the number of stars formed in the mass interval (m, m + dm) $\phi(m)\psi(t)dmdt$

$\psi(t)$ Star formation rate (SFR) - total mass of stars per unit time

$\phi(m)$ Initial mass function (IMF) - number of stars formed @ mass m

$\int_0^{\text{inf}} m\phi(m)dm = 1$ The IMF is normalized

$\phi(m)\ \alpha\ m^{1+x}$ Power law ; $x \equiv$ slope of the IMF

$$\frac{dM}{dt} = f$$

change in mass of the system, f ≡ gas inflow or accretion rate

$$\frac{dM_s}{dt} = \psi - E$$

E total ejection rate from stars of all ages and masse

$$\frac{dM_g}{dt} = -\psi + E + f$$

$$M = M_s + M_g$$

Total mass distributed in gas and stars.

$\mu = \frac{M_g}{M}$ gas fraction $\quad M_s = (1-\mu)M$

m ≡ initial mass

τ_m m mass star lifetime w_m m mass star remnant.

$$E(t) = \int_{m_t}^{\infty} (m - w_m)\psi(t - \tau_m)\phi(m)dm$$ ≡ Ejection rate

turn-off mass

$t - \tau_m$: time of birth of m mass stars

$$\frac{ZM_g}{dt} = -Z\psi + E_Z + Z_f f$$

E_Z: re-ejected + newly synthetized

evolution of mass of metals in the gas. Z can be any element (Ca, Mg, Fe ...)

$$\int_{m_t}^{\infty} m p_{zm} \psi(t-\tau_m)\phi(m)dm$$

rate of ejection of new metals

p_{zm}: mass fraction of a star of mass m converted to metals and ejected

$$E_Z(t) = \int_{m_t}^{\infty} [(m - w_m - m p_{zm}) Z(t-\tau_m) + m p_{zm}] \psi(t-\tau_m)\phi(m)dm$$

$(m - w_m - m p_{zm})$: unprocessed material

Total ejection of old and new metals

$$Z_s M_s + Z M_g = \int_0^t \int_{m_{t'}}^{\infty} m p_{zm} \psi(t'-\tau_m)\phi(m)dt'dm$$

Conservation equation

mean metal mass in stars / gas

$$R = \int_{m_t}^{\infty} (m - w_m)\phi(m)dm$$

Returned mass fraction

$$y = \frac{1}{1-R}\int_{m_t}^{\infty} mp_{zm}\phi(m)dm$$

yield = mass of new metals ejected when unit mass of matter is locked into stars.