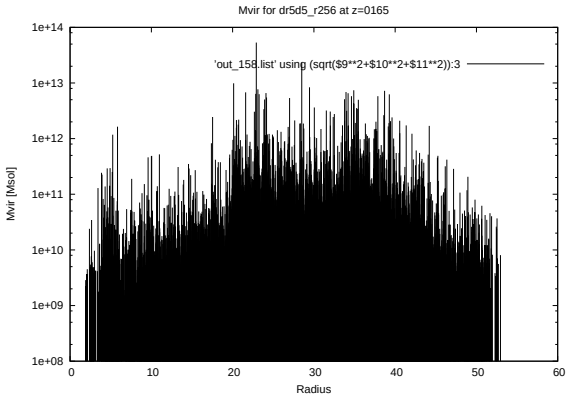
2.2.1 dr5d5_r256

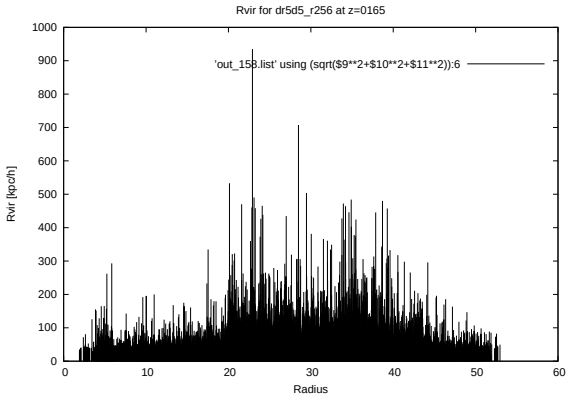


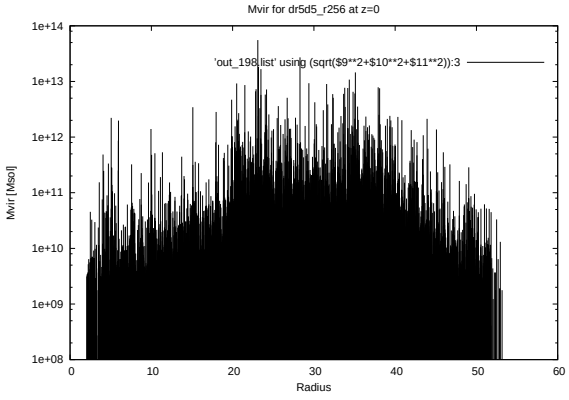


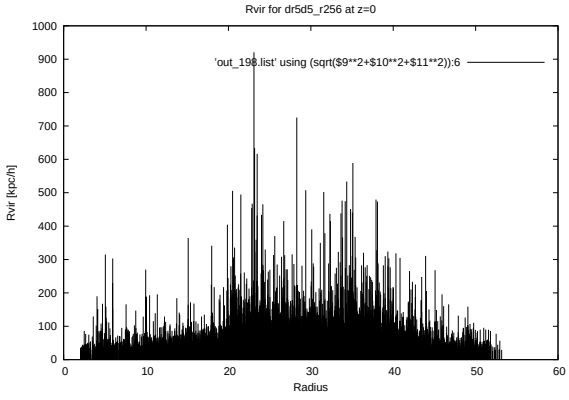










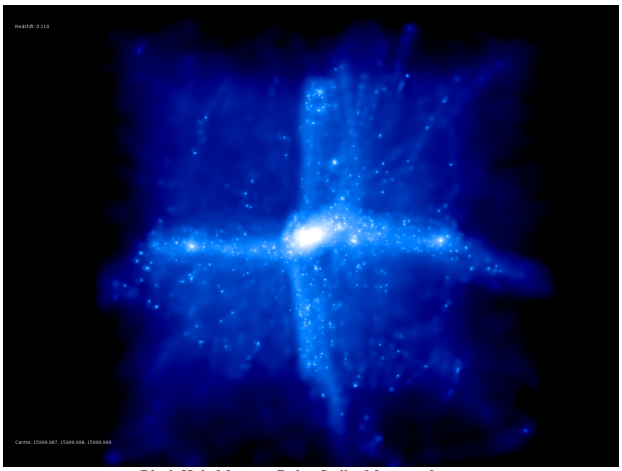


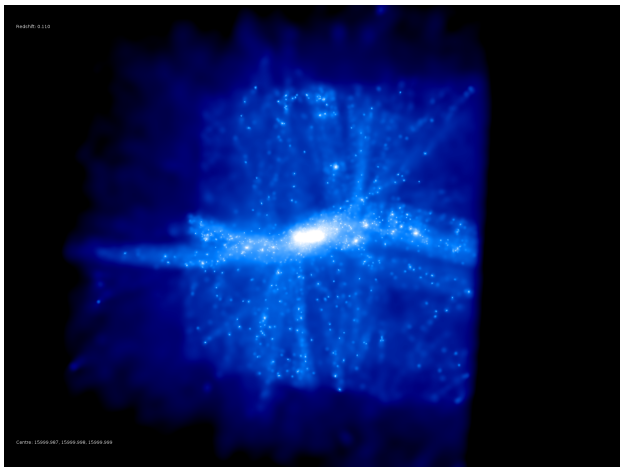
is being galacticussed
CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$
$\rightarrow$ re-rockstar on AMD ...-03

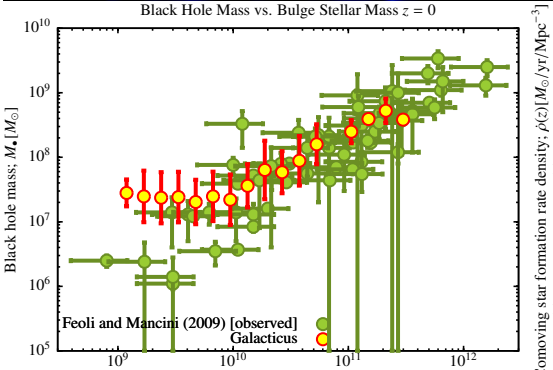
```
find_parents_and_cleanup.c:130:
lookup_new_id: Assertion ‘new_id’ failed.
```

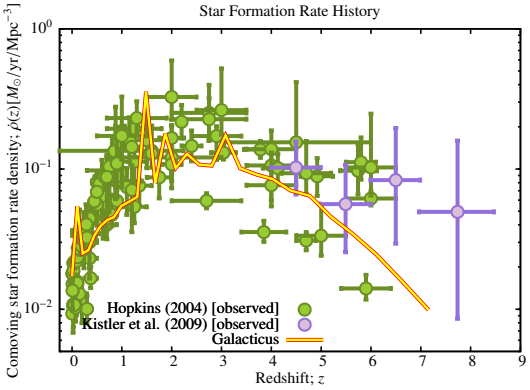
is being consistenttreed

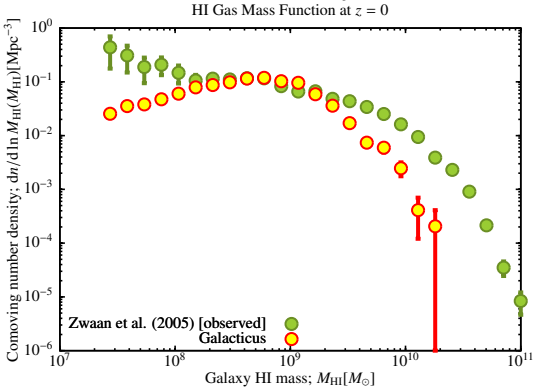
2.2.2 drd5_r256 (∼)

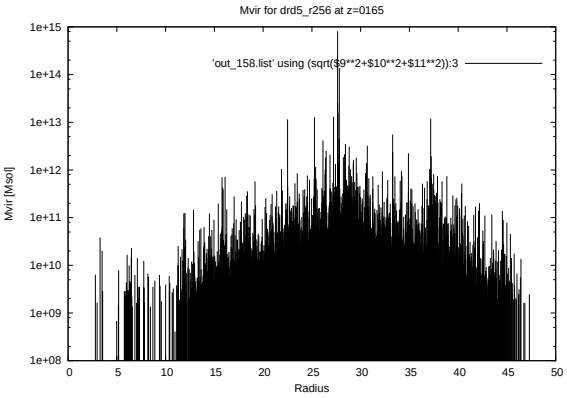


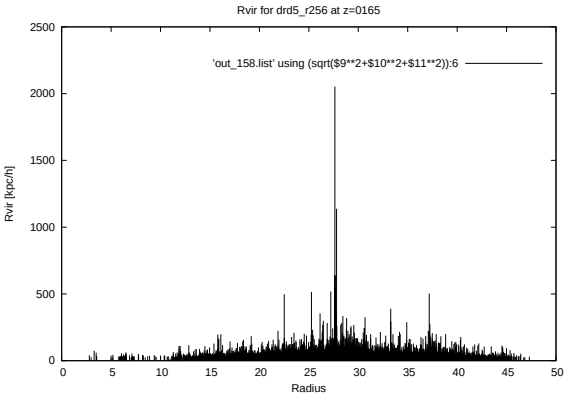


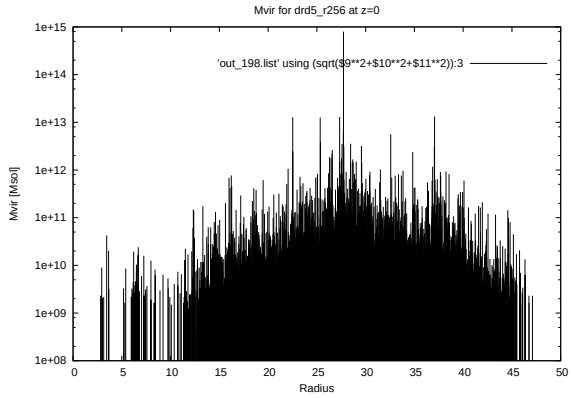


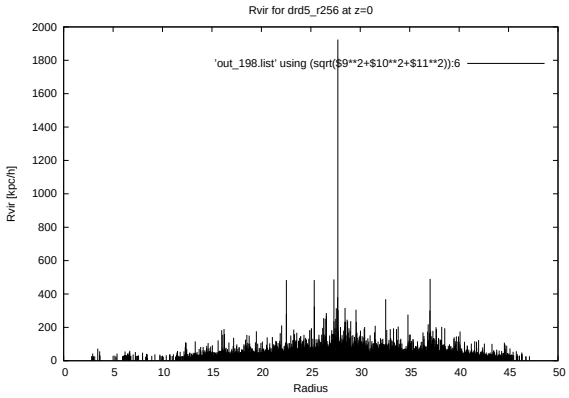










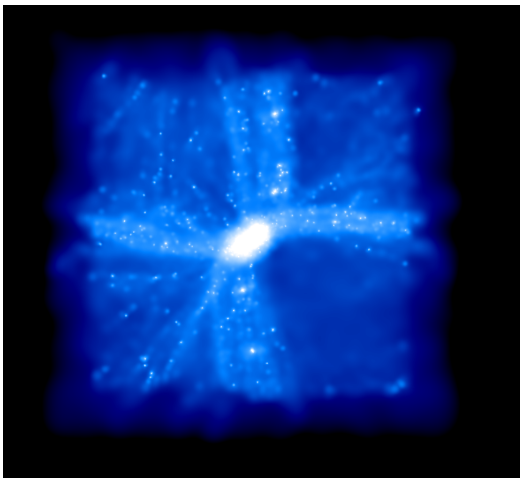


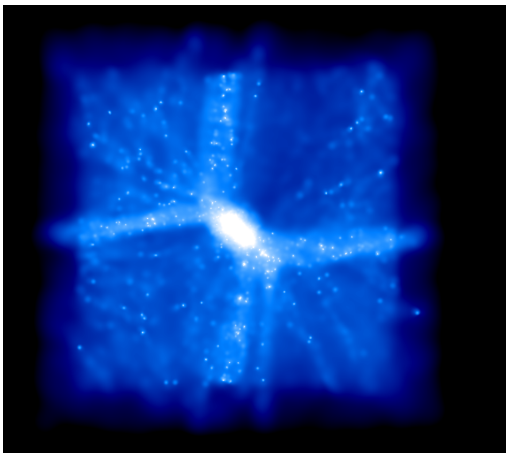
GALACTICUSSED $\surd$
galacticus running on SGE
$\rightarrow$ re-converted with bugfixed converter
tree copied to markus transfer
GALACTICUS:

```
Fatal error in Build_Descendent\_Pointers():
failed to find descendent node: 5546454 of 5522259
galacticus.sh: line 67: 25689 Aborted
```

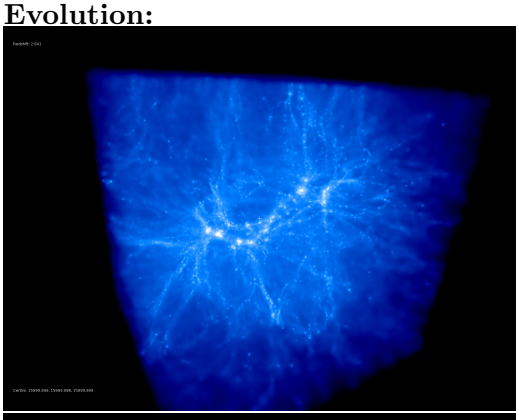
CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$

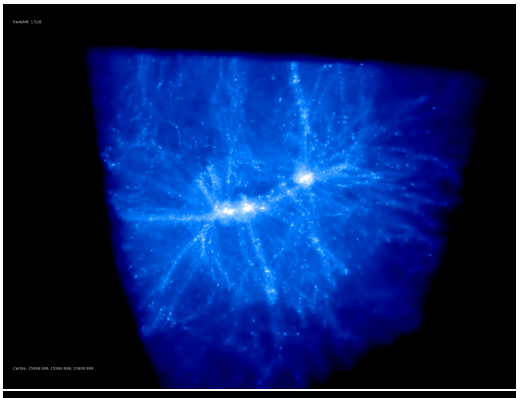
2.2.3 drd5_r256_2 (+ major merger in progress)

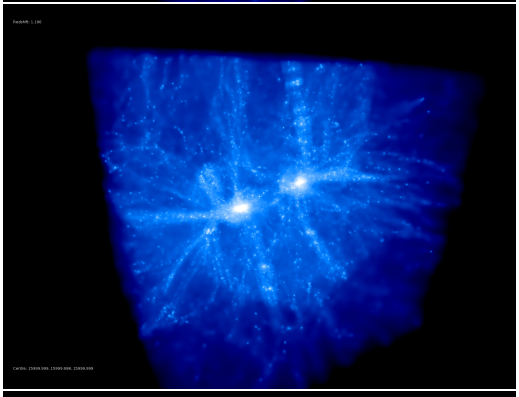


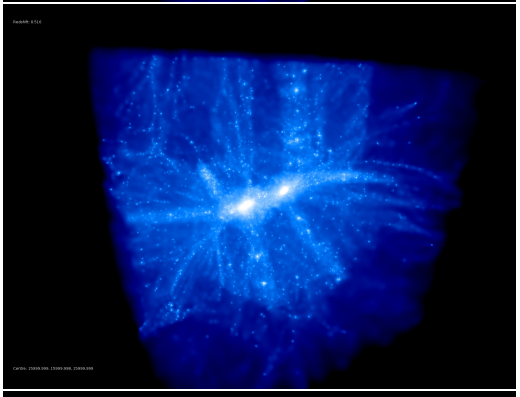


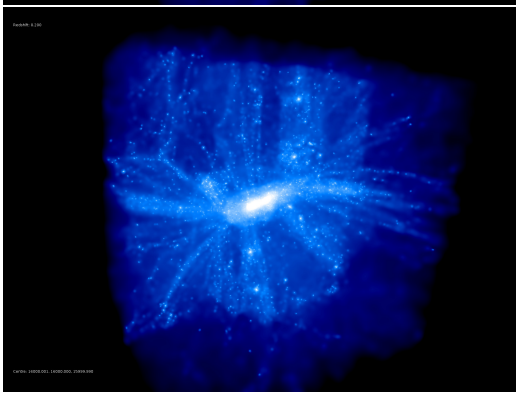
Evolution:

