CHEMICAL EVOLUTION OF THE MAGELLANIC CLOUDS

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1. INTRODUCTION. According to the stochastic self propagating star formation theory (SSPSF, Gerola and Seiden, 1978), the star formation process in galaxies changes from a fluctuating but continuous mode to a bursting one, when the size of the system becomes relatively small ($R \lesssim 3$Kpc). Then, due to its size, the LMC should be a system undergoing fluctuating but continuous star formation activity, whereas the SMC should be in the region between continuous and bursting modes (Gerola et al. 1980). In order to look better inside this problem a model of chemical evolution of the two Clouds, which takes into account the stochastic star formation rate, has been built. For the SMC both the continuous and the bursting modes of star formation have been considered. As a result we find that the different chemical histories of the two Clouds may be related to the fact that SMC has undergone several bursts of star formation (between 50 and 60), while a continuous star formation activity was present in LMC.

2. MODEL RESULTS. The basic assumptions of the model are: single zone description and complete instantaneous mixing of the gas; delay in the metal enrichment of the ISM due to stellar lifetimes (leading to a drop of the instantaneous recycling approximation); detailed description of the variation over the galactic lifetime of a set of elements (H, He, C+O, Si+Fe), due to stellar nucleosynthesis, stellar mass ejection and inflow of primordial gas. The basic equations of the temporal variation of the fractionary mass of each element can be found in Matteucci and Chiosi, 1983.
The stellar birthrate function is defined as: $Bm(t)=B(t)\varphi(m)$, where $\varphi(m)$ (the initial mass function) is assumed the same for the two Clouds ($x=1.35$ for $m \leq 2m_{\odot}$ and $x=2.0$ for $m > 2m_{\odot}$, Lequeux 1979). The rate of star formation is given by: $B(t)=\nu\langle\eta\rangle G(t)$, where: $\langle\eta\rangle$ is the average fractionary number of cells undergoing star formation during the galactic lifetime, as predicted by SSPSF theory; $G(t)$ is the current fractionary mass of gas; $\nu$ is an efficiency parameter (i.e. the rate of star formation per unit mass of gas involved in the star formation process). The value of $\nu$ has been estimated



*S. van den Bergh and K. S. de Boer (eds.), Structure and Evolution of the Magellanic Clouds, 95–96.*


https://doi.org/10.1017/S0074180900040018 Published online by Cambridge University Press

by means of observational properties of the two Clouds,(see Matteucci and Chiosi,1983),under the assumption that a fluctuating but continuous mode of star formation had taken place in both the galaxies. We find that a value of $\nu = 4\cdot10^{-9}$yrs fairly fits the main features of SMC,whereas $\nu = 10\cdot10^{-9}$yrs reproduces those of LMC. The different value of $\nu$ weakens the universality of the SSPSF theory, since other physical mechanisms have to be invoked to explain the increase of $\nu$ from SMC to LMC.

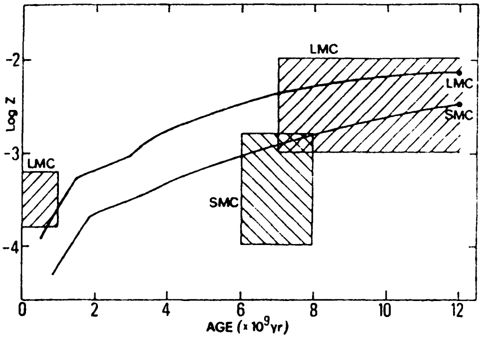


Fig.1-Metallicity vs. age relationships for the MC. The shaded area visualizes the data of Barbaro(1982).

Anyhow,another possible explanation exists. Since SMC lies in the transition region,according to the SSPSF theory,the number of star forming events occurred in it is not well known. If SMC has undergone several bursts during its lifetime,$\langle\eta\rangle$ should be different from the assumed value of 0.03. Then,starting from $\nu' = \nu\langle\eta\rangle = 0.12\cdot10^{-9}$yrs,which well fits the features of SMC, and keeping $\nu = 10\cdot10^{-9}$ yrs as in LMC,a value of $\langle\eta\rangle = 0.012$ is derived. At this stage we can predict how many star forming events have taken place in SMC,due to the functional relationship between $\langle\eta\rangle$ and the total number of bursts Nb. Assuming the bursts to have a triangular shape with a typical duration of $50\cdot10^{6}$yrs and maximum intensity of 0.1,according to the SSPSF theory,we find Nb$\simeq$58. In this way,the rate of star formation per unit mass of gas involved in the star forming process is constant for the two Clouds($\nu = 10\cdot10^{-9}$yrs),and their main features can be reproduced by varying only the number of star formation events. Figure 1 shows the Z vs. age relationship for clusters in the MC,accordingly to Barbaro(1982).The metal abundances in the present ISM, as given by Peimbert and Torres-Peimbert(1977),are also indicated for comparison(full dots). See that,although many uncertainties exist in both theory and observations,the theoretical relationships from our models seem to fit fairly well the observational trends. As a conclusion, the SSPSF theory is able to reproduce the main observed properties of the Magellanic Clouds,withouth invoking other physical processes as it seems the case for dwarf irregular galaxies(Matteucci and Chiosi,1983).

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https://doi.org/10.1017/S0074180900040018 Published online by Cambridge University Press