This is an in progress document on the files available at the school. Check often for a new version as I work on it. ....

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Projects, Data, Analysis Software and Simulations

The students will have access to:

SIMULATION DATA:

the following data are in /home/hipacc-29/[COSMO,DWARF,GALAXY]

-a fully completed Lambda CDM cosmological simulation of a 50Mpc per side volume.

- z=0 outputs of several realizations of a dwarf galaxy with different feedback implementations.

All simulations include gas cooling, metal cooling, star formation, feedback, cosmic UV background.

- Cosmological initial conditions for the 50 Mpc volume and for some individual galaxies in a cosmological context. It might be possible to run some of them at the school.

ANALYSIS TOOLS: in /home/hipacc-29/ANALYSIS

Decomposition: IDL software to separate a galaxy into its kinematic components: disk, bulge, halo.

IDLMAG: a simple IDL program to obtain rest frame photometric magnitudes in different bands from galaxies identified in simulations.

GALFIT a detailed howto to decompose artificial images of galaxies created with SUNRISE (see also P.Jonsson)

1DFits a simple idl routine to fit a bulge+disk profile. Not as good as GALFIT

Also available:

TIPSY: a graphic, interactive tool (in collaboration with Tom Quinn) to visualize and analyze simulations.

SUNRISE:.It will be possible to make artificial images of the simulations using SUNRISE..or at least try. SUNRISE is complicated. (in collaboration with P.Jonsson).

PROJECTS: rather than suggesting a list of predefined projects the students will be encouraged (and helped!) to develop their own research based on the data and the software available. I am sure we will be able to come up with something interesting. The simulations and the software lend themselves to a variety of approaches:

- analyze the global properties of galaxy populations at different redshifts: luminosity functions, baryon fractions, SFR vs HI abundance..
-identify galaxy populations at high redshift and find their present day counterparts.
- or viceversa.
-study the effects of different SN feedback implementations on the matter distribution in galaxies.

As the initial conditions are available, new, small simulations will be possible.

Suggested inspirational/bed time readings;

A paper on simulations of dwarf galaxies (also in /PAPERS)

http://dl.dropbox.com/u/1180829/nature08640.pdf
http://dl.dropbox.com/u/1180829/newsviews.pdf

A good review on galaxy formation:

http://arxiv.org/abs/1006.5394

A good review on high redshift galaxies

http://arxiv.org/abs/astro-ph/0701024

To start IDL on triton:

>module load idl/706
>idl

TIPSY inaccurate and outdated examples:

I suggest you try it on /DWARF/h516.g20/h516.cosmo25cmb.768g20MbwK.00512

Tipsy the program has lots of commands. You will find all the tipsy man pages converted to html format here:

http://www-hpcc.astro.washington.edu/tipsy/man/

The following is a common sequence of commands that I might run to analyze a galaxy run.
prompt% tipsy #small screen use -geom 500x500
openb tipsyfile.00100
loads 1 #if you have a standard formatted (xdr, most common) file
xall #or yall, or zall
makebox 1 # (shift)-click, (shift)-click, (shift)-click in tipsy window #make sure numlock is off
abox 1 #Activate box 1
boxstat 1 all # text listing of interesting information in box 1
boxstat 1 gas, star, or dark
readbinarray tipsyfile.den float
zarray logall wrbb 3 7
setsphere 2 pot 1 1e-3 #create sphere of radius 0.001 surrounding the minimum potential in box1
boxstat 2 all # what is density? If > 180, then I've found a halo, radius is virial radius or less, maybe make sphere bigger. If less, then make sphere smaller
markgal 2 40000 100 # box number, max gas temp, minimum density
psize mark 2 # resize the green marked particles to twice their original size
writemark 2 markfile # write the indices +1 of all marked particles to markfile
readmark markfile # read markfile
hard dump imagefile.xwd # create a hard copy image of what's on screen
viewgas logtemp 2 7

showvel yes
velscale 1e-4
viewstar tform 0.1 0.3
angleup 2 star
readarray amigaoutput.grp
markarray 0 625 625
xarray all default 624 626

Profile

profile 2 2 all sphere lin 196 outfile.profile 0

- "2": the box for which you will be extracting a profile (created with `makebox` or `setsphere`)
- "2": the center of mass of this box is where the profile is centered
- "all": particle type
- "sphere" (or "sph"): bin shape, concentric shapes across which properties will be integrated, "cylinder" (or "cyl") and "ellipse" (or "ell") are other possibility.
- "lin": bin type, how the bins will be distributed out in radius. "log" is an alternative
- "196": number of bins
- "outfile.profile": output file
- "0": minimum radius--size of smallest bin

<please enter: mass-unit(solar masses) distance-unit(kiloparsecs)>
13.5965e16 1e5
<enter: kpcunit msolunit fhydrogen>
1e5 13.5965e16 1e5 0.76
<enter: uv_type jnu21 alphaj>
uniform 0 0
Profile output columns: r # density M(r) vc(r) vr σr vθ σθ j jθ jφ [ρgas T P Entropy]
Profile is its own special world. When you are dealing with galaxies, you are constantly making profiles. Two of the major observational pieces of data against which we compare simulations are rotation curves (vc vs. r) and surface brightness profiles (stellar mass (kind of)/area vs. r, of course it's not really stellar mass, rather stellar brightness, but we can assume a constant mass to light ratio for our star particles). If you are dealing with dark matter halos, you need to make density profiles.