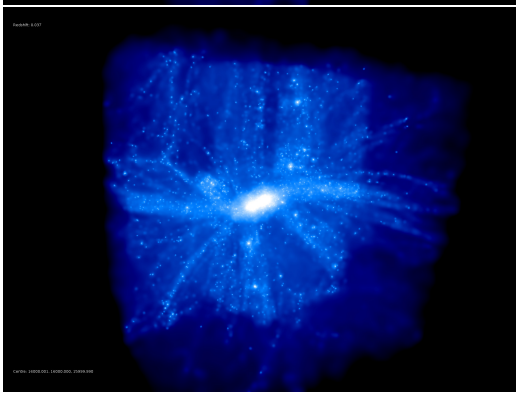


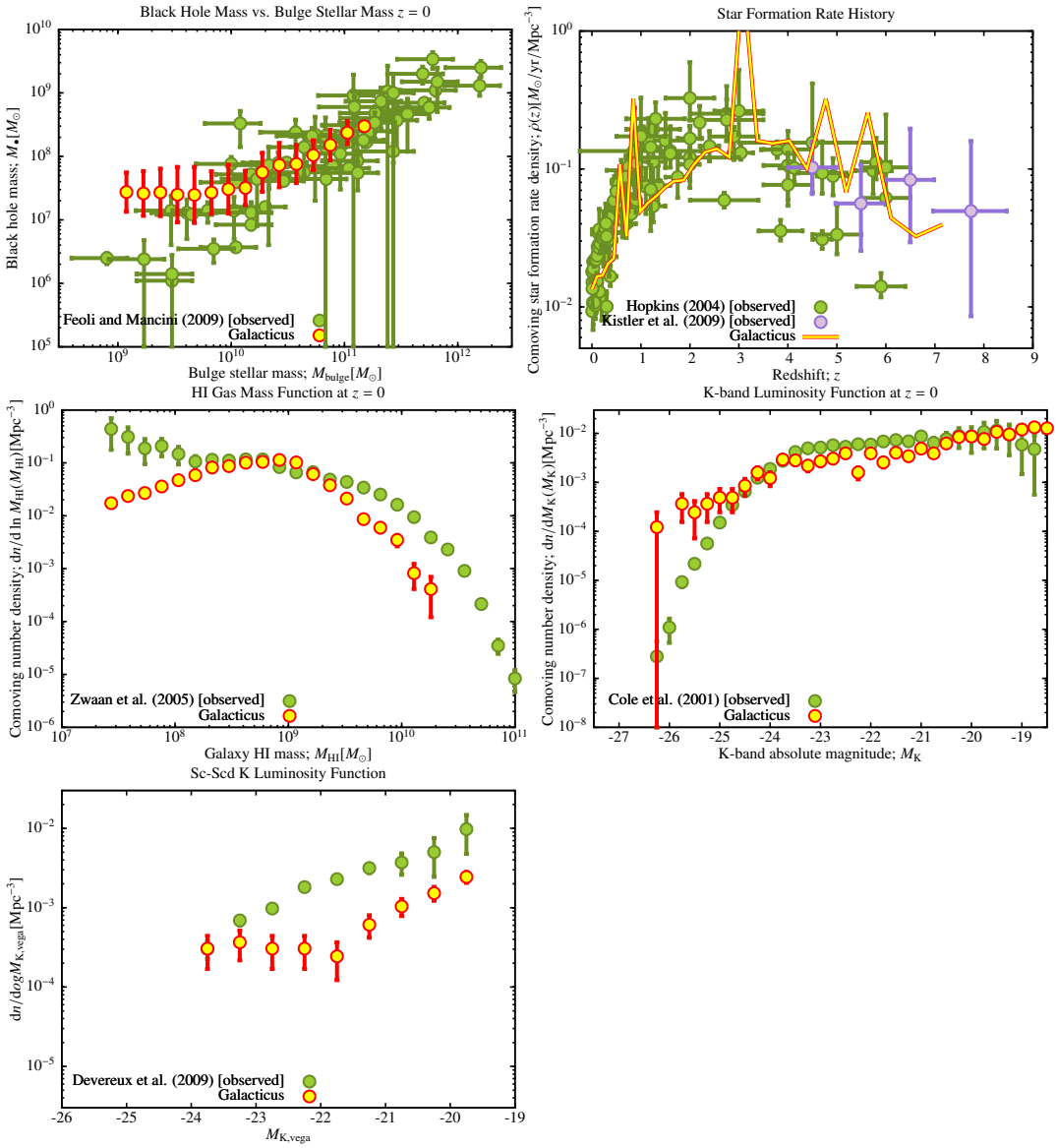


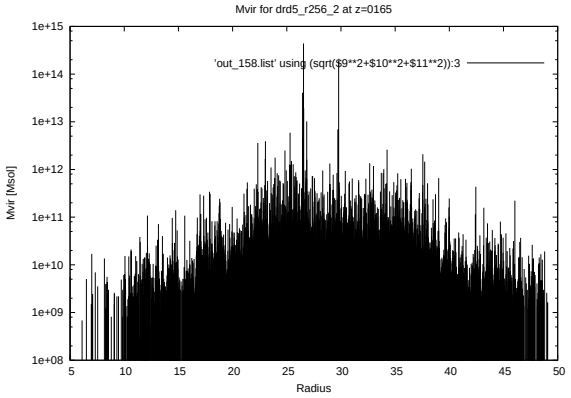


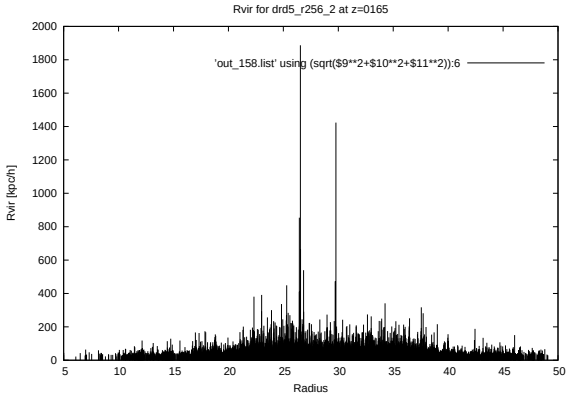


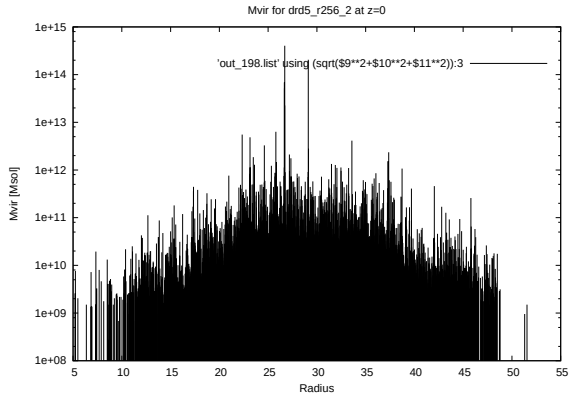


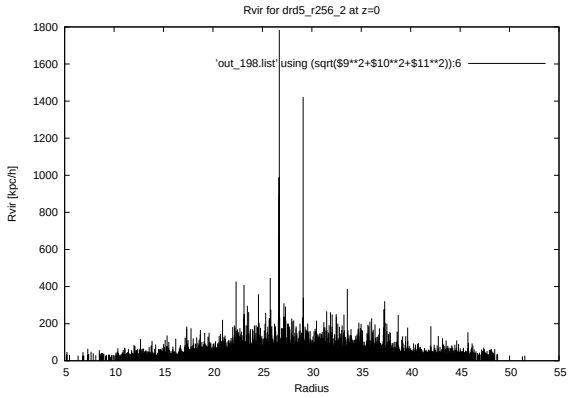



Black Hole Mass vs. Bulge Stellar Mass $z = 0$
Black hole mass; $M_\bullet[M_\odot]$
Bulge stellar mass; $M_{\rm bulge}[M_\odot]$
Feoli and Mancini (2009) [observed]
Galacticus
Star Formation Rate History
Comoving star formation rate density; $\dot{\rho}(z)[M_\odot/{\rm yr}/{\rm Mpc}^{-3}]$
Redshift; z
Hopkins (2004) [observed]
Kistler et al. (2009) [observed]
Galacticus
HI Gas Mass Function at $z = 0$
Comoving number density; ${\rm d}n/{\rm d}\ln M_{\rm HI}(M_{\rm HI})[{\rm Mpc}^{-3}]$
Galaxy HI mass; $M_{\rm HI}[M_\odot]$
Zwaan et al. (2005) [observed]
Galacticus
K-band Luminosity Function at $z = 0$
Comoving number density; ${\rm d}n/{\rm d}M_{\rm K}(M_{\rm K})[{\rm Mpc}^{-3}]$
K-band absolute magnitude; $M_{\rm K}$
Cole et al. (2001) [observed]
Galacticus
Sc-Scd K Luminosity Function
${\rm d}n/{\rm d}\log M_{\rm K,vega}[{\rm Mpc}^{-3}]$
$M_{\rm K,vega}$
Devereux et al. (2009) [observed]
Galacticus


Mvir for drd5_r256_2 at z=0165
'out_158.list' using (sqrt($9**2+$10**2+$11**2)):3
Mvir [Msol]
Radius


Rvir for drd5_r256_2 at z=0165
'out_158.list' using (sqrt($9**2+$10**2+$11**2)):6
Rvir [kpc/h]
Radius



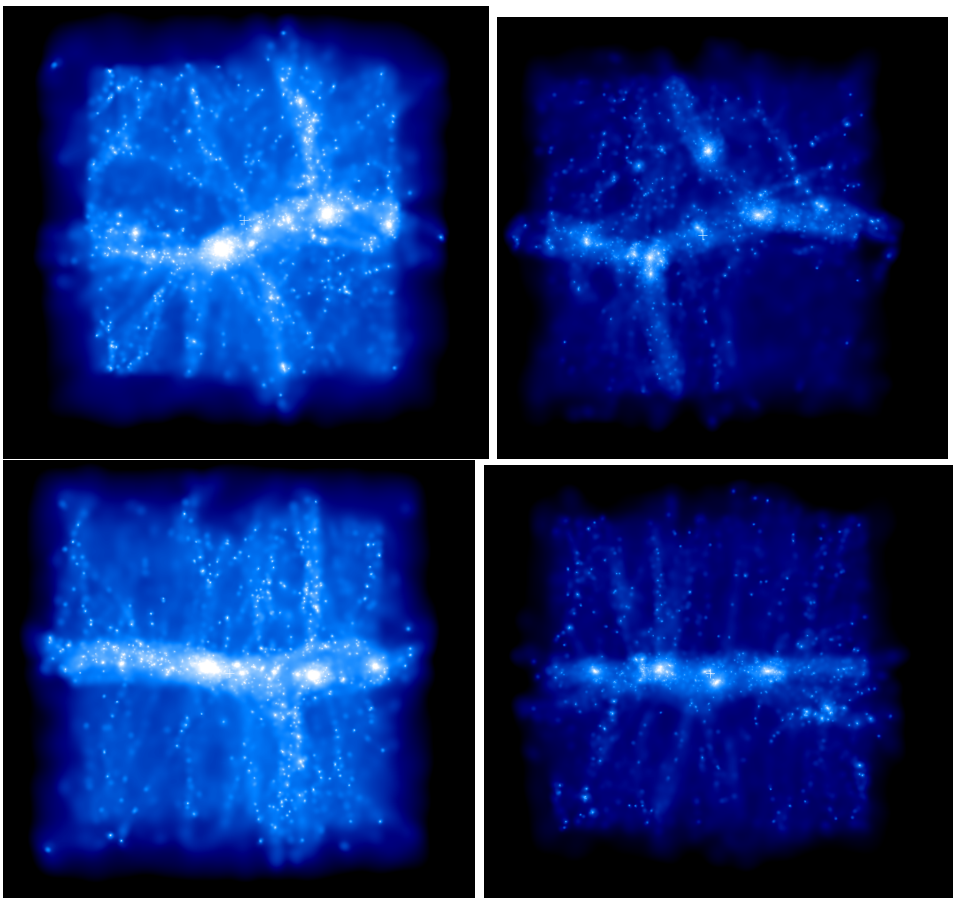


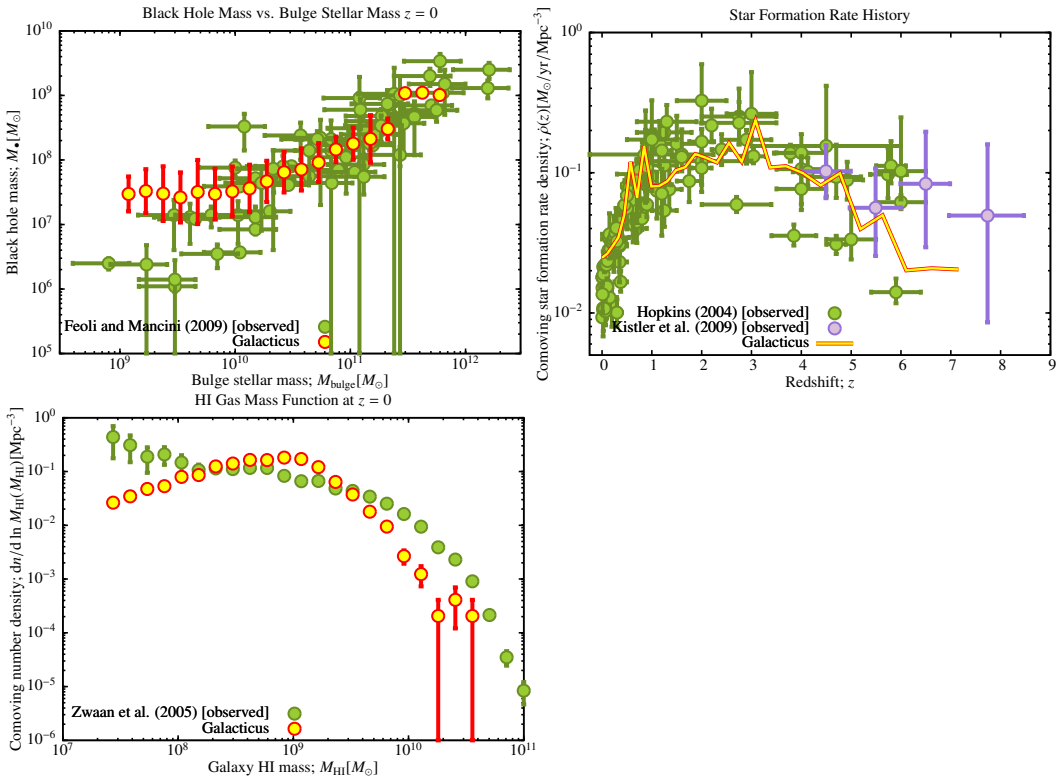
GALACTICUSSED $\surd$
→ fixed in revision 709
→ not fixed! E-Mail to Andrew
After fix in rev. 708 → is being re-galacticussed
→ DUMP IT ?
→ gadgetviewer: simulation has "artificial" cross galacticus running on SGE
→ re-converted with bugfixed converter (v0.3)
is being galacticussed → job seems to run!

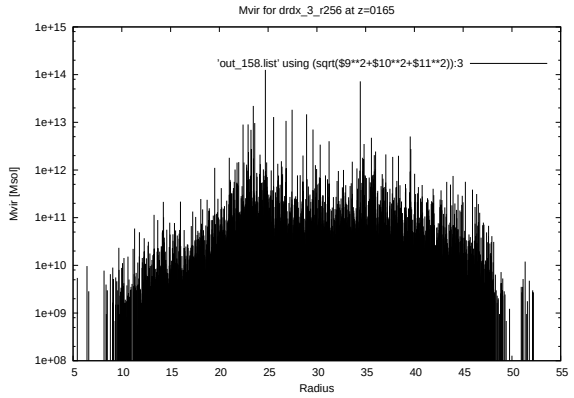
```
no: A fatal error occurred! Backtrace for this error:
#0  0x2B3F2E65E897
#1  0x2B3F2E65EE4E
#2  0x301763648F
#3  0x487AA0 in __merger_tree_read_MOD_build_descendent_pointers
#4  0x48ADC3 in __merger_tree_read_MOD_merger_tree_read_do
#5  0x48205E in __merger_tree_construction_MOD_merger_tree_create
#6  0x46F469 in __galacticus_tasks_evolve_tree_MOD_galacticus_task_evolve_tree._omp_fn.0
.F90:0
#7  0x46F9C4 in __galacticus_tasks_evolve_tree_MOD_galacticus_task_evolve_tree
#8  0x46FA4F in __galacticus_tasks_MOD_galacticus_task_do
#9  0x4600E4 in MAIN__ at Galacticus.F90:0
```

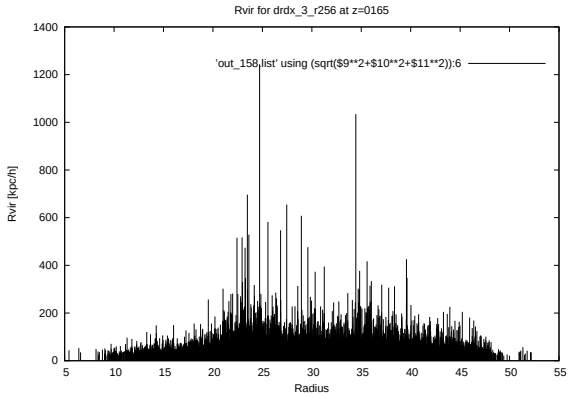
CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$ (lasted about 9000minutes)

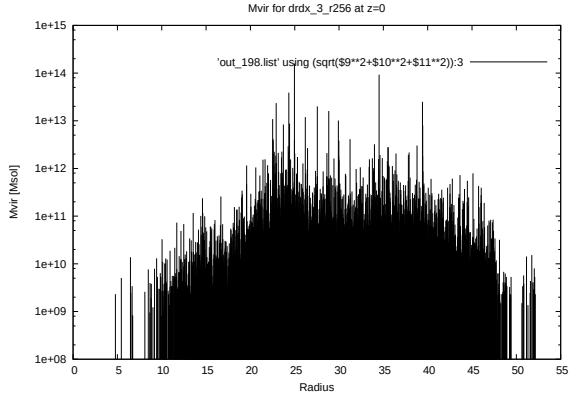
2.2.4 drdx_3_r256

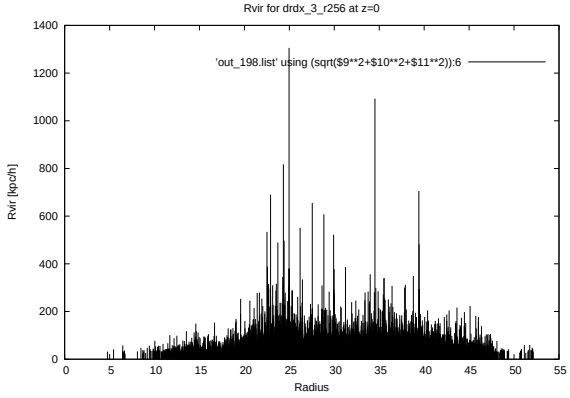












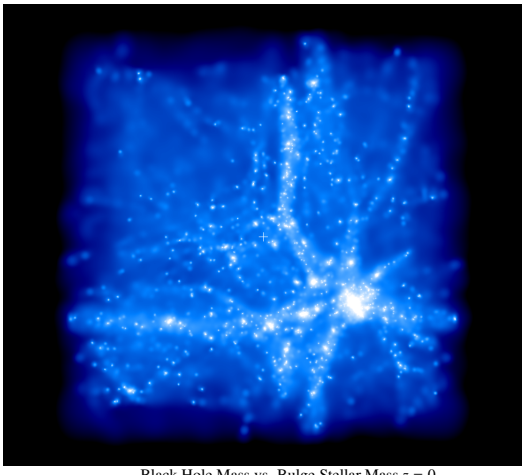
GALACTICUSSED $\surd$
$\rightarrow$ fixed in revision 709

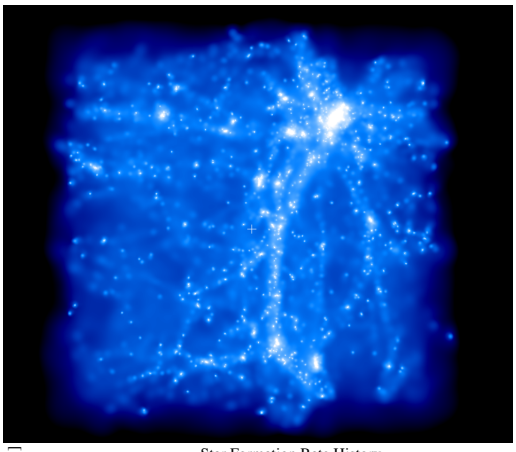
GALACTICUS REV708:

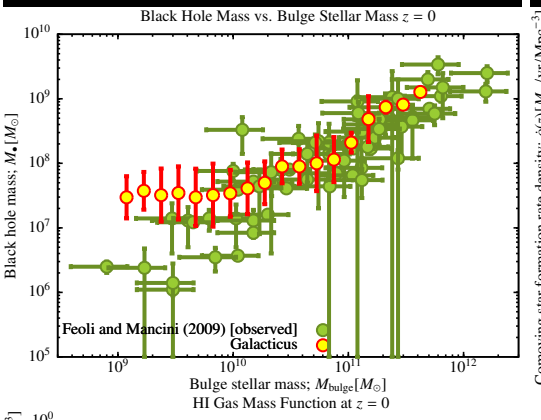
```
#4  0x301763648F
#5  0x49B1B8 in __merger_tree_read_MOD_build_descendent_pointers at merger_trees.construc
#6  0x49FF70 in __merger_tree_read_MOD_merger_tree_read_do at merger_trees.construct.read
#7  0x4923BE in __merger_tree_construction_MOD_merger_tree_create at merger_trees.constru
#8  0x4800C6 in __galacticus_tasks_evolve_tree_MOD_galacticus_task_evolve_tree._omp_fn.0
#9  0x2AC099B4F829
#10  0x3017A07CD0
#11  0x30176DFD3C
#12  0xFFFFFFFFFFFFFFFF
/sge-root/sge/AMD64/spool/astro13/job_scripts/83594: line 22: 13318 Aborted
```

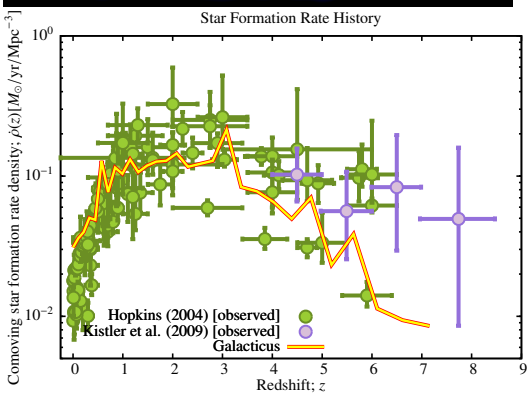
CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$
is being rockstarred on `astro-x4600-03`
This run is a test if r256 and r128 (`drdx_3`) are comparable $\rightarrow$ see pictures.

