Abstract.
We show a grid of multiphase models whose results are valid for any spiral galaxy, using as input the luminosity or the rotation velocity and the morphological type, measured by the classical index T from 1 to 10.

1. Introduction
A large number of numerical chemical evolution models has been developed, in order to relax the I.R.A. (Instantaneous Recycling Approximation) used in the first analytical models (Tinsley, 1980; Clayton, 1984). Different hypotheses about initial conditions, and Star Formation Rate (SFR) and Initial Mass Function (IMF) laws have been assumed. Most of them include a gas infall onto the disk, since the observed radial gradient of abundances in spiral disks (Milky Way Galaxy –MWG– among them), can not be explained by a closed box model. Most of works have only been applied to MWG. Exception to this is our chemical multiphase model, which we also used for a sample of external spirals (Mollá et al. 1996; 1999). On the other hand, most of models being numerical, results are shown in a graphical way, making difficult their possible use for the scientific community not directly involved in the chemical evolution field.

We have computed a grid of chemical multiphase evolution models, which allow to compare galaxy observations with theoretical models for a large range of possibilities in luminosities and morphological types and whose results will be available for the astronomical community.
2. The Multiphase Model Description and Previous Results

We assume a spherical protogalaxy with a gas mass which collapses to fall in the equatorial plane by forming the disk as a secondary structure. The infall rate of gas from a halo region to the disk is proportional to a parameter \( f \). The sphere is divided into concentric cylindrical regions 1 kpc wide, with a \textit{halo} and a \textit{disk} region. Stars form out in the halo, by a Schmidt law with \( n = 1.5 \) and a proportionality factor \( K \). In the disk stars form in two steps: molecular clouds form from the diffuse gas by a Schmidt law, \( n = 1.5 \), with a proportionality factor \( \mu \); then cloud-cloud collisions produce stars by a \textit{spontaneous} process, at a rate proportional to a parameter \( h \). Moreover a \textit{stimulated} star formation process, proportional to a parameter \( a \), is assumed, by the interaction of massive stars with surrounding molecular clouds.

The model for the Solar Neighborhood –SN– (Ferrini et al. 1992) allowed to estimate the values of parameters \( f, K, \mu, H \) and \( a \) in this region, in reproducing a large number of observational constraints. Then the model was applied to the whole galactic disk in Ferrini et al. (1994), where we calculated the radial variation of parameters through the use of process efficiencies (\( \epsilon \)'s). These \( \epsilon \)'s were calibrated from the SN model and assumed to remain constant for the whole MWG. Resulting radial distributions are in agreement with data, in particular for diffuse and molecular gas densities.

The infall rate \( f \) for other spirals was calculated (Mollá et al. 1996; 1999) from the collapse timescale \( \tau_0 \). By knowing that it depends on the total mass (Gallagher, Hunter & Tutukov 1984) it may be computed from its value for the MWG model, \( \tau_\odot \), and the ratio between total masses: \( \tau_0 = \tau_\odot (M_\odot, gal/M_{9, MWG})^{-1/2} \). The efficiencies \( \epsilon_\mu \) and \( \epsilon_h \) changed according the Hubble type, \( T \). The two efficiencies \( \epsilon_K \) and \( \epsilon_a \) are constant for all haloes and galaxies. Results show good agreement with observed radial distributions of abundances, gas and star formation rates and with other observed correlations.

3. The Generalization of the Model

The Universal Rotation Curve from Persic, Salucci & Steel (1996), an analytical expression of \( V(R) \) for any luminosity, measured by \( \lambda = L/L_0 \), is used to calculate radial distributions of total mass \( M(R) \), and the mass included in each one of our cylinders \( \Delta M(R) \). The latter is shown in Fig.1a). The infall rate parameter \( f \) is inversely proportional to the collapse time scale, \( \tau_0 \), calculated with the same expression of the above section. Values are shown in Fig.1b) vs the total mass of each galaxy. Points are the values used in our previous models of spiral galaxies.
Figure 1. Model input and parameters. a) $\Delta M(R)$ for each $\lambda = L/L_0$ ($L_0 = 2.5 \times 10^9 L_\odot$). b) $\tau_0$ vs the total mass of each galaxy in logarithmic scale. The dot symbols are the values used in previous models. c) Efficiencies $\epsilon_\mu$ vs the morphological type $T$. d) The same for efficiencies $\epsilon_h$.

Efficiencies $\epsilon_\mu$ and $\epsilon_h$ to form molecular clouds and stars, respectively, are assumed to be dependent on the morphological type $T$, as we show in Fig1.c) and 1d). A fit to the values used in previous works has been done and included in the model, allowing to obtain 10 different types of galaxies for each radial distribution of mass $\Delta M(R)$.

4. Preliminary Results and Conclusions

A biparametric grid of models is obtained for types 1 to 10 and different luminosities. Among the radial distributions predicted for these theoretical galaxies, we show the ones corresponding to the oxygen abundances in Fig.2. A radial gradient for the intermediate types ($7 < T < 4$) appears for all luminosities, larger for the less massive galaxies. The earlier types $T \leq 5$ reach soon a saturation level, flattening the gradient, while the latest ones ($T \geq 8$) have not developed a gradient in a Hubble time, although abundances are $12 + \log (O/H) \sim 7.5-8$.

This important result reproduces the observations and it solves the ap-
parent inconsistency of the largest gradients appearing in late type galaxies while some irregulars shows no gradient at all, with very uniform abundances (see Molla & Roy, 1999 and references therein). The explanation resides in the stimulated star formation which does not depend either on the Hubble type or on the galactocentric radius, maintaining a minimum level of star formation constant for all regions. Possible correlations must be still analyze, and will be presented in the future.

References

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