Rotation Curves

Rotation curves are always constructed using "all" (dark, gas, and star) the particles since the velocity at a given radius depends upon all the different types of mass interior to that radius. Star particles require information about dMSolUnit (mass converstion factor) and dKpcUnit (distance conversion factor), but they are not needed when you are creating a rotation curve, so it's OK to enter in "1 1" as the values for those parameters. Gas particles require that same information along with hydrogen fraction, uv_type, jnu, and alpha21.

- hydrogen fraction: use a hydrogen fraction of 0.76, by mass that's basically primordial, and that has worked for me every time.
- uv_type: how the uv background was implemented. The keyword "uniform" has worked for me (again courtesy of Fabio)
- j21: This is necessary if tipsy is simulating spectra and is the specific intensity (jv) of the 21 cm radiation. "0" works fine if you're not simulating spectra

- alphaj: the decay coefficient from state 2 to 1 for the 21 cm HI transition. Again, its for spectra, and "0" works fine for rotation curves.

An Example of a GASOLINE parameter file. To be updated!

```
 # This is NOT
# a complete list of parameters, but most parameters for a typical cosmological
# run are included and explained.
```

NOTE: a ready to run param file is in /DWARF/h516.g20/
h516.cosmo25cmb.768g20MbwK.param

```
bParaRead       = 1 #do not touch
bParaWrite      = 0 #do not touch
achInFile       = h516.cosmo25cmb.768g.tbin #input file
achOutName      = h516.cosmo25cmb.768g20MbwK #output files (will have .stepnr appended)
dMsolUnit = 13.5985e16 # mass unit in solar masses
dKpcUnit = 1e5 # length unit in kpc
achInFile = mysimulation.std # initial conditions file (tipsy format)
achOutName = mysimulation # output file root (also name of UV, director file)
bParaRead = 1 # default, parallel reading of initial conditions
bParaWrite = 0 # set to 0, can't yet write in parallel
dExtraStore = 0.3  # how much extra memory is needed? New star particles require more
memory.
dHubble0 = 2.894405 # Hubble constant for cosmo runs (in simulation units)
dOmega0 = 0.24 # total mass density
dLambda = 0.76 # cosmological constant
dRedTo = 0. # redshift to run simulation to for cosmo runs, if set, don't use dDelta
dTheta = 0.525 # initial tree opening-angle
dTheta2 = 0.7 # tree-opening angle after daSwitchTheta time
daSwitchTheta = 0.3 # time (in expansion factors) at which to switch dTheta
iCheckInterval = 4 # major step interval at which checkpoint files are written .chk0, .chk1
bPeriodic = 1 # set to 1 for cosmological runs. Makes boundaries periodic. What goes out the
left side comes in the right side
dxPeriod = 1.0 # use these next three for rectangular periodic boxes
dyPeriod = 1.0
dzPeriod = 1.0
nReplicas = 1 # set to 1 for cosmo runs
bEwald = 1 # set to 1 with bPeriod = 1 to make universe seem infinite in all directions to gravity
calculation.
bKDK = 1 # Kick,drift, kick method of splitting up timesteps into minor steps as opposed to 0
```

being Drift, Kick, Drift
iMaxRung = 22 # minimum timetep=timestep/2^iMaxRung
dEta = 0.195 # timestepping criteria, smaller=smaller time step, should be < 0.25
dEtaCourant = 0.4 # similar to above for SPH (0.4 default)
bStandard = 1 # reads and writes in standard tipsy format
bDoGravity = 1 # 1 to turn gravity on
bComove = 0 # 1 to make coordinates comoving
bCannonical = 1 # something wrt integration schem, ask TRQ
bGeometric = 0 # 0 is default SPH scheme
iGasModel = 2 # 0 for adiabatic, 2 is for cooling. never use 1
dConstGamma = 1.666667 # defines equation of state (5/3 = ideal gas)
dMeanMolWeight = 0.59259 # mean molecular weight
nSteps = 512 # number of time steps till run completion, used in combo w/ dDelta or dRedTo
iOutInterval = 8 # major step interval at which outputs are produced
iLogInterval = 1 # major step interval at which logfile is updated
bOverwrite = 1 # overwrites logfile
bVDetails = 0 # writes more on the screen output (stdout)
bDoDensity = 1 # writes a .den file (local densities for all particles)
nSmooth = 32 # number of particles used for smoothing (24 to 64 are OK)
bViscosityLimiter = 1 # just keep it 1 (speeds up SPH)
bFastGas = 1 # also just leave this at 1 (speeds up SPH)
dFracNoDomainDecomp = 0.1 # 0.1 default, also speeds up SPH
nTruncateRung = 32 # minimum number particles required to open new rung.
dhMinOverSoft = 0.1 # minimum smoothing length / gravitational softening (.1 - .5, higher value faster)
bViscosityLimitdt = 1 # reduces artificial viscoscity, leave on.
iBinaryOutput = 1 # makes output arrays (.iord etc.) binary
#options for physical softening, become available if -D CHANGESOFT is used.
# creates a switch from comoving to physical softening
bPhysicalSoft = 1 # turns it on
bSoftMaxMul = 1 # not sure on this (ask trq)
dSoftMax = 9 # (1+z) of the switch to physical softening.
# Star Formation Parameters, available if -D STARFORM is used while compiling.
bStarForm = 1 # turns on star formation
bUV = 1 # turns on UV background, a la Haardt & Madau
bFeedBack = 1 # turns on feedback recipe, time delays.
dMinGasMass =1.2e-13 # minimum gas particle mass, smaller particles =redistributed. Usually set to 1/3 of initial gas particle mass.
dOverDenMin = 0.0 # set to 2.0 to eliminate SF at high-z, non-cosmo -> 0.0
dPhysDenMin = 1.0 # min. physical density for star formation (atoms/cc)