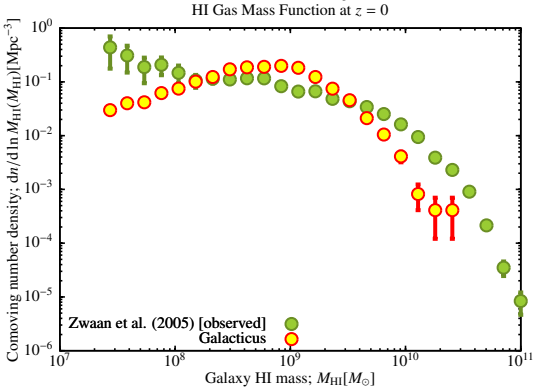
2.2.5 fuenfincr256_1

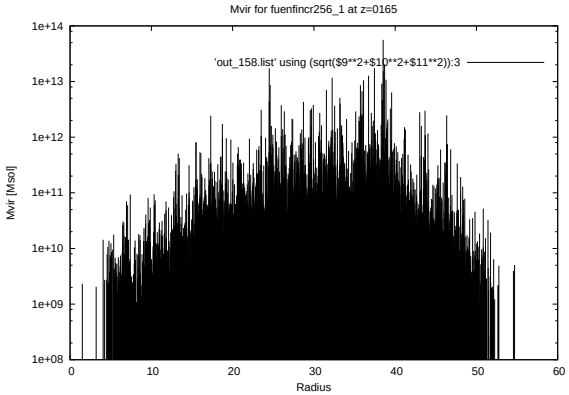


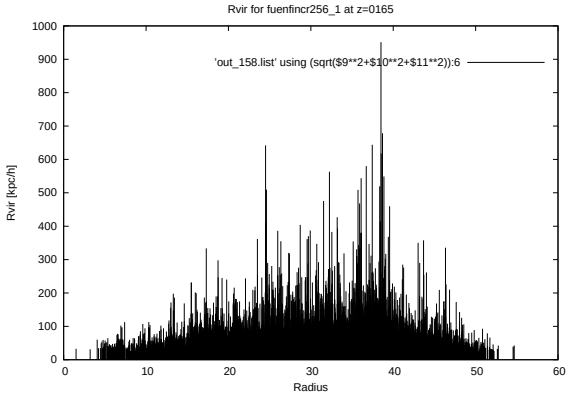


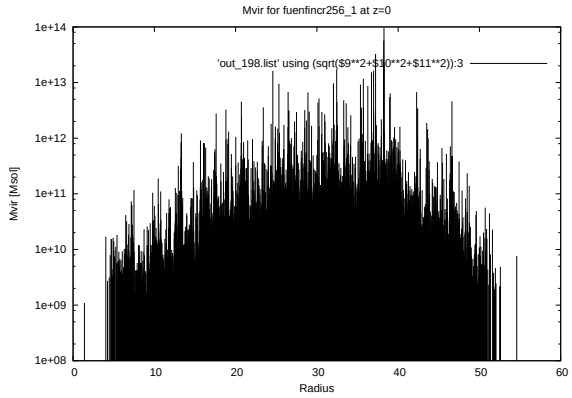


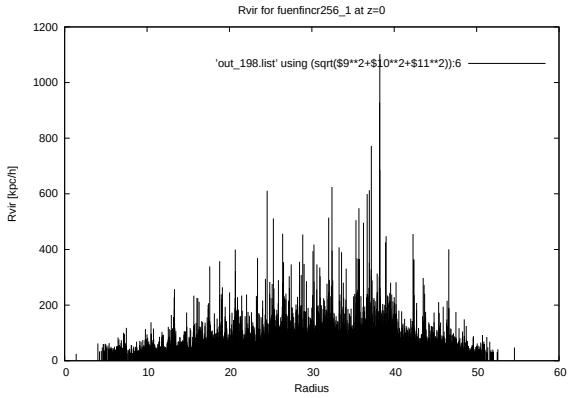












GALACTICUSSED $\surd$
$\rightarrow$ re-galacticussing with rev708
GALACTICUS: rev707 exited without error but not finished
GALACTICUSSED $\surd$ BUT:

```
[3:46:48 PM CEST] Markus Haider: der fuenfincr256_1 hat a problem
[3:46:52 PM CEST] Markus Haider: der hat keine output gruppe
[3:46:58 PM CEST] Markus Haider: also keinen output
[3:47:30 PM CEST] Markus Haider: btw schon einen output
[3:47:34 PM CEST] Markus Haider: aber es scheint was zu fehlen
```

$\rightarrow$ E-Mail to Andrew
$\rightarrow$ re-converted with bugfixed converter

```
 Running model.......
  Reading data for metallicity log10(Z/Z_Solar) = 0.198
   Found 188 ages in the file
  Found 1963 wavelengths in the file
gsl: ../../../../roots/brent.c:57: ERROR: function value is not finite
Default GSL error handler invoked.
```

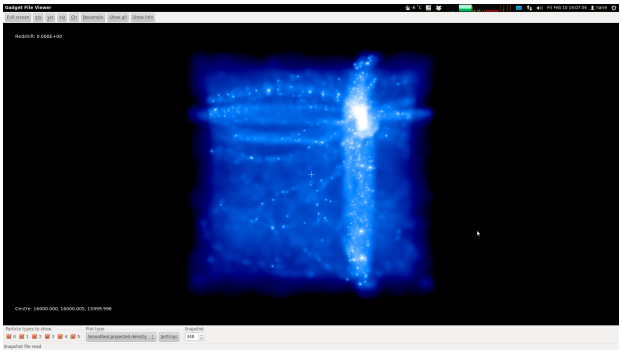
tree copied to markus transfer

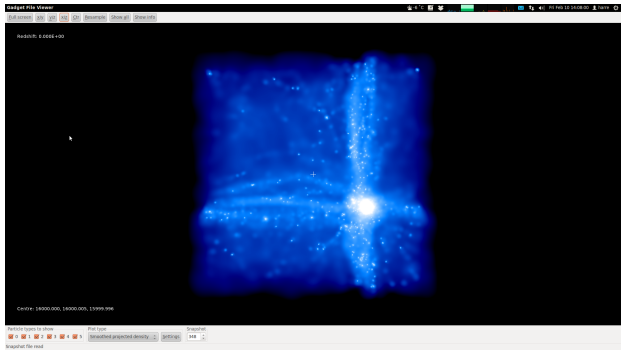
GALACTICUS:

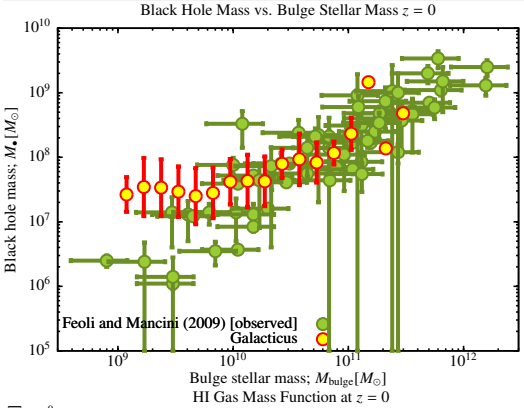
```
Fatal error in Build_Descendent_Pointers():
failed to find descendent node: 12048576 of 12014628
galacticus.sh: line 67:  5751 Aborted
```

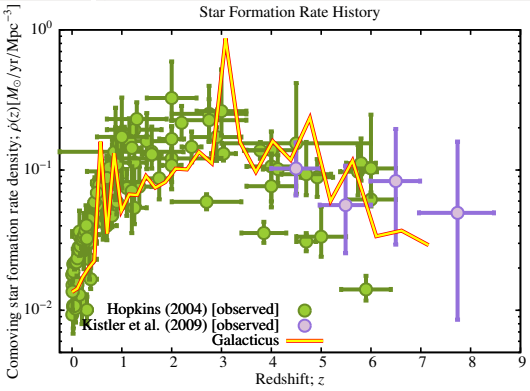
ROCKSTARRED $\surd$
CONSISTENTTREED $\surd$

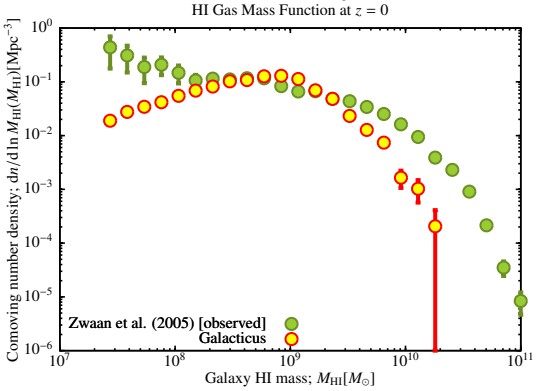
2.2.6 fuenfincr256_2 → dump!

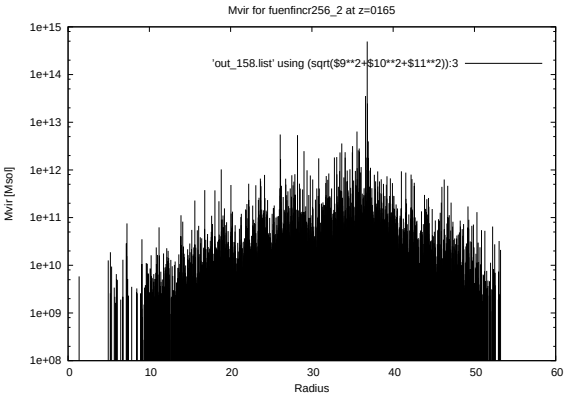


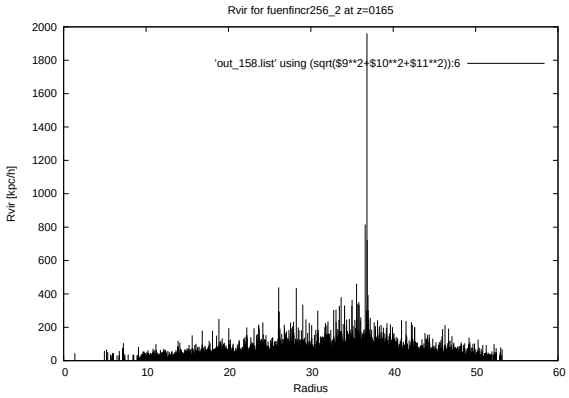


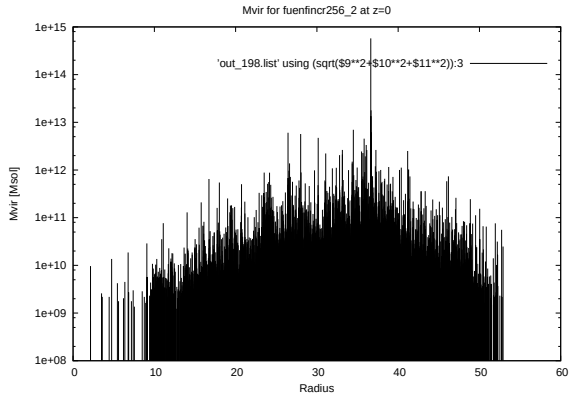


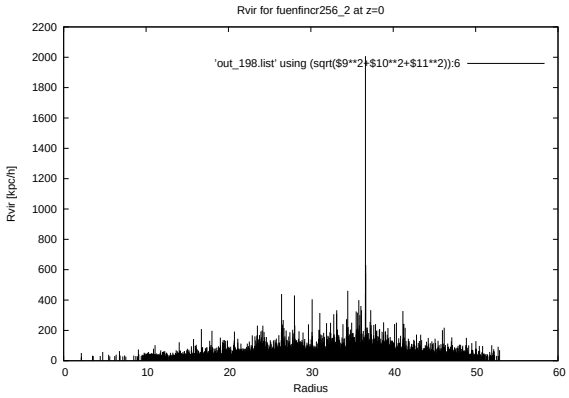










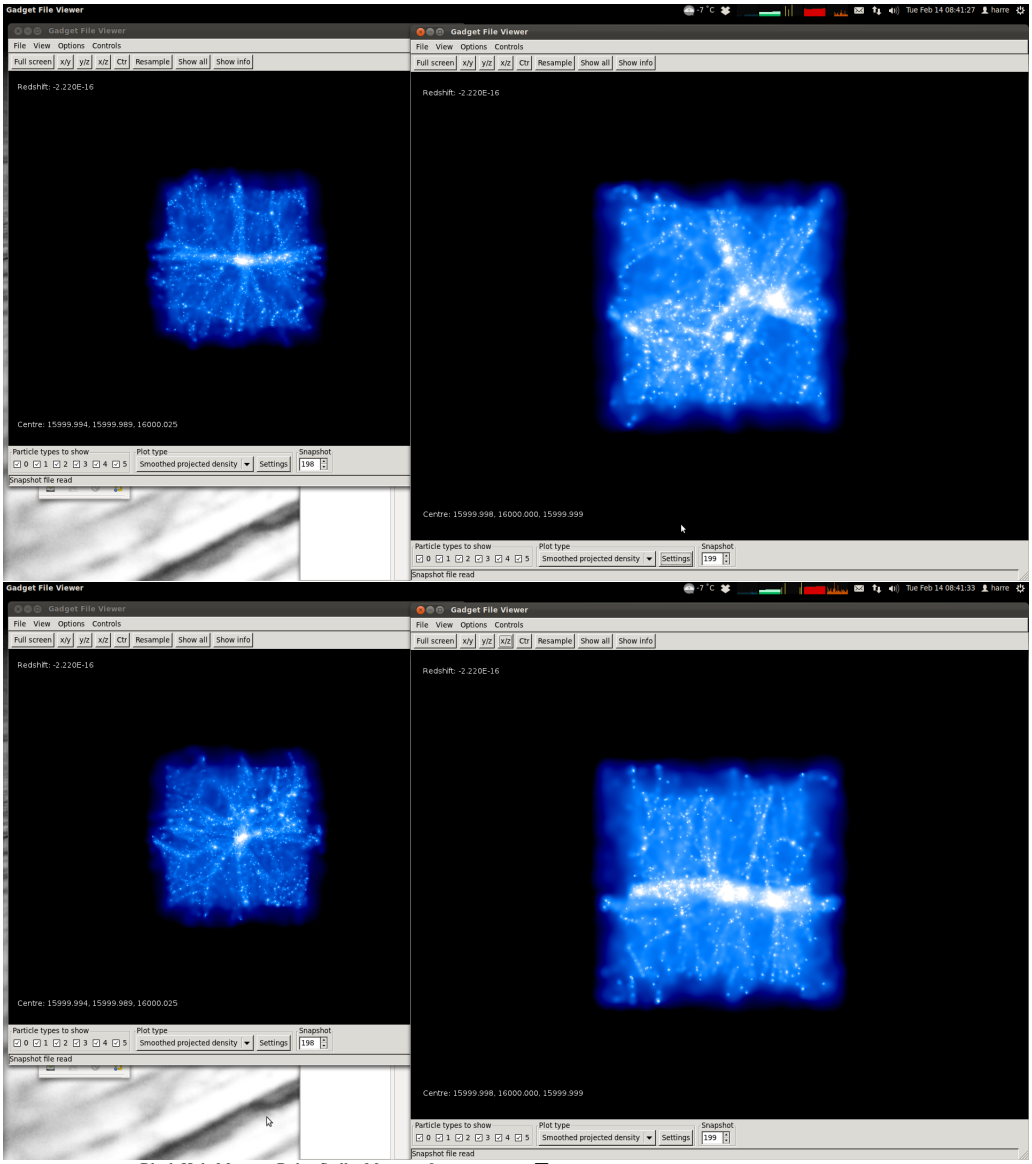


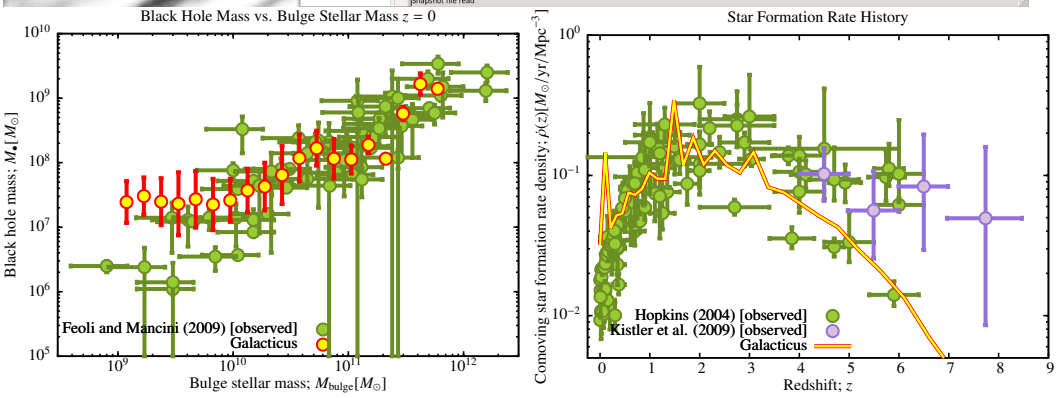
GALACTICUSSED $\surd$ → gadgetviewer: simulation has "artificial" cross on right upper corner
→ DUMP IT ?
→ re-converted with bugfixed converter (v0.3)
galacticus running on SGE
is being galacticussed → job seems to run!
GALACTICUS:

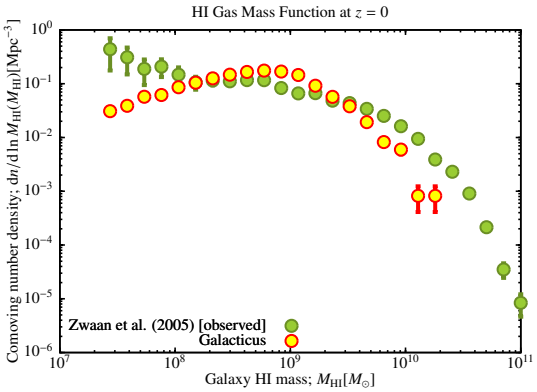
```
Fatal error in Build_Descendent_Pointers():
failed to find descendent node
```

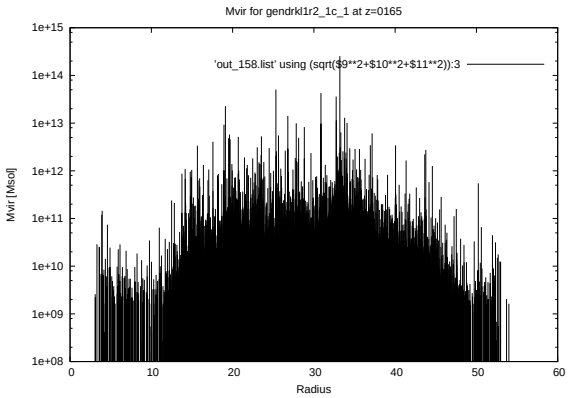
CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$ (lasted about 9000minutes)

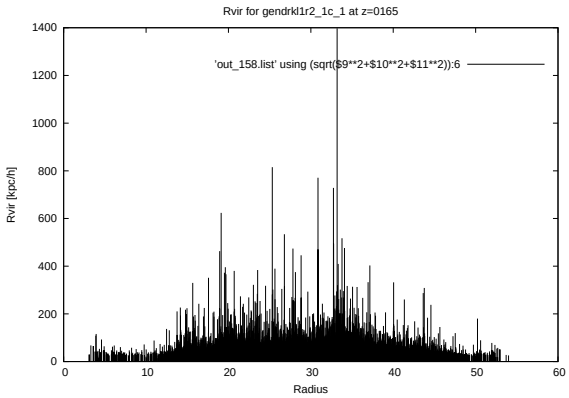
2.2.7 gendrkl1r2_1c_1

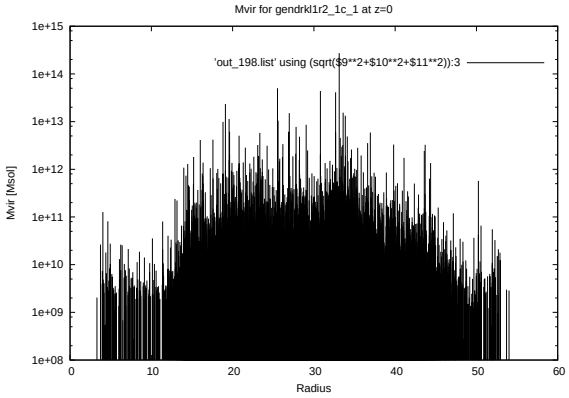


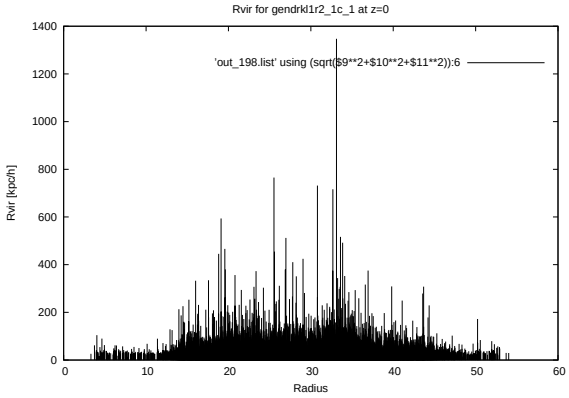












GALACTICUSSED WITH REVISION 709 $\surd$ CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$
is being rockstarred on `astro-x4600-03`

