Exercises — 11

The impact of strong stellar-driven outflows on rotation curves of low-mass galaxies

1. Calculate the stellar baryon conversion efficiencies, and compare with predictions from semi-empirical models (e.g., Moster et al. 2013)
2. Derive the circular velocity from Kepler's third law
3. Use the above expression and plot the rotation curves (circular velocity vs radial distance from galaxy center, out to ~ 20kpc) for all matter, and DM, gas and stars separately. Explain the differences with and without stellar-driven outflows.
4. Plot maximum circular velocity vs stellar mass (Tully Fisher relation), indicate the observed relation (e.g., Avila-Reese et al. 2008)

Exercises — 11

Helpful instructions/information:

- Stellar baryon conversion efficiency: $M_{stellar}/(f_{bar}*M_{halo})$,
  - stellar mass are star particles within 1/10 R_{vir},
  - halo mass are DM particles within R_{vir},
  - f_{bar} can be calculated from cosmological parameters
- Kepler's third law: centripetal force equal to gravitational force
- You will get six ascii-files:
  - two of them containing star particles,
  - two of them gas particles and
  - two of them DM particles.
- The two different files per particle type correspond to two different simulation runs, adopting different stellar feedback models ("nomw" and "winds", see next slide for more explanation)
- These ascii files have the following format (code units as before):

particle mass, x_position, y_position, z_position

- The positions are centered to the main galaxy (center of mass: x=0.0, y=0.0, z=0.0)

Exercises — 11

Further information: 2 cosmological hydrodynamic zoom-in simulation of a low-mass halo at z=0 with and without stellar-driven outflows

- WMAP3 cosmology, IC details described in Oser+10, Hirschmann+12 (Halo 3852)
- Run with a modified version of Gadget-2, for code details see *Hirschmann+13*
- Grav softening DM: 800pc; grav softening gas/stars: 400pc; Number of neighbours: 100
- M_{halo}= 3e11 $M_{\odot}$/h, R_{vir}= 109 kpc/h,
- *First simulation run with thermal stellar fb* (weak effect, *termed as "nomw" in the ascii file name*)
- *Second simulation run with* momentum-driven winds ("kicked" gas particles, decoupled from hydrodynamics for some time, *termed as "winds" in the ascii file name*)
- Both runs are taken from *Hirschmann+13*

Exercises — 11

- Reading suggestions — no part of the exam.
- Excellent review articles:
    - Somerville & Dave+15: excellent review article on current state of the art in cosmological hydro sims and SAMs
    - Naab & Ostriker+16: excellent review article on current state of the art in cosmological hydro sims and small-scale simulations
    - Specific, influential articles
        - Scannapieco et al. 2012: "The Aquila comparison project: the effects of feedback and numerical methods of galaxy formation"
        - Guedes et al. 2011: "Forming Realistic Late-type Spirals in a ΛCDM Universe: The Eris Simulation"
        - Stinson et al. 2013: "Making Galaxies In a Cosmological Context: the need for early stellar feedback"
        - Wetzel et al. 2016: "Reconciling dwarf galaxies with CDM cosmology"