Example feedback scheme (Dutton 2009 MNRAS, 396, 121)

Supernova drives outflows, which are assumed to move at the local escape velocity to maximize mass removal. ($< V_{esc}$ doesn't escape
$> V_{esc}$ moves less mass for same energy)

Energy driven wind model:

$$\Delta M_{eject}(R) = \frac{2\epsilon_{EFB}\,\eta_{SN}\,E_{SN}\,\Delta M_*(R)}{V_{esc}^2(R)}$$

ejected mass from radius R

mass of stars formed at radius R

$E_{SN} \simeq 10^{51}$ erg $= 5\times10^7$ km^2 s^{-2} $M_\odot$

$\eta_{SN} = 8.3\times10^{-3}$ # SN per $M_\odot$ of stars formed (this # for a Chabrier IMF)

ϵ_{EFB} = fraction of kinetic energy injected into wind
usually a large # in simulations (0.25 – 1)
usually a small # observed (0.02 – 0.1)

Momentum driven wind model

$$\Delta M_{eject}(R) = \frac{\epsilon_{MFB}\,p_{SN}\,\eta_{SN}\,\Delta M_*(R)}{V_{esc}(R)}$$

$p_{SN} = 3\times10^4\ M_\odot$ km s^{-1} is momentum produced by one SN

ϵ_{MFB} is again the coupling efficiency to the ISM

This formulation maximizes the impact of SN.

Luminosity function & Missing Satellite Problem

Schechter fcn:

$$\Phi(M) = \Phi_* \, e^{-(M/M_*)} \left(\frac{M}{M_*}\right)^{\alpha}$$ # of galaxies per Mpc^{-3} per mass

3 parameters: Φ_* characteristic density (Mpc^{-3})

M_* characteristic mass / luminosity

α faint end slope

traditionally used to fit the galaxy luminosity fcn
captures gross feature; can over-run some details
may vary with environment (cluster LF steeper than field LF)

Bell et al (2003)
find

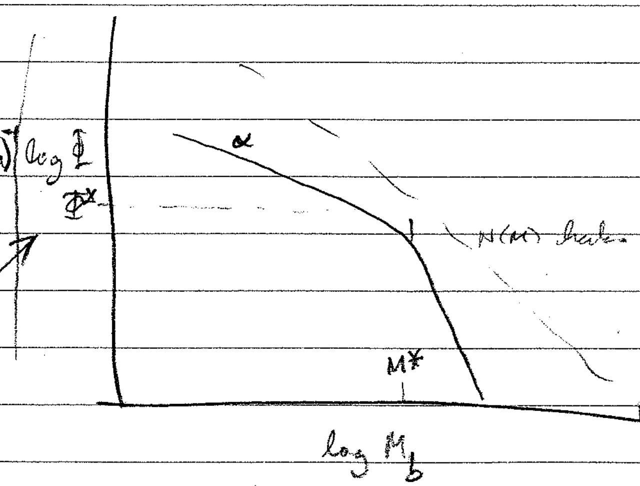
$\Phi_* = 4 \times 10^{-3}\ Mpc^{-3}\ (\log M)^{-1}$

$M_* = 10^{11}\ M_\odot$

$\alpha = -1.21 \pm 0.05$

sometimes $\frac{dN}{dM}$,

sometimes $\frac{d\log N}{d\log M}$



Weller, Ostriker & Bode (2005)
give $M_* = 1.1 \times 10^{15}\ M_\odot$

$\alpha = -1.9$

for CDM halo mass fcn

Integrated luminosity density

$$j = \int_0^\infty L\,\Phi(L)\,dL$$

$$j = L^* \Phi^* \,\Gamma(\alpha+2)$$

Abundance matching: map $\overset{\text{expected}}{\Phi(M_{halo})}$ to $\overset{\text{observed}}{\Phi(M_*)}$

The expected halo abundance is usually determined by matching the clustering of DM halos in simulations to that observed for large galaxy survey like SDSS.

Leads to $M_* - M_{halo}$ relations like that of Moster et al. (2010):

$$\frac{m}{M} = 2\left(\frac{m}{M}\right)_0 \left[\left(\frac{M}{M_1}\right)^{-\beta} + \left(\frac{M}{M_1}\right)^{\gamma}\right]^{-1}$$

where m is stellar mass and M is halo mass.

$(m/M)_0$, M_1, β, & γ are fit parameters of a broken power law

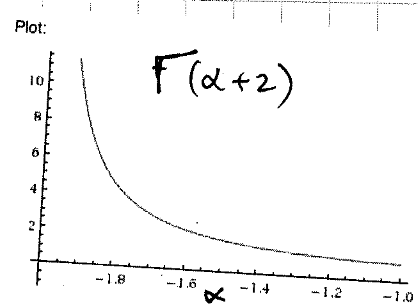
Moster et al (2010)

$\log M_1 = 11.884$

$(m/M)_0 = 0.0282$

$\beta = 1.057$

$\gamma = 0.556$



Note $\Gamma(\alpha+2) = 1 \to 2$ for $\alpha = -1 \to -1.5$

blows up as $\alpha \to -2$

(>10 for $\alpha < -1.9$,

goes to ∞ at $\alpha \to -2$)

$$j = L^* \Phi^* \Gamma(\alpha+2)$$