E-Mail sent to Bertschinger

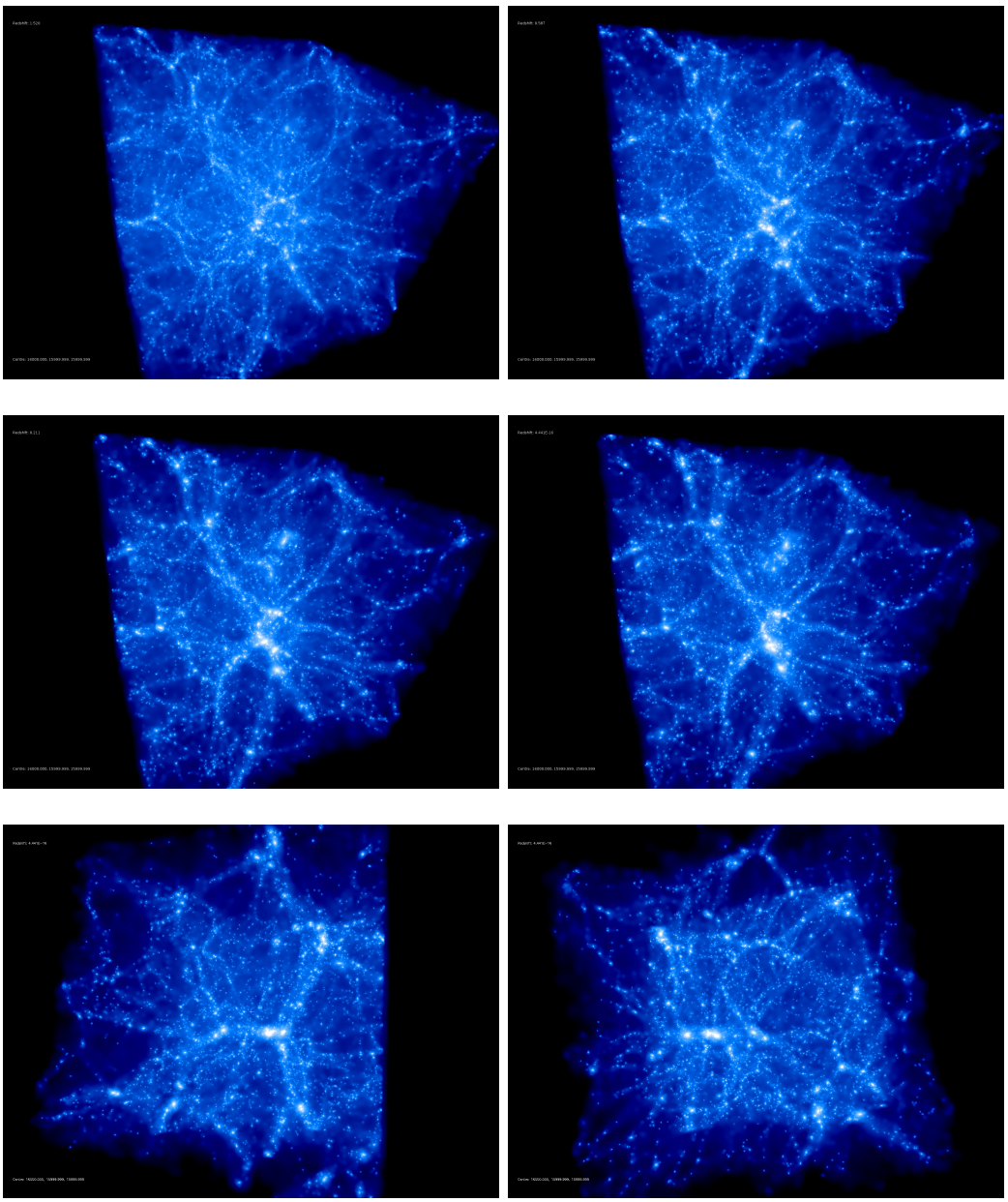
```
$ diff drkt+3c+sl5_1+r2/constraints_drkt+3c+sl5_1+r2.f
r128/h100/gendrkl1_1c_1/constraints_gendrkl1_1c_1.f

$ diff gendrkl1r2_1c_1/grafic_inc_gendrkl1r2_1c_1.f
r128/h100/gendrkl1_1c_1/grafic_inc_gendrkl1_1c_1.f
5c5
<   parameter (np1=256,np2=256,np3=256,ncon=1)
---
```

```
>  parameter (np1=128,np2=128,np3=128,ncon=1)
diff gendrkl1r2_1c_1/graficIO_gendrkl1r2_1c_1.out r128/h100/gendrkl1_1c_1/graficIO_gendrk
23c23
<  Particle lattice size: np1,np2,np3=         256         256         256
---
>  Particle lattice size: np1,np2,np3=         128         128         128
25,27c25,27
<  chosen:  0.12500000       0.0000000      5.00000007E-02
<  npart, L_x, L_y, L_z= 16777216    32.00    32.00    32.00 Mpc
<  Particle mass= .1447E+09 solar masses
---
>  chosen:  0.25000000       0.0000000      5.00000007E-02
>  npart, L_x, L_y, L_z=  2097152    32.00    32.00    32.00 Mpc
>  Particle mass= .1158E+10 solar masses
37c37
<           ak,akmax=   16.100662       16.000005475554534
---
>           ak,akmax=   16.068306       16.000005475554534
40,41c40,41
<       Mean sigma_delta, sigma_psi=   4.8100653       4.7177238      Mpc
<       Chisq, dof, nu=   16781832.         16777215  0.79710007
---
>       Mean sigma_delta, sigma_psi=   4.1531582       4.7162638      Mpc
>       Chisq, dof, nu=   2095840.0          2097151 -0.64012647
43c43
<  Constraint   1:  Sampled, desired= 0.28453870E-02 0.25000000E-01
---
>  Constraint   1:  Sampled, desired=-0.64672055E-02 0.25000000E-01
46c46
<       Sampled, desired=  0.21657717       16.718990
---
>       Sampled, desired=   1.1184790       16.713776
49c49
<  Constraint   1:  Final= 0.25000000E-01
---
>  Constraint   1:  Final= 0.25000002E-01
52,54c52,54
<       sigma_delta, sigma_psi=   4.9692168       7.6522889      Mpc
<       Chisq, dof=   16781832.         16777214
<       Maximum delta, displacement=   27.548712       17.026833      Mpc
---
>       sigma_delta, sigma_psi=   4.2376528       6.6093922      Mpc
>       Chisq, dof=   2095838.9          2097150
>       Maximum delta, displacement=   22.542503       14.168747      Mpc
56c56
<  Scaling density and displacements to a=  2.75129788E-02
---
>  Scaling density and displacements to a=  3.36233079E-02
58,59c58,59
<  For a=astart: linear sigma, delmax=  0.18037927      0.99999994
<  RMS, max. 3-D displacement=  0.27777302      0.61806273      Mpc
---
```

```
>  For a=astart: linear sigma, delmax=  0.18798503       1.0000000
>  RMS, max. 3-D displacement=  0.29319692      0.62853473      Mpc
```

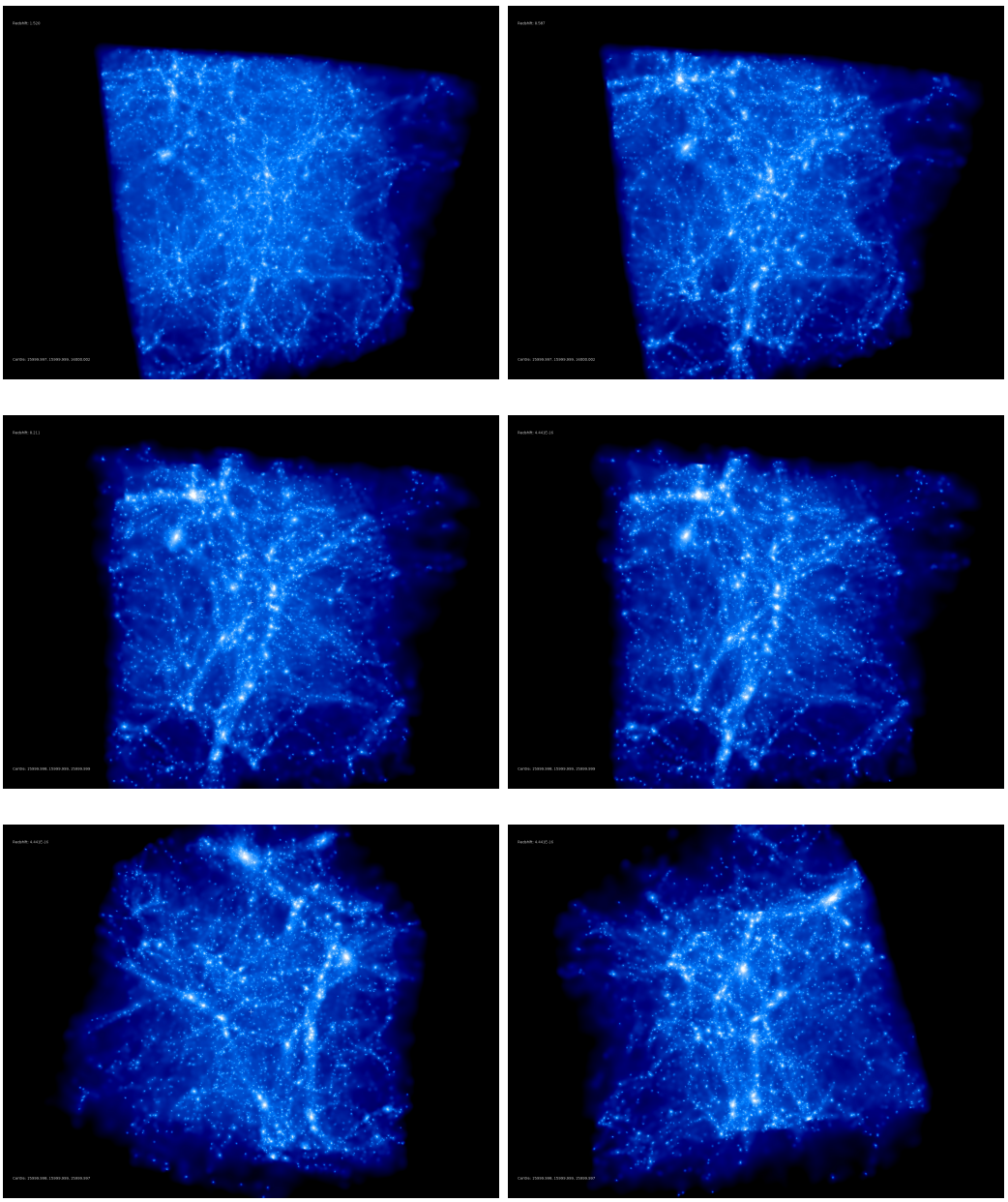
This run is a test if r256 and r128 (`gendrkl_1c_1`) are comparable → see pictures. Sims are not only different in resolution!

2.2.8 NGenIC_15039



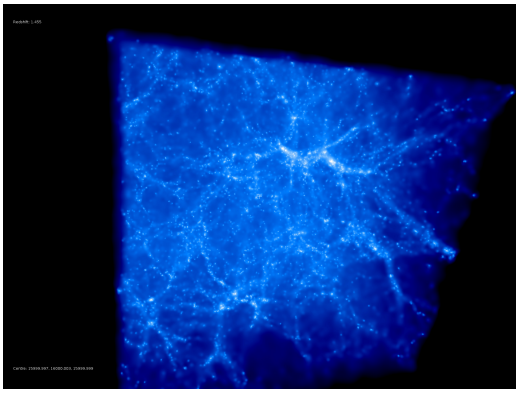
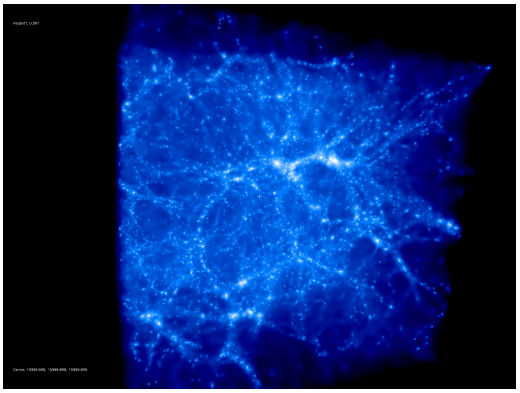
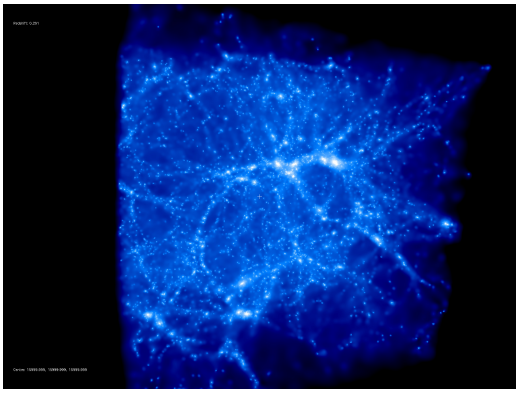
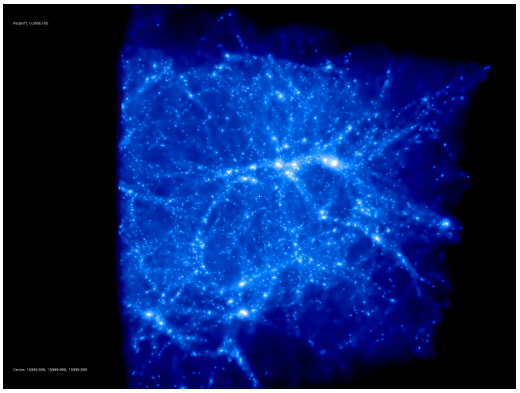
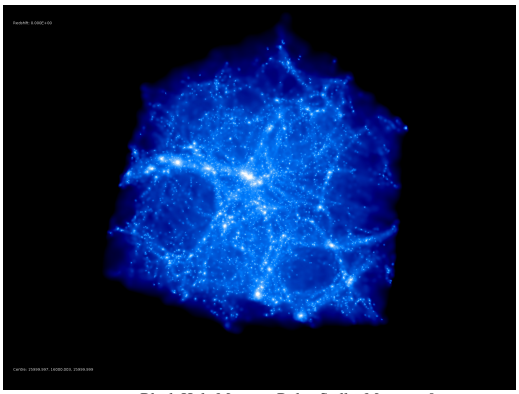
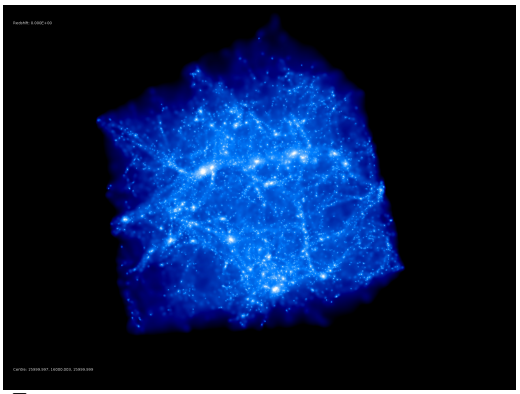
is being rockstarred (again)

