3. THE FATE OF THE GAS INJECTED BY YOUNG STELLAR CLUSTERS

Depending on the total amount of kinetic energy injected by the SSCs two outcomes are possible: if the kinetic energy is larger than the gravitational potential of the galaxy, all material will escape and become part of the IGM; otherwise, the gas will return to the disk. If the material returns and reincorporates to the galaxy two things can happen: it can fall back close to the galactic center or far from it. Considering that GWs are confined to a cone, material that does not reach a high altitude will fall close to the galactic center, while gas that reaches a high altitude can fall back at large galactocentric radii.

3.1. *Mass loss measures*

In order to quantify the mass loss in numerical models one has to determine which material will be considered lost to the IGM. A natural estimation can be derived by comparing the velocity of a parcel of gas and the escape velocity at its current position. This has been done, for instance, in previous work by MacLow & Ferrara (1999) and D'Ercole & Brighenti (1999). This work, however, used Eulerian codes in which material that leaves the computational domain cannot be further analyzed, and therefore was automatically considered unbound. In reality, some of this material would return to the galaxy. Our models, that use the SPH (Smooth Particle Hydrodynamics) integration scheme, are not limited by the extent of the computational domain; thus, they were able to trace all the material for the duration of the simulation. We will consider the following more stringent criterion: only material that has left a cylindrical region of $R_{\rm max} = 20$ kpc and $|z_{\rm max}| = 20$ kpc (see also D'Ercole & Brighenti 1999) *and* has a velocity larger than the escape velocity at its current position will be considered effectively lost.

Mass loss in our models is thus carried out by first computing the total mass of unbound (ejected from the galaxy) gas $M_{\rm ej}$. To do this, we consider the total galaxy gravitational potential given by,

$$\Phi_T(r) = \Phi_h(r) + \Phi_d(r)\,, \tag{9}$$

where r is the distance to the center, and Φ_h and Φ_d are the dark matter halo and disk components, respectively. Gas particles outside the cilinder with velocity larger than the escape velocity

$$v_{\rm esc} = \sqrt{-2\Phi_T(r)} \tag{10}$$

are considered to be unbound. We define a 'total mass ejection efficiency' as the ratio of the mass ejected (unbound) to the total gas mass,

$$\xi_m \equiv \frac{M_{\rm ej}}{M_g}\,. \tag{11}$$

The mass ejection efficiency has two limiting cases: $\xi_m \to 0$ when all the galactic ISM is bound, and $\xi_m \to 1$ when all the galactic gas is expelled from the galaxy.

One can also define a "metal ejection efficiency" as

$$\xi_z \equiv \frac{M_{c,\rm ej}}{M_c}, \tag{12}$$

where M_c is the total mass injected by the SSCs, and $M_{c,\rm ej}$ the mass, also originated in the SSCs, that is unbound. The mass injected by a star cluster contains the metals produced in the lifetime of the massive stars, $t \sim$40 Myr. For that time-span, using the metal yields calculated by Meynet & Maeder (2002), Tenorio-Tagle et al. (2005) showed that the metallicity of the combined stellar winds remains at a value of $\sim$0.5 $Z_\odot$ from the start of the SB, up to a $t = 3$ Myr evolutionary time, and then rapidly grows to $\sim$15 $Z_\odot$ at $t \approx 7$ Myr, decreasing gradually to $\sim$3 $Z_\odot$ at $t \approx 20$ Myr.

The metal ejection efficiency has two limiting cases: $\xi_z \to 0$, when all the metallic gas injected by the nuclear starburst is kept in the galaxy disk, and $\xi_z \to 1$, when all the metallic gas processed in the burst is expelled from the galaxy. Galaxies with $\xi_z \to 1$ would be metal poor, while the IGM around them should be metal rich. On the other hand, metallic gas injected from the SBs region with $v_g < v_{\rm esc}$ is going to return to the galactic plane, and the ISM of such galaxies will be contaminated with the metals produced in the nuclear starburst.

3.2. *Disk contamination measures*

As mentioned above, bound gas ejected by the SSCs will return to the galactic disk, either close to the center if it never reached a high altitude, or spread to large galactocentric radii if it did. This mechanism is of course a continuum, and "high" or "low" altitude are just relative terms. To quantify the contamination of the disk by material originated in the SSCs we will consider as 'high altitude' a distance of at least 3 times the scale height of the disk, H.

One can define a new parameter, the fraction of bound gas (that is inside a cylinder of radius $R_{\rm max}$ and with velocity less than the escape velocity) that reaches at least an altitude of $3H$:

$$\chi_b \equiv \frac{M_{{\rm ej},3H}}{M_g}\,, \tag{13}$$