The chemical evolution, providing a star formation history, is a preliminary step for our spectrophotometric model.

The code describes one–zone (no dependence on space, only on time) open models including the infall of primordial gas, according to the standard equations of galactic chemical evolution, which we outline below.

In order to simulate the chemical evolution of galaxies, we have to express the time derivative of total gas mass $M_g(t)$ and of the mass of gas in the form of element i, $M_{g,i}(t) = X_i(t)M_g(t)$, in terms of computable quantities at time t, i.e. as a function of the previous history of the galaxy, keeping into account all the processes intervening in the evolution:

$$\dot{M}_{g,i} = \dot{M}_{g,i}\Big|_{\rm SF} + \dot{M}_{g,i}\Big|_{\rm FB} + \dot{M}_{g,i}\Big|_{\rm Inf} \tag{1}$$

where the 3 terms on the right hand side represent, respectively, the depletion of gas due to the formation of new stars, the feedback to the ISM due to the final stages and death of stars, and the infall of primordial gas forming the galaxy.

The rate of gas depletion due to star formation can be written as:

$$\dot{M}_{g,i}\Big|_{\rm SF} = -X_i(t)\,\Psi(t) = -M_{g,i}(t)\frac{\Psi(t)}{M_g(t)} \tag{2}$$

where $\Psi(t)$ is the SFR, which we write as the sum of two terms, a Schmidt–type one and, when needed, an analytical one, explicit function of time (e.g. constant or exponential, used for instance to add a burst of star formation over a quiet evolution):

$$\Psi(t) = \nu\, M_g(t)^k + f(t) \quad M_\odot\, yr^{-1} \tag{3}$$

The stellar mass return to the ISM is computed under the assumption that it takes place entirely at the stars death. With this (good) approximation, the mass of gas in the form of element i given back to the ISM by all stars which have died before time t is:

$$M_{g,i}(t)|_{\rm FB} = \int_0^t dt' \int_{\mathcal{M}(t-t',Z(t'))}^{\infty} dm\, \Psi(t')\, \Phi(m) R_i(m, Z(t')) \tag{4}$$

where $\mathcal{M}(t,Z)$ is the mass of the star of metallicity Z and lifetime t, $\Phi(m)$ is the IMF (see below) and $R_i(m,Z)$ the mass fraction in the form of element i ejected by the star of mass m and metallicity Z (we adopt stellar ejecta from Portinari et al. 1998). The time derivative of this integral yields the rate of stellar feedback to the ISM:

$$\dot{M}_{g,i}(t)\Big|_{\rm FB} = -\int_0^t \frac{\partial \mathcal{M}(t-t',Z(t'))}{\partial t} \Psi(t')\, \left[\Phi\,(m)\, R_i\,(m, Z(t'))\right]_{m=\mathcal{M}(t-t',Z(t'))}\, dt' \tag{5}$$

The IMF is a power–law, $\Phi(m) \propto m^{-x}$ in different mass intervals, normalized to unitary total mass. Of course, since the purpose is the spectral synthesis, we adopt those IMF for which our SSP library has been computed (see Sec. **??**).

An equation analogous to the latter one holds for the type II supernova rate, i.e. the death rate of stars more massive than $M_{up} = 5 - 8 M_\odot$ (depending on stellar models having or not overshooting):

$$SNR(t) = -\int_0^t \frac{\partial \mathcal{M}(t-t', Z(t'))}{\partial t} \Psi(t') \left[\Phi\left(m\right)/m\right]_{m=max(M_{up},\mathcal{M}(t-t',Z(t')))} dt' \tag{6}$$

In practice, since only stars born during the last few 10^7 yr contribute to the above integral (the lifetime of the star with initial mass M_{up}), it is convenient to integrate from $t - \tau(M_{up}, Z(t))$. This is a good approximation since stellar lifetimes are weak functions of Z and the timescales involved are short.

We do not include type Ia supernovae. This is justified for our purposes: we are not interested at this stage in the detailed chemical evolution of galaxies, just on the global metal content and its evolutionary rate, since they provide a hint to the amount of dust in the ISM and its variation in time (but we are working to improve this point in order to predict the detailed evolution of heavy elements making up dust grains). Moreover the SNR is computed only to estimate the radio emission from galaxies (Sec. **??**), not the energetics of the ISM ruling for instance the star formation efficiency and the onset of galactic winds (see below).

We assume, as has been usually done, that the gas accretes into galaxies at an exponential rate:

$$\dot{M}_{g,i}\Big|_{\rm Inf} = X_{i,\rm Inf}\, A_{\rm Inf}\, \exp(-t/\tau_{inf}) \tag{7}$$

normalized in order to accrete a mass of gas $M_{\rm Inf}$ at time $t_{\rm Inf}$. $X_{i,\rm Inf}$ is the mass fraction of element i in the infalling gas.

We allow for the possibility of interrupting the star formation activity and the infall at a time t_{wind}. In models for the chemical evolution of galaxies (see Matteucci 1996), this break is introduced to reproduce the chemical and spectrophotometric properties of elliptical galaxies. The computation is usually performed igniting galactic winds when the amount of thermal energy from supernova explosions and stellar winds into the ISM overhelms the gravitational binding energy of the gas. Actually this requires a complicated treatment for a very simple and unrealistic scheme, i.e. the sudden break, all over the galaxy, of every activity. The many uncertain factors required for this computation (i.e. amount and distribution of dark matter, interactions of supernovae and stellar winds with ISM) are introduced as parameters to set in order to find the value of t_{wind} reproducing the observations.

Therefore we set t_{wind} directly as a parameter (Mihara & Takahara 1994, Matteucci 1996), with the typical values that fit the observed properties of elliptical galaxies. At that time the galaxy is supposed to be totally depleted of gas, and possibly replenished due to stellar feedback: a fraction f_{wind} of the stellar mass from dying stars remains within the galaxy while $1 - f_{wind}$ continues to be lost. We introduced this further parameter in order to reproduce the amount of dust and IR emission observed in local giant ellipticals (see Sec. **??**), that (with the ejecta we have adopted) require $f_{wind} \sim 10^{-3}$.