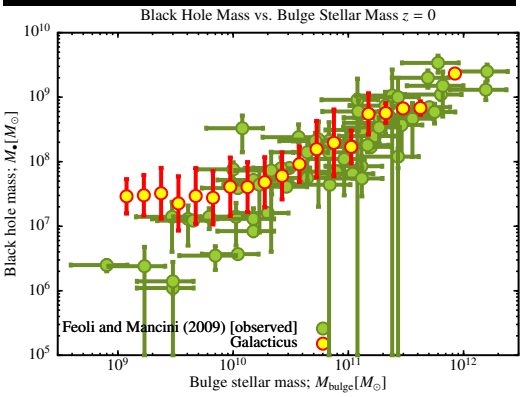
2.2.9 NGenIC_26214

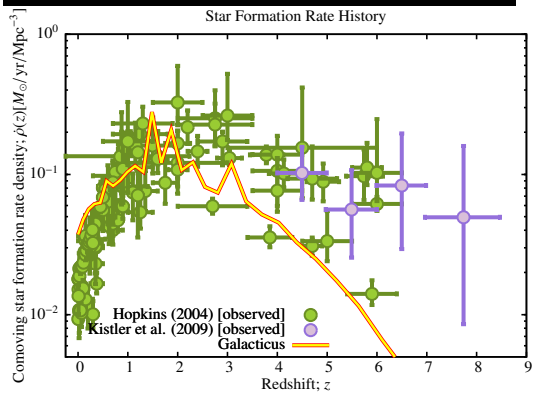


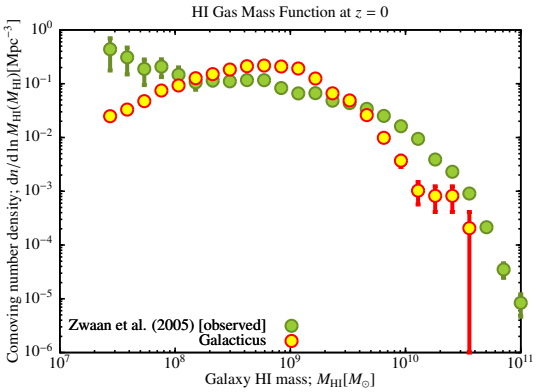
is being rockstarred

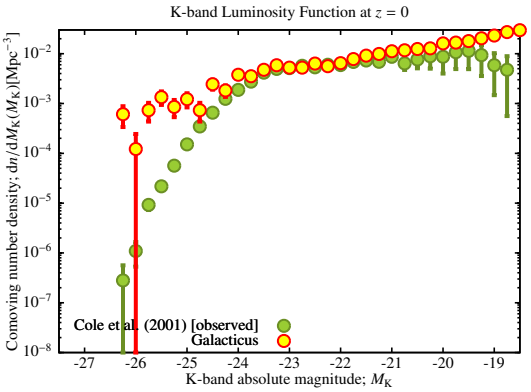
2.2.10 stages_07

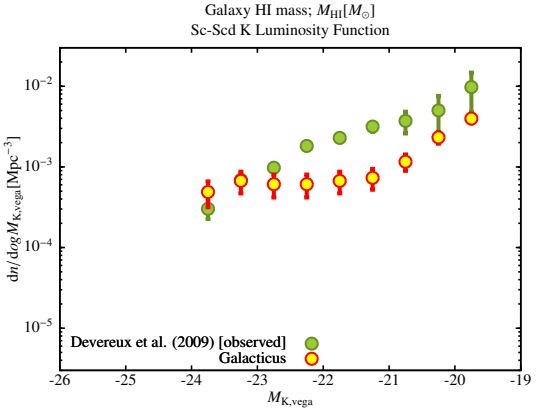







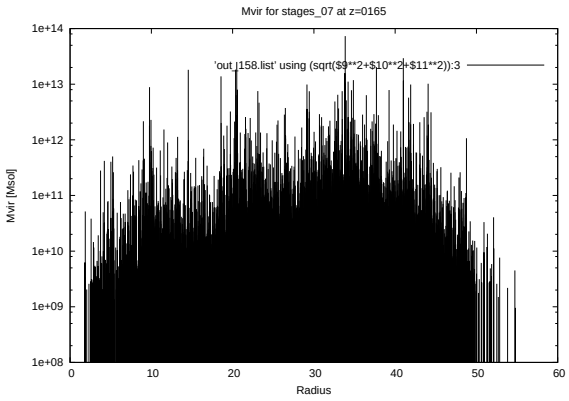


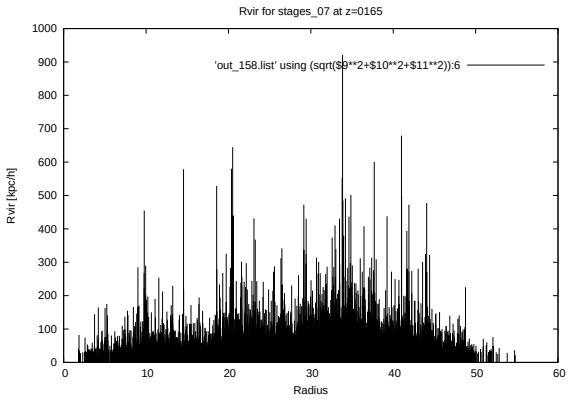


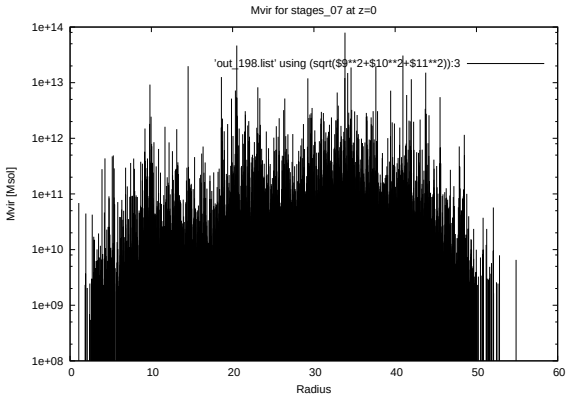


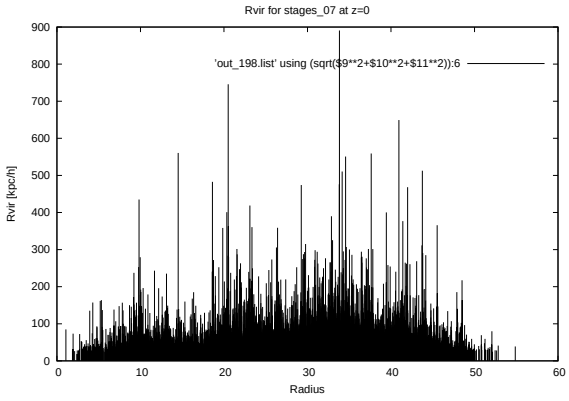






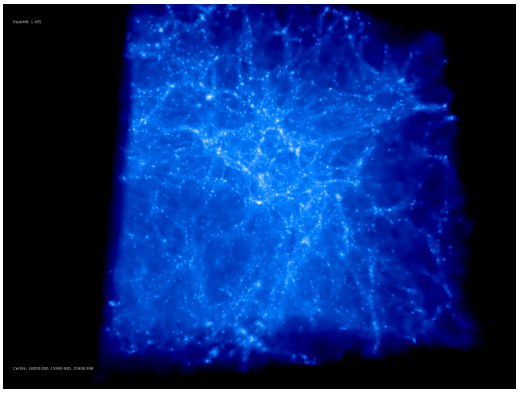
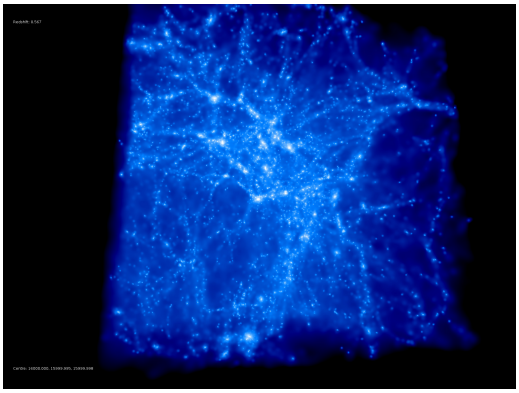
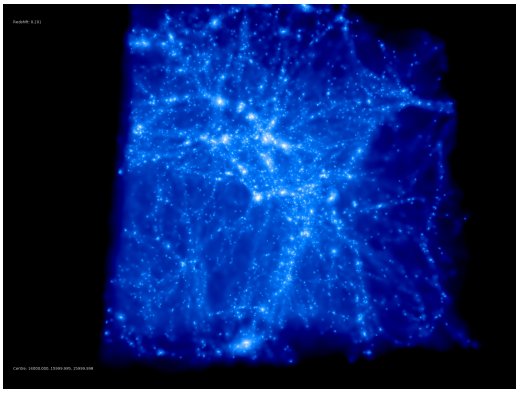
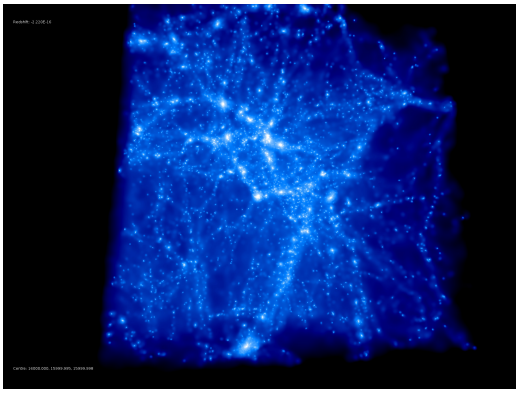
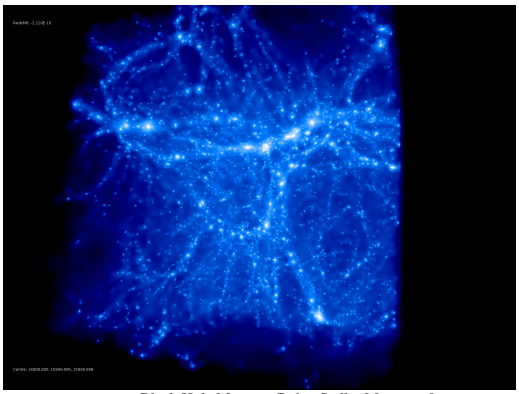
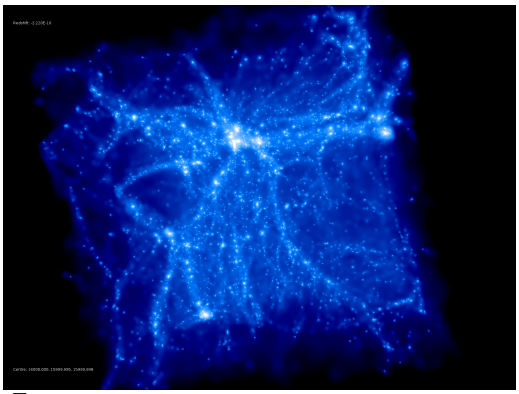


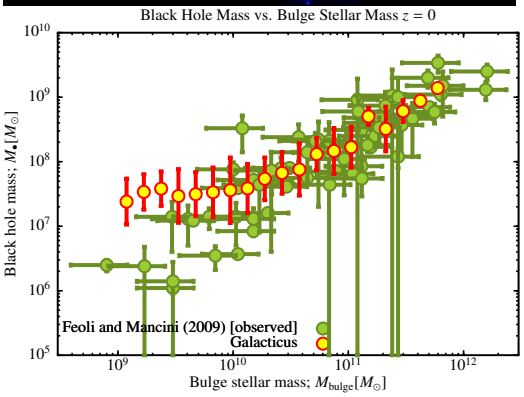


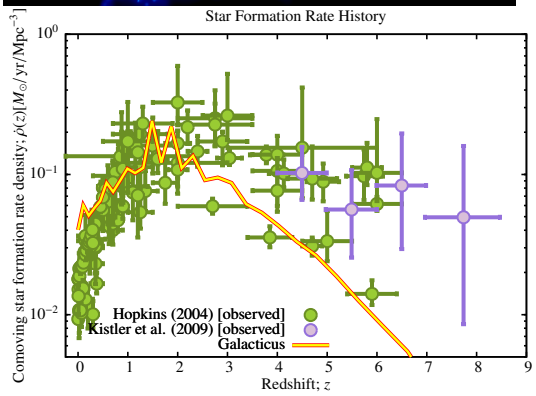


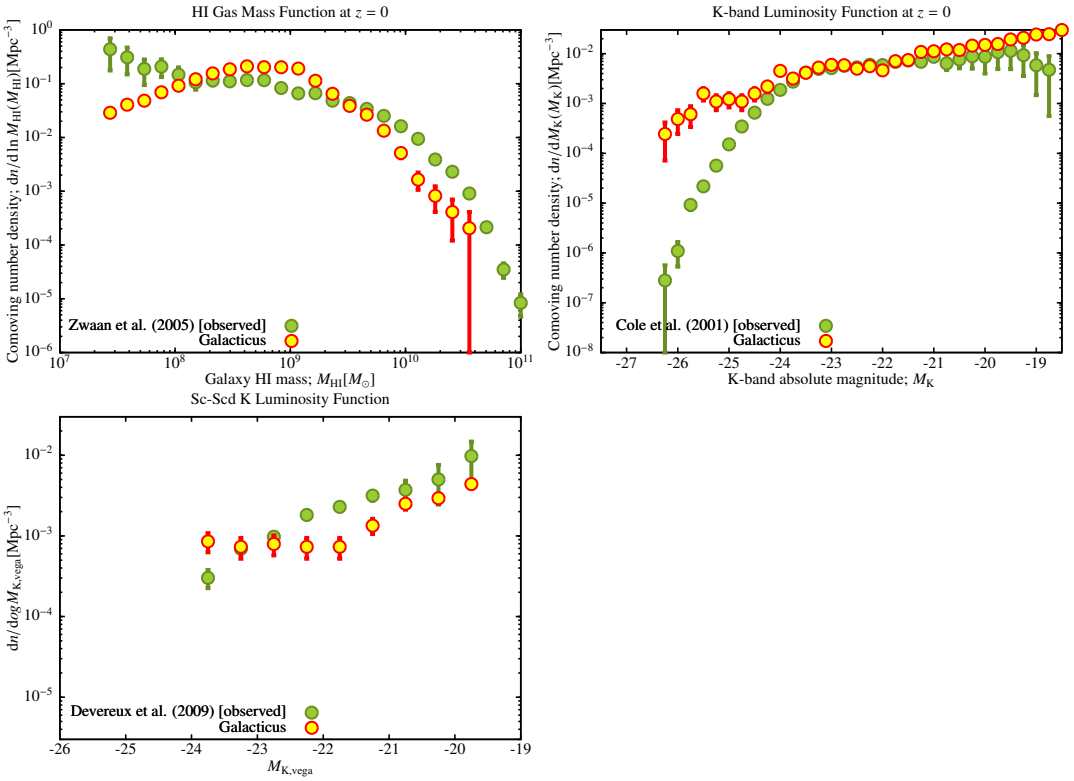
GALACTICUSSED $\surd$ CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$

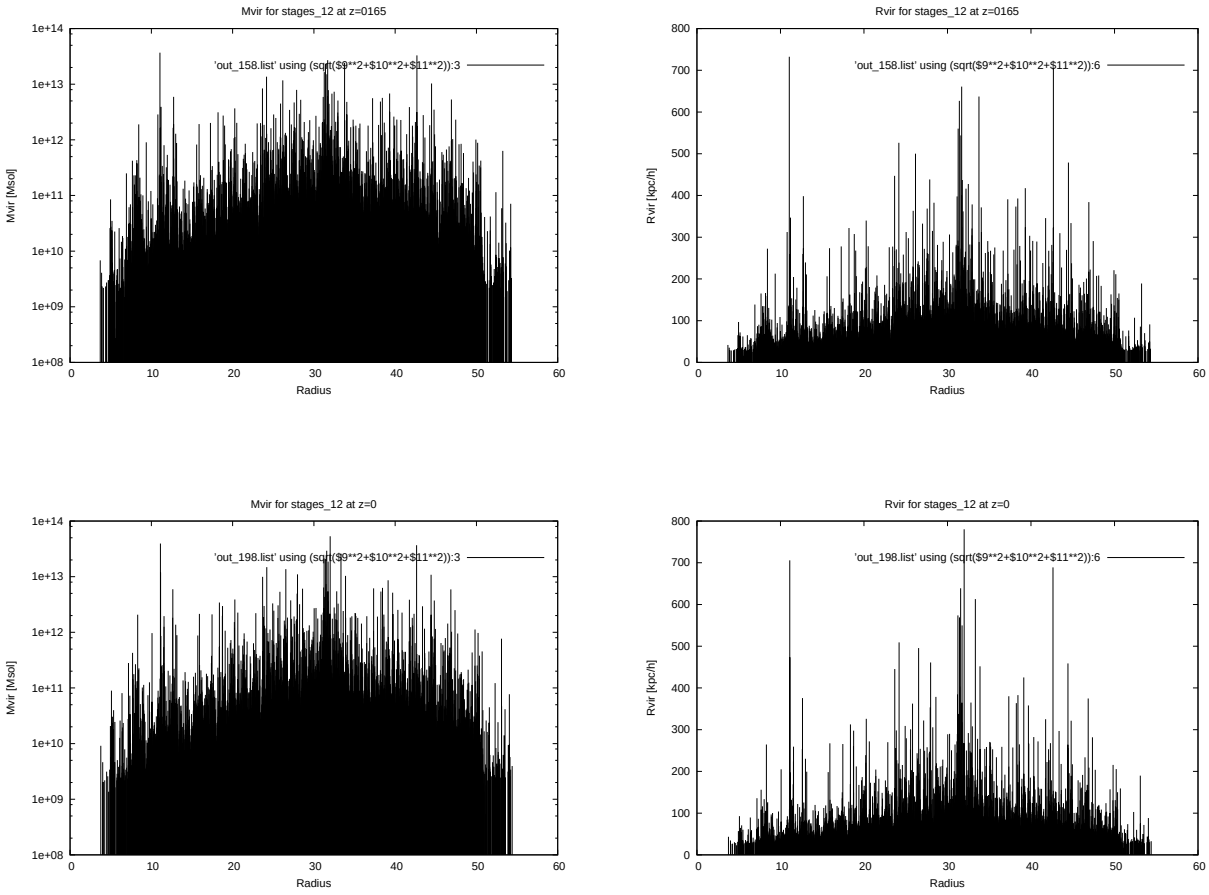
2.2.11 stages_12









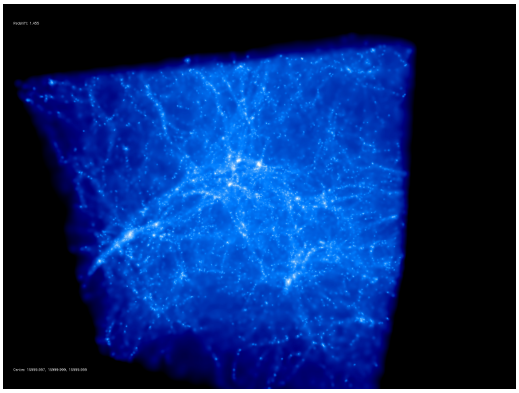
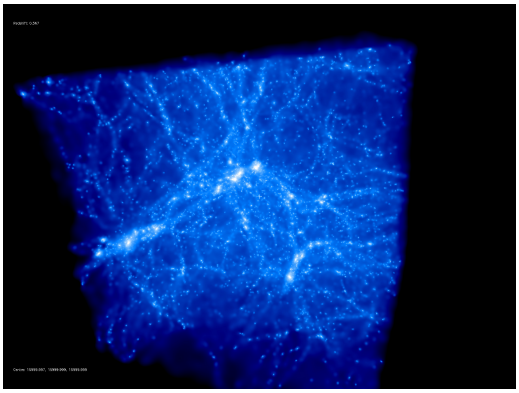
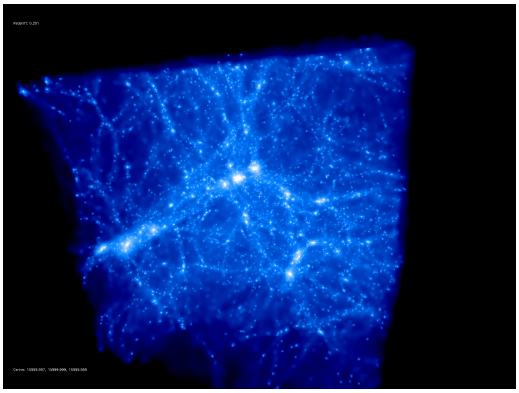
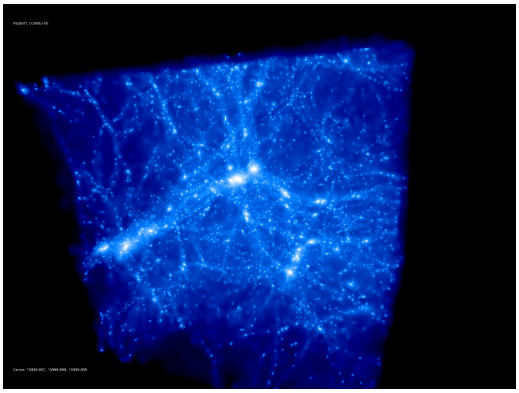
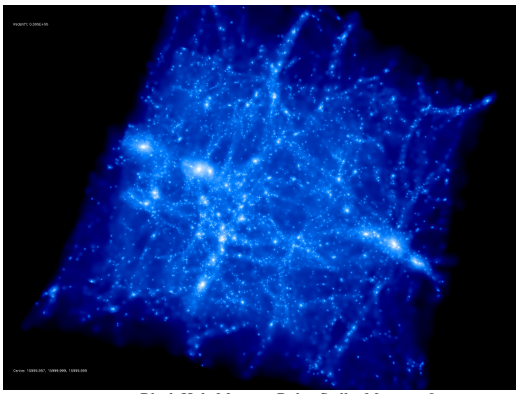
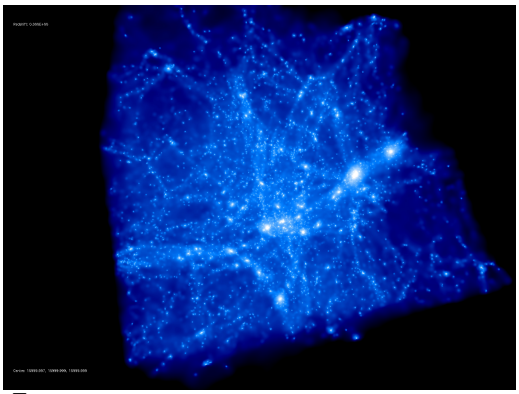
after Markus converter update is being galacticussed again
galacticus strange error:

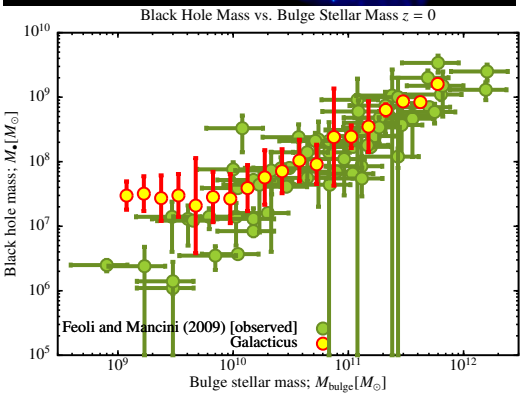
```
Fatal error in Cosmology_Age_Matter_Lambda():
```

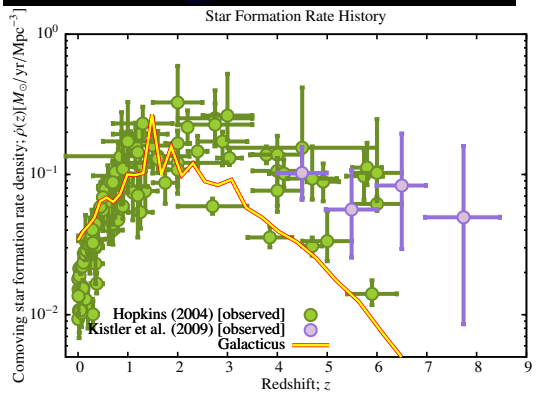
```
expansion factor is invalid
```

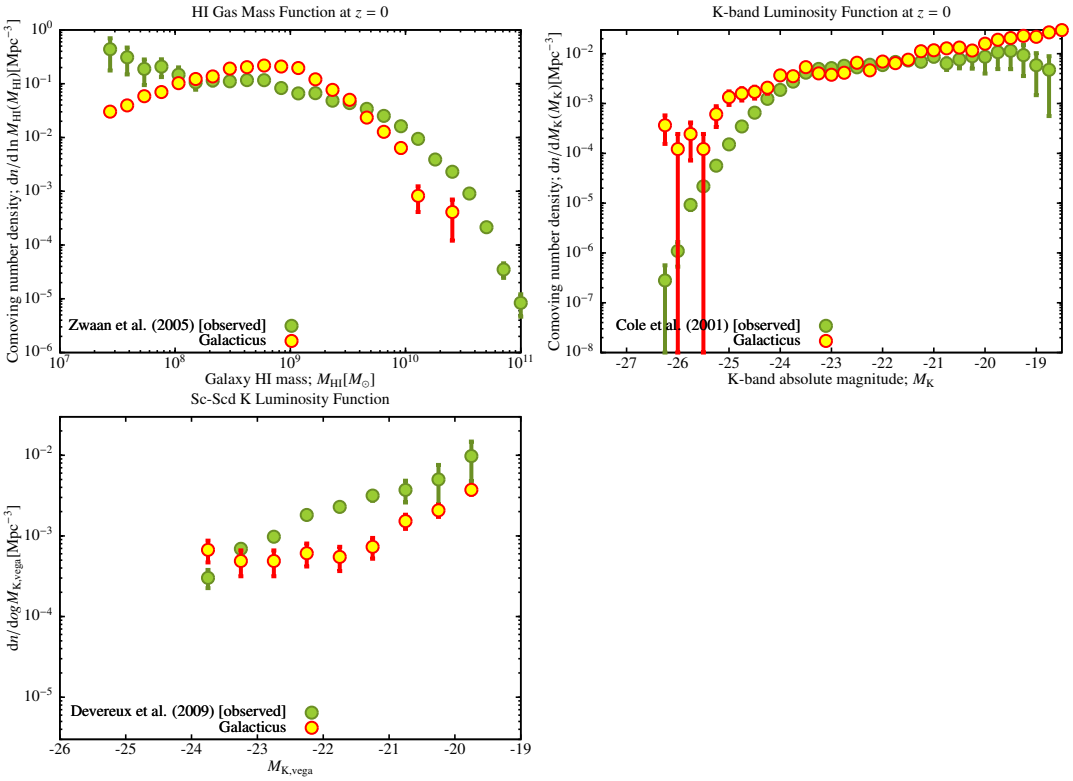
is being galacticussed
CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$

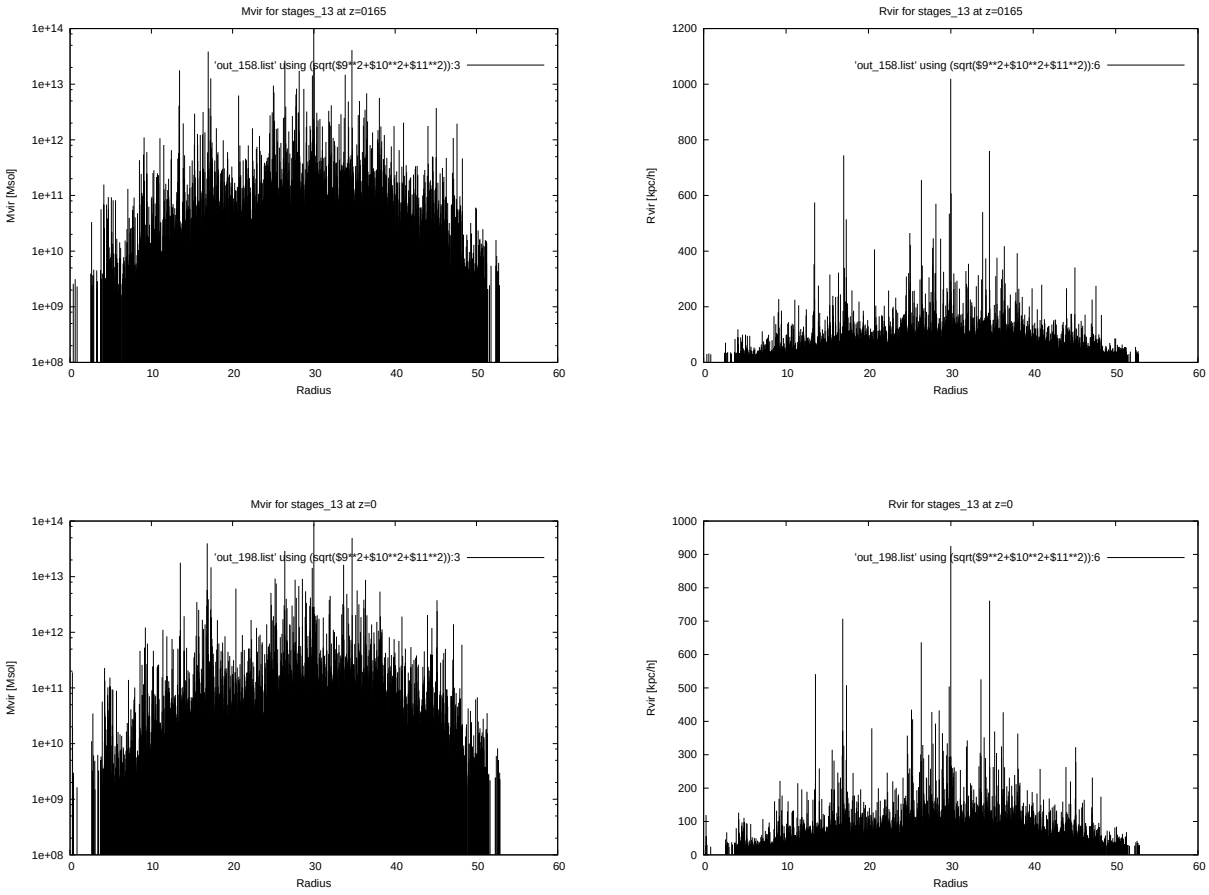
2.2.12 stages_13







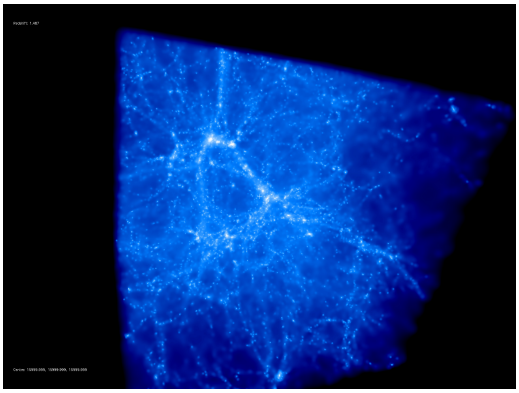
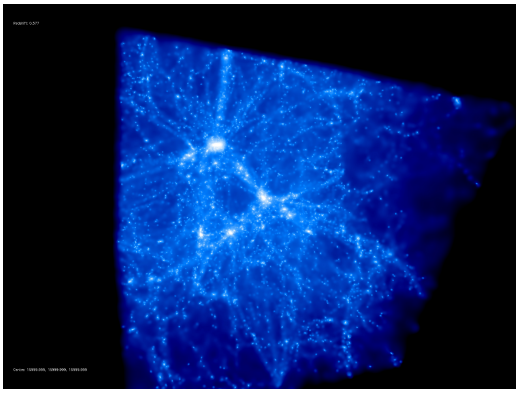
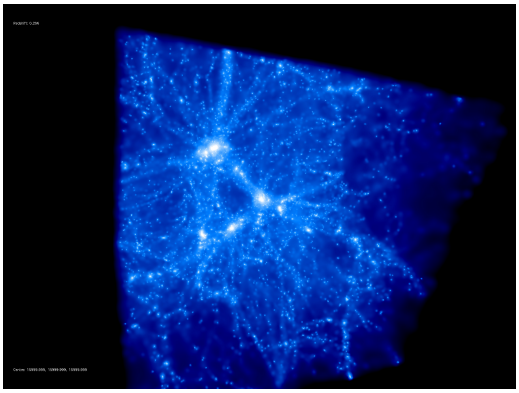
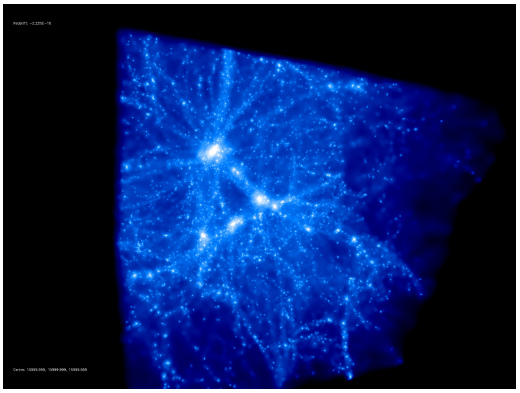
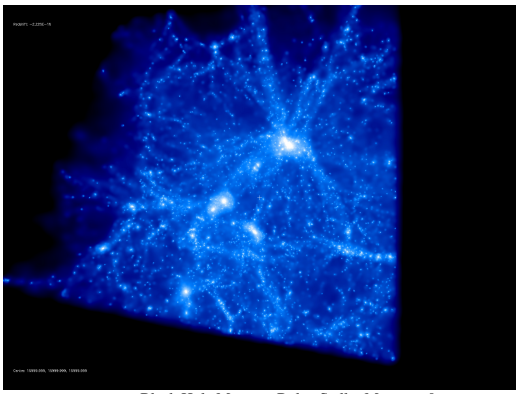


GALACTICUSSED $\surd$
after Markus converter update is being galacticussed again
galacticus strange error:

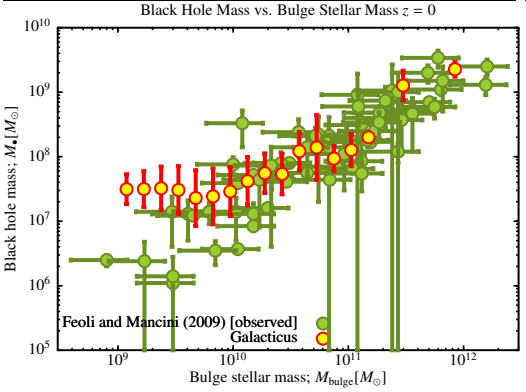
```
Fatal error in Cosmology_Age_Matter_Lambda():
expansion factor is invalid
```

is being galacticussed
CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$

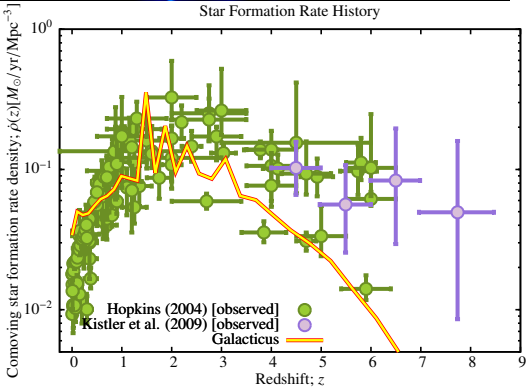
2.2.13 stages_14

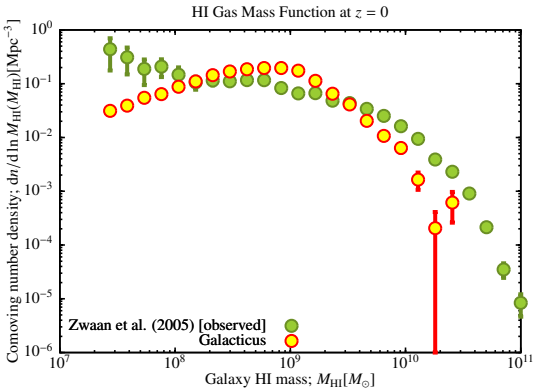






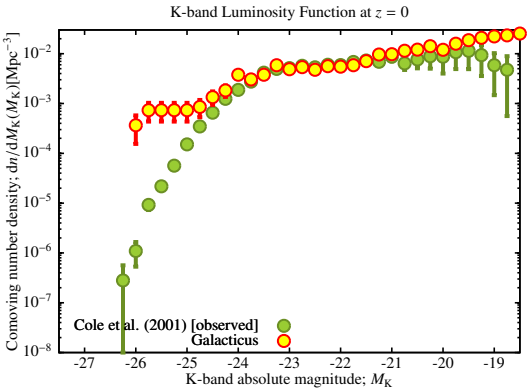

Black Hole Mass vs. Bulge Stellar Mass $z = 0$

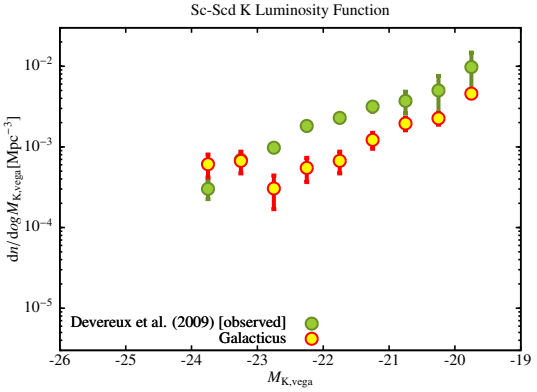


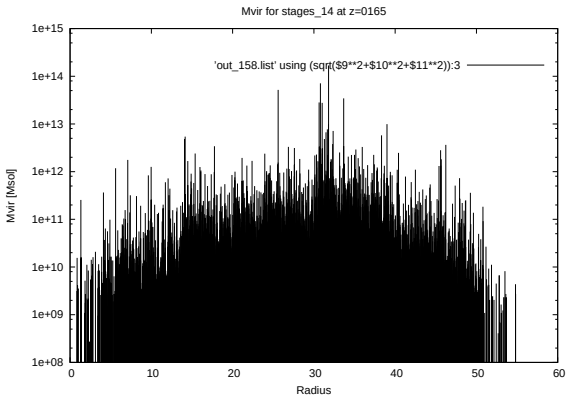
Star Formation Rate History

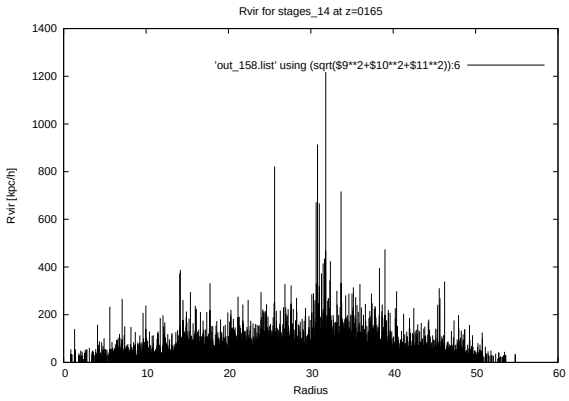


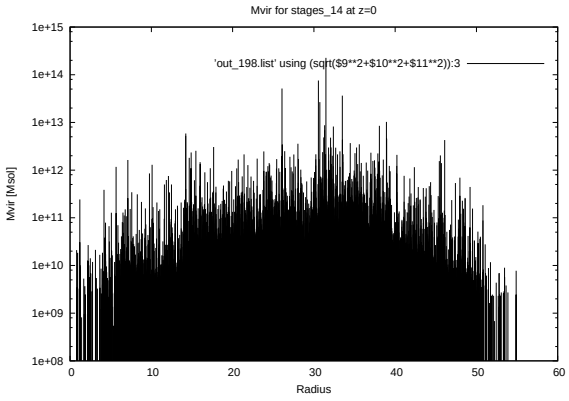


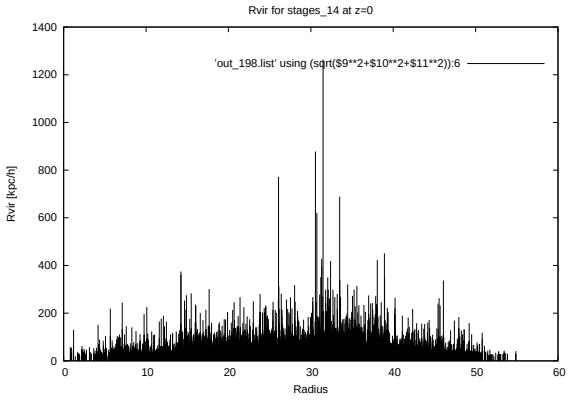






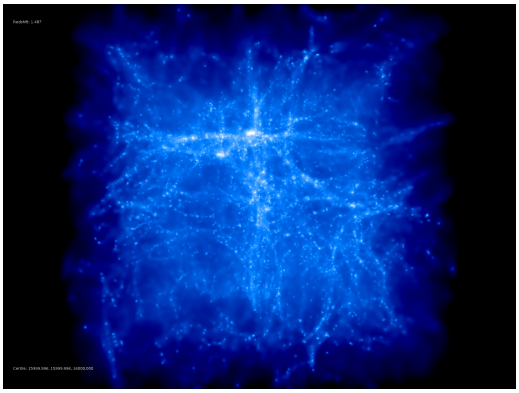
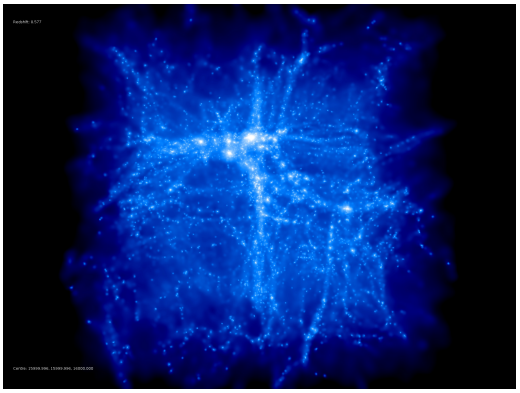
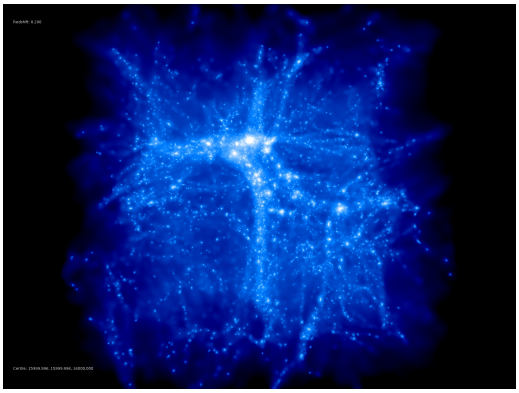
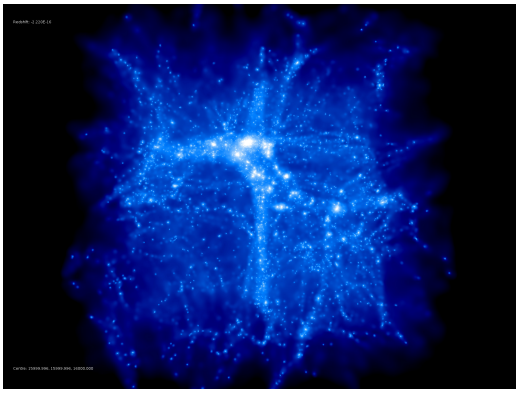
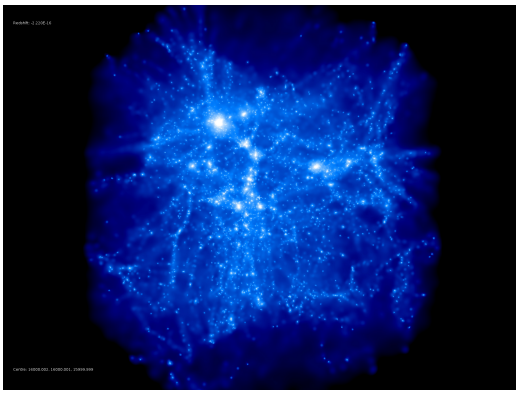
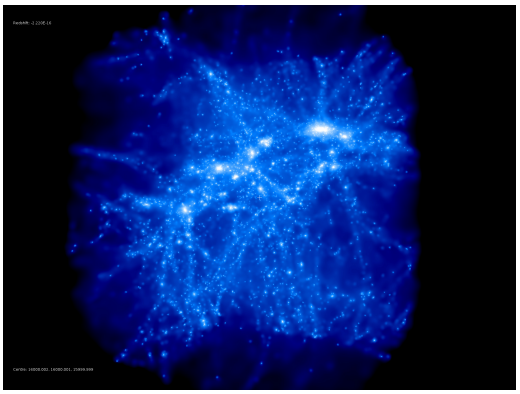


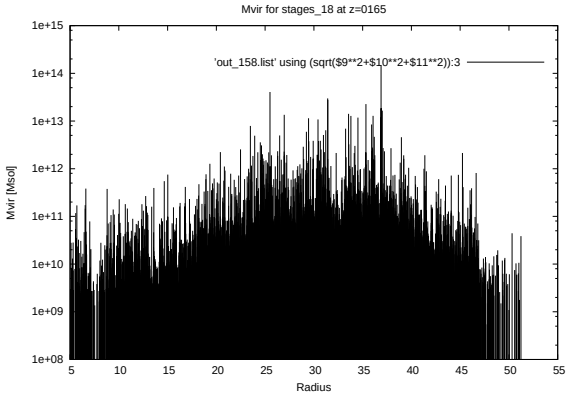


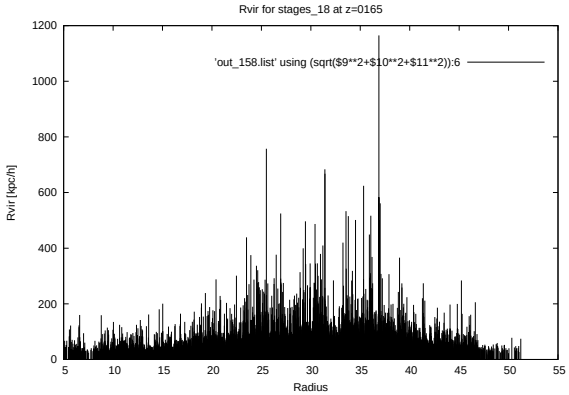


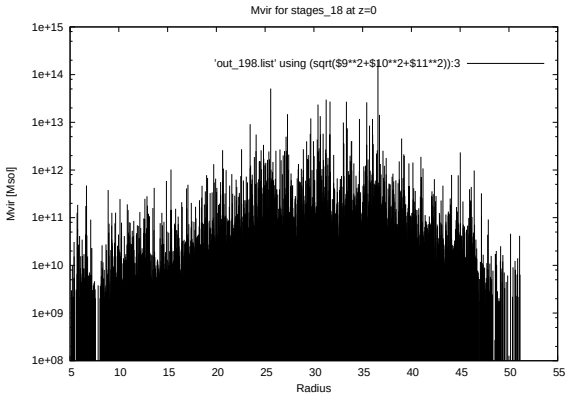
GALACTICUSSED $\surd$
CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$

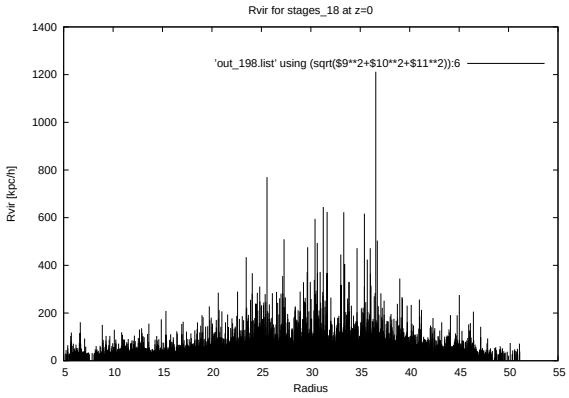
2.2.14 stages_18

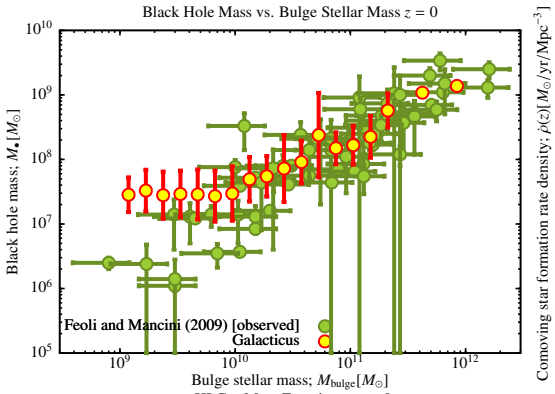







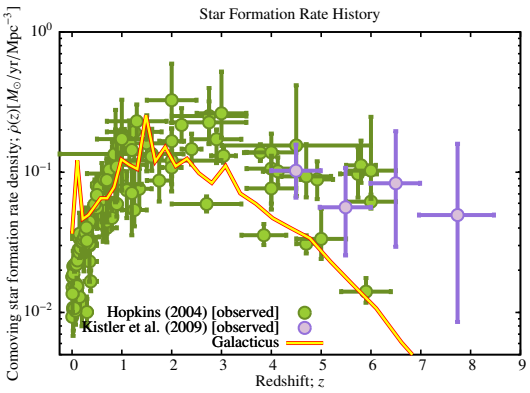


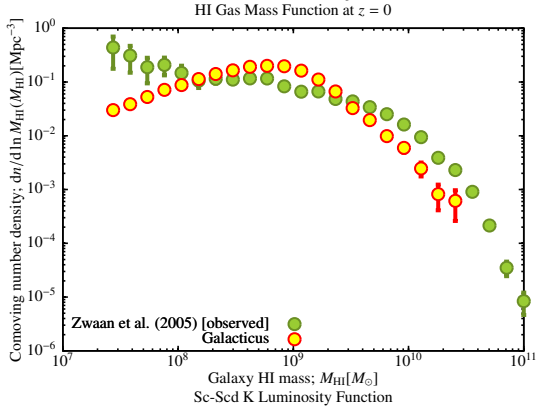


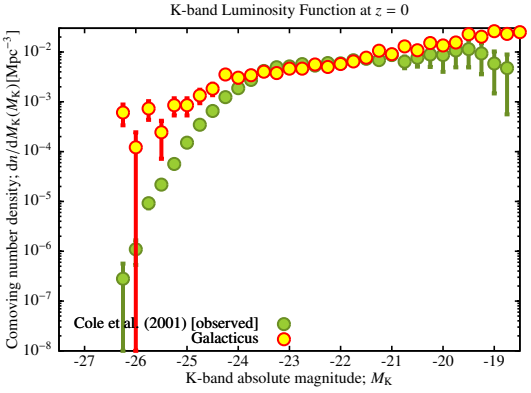


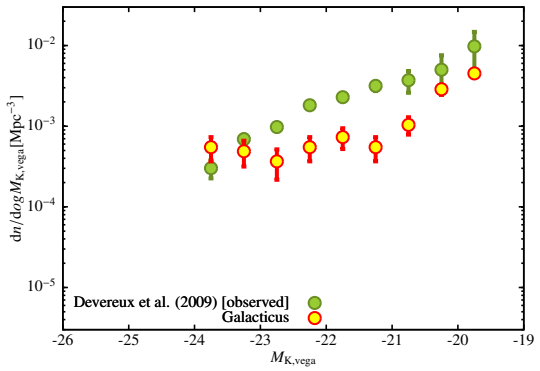










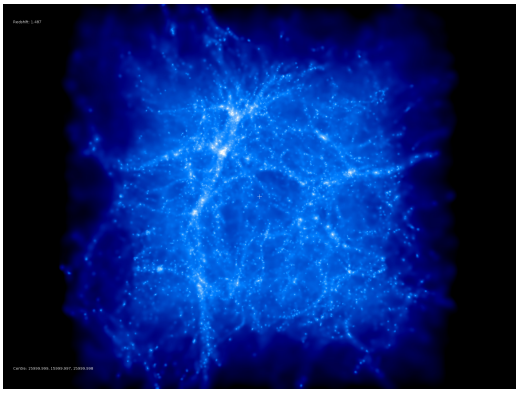
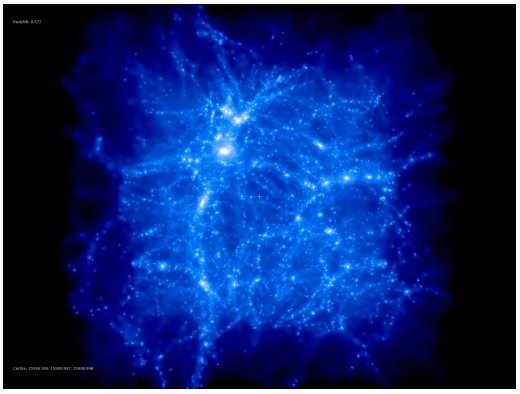
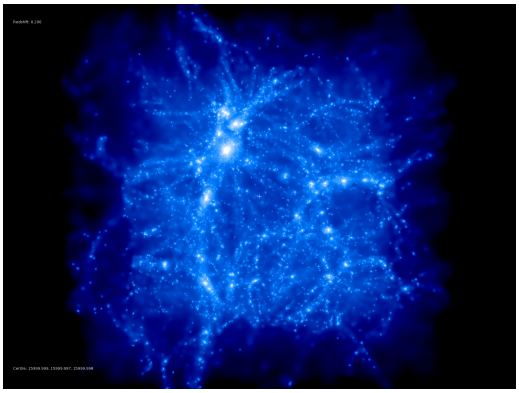
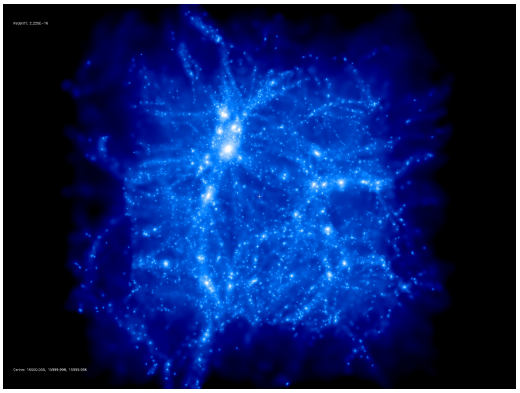
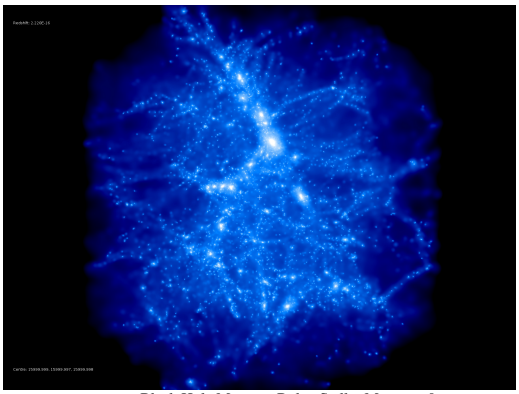
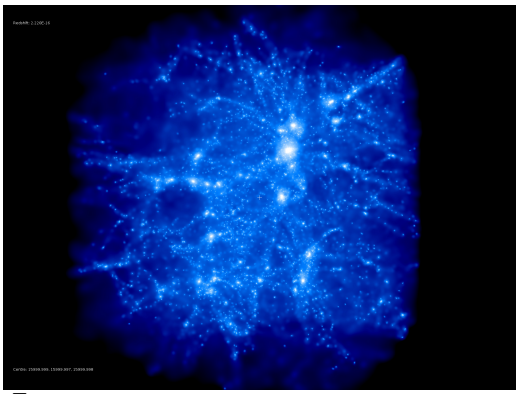


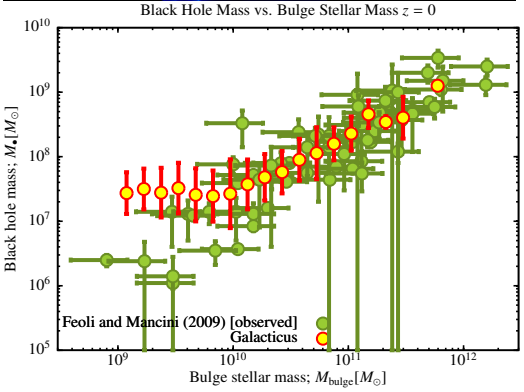
GALACTICUSSED √

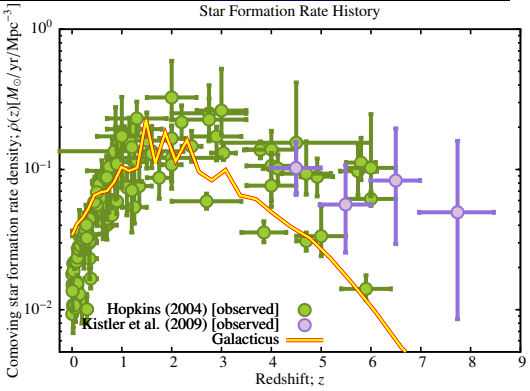
CONSISTENTTREED √

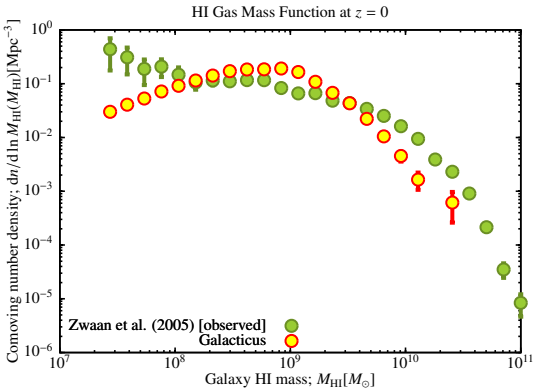
ROCKSTARRED √

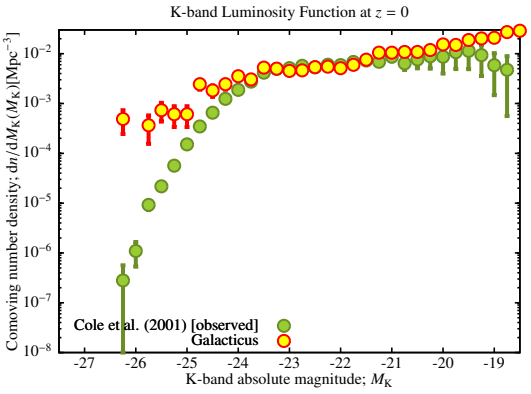
2.2.15 stages_19

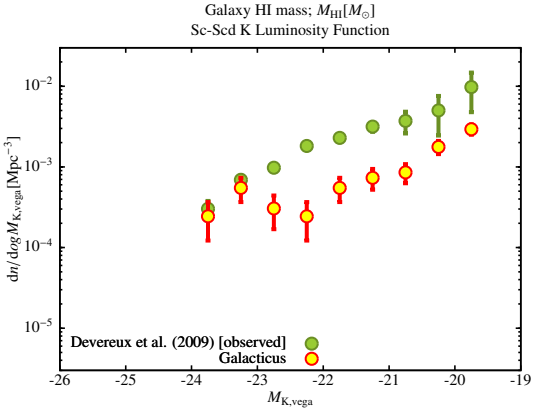







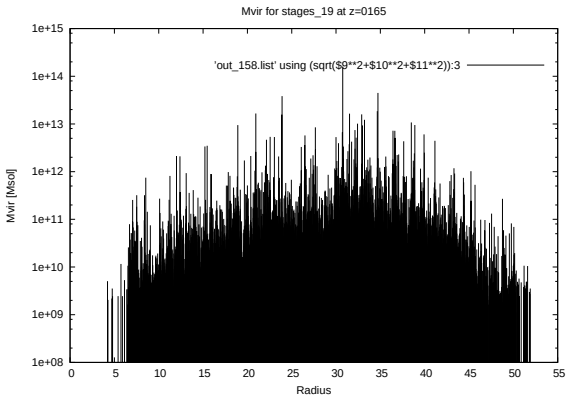


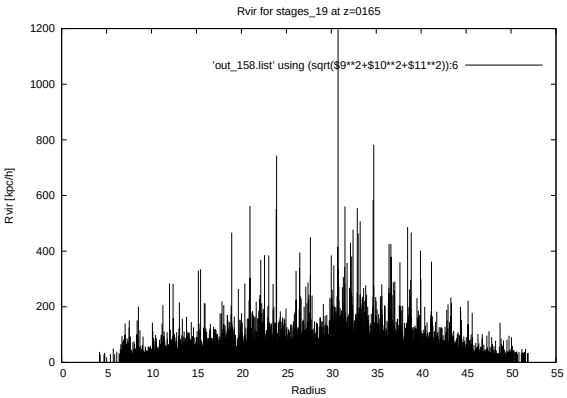


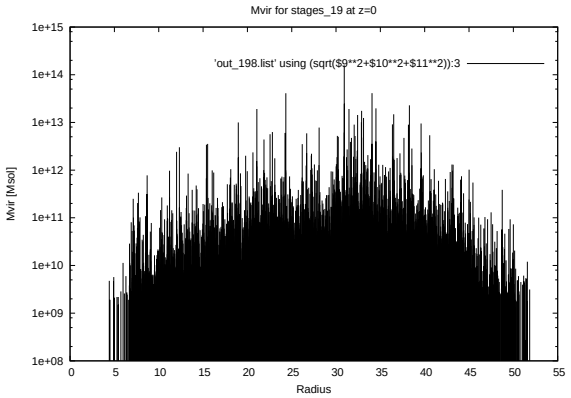

HI Gas Mass Function at $z = 0$
Comoving number density; $dn/d\ln M_{HI}(M_{HI})$[Mpc^{-3}]
Zwaan et al. (2005) [observed]
Galacticus
Galaxy HI mass; $M_{HI}[M_\odot]$

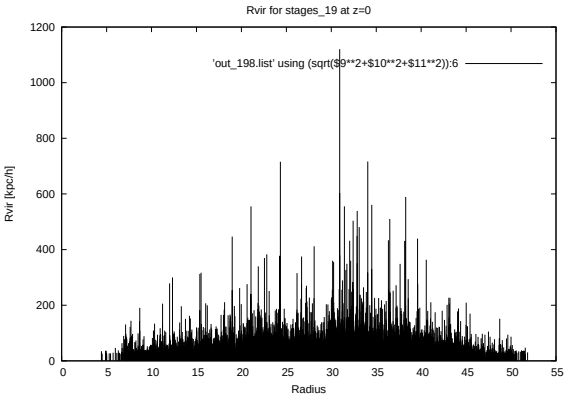

K-band Luminosity Function at $z = 0$
Comoving number density; $dn/dM_K(M_K)$[Mpc^{-3}]
Cole et al. (2001) [observed]
Galacticus
K-band absolute magnitude; M_K


Sc-Scd K Luminosity Function
$dn/d\log M_{K,vega}$[Mpc^{-3}]
Devereux et al. (2009) [observed]
Galacticus
$M_{K,vega}$

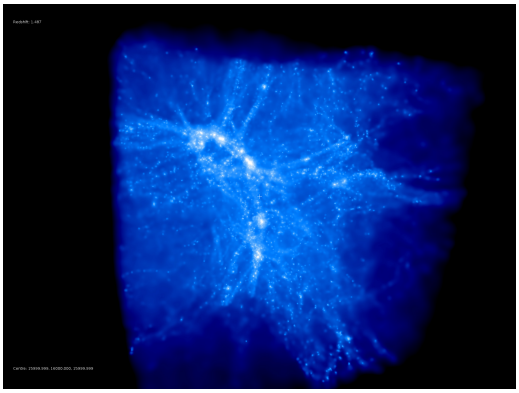
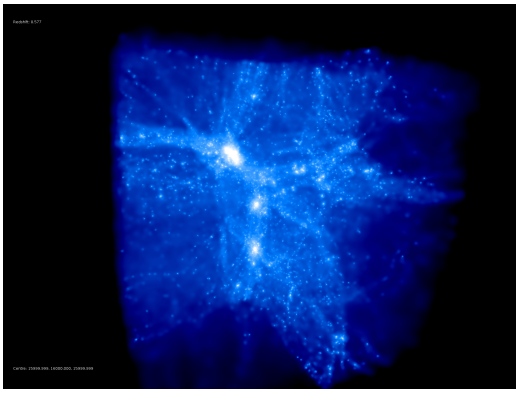
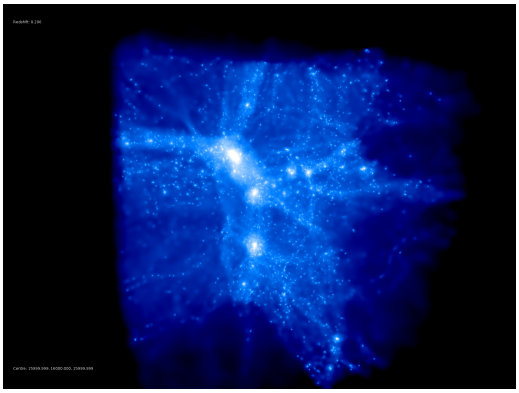
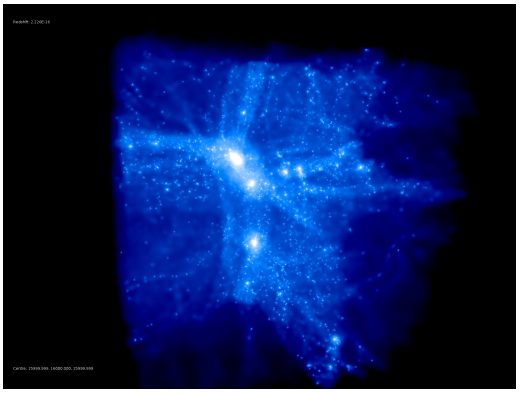
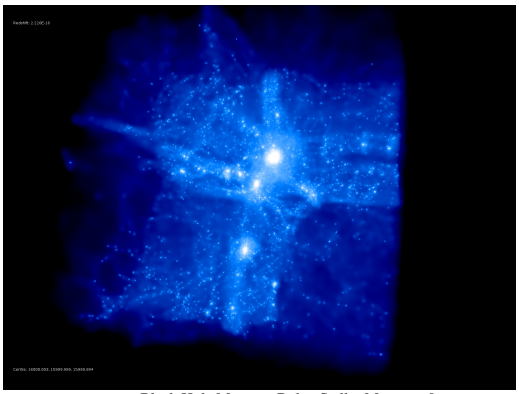
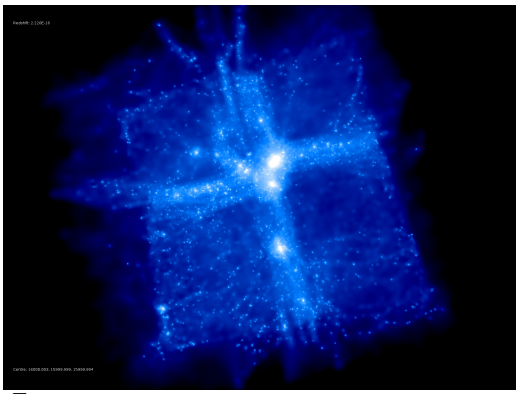

Mvir for stages_19 at z=0165
'out_158.list' using (sqrt($9**2+$10**2+$11**2)):3
Mvir [Msol]
Radius

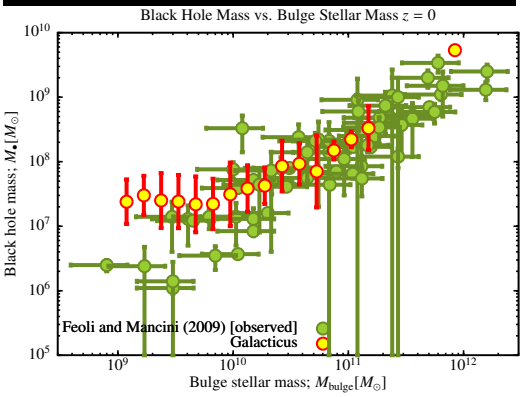

Rvir for stages_19 at z=0165
'out_158.list' using (sqrt($9**2+$10**2+$11**2)):6
Rvir [kpc/h]
Radius

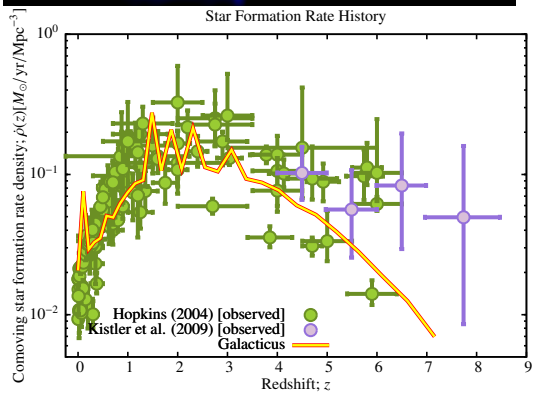

Mvir for stages_19 at z=0
'out_198.list' using (sqrt($9**2+$10**2+$11**2)):3
Mvir [Msol]
Radius

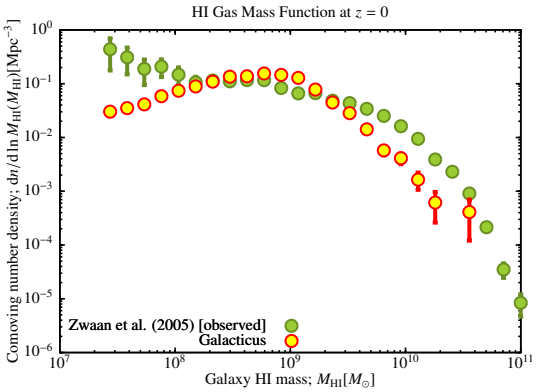

Rvir for stages_19 at z=0
'out_198.list' using (sqrt($9**2+$10**2+$11**2)):6
Rvir [kpc/h]
Radius

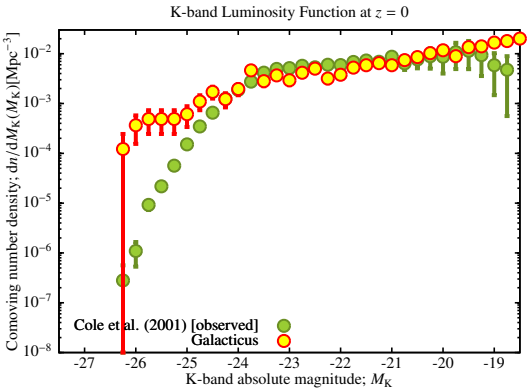
2.2.16 stages_20

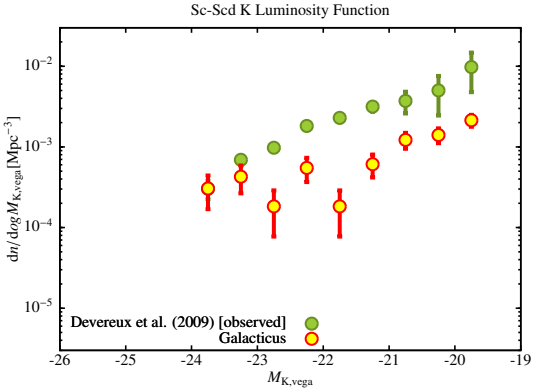







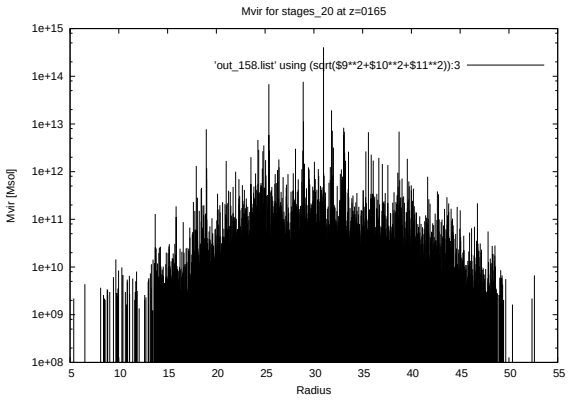


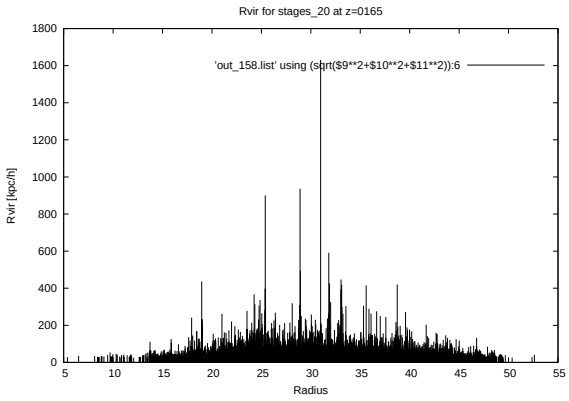


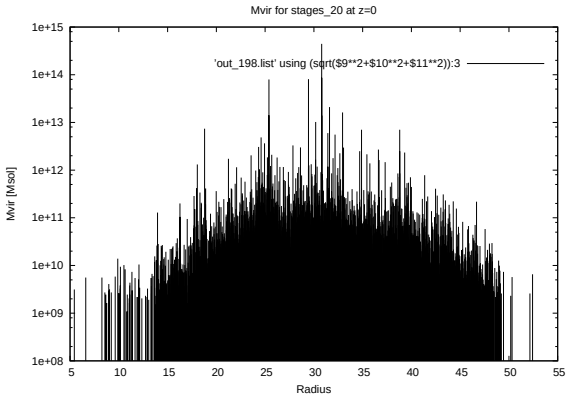

HI Gas Mass Function at z = 0
Comoving number density; $dn/d\ln M_{HI}(M_{HI})$[Mpc^{-3}]
Zwaan et al. (2005) [observed]
Galacticus
Galaxy HI mass; $M_{HI}[M_\odot]$

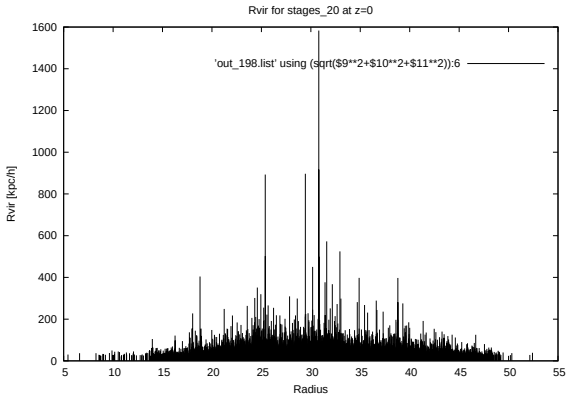

K-band Luminosity Function at z = 0
Comoving number density; $dn/dM_K(M_K)$[Mpc^{-3}]
Cole et al. (2001) [observed]
Galacticus
K-band absolute magnitude; M_K


Sc-Scd K Luminosity Function
$dn/d\log M_{K,vega}$[Mpc^{-3}]
Devereux et al. (2009) [observed]
Galacticus
$M_{K,vega}$

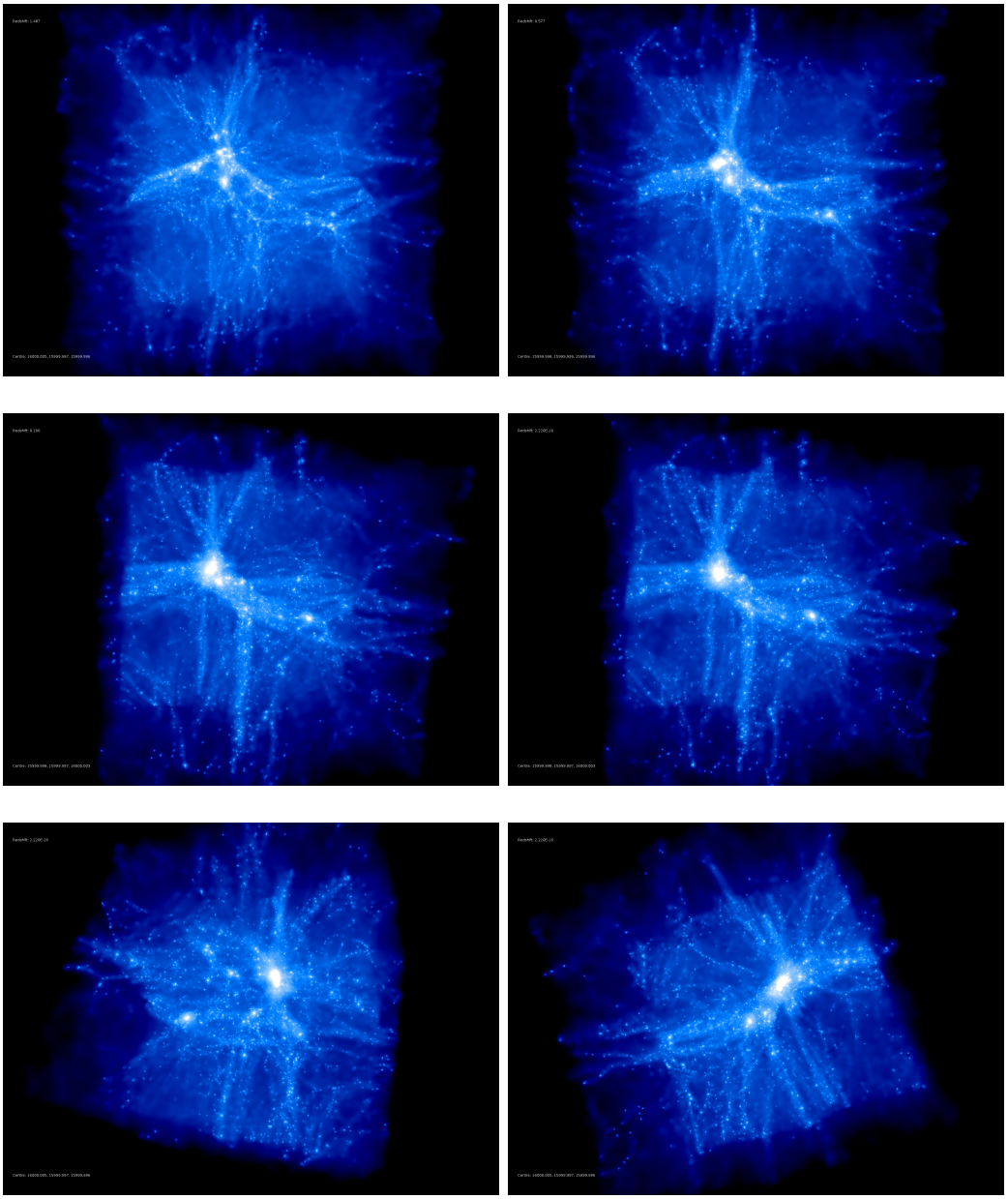

Mvir for stages_20 at z=0165
'out_158.list' using (sqrt($9**2+$10**2+$11**2)):3
Mvir [Msol]
Radius

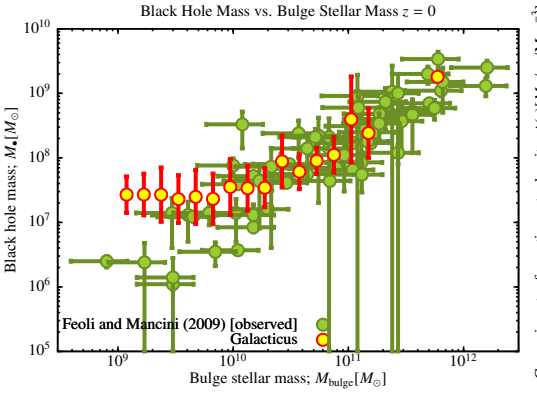

Rvir for stages_20 at z=0165
'out_158.list' using (sqrt($9**2+$10**2+$11**2)):6
Rvir [kpc/h]
Radius

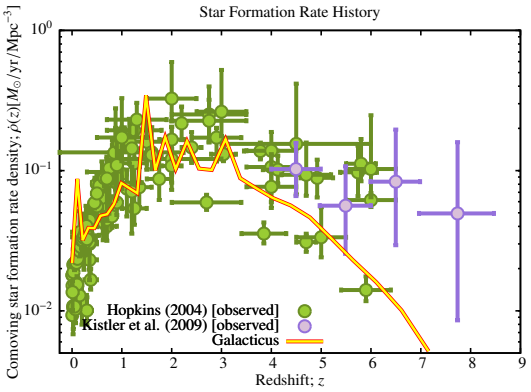

Mvir for stages_20 at z=0
'out_198.list' using (sqrt($9**2+$10**2+$11**2)):3
Mvir [Msol]
Radius

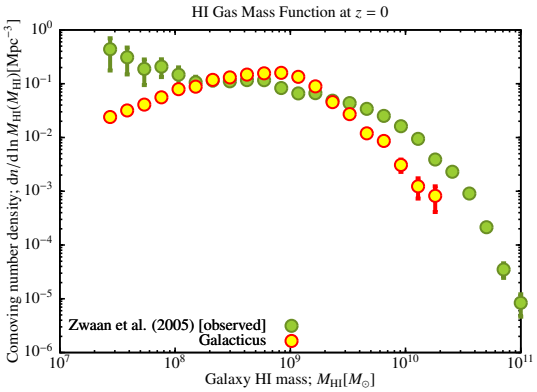

Rvir for stages_20 at z=0
'out_198.list' using (sqrt($9**2+$10**2+$11**2)):6
Rvir [kpc/h]
Radius

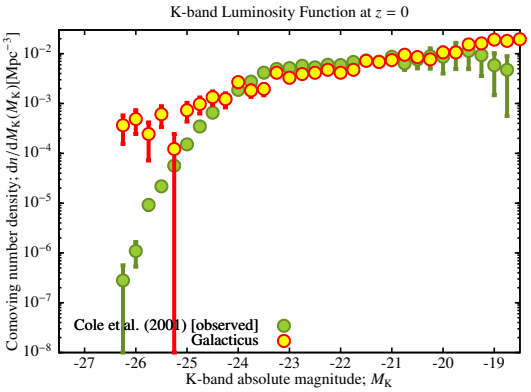
2.2.17 stages_21

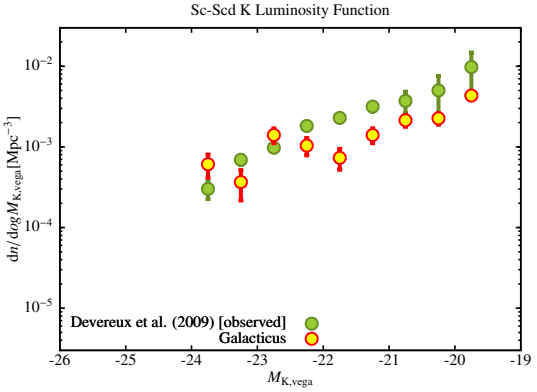


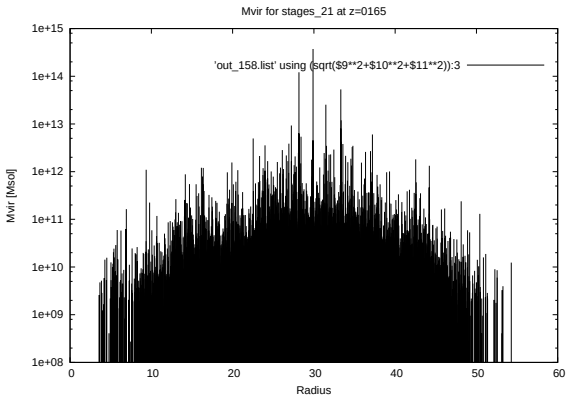


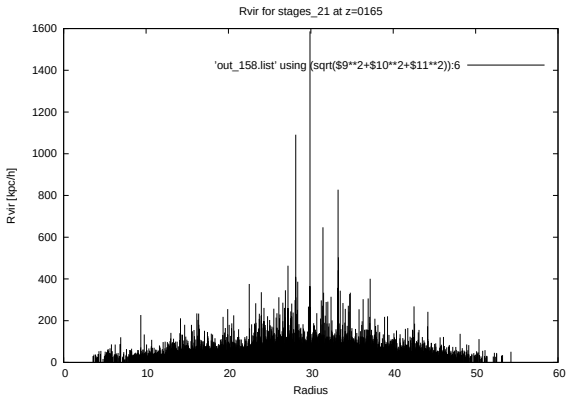


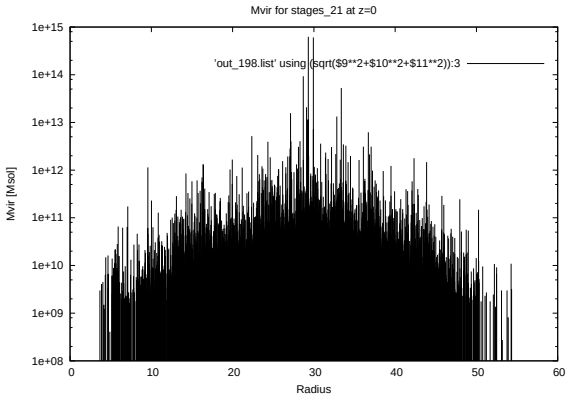


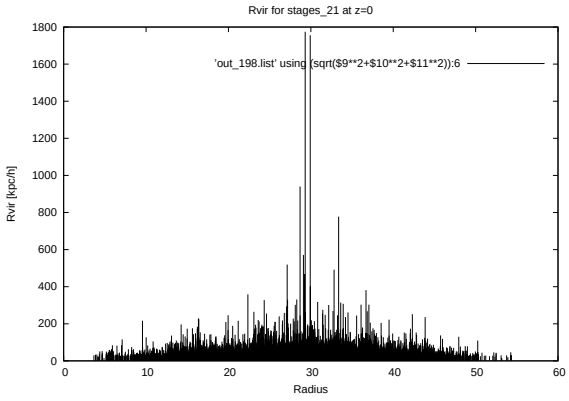












GALACTICUSSED $\surd$
CONSISTENTTREED $\surd$
ROCKSTARRED $\surd$